Fed Cattle Market Simulator Applications

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Structural and behavioral changes and their implications for price discovery have been significant concerns for many in the beef industry for at least two decades. However, structural changes (e.g., increased consolidation and concentration) make it more difficult to access necessary data to conduct some types of relevant research related to these issues. Co-authors of this fact sheet began meeting regularly in 1989 to discuss common livestock marketing research and extension interests. At the time, all were in the Department of Agricultural Economics at Oklahoma State University (OSU). Two were new assistant professors and two had several years' experience addressing various livestock marketing issues. From those early meetings came a desire to develop an experimental research tool to address beef industry issues that might otherwise be difficult to address because of data limitations.

The result was the Fed Cattle Market Simulator (FCMS), quickly dubbed the "Packer-Feeder Game" by OSU students. Since then, the market simulator has been used in the threefold mission of the land grant university system; i.e., teaching, extension, and research. This fact sheet describes key elements of the market simulator and summarizes ten years' experience in its use for classroom teaching, extension education, and experimental simulation research.

Overview of the Simulator

Structural features of the FCMS can be found in various publications (e.g., Ward et al, 1996), so only essential components are reviewed here. From the outset, the focus of the FCMS was on the price discovery process for fed cattle. Participants, whether students or adult learners, work in teams of two to four persons. There are eight cattle feedlots and four meatpacking firms. The feedlot teams are instructed to market fed cattle profitably for the cattle owner, and meatpacking teams are instructed to purchase fed cattle profitably for the meatpacking firm. Half-sheets of paper, each representing 100 head of fed steers, are bought and sold by feedlot marketing managers and beefpacking buyers. Predetermined cattle supplies are programmed into the software written exclusively for the simulator. Supplies are meant to mimic the cattle inventory cycle of the beef industry.

Cattle are placed on feed at 700 pounds, gain 25 pounds per week, and are ready to be sold between 1100 and 1200 pounds. During that five-week marketing window, those weights of fed cattle comprise the "show list," and packer buyers approach feedlots to bid on cattle. Packers operate different size plants with different cost structures, just like packing firms in the real fed cattle market. Packers know how many pens of cattle they need to buy in order to operate their plant efficiently at the minimum-cost volume. Packer buyers begin with the boxed beef price and estimate their breakeven price before bidding. The boxed beef price is determined by the level of trading in the simulated market and is based on research at OSU.

Feedlot marketing managers estimate their breakeven prices and arrive at an offer or counter-offer price. Feedlot managers understand they can market cattle at 1150 pounds, where their breakeven price is lowest. However, there are times they may choose to market lighter or heavier cattle. If they market cattle at heavier weights, they are penalized for over-finishing the cattle. Packers, on the other hand, prefer heavier cattle because slaughter and fabrication costs are the same per head for cattle of any weight, but costs are less per pound for heavier animals.

Feedlot marketers and packing plant buyers negotiate the sale/purchase price for each pen of cattle. They use information supplied to the market, much like information from the Agricultural Marketing Service (AMS) and National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture (USDA). A simulated trading week of seven minutes corresponds to one week of real-world business by feedlots and packers. Teams can trade cattle with fixed-price forward contracts if they so choose. The simulator also has a futures market. Teams can buy or sell three futures market contracts; i.e., one nearby contract and two distant contracts. Thus, teams can hedge cattle sales and purchases, or trade cattle with basis forward contracts.

At times, feedlot and packer teams share profits available to the industry. However, at other times, feedlots and packers must share losses, depending largely on cattle inventory numbers. How well individual teams do depends in part on their negotiating skills. Teams are recognized or rewarded with traveling "trophies" for how profitable they are. The most profitable team each four weeks receives the prized team trophy, a well-worn loving cup for third place at the 1924

Montana State Horseshoe Tournament. The best supporting team (there are no losers!) receives a homemade "trophy," a gold-and-silver cow-chips-on-a-shingle (yes, real cow chips in a sealed plastic bag) for their assistance in supporting the most profitable team.

Development Highlights

The FCMS was first offered as a special problems course in the fall semester 1990 while the simulator was still in the early development phase. Its value in teaching economic concepts was evident immediately. The developers received a Higher Education Challenge Grant from USDA the following year, which enabled full development of the simulator. The grant provided funding for writing an upgraded version of the software and improving the hardware components. Both aspects contributed to the effectiveness of the simulator. A later grant from the Chicago Mercantile Exchange allowed us to enhance the futures market component of the simulator.

The first extension workshop using the simulator was with managers of Excel Corporation and Caprock Industries in 1992. The simulator was initially conceived as an experimental economics research tool, but it was used mostly in its early years for classroom teaching and extension education. Writing research papers from data generated by the simulator began in 1994. Another grant, this time from the Research Institute on Livestock Pricing, enabled the developers to conduct the first formal laboratory experiment with the FCMS in 1995. At this point, the simulator was being used in all three missions of the land grant university system.

Use in Classroom Teaching

The FCMS has been employed in two ways for classroom teaching. The first is as a stand-alone course. During the spring semester, a one-hour special problems course is offered. Students meet weekly in a 90-minute session and "play" the simulator. Over the semester-long period, they experience nearly 1 1/2 years worth of fed cattle marketing and buying, experiencing a complete cattle cycle. In the market simulator, several economic concepts are brought to life. Students live the concepts taught in other courses. Some of those economic concepts include market supply and demand, price determination and discovery, market dynamics, marketing strategies, and breakeven analysis.

The second classroom use is as a supplemental lab to other agricultural economics courses. Once or twice during the course, students meet for about three hours and use the simulator. The simulator both reinforces concepts taught in class and exposes students to concepts they will discuss in later classes or courses.

The FCMS is an experiential learning tool with which students experience a simulated fed cattle market. Figure 1 shows the experiential learning model for the simulator that was modified from the experiential learning literature (Kolb). Students begin each trading period with background information obtained from previous experience, education, and FCMS trading periods including previous market reports and financial reports. During each trading period, they obtain additional information from various market information reports provided to them and from their observation of market behavior by other participants. That combination of information enables them to develop a strategy that they try to implement in the current trading period. After the trading session ends, regardless whether or not the strategy was implemented as planned, whatever was learned becomes information for the next trading period.

A special evaluation of the experiential teaching method was conducted to compare what managerial skills students

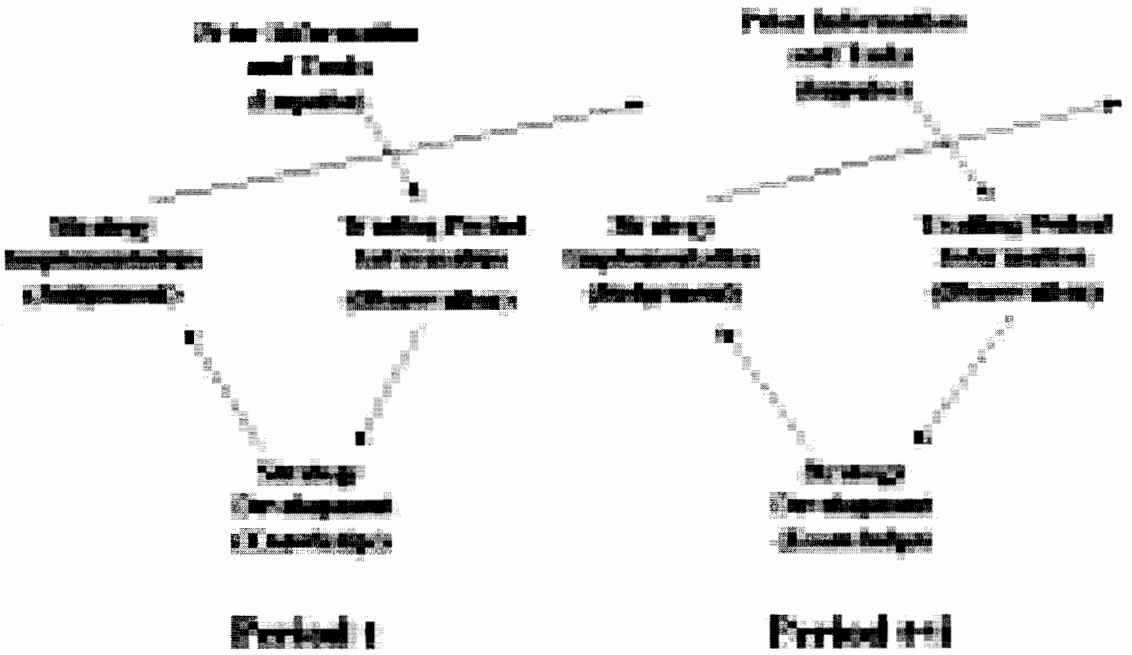

Figure 1. Kolb's experiential learning model

learn from the experiential method compared with other forms of teaching. The top six key skills taught by the experiential method are:

1. developing teamwork
2. adapting to new tasks
3. making decisions
4. assessing situations quickly
5. forecasting market conditions
6. analyzing data

In contrast, the only skill taught by both the lecture method and the experiential method is the one ranking sixth: analyzing data.

Six other universities have used the simulator for classroom teaching: Kansas State University, Iowa State University, University of Kentucky, Texas Christian University, South Dakota State University, and Colorado State University.

Use in Extension Education

Developers of the FCMS have conducted over 80 workshops featuring the simulator. Some are as short as four hours while others run for a day and a half or more. Longer sessions allow students to experience more of an entire cattle cycle and for that reason are the preferred delivery method. A key element of each workshop is a "debriefing" session of 30 minutes to an hour. Participants are asked what they learned or experienced, what strategies did or did not work as planned during the experiential workshop, and what they experienced that did or did not make economic sense to them. These discussions become "teachable moments" in a situation that parallels the real-world fed cattle market, allowing for discussion not only of what happened in the simulation, but why it happened as well.

Below is a breakdown of the workshops by type of audience:

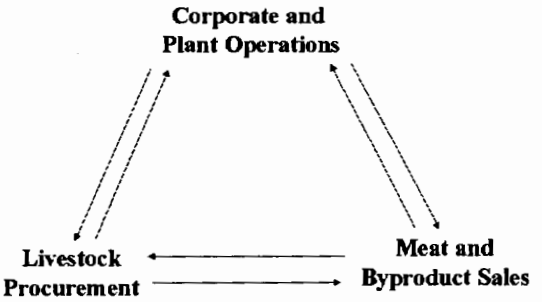

Figure 2. Three primary componets of a meatpacking firm and the two-way, interdependent learning

- Agricultural producers, 36—including six at National Cattlemen's Beef Association conventions
- Agribusiness managers, 18—including twelve with Excel Corporation
- Students and youth, 18—including six with the Noble Foundation's Agventure youth camp
- Extension and agricultural educators, 14—including extension agent training in seven states.

Excel Corporation, one of the three largest meatpacking firms in the U.S., has recognized the value of the market simulator in cross-training its employees. An annual workshop has become a regular part of Excel's employee training program. Figure 2 shows the three primary components of a meatpacking firm and the two-way, interdependent learning that occurs when employees from all components of Excel participate in a FCMS workshop.

Figure 3 maps the FCMS workshops since extension workshops began in 1992. Five other universities have conducted simulator extension education programs with the simulator; Kansas State University, Iowa State University,

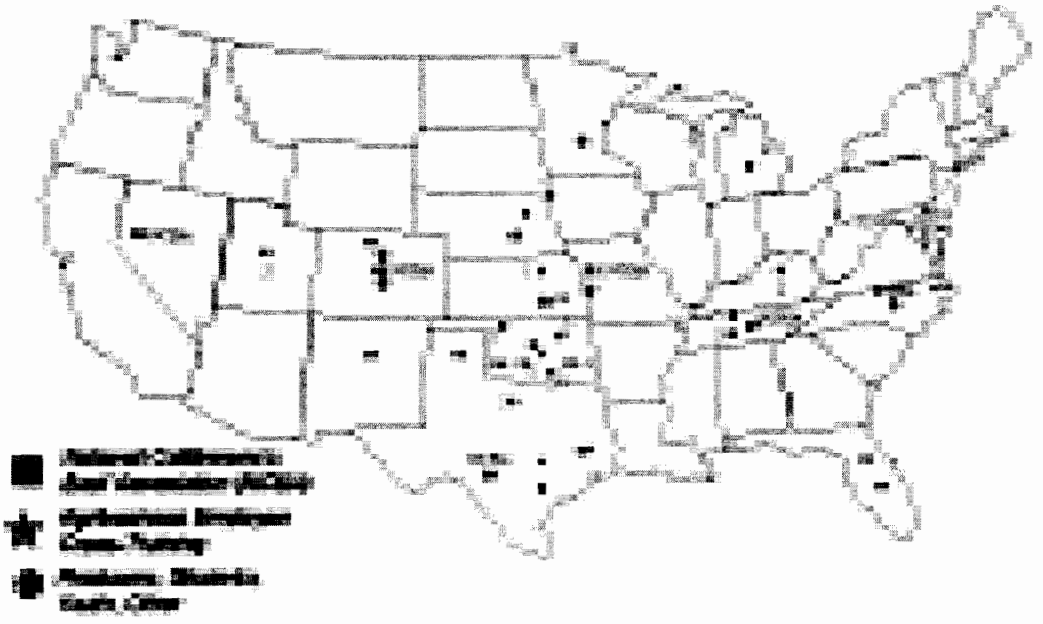

Figure 3. FCMS workshops since 1992

Texas A&M University, University of Kentucky, and Colorado State University.

Research Applications

Five formal experiments have been conducted with the market simulator. In addition, data generated by the simulator have been used to address four other related research questions. What follows is a synopsis of each research project in approximately the chronological order in which each was conducted. This brief summary is supplemented by Table 1, which identifies several elements of each study and includes key findings.

Formal Experiments—The first formal experiment involved estimating the impacts from imposing a marketing agreement onto the market (Ward et al, 1999). The largest packer agreed to purchase all fed cattle marketed by the two largest cattle feedlots. The agreement lasted 16 weeks and was replicated for another 16 weeks after an interval of having no formal agreement in place. The teams involved in the marketing agreement were instructed to share profit and loss statements and any other pertinent information in negotiating a profit-sharing price for cattle traded under the agreement.

The second experiment involved assessing the value of information in the price discovery process and the effect of reduced market information on marketing efficiency (Anderson et al, 1998b). Varying degrees of market information—i.e., within-week market information and end-of-week market summary information—were provided to feedlots and packers in a predetermined experimental design. Periods of reduced information varying in random lengths from four to eight weeks were interspersed with random periods of four to eight weeks in which normal amounts and kinds of information were available to the experimental market.

A third experiment examined impacts from imposing mergers between packer teams (Ward and Lee). This experiment was conducted with two large agribusiness firms: one, a large meatpacking firm, and the other, a large cattle feeding firm. In one case, the two smallest packers in the experimental market were merged; and in the other, the two largest packers were merged. In both cases, the mergers lasted ten weeks and were sandwiched between a ten-week pre-merger period and a ten-week post-merger or dissolution period. Merged teams were instructed to operate their meatpacking firms as a multi-plant (two-plant) operation.

Another experiment estimated the effects from imposing increasing levels of contracting between feeders and packers, from 0% to 88% (Lyford et al, 2001b). Feedlot teams were instructed to forward contract with specific packers using a formula price tied to the preceding week's cash market price. Each new level of contracting (0%, 25%, 50%, 62%, 75%, and 88%) lasted eight weeks.

Finally, an experiment at Colorado State University was designed to determine the pricing and marketing efficiency impacts from mandatory price reporting (Bastian, Koontz, and Menkhaus). Forward contract price information (volume and price range) was made available to participants during the 32 weeks for which data were collected. Prior to mandatory price reporting, AMS treated contracts as private transactions and did not collect or disclose contract price information. Normally reported information in the experimental market remained available to participants during the study period.

Other Research—When software for the simulator was written, the developers planned a means to capture and archive data generated by the simulator for later analysis. For example, data were collected from semester-long periods or workshops, but no formal experiment was conducted. Then the data were used to address industry issues.

Initially, data were used to compare price discovery in the FCMS with price discovery research using real-world data (Ward et al, 1996). A price discovery model was estimated with experimental market data and compared with similar models estimated with industry data.

Another study estimated economic gains from vertical coordination under alternative marketing and purchasing strategies (Anderson et al, 1998a). Total industry profit from alternative, simulated strategies was compared with profits generated by students in a semester-long class.

A procedure to evaluate the accuracy or precision of reported prices was demonstrated with data from the simulator (Ward and Choi). Data from a semester-long class were treated as the population of reported prices. Then various methods were employed to reduce the set of available reported prices, mimicking reductions in reported prices in the real-world market. The accuracy of reported prices from each sample was compared with the population of known reported prices.

FCMS data then enabled an examination of the relative negotiating strength of feeders and packers in the price discovery process under alternative supply conditions (Lyford et al, 2001a). An index of negotiating strength was developed, and a model explaining the variability in the index was estimated.

Evaluation Comments

Several observations can be made regarding the ten-year experience using the FCMS for teaching, extension, and research.

Teaching—For classroom teaching and extension education, the FCMS is extremely well-received and effective based on feedback from students and adult learners. Students and adults really like the hands-on, experiential learning nature of the simulator. "Lived" concepts and experiences stay with them far longer than textbook sections or lectures over the same concepts. Participants rate the market simulator highly on the basis of its ability to teach them about markets, market dynamics, and price discovery. Similarly, they rate the simulator highly for its realism compared with the real fed cattle market. Limitations for teaching involve the instructor time to set up and take down the equipment each class period.

Extension—The simulator also is effective in teaching adult learners. They, too, like the hands-on nature of the simulator and the realism compared with what they regularly experience in their real-world occupation. A limitation for extension workshops is the travel expense required to transport the specialized equipment to extension education sites. Also, too often for extension meetings, potential organizers and participants cannot conceive of a day-long or longer workshop led by two to four economists. As a result, too little time is allotted to FCMS workshops to achieve closer-to-optimal or maximum learning. Day-long producer workshops are desirable. They provide considerable learning time but usually do not require extended time away from home or the ranching operation.

Table 1. Summary of Research with the Fed Cattle Market Simulator.

Research Project	Data Source	Data Aggregation Observation	Trading Weeks	Findings
Fed cattle price discovery	OSU class, 1994	Transactions, 2,682	30-101	Generally consistent with previous research using real-world data. Emphasized the human element in market performance.
Marketing agreement: Impacts*	OSU class, 1995	Transactions, 2,770	40-114	Higher prices during agreement periods. Increased price variation during agreement periods.
Value of public market information *	OSU class, 1996	Transactions, 2,197	37-96	Increased price variation with reduced information. Reduced marketing efficiency (non-optimal weights) with reduced information.
Vertical coordination benefits	OSU class, 1995	Weeks, 70	29-98	Higher industry profits realized from non-price coordination strategies. Largest gains were related to following structural parameters of the market simulator.
Price reporting accuracy	OSU class, 1994	Transactions, 2,515	30-101	Little loss in price reporting accuracy as transaction numbers were reduced.
Meatpacking firm merger impacts *	Agribusiness workshops	Transactions, 1,062	41-70	Higher prices during merger periods. Relative profits were higher for the merged firms.
Negotiating strength of buyers/sellers	OSU classes, 1994-96	Transactions, 2,416***	32-100***	Negotiating strength favored feeders when supplies were light. Negotiating strength favored packers when supplies were heavy.
Extent of contracting *	OSU class, 1999	Weeks, 58	25-82	Higher contracting associated with lower prices. Higher contracting associated with inconsistently higher or lower price variation.
Mandatory price reporting impacts *	CSU** class, 2000	Transactions, 2,721	32 (total)	Additional information on forward contracting associated with lower, less variable cash prices and higher contract prices. Additional information associated with increased marketing efficiency (optimal weights).

* Formal experiment
** CSU is Colorado State University
*** Average of transactions and trading weeks for three semesters

Research—Two of the three observations from this experience are closely related. First, the FCMS is time intensive. Typically, for research experiments, workshops of 8-12 hours and classroom trading of 18-20 hours are required. Second, and related to that, the FCMS is resource intensive, not so much in dollar terms as in human resources. Classes and workshops typically require two instructors at a minimum and up to four instructors for intensive, two-day workshops. At least 24 participants are required (two people per team), and 36 are preferred. A practical maximum number of participants is 52 (four persons per team plus four futures market speculators).

Third, a frequently asked question about the market simulator pertains to the consistency of market performance across participating groups. A comparison of selected variables and models suggests relative consistency for the price determining variables; i.e., boxed beef prices and futures market prices, along with total show list inventory and weekly marketings. Coefficients for cash vs. contract trades also have been quite consistent. Less consistency was found for other variables such as the potential profit variable, weight variables, feedlot teams, and meatpacking firms. Since each group of participants differs somewhat from others, those differences would logically be reflected in the comparative performance of each team to the others, thus leading to differences in feedlot and meatpacking team coefficients and possibly among the weight variables.

Mean prices and volumes for three semester-long classes were compared. For the market as a whole (i.e., all packers), no significant differences were found, nor were any significant differences found for individual teams (Carlberg and Ward). Figure 4 shows average prices for three semester-long classes of the market simulator. The general movement of average prices is similar, but differences can be noted. Individual groups have an identity and can certainly influence short-run market performance, yet there appears to be reasonably consistent, long-run market performance across participating groups.

Future Plans

Changes are being made in the FCMS. One shortcoming of the experimental market has arisen because the real fed cattle market changed dramatically during the past decade. The industry has moved more rapidly than anticipated toward value-based pricing (typically called grid pricing). Consequently, efforts are underway to rewrite the FCMS software, changing the parameters of the simulator to encompass grid pricing. This simple-sounding modification is complicated by the fact that the software must incorporate within-pen carcass performance variability. Up to now, carcass characteristics were the same for each weight of cattle marketed. The new software is expected to have three levels of cattle quality. These changes will enhance the realism of the marketing and procurement decisions faced regularly by feeders and packers, respectively. It will also provide an opportunity to teach decision-making in a manner unlike what has been done previously.

Anyone interested in more information about the FCMS should contact Clement Ward at ceward@okstate.edu or 405-744-9821.

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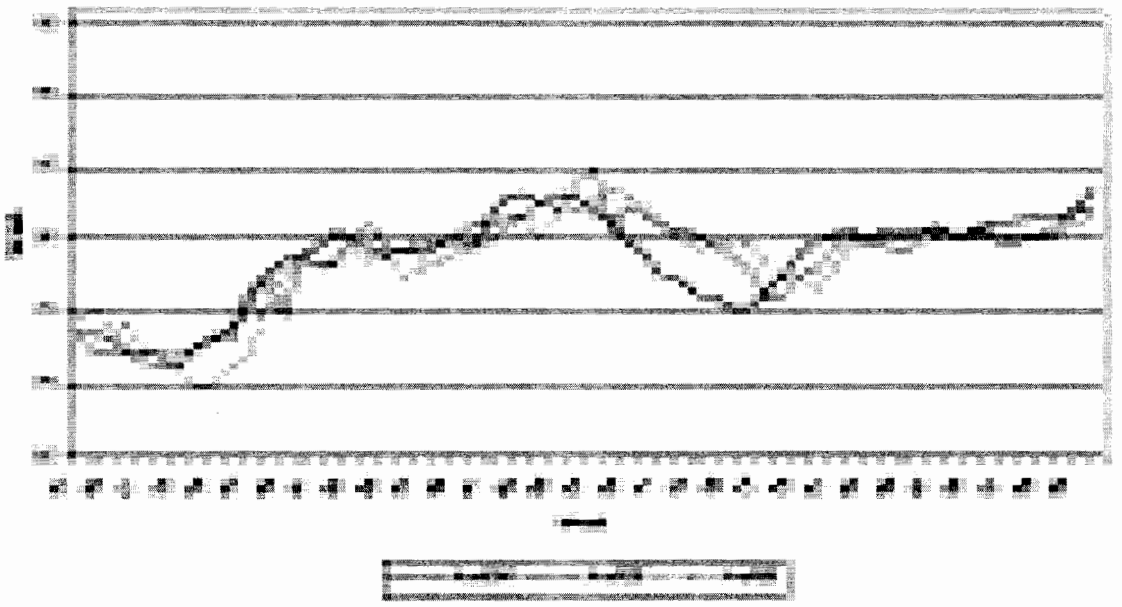

Figure 4. Average prices for three semester-long classes of the FCMS

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