B-817

Economic Components of the Fed Cattle Market Simulator

The "Packer-Feeder Game"

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Oklahoma Agricultural Experiment Station
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Structural and behavioral changes and their implications for price discovery have been significant concerns to 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.

As a result, the *Fed Cattle Market Simulator* (*FCMS*), quickly dubbed the "packer-feeder game" by Oklahoma State University (OSU) students, was developed. Since then, the market simulator has been used in the threefold mission of the Land Grant University system, i.e., teaching, extension, and research (Ward et al., 2001a). In addition, it has been incorporated into teaching and research programs at other universities.

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. Development was enhanced by a Higher Education Challenge Grant from the U.S. Department of Agriculture (USDA) the following year, which was key to full development of the simulator. The grant enabled writing software exclusive to the simulator and simultaneously improving the hardware components. Both aspects contributed to the effectiveness of the simulator. A later grant from the Chicago Mercantile Exchange enabled enhancing the futures market component of the simulator.

The first extension workshop using the simulator was with employees of Excel Corporation in 1992. Since then, extension workshops have been conducted with a wide range of participants; including high school age students, adult educators, producers, and agribusiness managers.

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. A grant from the Research Institute on Livestock Pricing enabled conducting the first formal, "laboratory" experiment with the *FCMS* in 1995. Considerable research has occurred in formal experiments and with data generated by the simulator since that first experiment (Ward et al., 2001a).

As originally designed, all fed cattle trading in the *FCMS* was on a live weight basis. However, as dressed weight and grid pricing became increasingly common in the industry, incorporating these pricing methods into the simulator became necessary. In 1999, a project to expand the scope of the simulator was undertaken. Since that time, a major revision of the original software has been completed. Similarly, all related teaching materials were updated as well, including descriptions of selected parts of the simulator (Ward et al., 2001b, 2001c, 2001d; Koontz et al., 2001).

The objective of this report is to identify and discuss the economic components of the *FCMS*. The report begins with an overview of the simulator and its operation. Then, the economic concepts incorporated into the simulator are discussed.

Overview of the Simulator

The focus of the *FCMS* is on the price discovery process for fed cattle. One early research effort was to compare price discovery with the *FCMS* and price discovery in the real-world fed cattle market (Ward et al., 1996). Figure 1 is a schematic diagram of the simulated market. There are eight cattle feedlots and four beefpacking firms. The focal point of the simulator is on slaughter cattle price negotiations between cattle feeders and packers. Participants work in teams and the teams trade paper pens of cattle. They use market information from the Market News Services segment of the simulator and results of their trades become market information for subsequent negotiations and trades. A separate live cattle futures market allows participants to hedge and use basis contracts plus use information generated by the futures market. A computer with software unique to the market simulator provides the necessary communications function. Cattle placements are given to feedlots and fed cattle trading information is collected, stored, and summarized. Market information and financial information is presented to the marketplace and participants in both electronic and hard copy form. A more detailed discussion of the operation of the simulator by participants follows.

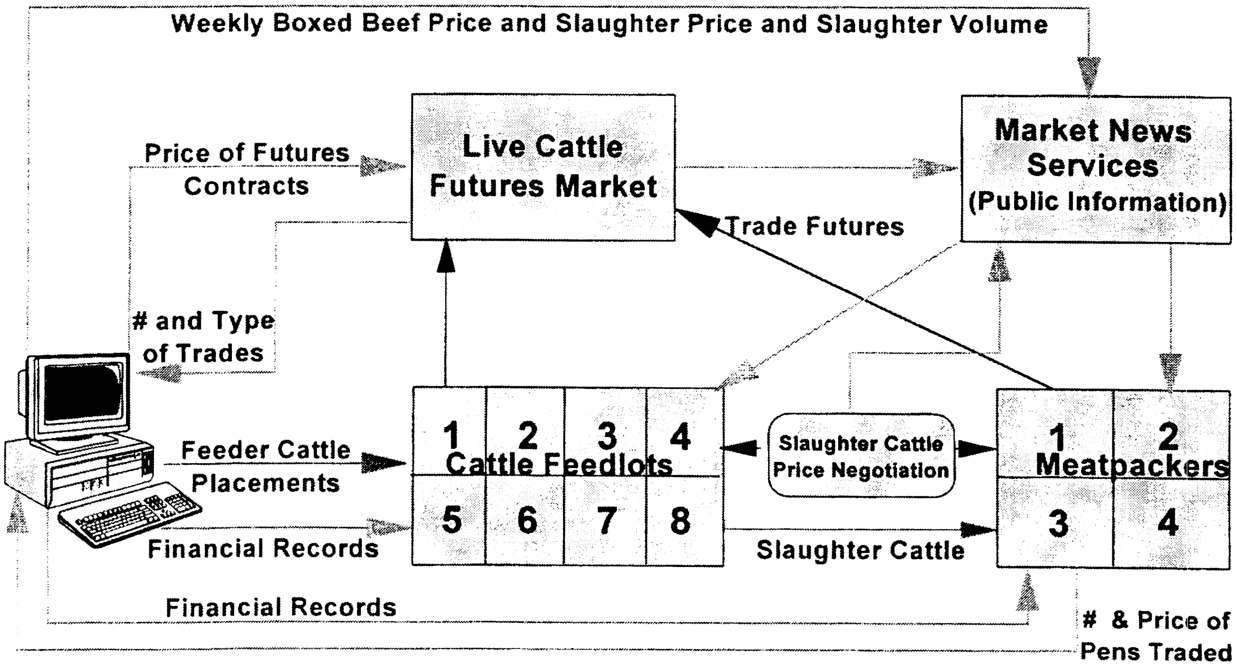


Figure 1. Schematic Diagram of the Fed Cattle Market Simulator

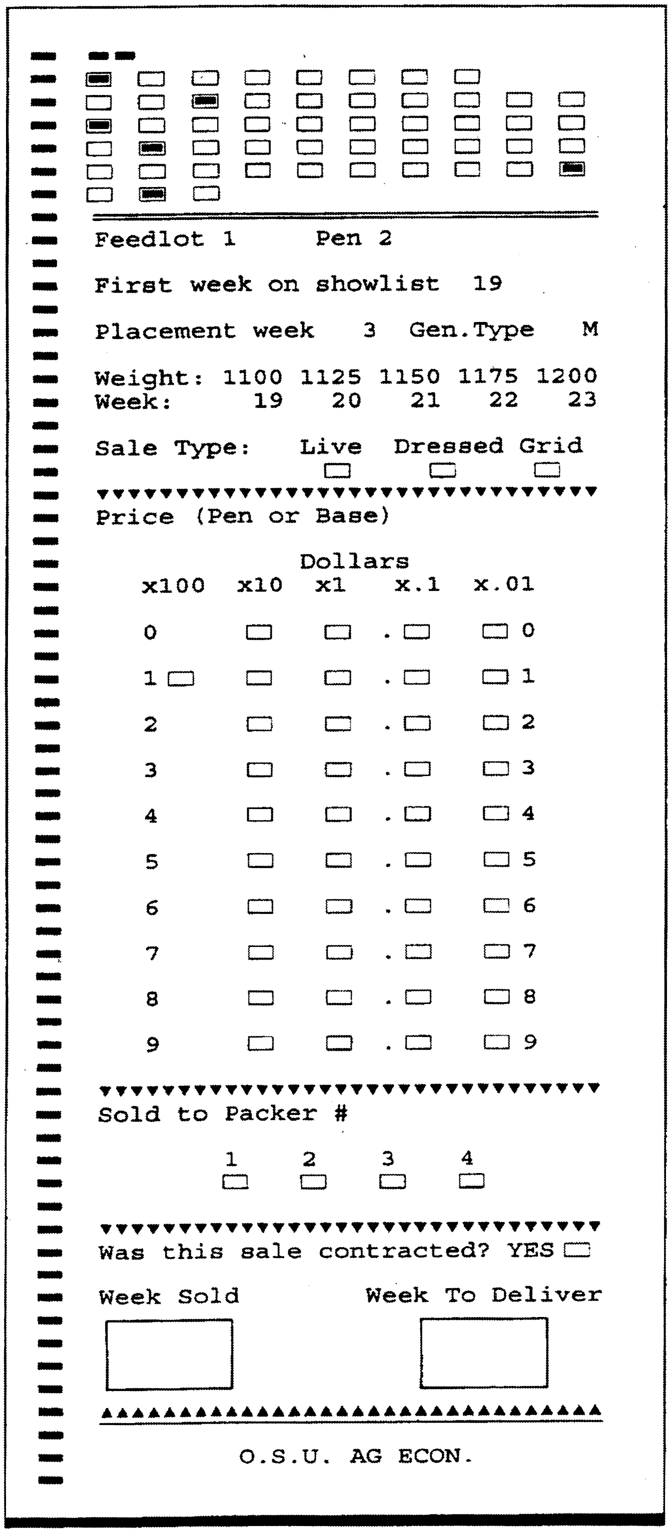
Participants in the simulated market, whether students or adult learners, work in teams of two-to-four persons. Feedlot teams are instructed to market fed cattle at a profit, and meatpacking teams are instructed to purchase fed cattle at a profit. Half-sheets of paper, each representing 100 head of fed steers, are bought and sold by feedlot marketing managers and packing plant buyers (Figure 2).

Predetermined cattle supplies are programmed into the software and are meant to mimic a somewhat exaggerated cattle inventory cycle in the beef industry. Thus, participants experience both larger supplies and smaller supplies of feeder cattle being placed in the cattle feeding industry. Cattle are placed on feed at 700 pounds, gain 25 pounds per week, and are ready to be sold for slaughter between 1100 and 1200 pounds. During a five-week marketing window, cattle are on the "show list" and packer buyers approach feedlots to bid on cattle. If cattle are not sold at or before 1200 pounds, the next week those 1225 pound cattle are sold to a default Packer 5 at a substantial discount.

Packers operate four plants, each of which is a different size with a unique cost structure, just like packing firms in the real fed cattle market. Packers know how many pens of cattle they need to operate their plant efficiently at the minimum-cost volume. Packer buyers begin with an expected boxed beef price and estimate their breakeven price before bidding. Bids may take the form of live weight, dressed weight, or value based grid-price offers. The volume of trading in the simulated market determines the boxed beef price as described in detail later.

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 processing 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 USDA. A simulated trading week of


Feedlot 1 Pen 2

First week on showlist 19

Placement week 3 Gen.Type M

Weight: 1100 1125 1150 1175 1200
Week: 19 20 21 22 23

Sale Type: Live Dressed Grid

Price (Pen or Base)

Dollars

x100	x10	x1	x.1	x.01
0			.	0
1			.	1
2			.	2
3			.	3
4			.	4
5			.	5
6			.	6
7			.	7
8			.	8
9			.	9

Sold to Packer #

1 2 3 4

Was this sale contracted? YES

Week Sold Week To Deliver

O.S.U. AG ECON.

Figure 2. Sample Cash Cattle Transaction Card

seven minutes corresponds to one week of real-world business by feedlots and packers. Teams can trade fed cattle in the cash market on either a live weight or dressed weight (carcass weight) basis, with fixed-price forward contracts, or using grid pricing.

Participants can also hedge or speculate with the futures market or use basis forward contracts. Half sheets of paper enable participants to place buy or sell orders of three types, market, limit, and stop (Figure 3). At any one time, teams can trade futures market contracts in any of three months, one nearby contract and two distant 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. Also, individuals are motivated by different stimuli; among them are ego, greed, and fear. Thus, teams are recognized or rewarded with traveling "trophies" for how profitable or unprofitable they may be. Sometimes these trophies have an interesting effect on the future behavior of the simulator participants.

Having given an overview of the simulated market, specific economic components are discussed in subsequent sections.

Boxed Beef Market

The boxed beef demand schedule in the *FCMS* is a key component to simulating the fed cattle market realistically. The demand schedule needs to reflect market reality when meatpackers sell boxed beef on the wholesale meat market and yet be scaled to the size of the experimental market. Participants need to see some degree of volatility in boxed beef prices based on volume of cattle traded and should be able to forecast changes in the boxed beef price after observing price/quantity patterns during the completed trading periods and given their expectations of future trading volumes.

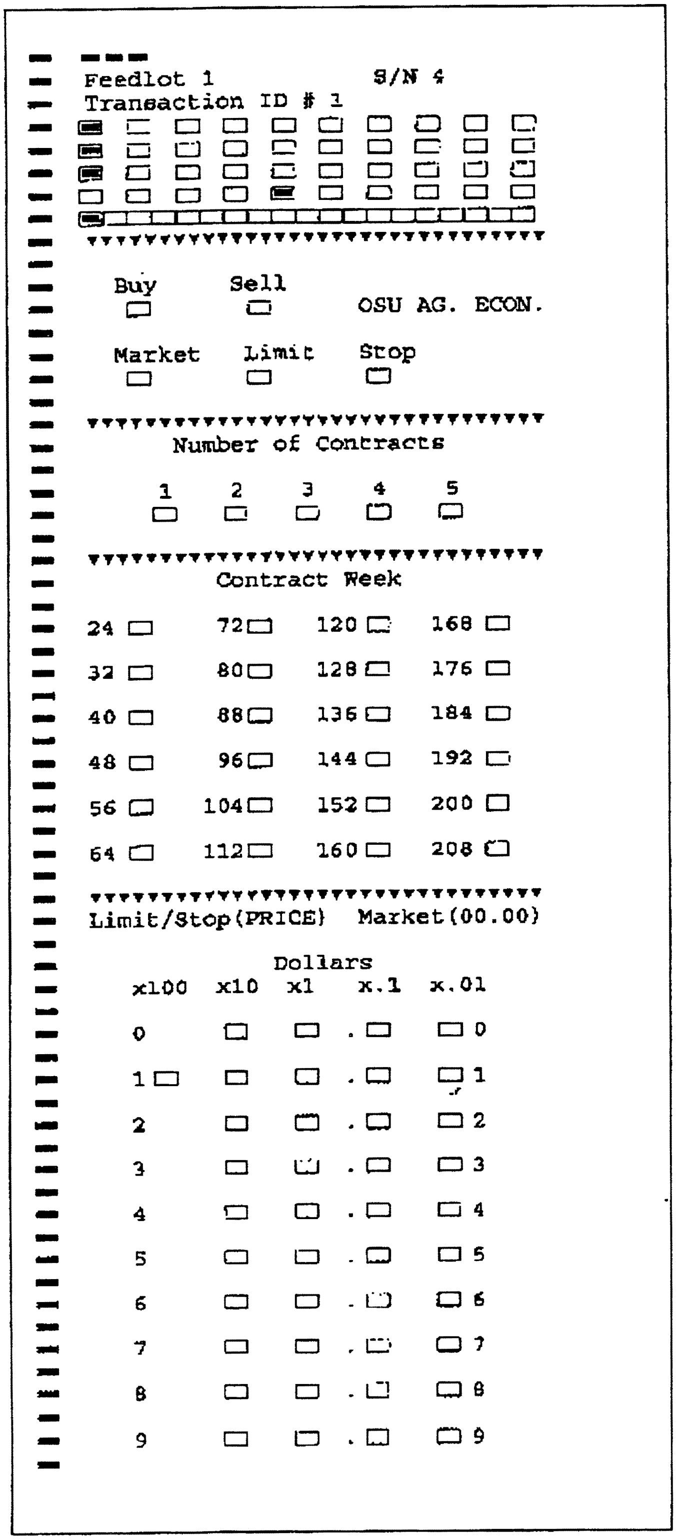

Feedlot 1 S/N 4
Transaction ID # 1
Buy Sell OSU AG. ECON.
Market Limit Stop
Number of Contracts
1 2 3 4 5
Contract Week
24 72 120 168
32 80 128 176
40 88 136 184
48 96 144 192
56 104 152 200
64 112 160 208
Limit/Stop(PRICE) Market(00.00)
Dollars
x100 x10 x1 x.1 x.01
0 . 0
1 . 1
2 . 2
3 . 3
4 . 4
5 . 5
6 . 6
7 . 7
8 . 8
9 . 9

Figure 3. Sample Futures Transaction Card

A study was undertaken to estimate a price dependent boxed beef demand function appropriate for the *FCMS* (Meyer, 1992). The boxed beef demand model specified weekly boxed beef prices as a function of lagged quantities of steer and heifer slaughter, cow slaughter, pork slaughter, chicken slaughter, turkey slaughter, and income. In addition, the model included a trend variable, monthly dummy variables, and an autoregressive component.

The key component of the boxed beef demand relationship is the lagged impact of fed cattle slaughter on boxed beef price. The estimated model was scaled to fit the market volume in the simulator. A mean slaughter level of 40 pens of 1150 pound cattle per week and an associated mean boxed beef price was set at a round number near mid 1990 levels. The model used is

$$P_{bb_t} = P\max_{bb} - \sum_{i=0}^{9} \beta_i q_{t-i} \qquad (1)$$

where P_{bb_t} is the boxed beef price in dollars per hundredweight in week t; $Pmax_{bb}$ is \$198.05, a constant; β_i represents the ith lag coefficient; and q_{t-i} is the total market volume (pens of 1150 pound equivalent cattle) in week t-i. These computations normalize weight allowing number of pen equivalents to reflect the entire poundage change. The respective lag coefficients of the model are shown in Table 1.

Table 1. Lag Coefficients of the Boxed Beef Equation

Week Number (i)	Lag Coefficient (β_i)
0	0.59621
1	0.08871
2	0.20197
3	0.20455
4	0.17051
5	0.14571
6	0.14777
7	0.16608
8	0.16181
9	0.06789

Note that the current week's coefficient significantly affects next week's boxed beef price. The boxed beef demand relationship between pens of cattle traded and boxed beef price is shown in Figure 4. The demand schedule reveals the market price for boxed beef for a constant stream of pens of cattle marketed at 1150 pounds. Figure 5 shows the distributed lag of flexibilities used to adjust the boxed beef price given the flow of animals processed in the simulator (Meyer). The individual flexibilities are graphed for each time period in the distributed lag along with the cumulative flexibility, which measures the aggregate dynamic adjustment of price. The price levels in Figure 4 will only be realized if the volume of cattle marketed on the x-axis is constant for 10 weeks, the length of the distributed lag. For example, if the flow of cattle to slaughter increases 10% from a constant 40 pens per week (with an associated boxed beef price of $120/cwt.) to a constant 44 pens per week, the boxed beef price will decrease approximately 6.5% (to about $112/cwt.). However, the decrease is over a 10-week period (Koontz et al., 1992).

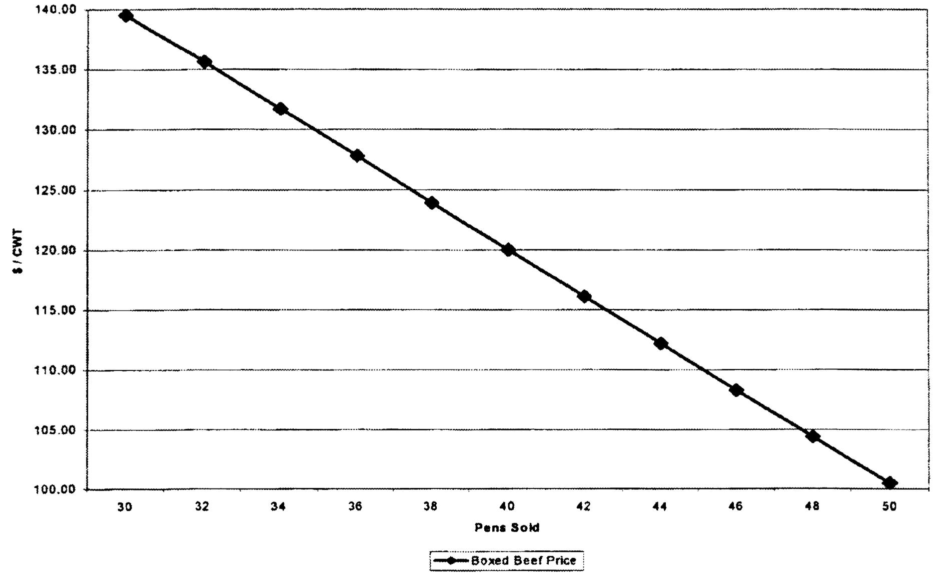


Figure 4. Boxed Beef Demand Schedule

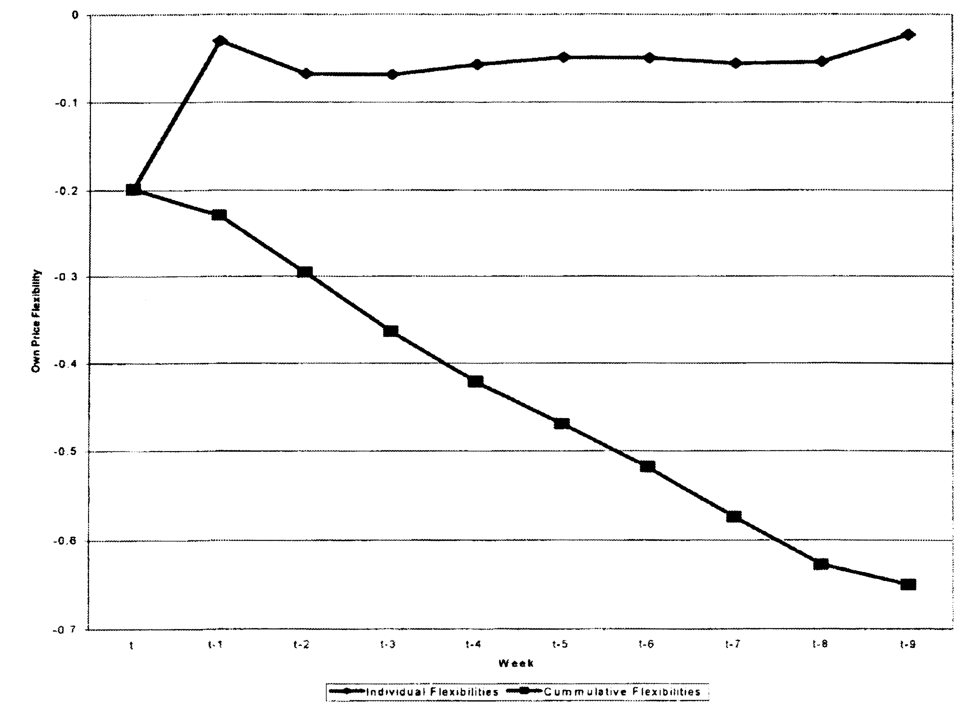


Figure 5. Distributed Lag of Boxed Beef Flexibilities

Packers in the simulator use boxed beef price as a measure of market demand. However, the price of all meat sold is on an adjusted basis. Starting with the boxed beef price, carcass premiums and discounts associated with carcass traits such as quality grade and yield grade are applied, yielding an adjusted boxed beef price for each pen.

Meatpacking Economics

Participants role playing as meatpacking firm cattle buyers purchase fed cattle from feedlot marketing managers, process the cattle into boxed beef, sell beef into the wholesale market, and attempt to make money in the process. Simulator participants determine the number of pens traded, the weight of cattle traded, and the prices paid for fed cattle. Total marketings of fed cattle are aggregated over all sales, weights, and genetic types to determine a total volume for the boxed beef market. During periods of high (low) volume, relatively low (high) prices are paid for meat. As with cattle feeding, because of the time lag between input purchase and product sales, there is uncertainty in packer profits. Beef is sold in the boxed beef market, at a computer-calculated price as previously detailed, the week after cattle are purchased.

Profits are defined the same for all meatpackers. Profit is total revenue minus total costs. Profitability in meatpacking can be calculated on a per head basis. Total revenue per head is the sum of meat and byproducts sales. Total costs per head are all costs related to slaughtering and processing, including byproducts processing, where the quantities are expressed in per head units.

Packers have control over several factors which affect profits; two of them are quantity of livestock purchased and costs of slaughtering and processing. Therefore, one key decision packers make daily, both in reality and in the market simulator, is how many animals to purchase. That decision in turn directly affects a packer's cost of slaughtering and processing. In the profit equation, there is an inverse relationship between slaughtering-processing costs and profit. When slaughtering-processing costs increase, profit decreases; and when slaughtering-processing costs decrease, profit increases. If market conditions are such that meatpackers are making profits, it is often more profitable for each packer to slaughter and process additional pens of cattle than the minimum-cost volume. The same economic logic occurs in a reverse setting. When market conditions are such that meatpackers are experiencing losses, it is often to the advantage of each packer to slaughter and process fewer pens of cattle than the minimum-cost volume.

One decision related to the question of how many animals to purchase is whether a meatpacker should temporarily close a plant. At some point, losses incurred from purchasing cattle may be so great that it is more economical for a plant to close than to remain open and continue purchasing cattle. If a plant is closed, that meatpacker will incur losses due to its fixed costs but will avoid losses associated with variable costs. It will be advantageous for a meatpacker to close if the losses incurred by purchasing cattle are greater than fixed costs.

Packing Plant Costs

The *FCMS* draws on published knowledge concerning the economies of size in packing plants (Sersland, 1985; Duewer and Nelson, 1991). The simulator uses estimates of short-run average cost for four packing plants, each being a different size. The smallest plant has a short-run optimal size of eight pens per week, i.e., 800 head/week, while the largest plant has a short-run capacity of 12 pens per week or 1,200 head/week. The other two plants are specified to have optimal capacities of 9 and 11 pens per week. The simulated market consists of two larger plants and two, slightly smaller plants. The shape and relationship of the cost curves for each packing plant in the game is shown in Figure 6 and plant costs are detailed in Table 2. The long run industry curve would create an envelope containing the short run curves.

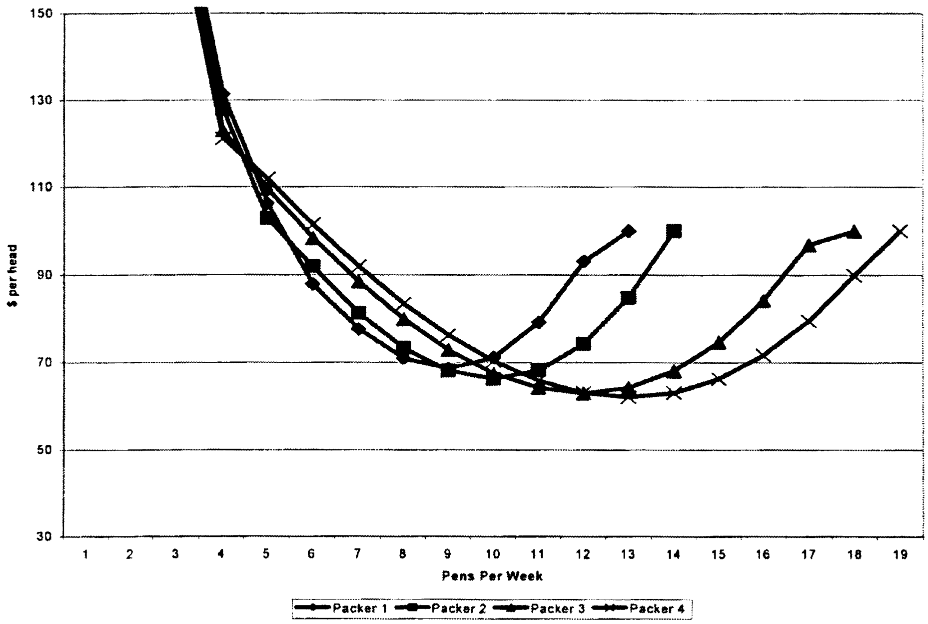


Figure 6. Meatpacking Plant Average Total Cost Curves

Table 2. Discrete Cost Functions for Each Packer ($ per head)

Pens Slaughtered	Packer 1	Packer 2	Packer 3	Packer 4
0	$30166.00[a]	$32803.00[a]	$38133.00[a]	$40986.00[a]
1	332.52	329.09	324.10	322.00
2	181.68	178.26	173.26	171.40
3	131.41	127.98	122.99	121.12
4	106.27	102.84	109.58	111.83
5	87.95	91.93	98.45	101.44
6	77.56	81.29	88.48	91.93
7	70.91	73.20	79.86	83.43
8	68.56	68.06	72.80	76.18
9	71.10	66.27	67.51	70.25
10	79.10	68.19	64.19	65.83
11	93.13	74.20	63.03	63.06
12	100.00	84.80	64.25	62.10
13	100.00	100.00	68.05	63.11
14	100.00	100.00	74.63	66.24
15	100.00	100.00	84.20	71.64
16	100.00	100.00	96.95	79.47
17	100.00	100.00	100.00	89.88
18	100.00	100.00	100.00	100.00
19	100.00	100.00	100.00	100.00
20	100.00	100.00	100.00	100.00

[a] Fixed costs, net on a per head basis

The absolute size of the four plants relative to actual plants is not intended to represent meatpacking plant capacities realistically. The combined optimal capacity of the four plants is 40 pens per week, or 4,000 head per week. Capacities of the packing plants (and likewise the feedlots) are scaled down to fit the needs of the simulator in an experimental market setting. However, critical to realistic simulation of the fed cattle market is that plant cost structures and relative costs between the different sizes of plants are realistic.

Little research has been done on short-run (weekly) cost curve structures, though considerable research has identified the intermediate (annual) cost curves. The processing cost for each packing plant when operated at its optimal capacity was determined from the long-run cost curve estimated by Sersland. A ten-pen-per-week packing plant was assumed to be equivalent to an annual capacity of approximately 394,000 head. In the simulator, a ten-pen-per-week processing plant operated at its optimal capacity slaughters and processes beef at a cost of $64.42/head. Likewise, the long-run cost curve indicates that a plant with 20 percent less capacity, an eight-pen-per-week plant, will have a processing cost of $68.56/head. Comparatively, a plant with 20 percent more capacity, a twelve-pen-per-week plant, will have a processing cost of $62.10/head. Note that costs per head were those close to industry figures when the market simulator was initially developed.

The second key feature of the cost structure for the meatpacking sector in the simulator is each plant's respective short-run cost structure. During the normal course of market events, the number of pens processed per week by each plant is expected to vary considerably. As processing volume varies, the cost per head is expected to vary and follow a short-run cost curve. The study closest to estimating weekly cost curve was by Duewer and Nelson. Their detailed budgets for 300 head per hour, double shift plants running five days/week were used to derive a weekly short-run cost curve for the simulator. The cost associated with operating each plant at its optimal capacity is also a point on the long-run cost curve (Koontz et al., 1992).

Carcass Quality Characteristics

In this market simulator, there are three genetic types, referred to as lower quality, higher yield (genetic type L); average quality, average yield (genetic type M); and higher quality, lower yield (genetic type H). Each genetic type differs for each weight of cattle on the show list. Carcass characteristics are shown in Tables 3, 4, and 5.

Table 3. Genetic Type H: High Quality Low Yield Cattle Carcass Characteristics

Weight Categories	Yield Grade 1-2	Yield Grade 3	Yield Grade 4-5	Prime	Choice	Select	Dressing Percentage	Light or Heavy
1100	48.0%	50.0%	2.0%	7.0%	50.0%	43.0%	63.0%	5.0%
1125	43.0	53.0	4.0	10.0	55.0	35.0	63.5	2.0
1150	36.0	58.0	6.0	13.0	60.0	27.0	64.0	0.0
1175	31.0	61.0	8.0	16.0	65.0	19.0	64.5	3.0
1200	25.0	65.0	10.0	19.0	70.0	11.0	65.0	7.0
1225	19.0	69.0	12.0	21.0	75.0	4.0	65.5	11.0

Table 4. Genetic Type M: Medium Quality Medium Yield Cattle Carcass Characteristics

Weight Categories	Yield Grade 1-2	Yield Grade 3	Yield Grade 4-5	Prime	Choice	Select	Dressing Percentage	Light or Heavy
1100	70.0%	30.0%	0.0%	3.0%	35.0%	62.0%	62.0%	3.0%
1125	63.0	35.0	2.0	5.0	40.0	55.0	62.5	1.0
1150	57.0	39.0	4.0	7.0	45.0	48.0	63.0	0.0
1175	51.0	43.0	6.0	9.0	50.0	41.0	63.5	1.0
1200	45.0	47.0	8.0	11.0	55.0	34.0	64.0	3.0
1225	39.0	51.0	10.0	12.0	60.0	28.0	64.5	5.0

Table 5. Genetic Type L: Low Quality High Yield Cattle Carcass Characteristics

Weight Categories	Yield Grade 1-2	Yield Grade 3	Yield Grade 4-5	Prime	Choice	Select	Dressing Percentage	Light or Heavy
1100	90.0%	10.0%	0.0%	1.0%	20.0%	79.0%	61.0%	7.0%
1125	85.0	15.0	0.0	2.0	25.0	73.0	61.5	3.0
1150	79.0	19.0	2.0	3.0	30.0	67.0	62.0	0.0
1175	72.0	24.0	4.0	4.0	35.0	61.0	62.5	2.0
1200	65.0	29.0	6.0	5.0	40.0	55.0	63.0	5.0
1225	58.0	34.0	8.0	6.0	45.0	49.0	63.5	8.0

The live weight of cattle for each genetic type is shown in the left column of each table. Several trends in carcass attributes can be noted regardless of genetic type. Heavier weight cattle result in heavier carcasses and have higher dressing percentage. Pens of lighter weight cattle have relatively more animals grading Select, YG 1-3, and have relatively more light carcasses. Pens of heavier weight cattle have relatively more animals that grade Choice, YG 4-5, and have relatively more heavy carcasses.

Differences among genetic types can be seen in these tables. For example, consider the percentage of carcasses grading Prime. Considerably more carcasses grade Prime in the H genetic type (higher quality, lower yield) than in the M genetic type (average quality, average yield) or L genetic type (lower quality, higher yield). Conversely, look at the percentage of carcasses yield grading 1-2. The percentages are much higher for the L genetic type than for the M or H genetic types.

Meatpacker Pricing of Fed Cattle

Another major decision packers make daily is how much to pay for cattle. Packer pricing of cattle is a two-stage process. First, a head buyer determines a daily procurement policy or buy order. Second, the buy order is given to field buyers to execute as they purchase cattle from feedlots. In general, meatpackers determine what to pay for cattle by adding the expected or estimated value of the cattle in terms of meat and byproduct sales, subtracting the processing cost and target profit levels, and finally making any weight correction needed.

There are several methods of pricing fed cattle. In the simulator, packers can price cattle on a live weight, dressed weight, or grid (i.e., dressed weight and carcass merit) method. All of these pertain to cash or spot market purchases. Packers can also forward price cattle with forward contracts or basis contracts.

Live Weight Price – Packer buyers regularly visit feedlots and view fed cattle on the show list. In the process, they assess the expected carcass characteristics of the cattle when they are slaughtered. With information on the characteristics of cattle and their price orders from the head buyer, they can compute breakeven prices and price bids. Assume sample carcass premiums and discounts as shown in Table 6. In addition, assume a base price of $120.00/cwt. for boxed beef, byproducts at $8.50/cwt. based on live animal weight, slaughtering/fabricating cost of $75.00 per head, and a $5.00/hd. profit target. Carcass characteristics are those shown in Table 4 for an 1150 pound carcass. Table 7 is an example of a price bid on a live weight basis for 1150 pound average quality, average yield (M genetic type) cattle given the premiums, discounts, and byproduct prices in Table 6. Prices are in dollars per hundredweight and quantities are in per head units.

Table 6. Example Premiums and Discounts, as Presented by a Packer

Quality	Premium/Discount
Choice Yield Grade 3 600-900 lbs.	BASE PRICE
Prime-Choice Price Premium	8.00/cwt.
Choice-Select Price Discount	-4.70/cwt.
Yield Grade 1 Premium	4.00/cwt.
Yield Grade 4-5 Discount	-9.00/cwt.
Light Carcasses (<550 lbs.)	-10.00/cwt.
Heavy Carcasses (>950 lbs.)	-10.00/cwt.

Table 7. Live Weight Price Example Bid for 1150 Pound Fed Cattle-Medium Type

Step	Amount
STEP 1: Compute Adjusted Boxed Beef Price	
Boxed Beef Price Forecast (Ch 3, 6/700 lb. carcass)	$120.00/cwt.
Less Discounts:	
45% Select X $4.70 Discount	-$2.12/cwt.
4% Yield Grade 4-5 X $9.00 Discount	-$0.36/cwt.
0% Light/Heavy X $10.00 Discount	-$0.00/cwt.
Sum for Adjusted Boxed Beef Price	$117.52/cwt.
STEP 2: Convert Boxed Beef Price to Live weight	
Adjusted Price X 63.0 Dressing %	$74.04/cwt.
STEP 3: Add Byproducts Value	
Step 2 + $8.50/Liveweight cwt.	$82.54/cwt.
STEP 4: Deduct Cost Plus Profit Margin	
$75.00/Head Cost (Slaughter+Fabrication)	
+ $ 5.00/Head Profit Target	
= $80.00/Head Total	
$80.00/Head Total /11.50 Live weight	-$6.96/cwt.
STEP 5: Step 3 + Step 4 = Bid Price	$75.58/cwt.

Note the expected boxed beef price will be the most current boxed beef price reported plus or minus how much a packer *thinks* the price will change in the following week. This generates a projected boxed beef price, for which some market outlook and judgment is required.

Dressed Weight Price – Packers also can bid on a dressed weight basis, often called an "in the beef" bid. Packers still visit feedlots and visually appraise the cattle. However, they need not estimate the live weight and dressing percentage because payment is on the dressed weight, not live weight. Table 8 shows the process of estimating a dressed weight bid price for the same pen and market conditions as in Table 7.

Table 8. Dressed Weight Price Example Bid for 1150 Pound Fed Cattle-Medium Type

Step		Amount
STEP 1:	Compute Adjusted Boxed Beef Price	
	Boxed Beef Price Forecast (Ch 3, 6/700 lb. carcass)	$120.00/cwt.
	Less Discounts:	
	45% Select X $4.70 Discount	-$2.12/cwt.
	4% Yield Grade 4-5 X $9.00 Discount	-$0.36/cwt.
	0% Light/Heavy X $10.00 Discount	-$0.00/cwt.
	Sum for Adjusted Boxed Beef Price	$117.52/cwt.
STEP 2:	Add Byproducts Value (On a dressed weight basis)	
	Step 2 + $8.50/Liveweight cwt. / Dressing %	
	[$117.52 + ($8.50/0.63)] =	$131.01/cwt.
STEP 3:	Deduct Cost Plus Profit Margin (On a dressed weight basis)	
	$75.00/Head Cost (Slaughter + Fabrication)	
	+ $ 5.00/Head Profit Target	
	= $80.00/Head Total	
	$80.00/Head Total / 7.25 Dressed Weight	-$11.03/cwt.
STEP 4:	Step 2 + Step 3 = Dressed Weight Bid Price	$119.98/cwt.

As with live weight pricing, packers begin by anticipating next week's boxed beef price. Also as before, the carcass characteristics and hence the discounts are the same for the pen of cattle. Note that Step 2 in the live weight pricing example is omitted in the dressed weight example. That is because no conversion is made to a live weight price in this case.

Grid Pricing – Grid pricing could be called carcass merit pricing. Price is established on each individual animal based on carcass merit. Nearly all grids are based on dressed weights for fed cattle. Unlike live weight pricing or dressed weight "in the beef" pricing where there is a single average price for the entire sale lot, a price is discovered for each animal in the pen with grid pricing. As a result, higher quality cattle receive higher prices and lower quality cattle receive lower prices, thereby improving pricing accuracy and rewarding cattlemen who market desirable types of cattle.

Most grids consist of a base price with specified premiums and discounts for carcasses above and below the base or standard quality specifications. Grid pricing has been simplified somewhat for the market simulator. There are just three quality grades of cattle (Prime, Choice, Select) and three groups of yield grades (YG1, YG2-3, YG4-5).

Packer grids may identify additional premiums for carcasses meeting specifications of Certified Angus Beef (CAB) or other marketing programs. Likewise, packers may specify discounts for hide damage, injection site blemishes, condemnations, and other "out" or unmarketable carcasses (in addition to discounts for light or heavy carcasses as shown in the sample premiums and discounts in Table 6).

The premiums for Prime and yield grade 1 (YG1) are fairly constant in the real world market with most volatility and movement occurring in the Choice-Select discount and the yield grade 3 to yield grade 4 discount (Ward, Feuz, and Schroeder, 1999). To maintain realism in the simulator, the Prime and YG1 premiums are held constant at $8.00/cwt and $4.00/cwt respectively.

Discounts for Select and yield grade 4-5 carcasses are variable in the simulator and depend on market conditions. The Choice-Select discount is computed from a continuous empirical model.

The program sums across all genetic types and all weights to arrive at the total poundage of Select beef and the total of all beef traded in the current trading period and uses these numbers to compute the percentage of Select beef traded. The Choice-Select discount is modeled in equation (2) and shown graphically in Figure 7,

(2)
$$P_{ch-sel} = \begin{cases} -16.10; & q_{\%sel} > 0.65 \\ \beta_0 + \beta_1 * [(q_{\%sel} - \beta_2) * 100.0]; & 0.35 \le q_{\%sel} \le 0.65 \\ 1.00; & q_{\%sel} < 0.35 \end{cases}$$

where $P_{ch\text{-}sel}$ represents the discount on Select carcasses relative to Choice in dollars per hundredweight; $q_{\%sel}$ is the percent Select beef traded in the current period; and β_0, β_1, and β_2 are constants equal to 1.00, -0.57, and 0.35 respectively.

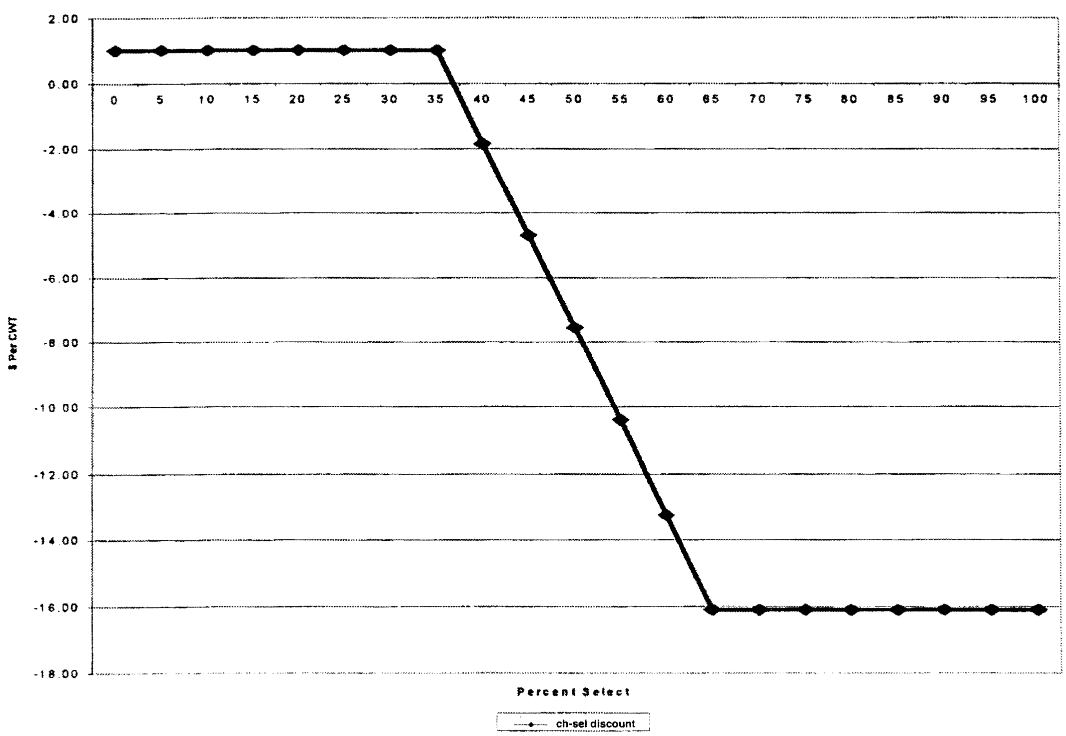


Figure 7. Choice-Select Discount Schedule

As weight increases (decreases), the percent of Select beef traded decreases (increases) and the discount decreases (increases). Thus in a market with tight (plentiful) supply, the show list will have greater numbers of lighter (heavier) cattle causing the percent Select beef to increase (decrease) and therefore the discount will generally become greater (smaller) (Figure 8).

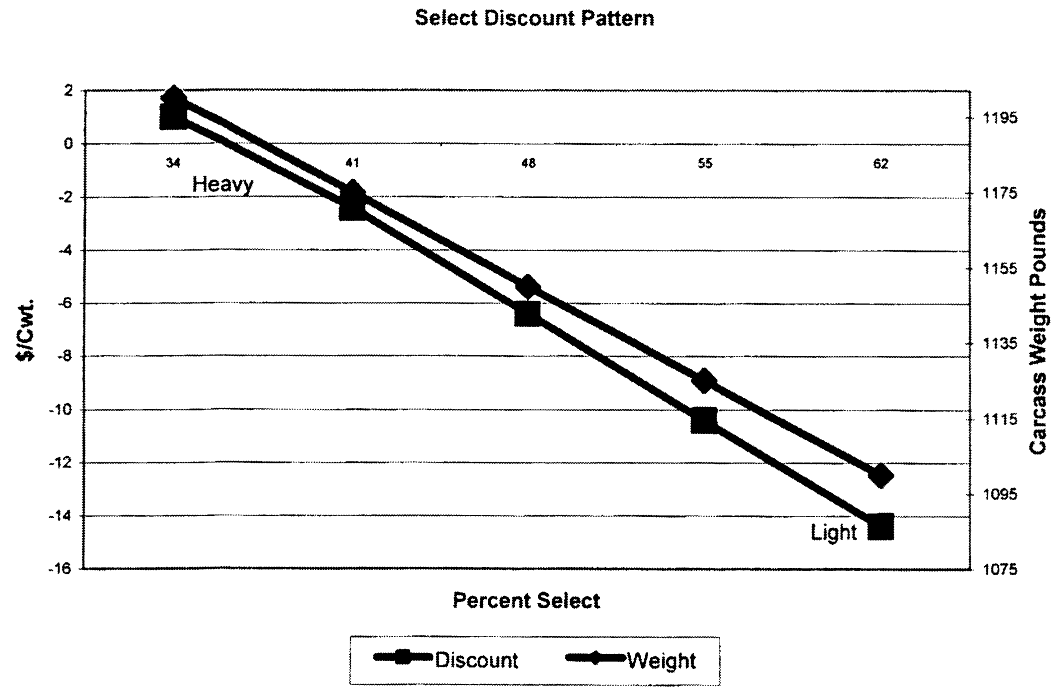


Figure 8. Select Discount Pattern

The yield grade 3 to yield grade 4-5 discount is handled in a similar manner. Each period the simulator computes the percent yield grade 4-5 beef traded for that period. The discount is then modeled as in equation (3) and shown graphically in Figure 9,

(3)

$$P_{yg3-45} = \begin{cases} -50.00; \quad q_{\%45} > 0.245 \\ \beta_1 * \{\beta_0 + 2 * [(q_{\%45} - \beta_2) * 100.0]\}; \quad 0.0 < q_{\%45} \leq 0.245 \\ -1.00; \quad q_{\%45} = 0.0 \end{cases}$$

where P_{yg3-45} is the discount on yield grade 4-5 carcasses relative to yield grade 3 in dollars per hundredweight; $q_{\%45}$ is defined as the percent yield grade 4-5 traded in that period; and β_0, β_1, and β_2 are the constants 17.0, -1.0, and 0.08 respectively.

As fed cattle weight increases (decreases), the percent of YG 4-5 beef traded increases (decreases) and the discount increases (decreases). Thus in a market with plentiful (tight) supply, the showlist will have greater numbers of heavier (lighter) cattle causing the percent YG 4-5 beef to increase (decrease) and therefore the discount will generally become greater (smaller) (Figure 10).

The premiums and discounts in Table 6 can be put into matrix format as in Table 9. The term grid comes from this matrix framework of premiums and discounts for specified carcass characteristics. To complete the matrix in Table 9, we assume quality grade and yield grade premiums and discounts are additive. For example, the premium for a Prime grade, yield grade 1 carcass in Table 10 is $12/cwt. That amount is the sum of the $8/cwt. premium for Prime grade carcasses plus the $4/cwt. premium for yield grade 1 carcasses. Likewise the discount for a Select grade, yield grade 4-5 carcass is -$13.70. The other cells in the matrix are completed in a similar manner.

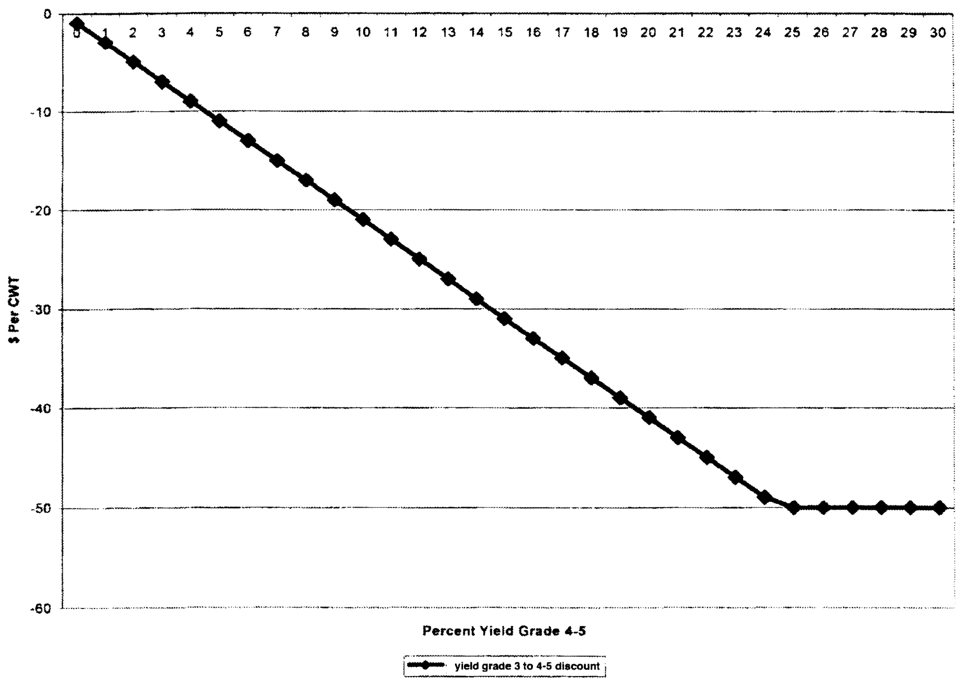


Figure 9. Yield Grade 3 to Yield Grade 4-5 Discount Schedule

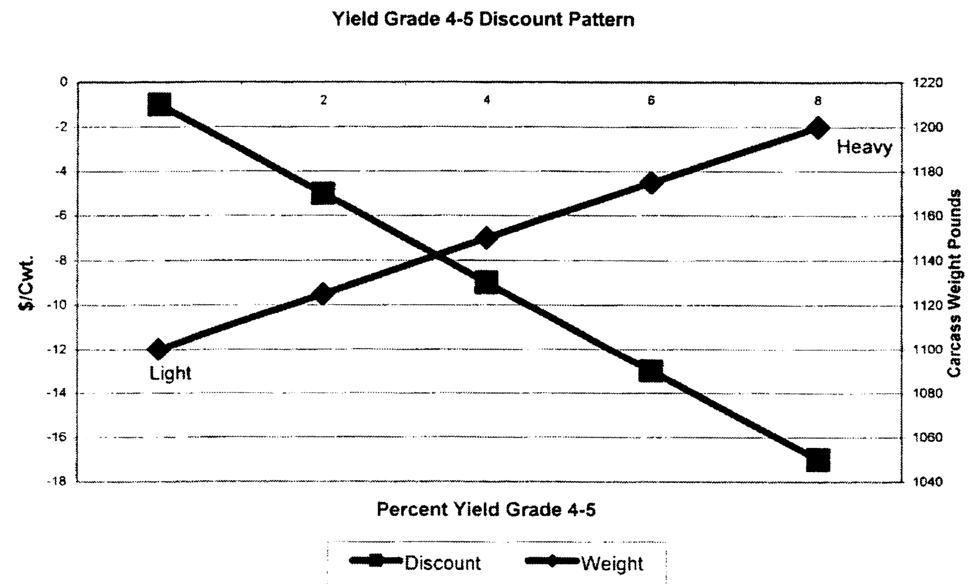


Figure 10. Yield Grade 4-5 Discount Pattern

Table 9. Example Grid in Initial Matrix Format ($/dressed Cwt.)

	Yield Grade		
Quality Grade	1	2-3	4-5
Prime	--	8.00	--
Choice	4.00	Base	-9.00
Select	--	-4.70	--
Light Carcasses (<550 lbs.)		-10.00	
Heavy Carcasses (>950 lbs.)		-10.00	

Table 10. Example Grid in Completed Matrix Format ($/dressed Cwt.)

Quality Grade	Yield Grade 1	Yield Grade 2-3	Yield Grade 4-5
Prime	12.00	8.00	-1.00
Choice	4.00	Base	-9.00
Select	-0.70	-4.70	-13.70
Light Carcasses (<550 lbs.)		-10.00	
Heavy Carcasses (>950 lbs.)		-10.00	

Table 11. Example Distribution of Carcasses in Matrix Format (% of pen total)

Quality Grade	Yield Grade 1	Yield Grade 2-3	Yield Grade 4-5
Prime	4	3	2
Choice	25	17	2
Select	27	19	2
Total carcasses100			
Light Carcasses (<550 lbs.)		0	
Heavy Carcasses (>950 lbs.)		0	

Grid Price Example – To compute a grid-based price, the distribution of carcasses by quality grades and yield grades from a sale lot of fed cattle must be known. That distribution, shown in Table 11, is also put into a matrix framework. Table 11 shows the distribution of carcasses for one, 100-head pen of medium quality, medium yield cattle (M genetic type) weighing 1150 lbs. Any differences in row, column, or pen totals are due to rounding of real numbers to integers in the examples.

In the simulator, packers and feeders typically negotiate the base price. For packers, bids include the projected price of boxed beef, byproducts value, and slaughter-processing costs. The base price could be discovered by a formula tied to the boxed beef price, futures market price, or some other arrangement. Once the base price is known for the grid in Table 10 (Step 1 in Table 12), the net price can be computed for a pen of cattle. Premiums or discounts for the distribution of carcasses in the pen are found by multiplying the percent of carcasses in each matrix cell in Table 11 times each premium and discount cell in Table 10. That sum for all cells is added to the base price (Steps 2 and 3 in Table 12). Steps 4, 5, and 6 in Table 12 are as described in Steps 2, 3, and 4 for the dressed weight pricing example. The market conditions existing in the live and dressed weight examples are also used in the grid price example.

Forward Contracting – The first three pricing methods could be considered spot or cash market transactions. Fed cattle are priced shortly before slaughter or price is discovered immediately after slaughter. There are good reasons cattle feeders and meatpackers may want to purchase cattle well in advance of slaughter. In the simulator, purchases of fed cattle by packers two or more weeks prior to delivery and slaughter are considered forward contract purchases. Contracts can be priced on a live weight, dressed weight, or grid basis. Estimating a bid price is the same as described above, with two additional considerations. Packers must anticipate which direction market prices are moving (higher or lower) and adjust their contract bid prices accordingly. Packers must also recognize that they are bidding on cattle weighing x this week, but weighing some additional amount (50 pounds or more) the week the contracted cattle are delivered for slaughter. Therefore, bids should be based on the expected market weight of cattle, not the current week's weight.

Similarly, feeders must also anticipate which direction market prices are moving (higher or lower) and adjust their contract offer prices accordingly. Feeders, too, must recognize that they are selling cattle weighing x this week, but weighing some additional amount the week the contracted cattle are delivered for slaughter.

Table 12. Grid Price Example Bid for 1150 Pound Fed Cattle-Medium Type

Step	Amount
STEP 1: Negotiate the base price.	\$120.00/cwt.
STEP 2: Calculate the net premium or discount. Multiply the percentage of carcasses in each cell of the distribution of carcasses times the respective premium or discount cell in the premium-discount grid. Note percentages are converted to decimal form. [(\$12 x 0.04)+(\$8 x 0.03)+(-\$1 x 0.02)+(\$4 x 0.25)+ (\$0 x 0.17)+(-\$9 x 0.02)+(-\$0.70 x 0.27)+(-\$4.7 x 0.19)+ (-\$13.7 x 0.02)]+[(-\$10 x 0.0)+(-\$10 x 0.0)] = \$0.16	\$0.16/cwt.
STEP 3: Step 1 + Step 2	\$120.16/cwt.
STEP 4: Add Byproducts Value (On a dressed weight basis) Step 3 + \$8.50 / Dressing % [\$120.16 + (\$8.50/0.63)] =	\$133.65/cwt.
STEP 5: Deduct Cost Plus Profit Margin (On a dressed weight basis) \$75.00/Head Cost (Slaughter + Fabrication) + \$ 5.00/Head Profit Target = \$80.00/Head Total \$80.00/Head Total / 7.25 Dressed Weight	-\$11.03/cwt.
STEP 6: Step 4 + Step 5 = Grid Bid Price	\$122.62/cwt.

Therefore, offer prices should be based on the expected market weight and breakeven price for cattle, not the current week's weight and breakeven price. Feeders especially must consider how forward sale of cattle affects their breakeven price if cattle to be delivered will weigh 1175 or 1200 pounds.

Feedlot Economics

In addition to adding grid pricing to the current version of the market simulator software, it was necessary to add multiple genetic types of carcasses to make the grid pricing component more realistic. Typically, cattle feeders cannot predict with accuracy the genetic potential of the cattle they feed and thus cannot predict the carcasses composition of the cattle. This complicates the grid pricing process, both in reality and in the market simulator. In the market simulator, participants are given information about the genetic type of cattle and their carcass characteristics.

Several factors affect the economic component of cattle feeding. Some factors are exogenous to the market. Participants role playing as cattle feedlot managers need to understand the exogenous and endogenous factors.

Feeder Cattle Prices, Placements, and Genetic Composition – Feeder cattle prices and placements are exogenous in the *FCMS*. Feedlot managers neither have control over the number of pens of cattle placed on feed in their feedlot nor the price paid for cattle they "custom" feed. To make the simulation realistic, feeder cattle placements and prices must have realistic relationships to each other and to the slaughter cattle market which is endogenous to the game, i.e., determined by actions of game players. To provide a variety of market conditions and learning experiences for participants, the number of feeder cattle placed weekly varies from relatively heavy periods of placements for up to six to eight weeks to relatively light periods of placements for approximately the same length of time. Figure 11 graphically displays the total placement pattern. Research has shown that real-world feeder cattle market prices are generally priced very near expected break-even prices (Buccola 1980). For example, if the futures market price for live cattle in the expected month of slaughter and current feed costs are used in a budget to determine the break-even price for feeder cattle, the actual market price and break-even price will generally be similar (Koontz et al., 1992).

Realistic relationships have been built into the simulator by considering the feeder cattle market to be derived based on current and expected future fed cattle market conditions. Figure 12 shows the demand relationship between feeder cattle prices and number of pens of cattle placed on feed at different costs of gain (essentially different grain market prices) for a constant genetic type M. When the genetic type is allowed to vary and the cost of gain is held constant at $0.45 per pound, Figure 13 shows the demand relationship across genetic types.

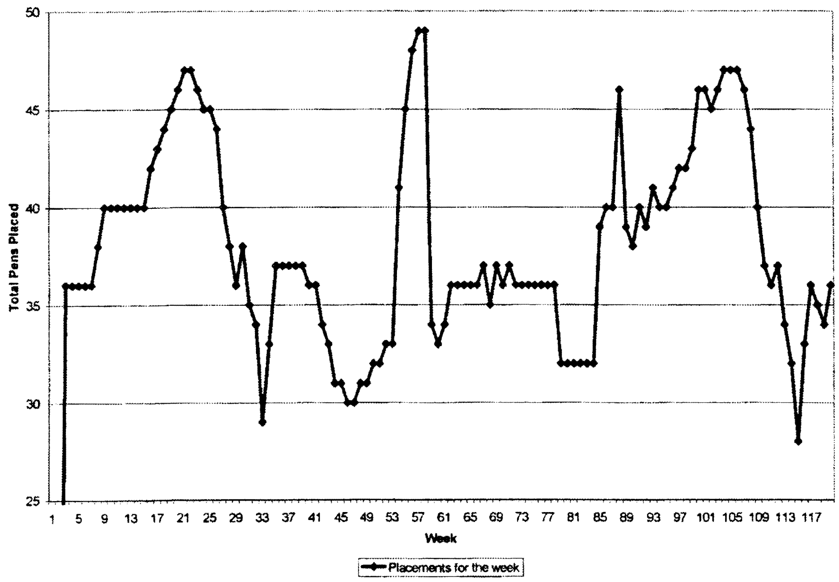


Figure 11. Feeder Placements by Week

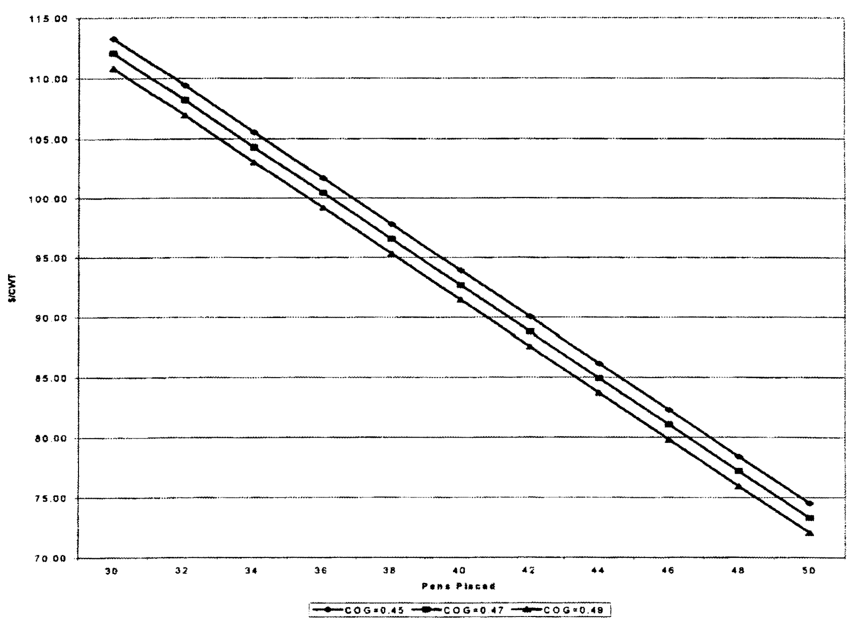


Figure 12. Feeder Cattle Demand, Genetic Type M Constant

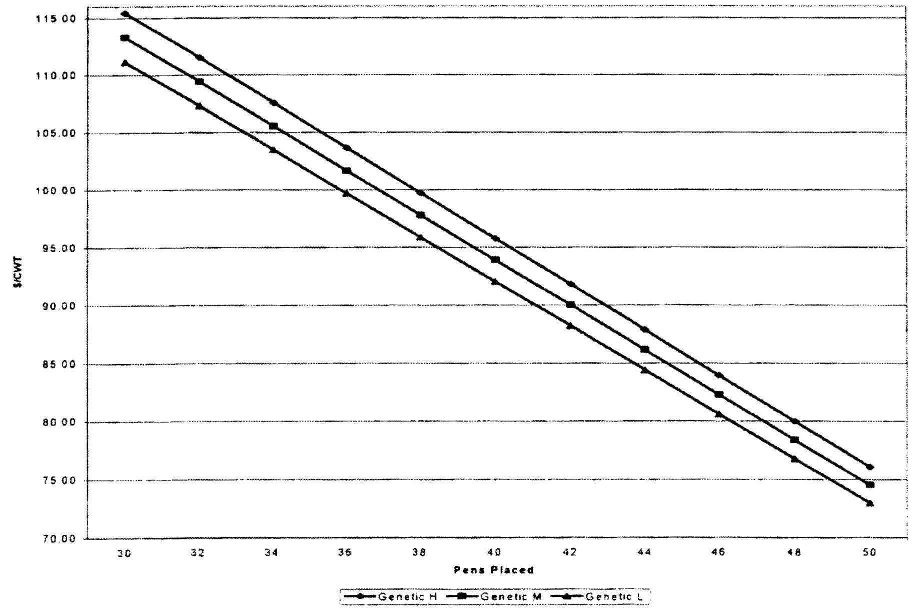


Figure 13. Feeder Cattle Demand, Cost of Gain $0.45 Constant

As more (less) cattle are placed on feed through the trading scenario, feedlots pay lower (higher) feeder cattle prices. Furthermore, as grain prices increase (decrease) feeder cattle prices decrease (increase). The price paid for a pen of feeder cattle placed on feed is largely determined by the supply of cattle available for slaughter at the time the pen is ready for slaughter. A readily available proxy for slaughter cattle supply 18 weeks in the future is total current placements. For example, cattle placed in the current week at 700 pounds and growing at the assumed growth rate of 25 pounds/week will weigh 1150 pounds in 18 weeks and be ready for slaughter. Given knowledge of feeder cattle placement numbers and growth rates, along with knowledge of the boxed beef demand curve, one can calculate an expected box beef price 18 weeks into the future. Given an expected boxed beef price, an expected slaughter cattle price can be derived by assuming a normal ratio of live cattle to boxed beef price (Koontz et al., 1992). The expected future boxed beef price is given by

(4)
$$P^{*}_{bb_t} = (P\max_{bb} + BBS_t) - (q_{placed_t} * \sum_{i=1}^{10} \beta_i)$$

where $P^{*}_{bb_t}$ is the expected boxed beef price in time t in dollars per hundredweight; $Pmax_{bb}$ is $198.05, a constant also in pounds per hundredweight, as in (1) above; BBS_t is boxed beef strength, 0.0 under this configuration; is the feeder cattle placement in pens placed in time t; and β_i is the ith coefficient. The sum of these weights is equal to 1.95121.

To avoid placing too much emphasis on a one-week change in placements, an average of the past five-weeks' placements and projected placements for next week are used to proxy slaughter supplies 18 weeks into the future. This effectively smoothes the dynamics of feeder cattle prices.

Feeding costs are a function of the cost of gain and the amount of weight gained. Within the *FCMS*, all feeder cattle placement weights are restricted to 700 pounds. This approximates the average weight of steers placed on feed when the simulator was originally developed (Eilrich, 1991). It is unrealistic to assume that all cattle are placed at the same weight, but since the players do not control placement weights and numbers, the key element to be generated by the placement process is a variable size show list. Thus, for simplicity of varying later show list size, varying the numbers of animals placed accomplished this objective.

Cost of gain per pound is exogenously specified in the simulator and varies by only a few cents over the course of the simulation (Figure 14). Thus by design, changes in the cost of gain are not intended to be a major factor in the profitability of feeding cattle. This design is based on two assumptions. First, feed grain prices do not generally change drastically in 18 weeks during most periods. Second, many feedlots feed their own cattle and so pre-purchase, contract, or self-produce their feed such that their feed costs for the forthcoming feeding period are predetermined. Thus, current feeding costs are assumed to be a good proxy for expected feeding costs (Koontz et al., 1992).

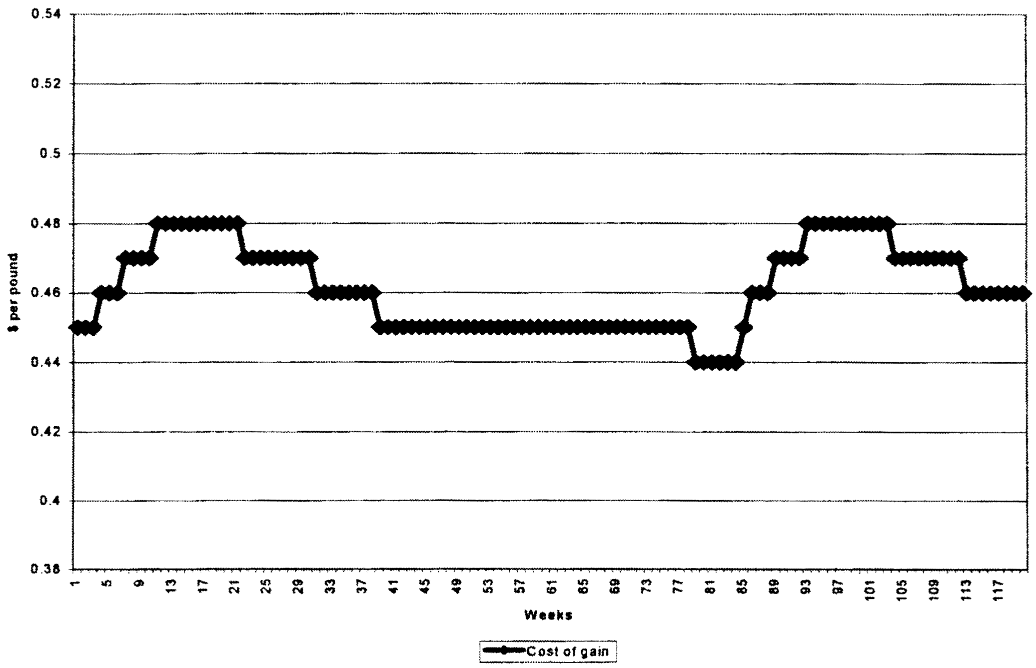


Figure 14. Cost of Gain by Week

The simulator also exogenously specifies the mix of genetic types given to each feedlot in a given week. The genetic distribution of placements is variable at the discretion of the simulator operator. The distribution can be changed from all of one type, either low, medium, or high, to some combination of all three. Low genetic type cattle are intended to represent high yielding cattle that tend to grade largely Select. Medium genetic type cattle represent medium yielding cattle that will have individual carcasses grading both Choice and Select. High genetic type cattle will be lower yielding cattle that will tend to grade mostly Choice. Figure 15 graphically depicts two sample weeks of feeder placements with corresponding genetic distribution. The scenario shown is a "normal" distribution (normal distribution in the statistical sense) of high, medium, and low genetic cattle for each feedlot under two placement conditions.

The price of replacement feeder cattle in the simulator is modeled by means of a series of four equations, (4), (5), (6), and (7). The first deals with estimated boxed beef price and is discussed above. Equation 5 models the estimated packer breakeven for the week of placement given the estimated boxed beef price

(5)
$$P^*_{pbe_t} = \{(P^*_{bb_t} - C_{package})*[(cwt\_per\_hd * dress\_percent_{1150})/100)] \\ - C_{shipping} + (P_{bp} * cwt\_per\_hd)\} / cwt\_per\_hd$$

where $P^*_{pbe_t}$ is packer breakeven price in time t in dollars per hundredweight of dressed weight; *cwt_per_hd* is 11.5, a constant conversion factor to hundredweight per head of live weight; $C_{package}$ is 2.12, a constant; and is 64.60, a constant. $C_{package}$ is the cost of packaging the dressed product and is expressed in dollars per hundredweight. $C_{shipping}$ is the cost of shipping the dressed product from the packing plants and is expressed in dollars per head. Shipping cost is assumed to be the same for all packers in the simulator.

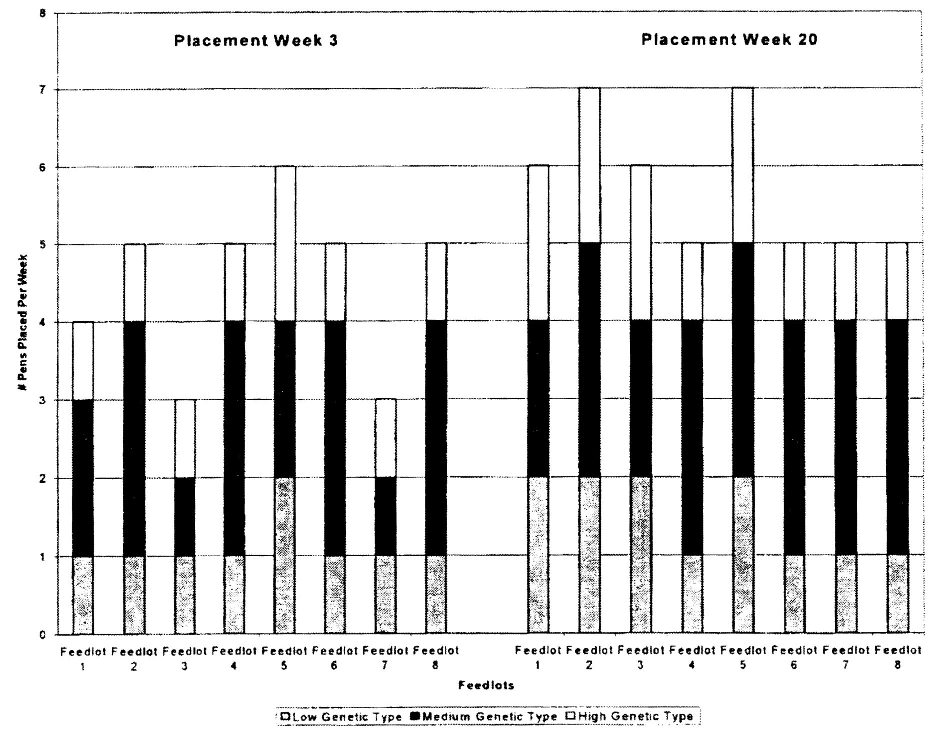


Figure 15. Feedlot Placement Distribution for Two Sample Weeks

Another factor that enters into the feeder price is the estimated cost of gain for feeder cattle placed in this period. The estimated cost of gain used in the simulator assumes all fed cattle will be marketed at 1150 pounds and the weekly cost of gain will remain constant over the entire feeding period. This means that each animal will gain 450 pounds at the current cost of gain. This estimated cost of gain is

(6) $$C^{*}_{cog} = C_{cog_t} * 450$$

where C^{*}_{cog} is the total estimated cost of gain for new incoming feeders in dollars per head and C_{cog_t} is cost of gain per pound for the current feed period in dollars per hundredweight.

Feed conversion for fed cattle is measured as pounds of feed used per pound of beef produced. Realistically, there is a point when feed conversion diminishes. In the simulator, a feed conversion inefficiency factor is applied to over-finished cattle. Cattle weighing 1100, 1125, or 1150 pounds are not penalized with this factor. However, over-finished cattle weighing 1175, 1200, and 1225 pounds are penalized 8%, 18%, and 28%, respectively, over the entire feed period. For example, if an animal is sold weighing 1175 pounds and the feed cost is $0.48 per pound, then applying the 8% surcharge over the entire feeding period, (1175-700) x 0.48 = $228.00 x 1.08 = $246.24. This represents $246.24-228.00 = $18.24 added cost for the feeding period. These surcharges are exaggerated in the simulator so as to facilitate encouraging cattle feeders to market cattle in a shortened market window. In reality, feeding inefficiency of cattle occurs less dramatically, leading in part to a market window extending over a longer time and wider weight range than was believed feasible for the simulator.

Replacement feeder cost is given as the feeder's breakeven price given the estimated packer breakeven price and the total estimated cost of gain. An adjustment factor is used to specify a constant profit level for the cattle feeders, in this case a 4% profit level. Replacement feeder cost is

(7) $$P_{fc_t} = \{[(cwt\_per\_hd * P^{*}_{pbe_t}) - C^{*}_{cog}] / cwt\_per\_feeder\} * \pi_{adj}$$

where P_{fc_t} is the replacement cost of feeder steers in dollars per hundredweight; *cwt_per_feeder* is 7.0, a constant conversion factor; and π_{adj} is 0.96, a constant profit adjustment factor.

Cattle Feeding Breakeven Price Example – Participants are given an initialization table (Table 13) at the beginning of each workshop or class with the following summary of market information. Information listed corresponds to columns in Table 13.

- Current week number or the week feeder cattle are placed on feed (Plct Week)
- Week in which cattle placed on feed during the current week will reach the show list (i.e. 1100 pounds) (Show List Week)
- Total number of pens of cattle placed on feed in all feedlots during the current week (# of Pens Placed)
- Price of feeder cattle placed on feed this week (700 lb. Feeder Price)
- Cost of gain this week (Current Cost of Gain/lb.)
- Projected break-even price (Projected Break-even)
- Actual cost of gain for 1150 lb. cattle (Actual COG for 1150)
- Actual breakeven price for 1100 to 1200 lb. cattle (Actual Breakeven Price)

The projected break-even price assumes cattle placed on feed this week will be sold at 1150 pounds after 18 weeks on feed and that the cost of gain during the feeding period does not change. Actual cost of gain accounts for changes in week-to-week cost of gain over the 18-week period.

An important factor for cattle feeders in marketing cattle effectively is knowing their breakeven price. Participants are taught to compute their breakeven price each week for cattle on the show list (Koontz et al 1992). Table 14 presents an example of how participants calculate a breakeven price for fed cattle in the market simulator.

Participants have to compute the cost of gain for the total number of weeks cattle are on feed, since the cost of gain changes somewhat over the feeding period. Similarly, participants need to compute the breakeven price for each slaughter cattle weight group. In many cases, participants compute the breakeven price for one weight group and make adjustments for lighter or heavier cattle. Cattle weighing 1150 pounds have the lowest average cost of production and therefore the lowest breakeven price. Cattle weighing 1100 or 1125 pounds have a higher breakeven price. Since cattle weighing 1175, 1200, or 1225 pounds have a feed conversion inefficiency surcharge applied to them, cattle in these weight groups also have higher breakeven prices.

Packer 5 purchases all cattle that reach 1225 pounds. Packer 5 is a hypothetical firm in the simulator. In essence, fed cattle allowed to reach 1200 pounds but then which are not sold in that week, are assigned or sold to Packer 5. The sale price is computed by taking the mean selling price of all weights of cattle marketed during the current trading period and subtracting $1.00 per hundredweight from each pen of overweight cattle marketed, up to a maximum of ten pens. All pens at or in excess of the ten-pen maximum are purchased at the mean price minus $10.00 per hundredweight.

Market Information

Various types of publicly reported market information become available to both cattle feeders and meatpackers on a regular basis. Similarly in the simulator, various types of market information are collected and disseminated to all participants.

Within-Week, End-of-Week Information – During each trading period, up to two scrolling LED light bars report total pens of cattle sold, number of those sold that were contracted, high and low live weight prices, high and low dressed weight prices, and the current volumes traded and prices of each of the three currently open futures contracts are displayed in real-time. The simulator can be configured for different levels of real-time information, from none to all of the information. It can also be configured for zero, one, or two operating light bars.

Table 13. Week 21 Initialization Table

O.S.U. AG ECONOMICS INITIALIZATION TABLE WEEK 21

Plct Week	Show ListWeek	# of Pens Placed	700 lb. Feeder Price	Current Cost of Gain/lb.	Projected Break-even	Actual COG for 1150	Actual Breakeven Price				
							1100	1125	1150	1175	1200
1	17	35	99.72	0.45	78.31	0.470	80.51	79.78	79.09	79.95	81.33
2	18	35	99.72	0.45	78.31	0.472	80.57	79.85	79.15	80.01	0.000
3	19	36	98.71	0.45	77.69	0.473	79.99	79.28	78.60	0.000	0.000
4	20	36	97.94	0.46	77.62	0.000	79.57	78.86	0.000	0.000	0.000
5	21	36	99.49	0.46	78.56	0.000	80.60	0.000	0.000	0.000	0.000
6	22	36	97.71	0.46	77.48						
7	23	36	97.95	0.47	78.01						
8	24	38	97.25	0.47	77.59						
9	25	40	96.54	0.47	77.15						
10	26	40	95.22	0.47	76.35						
11	27	40	94.52	0.48	76.32						
12	28	40	93.46	0.48	75.67						
13	29	40	92.22	0.48	74.92						
14	30	40	90.81	0.48	74.06						
15	31	40	89.58	0.48	73.31						
16	32	42	88.52	0.48	72.66						
17	33	43	87.29	0.48	71.92						
18	34	44	86.06	0.48	71.17						
19	35	45	85.00	0.48	70.52						
20	36	46	84.12	0.48	69.99						
21	37	47	83.24	0.48	69.45						

Table 14. Worksheet to Compute Break-Even Price for 1150-Pound Fed Cattle

Step		Amount
STEP 1:	Calculate Total Cost of Gain (Slaughter Weight – Placement Weight) X Cost of Gain/lb. ((1150#-700#) X $0.477/#) =	$214.65/head.
STEP 2:	Calculate Total Feeder Cattle Purchase Cost Placement Weight X Purchase Price/Cwt. 7.0 Cwt X $93.61/Cwt =	$655.27/head.
STEP 3:	Convert to Cost/Cwt. of Slaughter (Step 1 + Step2) / Slaughter Weight/Cwt. ($214.65 + $655.27) / 11.5 Cwt.	$75.65/Cwt.

Zero light bars reveal no real-time information. If the game is configured for one light bar, the display sequence will be (assuming the current game week is 21 and using possible volumes and prices):
Week 35—TTL Pens/Contracted 38/5—Live Price Hi/Lo 75.35/73.20—Carcass Price 119.60/116.19—Futures Vol 10—WK 24 76.15 6—WK 32 77.85 3—WK 40 78.10.

The interpretation of this message is as follows. In Week 35, 38 total pens of cattle were traded, of which 5 pens were contracted. The highest live price reported this week was $75.35/cwt; and the lowest price, $73.20/cwt. The highest and lowest dressed weight prices were $119.60 and $116.19/cwt. respectively. For this week in the futures market, 10 contracts (volume) for futures contract week 24 were traded with the current market price (last trade) at $76.15/cwt. Likewise, for contract weeks 32 and 40, there were 6 and 3 contracts traded in each futures contract week, respectively. Current or last prices for those weeks were $77.85 and $78.10/cwt., respectively. The light bar scrolls the entire message and is updated regularly, about two times per minute. Assuming it is configured for two light bars, the cash market information will be displayed on one bar while the futures information is displayed on the second bar.

After the trading session ends, public market information is updated on a chalk or white board as shown in Table 15. An average of cash cattle prices is given by weight group and transaction type. Also reported is the current Select discount, current yield grade 4-5 discount, current cost of gain, current replacement feeder price, current boxed beef price, and volume of pens traded for the trading week.

Usually, comparable information for five-to-eight preceding weeks or trading periods are maintained for participants.

Cattle On Feed Report – Every four weeks, participants are given a calculated cattle on feed report. In the simulator, the computer constantly keeps track of cattle. At any time, it knows exactly how many cattle are on feed in each weight category and the total number. An example of one of these reports is shown in Table 16.

Rather than reporting on-feed information compared to a past period, as occurs with real-world Cattle on Feed Reports, in the simulator, on-feed information is compared to a "normal" for the simulated market. This normal or base for comparison purposes can be likened to the simulated market in equilibrium. Reported and normal numbers shown in the report are in total pens of cattle in each category. For example, beginning cattle on feed in week 76 was 745 total pens, compared with 760 total pens when the market is in equilibrium. Thus, beginning cattle on feed is 1.97% below the normal number on feed in week 76.

Table 15. *FCMS* Example End-of-Week Information

Week	30	31	32	33	34
Live:					
1150	$78.93	$78.53	$78.13	$77.94	$75.50
1175	—	—	—	—	—
Dressed:					
1150	$126.63	$127.80	$126.00	$125.85	$125.17
1175	—	$126.50	—	$126.25	—
Discounts:					
Choice – Select	-$5.37	-$5.84	-$6.89	-$6.24	-$7.71
YG 3 – YG 4-5	-$9.03	-$9.41	-$8.20	-$8.84	-$8.01
Cost of gain[a]	$0.47	$0.46	$0.46	$0.46	$0.46
Feeder Price	$99.65	$101.62	$102.20	$102.40	$102.20
Boxed Beef Price	$126.76	$125.51	$121.41	$119.49	$122.86
Volume Sold	36	44	47	38	42

[a] All prices are given in dollars per hundredweight except cost of gain, which is dollars per pound.

Table 16. Monthly Cattle-On-Feed Report Example

MONTHLY CATTLE ON FEED REPORT -- BEGINNING WEEK 80

	Reported	Normal	% Difference
Beginning Cattle on Feed	745	760	-1.97%
Placements for the Month	136	160	-15.00%
Marketings for the Month	171	160	6.88%
Ending Cattle on Feed	710	760	-6.58%
700 to 899 lb. Cattle	280	320	-12.50%
900 to 1099 lb. Cattle	290	320	-9.38%
1100 lb. Cattle and Up	140	120	16.67%

Placements are added to the beginning cattle on feed and marketings are subtracted to arrive at the ending cattle on feed for week 80. Ending cattle on feed is also reported by weight groups. This information is especially important for the 1100 pound and higher weight group, since that represents the current size of the show list. Research has shown this to be an important piece of information in price discovery in the simulator, which is not typically available in the real fed cattle market (Ward et al., 1996).

Futures Market

A futures market component is included in the simulator and is an effective teaching tool. Participants use the futures market to hedge fed cattle prices or speculate on price movements. Futures trades can be made by the eight feedlot teams and four meatpacker teams. Plus, there can be up to four speculators. Futures contracts mature every eight weeks, e.g. Week 24, Week 32, Week 40, etc. At any one time, there are three, open futures contracts to trade. These are the three closest (in time) contract weeks, often referred to as a nearby contract and two distant contracts. For example in Week 26, open contracts available to trade are Weeks 32, 40, and 48.

In the real world, fed cattle futures contracts are 40,000 pounds per contract. In the simulator, the futures contract size is the same as the pen size, 100 head of 1150 pound fed steers or 115,000 pounds. The simulator futures market cash settles all futures transactions at the average price for 1150 pound cattle traded during the expiration week. Since this is a cash settled contract, there is not an option to deliver cattle as there is in the real fed cattle market. All cattle in the feedlots must be physically sold to a meatpacker in the simulator.

Three types of futures market orders are available to participants; market, limit, and stop orders. Participants trading futures contracts must specify the type of order, contract to trade, and the number of contracts they wish to buy or sell on a futures trading card (refer back to Figure 3). The market order is a buy or sell transaction for the person placing the order at the current market price when the order form is scanned. Limit orders trigger a buy or sell transaction if the market touches some price level specified by that order. Stop orders are used to limit losses or protect profits at some level preset on the order. When/if the market price level is reached, the order is executed as specified. Orders may be either buy (long) or sell (short) and may be placed for 1-to-5 contracts per order form. Each executed contract results in a market movement of $0.05 per hundredweight. If a contract is in opposition to market direction, e.g. a sell (buy) contract in an uptick (downtick) market, the market momentum will stop and await direction from the next contract traded. Futures transaction statements (Figure 16) are distributed each week in addition to regular financial statements to the participants (Figures 17 and 18).

The futures market price level for each contract is determined by actions of the players in the simulation. Selling contracts pressures futures prices downward, while buying contracts pressures those prices upward. Simulator participants are encouraged to hedge cattle and speculate cautiously. Classroom or workshop administrators (often acting as speculators) watch the futures market to assure proper market action and reaction. Market convergence at delivery time is assured through collective efforts of the hedgers and speculators.

Summary and Concluding Observations

Summary – This report details the economic components of the *Fed Cattle Market Simulator* (*FCMS*) or packer-feeder game. The *FCMS*, originally conceived to be an experimental economics research tool, has been an effective teaching tool both in the classroom and in applications outside the classroom with youth and various groups of adult learners. Repeatedly, students state that even though they have taken many other economics, marketing, and management courses, it was through the *FCMS* that they integrated the concepts and made them meaningful. By altering the focus of experimental economics from research to teaching, the same methods used in developing controlled experiments to learn about human economic behavior enable participants to learn and experience how markets operate and how to apply their innate and acquired skills in the marketplace.

The teaching potential of this experimental market simulator is clear. Participants must demonstrate their understanding of many important economics, marketing, and management concepts. Examples of concepts and principles taught include production efficiency, breakeven analysis, price forecasting using market supply and demand conditions, economies of size, and risk management, among others. Participants must develop and apply interpersonal negotiation and conflict resolution skills. They develop an appreciation for business ethics. They are exposed to the micro/macro paradox often faced by agricultural producers. For example, individual strategies and plans may be correctly formulated, but implementing them may be difficult if market conditions change due to the collective actions of others in the marketplace. Sometimes, what is good for the individual team is not good for the entire market if everyone pursues the same strategy. Thus, participants must learn to develop, implement, and modify decision-making strategies. The simulator creates and capitalizes on teachable moments and creates a need to know atmosphere in the classroom. Finally, participants also begin to see the value of applied research.

TRADES THIS WEEK

Buy	Sell	Week	Price	Profit/Loss
X		64	83.90	0.00
X		64	83.95	0.00
X		64	84.00	0.00
X		64	84.05	0.00
X		64	84.10	0.00
X		64	84.40	0.00
X		64	84.45	0.00
X		64	84.50	0.00
X		64	84.55	0.00
X		64	84.60	0.00

OPEN POSITION STATUS

Number	Week	Buy/Sell	Avg. Price	Est. Value
0	64	0.00	0.00	
0	72	0.00	0.00	
0	80	0.00	0.00	

Estimated Value of Open Positions 0.00

Profit/Loss(net)	Contract Week	# Contracts Closed	Closing/Opening
0.00	24	0	76.00
0.00	32	0	77.25
0.00	40	0	72.25
0.00	48	0	73.00
0.00	56	0	80.65
140129.11	64	40	85.60
0.00	72	0	81.30
0.00	80	0	80.25
0.00	88	0	76.00

Profit/Loss of Closed Positions $ 140,129.11
Contract for week 64 cash settled at $ 85.24

Figure 16. Futures Transaction Summary

Packer 1 - Weekly Financial Summary - Week 22

Receipts From Sale of Boxed Beef -- $699340

Transaction Summary

Weight	Adj. BB Price	Gross Rev.	Profit/Head
1150 GH	124.85	100820	41.24
1150 GM	124.40	99906	36.48
1150 GH	124.85	100820	41.24
1150 LL	123.95	99865	28.39
1150 DM	124.40	99906	32.15
Ave.	Ave.	Ave.	Profit/Unit
1150	124.62	99978	33.56

Expenditures -- $668038

Slaughter Cattle Purchased $618401

Feedlot	Weight		Price		Gross Cost
	Live	Carcass	Live	Carcass	
7 GH	1150	724	76.22	120.98	87648
7 GM	1150	724	74.70	118.58	85909
5 DM	1125	703	77.00	123.20	91448
5 LL	1150	724	77.37	122.81	88976
5 LM	1150	724	78.88	125.21	90712

Processing Cost -- $49637

# Pens	Cost/Pen
7	7091

Figure 17. Sample Weekly Financial Statement for Packers

Feedlot 5 - Weekly Financial Summary - Week 21

Receipts From Sale of Cattle $544469

Transaction Summary

Packer	Weight		Price		Profit/Hd
	Live	Carcass	Live	Carcass	
3 DL	1150	724	80.01	127.00	20.53
4 GH	1150	724	76.68	121.72	-17.74
4 LM	1150	724	79.75	126.59	17.54
4 LL	1150	724	78.00	123.81	-2.58
4 LM	1150	724	78.00	125.40	8.92
4 DH	1150	724	80.01	127.00	20.53
	Avg.	Avg.	Avg.	Avg.	Avg.
	1150	724	78.91	125.25	7.87

Expenditures $537597

Feeder Cattle Purchased -- $ 404397

#Pens	Weight	Price	Cost/Hd.
7	700	82.53	577.71

Feeding Cost -- $ 114257

# of Pens on Feed	Total lbs. Gained	Cost of Gain/lb.
111	277500	0.4800

Figure 18. Sample Weekly Financial Statement for Feedlots

Fundamental revisions in the simulator have increased the scope of concepts that may be taught. Instructor-users of the new software have seen the situational complexities grow at a seemingly exponential rate as changes have been added. Likewise, the number of teachable moments has increased with complexity and the revised simulator can be used to teach additional production and marketing concepts. Feed conversion efficiencies of different genetic profiles, carcass concepts, solutions to dynamic marketing problems, and multiple strategies may be addressed with simulator scenarios.

Concluding Observations – The *FCMS* is currently applied to the cattle feeding and beefpacking industries, but with significant modifications could be developed to simulate other agricultural commodity sectors. Many facets of the simulator apply to a majority of agribusiness sectors. Experience to date indicates the market simulator can be used effectively with a wide range of participants, from youth to corporate executives.

Research experiments have been designed to test various hypotheses and others are possible. For example, does the *FCMS* represent an efficient market as defined in the economics literature? Does grid pricing in the *FCMS* improve the price signaling function compared with live and dressed weight pricing? Is teaching with the *FCMS* superior to teaching similar economic concepts by traditional lecture or other methods?

This revised version of the market simulator both presents challenges to knowing the best way to teach some economic concepts, such as grid pricing, but it also provides expanded opportunities both for teaching and research.

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