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Experimental Simulation of Public Information Impacts on Price Discovery and Marketing Efficiency in the Fed Cattle Market

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Federal budgetary pressures raise questions regarding the importance of public market information. This study assesses the impact on price discovery and production efficiency of reducing public price and quantity information. The amount and type of information provided to Fed Cattle Market Simulator (FCMS) participants was varied by periodically withholding current and weekly summary information according to a predetermined experimental design. Results show that reducing information increased price variance and decreased marketing efficiency; that is, more cattle were delivered at weights deviating from 1,150 pounds—the least-cost marketing weight in the simulator. These factors, which increase costs, make the industry less competitive.

Key words: efficiency, experimental economics, fed cattle, price discovery, public information

Introduction

In determining a transaction price, both buyers and sellers depend on information about prices paid by others. In agricultural markets, much of the price and quantity information available to decision makers is collected and disseminated by government agencies. The amount of government-provided information was reduced throughout the 1980s and 1990s, and continues to be reduced as government agencies look for ways to cut their budgets in the ongoing effort to reduce federal spending. If public resources are to be efficiently allocated, it is vital to know the potential impact of such reductions on the affected markets.

The fed cattle market—like most agricultural markets—receives considerable information through government reporting.¹ Furthermore, this market has undergone tremendous change in the last 15 years. The market share of the four largest meat-packing firms increased significantly over this time period. In 1980, the four largest meat packers accounted for 35.7% of the total steer and heifer slaughter. By 1995, their

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¹The term "government reporting" as used here encompasses the collection and compilation of data as well as its dissemination in government reports.

share had risen to 79.3% (Grain Inspection, Packers, and Stockyards Administration). In addition, cattle are increasingly traded on a forward contract basis. Forward contracts and marketing agreements were virtually nonexistent in 1980, but in 1996, 19.1% of the cattle slaughtered by the four largest firms were traded using these instruments (Grain Inspection, Packers, and Stockyards Administration). Structural changes related to the number and size of firms in the market and behavioral changes related to the increased use of contracting and other forms of nonprice coordination may have affected the role of information in this market. Information asymmetries may exist due to larger firms having more resources to use in obtaining private information. Larger firms also may have more information simply due to the greater volume of their own transactions. Furthermore, as forward contracting increases, less information is revealed through cash market transactions.

In light of these facts and the limited funding for government collection and reporting of information, a determination of the importance of public information to the efficient functioning of this market is warranted. The debate over mandatory versus continued voluntary price reporting provides additional incentive to investigate the role of information in the fed cattle market. The unwillingness of some firms to report prices has led to concerns that price reports are not representative of the market (Schroeder et al. 1997). Understanding the effect of insufficient public information on price discovery and marketing efficiency in the fed cattle market is critical if policy decisions related to government price reporting are to be made judiciously.

Policy makers are not the only ones interested in identifying the impacts of policy changes. In the fed cattle market, cattle feeders and meat packers would certainly like to know how price reporting changes may affect the market in which they operate. For example, will a reduction in the availability of public information result in a bargaining advantage for either packers or feeders? Will it lead to greater risk in the market due to increased price variability? Knowing the answers to such questions could help market participants develop strategies for dealing with any possible public information reductions.

This research seeks to improve policy decisions regarding the level of public price reporting in the fed cattle market by determining how reductions in information affect that market. Specifically, it is necessary to know the effect of reducing public price and quantity information on the level and variability of prices and on production efficiency in the fed cattle market. In pursuing these objectives, this study employs experimental simulation of the fed cattle market to obtain data which are then used in regression analysis.

Background and Theory

The ability of any market to function efficiently with respect to pricing depends in large part on the information available to market participants. Grossman and Stiglitz note that prices cannot perfectly reflect all available information, since information is costly. The fact that prices imperfectly reflect information represents the necessary compensation to economic agents who use resources to obtain it. Consequently, an increase in the quality of information or a decrease in its cost will increase the informational content of prices. Other authors note the link between information and pricing efficiency. For example, Stigler equates price dispersion with ignorance in the market.

He relates the level of price dispersion to search costs—that is, the cost to sellers of determining the bid prices of competitors and, what is more important, to buyers of surveying the offer prices of sellers. Devine and Marion characterize price dispersion as an imperfection in a market for a homogeneous product. They found that disseminating accurate retail price information reduced price dispersion among items at competing grocery stores and reduced the average price level in the market.

In agricultural markets, government reports traditionally have been the primary source of information concerning both prices and production. Though market alternatives to government reporting may exist, these alternatives may not have the same informational content as government reports (Carter and Galopin).

Irwin recently examined the value of one type of public information—situation and outlook programs. He found that given some reasonable assumptions, public situation and outlook information leads to increased social welfare by increasing the speed of convergence to equilibrium. Such public information increases the speed of convergence, he argues, by educating producers about the underlying economic model and economic conditions, and by collecting information less expensively than private firms. Moreover, Irwin hypothesizes that in markets characterized by imperfect information and/or asymmetric information, public information may force informed market participants to reveal more of their information through prices. This competitive impact of public information may be of particular importance in the imperfectly competitive fed cattle market.

While Irwin examines situation and outlook reports, many other authors have evaluated the informational content of government production and inventory reports. Colling, Irwin, and Zulauf found that nearby pork belly and live hog futures prices responded significantly to the U.S. Department of Agriculture's (USDA's) "Cold Storage Report" (CSR) release. Colling and Irwin note that unanticipated information in the USDA's "Hogs and Pigs Reports" (HPR) does affect the live hog futures market, but not enough to permit profitable trading based on that unanticipated information. In a similar study of the live cattle futures market, Grunewald, McNulty, and Biere found that the market also responds to unanticipated information in the "Cattle on Feed Report" (COF).

Additional studies have attempted to assess the informational content of government reports by observing the price impacts of report releases. Sumner and Mueller concluded that USDA harvest forecast announcements had a significant impact in corn and soybean futures markets. Milonas had previously obtained similar results looking at crop report impacts on corn, wheat, soybean oil, and soybean meal cash prices. Conversely, Patterson and Brorsen found little evidence that the "U.S. Exports Sales Report" provided any new information to the market.

All of these studies focused on production or inventory reports rather than price reports. In addition, with the exception of Milonas, they have examined futures market rather than cash market responses to public information. This study is unique in that it investigates how a cash market (the fed cattle market) responds to a reduction in public price information. For this reason, the results of previous studies provide limited insight into what results can be expected from this analysis. Market responses to government reports noted in several studies mentioned above indicate some impact on price discovery. It can be hypothesized that price dispersion (variance) should increase as public information is reduced, since participants are forced to make less informed

pricing decisions; however, previous studies provide little basis for hypothesizing price-level effects.

Fed Cattle Market Simulator Description, Experimental Design, and Data Collection

The Fed Cattle Market Simulator (FCMS) allows experimental simulation of the fed cattle market. Within this simulated market, the decisions made by one firm directly influence the subsequent behavior and performance of other firms and of the market as a whole. Market participants must make a series of marketing decisions (e.g., when and at what price to buy or sell cattle), and then react to the consequences of those decisions.

FCMS participants act as feedlot marketing managers and meat-packing procurement managers. Eight feedlot and four meat-packing teams, consisting of from two to four persons, buy and sell simulated pens of fed cattle. The number of feedlot and meat-packing teams is limited because the FCMS was not intended to represent a perfectly competitive market. Rather, it reflects the fed cattle market, that is, a few large cattle feeding firms and even fewer large meat-packing firms.

Participants experience increasing degrees of market complexity, beginning with cash trading only and progressing through the addition of forward contracting and a live cattle futures market. Forward contracts are defined as transactions which occur this week for delivery two or more trading periods in the future. Market price reports do not include these contract prices. Futures market contracts expire at eight trading-period intervals, consistent with the two-month intervals for live cattle contracts on the Chicago Mercantile Exchange (CME). Three contracts—a nearby and two distant—are open at all times. Because the futures contract is specifically designed for this simulated market, the basis is zero.

One week in the FCMS consists of an 8- to 12-minute cycle. During the first five to seven minutes of the cycle, feeders and packers negotiate prices and finalize trades. Transactions are conducted face-to-face, and decisions of participants largely determine the direction of market prices and the profitability of each feedlot and meat-packing team. Generally, about 40 trades occur each week. Each feedlot has a number of paper pens of cattle, each sheet of paper representing 100 steers on a show list. Prices are negotiated and sales occur for the range of available weights of show-list cattle, from 1,100 to 1,200 pounds in 25-pound increments. Completed transaction sheets are scanned into a computer for record keeping and analysis.

Throughout the trading period, market information is provided on two digital display bars. One display bar scrolls cash market information (trading volume and high-low prices) which is analogous to current market information available to fed cattle buyers and sellers from the USDA/Agricultural Marketing Service (USDA/AMS). The other display bar scrolls futures market information (trading volume and current prices for three futures market contracts) which is analogous to information available from the Chicago Mercantile Exchange.

The three- to five-minute period following trading is an information-processing period or “weekend” during which each team updates its show list, calculates breakeven prices, and formulates marketing strategy. For each period, the FCMS software provides an individual income statement for each team, as well as summary market information for

the preceding period. This summary information also resembles that available from USDA/AMS in the real-world fed cattle market.

The data used in this study were collected from the FCMS during an agricultural economics course which met weekly in 90-minute sessions during the spring 1996 semester at Oklahoma State University. FCMS-generated data have been used previously in research relating to price discovery in the fed cattle market by Ward et al. and by Dowty. The data for this experiment were collected in a manner similar to the method employed in those studies.

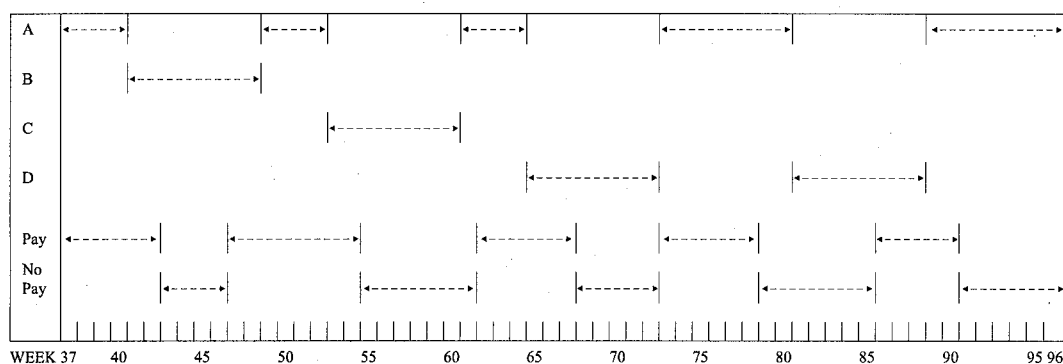
Trading in the FCMS course began in week 21. Feeder cattle weighing 700 pounds are placed on feed in week 1, gain 25 pounds per week, reach the show list in week 17, and weigh 1,150 pounds in week 19. By week 21, there are two weeks of historical market information generated from a predetermined base of trading activity which is programmed into the simulator. This base of information provides a starting point for market simulation by the participants.

Teams were rotated twice during a 12-week preliminary learning phase during which no data were collected for analysis. By week 33, final teams had been established. Data collection began at week 37 and continued through week 96—a simulation period of 60 weeks, or approximately one year and two months. Teams were rotated a final time after week 72, and trading ended after week 97.

Each FCMS transaction represents a data point. Each transaction involves the sale/purchase of one pen of 100 steers between one feedlot and one packer. During the 60 weeks of the experiment, 2,197 transactions occurred. For each of these, the following data were recorded: week traded, packer purchasing cattle, feedlot selling cattle, weight of cattle, transaction price, and type of transaction (cash or contract). In addition to these transactions data, weekly data also were recorded, including the breakeven price for 1,150 pound steers, boxed beef price at which meat would be sold that week, closing nearby futures price for the preceding week, previous week's fed cattle marketings, and number of pens of cattle on the show list at the beginning of each trading week.

In this experiment, the amount and type of cash market information available to FCMS participants was changed at predetermined intervals.² Two limited information alternatives were specified in addition to complete (or full) information and no (cash market) information. The complete information set consisted of current information displayed on a light bar at the front of the room as well as end-of-week summary information posted on the blackboard at the end of each trading session. Current information consisted of cash and contract trading volume and high-low cash prices during the week being traded. This information was sent directly to the light bar from a scanner used to record transactions. Summary information consisted of weekly average cash prices by weight groups, weekly average boxed beef price, weekly average feeder cattle price, cost of gain, and total volume of cattle traded the preceding week. One incomplete information set consisted only of summary information and another consisted only of current information.

² It is critical to note the distinction being made here between cash and futures market information. This experiment involved varying levels of cash market information. Futures market information was available to participants at all times. This is appropriate given the objective of this experiment, i.e., to assess the market impacts of *publicly funded* information such as that provided by USDA/AMS. Futures market information, while public in the sense of being widely available, would more appropriately be considered private information for the purpose of this study, since public funds are not used in its collection/dissemination.



Notes: A = full information periods, B = the removal of current information, C = the removal of summary information, and D = the removal of all cash market information. Teams were rotated at the end of week 72.

Figure 1. Experimental design for estimating public information impacts on the FCMS

One final note concerning the design of the experiment is in order. In accordance with experimental economics methods, participants were paid based on the profitability of their team (Friedman and Sunder). Performance was not evaluated continuously for payment purposes. Rather, participant performance was evaluated over randomly selected four- to eight-week intervals. Participants were notified of the beginning of these payment periods but not the duration. These periods were selected so as not to coincide exactly with an information alternative period. Figure 1 provides a comprehensive description of the experimental design.

The FCMS transactions data were used to determine what effects a reduction in public price information might have on the pricing and productive efficiency of the cash fed cattle market. Based on pricing efficiency theory, it was hypothesized that reducing the amount of information available to market participants would increase the within-week price variance due to less efficient price discovery. It was further hypothesized that the less informative prices would lead to less efficient production. In the FCMS, the least cost of production or optimal marketing weight for fed cattle is 1,150 pounds. Here, optimal is in a comparative static sense. That is, deviations from the optimal weight result in less efficient use of resources and reduced revenue for the industry compared with what would have been realized by marketing 1,150-pound cattle. Weight deviations from 1,150 pounds can therefore be used as a measure of the productive efficiency lost as a result of reduced information.

Finally, we hypothesized that reducing information would lead to lower fed cattle prices. This price-level change would favor packers. This hypothesis is based on the fact that demand for fed cattle is derived from the retail demand for beef. Packers, by virtue of their position in the market, are better able than feeders to assess this retail demand. In the absence of objective market reporting, this fact could give packers an information advantage over feeders.

Model Development

The transactions data from the FCMS are used to estimate three basic models. Two of these, a transactions price model and a price variability model, are based on other models employing FCMS data (Ward et al.; Dowty). A third model is developed to give further insight into any loss of productive efficiency resulting from incomplete information. In the FCMS, the least-cost or optimal weight for marketing fed cattle is 1,150 pounds. This fact quickly becomes obvious to feedlot and packer teams, as deviations from this optimal weight reduce their revenues. An ordered logit model with absolute weight deviations from 1,150 pounds as the dependent variable is estimated to determine the effect of limited information on participants' ability to efficiently market fed cattle.

The selection of variables for inclusion in the two price-related models is based on previous research into fed cattle transactions prices (Jones et al.; Schroeder et al. 1993; Ward 1981, 1982, 1992). Variables chosen from previous research to explain transactions prices for fed cattle included boxed beef prices, futures market prices, total show list, total weekly slaughter, potential profit/loss in the market, and individual buyers (packers) and sellers (feedlots). This previous research draws on the pricing process followed by packers in determining bid prices for fed cattle. Discussion here focuses on the variables specifically arising from this experiment, i.e., information-level dummy variables. Specifications of the three models are presented below. Complete variable definitions and their hypothesized signs are provided in table 1, and table 2 presents summary statistics for each of the continuous variables used in the models.

The price-level model is specified as:

$$(1) \quad \begin{aligned} PRC_{it} = & \beta_0 + \beta_1 BBP_{t-1} + \beta_2 FMP_{t-1} + \beta_3 TSL_{t-1} + \beta_4 TLST_{t-1} \\ & + \beta_5 PPL_t + \sum_{j=1}^8 \beta_{6j} FDLT_{ijt} + \sum_{j=1}^4 \beta_{7j} PACKER_{ijt} \\ & + \sum_{j=1}^n \beta_{8j} DINFO_{ijt} + \beta_9 DPAY_t + v_{it}, \end{aligned}$$

where PRC is the transaction price for one pen of fed cattle, BBP is the lagged boxed beef price, FMP is the lagged fed cattle futures market price, TSL is the total pens of fed cattle slaughtered, $TLST$ is the total number of pens on the show list, PPL is the potential profit or loss available to the industry, $FDLT$ denotes binary variables identifying the feedlot involved in the transaction, $PACKER$ denotes binary variables identifying the packer involved in the transaction, $DINFO$ denotes binary variables identifying information available at the time of the transaction, and $DPAY$ is a binary variable identifying payment/nonpayment periods.

The price variance model is written as:

$$(2) \quad \begin{aligned} VPRC_{it} = & \alpha_0 + \alpha_1 BBP_{t-1} + \alpha_2 FMP_{t-1} + \alpha_3 TSL_{t-1} + \alpha_4 TLST_{t-1} \\ & + \alpha_5 PPL_t + \sum_{j=1}^8 \alpha_{6j} FDLT_{ijt} + \sum_{j=1}^4 \alpha_{7j} PACKER_{ijt} \\ & + \sum_{j=1}^n \alpha_{8j} DINFO_{ijt} + \alpha_9 DPAY_t + \epsilon_{it}, \end{aligned}$$

where $VPRC$ is the natural log of \hat{v}_{it}^2 , the price variance estimate calculated from the price-level model; other variables are as defined previously.

The weight deviation model is specified as:

$$(3) \quad WTV_{it} = \gamma_0 + \gamma_1 BBP_{t-1} + \gamma_2 TSL_{t-1} + \gamma_3 TLST_{t-1} \\ + \gamma_4 PPL_t + \sum_{j=1}^8 \gamma_{5j} FDLT_{ijt} + \sum_{j=1}^4 \gamma_{6j} PACKER_{ijt} \\ + \sum_{j=1}^n \gamma_{7j} DINFO_{ijt} + \gamma_8 DPAY_t + u_{it},$$

where WTV is a categorical variable indicating absolute weight deviation from 1,150 pounds, and other variables are as defined previously.

Specification of a logit model is possible due to the fact that cattle weight in the FCMS is a discrete variable. Cattle enter the show list at 1,100 pounds. Cattle not sold gain 25 pounds each week until they reach a maximum weight of 1,225 pounds.³ Thus, absolute weight deviations from 1,150 pounds will always be 0, 25, 50, or 75 pounds. These values are represented by a categorical variable with values of 0, 1, 2, and 3 representing 0, 25, 50, and 75 pound deviations, respectively.

In the above models, t denotes the simulation week ($t = 36, 37, \dots, 96$), and i denotes transactions within a week ($i = 1, 2, \dots, n_t$). In order to estimate the models, base feedlot and packer dummy variables must be excluded from the estimation to avoid perfect collinearity. Feedlot 1 and packer 1 are used as bases. Subscripts in the above equations indicate that these are hierarchical models, since some variables have the same value for every transaction in a given week (i.e., they have no i subscript). In this experiment, numerous transactions occur each week. Goldstein points out that if modeling does not take into account the hierarchical nature of data, coefficient estimates may be inefficient, and standard errors, confidence intervals, and significance tests may be incorrect. To avoid the problems discussed by Goldstein, both price-level and variance models are specified as weighted random effects models (WREMs) for unbalanced panel data. The random effects model assumes two components for the error term. Thus the error term in equation (1) (v_{it}) can be represented as the sum of its components:

$$(4) \quad v_{it} = e_{it} + u_t.$$

The component e_{it} is the random variation in prices within each week, while the second component, u_t , is the random disturbance which is common to prices in each trading week. Error terms in equations (2) and (3) may be similarly represented.

Cross-sectional heteroskedasticity will be a problem with these data due to the nature of this experiment. It cannot be assumed that the variance of prices will be constant among the different information periods established in the experiment. Therefore, the natural log of the squared error terms from the basic random effects model is used as the dependent variable in an artificial regression against the independent variables. Predicted values from this regression are then used to generate weights which are

³ Feedlots can sell cattle weighing 1,200 pounds. Cattle unsold at the end of the trading week in which they weigh 1,200 pounds are automatically sold to an anonymous packer for a large discount in price, beginning at \$5/cwt below the average price that week. All cattle sold to the anonymous packer weigh 1,225 pounds.

applied to the models, resulting in weighted random effects models. All models are estimated using the LIMDEP 6.0 econometric program (Greene).

Two versions of each of the three models are specified using different definitions for the information period dummy variables. The most basic models represent all limited information periods with a single dummy variable. The comparison is thus between full and limited information, with no distinction made between the types of information withheld. The second specifications use two information dummy variables: one to represent the withholding of current (within-week) information, and another to represent the withholding of summary (end-of-week) information. The interaction of these two dummy variables represents periods when all information is withheld. Thus, under this definition of information periods, the following interaction term ($DINFO1 \times 2$) is included in each of the three model specifications:

$$(5) \quad DINFO1 \times 2_{3it} = (DINFO_{1it} \cdot DINFO_{2it}),$$

where $DINFO_{ijt}$ is as defined for equation (1).

Results and Discussion

Results from the price-level, price variance, and weight deviation models for the single-information period specification are given in table 3. Table 4 shows results from the models using separate dummy variables for current and summary information.

Price Discovery Variables

The results of the basic single-information period price model differ somewhat from previous studies using FCMS data. The effect on price of several of the independent variables seems to have been altered by the withholding of information. Boxed beef price previously has been found to have a strong relationship with fed cattle transactions prices (Ward et al.; Dowty). In this model, however, the coefficient on lagged boxed beef price, while still significant at the 0.01 level, is much smaller than in previous studies. The elasticity of fed cattle price with respect to boxed beef price at the means is 0.371. This compares to elasticities of 0.792 and 0.520, respectively, calculated using data from Ward et al. and from Dowty.

Boxed beef price was one element of the end-of-week summary information. When this information was withheld, boxed beef price information was not available at all to feedlots. Packers could determine this price from sales data on their profit-and-loss statements; however, it was not publicly available to them either. This reduced availability of boxed beef price may have weakened the relationship between boxed beef price and fed cattle transaction price.

On the other hand, the relationship between futures market price and transaction price is much stronger in this model than in previous studies. This relationship is stronger than that between boxed beef price and transaction price, and is not consistent with previous FCMS studies; however, given the design of the experiment, it may not be surprising. Futures market prices were never withheld from participants in this study. Therefore, they may have come to rely more heavily upon these prices than boxed

Table 3. Estimated Coefficients for Price-Level, Price Variance, and Weight Deviation Models Using Single-Information Period Dummy Variables

Variables	MODEL		
	Price-Level	Price Variance	Weight Deviation
BBP_{t-1}	0.235** (4.291)	-0.133** (-6.779)	-0.005 (-1.731)
FMP_{t-1}	0.436** (5.863)	0.010 (0.384)	N/A
TSL_{t-1}	0.082* (2.165)	-0.101** (-7.406)	-0.050** (-8.541)
$TLST_{t-1}$	-0.070** (-6.786)	0.011** (3.488)	0.039** (17.644)
PPL_t	-0.068 (-1.377)	0.048** (2.712)	-0.059** (-5.057)
$FDLT_2$	0.572** (15.888)	-0.803** (-4.324)	0.446* (2.500)
$FDLT_3$	0.375** (9.914)	-0.111 (-0.565)	0.963** (5.198)
$FDLT_4$	0.960** (25.529)	-0.657** (-3.355)	1.243** (6.353)
$FDLT_5$	0.678** (16.047)	-0.165 (-0.852)	1.946** (9.852)
$FDLT_6$	0.481** (11.948)	-0.107 (-0.529)	0.770** (3.812)
$FDLT_7$	0.813** (17.831)	-0.026 (-0.138)	1.150** (6.132)
$FDLT_8$	0.459** (9.879)	0.452* (2.317)	1.841** (9.656)
$PACKER_2$	0.152** (4.144)	-0.034 (-0.213)	-0.916** (-6.241)
$PACKER_3$	0.123** (3.755)	-0.340* (-2.429)	-0.029 (-0.242)
$PACKER_4$	0.404** (13.073)	-0.929** (-6.711)	-0.937** (-7.749)
$DINFO$	0.149 (0.433)	0.790** (7.051)	0.420** (4.162)
$DPAY$	1.193** (3.468)	-0.259* (-2.363)	0.058 (0.590)
Constant	19.576* (2.170)	17.521** (5.953)	N/A

Notes: Single and double asterisks (*) denote significance at the 0.05 and 0.01 levels, respectively. Numbers in parentheses are *t*-statistics. The price-level model measures the fed cattle transaction price level, the price variance model measures the estimated price variance calculated from the errors of the price model, and the weight deviation model measures the deviation of slaughter weights from 1,150 pounds.

Table 4. Estimated Coefficients for Price-Level, Price Variance, and Weight Deviation Models Using Information Type Variables with Interaction Term

Variables	MODEL		
	Price-Level	Price Variance	Weight Deviation
BBP_{t-1}	0.118* (2.085)	-0.076** (-3.680)	-0.007 (-1.639)
FMP_{t-1}	0.327** (4.141)	0.096** (3.611)	N/A
TSL_{t-1}	0.038 (1.031)	-0.047** (-3.515)	-0.046** (-7.664)
$TLST_{t-1}$	-0.063** (-4.491)	0.026** (5.849)	0.039** (10.610)
PPL_t	-0.091* (-2.005)	0.048** (2.971)	-0.054** (-4.261)
$FDLT_2$	0.500** (9.410)	-0.459** (-2.751)	0.449* (2.440)
$FDLT_3$	0.334** (5.595)	-0.080 (-0.457)	1.007** (5.349)
$FDLT_4$	0.765** (14.119)	-0.367* (-2.085)	1.266** (6.360)
$FDLT_5$	0.406** (6.602)	0.190 (1.094)	2.012** (9.889)
$FDLT_6$	0.463** (7.642)	-0.040 (-0.220)	0.758** (3.680)
$FDLT_7$	0.649** (9.545)	0.428* (2.499)	1.114** (5.731)
$FDLT_8$	0.383** (5.938)	0.071 (0.405)	1.858** (9.614)
$PACKER_2$	0.119* (2.192)	-0.155 (-1.083)	-0.857** (-5.829)
$PACKER_3$	0.112* (2.463)	-0.626** (-4.984)	-0.012 (-0.098)
$PACKER_4$	0.399** (8.851)	-0.597** (-4.795)	-0.891** (-7.265)
$DINFO_1$	-2.370** (-3.579)	0.899** (4.236)	0.026 (0.128)
$DINFO_2$	0.723 (1.135)	-0.557** (-2.652)	1.108** (6.393)
$DINFO1 \times 2$	2.521* (2.280)	0.808* (2.214)	-0.763* (-2.101)
$DPAY$	1.033** (3.300)	-0.485** (-4.743)	0.196 (1.884)
Constant	43.726** (3.953)	-0.222 (-0.061)	N/A

Notes: Single and double asterisks (*) denote significance at the 0.05 and 0.01 levels, respectively. Numbers in parentheses are *t*-statistics. See footnote to table 3 for model descriptions.

beef prices in their decision making. The elasticity of fed cattle price with respect to futures price is 0.441. In Ward et al. and in Dowty, this elasticity was 0.040 and 0.265, respectively.⁴

The coefficient describing the relationship between lagged total show list and transaction price is negative and significant. This is consistent with the findings of Ward et al. Not consistent with Ward et al. or Dowty is the positive and significant coefficient on lagged total slaughter; however, this coefficient estimate is not particularly robust. In the price-level model with two information period dummy variables, it is not significant at the 10% level.

The variation in transactions prices among feedlots is greater in this study than in others using similar data. Average prices received by feedlots in this study had a range of \$0.96/cwt. This compares with ranges of \$0.34/cwt and \$0.49/cwt for Ward et al. and Dowty, respectively. Apparently some feeders found more successful strategies than others for dealing with the lack of information. Average prices paid by packers in this study had a range of \$0.40/cwt. This range is consistent with Ward et al. and Dowty, who found ranges of \$0.38/cwt and \$0.48/cwt, respectively. In both the price-level and variance models estimated in this study, significant differences exist between payment and nonpayment periods. Price is significantly higher and variance significantly lower in payment periods. Dowty found no significant price-level differences between payment and nonpayment periods; however, he did find that variance was significantly higher in payment periods. Since pay periods enter this experiment in exactly the same manner as in Dowty's experiment, it is difficult to say why the results are not consistent. One logical explanation is that this difference results from the fact that entirely different participants were involved in each experiment.

Results of Price-Level Models

The impact of limited information on prices is revealed by the coefficient on the limited information dummy variable. In the basic price model, that coefficient is not significantly different from zero. The effect of limited information on price therefore cannot be determined when all limited information periods are aggregated. In the second specification of the price model in which three information dummy variables are used (current information, summary information, and interaction of the two), removal of the current trading information results in a \$2.37/cwt decline in fed cattle prices, while removal of both current and summary information results in a \$2.52/cwt increase in fed cattle prices. Removal of summary information alone has no significant impact on prices.

Results of the price-level models are difficult to interpret. Aggregating the limited information periods suggests that limiting public information does not affect the price level; however, a model specification using more narrowly defined information variables suggests that the price effects of limited information are important and that the effects can be positive or negative. Removing current information reduced prices (favoring

⁴ A price-level model containing interaction terms between the single-information period dummy variable and these two independent variables was estimated. Interaction terms were not significant. The fact that information was withheld would likely affect participants' reliance on the information, even when it was fully available. For this reason, interaction terms which compare the impacts of the variables between full and limited information periods will not provide a reliable test of the effect of limiting information. Thus, the models reported here do not contain interaction terms.

packers), whereas withholding all information increased prices (favoring feeders). It could be argued that limiting current information gives packers an advantage, since they are in a better position to assess the remaining summary information—particularly boxed beef price and total slaughter figures. With the removal of all information, however, neither packers nor feeders have an advantage. The increase in price simply reflects higher search costs incurred by packers and feeders who must now survey the market on their own to determine a purchase or sale price instead of simply relying on public information (Stigler). Clearly, these hypotheses are ad hoc and are offered only as a possible explanation for the results obtained here. Reasonable alternative hypotheses may argue for opposite results, particularly for the effects of removing all information. More research is needed to clearly define any price-level effects that may result from limiting information.

Results of Price Variance Models

The results of the price variance model are more conclusive than those of the price-level model when aggregated information periods are considered. The coefficient on the information dummy variable is positive and highly significant, indicating an increase in price variance due to limited information. This is consistent with hypothesized results.

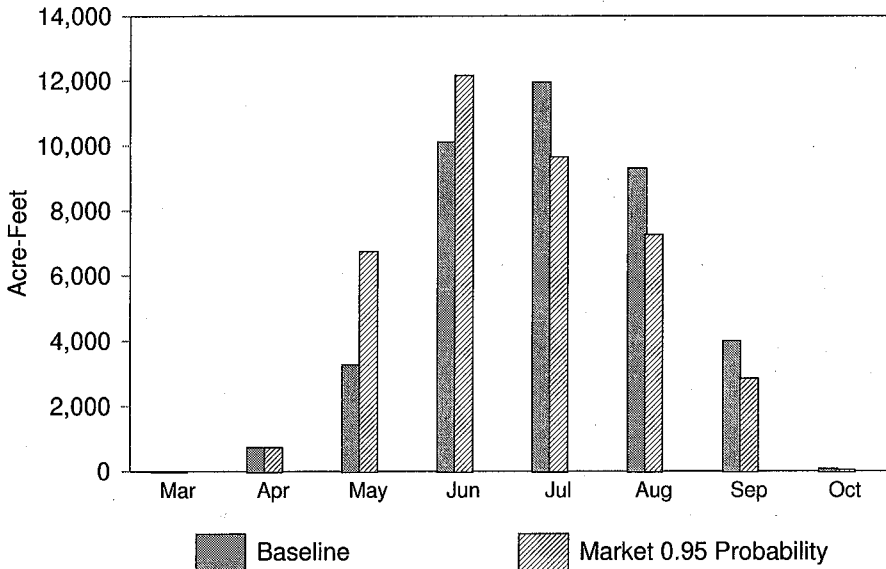
Results again become more ambiguous as efforts are made to determine effects of different types of information. In the second specification of the variance model, variance is increased by removal of current information and by removal of all information. Removal of summary information, however, decreases the variance of prices.

The price variance model provides stronger evidence of the importance of public information to the efficient functioning of the fed cattle market than does the price-level model. The aggregate information period model shows conclusively that limiting information increases price variance. Evidence further indicates that limiting current information definitely increases price variance; however, in the second model, limiting summary information decreases price variance. It is possible (perhaps even likely) that limiting summary information would lead to greater reliance on current price information. The resulting inertia could perhaps reduce price variability. This does not mean that limiting summary information would result in a more efficient market. On the contrary, if prices fail to quickly register changes occurring in underlying supply/demand conditions, the market would be much less efficient from a resource allocation standpoint in spite of the increased price stability.

Results of Pricing Efficiency Models

The effect of limiting information on the efficiency of the market is further examined using an ordered logit model with absolute weight deviations from the optimal 1,150-pound weight as the dependent variable. Results of the single-period model clearly indicate that limiting information results in marketing fed cattle at higher deviations from the least-cost weight. The second specification of the model indicates that these higher deviations are due to the removal of summary information.

Direct observation of FCMS transactions data from the experiment clearly shows that weight deviations were toward heavier and less cost-efficient weights. Just over half of



Note: Experimental data consist of 2,197 observations collected from simulator weeks 37–96. Base data consist of 2,682 observations collected from simulator weeks 30–101.

Figure 2. Comparison of FCMS fed cattle marketings by weight group: Experimental vs. base data

all fed cattle were marketed at 1,175 pounds. Only 6% were marketed at the least-cost, 1,150-pound weight. This is not at all consistent with results of previous use of the FCMS. Figure 2 compares the marketing weights obtained under this experiment with those obtained from the FCMS when no experiment was being conducted (Ward et al.). These results suggest that removing summary information results in lost efficiency regardless of the price variance effects of removing information.

The most significant result of the logit model is that the productive efficiency of the industry is reduced. Rausser, Perloff, and Zusman define productive efficiency as requiring that each firm produces in a manner that places the economy on its production possibilities frontier. Such is not the case when cattle are fed to heavier-than-optimal weights. Resources must be expended in cattle feeding which would be better utilized elsewhere. This represents a loss to society, not just to cattle feeders.

Summary and Conclusions

Data from the FCMS were used to assess the impact of limiting information on the efficiency of the fed cattle market. Results of the econometric models developed here indicate that the absence of current market information created inefficiencies. This was evidenced by increased transaction price variance and by the increased marketing of fed cattle at less industry-efficient weights as a consequence of the removal of information

from the market. The results of this experimental simulation also provide evidence that traditional, predictable economic relationships may be altered in the absence of public market information, thereby contributing to pricing inefficiencies. Differences in econometric results for this study compared with two previous studies suggest that removing and restoring different types and amounts of information into the FCMS altered the normal economic relationships between transactions prices and traditional variables—particularly boxed beef prices, but also futures market prices and fed cattle marketings to a lesser extent.

Looking only at price-level impacts, it is impossible to determine which sector of the industry stands to lose most from reduced market information. Price impacts were sometimes in the feeders' favor and sometimes in favor of the packers. Rather than focusing on who stands to gain or lose from reducing public information, the price variance and weight deviation models investigate factors which impact the competitiveness of the entire industry. Results of the price variance model indicate that reducing market information definitely increases price variance, and consequently, the price risk faced by all market participants. Results of the weight deviation model reveal that reducing public information leads to a loss in production efficiency—in other words, inefficient use of the resources employed in feeding cattle. This loss of efficiency would appear to have a greater impact on the profitability of feeders than on packers, since feeders bear the larger portion of the increased feeding costs.

Both of these factors—increased price risk and decreased production efficiency—raise costs in the fed cattle industry. Ginn and Purcell contend that higher costs due to price risk are in some measure responsible for beef's loss of market share to poultry and pork in the 1980s. While their hypothesis is only one of many possible explanations for beef's loss of market share, it does correctly emphasize that higher costs reduce the competitiveness of the beef industry. If reducing public information increases costs due to risk and production inefficiencies (as this research suggests it will), then feeders and packers may need to consider how any public policy change regarding public market information could affect the competitiveness of the entire beef industry rather than narrowly focusing on which side may gain a short-term advantage over the other.

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