COSTS OF OPERATING A COMPUTERIZED TRADING SYSTEM FOR SLAUGHTER LAMBS

James R. Russell and Wayne D. Purcell

Recent interest in thin markets and rapidly advancing technology has focused increased attention on electronic marketing (Henderson et al.; Russell; Schlei), with particular emphasis on computerized trading systems. Decreased costs of access and increased reliability of computer hardware, software, and communication systems are increasing the likelihood that computerized trading systems will be a viable marketing alternative.

There are a number of factors that determine the feasibility of a computerized trading system, but the cost of a proposed or developing electronic system is important. Feasibility may hinge on the capacity of a system to be cost efficient at all levels in the marketing continuum. Theoretically, a potential trader would be expected to participate in a new electronic marketing system if he expected the discounted value of increased price, more efficient pricing, or other benefits to exceed any expected increases in costs. It may be difficult to get a potential trader to visualize price benefits, but relatively easy to show reduced marketing costs. Even after implementation of a new system, it is more difficult to demonstrate price benefits. Price benefits are linked to value-related dimensions of the product, while costs are typically computed on a per-unit basis. Not all participants will agree on the value of an individual commodity of a specific grade and quality and on the correct price. Everyone can see reduced costs.

To date, little work has been completed on the cost of computerized marketing. There are a few preliminary estimates (Baldwin; Chieruzzi; Glazener; Helmreich and Epperson). Other authors have made passing references to cost in more broadly defined papers (Ethridge; Henderson and Baldwin). This article will focus on the cost of operating the computerized trading system utilized by Eastern Lamb Producers Cooperative, Inc. (ELPC).[1] ELPC uses the services of National Electronic Marketing Association, Inc. (NEMA) to conduct the computerized portion of the sale.[2]

BACKGROUND

ELPC currently sells approximately 30,000 slaughter lambs per year from the states of Kentucky, North Carolina, Ohio, Virginia, Vermont, and West Virginia. Holder gives details of the organization and its pooling and grading procedures. ELPC sold lambs for member producers via a teleauction from 1971–79 before switching to NEMA's computerized system in 1980. NEMA's computerized auction is a remote-access time-sharing system. NEMA buys computer time from Computer Sciences Corporation (CSC) and uses CSC's communication network. Users access the system with their computer terminal via a local telephone number or via in-WATT service. ELPC uses a progressive auction. Many of the specific procedures and parameters used by ELPC affect cost and therefore limit generalizations to other organizations.

VARIABLE COSTS

The costs of 32 ELPC computerized slaughter lamb sales, held from November 1980 to August 1981, were examined.[3] Table 1 gives the means, standard deviations, and ranges of factors related to variable costs, which includes communication and computer procesing charges. Cost functions estimated from this data base should not be projected significantly beyond the ranges of the above variables if estimates are to remain reasonably reliable.

Table 2 presents calculations from original data, provided by NEMA, for the variable cost per head, standard deviation of variable cost per head, number of terminals per sale, and number of sales by size of sale. Although the relationship is not perfect, the data in Table 2 exemplify the importance of sale size on per-unit variable costs. Auctions which sold 1,200–1,399 head had an average variable cost per head of $.1025—a decrease of over 57 percent when compared to sales

James R. Russell is an Assistant Professor in the Department of Agricultural Economics, Oklahoma State University. Wayne D. Purcell is a Professor of Agricultural Economics, Virginia Tech.

Department of Agricultural Economics Paper A. E. 8284, Oklahoma State University.

[1] The system is also used by the Corn Belt Lamb Electronic Market (CBLEM), which currently sells slaughter lambs from the states of Kansas, Iowa, Minnesota, Missouri, Oklahoma, and Wisconsin.

[2] NEMA is a corporation organized to promote and provide electronic services to its user members. NEMA was first organized as EMA,—Electronic Marketing Association, with grants provided by USDA-AMS in cooperation with Virginia Tech and the Virginia Department of Agriculture and Consumer Services. NEMA is now a subsidiary of the National Livestock Producers Cooperative.

[3] Earlier sales were excluded because the conversion of software from the ALADDIN language to the FORTRAN language was incomplete.

Table 1. Mean, Standard Deviation, and Range of Variables Related to Variable Cost of the Computerized Slaughter Lamb Auction Utilized by Eastern Lamb Producers Coop, Inc. (November, 1980–August, 1981).

Variable	Mean	Standard Deviation	Range
Total Variable Cost Per Auction (in dollars)	101.6	38.5	33.7-194.7
Total Variable Cost Per Head Per Auction (in cents)	15.9	7.6	8.0-43.0
Length of Sale (in minutes)	13.6	7.1	5.5-29.0
Number of Computer Terminals Used Per Auction	8.0	2.3	4.0-12.0
Number of Lots Per Sale	2.9	1.2	1.0-5.0
Number of Head Offered Per Sale	739.8	367.2	238.0-1,383.0

Table 2. Variable Cost Per Head, Standard Deviation, Average Number of Terminals Per Sale, and Number of Sales by Size of Sale for Eastern Lamb Producers Coop's Computerized Slaughter Lamb Sales (November, 1980–August, 1981).

Size of Sale (head)	Variable Cost Per Head (cents)	Standard Deviation of Cost Per Head (cents)	Number of Terminals Per Sale	Number of Sales
200-399	24.33	9.90	6.8	9
400-599	13.20	2.39	7.0	5
600-799	13.50	0.71	9.0	2
800-999	12.67	2.33	8.8	6
1,000-1,199	13.33	1.86	9.5	6
1,200-1,399	10.25	2.63	8.3	4

involving 200–399 head. This result holds in spite of the fact the larger sales averaged 1.5 more terminals per sale.[4]

Models estimating the total variable factor cost function (models 2–5) for ELPC's computerized slaughter lamb sales are given in Table 3. Since none of the functions include fixed costs, the population regression lines should pass through the origins.[5] Incorporating this a priori knowledge, the intercept terms in the models were restricted to zero. This allows fewer parameters to be estimated and reduced the variance on the remaining restricted estimators (Kmenta). However, coefficients of determination (R^2) are lowered (Kmenta), and the sum of the residuals is no longer required to be zero (Draper and Smith) because of the restrictions. The models possess the usual desirable properties, assuming that the intercept is truly zero (Kmenta).

Table 3. Models Estimating Total Factor Cost (Model 1) and Total Variable Cost (Models 2 thru 5) for Eastern Lamb Producers Coop's Computerized Slaughter Lamb Sales (November, 1980–August, 1981).[a]

Model	Number of Computer Terminals Per Sale (Ter)	Length of Sale in Minutes (T)	Number of Lots Offered Per Sale (L)	L^2	Number of Head Offered Per Sale (H)	H^2	R^2
1	3.24*** (2.55)	1.32** (1.93)	19.51*** (5.62)				.966
2			46.07*** (8.64)	-3.39*** (-2.49)			.955
3					.197*** (8.50)	-.000068*** (-3.12)	.943
4			33.15*** (23.25)				.946
5					.127*** (19.56)		.925

[a] Numbers in parentheses are t statistics. One, two, and three asterisks (*) indicate 10%, 5%, and 1% levels of significance, respectively. All models estimate cost in dollars per sale.

Model 1, Table 3, estimates total variable factor cost as a function of the number of computer terminals logged on per sale (TER), the length of the sale in minutes (T), and the number of lots offered per sale (L). CSC charges NEMA for computer services based on both the amount of computer time and number of computer processing units used. Computer time used during a sale is a function of the length of the sale in minutes and the number of terminals logged on. The number of computer-processing units utilized is a function of the number of terminals logged on and the number of lots offered per sale.

Total variable cost functions are estimated for models 2–5 in Table 3. The quadratic models of 2 and 3 are preferred to the linear models of 4 and 5 because of the declining marginal costs associated with the quadratic models.[6] However, the choice between models 2 and 3 is dependent on whether one considers lots sold (L) or head sold (H) as the output of an electronic marketing system.

The distribution of cost savings (or increases) among participants in the marketing continuum is important. Table 4 displays the distribution of variable costs per head related to ELPC's computerized slaughter lamb auction. Producer charges are the same as the teleauction sales being conducted prior to the computerized auction. The $1.50 per head is 0 to $.50 per head higher than conventional marketing methods, depending on the particular auction market considered. ELPC pays $.25 per head for the use of NEMA's computerized trading system. The manager of ELPC has indicated that the $.25 per head is lower than the charge for the teleauc-

[4] The Corn Belt Lamb Auction began using NEMA's computerized system during October 1981. Early sales have averaged approximately 2,000 head, required 8–10 minutes, with 7–8 terminals logged on. Although the bills for computer charges have not been received, the variable cost per head for these sales will approximate $0.05.

[5] Some may argue that because of sampling problems, positioning of the functions, etc. the models should include intercepts. Models 1 thru 5 were also fitted with intercepts. Only models 4 and 5 possessed intercepts which were significantly different from 0 at the 10-percent level. Since models 1–3 are the preferred models in Table 3, it was felt that sufficient reason existed to argue that the models without intercepts are the correct specification.

[6] The quadratic form of the cost functions may be interpreted as a Taylor series approximation of the true cost curves over the intervals from 0 to 6.79 lots or from 0 to 1,448.5 head. If the sales were of sufficient length, the function should eventually reach the point where cost increases at an increasing rate.

Table 4. Distribution of Variable Costs Per Head Related to the Computerized Lamb Auction Utilized by Eastern Lamb Producers Coop., Inc.

Source	Individual Lamb Producers	Lamb Buyers
	------- Dollars --------	
Grading	.30	
Charge by Local Auction Markets	.75	
ELPC Charges[a]	.45	
Total Variable Cost Attributable to Computerized Auction	1.50	0[b]

[a] From this $.45 per head, ELPC paid NEMA $.25 per head for handling the computerized sales. NEMA then paid Computer Sciences Corporation an average of $.16 per head for computer time.
[b] Costs are confined to negligible paper and electricity used by the computer terminals.

tion sales. NEMA's variable costs, as mentioned earlier, have averaged $.16 per head for ELPC's sales. Finally, the lamb buyers have no variable costs other than the negligible paper and electricity used by the computer terminals. Hence, the computerized trading system has resulted in the same variable cost for producers, the same or lower for ELPC, and the same for the lamb buyers.

FIXED COSTS

Fixed costs for the computerized system are relatively easy to determine, but difficult to allocate to the appropriate activity. NEMA's capital investments have been made with the assumption that future growth will occur. A large proportion of the time of NEMA's current personnel is spent trying to ensure that growth will occur through promotion, training, and modifying current programs to better fit the needs of potential users. As such, NEMA's fixed expenses should be allocated to future potential rather than to current volumes. Should this expected potential later fail to develop, adjustments will be made by curtailing some of the fixed expenses.

Table 5 lists NEMA's annual fixed expenses. A portion could be appropriately allocated to ELPC's slaughter lamb programs. The cost of the software was not included, since the software was developed by CSC for NEMA at no cost to NEMA.[7] Similarly, the funds from the USDA-AMS grants were not included, since they involved public funds at no cost to NEMA.[8] Naturally, an organization developing a new computerized system would need to consider the development costs excluded from these estimates.

Since all of the fixed resources could be utilized at least 40 hours per week, it is possible to allocate fixed expenses to a specific activity by the proportion of time

Table 5. Allocation of Annual Fixed Expenses of National Electronic Marketing Association, Inc. to Eastern Lamb Producers Coop's [ELPC] Computerized Slaughter Lamb Sales Under Alternative Scenarios.

Type of Expense	Annual Costs	Fixed Cost Per Sale Under Alternative Allocations (40 sales per year) 1%	3%	5%
	---------- Dollars ----------			
Manager's Salary[a]	21,000.00	5.25	15.75	26.25
Secretary's Salary[a]	10,400.00	2.60	7.80	13.00
Benefits/Taxes on Salaries[a]	4,396.00	1.10	3.30	5.50
Office Rent[a]	1,980.00	.50	1.49	2.48
Electricity[a]	381.36	.10	.29	.48
Phone (3 lines)[a]	1,080.00	.27	.81	1.35
Paper and Supplies[a]	120.00	.03	.09	.15
Depreciation:[a]				
T1745 Terminals $1,500 ÷ 5)	300.00	.08	.22	.38
ADM103A Terminals	150.00	.04	.11	.19
Office Furniture & Equipment ($2,000 ÷ 10)	200.00	.05	.15	.25
Service on Terminals[b]	236.71	.06	.18	.30
Program Storage Cost[a]	6,000.00	1.50	4.50	7.50
TOTALS	46,244.07	11.56	34.68	57.81

[a] Estimated from interviews with NEMA personnel and from NEMA records.
[b] Obtained from Chieruzzi's analysis.

the resources are utilized in that particular activity. Assuming 40 sales per year, the alternative allocations of 1 percent, 3 percent, and 5 percent would correspond to NEMA utilizing its fixed resources for 31.2, 62.4, and 93.6 minutes for each ELPC sale. Considering the fact that ELPC sales have averaged 13.6 minutes in length, a 3-percent allocation (corresponding to 62.4 minutes per sale) is realistic. The additional 48.8 minutes (62.4 − 13.6) are used for data entry, telephone calls, education, and so forth.

Hence, even at the relatively low current annual sales volume, fixed costs on a per-unit basis appear to be reasonable. Low (3 percent) allocations of NEMA's fixed expenses to ELPC slaughter lamb sales is dependent on full utilization of NEMA's fixed resources. Should lower sustained levels of resource utilization appear likely, services currently provided to member organizations by NEMA could be reduced, thus lowering fixed expenses. In the limit, if ELPC were the only member organization, NEMA could be dissolved with ELPC handling the computerized sales. All of NEMA's fixed expenses could be eliminated, except program storage, which could be greatly reduced.[9]

TOTAL COSTS

Assuming that 3 percent of NEMA's fixed resources are allocated to ELPC lamb sales, the system total cost (TC) and average cost (AC) functions would be represented by equations (1) and (2):

$$(1) \quad TC = 34.68 + .197\,H - .000068H^2,$$
$$(2) \quad AC = .197 + 34.68\,(1/H) - .000068H.$$

[7] Computer Sciences Corporation personnel have estimated this development cost at approximately $60,000.
[8] The portion of the USDA-AMS grant applicable to the slaughter lamb program is $13,850. Assuming a depreciable life of 10 years and assuming ELPC provided 20 percent of the lambs offered through NEMA, inclusion of the federal funds would add $277 per year to be allocated to ELPC slaughter lamb sales.
[9] At the present time, this scenario appears unlikely.

A graphical representation of cost curves generated from equations (1) and (2) is depicted in Figure 1. As with the variable cost curves, the quadratic nature of TC invalidates the function for sale sizes greater than 1448.5 head.[10] As the figures and functions demonstrate, the average cost per head ranges from $0.55 for a sale with 100 head to $0.12 for a sale with 1,448 head. Using extended teleauction costs of $0.265 per head, the computerized sales become cost effective at a 372-head sale.[11] Based on the fitted equation, ELPC's average sale size of 740 head generated an average total cost of $0.19 per head. The $0.19 per head is $0.075 per head lower than estimated teleauction costs.

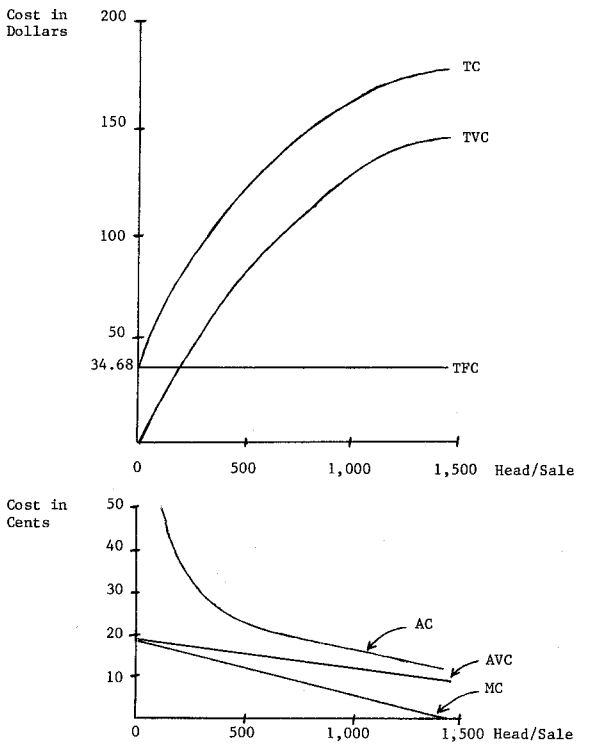

Figure 1. Total, Average and Marginal Cost Curves for Eastern Lamb Producer Coop's Computerized Slaughter Lamb Sales [November, 1980–August, 1981].

Table 6 summarizes the distribution of per-head costs for ELPC slaughter lamb sales. Assuming 40 sales per year, with an average of 740 head per sale, individual lamb producers pay $1.50 per head. ELPC, EMA, and lamb buyers incur costs of $0.27, $0.20, and $0.12 per head, respectively. It should be remembered that these costs are based on historical data (November, 1980 – August, 1981) and may not be indicative of future costs. Per-head terminal costs can be reduced by using the terminals for other sales and in providing other services.[12] Auction charges can be reduced by increasing the number of head offered per lot and per sale. Increased bargaining power may lead to reduced grading and auction market fees.

Table 6. Distribution of Per Head Costs Related to ELPC's Computerized Slaughter Lamb Sales (November, 1980–August, 1981).[a]

Source	Individual Lamb Producers	ELPC	EMA	Lamb Buyers[b]
	---------- Dollars ----------			
Variable:				
Grading	.30			
Charge by local auction markets	.75			
ELPC fees	.45			
EMA fees		.25		
Computer charges			.16	
Fixed:				
3% Allocation of EMA's Annual Fixed Expenses			.04	
Terminal Depreciation and Service[c]	____	.02	___	.12
TOTALS	1.50	.27	.20	.12

[a] Based on 40 sales per year, 740 head per sale.
[b] Assumes buyer purchases 1/8 of lambs offered.
[c] Assumes terminals are used 100% for ELPC sales.

IMPLICATIONS

The costs associated with the ELPC's computer sales compare favorably to previous ELPC teleauction sales. The analysis demonstrates that remote-access time-sharing computerized systems can compete with teleauctions. This conclusion is strengthened by the fact that other lamb teleauctions (CBLEM, OK Sheep Expansion, etc.) have switched to NEMA's computerized sales.

Inferences across other commodities, systems, or market participants are not justified unless *a priori* information suggests that sales conditions are similar. Average lot size, number of head offered per sale, and number of buyers participating are important factors determining per-head cost of a computerized system. Future research should examine costs across systems, across commodities, and by participants. The future of electronic marketing may hinge on its ability to be cost competitive when compared to more traditional marketing channels.

[10] Again, the quadratic form of the cost function may be considered a Taylor series approximation of the true cost curve for the interval 0 to 1,448.5 head. If the sales were of sufficient length, the function should eventually reach the point where cost increases at an increasing rate.

[11] Roy Meek, manager of ELPC, estimates previous teleauction costs at $0.30 per head. Preliminary analysis performed by the authors before the introduction of the computerized sales calculated teleauction costs of $0.265 per head (using engineering methods of cost estimation). In an unpublished work, Russell used historical data to estimate the communication cost of OK Sheep Expansion's slaughter lamb teleauction (an Oklahoma organization using similar procedures) at $0.22 per head. Because the engineering estimate was objective and considered ELPC procedures, it was deemed to be the most appropriate. Since a high proportion of teleauction costs is generated by getting all of the buyers on the phone, teleauction costs are less sensitive to volume offered than computerized trading.

[12] Many of the buyers are using their terminals for both ELPC and CBLEM sales. ELPC is also using its terminal for accounting purposes. Both of these would reduce the "terminal" charges used in previous cost estimates.

REFERENCES

Baldwin, D. "Slaughter Hogs." In *Proceedings National Symposium on Electronic Marketing of Agricultural Commodities,* edited by T. L. Sporleder, pp. 74.91, MP-1463. Texas A&M, 1980.

Chieruzzi, A. "A Cost Comparison of Computerized and Conventional Auction Marketing Systems for Slaughter Cattle." Master's thesis, Virginia Tech, 1980.

Draper, N. R., and H. Smith. *Applied Regression Analysis.* New York: Wiley, 1966.

Ethridge, D. E. "A Computerized Remote-Access Commodity Market: Telcot." *S. J. Agr. Econ.* 10(1978):177–82.

Glazener, G. "The Economic Feasibility of Computerized Spot Markets for Feeder Cattle in Texas." Master's thesis, Texas A&M University, 1979.

Helmreich, D. P., and J. E. Epperson. *Settings for an Agricultural Multicommodity Computerized Exchange.* University of Georgia, College of Agr. Exp. Sta. Res. Bull. 273, 1982.

Henderson, D. R., and E. D. Baldwin. "Marketing slaughter Hogs by Remote-Access Computerized Auction: Theory and Empirical Results." Paper presented at the annual meeting of the Amer. Agr. Econ. Assoc., July, 1981.

Henderson, D. R., L. F. Schrader, T. L. Sporleder, and E. D. Baldwin. "The Economic Feasibility and Impacts of Electronic Markets: A Tentative Appraisal." Paper presented at joint annual meeting of Amer. Agr. Econ. Assoc. and Western Agr. Econ. Assoc., July 1979.

Holder, D. L. "Benefits of a Sheep and Lamb Teleauction in Virginia and West Virginia." Paper presented at the annual meeting of the Southern Agr. Econ. Assoc., February, 1979.

Kmenta, J. *Elements of Econometrics.* New York: Macmillan, 1971.

Russell, J. R. "Electronic Marketing: Conceptual, Theoretical, and Empirical Considerations." Ph.D. dissertation, Virginia Tech, 1981.

Schlei, B. L. "Electronic Trading of Agricultural Products." Paper presented to the Commonwealth Club, San Francisco, July, 1980.