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PRICE DISCOVERY DIMENSIONS OF COMPUTERIZED ELECTRONIC TRADING IN A THIN MARKET

by

Shannon R. Hamm, Wayne D. Purcell,
and Michael A. Hudson*

* The authors are, respectively, Agricultural Economist with AMS, USDA, Professor, and Research Associate in the Agricultural Economics Department at Virginia Tech, Blacksburg, Virginia.

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(ABSTRACT)

Bidding behavior on computerized electronic sales of slaughter lambs differs by buyer type. The number of different buyers bidding is important to the amount of price improvement during any auction. The most important finding is that two buyers will compete aggressively because of anonymous bidding.

PRICE DISCOVERY DIMENSIONS OF COMPUTERIZED ELECTRONIC TRADING IN A THIN MARKET

Writings about the efficiency and equity of price discovery processes in thin markets have comprised a significant part of the literature on pricing in recent years. There is concern over the capacity of thin markets, especially those markets with a limited number of buyers, to price the product accurately relative to an intrinsic value based on product yield at the final level of consumption. There is concern that the level of pricing efficiency is reduced by problems of pricing accuracy and low levels of buyer competition. And there is direct concern over the level of price competition in a market arena when there are no more than 3-4 buyers (Hayenga).

Electronic markets have the capacity to centralize the price discovery process. The product can move directly from the farm or feedlot to the buyer. Procurement costs to the buyer are reduced and, assuming adequate levels of competition, at least part of the these decreased costs will be passed to producers in the form of higher prices. There is developing evidence that these theoretical benefits do in fact materialize (Russell and Purcell).

Little attention has been paid to how electronic marketing affects the level and nature of competition in the bidding arena. This article describes the bidding behavior of buyers on a computerized electronic marketing system for slaughter lambs and analyzes the implications to price discovery and price competition in a thin market.

Background

Slaughter lambs are produced in relatively small numbers in widely dispersed geographical areas. The producers of lambs in Virginia, North Carolina, West Virginia, Tennessee, and Kentucky fit this pattern. Final buyers for lambs in this multi-state production area are found in New England, the North Central area (especially Detroit), and in Canada. A high-cost assembly problem has existed in this market for many years. Packers were relying on a single or limited number of order buyers to assemble the lambs as early as the 1950's. Producer dissatisfaction with the thin market which developed led to the development of a producer organization, Eastern Lamb Producers Cooperative (ELPC), which has operated out of Dublin, Virginia since 1970.

From 1971 to mid 1980, ELPC operated an electronic marketing system involving a conference telephone network. Buyers were accessed by phone, assigned a number to be used in bidding, and lambs were described and sold by auction over the telephone. During 1980, ELPC adopted a computerized electronic system which had been developed under the auspices of a matching fund project involving the Agricultural Marketing Services (AMS) of the USDA, Virginia Department of Agriculture and Consumer Services (VDACS) and Virginia Polytechnic Institute and State University (VPI). A non-profit organization, Eastern Electronic Marketing Association (EEMA), was organized to conduct the sales during a test period. In October of 1982, the system was acquired by National Livestock Producers Association and now operates as the National Electronic Marketing Association (NEMA) in the private sector.

Procedurally, producers consign lambs to ELPC. The lambs are described using estimated grade and weight and assigned a lot number. Buyers access the system via a computer terminal and request a printout with the descriptions and locations of the lots about an hour before the time of the sale. At the control office, ELPC and NEMA personnel arrange the lots in a sale order.

When the sale begins, the first lot is offered, by lot number, at a starting price set by ELPC and NEMA personnel. If no bid is received within 20 seconds (CP)[1], the price drops $1.00 per cwt. This process is continued until a bid is received or until the lot is cancelled by control personnel. When a bid is received, the system then reverts to an ascending auction. The high bid is displayed on each buyer's terminal, updated every 5 seconds (CP), and 30 seconds (CP) are allowed for a new bid before a sale is declared. The time remaining for bids is updated every 5 seconds (CP) on each buyer's terminal. To raise the high bid displayed on his or her terminal by $.25 (CP), the buyer simply presses the escape key on the terminal. An asterisk is displayed on the terminal of the buyer with the high bid. All bidding is therefore anonymous and no buyer can know either the identity or number of other bidders. Only the successful bidder knows who bought each lot. The buyer picks up the lambs at various collection points where the lambs are weighed and officially graded by a qualified grader.

Price Discovery Processes

The objectives of this analysis were:

1. To describe the bidding strategies employed by buyers on the computerized system for slaughter lambs;

2. To model and measure the impact of anonymous bidding on the price level and/or price improvement during computerized electronic marketing sales; and

3. To infer the implications of computerized electronic systems to the level of price competition realized in thin markets for slaughter lambs.

Price and related data were analyzed for 153 lots of lambs across the time period from April 1981 to September 1983. The price series was tested for trend and for the existence of a statistically significant seasonal pattern. Both trend and a seasonal pattern were found to be present, and the price data were transformed to correct for the trend and seasonal components.[2]

Table 1 defines variables employed in the analysis. The final price for each lot (DETCPL) proved difficult to analyze when used as a dependent series. There are many forces outside the electronic market which exert an influence on price. Prices of competing products, changes in the mix (of grades) of lambs moving to market, the regional distribution of supply, and many other forces influence price.[3] Given these conceptual problems, emphasis was placed on analysis of the price improvement variable (PDIFF).

Table 2 summarizes basic characteristics of the bidding behavior exhibited by buyers. In general, the smaller buyers (typically producers) entered the bidding process earlier, bid

TABLE 1. Definitions of Variables Employed in Describing and Analyzing Bidding Behavior in a Computerized Electronic System for Slaughter Lambs.

Variable	Definition
FTIME	The number of seconds that a buyer waits before entering the sale.
STIME	The number of seconds that a buyer waits before bidding the second time.
DETCPL	The detrended electronic sale price of slaughter lambs ($/cwt).
PDIFF	The amount by which the price improves between the first and last bid ($/cwt).
BTIMDIFF	The number of seconds that bidders wait between bids.
NUMBUYRS	The number of different buyers bidding during a sale.
NUMBIDS	The number of bids during a sale across all bidders.
FCOUP	The number of couplings which occurs at the end of the auction.
COUP	The number of couplings at intermediate points in the auction. (Equals FCOUP when the only couplings are at the end of the auction).
HEAD	Number of lambs in the lot being auctioned.

TABLE 2. Descriptive Measures of the Bidding Actions of Different Buyer Types During Computerized Electronic Sales for Slaughter Lambs.

Bidding Variables	Small Buyers			Packer/Order Buyers		
	Mean	Min	Max	Mean	Min	Max
FTIME[a]	16.25	0.00	108.00	17.00	0.00	54.00
STIME[a]	29.08	0.00	65.00	16.40	0.00	46.00
DETCPL[b]	60.36	49.75	75.00	59.68	45.50	75.75
PDIFF[a]	1.78	0.00	5.75	2.11	0.00	7.75
BTIMDIFF[a]	8.46	0.00	25.00	11.15	0.00	25.00
NUMBUYRS	2.55	0.00	6.00	2.61	1.00	6.00
NUMBIDS	7.84	1.00	21.00	9.06	1.00	26.00

[a] Seconds
[b] Dollars per cwt.

more times per lot, but were less successful in buying lambs than the larger buyers (order buyers and packers). The smaller bidders are typically looking for arbitrage opportunities and will tend to buy only if they can buy at relatively low prices. The small buyers were successful bidders on 38 of the 153 lots.

Measures of the relationships between observable dimensions of the bidding process and price level or price improvement are shown in correlations in Table 3. Significance levels are shown in ( )'s. The positive relationship to the number of different buyers bidding (NUMBUYRS) was expected. The relationship between the overall measure average bid time and price or price improvement was not highly significant.

Table 4 provides more detailed measures of the relationship between PDIFF and the "bid time" variable. The classes employed in the analysis were defined as follows: C1, 0 to 3 seconds; C2, 4 to 6 seconds; C3, 7 to 9 seconds; C4, 10 to 12 seconds; C5, 13 to 15 seconds; and C6, 16 to 18 seconds. Class C4, for example, contains those sales where the average wait time was between 10 to 12 seconds inclusive. PDIFF was regressed on all classes except C4 to estimate differences across classes. All coefficients were negative with C5 or the 13 to 15 second interval, occurring in 17 sales, showing a significantly lower PDIFF measure. These results question the need for a "wait period" as long as 30 seconds.

In a conceptual sense, the most important difference between the computerized electronic market and other types of markets is the anonymity of the buyers. In conference telephone sales,

TABLE 3. Correlations Between Selected Measures of the Bidding Process, Price Level (DETCPL), and Price Improvement(PDIFF).

Variable	Correlation DETCPL	PDIFF
NUMBIDS	0.06082 (0.45670)	--- ---
NUMBUYRS	0.21747 (0.00710)	0.44889 (0.00010)
BTIMDIFF	-0.11150 (0.71400)	0.12063 (0.13750)
HEAD	0.08450 (0.30070)	0.20425 (0.01160)
COUP	0.13084 (0.10690)	0.61502 (0.00010)
FCOUP	0.12845 (0.11360)	0.60895 (0.00010)

TABLE 4. Relationship Between Average Bid Wait Time (BTIMDIFF) and Price Improvement (PDIFF).

Class(seconds)	Coefficient	P-Value[a]	Number Sales
C1(0-3)	-1.910	0.0001	7
C2(4-6)	-0.265	0.5751	7
C3(7-9)	-0.099	0.6474	68
C4(10-12)			51
C5(13-15)	-0.765	0.0209	17
C6(16-18)	-0.319	0.6471	3

[a] Significance level.

buyer numbers are often assigned at random for each sale in an attempt to maintain anonymity. But the buyers over such systems typically number 10 or less, and participants become adept at recognizing voices. Without anonymity, the buyer(s) known to dominate past sales can become the "price leader(s)". Other buyers watch to see where the buying strength is, and may be reluctant to interfere with the early interaction between two or more strong buyers.

To model the influence of the anonymity feature, the concept of a "coupling" was introduced. To illustrate, assume the bidding sequence for a particular lot of lambs was A, D, C, A, C, A, C, A, F, A, C, A, C, A, C, A where A, D, etc. refer to different buyers. The fifth bid, by buyer C, constitutes a "comeback" bid against buyer A after the CA pair (bids 3 and 4) has been recorded. Bids 5, 6, 7, and 8 are thus "comeback" bids involving the same pair of buyers, C and A. This sequence constitutes four couplings (the COUP variable). Buyers C and A record five couplings at the end of the sale (the FCOUP variable).

It was hypothesized that the existence of couplings, especially final couplings, would be associated with higher prices and/or larger increments of price improvement. Indirectly, the hypothesis is that the bidding lasts longer when couplings are present. Conceptually, it could be argued that no two buyers would continue bidding against each other, especially at the end of the bidding for a particular lot, if they were the only two bidders still active and if they knew they were the only two. Some form of collusion would be expected, suggesting a long string of couplings at the end of the bidding would be most

unlikely. Examination of the 153 lots sold reveals final couplings (FCOUP) occurred in 83 lots with the final coupling variable exhibiting a range of 1 to 18 and a mean of 2.37 across the 83 lots.

Table 3 provided measures of the correlation between price, price improvement, and the two coupling variables. There is support for the hypothesis that price levels, and price improvement during the bidding, will be greater when bidding is anonymous in the computerized system.

Table 5 provides additional empirical support for the importance of the anonymity feature. Using a 0-1 approach (D1 signifies the existence of couplings), the means for DETCPL and PDIFF with and without couplings were tested. The significance level for DETCPL is 0.0792, 0.0001 for PDIFF. Both DETCPL and PDIFF tend to be greater when couplings occur. These results suggest that the level of competition in a thin market can be enhanced by anonymous bidding procedures.

Table 6 reports more thorough investigation of the FCOUP variable. The maximum number of final couplings observed was 18. The FCOUP variable was divided into 3 classes: D1, 1-6 couplings; D2, 7-12 couplings; and D3, 13-18 couplings. The statistical measures between DETCPL and the FCOUP classes are not strong, but the measures involving PDIFF are extremely strong. When interpreting these results, it is important to keep in mind that more couplings tend to be associated with more bids, and PDIFF must increase if the number of bids is higher. But combining the information from Tables 5 and 6 suggests there are more bids, and

TABLE 5. Test For the Difference Between the Means of DETCPL and PDIFF Price Improvement When Couplings Occur, N = 153.

VARIABLE	0-1 Value	MEAN	Std. Err. of Mean	p-values for EQUAL Variances	p-values for UNEQUAL Variances
DETCPL	0	50.204	0.4210	0.0792	
DETCPL	1	51.258	0.4359		
PDIFF	0	1.561	0.1158		0.0001
PDIFF	1	2.481	0.1420		

TABLE 6. Tests For the Difference Between the Means of DETCPL and PDIFF when a Final Coupling Occurs Within Three Ranges, N = 153.

MODEL	Variable	Class D1	D2	D3	MEAN	MIN	MAX	Std. Err. of Mean	p-values for EQUAL	UNEQUAL Variances
1	PDIFF	0	0	0	1.98	0.00	7.75	0.1479		0.4325
	PDIFF	1	0	0	2.13	0.50	5.75	0.1238		
2	PDIFF	0	0	0	1.93	0.00	7.75	0.1045		0.0001
	PDIFF	0	1	0	3.00	2.00	5.00	0.2079		
3	PDIFF	0	0	0	1.93	0.00	5.75	0.0887	0.0001	
	PDIFF	0	0	1	5.15	3.75	7.25	0.6828		
4	DETCPL	0	0	0	50.57	38.86	62.12	0.4103	0.4834	
	DETCPL	1	0	0	51.00	39.37	59.13	0.4622		
5	DETCPL	0	0	0	50.64	38.86	62.12	0.3238	0.2823	
	DETCPL	0	1	0	51.72	43.91	55.48	0.9426		
6	DETCPL	0	0	0	50.74	38.86	62.12	0.3111	0.7677	
	DETCPL	0	0	1	51.25	43.92	55.48	1.9500		

more price improvement, because two buyers do continue to bid back and forth at the end of the sale. Further support for the importance of anonymous bidding emerges from the fact that two variables, NUMBUYRS and FCOUP, explain over 50% of the variability in PDIFF (Equation 1):

$$(1) \quad PDIFF = 0.5147 + \underset{(10.344)}{0.19912}*FCOUP + \underset{(7.246)}{0.50105}*NUMBUYRS$$

ADJUSTED R-SQUARED = .5277
OBSERVATIONS = 153

The occurence of one final coupling is associated with a $.20 per cwt. increase in price improvement. The introduction of an added buyer who bids during the auction brings a $.50 per cwt. increase.

Conclusions

Bidding behavior on computerized electronic auctions for lambs is essentially consistent with the behavior in conventional markets. The most striking difference is the anonymous bidding processes. Across 153 auctions, two buyers often continued to compete aggressively at the end of the auctions, recording as many as 18 "comeback" bids when only two buyers remained. In a thin market characterized by only a limited number of buyers, the anonymity feature appears to improve the level of competition.

FOOTNOTES

1 The rotation CP will be used to indicate a controllable parameter which can be changed by NEMA control personnel prior to the starting of a sale.

2 A linear trend regression model with seasonal dummy variables was fitted to the data. The residuals from this model were added to the mean of the series to generate a detrended series.

3 Location and size of lot would also appear to be factors, but there was no noticeably significant correlation between either of these variables and final price.

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