GENETICS, CARCASS DISCOUNTS, AND GRID PRICING IN THE FED CATTLE MARKET AND WELFARE IMPACTS OF BEEF AND PORK CHECKOFF PROGRAMS

By

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PREFACE

This dissertation is comprised of three essays, each of which forms one of the main chapters or sections of the text. The first essay, "Inside The Fed Cattle Market Simulator: Multiple Genetics and Pricing Options" examines the theory and practice of using Oklahoma State University's Fed Cattle Market Simulator, an experiential learning tool, for the purpose of teaching the mechanics of fed cattle livestock marketing. This essay follows development of the simulator from its inception to present from the standpoint of marketing theory and empirical models used in the simulation. New dressed weight and grid or value based pricing options are explored. The upgraded software now includes multiple genetic types of cattle; implications relating to management strategy are dealt with. Additional teaching topics are explored and discussed.

The second essay is entitled "Examining The Choice-Select and Yield Grade 4-5 Discount Components of Grid Pricing For Fed Cattle". These two discounts comprise two significant sources of variability in fed cattle price and producer profit. These data series are examined and their relationship is shown to have statistically changed at a point in time around the inception of mandatory price reporting. Three models of each discount series are examined and reported on. In both cases, a partial adjustment model performed best in explaining the dynamics of the carcass discounts. It is noted that after

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The third and final essay, "Generic Advertising and Research In Beef and Pork Without Supply Control" examines the generic research and promotion programs funded by the beef and pork "checkoff" programs as regulated by the United States Department of Agriculture. Since inception of these programs, substantial litigation has been filed and adjudicated with respect to them. The purpose of this research was to follow this litigation and attempt to determine the final handling of these programs regarding constitutionality issues. In addition, an economic analysis of impact was conducted to determine the resulting forces upon the industry and economy if these programs are terminated. It is found these programs produce economic benefits to both producers and consumers and a judicial "striking down" of these programs would be detrimental.

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Lisa, what can I say about you? Every time we needed something you were always there. My my what a special friend and daughter of the heart you have been to us. Thank you for everything and all you are. Just keep on being the person you are forever, okay?

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My beloved wife Geniva has certainly paid an awesome price for this accomplishment. I know without a shadow of a doubt that nothing about this education and degree would have happened without her. She has loved, supported, and strengthened me as I struggled and crawled through this experience. A man can take a hammer and beat a great mountain into a pile of gravel with a woman of this caliber by his side. For her I insert one equation that only she is capable of interpreting. So my beloved one:

(1) O+=+| |only for you .

I LOVE YOU FOREVER AND ALWAYS!

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CHAPTER I

INSIDE THE FED CATTLE MARKET SIMULATOR: MULTIPLE GENETICS and PRICING OPTIONS

INTRODUCTION

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. Four OSU agricultural economists (Stephen Koontz, Derrell Peel, James Trapp, and Clement Ward) began meeting regularly in 1989 to discuss common livestock marketing research and extension interests.

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 (Ward et al 2001a). Initially, cattle trades in the *FCMS* were only on a live weight basis. As dressed weight and grid pricing became increasingly common in the industry, incorporating these pricing methods became necessary. In 1999, a project to expand the scope of the simulator was undertaken. This project was to incorporate dressed weight and grid pricing, floating carcass premiums and discounts, and multiple genetic feeder cattle types. The objective of this paper is to examine the revised simulator and its underlying economic components.

Overview of the Simulator

From the outset, the focus of the *FCMS* was on the price discovery process for fed cattle (Ward et al 1996). Participants, whether students or adult learners, work in teams of two-to-four persons. There are eight cattle feedlots and four meatpacking firms, numbered one through eight and one through four, respectively. The 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 beefpacking buyers (Figure I-1)(Ward et al 2001b). Predetermined cattle supplies are programmed into the software and 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 for slaughter between 1100 and 1200 pounds. During that five-week marketing window, cattle are on the "show list" and packer buyers approach feedlots to bid on cattle (Ward et al 2001b). If cattle are not sold at or before the weight of 1200#, the next week those 1225# cattle are sold to a default Packer # 5 at a substantial discount. Packers operate four plants, each of which is a different size with different cost structures, 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.

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. This will be addressed later in the paper. 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 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 trade 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 (Ward et al 2001e).

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.

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.

A study was undertaken to estimate a price dependent boxed beef demand function appropriate for the *FCMS* (Meyer). 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# cattle per week and an associated mean boxed beef price was set at a round number near mid 1990 levels. The model used is shown in (1) with its respective lag coefficients shown in

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

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# equivalent cattle) in week t-i. These computations normalize weight allowing number of pen equivalents to reflect the entire poundage change.

Table I-1. Lag Coefficients of 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 I-3. The demand schedule reveals the market price for boxed beef for a constant stream of pens of cattle marketed at 1150 pounds. Figure I-4 also shows the distributed lag of flexibilities used to adjust the boxed beef price given the flow of animals processed in the game (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 I-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 to a constant 44 pens per week, the boxed beef price will decrease approximately 6.5%. However, the decrease is over a 10-week period (Koontz et al 1992).

Packers in the simulator use boxed beef price as a measure of market demand, however, all meat sold from the cooler is sold on an adjusted basis. The adjustment starts with the boxed beef price. Carcass premiums and discounts associated with carcass traits, e.g. quality grade and yield grade, appropriate to the week sold and each pen purchased are applied, yielding an adjusted boxed beef price for the pen.

Meatpacker Economics

General

Participants role playing as meatpacking 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 (Ward et al 2001d). The game players 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 product revenues. 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 (Ward et al 2001d). Therefore, one key decision packers make daily, both in reality and in the packer-feeder game, 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 more pens 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 than the minimum-cost volume. A 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 variable costs. It will be advantageous for a meatpacker to close if the losses incurred by purchasing cattle are greater than fixed costs (Ward et al 2001d).

Packing Plant Costs

The *FCMS* draws on published knowledge concerning the economies of size in packing plants (Sersland; Duewer and Nelson). 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 relatively large plants and two relatively small plants. The shape and relationship of the cost curves for each packing plant in the game is shown in Figure I-5. Plant costs are detailed in Table I-15. The long run industry curve would create an envelope containing the short run curves.

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 a classroom setting. However, critical to realistic simulation of the fed cattle market is that plant cost structures be realistic on a per head basis and that relative costs between the different sizes of plants are also realistic.

Little research has been done on short-run (weekly) cost curve structures, though considerable research has identified the intermediate (annual) and long-term (life of plant) 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, 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.

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 closest available study to a weekly cost curve study was found to be 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 I-2, I-3, and I-4.

Table I-2. 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 I-3. 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 I-4. 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 relatively clearly 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 (Ward et al 2001d).

Meatpacker Pricing of Fed Cattle

Another major decision packers make daily is how much to pay for cattle (Ward et al 2001d). 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 (Ward et al 2001d).

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 I-5. 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 I-3 for an 1150# carcass. Table I-6 is an example of a price bid on a live weight basis for 1150# average quality, average yield (M genetic type) cattle given the premiums, discounts, and byproduct prices in Table I-5. Prices are in dollars per hundredweight and quantities are in per head units.

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 (Ward et al 2001d).

Table I-5. Example Premiums and Discounts, As Presented by a Packer

Quality	Premium/Discount
Choice Yield Grade 3 600-900#	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.
Byproducts (Priced per cwt live weight basis)	8.50/cwt

Table I-6. 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 # 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.

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 I-7 shows the process of estimating a dressed weight bid price for the same pen and market conditions as in Table I-6 (Ward et al 2001d).

Table I-7. 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 # 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 / 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 process 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 I-5) (Ward et al 2001d).

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 (Ward and Schroeder). 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 (2) and shown graphically in Figure I-6:

(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-sel} represents the Choice-Select discount 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.

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 showlist 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 I-7).

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 (3) and may be graphically viewed in Figure I-8.

$$(3) \qquad P_{yg3-45} = \begin{cases} -50.00; & q_{\%45} > 0.245 \\ \beta_1 * \{\beta_0 + 2 * [(q_{\%45} - \beta_2) * 100.0]\}; & 0.0 < q_{\%45} \le 0.245 \\ -1.00; & q_{\%45} = 0.0 \end{cases}.$$

Where $P_{yg3\text{-}45}$ is the yield grade 3 to yield grade 4-5 discount 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 with the quality grade versus weight scenario, as 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 I-10).

Both of these discounts imply negative values and are given in terms of dollars per hundredweight.

The premiums and discounts in Table I-5 can be put into matrix format as in Table I-8. The term grid comes from this matrix framework of premiums and discounts for specified carcass characteristics.

To complete the matrix in Table I-8, 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 I-9 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.

Table I-8. 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 I-9. Example Grid in Completed Matrix Format ($/dressed Cwt.)

	Yield Grade		
Quality Grade	1	2-3	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	

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 (Ward et al 2001d). That distribution, shown in Table I-3, is also put into a matrix framework. Table I-10 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.

Table I-10. Example Distribution of Carcasses In Matrix Format (% of pen total)

	Yield Grade		
Quality Grade	1	2-3	4-5
Prime	4	3	2
Choice	25	17	2
Select	27	19	2
Total carcasses	100		
Light Carcasses (<550 lbs.)		0	
Heavy Carcasses (>950 lbs.)		0	

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 I-5 (i.e., the "base" price in Table I-9), 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 I-10 times each premium and discount cell in Table I-9. That sum for all cells is added to the base price. Steps 4, 5, and 6 are as described in Steps 2, 3, and 4 for the dressed weight pricing example. This process is illustrated in Table I-11. The market conditions existing in the live and dressed examples are also used in the grid price example.

Table I-11. 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 + Step2	$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.

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 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 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. Therefore, offer prices should be based on the expected market weight of cattle, not the current week weight. Feeders also must consider how forward sale of cattle affects their breakeven price, especially if the cattle to be delivered weigh 1175 or 1200 pounds (Ward et al 2001).

Feedlot Economics

Feeder Cattle Prices, Placements, and Genetic Composition

Feeder cattle prices and placements are exogenous in the *FCMS*. Feedlot managers do not have control over the number of pens of cattle, which are placed on feed in their feedlot or the price paid for cattle they "custom" feed (Ward et al 2001c). 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 I-9 graphically displays total placements over all weeks. Research has shown that real-world feeder cattle market prices are generally priced very near expected break-even prices (Buccola). 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 11 shows the demand relationship between feeder cattle prices and number of pens of cattle placed on feed at different costs of gain (different grain market conditions) for a constant genetic type M. For the purposes of replacement feeder cattle price, the genetic type is always assumed constant at type M, however, if the genetic type were allowed to vary and the cost of gain were held constant at $0.45 per pound, Figure I-12 shows the demand relationship across genetic types.

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 model's assumed rate of growth of 25 pounds/week/head will weigh 1150 pounds in 18 weeks and be ready for slaughter. Given knowledge of feeder cattle placement numbers and growth rates and 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 the model in (4):

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

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; q_{placed_t} is the feeder cattle placement in pens placed in time t; and β_i is the ith coefficient, see above Table I-1, 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-week's placements and the projected next week's placements 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 (Eilrich). 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. For simplicity varying the numbers of animals placed and not the weights or some combination of numbers and weights did this.

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 I-13). Thus by design, changes in the cost of gain are not intended to be a major factor in the profitability of cattle feeding. This design is based on several assumptions. First, feed grain prices do not generally change drastically in 18 weeks during most periods. Secondly, 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 of expected feeding costs (Koontz et al 1992).

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, low, medium, or high types, 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 individuals grading both Choice and Select. Whereas, high genetic type cattle will be lower yielding cattle that will tend to grade mostly Choice. Figure I-14 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.

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

Where $P^{*}_{pbe_t}$ is packer breakeven price in time t in dollars per hundredweight dressed weight; cwt_per_hd is 11.5, a constant conversion factor in hundredweight per head live weight; $C_{package}$ is 2.12, a constant; and $C_{shipping}$ 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. This factor is assumed to be a constant across all packers for the purposes of the simulator.

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 shown in (6).

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

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 the current feed period in dollars per hundredweight.

Feed conversion in fed cattle is measured as pounds of feed used per pound of beef produced. Realistically, there is a point such that feed conversion diminishes. In the simulator a feed conversion inefficiency factor is applied to over finished cattle. Cattle weighing 1100#, 1125#, or 1150# are not penalized with this factor. However, over finished cattle weighing 1175#, 1200#, and 1225# are penalized 8%, 18%, and 28%

respectively over the entire feed period. For example, if an animal is sold weighing 1175# and the feed cost is $0.48 per pound, then applying the 8% surcharge over the entire feeding period, (1175-700)X0.48 = $228.00X1.08 = $246.24. This represents 246.24-228.00 = $18.24 cost for the feeding period. Likewise for a 1200# animal with the same feed cost per pound of gain and an 18% surcharge, the feed cost would be, (1200-700)X0.48 = $240.00X1.18 = $283.20, or 283.20-240.00 = $43.20 cost for the feeding period. These surcharges are exaggerated in the simulator; however, the issue the surcharges address is valid.

Replacement feeder cost is then 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. Equation 7 shows the replacement feeder cost.

(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 I-16) at the beginning of each meeting with the following summary of market information:

1. Current week number;
2. Week in which cattle placed on feed during the current week will reach the show list (i.e. 1100 pounds);

3. Total number of pens of cattle placed on feed in all feedlots during the current week;
4. Price of feeder cattle placed on feed this week;
5. Cost of gain this week;
6. Projected break-even price;
7. Actual cost of gain;
8. Actual breakeven price for 1100 to 1200 pound cattle.

The projected break-even 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 (item # 7 in the above list) accounts for changes in cost of gain over the 18-week period.

An important step for cattle feeder in marketing cattle effectively is to know their breakeven price. Participants are taught to compute their breakeven price each week for cattle on the show list (Koontz et al 1992). Table I-12 presents an example of how participants calculate a breakeven price for fed cattle.

Table I-12. 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.

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# have the lowest average cost of production and therefore the lowest breakeven price. Cattle weighing 1100# or 1125# have a higher breakeven price. Since cattle weighing 1175#, 1200#, or 1225# have a feed conversion inefficiency surcharge applied to them these weights also have higher breakeven prices.

Packer # 5 purchases all cattle that reach 1225#. Packer # 5 is a hypothetical firm in the simulator, which has no competition and makes its purchases at its own specified price. That price is computed by taking the mean selling price of all weights of cattle marketed this 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 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.

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 is configurable for different levels of real-time information, from none to all of the information. It is also configurable for zero, one, or two operating light bars.

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 various volumes and prices for example):

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 1

The interpretation of this message is fairly straightforward. In Week 35, 38 total pens of cattle have been traded. of those 38 total pens, 5 pens were contracted. The highest live price reported this week has been $75.35/cwt and the lowest price has been $73.20/cwt. The highest and lowest dressed weight prices have been $119.60 and $116.19 respectively. For this week in the futures market, 10 contracts for contract week 24 have been traded with the current market price at $76.15. Likewise, for contract weeks 32 and 40, there have been 6 contracts and 3 contracts traded in each contract week respectively. The market prices for those weeks currently are $77.85 and $78.10. The light bar will scroll the entire message and is updated regularly, about two times per minute. Assuming it is configured for two light bars, the cash cattle 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 I-13. An average of cash cattle prices is given by weight groups and transaction type, current Select discount, yield grade 4-5 discount, current cost of gain, current replacement feeder price, current boxed beef price, and volume of pens traded for this period.

Table I-13. *FCMS* Example Board 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.

Usually, comparable information for five to eight preceding weeks or trading periods are maintained for participants. Period ending summary prices for futures trading are not given but participants are expected to watch the real-time scrolling light bars for this information.

A futures market component is included in the simulator that can be used as a teaching tool. The participants can use this market to hedge their cattle or speculate on price movement. A written pre-work essay describes this option in the simulator (Ward et al 2001e) and includes a short treatise on the real world live cattle futures market. Futures trades are available to eight feedlots, four meatpackers, and four speculators. Speculators are other individuals in the room typically the teaching team. Delivery weeks occur each eight weeks, e.g. Week 24, Week 32, Week 40, etc. At any one time, there are the three closest (in time) delivery weeks available for trade; trade in other weeks is not allowed. For example in Week 26, weeks available for trade are 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# fed steers or 115,000 pounds. The simulator futures market cash settles all futures transactions at the average 1150# price derived from cash sales during the expiration week; there is not an option of delivery within the simulator. All cattle in the feedlots must be physically sold to a meatpacker in the game.

Three types of futures orders are available; market, limit, and stop orders, see Figure I-2. The market order triggers a buy or sell transaction for that trader placing the order at the current market price when the order 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; if the level is reached the order is executed as specified. Orders may be either buy or sell (long or short) and may be placed for 1 – 5 contracts per order (each piece of paper). 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 transactions statements (Figure I-15) are distributed each week in addition to regular financial statements to the participants.

Price levels of the contracts are determined by actions of the players in the game. Selling contracts pressures futures prices downward while buying contracts pressures those prices upward. Game players are encouraged to hedge cattle and speculate cautiously. The game administrators (speculators) will 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.

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, thus 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 I-14.

Table I-14. 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%

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; 745 total pens reported, with 760 total pens being normal when the market is in equilibrium. Thus, beginning cattle on feed is 1.97% below the normal number on feed in week 76.

Summary and Observations on Future Research

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. Repeatedly, students state that even though they have taken many other economics, marketing, and management courses, it was through the *FCMS* 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, enables 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 demonstrate increased understanding of many important economics, marketing, and management concepts. Examples of concepts and principles taught are: production efficiency, breakeven analysis, price forecasting using market supply and demand conditions, economies of size, and risk management. Participants must develop interpersonal negotiation and conflict resolution skills. They develop an appreciation for business ethics. They are exposed to the micro/macro paradox and they work at developing, implementing, and changing 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 (Koontz et al 1992).

Fundamental changes in the simulator brought about by revisions have increased the scope of concepts that may be covered. The developers have seen the situational complexities grow at an exponential rate as changes have been added. The numbers of teachable moments have increased with complexity and the revised simulator can be used to teach an increased amount of both 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.

The *FCMS* is currently applied to the cattle feeding and beefpacking industries, but could be modified to simulate markets for other commodities. Many facets of the simulator apply to a majority of agribusiness sectors. Experience to date indicates the game can be used effectively with a wide range of participants.

Research experiments could be designed to test various hypotheses. An investigation could be conducted to determine if teaching grid pricing with *FCMS* is a superior method than teaching by traditional lecture. Other topics that the author feels might be of interest to education and the fed cattle industry are: assuming information in this model is costless, is the *FCMS* market efficient as defined by Fama? By what expansion or contraction path along the long-run industry cost envelope would the four packers follow as they increase or decrease production from an average of forty (40) pens per week? Does grid pricing in *FCMS* move price and quantity signals up and down the supply chain causing different actions and reactions by producers and packers than otherwise seen with live weight pricing?

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FED CATTLE MARKET SIMULATOR

APPENDIX

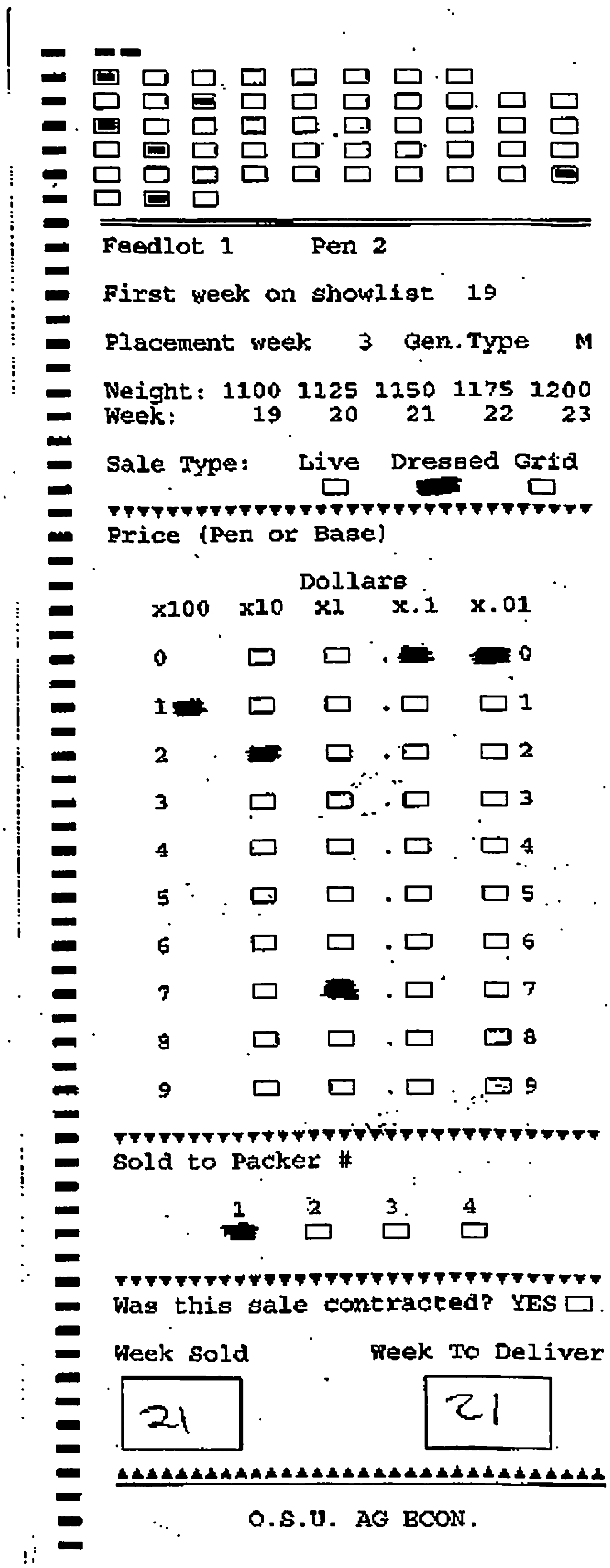
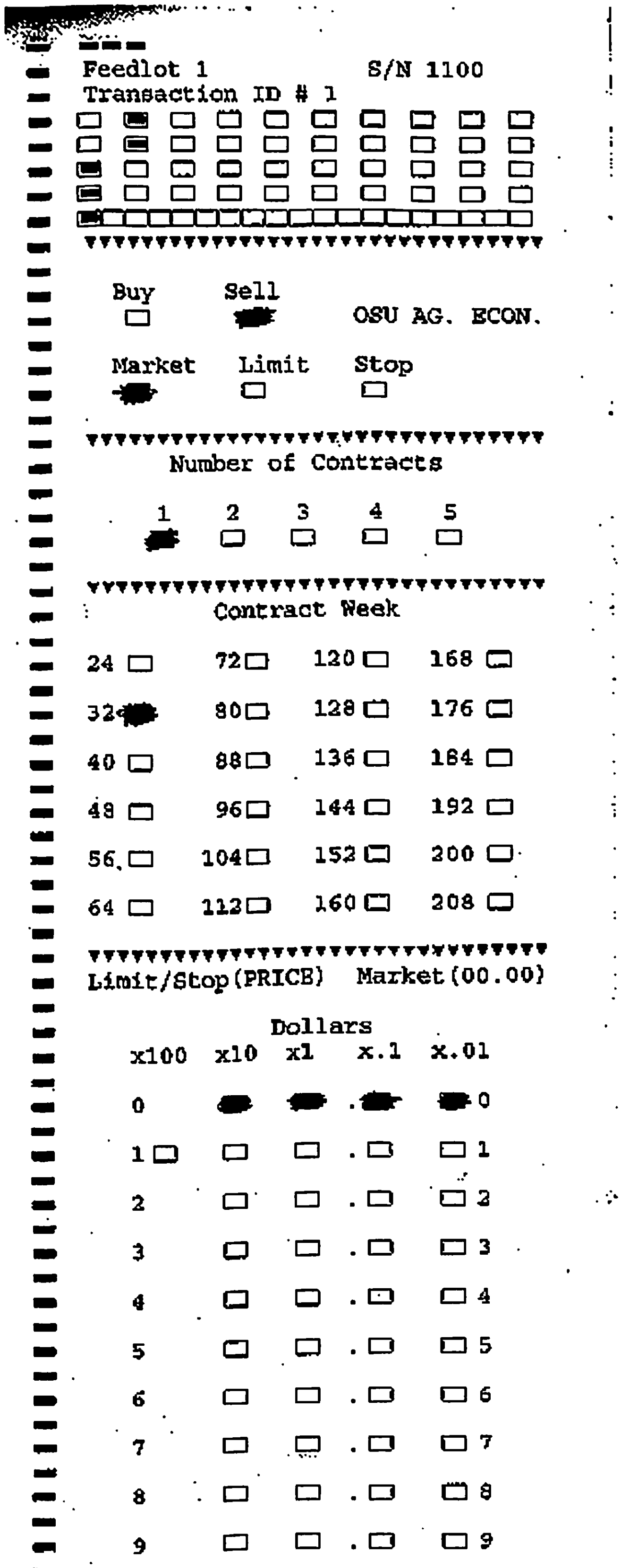


Figure I-1. **Sample Cash Cattle Transaction Card**


Feedlot 1 S/N 1100
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 I-2. Sample Futures Transaction Card

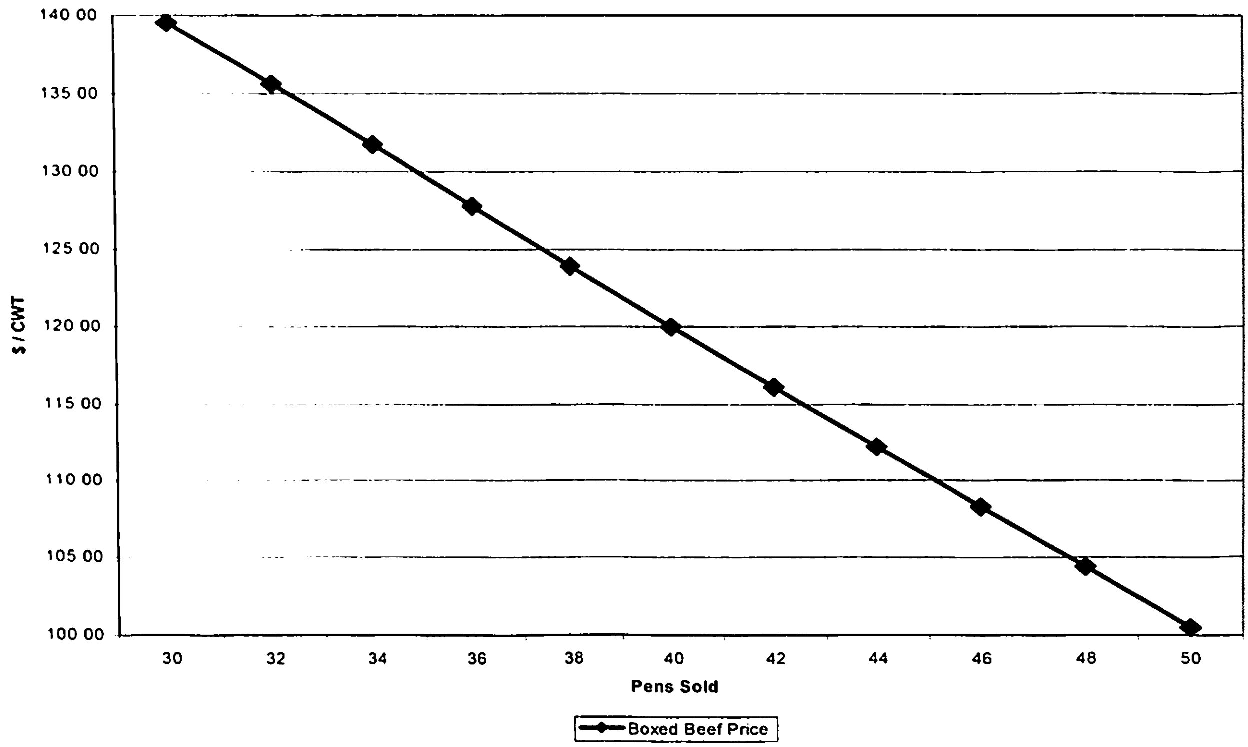


Figure I-3. Boxed Beef Demand Schedule

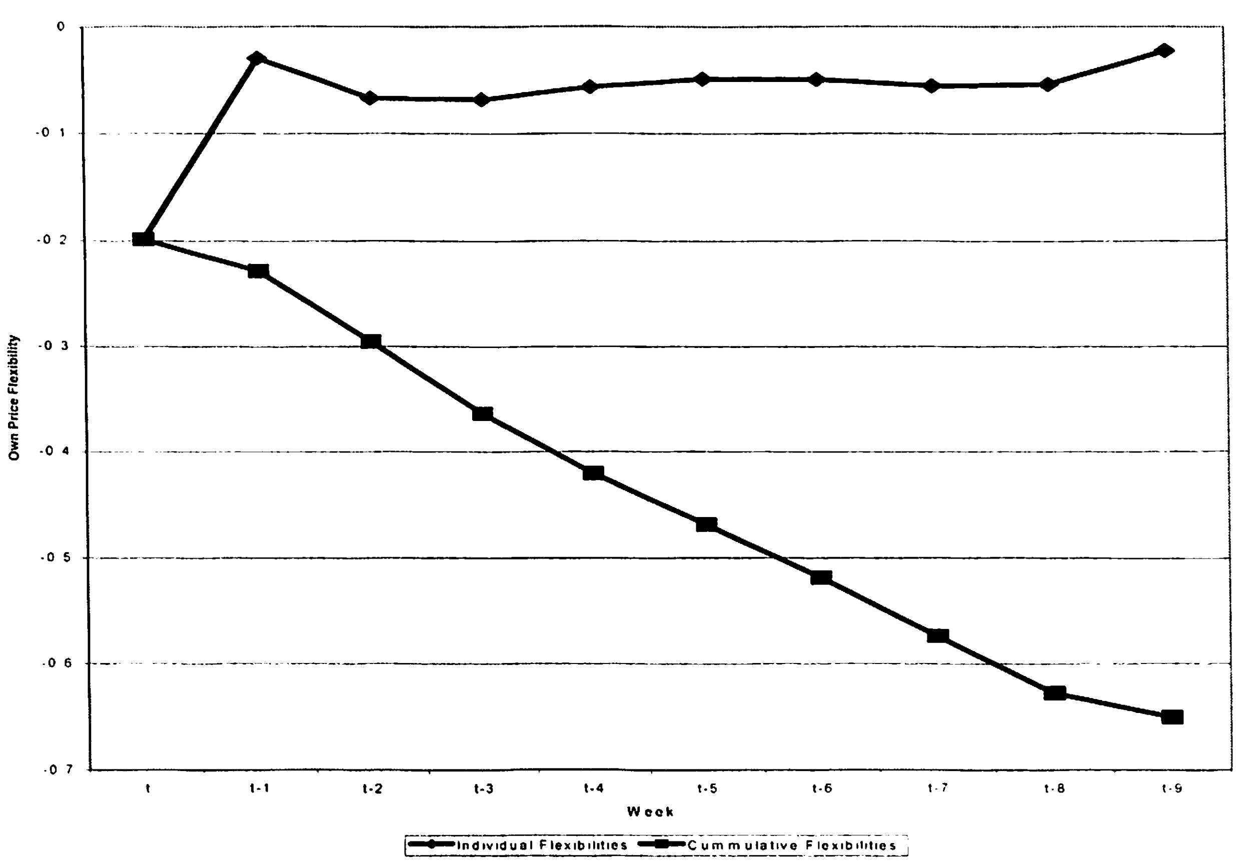


Figure I-4. Distributed Lag of Boxed Beef Flexibilities

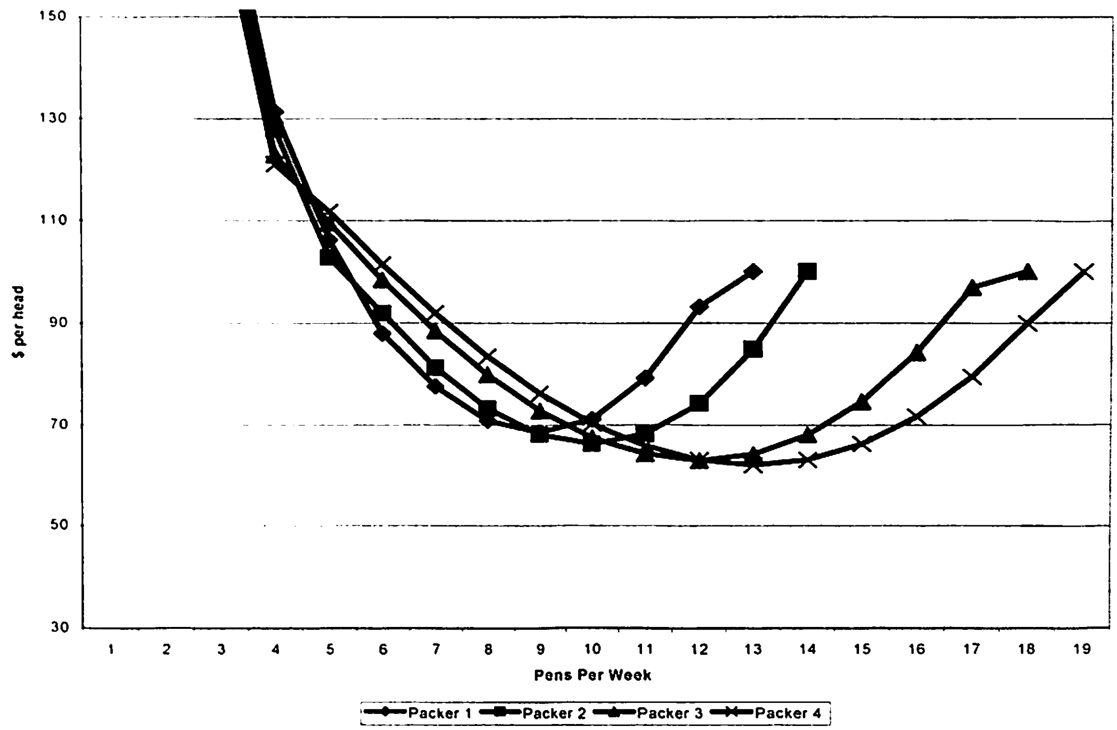


Figure I-5. Meatpacking Plant Average Total Cost Curves

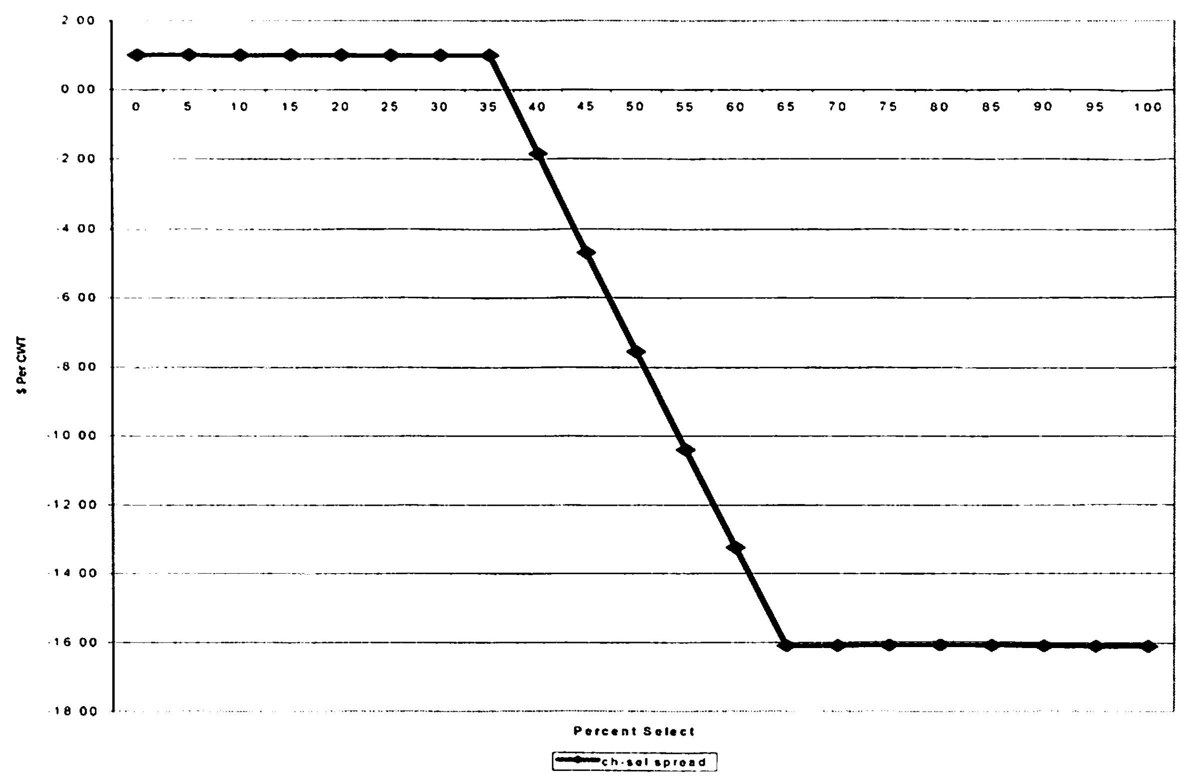


Figure I-6. Choice-Select Discount Schedule

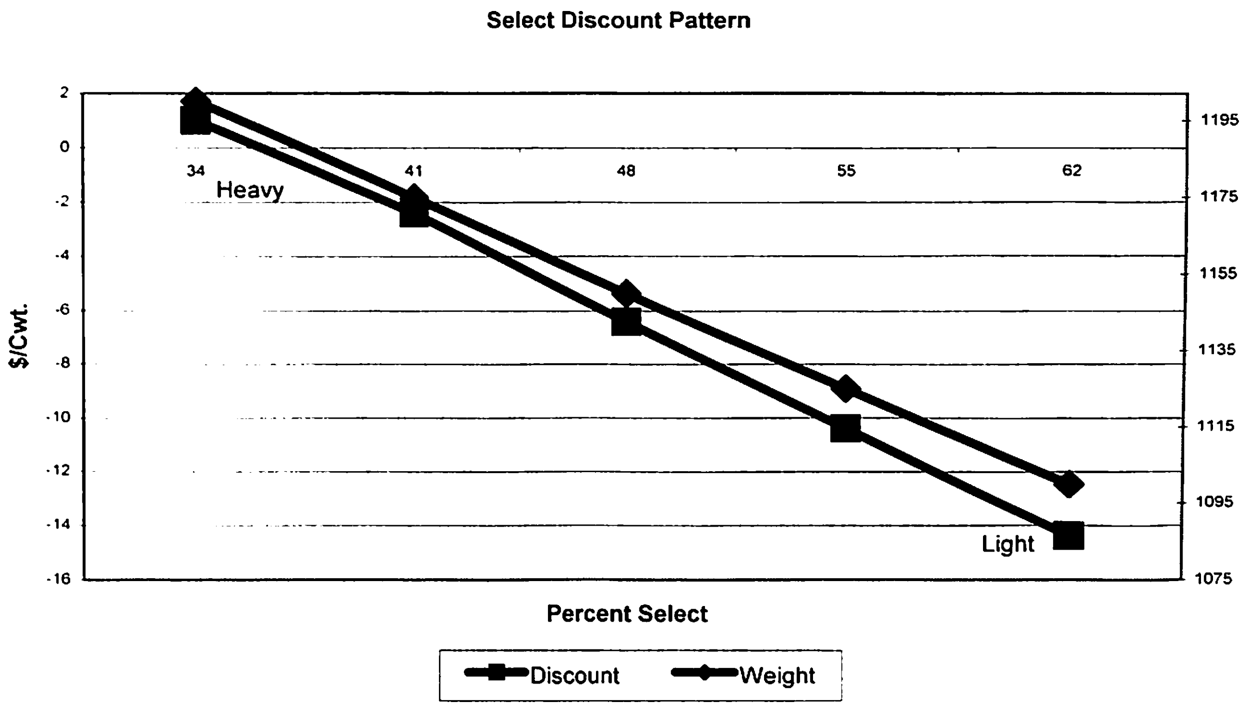


Figure I-7. Select Discount Pattern

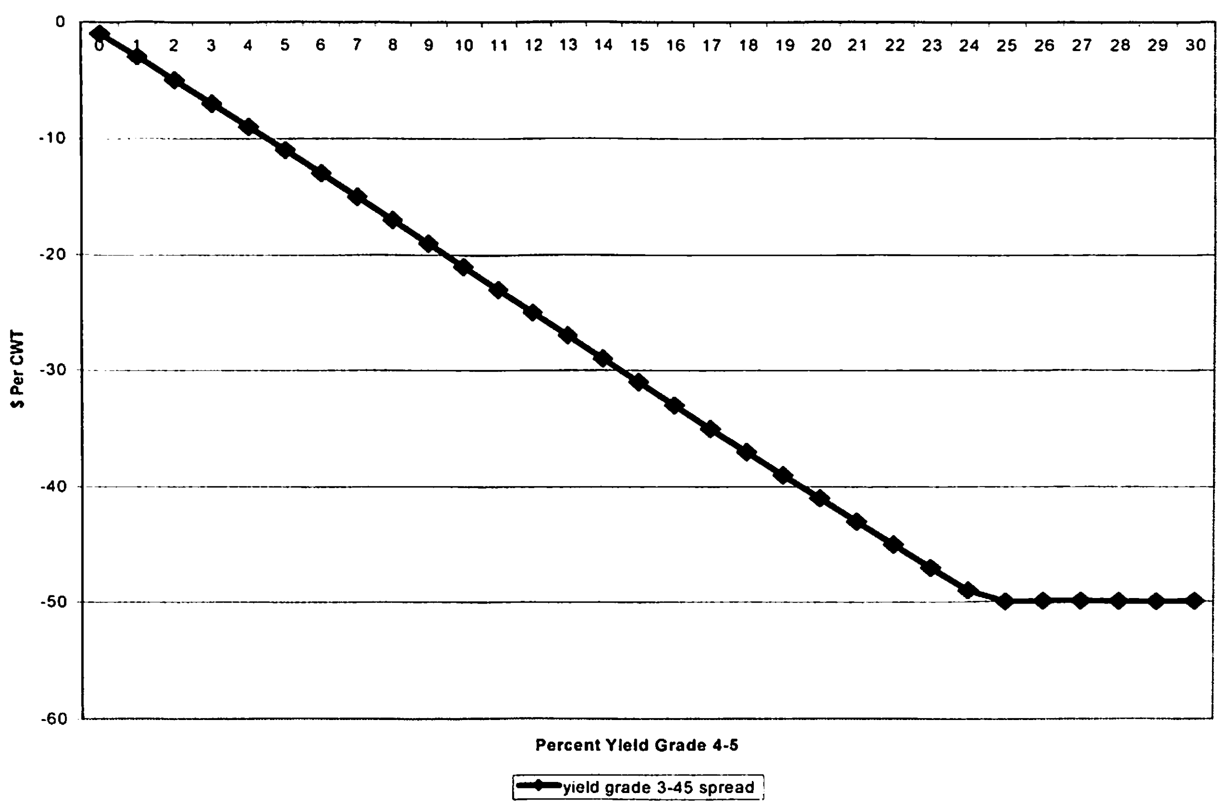


Figure I-8. Yield Grade 3 to Yield Grade 4-5 Discount Schedule

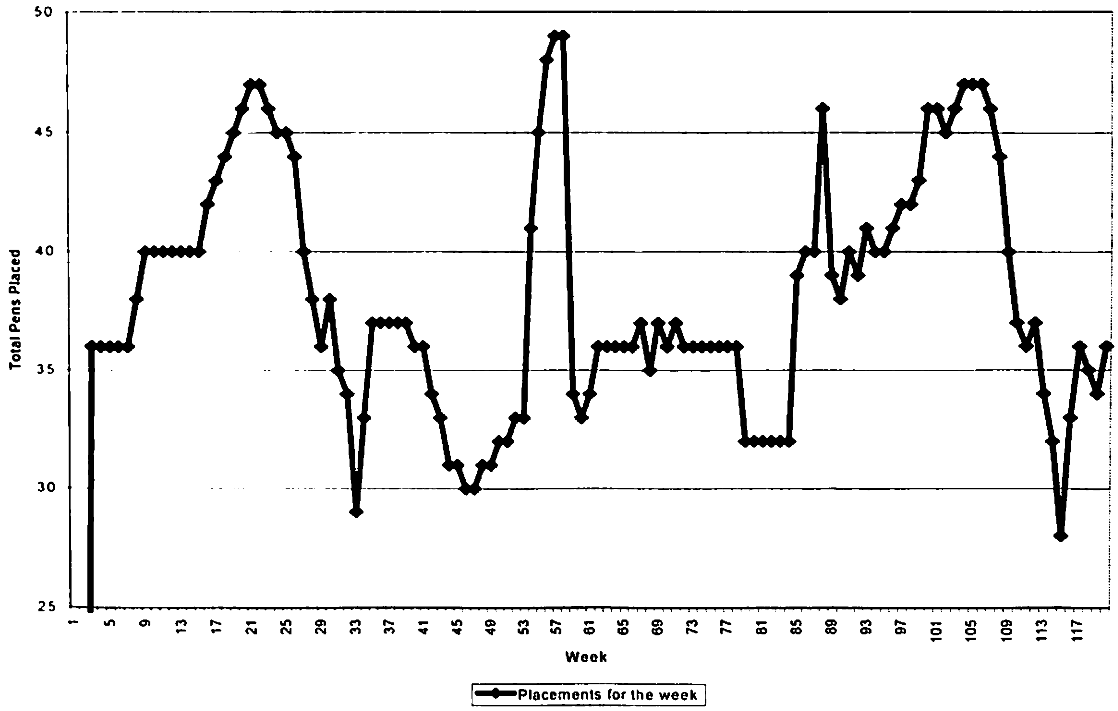


Figure I-9. Feeder Placements By Week

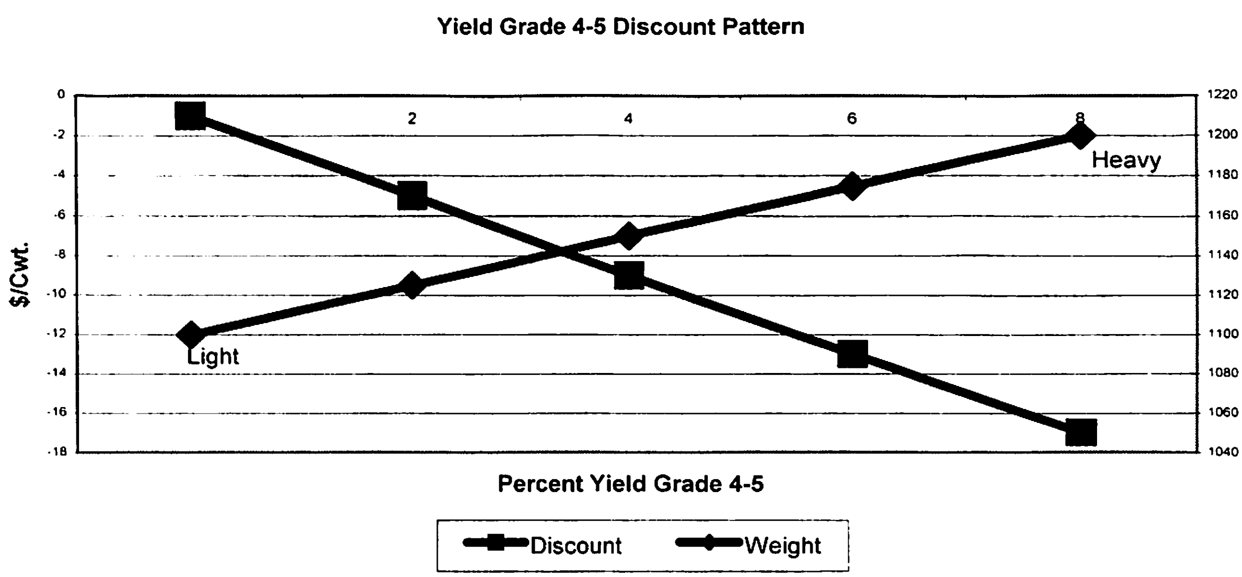


Figure I-10. Yield Grade 4-5 Discount Pattern

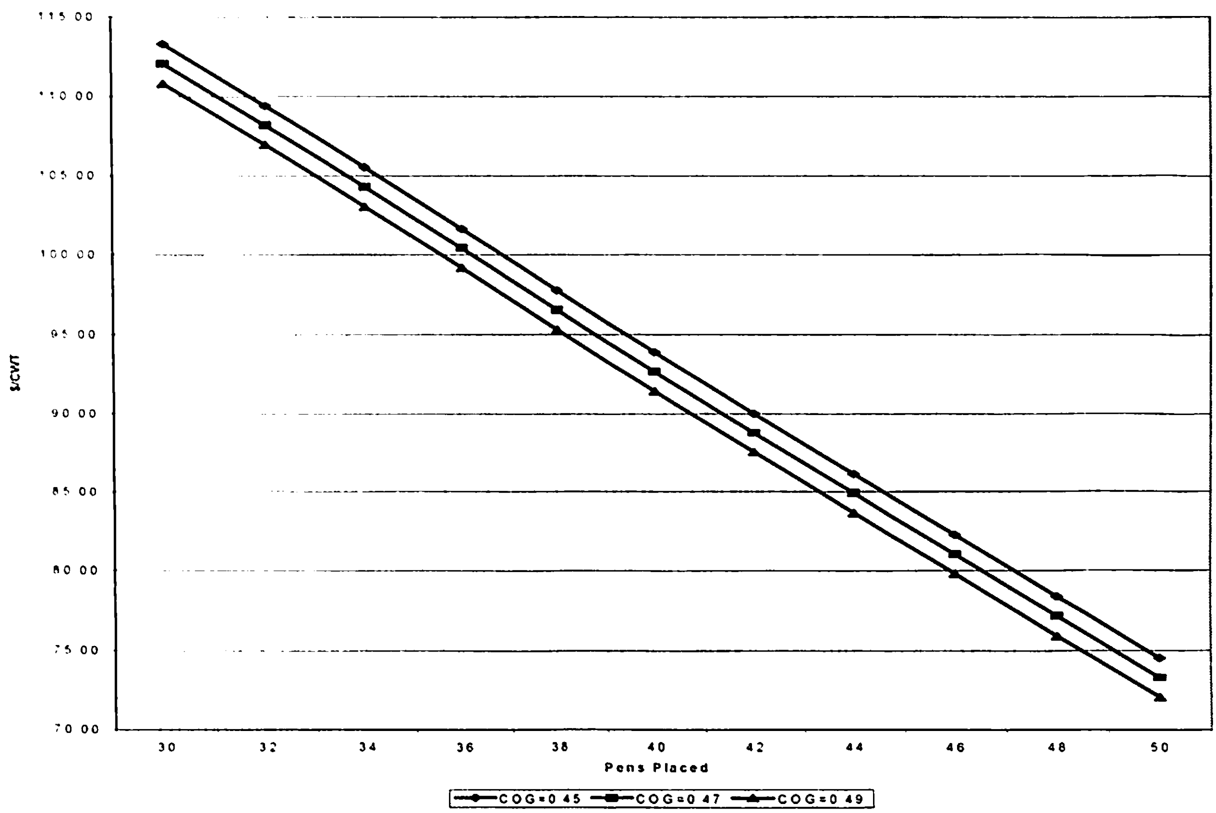


Figure I-11. Feeder Cattle Demand, Genetic Type M Constant

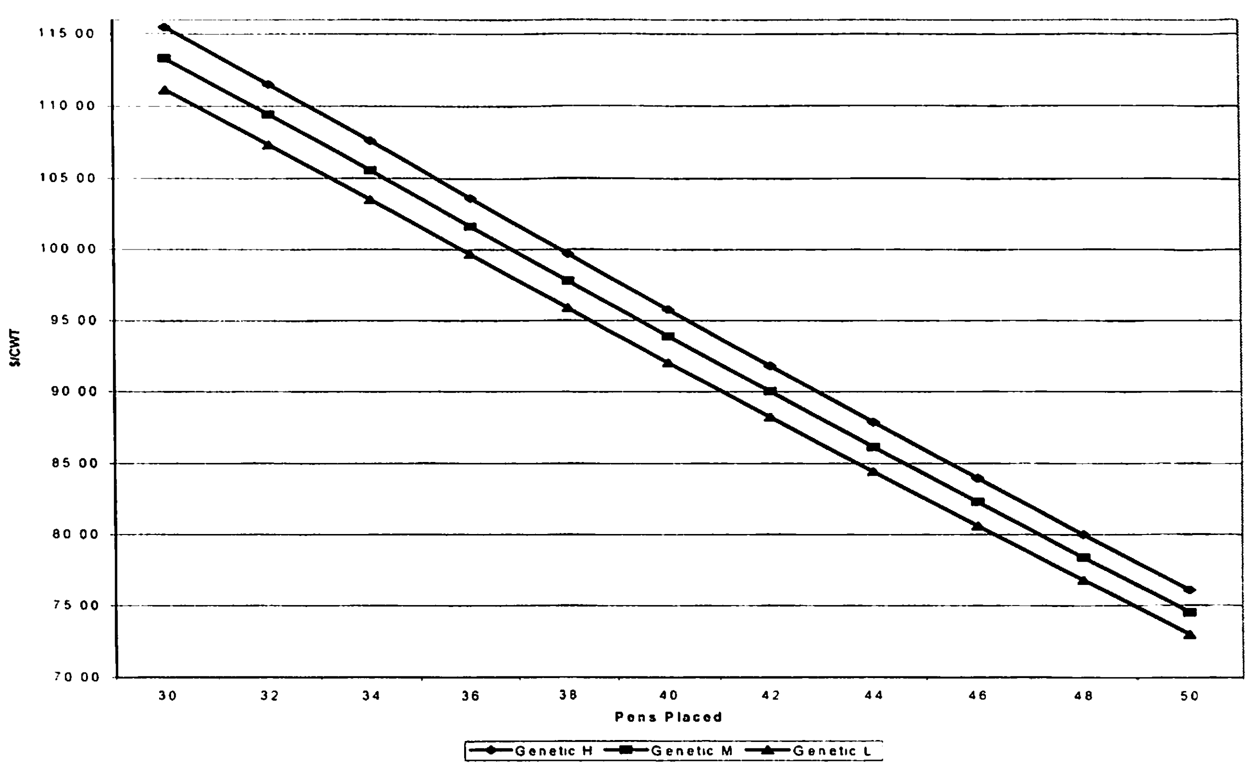


Figure I-12. Feeder Cattle Demand, Cost of Gain $0.45 Constant

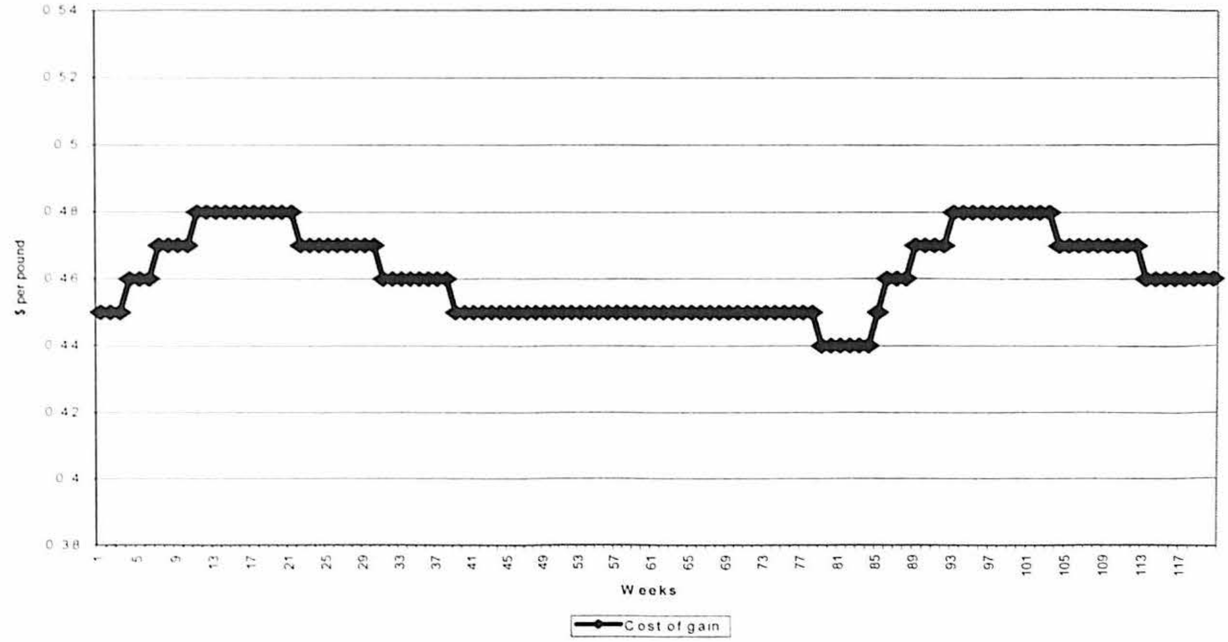


Figure I-13. Cost of Gain By Week

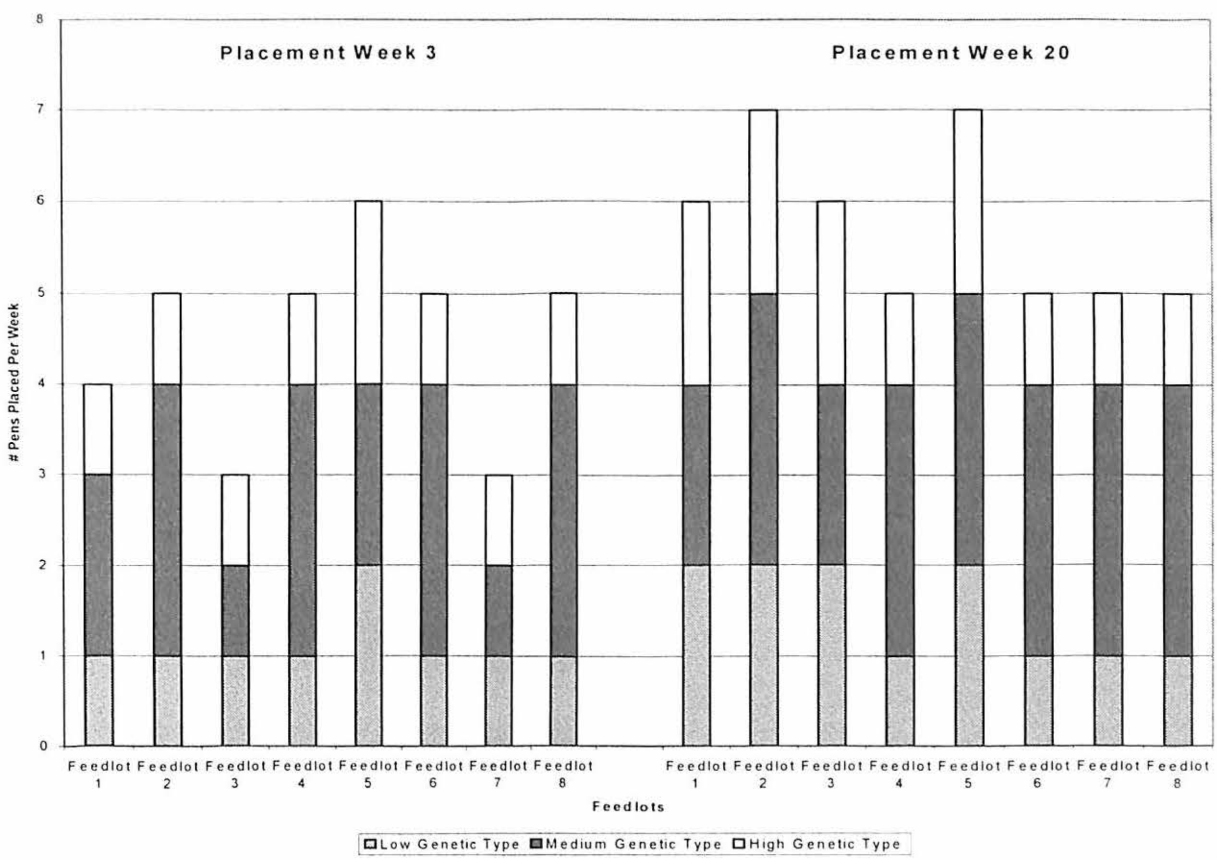


Figure I-14. Feedlot Placement Distribution For Two Sample Weeks

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 I-15. Futures Transaction Summary

Table I-15. 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

Table I-16. 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						

CHAPTER II

EXAMINING THE CHOICE-SELECT and YIELD GRADE 4-5 DISCOUNT COMPONENTS of GRID PRICING FOR FED CATTLE

INTRODUCTION

Fed cattle are traditionally sold when the feedlot marketing manager (i.e. producers of fed cattle) and packer (purchasers of fed cattle) meet, possibly view the cattle, and negotiate a live price per pound for the entire group of cattle. This system implies both buyers and sellers are expert cattlemen and estimate the quality grade and yield grade of the cattle with their hide on. The buyer is expected to provide a fair appraisal of the pen's quality and yield grade distributions by means of a short visual inspection. This method is inefficient. Several research studies indicate higher (lower) quality cattle within a pen or group are not marketed at a premium (discount) price to represent their respective higher (lower) quality (Feuz; Schroeder and Graff; Ward and Lee). Often the packer buyer will offer the same price for several pens of cattle with differing qualities, each of which could have different owners. The entire group is then marketed at an average live price.

Grid pricing of cattle, from the economic sense of pricing efficiency, is a superior method of marketing fed cattle (Feuz; Schroeder, and Graff; Ward and Lee). The incentive (disincentive) mechanism embodied in a grid pricing system is a function of the grid's discount and premium structure. The general economic incentive structure embodied in packer grids has been pointed to as an obstacle preventing many slaughter cattle producers from selecting grid pricing as a marketing channel (Fausti, Qasmi, and Wittig). In a grid pricing scheme, each animal is priced separately based on that animal's own carcass characteristics.

Quality and yield grades have been established describing particular carcass qualities of beef animals. The grades that are relevant for fed cattle are Prime, Choice, Select, and Standard. Historically, the Prime grade receives a price premium. The Prime-Choice premium has been fairly constant over time, as shown in Figure 1 (Ward, Feuz, and Schroeder). Choice is the benchmark grade. The Choice-Select discount is a focal point for the market and has been rather volatile over time as Figure 1 illustrates. The Select-Standard discount appears to be an almost linear combination of the Choice-Select discount. The Choice-Select and Select-Standard price discounts represent price discounts to the Choice benchmark.

Established yield grades range from 1 (most lean, least waste) to 5 (least lean, most waste). Yield grades are a measure of pounds of marketable meat in a carcass and implicitly measure exterior leanness of muscle structure. Yield grade 3 is the benchmark. Carcasses judged to be yield grades 1 and 2 are assigned a price premium while carcasses that are 4, 5, and 5+ are discounted to the benchmark yield grade three. As discussed above, the yield grade 1-2 and yield grade 2-3 premiums have been fairly stable over time (Figure 2). The focal point of this study will be the yield grade 4-5 discount. As with the Choice-Select discount, 4-5 has the greatest variance and volatility over time. Yield grade 5+ appears to be a linear combination of the 4-5 discount.

The purpose of this research is to determine the economic factors that influence the Choice-Select and yield grade 4-5 price discounts as well as their direction and magnitude. There has been little study on the two spreads; yet millions of pounds of meat that depend on these discount components of carcass beef prices are sold annually. Introductory work by the Livestock Marketing Information Center (LMIC) in Letters # 44 (LMIC 1999a) and # 46 (LMIC 1999b) discuss data sets now available for weekly carcass discount data. Initial models are set out by LMIC and their implications are discussed. The author(s) asserts in both reports that more research needs to be done on the factors causing variation in the Choice-Select spread as well as other carcass price spreads. An understanding of these factors would be of importance to producers, packers, and agricultural economists because managerial decisions are made that affect buyers and sellers on a day-to-day basis.

The objective of this study is to determine the factors explaining Choice-Select and yield grade 4-5 discount components of grid pricing of fed cattle. Additionally, seasonality factors will be considered and addressed.

Grid Structures

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 valued cattle receive higher prices and lower valued 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. As stated earlier there are four quality grades that apply to fed cattle (Prime, Choice, Select, and Standard) and six yield grades (YG1, YG2, YG3, YG4, YG5, and YG5+). The carcass benchmark or the "average" carcass is Choice, yield grade 3.

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, dark cutters, hard bones, lightweight and heavyweight carcasses, and other "out" or unmarketable carcass.

Using the premiums and discounts, a price grid is constructed that defines departures from the benchmark carcasses due to quality grade or yield grade. At least for the purpose of example, most grids are additive in nature so that the price of a carcass graded as Prime, yield grade 1 would be paid the base price *plus* Prime premium *plus* yield grade 1 premium. Likewise a Select, yield grade 5 carcass would be paid the base price *plus* Select discount *plus* yield grade 5 discount. Both premiums will be positive numbers and discounts will be negative numbers.

Since fed cattle are heterogeneous in quality and yield there will be cattle of many differing grades in a pen. A pen may be represented as a quality distribution and a yield grade distribution. To arrive at the combination distribution, envision a matrix with yield grades across the columns and quality grades down the rows. Thus if there are 10% Prime and 10% yield grade 1, there will be 0.1 times 0.1 equals 1% carcasses that will be Prime, yield grade 1. Likewise, as example, suppose there are 55% Choice and 60% yield grade 3 carcasses, there will be 0.55 times 0.60 equals 0.33 or 33% Choice, yield grade 3 carcasses in the pen. The pen distribution is then multiplied by its associated premium/discount. Summing these numbers across all grid cells yields a number representing a single net premium and discount. The net premium and discount is then added to the base price to produce the net dressed weight price received. Packers voluntarily report premiums and discounts they presume to use on a weekly basis to USDA-AMS.

Each packer may have more than one grid. Thus one grid might reward yield grade 1 more significantly while at the same time having a smaller discount on Select carcasses. This grid would be conducive to leaner cattle. At the same time they might have a grid that rewards and penalizes in about the same ratio. Thus the structure of a given packer's grid may be determined by their own branded program, the background of their consumer base, or some other method of management decision. These premiums and discounts may then be viewed as components of a pricing system.

Data

Data for this study was obtained from the Livestock Marketing Information Center (LMIC) (Table II-1).

Table II-1. Description of Data Series Used In Analysis

Data Description[a]
National Carcass Premiums and Discounts For Slaughter, Steers and Heifers ($/Cwt.)
Weekly Federally Inspected Meat Production (million lbs.)
Weekly Boxed Beef Cutout Value/By Products
Dodge City Choice Steers ($/Cwt.)
USDA National Steer and Heifer Estimated Grading Percent Report
Average live weights Texas/Oklahoma Panhandle (lbs.)

[a] All data series obtained at LMIC website.

Premium and discount data used in the models was collected from the USDA report "National Carcass Premiums and Discounts For Slaughter Steers and Heifers". The weekly data series used begins February 17, 1997 and ends March 17, 2003. Summary statistics for the data are found in Table II-2. The discount series used in this research were not calculated. Instead reported discount series are used for Choice-Select and yield grade 4-5 discounts. The discount series are recorded at LMIC as negative numbers, therefore, please note this deviation from the "normal" expectations.

Table II-2. Summary Statistics For Variables, 2-17-1997 through 3-17-03

Variable	Mean	Standard Deviation	Minimum	Maximum
Choice-Select discount ($P_{ch\text{-}sel}$) ($/Cwt.)	-7.7111	2.9564	-16.0000[a]	-2.0000[a]
Yield grade 4-5 discount ($P_{YG4\text{-}5}$) ($/Cwt.)	-14.3884	2.2458	-19.5000[a]	-10.7500[a]
Percent Choice ($q_{\%choice}$) (%)	0.5306	0.0220	0.4821	0.5884
Percent 4-5 ($q_{\%YG4\text{-}5}$) (%)	0.0223	0.0115	0	0.0615
Boxed beef price ($P_{BoxedBeef}$) ($/Cwt.)	111.7603	10.3759	91.6100	135.3480
Production ($q_{Production}$) (million lbs.)	495.5533	33.8047	348.4000	568.4000
Observations	318			

[a] Note: While these are in the correct order for mathematical minimums and maximums, a -$16.00 is a wider or greater discount than -$2.00. So while these are mathematically true, in application the reverse order is more correct.

It should be noted that mandatory price reporting (MPR) by packers as required by the Agricultural Market Service (AMS) began April 3, 2001. The method of reporting data changed at that time. Upon visual inspection of the data of the quality and yield grade series in Figures II-1 and II-2, there seems to be a difference from the time period before and after MPR. A Student's-t and F-test are used to determine if the Choice-Select and yield grade 4-5 series have the same means and variances respectively both before and after MPR.

Table II-3. Summary Statistics Before and After Mandatory Price Reporting, April 3, 2001

		Before MPR	After MPR
Choice-Select discount ($/Cwt.)			
	Mean	-7.6091	-7.9643
	Standard deviation	3.1920	2.3682
	Minimum	-14.5800	-16.0000
	Maximum	-2.0000	-3.9200
	Skewness	-0.1768	-0.9585
	Kurtosis	-0.7087	1.9471
Yield grade 4-5 discount ($/Cwt.)			
	Mean	-15.4867	-12.0527
	Standard deviation	1.7715	1.0294
	Minimum	-19.5000	-16.500
	Maximum	-11.4300	-10.7500
	Skewness	0.3397	-2.3184
	Kurtosis	0.1868	6.4094

These statistical tests were conducted using Simetar© software (Richardson). With respect to the Choice-Select discount, the tests are conducted under the null hypothesis that both means and variances (before and after) are equal. The test statistic for the t-test for means is 1.11 versus the critical value of 2.25 at the 95% significance level (Table II-3). Therefore there is not enough information to reject the null hypothesis the means are equal. The test statistic for the F-test is 1.82 versus the critical value of 1.34, thus the null hypothesis of equal variances is rejected for this series. For these same two tests on the yield grade 4-5 series, under the null hypothesis of equal means and variances, test statistics are –21.72 and 2.96 for the t-test and F-test respectively, while the critical values are 2.25 and 1.34. Therefore, both null hypotheses are rejected and it is concluded that neither means nor variances are the same after MPR as before.

Analyzing the distributions for both the Choice-Select and yield grade 4-5 discounts, quantile-quantile (QQ) plots were constructed of each series with the Simetar© software

(Richardson). A QQ plot is a graphical technique for determining if two data sets come from populations with a common distribution (1.3.3.24. Quantile-Quantile Plot). This is a plot of the quantiles of the first data set against the second data set. The definition in use of a quantile is that fraction or percent of points below the given value. For example at the 30% quantile, 30% of the data points are below this quantile while 70% of the data points fall above this quantile. A 45-degree line is also plotted as a reference. If both samples come from the same distribution the data points should line up along the 45-degree line. The greater the departure from the line the more evidence the two samples did not come from the same distribution. QQ plots may be used to detect shifts in location, shifts in scale, changes in symmetry, differences in the tails, and the presence of outliers. While there are other normality tests, QQ plots provide a graphical tool to observe the entire distribution.

The QQ plot for the Choice-Select discount series was constructed by plotting the series versus a theoretical normal distribution generated with the same mean and variance of the discount series (Figure II-3). Data may be seen diverging from the theoretical line at the right tail. It is suggestive this discount series may not be distributed normally. The QQ plot for the yield grade 4-5 discount series (Figure II-4) was also constructed plotting the yield grade discount series versus a simulated normal distribution using the mean and variance from the yield grade series. There is a significant degree of divergence at both tails from the 45-degree line; also suggesting the yield grade discount series is not normally distributed.

Procedure

Some economic analysis assumes product homogeneity, particularly in a competitive market structure, but the core of some analysis has to do with heterogeneity. Problems involving heterogeneity examine product differentiation, product quality, product grades, and product standards (Ladd and Martin). Grid pricing of fed cattle has just such a heterogeneous nature. The price of dressed beef is made up of many factors; some of these factors have boxed beef product demand associated with them such as marbling, tenderness, and flavor. Some factors involve a byproduct to be disposed, while yet other factors are "bads" that packers must endure to get more of what they want ("goods"). For example, to get more Prime cattle the packer must deal with poorer yield grades resulting from waste fat. It has been shown that some characteristics actually have negative implicit prices and may be thought of as "inferior characteristics." In other words, their presence in any quantity sometimes, above certain threshold values at other times, or between two threshold values reduces the value of a product or a component (Ladd and Martin).

To determine the makeup of components of a grid pricing system it is necessary to look at some of that system's hedonic parts or characteristics. Previous research (McDonald and Schroeder) has shown that the dressed price of fed cattle can be expressed as:

(1) $$P_{dr} = f(base, dressing\ percent, quality\ grade, yield\ grade, out\ carcasses)$$

where P_{dr} is the dressed weight price, *base* is the base price of the grid, *quality (yield) grade* is the quality (yield) grade distribution of the pen, and *out carcasses* are the percentage of carcasses that are excessively heavyweight or lightweight or have other undesirable traits. The quality grade component in (1) deals with a distribution of quantities but continuing along the same line of logic a net price of the quality grade component of dressed beef price then may be thought of being made up

(2) $$P_{quality} = f(prime-choice, choice-select, select-standard, YG1-2, YG2-3, YG3-4, YG4-5, YG5+)$$

where $P_{quality}$ is the net premium/discount attributable to price due to the quality grade component; *prime-choice* is the Prime-Choice premium, *choice-select* is the Choice-Select discount, *select-standard* is the Select-Standard discount, *YG1-2* and *YG2-3* are the yield grade 1-2 and yield grade 2-3 premiums, *YG3-4, YG4-5,* and *YG5+* are the yield grade 3-4, yield grade 4-5, and yield grade 5+ discounts respectively.

It is intuitive that as quality grade of an animal or pen goes from Standard toward Prime it is probable at that same time yield grade is decreasing (the yield grade number increases, 3 to 4, 4 to 5). In other words, quality and yield grades are inversely related. Thus there is a tradeoff, as an animal is fed to a higher quality grade it would be reasonable for the yield grade to decrease. Likewise it makes sense for the yield grade to be empirically modeled as:

$$(3) \qquad \begin{aligned} P_{yield} = f(&prime-choice, choice-select, select-standard, \\ &YG1-2, YG2-3, YG3-4, YG4-5, YG5+) \end{aligned}$$

where P_{yield} is the net premium/discount attributable to price due to the yield grade component.

Prime - Choice, yield grade 1-2, and yield grade 2-3 premiums and yield grade 3-4 discount have been fairly constant and stable over time (Figures 1 and 2). Standard - Select and yield grade 5+ discounts appear to be a linear combination of Choice – Select and yield grade 4-5 discounts, respectively. Since in the case of yield grade discounts, there is no defined demand for yield grades 4, 5, or 5+ beef, this discount acts as a price penalty that is levied as a greater percentage of the pen becomes fatter and heavier.

It has been pointed out that hedonic models are problematic. Prior literature points out model identification can only be obtained through arbitrary functional form assumptions; hedonic models are oft times non-linear; and endogeneity are some problems mentioned (Ekeland, Heckman, and Nesheim). However in the face of products whose characteristics create heterogeneity, it is the positive or negative value of those sub-characteristics that describe the value of the more inclusive larger component. From that standpoint a hedonic model with its associated problems seems justified.

A priori expectations of those characteristics that influence the Choice – Select discount could be seen in this general specification

$$P_{ch-sel} = f(q_{\%choice}, q_{\%YG4-5}, P_{BoxedBeef}, q_{Production}, \delta_s), \tag{4}$$

where $P_{ch\text{-}sel}$ is the Choice – Select discount, $q_{\%choice}$ is the percentage of Choice beef in the period's production, $q_{\%YG4\text{-}5}$ is the percentage of yield grade 4-5 in the period's production, $P_{BoxedBeef}$ is the price of wholesale boxed beef, $q_{Production}$ is the quantity of production for this period, and δ_s is a seasonal component. Biological cycles and seasonal weather patterns cause seasonal production patterns in fed cattle. Better cow-calf producers manage for fall or spring calving, this creates heavier feedlot placements two times a year. Warm weather feeding creates "sick days friendly" seasonality in fed cattle production. These factors and others create a seasonality that should be taken into consideration with a seasonality component. Using the same logic as that of the net price of the Choice-Select discount, a general specification of a yield grade 4-5 discount model could be

$$P_{YG4-5} = f(q_{\%choice}, q_{\%YG4-5}, P_{BoxedBeef}, q_{Production}, \delta_s), \tag{5}$$

where $P_{YG4\text{-}5}$ is the yield grade 4-5 discount and other terms are as described above.

A group of specific models based upon the general specifications of (4) and (5) were examined. There are corresponding Choice-Select and yield grade 4-5 models for each of three estimated models. A fourth model derived from demand theory was discarded, as there were too many econometric problems for it to be viable.

Subscript numbering of the coefficients in each model was chosen for consistency across all models. All modeling was done with SAS, first using Proc Reg, followed by a battery of misspecification tests, joint conditional means (JCM) and joint conditional variance (JCV) tests. When misspecification tests of individual assumptions that underlie regression models are executed on a model, they often lead to erroneous conclusions regarding the source of misspecification. Testing for joint assumptions leads to fewer erroneous conclusions (McGuirk, Driscoll, and Alwang). JCM test will be used to test for lack of structural change in the mean equation, linearity in the parameters, and absence of autocorrelation or serial correlation in the error terms. JCV tests σ^2 for lack of structural changes and no static or dynamic heteroscedasticity or non-constant variance due to structural or temporal disturbances in the error. Normality of the error terms will also be tested in each model. In the presence of autocorrelation and/or heteroscedasticity, final estimation of the model with simultaneous corrections for other problems will be made with Proc Autoreg in SAS. The errors will be cast as an autoregressive process. Otherwise final estimation will be made with Proc Reg.

Model I

Model I is a straightforward set of models that come directly from (4) and (5). *Choice-Select*-can be modeled as shown in Equation (6) shown below:

$$P_{ch-sel_t} = \beta_0 + \beta_3 q_{\%choice_t} + \beta_4 q_{\%YG4-5_t} + \beta_5 P_{BoxedBeef_t} + \beta_6 q_{Production_t} + \beta_7 dt_{2_t} + \sum_{i=8}^{18} \beta_i dum_{i-7_t} + v_t \quad (6)$$

where P_{ch-sel_t} is the Choice-Select discount in time t, $q_{\%choice_t}$ is the percent Choice in time t's slaughter, $q_{\%YG4-5_t}$ is the percent yield grade 4-5 in the slaughter of time t, $P_{BoxedBeef_t}$ is the price of boxed beef in time t. $q_{Production_t}$ is federally inspected production in time t, dt_{2_t} is a parameter measuring structural shift at the point of MPR; dum_{j_t} is a binary dummy variable representing seasonal effects for month j, j = 1,...,12 in time t; and v_t is the normal disturbance term.

Table II-4. Test Results For Choice-Select Model I

	Test	Joint test p-value	Individual test p-value
JCM		<0.0001	
	Structural change in mean equation		0.0492
	Non-linearity		0.0605
	Autocorrelation		<0.0001
JCV		<0.0001	
	Structural change in variance		0.7758
	Static heteroscedasticity		0.8637
	Dynamic heteroscedasticity		<0.0001
Normality			
	Shapiro-Wilk		<0.0001
	Kolmogorov-Smirnov		<0.0100
	Cramer-von Mises		<0.0050
	Anderson-Darling		<0.0050

The null hypothesis of JCM test was rejected at p-value <0.0001. Checking the individual tests showed rejection of the null with respect to no structural change in the mean equation and no autocorrelation. The structural change binary variable dt_2 was added to the model at the midpoint of the series to correct functional form in the mean equation. Testing JCV resulted in a rejection of the null hypothesis at a p-value of <0.0001. Evaluating null hypotheses for individual tests resulted in failure to reject for no structural change in variance and no static heteroscedasticity. However, the null hypothesis was rejected for no dynamic heteroscedasticity at a p-value of <0.0001. Estimation of the final model was done with Proc Autoreg to complete all corrections and express the errors as a process of autoregressive terms. The issue of heteroscedasticity will not be dealt with. This will yield an estimator that is unbiased and consistent but will have no efficiency properties. Normality of error terms was tested with four different tests. The null hypothesis of normality was rejected at the 0.05 level with Shapiro-Wilk (SW) at a p-value of <0.0001. SAS will compute the SW test only if the number of observations are 2000 or less. The other three tests of normality, Kolmogorov-Smirnov (KS), Cramer-von Mises (CM), and Anderson-Darling (AD) are EDF (empirical distribution function) tests (SAS Institute, Inc. b). Results of KS, CM, and AD also reject the null hypothesis of normality at the 0.05 level. Though normality is rejected it may still be achieved through asymptotic convergence appealing to the Central Limit Theorem. This model will require a number of corrections.

Yield grade 4-5- Model I may be specified as follows:

(7) $$P_{YG4-5_t} = \alpha_0 + \alpha_3 q_{\%choice_t} + \alpha_4 q_{\%YG4-5_t} + \alpha_5 P_{BoxedBeef_t} + \alpha_6 q_{Production_t} + \sum_{j=8}^{18} \alpha_j dum_{j-7_t} + \psi_t ,$$

where P_{YG4-5_t} is the yield grade 4-5 discount in time t, ψ_t is the normal disturbance term, and other terms are defined above.

Table II-5. Test Results For Yield Grade 4-5 Model I

	Test	Joint test p-value	Individual test p-value
JCM		<0.0001	
	Structural change in mean equation		0.8687
	Non-linearity		0.8542
	Autocorrelation		<0.0001
JCV		<0.0001	
	Structural change in variance		0.3327
	Static heteroscedasticity		0.2333
	Dynamic heteroscedasticity		<0.0001
Normality			
	Shapiro-Wilk		<0.0001
	Kolmogorov-Smirnov		<0.0100
	Cramer-von Mises		<0.0050
	Anderson-Darling		<0.0050

The null hypothesis of the JCM joint test was rejected at a p-value <0.0001. Results of individual tests showed not enough information to reject the null hypothesis with respect to a lack of structural change in the mean equation and linearity in the parameters. The null hypothesis of no serial correlation was rejected at a p-value of <0.0001. The JCV joint test rejected the null hypothesis with a p-value of <0.0001. Examining the individual tests revealed not enough information to reject the null hypothesis for no structural change in variance and no static heteroscedasticity. However, the null hypotheses were rejected for dynamic homoscedasticity. The null hypothesis of normality of the error terms was rejected by all four normality tests, however, normality may be achieved through asymptotic convergence appealing to the Central Limit Theorem. The final model will be estimated in Proc Autoreg to correct econometric problems and express error terms as an autoregressive process. Heteroscedasticity will not be corrected, thus the estimator will be inefficient. This model is fairly good; the results will be examined for significance of estimated coefficients.

Model II

One theoretical approach widely used in livestock price analysis and price discovery is the partial adjustment (PA) model. This model has been extensively used in the past as a pattern for empirical models (Carlberg). The PA model was developed by Nerlove to derive elasticities for supply and demand of agricultural prices. He contends short-run elasticities cannot be accurately measured as they correspond to a single point or snapshot in time. He further argues that estimation of long-run elasticities is difficult due to continually changing prices and adjustment paths to equilibrium (Carlberg). PA models have an intuitive appeal as they imply quantities and prices adjust slowly over time to new market conditions and market information. This slower adjustment process is oft used as justification of lagged dependent variables in an empirical model.

Choice-Select-the discount series can be modeled as a partial adjustment process of two lags. Consider the following model using lag notation

$$(1-\beta_1 B-\beta_2 B^2)P_{ch-sel_t}=\beta_0+\beta_3 q_{\%choice_t}+\beta_4 q_{\%YG4-5_t}+\beta_5 P_{BoxedBeef_t}+ \beta_6 q_{Production_t}+\beta_7 dt_{2_t}+\sum_{i=8}^{18}\beta_i dum_{i-7_t}+v_t .$$

It can be argued that given some exogenous shock occurring in this market, there will a price adjustment of β_2 in time period t-2 and β_1 in time period t-1, bringing about the full adjustment by time t. Multiplying the lag operator through and simplifying terms yields:

$$P_{ch-sel_t}=\beta_0+\beta_1 P_{ch-sel_{t-1}}+\beta_2 P_{ch-sel_{t-2}}+\beta_3 q_{\%choice_t}+\beta_4 q_{\%YG4-5_t}+ \beta_5 P_{BoxedBeef_t}+\beta_6 q_{Production_t}+\beta_7 dt_{2_t}+\sum_{i=8}^{18}\beta_i dum_{i-7_t}+v_t . \tag{8}$$

Table II-6. Test Results For Choice-Select Model II

	Test	Joint test p-value	Individual test p-value
JCM		<0.0001	
	Structural change in mean equation		0.0056
	Non-linearity		0.9041
	Autocorrelation		<0.0001
JCV		<0.0001	
	Structural change in variance		0.0513
	Static heteroscedasticity		0.5272
	Dynamic heteroscedasticity		<0.0001
Normality			
	Shapiro-Wilk		<0.0001
	Kolmogorov-Smirnov		<0.0100
	Cramer-von Mises		<0.0050
	Anderson-Darling		<0.0050

The null hypothesis of JCM test was rejected at p-value <0.0001. Checking the individual tests showed rejection of the null with respect to no structural change in the mean equation and no autocorrelation. The structural change binary variable dt_2 was added to the model at the midpoint of the series to correct functional form in the mean equation. Testing JCV resulted in a rejection of the null hypothesis at a p-value of <0.0001. Evaluating null hypotheses for individual tests resulted in failure to reject for no structural change in variance and no static heteroscedasticity. However, the null hypothesis was rejected for no dynamic heteroscedasticity at a p-value of <0.0001. Estimation of the final model was done with Proc Autoreg to complete all corrections and express the errors as a process of autoregressive terms. The four normality tests reject the null hypothesis of normality at a significance level of 0.05 in the error terms; however, normality may be achieved through asymptotic convergence appealing to the Central Limit Theorem. Heteroscedasticity will not be corrected. The estimator will be unbiased and consistent but will lose all efficiency properties. This model will be further evaluated in the model selection process.

Yield grade 4-5-likewise the same logic used above yields a PA model for the yield grade 4-5 model as

$$(1-\alpha_1 B-\alpha_2 B^2)P_{YG4-5_t} = \alpha_0 + \alpha_3 q_{\%choice_t} + \alpha_4 q_{\%YG4-5_t} + \alpha_5 P_{BoxedBeef_t} + \alpha_6 q_{Production_t} + \alpha_7 dt_{2_t} + \sum_{j=8}^{18} \alpha_j dum_{j-7_t} + \psi_t ,$$

again multiplying the lag operator through and simplifying terms yields (9).

$$P_{YG4-5_t} = \alpha_0 + \alpha_1 (P_{YG4-5_{t-1}})^2 + \alpha_2 P_{YG4-5_{t-2}} + \alpha_3 q_{\%choice_t} + \alpha_4 q_{\%YG4-5_t} + \alpha_5 P_{BoxedBeef_t} + \alpha_6 q_{Production_t} + \alpha_7 dt_{2_t} + \sum_{j=8}^{18} \alpha_j dum_{j-7_t} + \psi_t \quad (9)$$

where P_{yg4-5} and the other terms are defined as in Model I.

After examining test results for the JCM joint test, the null hypothesis was rejected with a p-value of <0.0001. Individual misspecification tests found there was not enough information to reject the null hypothesis of no structural change in the mean equation, while the null hypothesis for both linearity in parameters and no autocorrelation is rejected at p-values of 0.0165 and <0.0001 respectively. The null hypothesis of the JCV

Table II-7. Test Results For Yield Grade 4-5 Model II

	Test	Joint test p-value	Individual test p-value
JCM		<0.0001	
	Structural change in mean equation		0.1570
	Non-linearity		0.0165
	Autocorrelation		<0.0001
JCV		0.0008	
	Structural change in variance		0.0040
	Static heteroscedasticity		0.0003
	Dynamic heteroscedasticity		0.1084
Normality			
	Shapiro-Wilk		<0.0001
	Kolmogorov-Smirnov		<0.0100
	Cramer-von Mises		<0.0050
	Anderson-Darling		<0.0050

joint test is rejected at a p-value of 0.0008. Individual tests for these assumptions conclude structural change in the variance and static heteroscedasticity with p-values of 0.0040 and 0.0003; the null hypothesis regarding dynamic homoscedasticity cannot be rejected. Normality testing concludes non-normal error terms, however, normality may be achieved through asymptotic convergence appealing to the Central Limit Theorem. Non-linearity in parameters will be dealt with by the use of a squared term of the first partial adjustment variable. A binary structural change variable (dt_2) will deal with a structural change in variance. Using the above correction techniques, final modeling will take place in Proc Autoreg, simultaneously modeling the error terms as an autoregressive process. Static heteroscedasticity will not be dealt with. This will leave the estimator inefficient but unbiased and consistent; the assumed cause of the non-constant variance is the data series broken by MPR. A test for ARCH disturbances was performed. There was not enough information to reject the null hypothesis of homoscedasticity for the first order (SAS Institute, Inc.a).

Model III

Model III specifications are reduced form specifications of Model II. In the case of Choice-Select, it is hypothesized that the economic factors that most matter are one lag of the partial adjustment process, the percent Choice in the period's production, and seasonality. Consider equation 8 with these four restrictions, $\beta_2=\beta_4=\beta_5=\beta_6=0$, equation (8) then reduces to (10).

Choice-Select-the restricted PA model can be expressed as:

(10) $$P_{ch-sel_t} = \beta_0 + \beta_1 P_{ch-sel_{t-1}} + \beta_3 q_{\%choice_t} + \beta_7 dt_{2_t} + \sum_{i=8}^{18} \beta_i dum_{i-7_t} + v_t$$

where $P_{ch\text{-}sel}$ and other variables are defined in Model I above.

Table II-8. Test Results For Choice-Select Model III

Test		Joint test p-value	Individual test p-value
JCM		<0.0008	
	Structural change in mean equation		0.8306
	Non-linearity		0.4738
	Autocorrelation		<0.0001
JCV		<0.0001	
	Structural change in variance		0.0416
	Static heteroscedasticity		0.4903
	Dynamic heteroscedasticity		<0.0001
Normality			
	Shapiro-Wilk		<0.0001
	Kolmogorov-Smirnov		<0.0100
	Cramer-von Mises		<0.0050
	Anderson-Darling		<0.0050

The p-value of JCM clearly shows the null hypothesis of the joint test is rejected. Examining tests of individual assumptions reveals not enough information to reject the null hypothesis of no structural change in the mean equation and linearity in parameters. Whereas the null hypothesis of no serial correlation is clearly rejected (p-value < 0.0001). The null hypothesis of the JCV joint test is rejected with a p-value of <0.0001. Results of individual tests show the null hypothesis of no structural change in the variance and dynamic homoscedasticity must be rejected. Normality of the error terms is also obviously rejected by the four normality tests. Even though the test shows the disturbance terms to be non-normal, normality may be achieved through asymptotic convergence appealing to the Central Limit Theorem. A binary structural change variable (dt_2) will deal with structural change in variance. Final estimation will be made with Proc Autoreg to deal with autocorrelated error terms. The dynamic heteroscedasticity is not dealt with though LM statistics for ARCH effects show a rejection of null hypothesis of homoscedasticity through order 12. Ignoring the heteroscedasticity problem, the resulting estimator will be unbiased and consistent although the estimator will lose all efficiency properties. This model is more parsimonious and should be considered for further testing.

Yield grade 4-5- for the yield grade discount similar logic is employed. Now consider (9) with the four restrictions $\alpha_2=\alpha_4=\alpha_5=\alpha_6=0$ then equation (9) reduces in terms to (11).

(11) $$P_{YG4-5_t} = \alpha_0 + \alpha_1 (P_{YG4-5_{t-1}})^2 + \alpha_4 q_{\%YG4-5_t} + \alpha_7 dt_{2_t} + \sum_{j=8}^{18} \alpha_j dum_{j-7_t} + \psi_t \,.$$

Table II-9. Test Results For Yield Grade 4-5 Model III

	Test	Joint test p-value	Individual test p-value
JCM		0.0177	
	Structural change in mean equation		0.1498
	Non-linearity		0.0465
	Autocorrelation		0.0179
JCV		0.0002	
	Structural change in variance		<0.0001
	Static heteroscedasticity		0.0022
	Dynamic heteroscedasticity		0.5699
Normality			
	Shapiro-Wilk		0.1053
	Kolmogorov-Smirnov		0.1482
	Cramer-von Mises		0.1274
	Anderson-Darling		0.0810

The null hypotheses of the JCM and JCV joint tests were rejected with a p-value of 0.0177 and 0.0002, respectively. The individual tests of assumptions reject the null hypotheses for both linearity of parameters and no autocorrelation. Individual tests also reject the null hypotheses of no structural change in variance and static homoscedasticity where p-values are given at <0.0001 and 0.0022. There is not enough information to reject the null hypothesis of normality under all four normality tests. Structural change in variance is corrected with a binary dummy variable (dt_2) changing the structure at the midpoint of the data series. The partial adjustment term (t-1) is squared to correct for non-linearity. The final model is estimated with Proc Autoreg to simultaneously estimate the error terms as an autoregressive process. The static heteroscedasticity is not dealt with as the LM test for ARCH disturbances fails to reject the null hypothesis of homoscedasticity at order one.

Results

Choice-Select

Coefficient estimates for Models I, II, and III of the Choice-Select discount are presented in Table II-10. Very little is interesting about Model I since little is significant, in addition, misspecification testing revealed weaknesses in this model. After correction of these weaknesses, price of boxed beef is significant at the 0.10 level and has the expected sign. Autoregressive error terms show significance, implying that adjustment in the carcass beef market takes place slowly over time.

Model II was estimated with Proc Autoreg. Both partial adjustment terms are significant at the 0.05 level. Since the Choice-Select discount is almost always negative, the positive sign on the term at time t-1 is expected. The term at lag t-2 has a positive sign but having lags with alternating signs is also expected. The significance of these two terms could be seen as inertia in the quality market for different grades of beef. Quantity of Choice in this period's production is significant with the expected sign. As the number of Choice cattle in the pen increases the Choice-Select discount narrows or becomes smaller in absolute value. As with Model I, the price of boxed beef is significant but at the 0.05 level with the expected sign. Also like Model I, the sign is negative implying that as the price of boxed beef increases, one would expect to see cattle sold from feedlots with fewer days on feed, hence percent Choice would decrease and the discount would widen or become more negative. A structural shift variable is significant at the 0.05 level and indicates a narrowing in the Choice-Select discount at the midpoint of the data series. Seasonal terms for April and September were significant at the 0.10 level. Notice that seasonality in Choice-Select during the second and third quarter of the year has a greater negative impact on the discount than the first and fourth quarters. Prior research has shown demand for both beef quality grades, Choice and Select, becomes more inelastic during the second and third quarters and these two grades are not substitutes for one another during these quarters (Lusk et al.). These are considered to be "grilling" months. At this time of year, retailers may adjust their offerings to accommodate changes in consumer tastes and preferences. Lusk further shows that during the first and fourth quarter Choice and Select beef are substitutes for one another. Thus it might be expected to see the pattern in the quality discount follow this same pattern.

Model III describes a more simplistic quality discount. The coefficient for the partial adjustment term is significant at the 0.05 level and has the expected sign. The coefficient for percent Choice in this period's production is significant at the 0.05 level and also has the expected sign. As the quantity of Choice increases, the Choice-Select discount narrows. Coefficients for April, May, September, and October are significant at levels of 0.05, 0.05, 0.10, and 0.10, respectively. The AR1 (autoregressive lag 1) term is significant and negative. AR2, AR5, and AR6 terms are significant at the 0.05, 0.10, and 0.05 levels and all negative but AR6. The possible implication of this might be the model would benefit from partial adjustment terms at additional levels.

During model selection, Model I was eliminated because of poor econometric qualities. The following hypothesis was then tested:

H_0: $\beta_2 = 0, \beta_4 = 0, \beta_5 = 0, \beta_6 = 0$ vs. H_a: At least one $\beta \neq 0$

The hypothesis will be tested with a likelihood ratio test. The test statistic: $TS = -2*(LL_{restricted} - LL_{unrestricted}) \xrightarrow{d} \chi^2_{95,4}$

$TS = -2 * (-302.1092 + 280.9039) = 42.4106$; critical value $\chi^2_{95,4} = 9.49$

Since |TS| > critical value, therefore reject the null hypothesis and conclude there is additional information contained in Model II and should be used in the analysis even though Model III is a more parsimonious model.

Yield grade 4-5

Estimates of the coefficients for Models I, II, and III of the yield grade 4-5 discount grid components are presented in Table II-11. All three yield grade discount models had substantial econometric problems. However given results of the statistical test involving MPR that this series is not equal in mean or variance before and after the inception of MPR, it is probably not surprising to find fairly poor results of these regressions. Other than the intercept term, Model I shows significance on the quantity of yield grade 4-5 carcasses in this period's production at the 0.10 level. The sign is as expected, as percent 4-5 carcasses increases the discount should widen or become more negative. Seasonality terms in November are significant at the 0.05 levels. AR1, AR2, AR3, and AR4 terms are significant at the 0.05, 0.10, 0.05, and 0.10 levels. These terms may imply heavy autocorrelation or possibly point to a partial adjustment process taking place.

Model II's intercept and two partial adjustment terms are significant at the 0.05 level and have the expected signs. Structural change is taking place as evidenced by its coefficient. It is significant at the 0.05 level and has the sign expected from Table II-3 which showed a decrease in the mean discount level before and after MPR. Seasonal terms for February, March, August, September, and October are significant at the 0.05

level. All four autoregressive terms are significant at the 0.05 level, again this model might benefit from additional partial adjustment terms or there may substantial inertia in this market.

Model III being a reduced form model of II yields some explanatory power in a parsimonious form. The intercept and partial adjustment lag are significant at the 0.05 level and have the expected signs. It is somewhat worrisome that percent yield grade 4-5 in this period's production is not significant. However, the coefficient for the structural change parameter is significant at the 0.05 level and has the expected sign as the mean of the discount after MPR is less that the mean before MPR. Seasonality terms February, August, and September are significant at 0.05; January and March are significant at the 0.10 level.

In the model selection for the yield grade discount, Model I was discarded first. The hypothesis that there is additional information contained in Model II than in Model III is then tested.

H_0: $\alpha_2 = 0, \alpha_3 = 0, \alpha_5 = 0, \alpha_6 = 0$ vs. H_a: At least one $\alpha \neq 0$

The hypothesis again will be tested with a likelihood ratio test. The test statistic: $TS = -2*(LL_{restricted} - LL_{unrestricted}) \xrightarrow{d} \chi^2_{95,4}$

$TS = -2*(-186.4596 + 172.4379) = 28.0434$; critical value $\chi^2_{95,4} = 9.49$

Since |TS| > critical value, therefore reject the null hypothesis and conclude there is additional information contained in Model II and should be used in the analysis.

Summary and Conclusions

Examples of economic hysteresis typically show some exogenous shock from which the economy or some individual market never recovers. Exogenous forces were applied to the carcass beef market with the advent of MPR on April 3, 2001 and immediately followed by the tragic events of September 11, 2001. Initial examination of plots of both Choice-Select and yield grade 4-5 discounts show changes visible to the human eye with the advent of MPR. Statistical tests show both quality and yield grade discounts may have changed in variance and yield grade discount may have changed in mean also. All three models of both discounts show many temporal econometric problems. Is it possible those exogenous shocks have produced hysteresis in this market?

The first objective of this study was to determine the factors explaining the Choice-Select and yield grade 4-5 discounts of fed cattle. The results show a partial adjustment model with two lags best describes these two discount components. With respect to the quality discount, partial adjustment coefficients, percent of Choice, boxed beef price, and a structural shift coefficient describe the structure. An increase in the boxed beef price will cause feeders to market their cattle sooner to take advantage of the price. This action will lead to a smaller percentage of Choice cattle and a larger quality discount.

The yield grade model is made up of the statistically significant two partial adjustment terms and the structural change term. While there can be an argument made that quality discount is the inverse demand of Choice carcass beef minus the inverse demand of Select carcass beef, it is much more difficult to understand how the yield grade 4-5 discount could be made up of differences in demand. It is rather more intuitive that this discount is a penalty or economic disincentive to feed cattle to higher yield grades. Thus, it may be more believable to see this discount as a continually moving partial adjustment process or an autoregressive process. The discontinuity in the yield grade series makes the modeling process more obscure than it otherwise might be.

The second objective of this study was to examine seasonality factors. Figure II-5 shows a plot for seasonality terms of both selected quality and yield grade models. The seasonality in Choice-Select finds a smaller relative discount in the first and fourth quarters of the year and larger relative discounts in the second and third quarter. These findings suggest during the second and third quarter that Choice and Select beef are not substitutes for one another. These are the "grilling" months; consumer tastes and preferences may drive this difference. This corresponds to the findings of Lusk et al. The second possible implication relates to the timing of production. Calves born during springtime calving will be weaned in the early fall, put on wheat through the following winter, and then moved to the feedlot during the first weeks of March. These cattle should be finished and ready to sell in August, September, and October. This would give buyers enough supply to be "choosey" when making procurement bids. Thus it would be possible to sustain a greater discount for better quality grade.

The seasonal terms of the yield grade 4-5 model may be explained in much the same manner when looking at the timing issues. Spring and summer is a much better time to feed cattle from the standpoint of producers because of ice, snow, and weather related illness. As cattle do not have to divert body energy to stay warm, they could, in fact, have a higher yield grade.

In conclusion if a producer markets fed cattle on a grid, examination of Figure II-5 shows an advantage in the first quarter of the year for cattle likely to grade a higher percentage of Select. For heavier cattle more likely to contain a higher percentage of yield grade 4's and 5's, a producer would appear to benefit with an anticipated marketing date in the second quarter.

Furthermore, I would recommend re-estimating the models after additional time has elapsed to have more data. These discount components represent an important part of cattle feeding profits; additional understanding would be very beneficial to producers and consumers alike.

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CHOICE-SELECT

APPENDIX

Table II-10. Models of Choice-Select Discount, Coefficients and Standard Errors

Variable	Model I	Model II	Model III
Intercept (β_0)	-3.6684 (2.4931)	-1.7550 (1.1287)	-4.4812** (2.1027)
Choice-Select discount t-1 (β_1)	NA	1.6706** (0.0516)	0.8883** (0.0548)
Choice-Select discount t-2 (β_2)	NA	-0.7429** (0.0491)	NA
Percent Choice (β_3)	-1.3978 (3.2100)	4.7105** (1.6072)	7.2777** (3.4724)
Percent YG4-5 (β_4)	-0.2398 (15.8951)	-3.4387 (2.8433)	NA
Price of boxed beef (β_5)	-0.0268* (0.0149)	-0.0110** (0.0033)	NA
Production (β_6)	0.00003 (0.0012)	-0.00011 (0.0010)	NA
Structural change (β_7)	-0.5844 (0.5860)	0.1838** (0.0690)	-0.0631 (0.1309)
January (β_8)	0.1875 (0.2593)	0.1199 (0.1058)	0.3177 (0.2252)
February (β_9)	0.0661 (0.3458)	0.0092 (0.1132)	0.0373 (0.2923)
March (β_{10})	0.2903 (0.3997)	0.1086 (0.1096)	-0.0258 (0.3031)
April (β_{11})	0.4715 (0.4365)	-0.2681* (0.1138)	-0.6691** (0.2988)
May (β_{12})	-0.0117 (0.4523)	-0.0338 (0.1206)	-0.5908** (0.2604)
June (β_{13})	-0.3015 (0.4540)	0.0356 (0.1078)	-0.2734 (0.2523)
July (β_{14})	-0.4188 (0.4478)	-0.0511 (0.1015)	-0.0228 (0.2505)
August (β_{15})	-0.3435 (0.4287)	-0.0633 (0.1143)	-0.3304 (0.2564)
September (β_{16})	-0.1407 (0.3996)	-0.1938* (0.1135)	-0.4806* (0.2590)
October (β_{17})	-0.0450 (0.3517)	-0.0787 (0.1174)	-0.4341* (0.2554)
November (β_{18})	-0.0072 (0.2689)	-0.0684 (0.1048)	-0.1571 (0.2154)
AR1	-1.2074** (0.0595)	0.6487** (0.0750)	-0.2489** (0.0755)
AR2	0.0661 0.0933)	0.3526** (0.0885)	-0.1504** (0.0671)

Table II-10. Models of Choice-Select Discount, Coefficients and Standard Errors

Variable	Model I	Model II	Model III
AR3	0.0515 (0.0922)	0.1613** (0.0698)	-0.0120 (0.0643)
AR4	0.1678** (0.0580)	NA	-0.0309 (0.0637)
AR5	NA	NA	-0.1255* (0.0640)
AR6	NA	NA	0.1403** (0.0607)
R^2	0.9520	0.9603	0.9549
AIC	670.6747	605.8078	646.2183
Log Likelihood	NA	-280.9039	-302.1092

Notes: Standard errors are given in parentheses. Single and double asterisks (* and **) denote significance at the 0.10 and 0.05 levels, respectively.

Table II-11. Models of Yield Grade 4-5 Discount, Coefficients and Standard Errors

Variable	Model I	Model II	Model III
Intercept (α_0)	-14.4390** (2.1751)	-2.6559* (1.3875)	-7.6163** (0.2076)
(Yield grade 4-5 discount)^2 t-1 (α_1)	NA	-0.0141** (0.0034)	-0.0318** (0.0007)
Yield grade 4-5 discount t-2 (α_2)	NA	0.5114** (0.0958)	NA
Percent choice (α_3)	1.4105 (2.2076)	-0.7533 (1.8490)	NA
Percent YG4-5 (α_4)	-19.3498* (11.2548)	-0.3398 (5.1220)	0.7207 (4.5140)
Price of boxed beef (α_5)	0.0073 (0.0111)	-0.0027 (0.0041)	NA
Production (α_6)	-0.0008 (0.0008)	-0.0012 (0.0009)	NA
Structural change (α_7)	NA	0.4377** (0.1339)	0.3664** (0.1264)
January (α_8)	0.0995 (0.1701)	-0.2163 (0.1357)	-0.1879* (0.1077)
February (α_9)	-0.0770 (0.2271)	-0.3855** (0.1415)	-0.2730** (0.1177)
March (α_{10})	-0.2314 (0.2667)	-0.2981** (0.1350)	-0.2115* (0.1135)
April (α_{11})	-0.0667 (0.2953)	-0.0028 (0.1363)	-0.0256 (0.1209)
May (α_{12})	0.1198 (0.3104)	-0.1570 (0.1406)	-0.1669 (0.1223)
June (α_{13})	0.3141 (0.3133)	-0.0807 (0.1432)	-0.1092 (0.1230)
July (α_{14})	0.5698 (0.3104)	-0.1856 (0.1348)	-0.1549 (0.1215)
August (α_{15})	0.5493 (0.3010)	-0.4104** (0.1362)	-0.3458** (0.1181)
September (α_{16})	-0.1126 (0.2791)	-0.5959** (0.1390)	-0.3829** (0.1179)
October (α_{17})	-0.2640 (0.2367)	-0.3099** (0.1376)	-0.1577 (0.1147)
November (α_{18})	-0.4677** (0.1756)	-0.2076 (0.1338)	-0.0327 (0.1084)
AR1	-0.8688** (0.0606)	-0.3763** (0.1100)	0.0413 (0.0612)

Table II-11. Models of Yield Grade 4-5 Discount, Coefficients and Standard Errors

Variable	Model I	Model II	Model III
AR2	0.1350*	0.5010**	0.1591**
	(0.0793)	(0.1048)	(0.0611)
AR3	-0.3851**	-0.2709**	-0.1308**
	(0.0796)	(0.1103)	(0.0622)
AR4	0.1439*	0.2062**	-0.0416
	(0.0826)	(0.0863)	(0.0607)
R^2	0.9640	0.9652	0.9622
AIC	421.0057	392.8757	414.9192
Log Likelihood	NA	-172.4379	-186.4596

Notes: Standard errors are given in parentheses. Single and double asterisks (* and **) denote significance at the 0.10 and 0.05 levels, respectively.

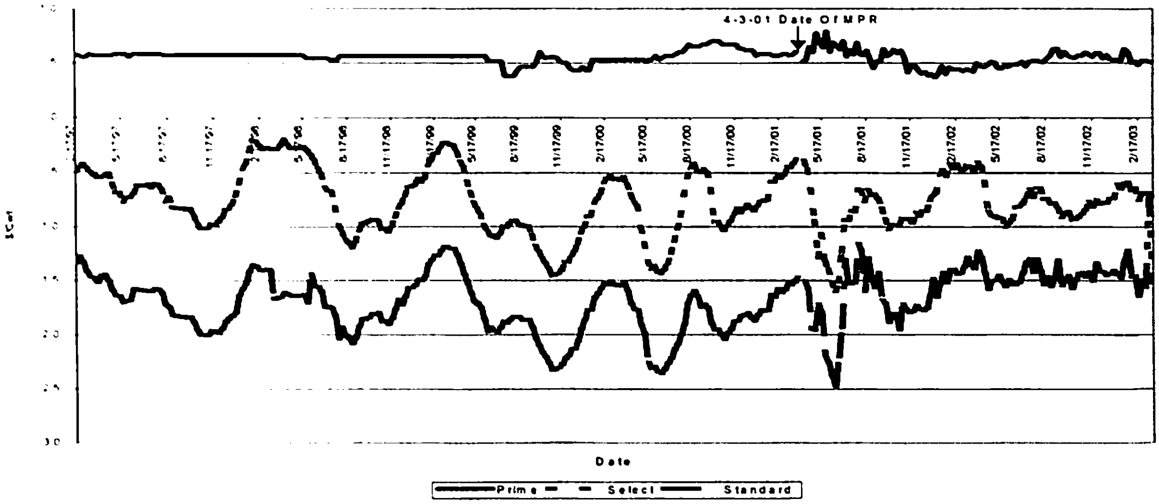

Figure II-1. Weekly Reported Quality Grade Premiums and Discounts, 2-17-1997 Through 3-17-03

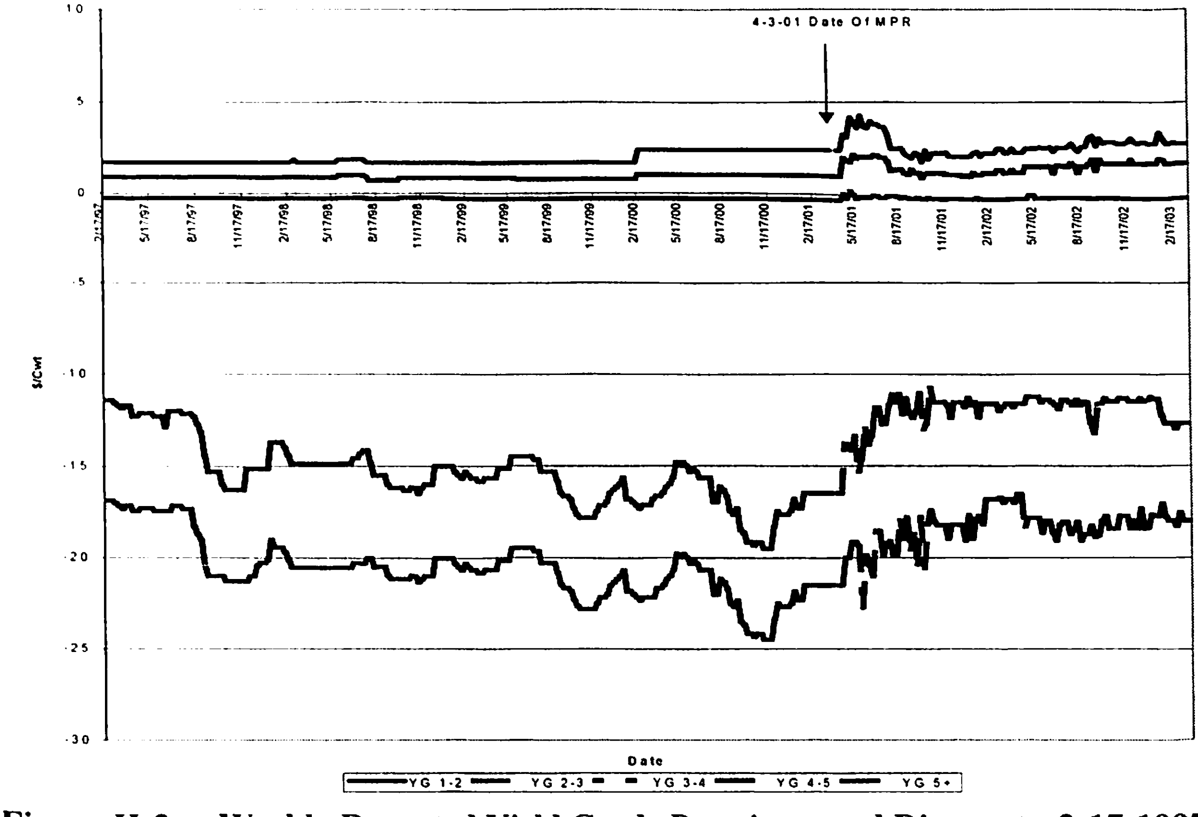

Figure II-2. Weekly Reported Yield Grade Premiums and Discounts, 2-17-1997 Through 3-17-03

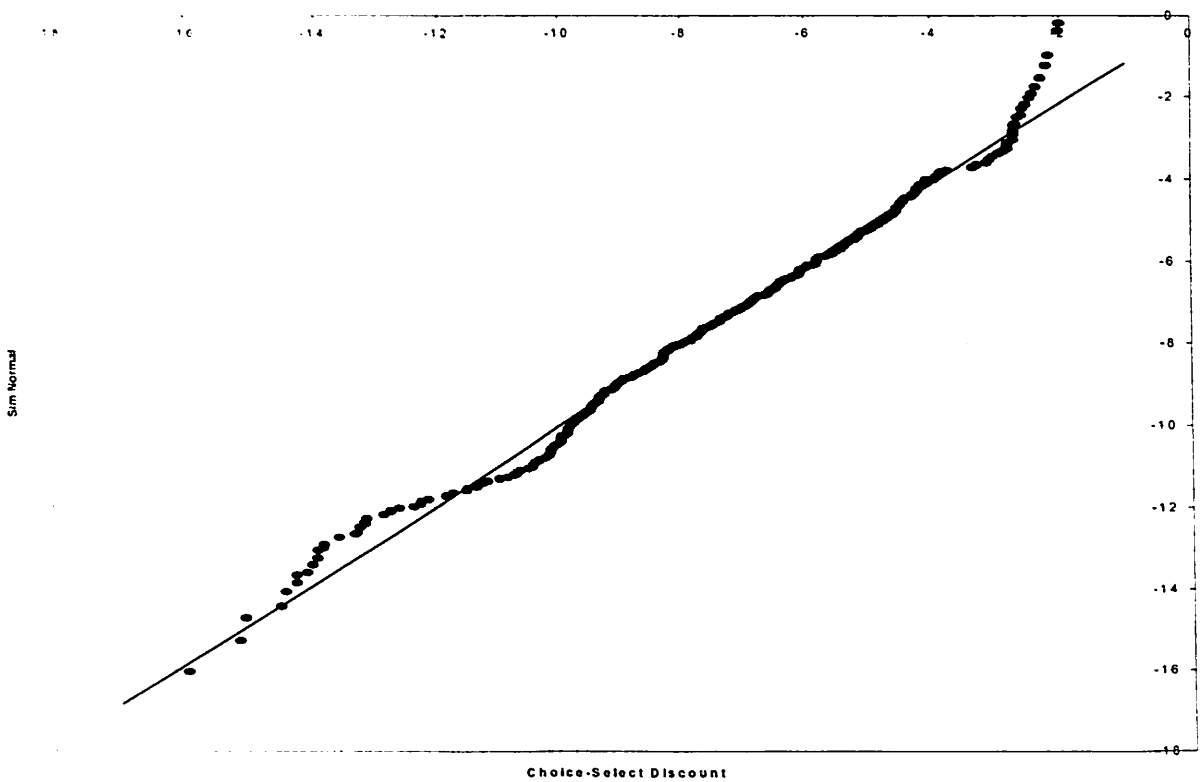

Figure II-3. QQ Plot For Choice-Select Spread Versus Normal Distribution

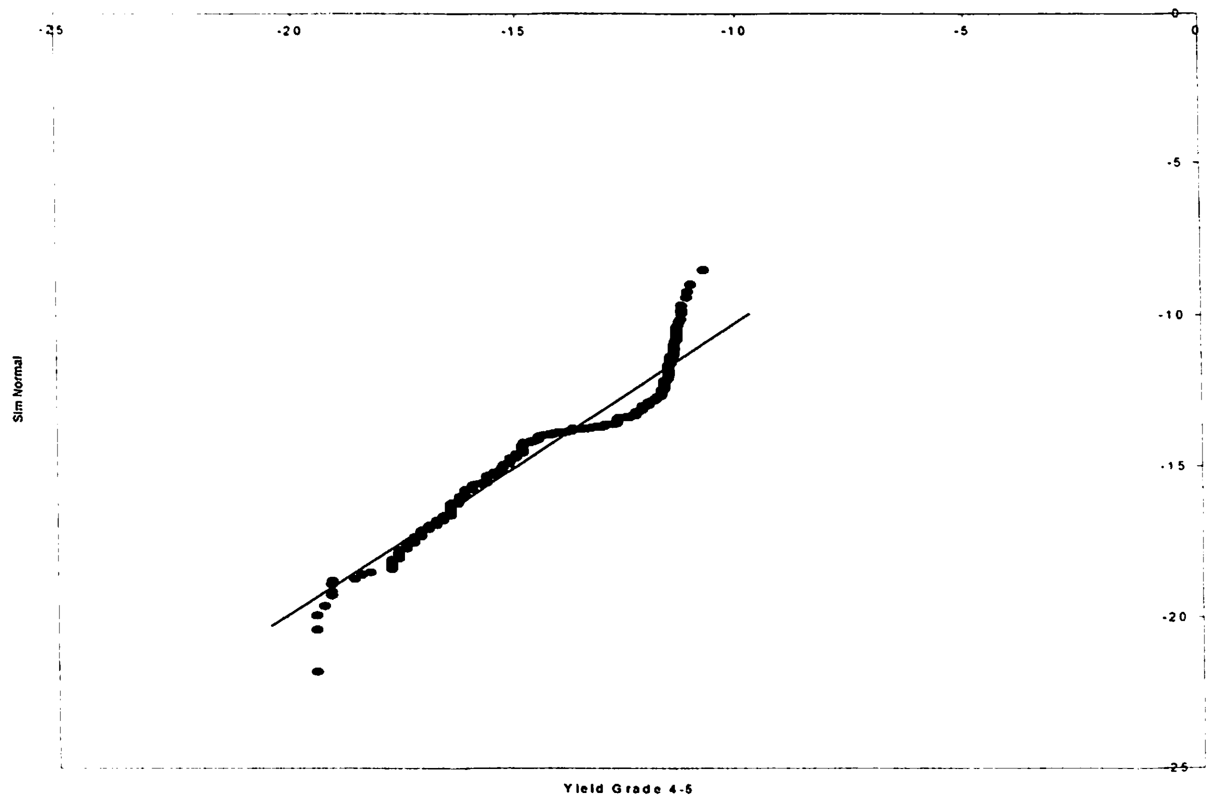

Figure II-4. QQ Plot For Yield Grade 4-5 Spread Versus Normal Distribution

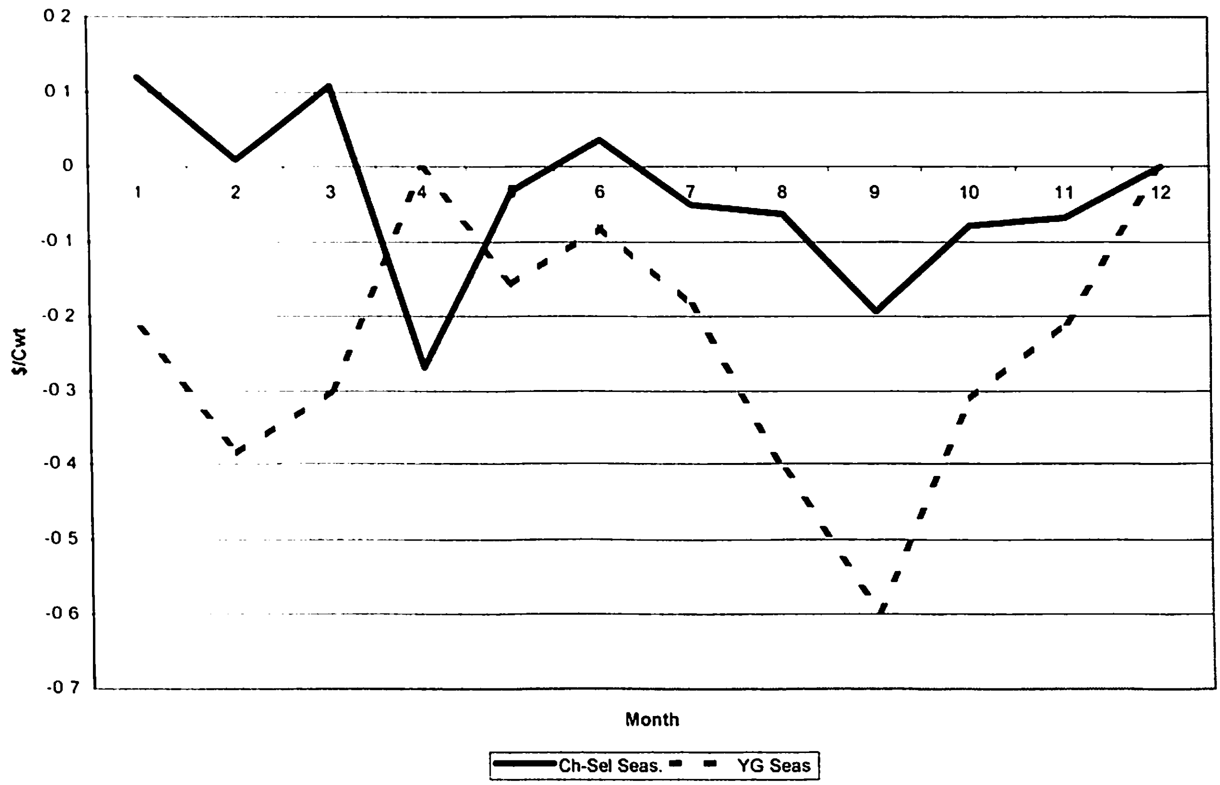

Figure II-5. Chart of Model II Quality and Yield Grade Seasonality Relative To December

CHAPTER III

GENERIC ADVERTISING AND RESEARCH IN BEEF AND PORK WITHOUT SUPPLY CONTROL

INTRODUCTION

World War I created a vast disruption of agriculture in Europe. At the same time, American farmers were able to greatly increase exports to Europe. These increases were aided by new American inventions such as the grain combine harvester. After the close of that World War, Europeans began to regain their respective market shares. This, coupled with onset of the Great Depression in America, worked to cause a disaster within U. S. agriculture. Masses of farmers declared bankruptcy, packed their meager belongings, and moved from the farm. Loss of markets, land erosion, low product prices to producers, and farmer's exodus caused agriculture to become a very beleaguered industry.

With the election of Franklin D. Roosevelt in 1932, Henry Wallace was appointed Secretary of Agriculture (Agricultural Adjustment Act, November 2001). In 1933, the Agricultural Adjustment Act (AAA) was drafted and passed in Congress. The AAA paid farmers to *not grow* specific crops, such as milk and butter, or *not raise* pigs and lambs.

Revenue to pay farmers for these adjustments was raised by a tax on companies that bought the raw agricultural commodities and processed them into finished food and fiber goods. The AAA was tried in court and declared unconstitutional. Judges ruled that it was illegal to levy a tax on one group (processors) in order to pay benefits to another group (farmers).

Congress passed the amended Agricultural Adjustment Act of 1935. In an address to a group of farmers, President Roosevelt spoke of the success of the AAA of 1933 and the anticipated success of the amended AAA of 1935. In his speech, he alluded to things past and things to come.

"Those people, my friends, did not understand and many of them do not understand today that, if the farm population of the United States suffers and loses its purchasing power, the people in the cities in every part of the country suffer of necessity with it." (The American Experience/Presidents/FDR/Address on Agricultural Adjustment Act, November 2001).

He cited numerous examples of how low farm prices were when the AAA was initially enacted and how much progress had been made in increasing prices and cutting over-production in the interim. Roosevelt was correct about the benefits of AAA; to the farmers it probably made the difference between starving and continuing to operate their farm. His speech continued as he spoke of support for the new program.

"I think that you and I are agreed in seeking a continuance of a national policy which on the whole is proving successful. The memory of old conditions under which the product of a whole year's work often would not bring you the cost of transporting it to market is too fresh in your minds to let you be led astray by the solemn admonitions and the specious lies of those who in the past profited most when your distress was greatest." (The American Experience/Presidents/FDR/Address on Agricultural Adjustment Act. November 2001).

Concepts of farm programs were becoming a part of life in American agriculture. The amended AAA of 1935 dealt with major farm problems, explicitly over-production. But there was now lacking a method to increase demand for food and fiber to increase farm income. To meet this issue the Agricultural Marketing Agreement Act of 1937 (AMAA) was drafted by the Roosevelt administration, passed by Congress, and became law. It was the AMAA and subsequent State actions that established federal and state marketing orders. Basically, a marketing order provides producers of a particular commodity with a method of regulating the market supply and demand for their product(s) under the auspices and regulations of the U.S. Secretary of Agriculture or respective State Secretary of Agriculture. These market orders provide, in various instances, rules and regulations for production limits or quotas, size and/or quality grades, product color, taste, etc. As the AMAA was amended by Congress in 1954, orders may provide for generic promotion to increase demand for a certain commodity or product.

A number of times throughout this analysis the beef industry and beef checkoff may be used in an example, which applies to beef or pork. Parts of the analysis that are industry specific will be noted.

Problem Statement

Since the beginning of agricultural marketing orders, a great deal of litigation has been involved with individual orders. Part of the litigation is derived from a desire to be a "free rider" and still retain full benefits of the paying coalition. Indeed, part of the litigation arises from producers disagreeing with the marketing orders. Some have suggested the greatest cost of market order litigation is in the form of bad will between producers, processors, and other associated groups. "Economists and other analysts will no doubt try to enumerate the cost of these lengthy challenges, but perhaps the biggest cost is immeasurable: the cost arising from the ill will engendered along both sides of this debate."(Crespi, 2000). This paper will look at the market order litigation involving beef and pork in light of prior decisions.

The objectives of this study are twofold, first to determine whether the beef and pork research and promotion orders will survive court litigation intent on destroying them. The second objective is to determine the economic welfare impacts of overturning the beef and pork orders.

Market Order Litigation

In 1936, the Supreme Court balked at the broad tax provisions of the AAA of 1935 in the case *United States v. Butler* (297 U.S. 1). The high court stated only Congress or the states could tax and giving these powers to the Secretary of Agriculture violated the Tenth Amendment. Somewhat later that year in *United States v. David Buthick Co.* (15 F. Supplemental 655), a Massachusetts District Court ruled the tax and market order provisions of AAA 1935 were inseparable. The entire Act appeared to be in jeopardy at this time. Congress, in an attempt to begin again, drafted what would become the 1937 Agricultural Marketing and Agreement Act (7 U.S.C. § 601 et seq; hereinafter called the "AMAA"). In the AMAA, Congress makes the distinction that self-funding is done through assessments not taxes. Based on previous court rulings, only Congress had power to levy and collect taxes, whereas the Secretary of Agriculture can make an assessment on assets to fund market self-improvement provisions. While we as economists see very little difference between assessments and taxes; in the eyes of the Court this difference is rather dramatic. A marketing order can only be set up by the Secretary provided a two-thirds majority of effected producers vote in favor of the order, while repeal of an order requires a simple majority of those producers.

Since the Supreme Court had struck down both predecessors of the AMAA, the first court test of the AMAA was very important. That test case was *United States v. Rock Royal Co-op.* In 1939, a few dairy processors were filed against because they did not pay their assessments under the Milk Order No. 27. The respondents claimed the Order had been adopted improperly and both the Act and Order were unconstitutional under the Fifth, Tenth and Fourteenth Amendments[1]. The District Court found in favor of the defendants. The Secretary then appealed the decision to the Supreme Court, which upheld both the Act and Order in a 5 to 4 decision (*United States v. Rock Royal, Co-op., Inc.*)(307 U.S. 533). Roosevelt's New Deal administration finally had a marketing order able to withstand a court test. The *Rock Royal* decision is precedent setting from the standpoint the Supreme Court had established a property right for the dairy, fruit and vegetable producers to be able to vote themselves into and out of a regulated industry. This precedent held great strength, as the next test did not take place for fifty years.

The next event of importance took place in 1954 when the Congress amended the AMAA to give enabling authority to the Secretary of Agriculture to add "marketing

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[1] Alleged violations related to unconstitutional infringement on due process rights (Fifth Amendment). rights reserved only for states (Tenth Amendment), and property rights (Fourteenth Amendment).

development projects" to the language of the AMAA. This took place in the Agricultural Act of 1954 (§ 401(c)) enabling the tools of advertising and promotion to be applied over a broad group of agricultural commodities, thereby helping stimulate market demand and consumer perception. Stipulations of advertising portions of the orders are stated such that advertising and/or promotion must be generic in nature thus it can't benefit some growers over others. Monies raised from the assessment may not be used to promote political or ideological viewpoints. This is an important point in following litigation history, events, and rulings.

Discussion now leads to two different Supreme Court decisions that appear to have nothing to do with agriculture and marketing orders, but taken together, they form two-thirds of the framework which later marketing order litigation is based. In 1977, Louis Abood and some other Detroit schoolteachers challenged a collective bargaining agreement between Detroit Federation of Teachers and Detroit Board of Education. According to their bargaining agreement, any Detroit teacher who had not become a member of the Federation within 60 days of their employment was required to pay a fee (service charge) equal to their union dues. Abood and other objecting teachers disagreed with the agreement and contended charges were being used for other purposes such as funding political endorsements. In a nutshell, the teachers believed they were being compelled to speak when they would have rather maintained their silence. Furthermore, they disagreed with the speech they were required to help finance. The case was finally decided in the Supreme Court in May of 1977 (*Abood v. Detroit Board of Education* (431 U.S. 209)). The Court ruling stated although Abood and other teachers were not being restrained from their freedom of speech, this same freedom of speech included the right not to be compelled to speak. This was precedent for the original reverse freedom of speech case.

Then, in 1980, the high court heard another seemingly unrelated case, *Central Hudson Gas & Electric v. Public Service Commission of New York*. In this case, Public Service Commission of New York (Commission), in 1973, issued an order in which all electric utilities were prohibited from all advertising that might increase energy demand. This was principally created by the energy crisis and caused by shrinking national petroleum inventories. Central Hudson opposed the Commission ban based on First Amendment grounds. The Supreme Court made the final ruling on *Central Hudson Gas & Electric v. Public Service Commission of New York* (447 U.S. 557) in June of 1980. In the ruling, the Court established a "three-prong test" which must be administered in commercial speech cases. If commercial speech is legal, appropriate, and non-misleading, then the three prongs are: (1) does the government's program involve a substantial government interest? (In other words, does the program further the government's agenda?) (2) does the regulation directly advance that governmental interest? (3) is the governmental program tailored narrowly enough to minimize any impact on First Amendment rights? If a government program is unable to pass all three of these "prongs" then the program is considered unconstitutional. In the case of *Central Hudson*, the court found the Commission's ruling passed the first two prongs but failed the third prong because it was tailored too broadly when a narrower ruling would have served the same purpose. The Court ruled in favor of Central Hudson and Public Service Commission's regulation was struck down. This ruling created groundwork whereby regulations like market orders could be challenged. From this point, all litigation must pass the tests of *Abood* and *Central Hudson.*

Congress passed both the Beef Promotion & Research Act (7 USC 2901)(beef checkoff) and Pork Promotion, Research & Consumer Information Act (7 USC 4801)(pork checkoff) in 1985. These enabling acts were then followed by their respective marketing orders. The beef act was responsible for creation of the Cattlemen's Beef Promotion & Research Board. The pork act subsequently caused the creation of The National Pork Producers Council. Both market orders are considered "stand alone", or in other words, both orders are separate from the AMAA. In 1990, Congress established the Mushroom Promotion, Research and Consumer Information Act (7 USC 6101-6112, 7 CFR Part 1209). This resulted in an accompanying market order and birth of the Mushroom Council. The mushroom act is also a "stand alone" act and not an add-on to AMAA. These three orders; beef, pork, and mushroom can be contrasted to other orders set up by the AMAA, the California fresh "tree fruit" order as an example (Table 1). The AMAA orders are rather more restrictive with respect to supply quotas, product quality regulations, handling, and packing restrictions. Some of the AMAA orders collectivize producers such that anti-trust exemptions are granted to the group.

The beef act set up what was to become known as the "beef checkoff." The assessment required domestic cattle producers and foreign importers to be assessed one dollar per beef animal transaction at any market level unless that animal is held for a specified very short period. For example, if the animal were bought this week for the purpose of being marketed next week, or some similar scenario, there would be no assessment. Most funds obtained from the assessment were to be used for both generic promotional advertising and research.

The pork act likewise set up the "pork checkoff." The assessment required is made on first time sales of hogs in three separate categories: feeder pigs, breeding hogs, and slaughter hogs. The assessment is 0.45% of the value of each sale[2], in other words assessments are $0.45 per $100 of value. Funds obtained were to be used for generic promotional advertising and research like the case of beef.

Mushroom assessments under the Mushroom Promotion, Research, and Consumer Information Act of 1990 are made on the basis of $0.045 per pound. Again, like the other two cases resulting funds were used for generic promotional advertising and research as stipulated by the Act and Order. Table III-1 compares the marketing orders for beef, pork, mushrooms, and California fresh "tree fruit".

Following *Central Hudson*, the next case involving promotion and research programs was *United States v. Frame* in 1989. Robert Frame, Sr. operated a cattle auction business and raised cattle in Pennsylvania. Frame disagreed with the order and refused to pay his assessments. The Secretary of Agriculture brought suit against Frame and won the case in District Court. Frame appealed his case to the 3rd Circuit Court of Appeals. Frame's argument was threefold: (1) as in Rock Royal, that the Beef Act unlawfully gave the Secretary authority in violation of the Tenth Amendment, (2) that assessments violated Frame's equal protection rights under the Fifth Amendment, and (3) that his First Amendment rights had been abridged by forcing him to speak in conjunction with his competitors when he would have rather remained silent. The 3rd Circuit held that in cause (i) and cause (ii) there was no case. However, the Court held on

[2] Pork producers voted to lower this to $0.40 in 2002.

First Amendment grounds. Frame's rights had indeed been abridged, but not sufficiently to strike down the Beef Act. At the same time, the court stated this type of commercial speech had to be held to an even higher standard of scrutiny because Frame was forced by law to associate with the Beef Board. The court further found that Frame had not convinced them (justices) he (Frame) was interested in anything other than strategy. Frame, then, appealed to the Supreme Court, which denied him a hearing (110 U.S. 1168).

Following the *Frame* decision, there appeared before the high court in 1993, the case *Cal-Almond v. U.S. Department of Agriculture*. It should be noted that there were some differences between the almond marketing order and other orders. The main difference involved credit back from the assessment if the individual producer/handler did their own branded advertising from their compelled industry assessments. The producer/handler could be refunded the value of their own advertising up to the value of their assessment. In this regulated industry, Blue Diamond Almonds was the largest producer/handler, controlling 92 percent of all almonds sold in grocery stores plus their own retailing stores. Most producer/handlers sold to cereal makers and ice cream manufacturers. Blue Diamond potentially could be a fierce competitor wielding so much market share. Cal-Almond, Inc. sold almonds for use in a particular brand of ice cream and helped advertise the ice cream. Cal-Almond was denied credit back on their advertising because the order stipulated the advertised product must contain at least fifty percent almonds. However, Blue Diamond was allowed to recover their advertising expenses. In 1987, Cal-Almond, along with Salsbury Orchards and Almond Processing, Inc., challenged the almond order. The case appeared before the 9th Circuit Court as *Cal-*

Almond v. USDA (14 F.3d 429). The 9th Circuit applied the three prongs of *Central Hudson* decision and ruled the first "prong" held. The court contended the order represented substantial government interest. However, the government could not prove the board's advertising increased demand for the almonds and further could not prove the board's advertising was better than advertising that was not allowed credit back. Having failed two of the three prongs, the 9th Circuit ruled the advertising segment of the almond order was unconstitutional and did violate the appellants First Amendment rights of free speech.

Hard upon the heels of the *Cal-Almond* case came the case of *Goetz v. Glickman* in 1996 (No. 94-1299-FGT, District of Kansas). Jerry Goetz, primarily a livestock auctioneer and Kansas cattle rancher, challenged the $1.00 per head "checkoff" assessment on cattle sold. Goetz made the following claims concerning beef assessments: (1) the assessment violated the Constitution's commerce clause, (2) assessment constituted an unconstitutional direct tax; (3) assessment unconstitutionally delegated authority to the Beef Board and Secretary; (4) assessment did violate Goetz's equal protection rights; (5) assessment did constitute an unconstitutional taking for non-public purposes; (6) assessment did violate Goetz's First Amendment rights of free speech. Judge Frank Theis of U.S. District Court for the state of Kansas granted a motion from the Secretary to dismiss these constitutional challenges. Without the *Cal-Almond* decision, *Goetz* would not amount to much. However in his ruling, Judge Theis never referred to *Cal-Almond* but citing rulings set forth in *Frame*. The case was not carried further at that time.

In 1995, the 9th Circuit Court heard *Wileman Bros. & Elliott, Inc. v. Espy* (58 F.3d 1367). This case involved a coalition of handlers of California nectarines, peaches, and plums. The "tree-fruit" case began as a dispute over regulations in the marketing order dealing with size and quality. The District Court ruled in favor of the Secretary sustaining the order. The plaintiffs appealed to the 9th Circuit and added that, while they disagreed with the order, they were being compelled to participate with the program's generic advertising program. The objecting handlers stated generic advertising claimed all California tree-fruit was the same while the plaintiffs were trying to show product differentiation. The 9th Circuit Court of Appeals overturned the lower courts' ruling, stating there was no evidence that generic advertising was better than the handlers' own advertising, as in *Central Hudson*'s second prong. Also, the marketing order was more restrictive than it needed to be and lacked credit back on individual advertising. The 9th Circuit ruled this was clearly unconstitutional infringement on the tree-fruit handlers' freedom of speech. The Secretary of Agriculture appealed this decision to the Supreme Court claiming *Wileman* was in direct opposition to *Frame*[3]. The Supreme Court heard the case and issued a ruling in December 1996, *Glickman, Secretary of Agriculture v. Wileman Brothers & Elliott, Inc. et al* (521 U.S. 457). In their ruling, the Court reversed the 9th Circuit in a 5-4 decision stating two main findings. First, handler's opposition with the content of generic advertising was found to lack any relevance on validity of the entire generic program. Second, the justices stated the 9th Circuit had erred using *Central Hudson* to test for constitutionality. The 9th Circuit Court stated the generic program had increased demand more than would advertising programs of the individual tree-fruit

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[3] With a change in Secretaries, the case had now become *Glickman, Secretary of Agriculture v. Wileman Brothers & Elliott, Inc. et al.*

handlers and was troubling to the court. They stated this was "inconsistent with the very nature and purpose of the collective action program." (521 U.S. 474). The high court went on to point out three different aspects of the tree-fruit marketing order that set it apart from other examples found to be unconstitutional. First, the market order does *not* prevent producers or handlers from communicating any message to their audience, distinguishing this case from *Central Hudson.* Second, producers/handlers are *not* required to engage in any form of speech. Third, the order does *not* require producers/handlers to endorse or help finance political or ideological views or beliefs, different from *Abood.* Whether or not the individual producer/handler was hurt was immaterial, as they had chosen to operate within an industry that was regulated.

Writing for the dissenters, Justice Souter states: "The legitimacy of governmental regulation does not validate coerced subsidies for speech that the government cannot show to be reasonably necessary to implement the regulation, and the very reasons for recognizing that commercial speech falls within the scope of First Amendment protection likewise justifies the protection of those who object to subsidizing it against their will. I therefore conclude that forced payment for commercial speech should be subject to the same level of judicial scrutiny as any restriction on communications in that category." (521 U.S. 478, 479).

Justice Souter then makes two points. Initially, he believed the tree-fruit order did not further any vital policy interest of the government. He felt there was an arbitrariness of commodities covered. Maybe a commodity was covered in one section of the United States but not in another. Secondly, he felt the 9th Circuit *Central Hudson* test was correct and the test the Supreme Court had applied, *Abood*, was incorrect. However, he felt *Wileman* would fail all three prongs of *Central Hudson*. Souter went on to say of the three prong test: 1) the Secretary must provide compelling evidence that the advertising supports a substantial government interest, 2) the Secretary must show how the compelled advertising advances government interest by either showing "that its mandatory scheme appreciably increases the total amount of advertising for a commodity or somehow does a better job of sparking the right level of consumer demand than a wholly voluntary system would." (p. 501). Finally, to satisfy the third prong, the Secretary must demonstrate that generic advertising is narrowly tailored to achieve government interest (Crespi). Souter states that a credit back branded advertising stipulation would accomplish this. Based on Justice Souter's writing of the dissenting opinion, not just a 5-4 majority but a 9-0 majority believe generic advertising is constitutional. Justices are just split on their way of implementing it.

United Foods, Inc., a Tennessee food processor, contested the 1990 Mushroom Promotion, Research, and Consumer Information Act (Mushroom Act) on the grounds the assessments made under the order were forced, commercial speech with which United Foods differed. The mushroom industry is somewhat different than tree-fruit producers/handlers, pork, and beef producers in that there are substantially fewer producers and the market is substantially differentiated with considerable branded advertising according to United Foods pleadings. In November of 1999, the 6th Circuit Court of Appeals ruled the Mushroom Act was unconstitutional in *United States et al v. United Foods, Inc.* (197 F.3d 221) Judge Merritt's opinion was given, "The Court's holding in *Wileman*, we believe, is that nonideological, compelled, commercial speech is justified in the context of the extensive regulation of an industry but not otherwise." (197 F.3d 224).

On August 18, 2000 on behalf of the Secretary of Agriculture, the U.S. Solicitor General petitioned the Supreme Court to hear *United Foods*. The Solicitor General maintained the 6th Circuit erroneously applied the Wileman case and the 6th Circuit's decision conflicts with other court decisions rendered. (Chartier, George October 2001)

On June 25, 2001 the Supreme Court voting 6-3 sustained the ruling of the 6th Circuit Court of Appeals and declared the Mushroom Act unconstitutional. The high court decided the Mushroom Act violates First Amendment right to freedom of speech, in *United States et al v. United Foods, Inc.* (121 S. Ct. 2334 November 2001). The justices representing a majority of the Court were Justices Kennedy, Rehnquist, Stevens, Scalia, Souter, and Thomas. The dissenters were Justices Breyer, Bader Ginsburg, and O'Connor.

Writing for the majority, Justice Kennedy drew a distinction between *Wileman* and *United Foods*. Peach and nectarine generic advertising is "part of a broader collective enterprise", but in the Mushroom Act "there is now heavy regulation", he said. "It is undisputed that most monies raised by the assessments are spent for generic advertising to promote mushroom sales." (United States etal. v. United Foods, Inc. October 2001)

Justice Thomas in a separate concurring statement stated, "I write separately, however, to reiterate my views that paying money for the purposes of advertising involves speech, and that compelling speech raises a First Amendment issue just as much as restricting speech. ... Any regulation that compels the funding of advertising must be subjected to the most stringent First Amendment scrutiny." (United States etal. v. United Foods, Inc. October 2001)

The question before the courts in new court challenges will be, "Are you primarily in an advertising and promotion program or are you primarily in what Justice Kennedy termed a cooperative arrangement among producers to displace competition where you set prices, controls on market supply or shipments?" said Attorney Brian C. Leighton, co-counsel for United Foods, Inc. "Almost nobody can say they are in the latter category." (Hall)

In the dissenting opinion, Justice Breyer states: "...that the regulatory program before us is a species of economic regulation...I would characterize the program for three reasons...first, the program does not significantly interfere with protected speech interests. It does not compel speech itself; it compels the payment of money...Second, this program furthers, rather than hinders, the basic First Amendment speech objective...Third, there is no special risk of other forms of speech-related harm...Taken together, these circumstances lead me to classify this common example government intervention in the marketplace as involving a form of economic regulation, not commercial speech, for purposes of applying First Amendment presumptions. and seen as such, I cannot find the program lacks sufficient justification to survive constitutional scrutiny...the standard permits restrictions where they directly advance a substantial government interest that could not be served as well by a more limited restriction." (United States etal. V. United Foods, Inc. October 2001)

Justice Breyer stated in his opinion the high court had disregarded controlling precedent, failed to properly analyze the strength of relevant regulatory and commercial speech interests. and introduced into First Amendment law an unreasoned legal principle that may well pose an obstacle to development of beneficial forms of economic regulation.

In February 2001. the USDA announced a temporary settlement with the National Pork Producers Council (NPPC) and the Michigan Pork Producer Council. This settlement requires a certain restructuring whereby the Pork Board is required to: (1) employ its own management and staff that differs from the NPPC's; (2) manage separate contracts for promotion. research, and consumer information projects; (3) maintain separate office operations from the NPPC; and (4) maintain separate communications from the NPPC. Under this restructuring agreement the state pork producer associations will continue to operate independently and further be accountable for all "checkoff" funds spent. but may cooperate on projects and communications with state affiliate organizations of the NPPC. Further, the Pork Board will have approximately two years to demonstrate to pork producers and importers the "pork checkoff" program has value.

Following United Foods decision, in October 2001, Livestock Marketing Association (LMA) filed suit against USDA and Cattlemen's Beef Promotion and Research Board in U.S. District Court for the District of South Dakota, Northern Division. Their pleading states plaintiffs object to payment of $1.00 per head beef assessment on the following grounds: i) they (plaintiffs) believe United States beef is superior to imported beef but they (plaintiffs) are being compelled to finance generic messages of "Beef. Its What's for Dinner" and "Beef. It's What You Want". These generic messages do not differentiate between domestic grain fed and imported, primarily grass fed beef. The plaintiffs indicate the generic program may make imported beef indistinguishable from domestic beef, thereby increasing quantities of imported beef and reducing domestic market prices for U.S. cattle producers[4]. ii) plaintiffs also object to the use of compelled assessments in a manner which may both act against producers and may simultaneously benefit corporations, packers, and retailers rather than cattle producers (Plaintiffs' Brief In Support of Their Motion For Summary Judgment On First Amendment Claims). Objections made by LMA are very similar to objections made in the United Foods case.

In the fourth week of November 2001, the Supreme Court refused to consider an appeal on *Goetz v. Glickman* decision in U.S. District Court. Goetz was to be heard following the *United Foods* decision. U.S. District Court Judge Charles Kommann in South Dakota ruled on June 21, 2002 the beef checkoff to be unconstitutional on first amendment grounds. Department of Justice officials filed a July 8 stay of injunction, as the injunction issued by Judge Kommann would stop assessment collections July 15, 2002. Officials from the Secretary of Agriculture have asserted the beef checkoff program constitutes government speech and U.S. Court of Appeals for the 8th District Circuit in St. Paul, MN should hear LMA's argument to that assertion in early 2003. The case is now in the appeal process.

In a judgment issued October 25, 2002 by U.S. District Court for the Western District of Michigan, Judge Richard Alan Ensien ruled the Pork Production, Research, and Consumer Education Act of 1985 unconstitutional. The ruling included the following passage. "Even aside from the important political and philosophical objections to such speech, the commercial interests of objecting producers to such speech is ample.

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[4] This line of argument led to support for Congressionally mandated Country of Origin Labeling (COOL) of fresh beef and pork.

In days of low return in agriculture, the decision of individual farmers to devote funds to uses other than generic advertising are very important. Indeed, the frustration of some farmers are likely to only mount when those funds are used to pay for competitors' advertising, thereby depriving the farmer of the ability to pay for either niche advertising or non-advertising essentials (such as feed for livestock). This is true regardless of whether objecting farmers are correct in their economic analysis that the assessments and speech do not sufficiently further their own particular interests.

In short, whether this speech is considered on either philosophical, political, or commercial grounds, it involves a kind of outrage which Jefferson loathed. The government has been made tyrannical by forcing men and women to pay for messages they detest. Such a system is at the bottom unconstitutional and rotten."

Department of Agriculture officials then filed a motion in appellate court to continue collections while they (USDA) appeal the District Court decision. The U.S. Court of Appeals for the 6th Circuit granted this motion on November 15, 2002. This case is currently in the appeal process. As a matter of record, though there have been many instances of constitutionality litigation in beef, this case is the only constitutional issue for pork since the inception of the checkoff.

Impact of Dissolution of Beef and Pork Checkoffs, A Conceptual Framework

In this section and from a sense of terminology, the term "coalition advertising" will mean all promotional or generic advertising expenditures by any group, which has little or no control over industry supplies or by extension prices, as these producers will by definition be price-takers. However, its advertising expenditures may indirectly affect both the output and the price. "The reason is that advertising expenditures shift the demand curve for the product by attracting new consumers and altering the tastes and preferences of former buyers. of course, this shift is not accomplished instantaneously nor do the effects of a dollar spent on advertising disappear at once" (Nerlove and Waugh). In fact, research since that of Nerlove and Waugh have shown that effectiveness of generic advertising to be approximately 3 quarters or 9 months (Cox).

As contrasted to existing theory of advertising under conditions of imperfect competition, a theory of advertising without supply control does not need to consider the effects of advertising on the price elasticity of demand and cross elasticities of demand of competing goods or commodities. Since advertising expenditures shift the demand curve for a good or product, these same expenditures affects both that goods equilibrium price and quantity. Increased advertising shifts the demand curve upward and to the right, however, by assumption, producers do not directly control supply, so the long-run effect of the shift in demand is to move price and quantity along the long-run supply curve to a new equilibrium where the long-run supply intersects the new demand curve.

A simple demand function can be specified where demand q of the commodity is some function of own price, p and advertising monies spent in generic promotion, a. In addition, a supply function may be specified such that supply q is a function of own price and research monies used for production research, δ. The demand function is derived demand at the feeder level and the supply is farm level supply. These functions are assumed to be continuous and differentiable.

(1) $$q = D(p, a)$$

(2) $$q = S(p, \delta)$$

Assume that in the demand and supply equations, price may be some function of advertising or research respectively.

$$p = f(a) \text{ and } p = f(\delta)$$

Substituting these assumptions back into (1) and (2) yields:

$$q = D(p(a), a) \text{ and}$$

$$q = S(p(\delta), \delta).$$

Demand may be enhanced by advertising (generic promotion), market research, or product research, e.g. developing new muscle cuts etc. Since all these effects might increase demand then all these effects are summed to form a (Wohlgenant 1993). Assume all other variables are constant at some level. It is assumed that quality of factor inputs remains constant for this analysis, whereas this quality may vary from producer to producer, e.g. breeding stock. It is also assumed there are neither external economies or diseconomies, therefore the horizontal sum of each individual producer's supply curve above their average variable cost will be equal to the industry supply.

Market equilibrium conditions require that quantities demanded are equal to quantities supplied. Thus the effect of a change in advertising expenditures on quantity may be found by taking total derivatives of (1) and (2) with respect to a (Chiang):

(3) $$\frac{dq}{da} = \frac{\partial D}{\partial p}\frac{dp}{da} + \frac{\partial D}{\partial a}\frac{da}{da},$$

(4) $$\frac{dq}{da} = \frac{\partial S}{\partial p}\frac{dp}{da} + \frac{\partial S}{\partial \delta}\frac{d\delta}{da}.$$

For this simplistic generalized model, consider that checkoff dollars may be spent on either a or δ. Hence monies spent for advertising can't be spent for research so $\frac{d\delta}{da} = \frac{da}{d\delta} = -1$. After re-arranging terms (3) and (4) become

(5) $$\frac{dq}{da} - \frac{\partial D}{\partial p}\frac{dp}{da} = \frac{\partial D}{\partial a},$$

(6) $$\frac{dq}{da} - \frac{\partial S}{\partial p}\frac{dp}{da} = \frac{\partial S}{\partial \delta}(-1).$$

Rewriting (5) and (6) in detached matrix form gives

$$\begin{bmatrix} 1 & -\frac{\partial D}{\partial p} \\ 1 & -\frac{\partial S}{\partial p} \end{bmatrix} \begin{bmatrix} \frac{dq}{da} \\ \frac{dp}{da} \end{bmatrix} = \begin{bmatrix} \frac{\partial D}{\partial a} \\ -\frac{\partial S}{\partial \delta} \end{bmatrix}.$$

Solving for $\frac{dq}{da}$ by Cramer's Rule yields

$$\frac{dq}{da} = \frac{\begin{vmatrix} \frac{\partial D}{\partial a} & -\frac{\partial D}{\partial p} \\ -\frac{\partial S}{\partial \delta} & -\frac{\partial S}{\partial p} \end{vmatrix}}{\begin{vmatrix} 1 & -\frac{\partial D}{\partial p} \\ 1 & -\frac{\partial S}{\partial p} \end{vmatrix}}$$ and

(7) $$\frac{dq}{da}=\frac{-\frac{\partial D}{\partial a}\frac{\partial S}{\partial p}-\frac{\partial D}{\partial p}\frac{\partial S}{\partial \delta}}{-\frac{\partial S}{\partial p}+\frac{\partial D}{\partial p}}.$$

In a like manner, solving for $\frac{dp}{da}$

$$\frac{dp}{da}=\frac{\begin{vmatrix}1 & \frac{\partial D}{\partial a}\\ 1 & -\frac{\partial S}{\partial \delta}\end{vmatrix}}{\begin{vmatrix}1 & -\frac{\partial D}{\partial p}\\ 1 & -\frac{\partial S}{\partial p}\end{vmatrix}},$$

(8) $$\frac{dp}{da}=\frac{-\frac{\partial S}{\partial \delta}-\frac{\partial D}{\partial a}}{-\frac{\partial S}{\partial p}+\frac{\partial D}{\partial p}}.$$

Checkoff funds may be spent on research in the case of some commodities. So the effect of a change in those research funds on the commodity quantity can be found by taking the total derivative of (1) and (2) with respect to δ

(9) $$\frac{dq}{d\delta}=\frac{\partial D}{\partial p}\frac{dp}{d\delta}+\frac{\partial D}{\partial a}\frac{da}{d\delta},$$

(10) $$\frac{dq}{d\delta}=\frac{\partial S}{\partial p}\frac{dp}{d\delta}+\frac{\partial S}{\partial \delta}\frac{d\delta}{d\delta}.$$

Re-arranging terms

$$\frac{dq}{d\delta}-\frac{\partial D}{\partial p}\frac{dp}{d\delta}=\frac{\partial D}{\partial a}(-1),$$

$$\frac{dq}{d\delta}-\frac{\partial S}{\partial p}\frac{dp}{d\delta}=\frac{\partial S}{\partial \delta}.$$

Re-writing the above equations into detached matrix form

$$\begin{bmatrix} 1 & -\frac{\partial D}{\partial p} \\ 1 & -\frac{\partial S}{\partial p} \end{bmatrix}\begin{bmatrix} \frac{dq}{d\delta} \\ \frac{dp}{d\delta} \end{bmatrix}=\begin{bmatrix} -\frac{\partial D}{\partial a} \\ \frac{\partial S}{\partial \delta} \end{bmatrix}.$$

Solving for $\frac{dq}{d\delta}$ and $\frac{dp}{d\delta}$ by Cramer's Rule

$$\frac{dq}{d\delta}=\frac{\begin{vmatrix} -\frac{\partial D}{\partial a} & -\frac{\partial D}{\partial p} \\ \frac{\partial S}{\partial \delta} & -\frac{\partial S}{\partial p} \end{vmatrix}}{\begin{vmatrix} 1 & -\frac{\partial D}{\partial p} \\ 1 & -\frac{\partial S}{\partial p} \end{vmatrix}},$$

(11)
$$\frac{dq}{d\delta}=\frac{\frac{\partial D}{\partial a}\frac{\partial S}{\partial p}+\frac{\partial S}{\partial \delta}\frac{\partial D}{\partial p}}{-\frac{\partial S}{\partial p}+\frac{\partial D}{\partial p}},$$

$$\frac{dp}{d\delta}=\frac{\begin{vmatrix} 1 & -\frac{\partial D}{\partial a} \\ 1 & \frac{\partial S}{\partial \delta} \end{vmatrix}}{\begin{vmatrix} 1 & -\frac{\partial D}{\partial p} \\ 1 & -\frac{\partial S}{\partial p} \end{vmatrix}},$$

(12) $$\frac{dp}{d\delta}=\frac{\frac{\partial S}{\partial \delta}+\frac{\partial D}{\partial a}}{-\frac{\partial S}{\partial p}+\frac{\partial D}{\partial p}}.$$

As is the usual case in comparative statics, it is necessary to determine whether or not the equilibrium condition for the demand and supply function is stable. In other words, a particular equilibrium is stable if a disturbance (shock) results in a return to equilibrium and unstable if it does not. The useful stability condition here is Marshallian. Re-writing the demand and supply functions in inverse (price dependent) form, i.e. $P_d = D^{-1}(q,a), P_s = S^{-1}(q,\delta)$.

Define excess demand price as $F(q,a,\delta) = P_d - P_s = D^{-1}(q,a) - S^{-1}(q,\delta)$.

The Marshallian stability condition states that producers will raise their output when $F(q) > 0$ and lower it when $F(q) < 0$. Thus the equilibrium is stable if $dF(.)/dq = F'(.) = D^{-1\prime}(.) - S^{-1\prime}(.) < 0$ (Henderson and Quandt). If the industry supply curve is upward sloping and the demand downward, an upward shift in the demand curve resulting from increased advertising expenditures will result in both an increased price and an increase in marketings. On the other hand, if the industry supply curve is forward falling we must have a supply curve that cuts the demand curve from below in order to have stability. A forward falling (negatively sloped) supply curve can be caused by economies of scale outweighing diseconomies or some scenario whereby many new producers enter the input market as buyers, thereby, the price of the input(s) r's drop, thus reducing marginal costs. The industry supply curve tips forward as the equilibrium of supply and demand is traced.

In effect, there are three possible cases in the slope of the demand and supply curves to test for stability.

1. Case 1—the supply function has a positive slope and the demand function has a negative slope. If D(.) > S(.) (left of equilibrium) producers will increase their output moving toward equilibrium. If S(.) > D(.) (right of equilibrium) producers will decrease their output, again moving toward equilibrium. This case results in stability of the equilibrium.

2. Case 2—the demand function has a negative slope and the supply function is either perfectly elastic or negatively sloped where $\frac{\partial S^{-1}}{\partial q} > \frac{\partial D^{-1}}{\partial q}$. Again, if D(.) > S(.) producers will increase their output to gain benefit of the greater demand and will decrease output if S(.) > D(.). This case also yields a stable equilibrium.

3. Case 3—the demand and supply functions both have negative slopes such that $\frac{\partial D^{-1}}{\partial q} > \frac{\partial S^{-1}}{\partial q}$. In this case, if D(.) < S(.) (left of equilibrium) producers will decrease output, moving away from the equilibrium. If S(.) < D(.) (right of equilibrium) producers will increase their output, again moving away from the

equilibrium point. This case results in divergence from equilibrium, therefore is not stable.

So looking at $v = pq$, where v is the total dollar value of the commodity marketed. Given an upward sloping industry supply function $\frac{dv}{da}$ will always be positive. Note industry output depends indirectly on the level of coalition advertising expenditures.

Taking the total derivative with respect to a,

(13) $$\frac{dv}{da} = p\frac{dq}{da} + q\frac{dp}{da}.$$

Substituting equations 7 and 8 into equation 13

$$\frac{dv}{da} = p\left[\frac{-\frac{\partial D}{\partial a}\frac{\partial S}{\partial p} - \frac{\partial D}{\partial p}\frac{\partial S}{\partial \delta}}{-\frac{\partial S}{\partial p} + \frac{\partial D}{\partial p}}\right] + q\left[\frac{-\frac{\partial S}{\partial \delta} - \frac{\partial D}{\partial a}}{-\frac{\partial S}{\partial p} + \frac{\partial D}{\partial p}}\right].$$

Multiplying the numerator and denominator of the right hand side price component by $\frac{1}{q}$ and applying the definition of price elasticity of industry supply, e and demand, η where

$$e = \frac{\partial S}{\partial p}\frac{p}{q} \text{ and } \eta = \frac{\partial D}{\partial p}\frac{p}{q}$$

$$\frac{dv}{da}=\frac{1}{\frac{1}{q}}\left[\frac{-\frac{\partial D}{\partial a}e-\frac{\partial S}{\partial \delta}\eta}{-\frac{\partial S}{\partial p}+\frac{\partial D}{\partial p}}\right]+q\left[\frac{-\frac{\partial S}{\partial \delta}-\frac{\partial D}{\partial a}}{-\frac{\partial S}{\partial p}+\frac{\partial D}{\partial p}}\right].$$

Combining, re-arranging terms, and factoring out $\frac{-1}{-1}$ gives

(14)
$$\frac{dv}{da}=q\left[\frac{\frac{\partial D}{\partial a}(e+1)+\frac{\partial S}{\partial \delta}(\eta+1)}{\frac{\partial S}{\partial p}-\frac{\partial D}{\partial p}}\right].$$

Multiplying both terms in the denominator by $\frac{p\,q}{p\,q}$ yields

$$\frac{dv}{da}=q\left[\frac{\frac{\partial D}{\partial a}(e+1)+\frac{\partial S}{\partial \delta}(\eta+1)}{\frac{q}{p}(e-\eta)}\right]$$

and finally

(15)
$$\frac{dv}{da}=p\left[\frac{\frac{\partial D}{\partial a}(e+1)+\frac{\partial S}{\partial \delta}(\eta+1)}{e-\eta}\right].$$

Once again looking at $v=pq$ taking the total derivative with respect to δ, then

(16)
$$\frac{dv}{d\delta}=p\frac{dq}{da}+q\frac{dq}{da}$$

substituting (11) and (12) into (16)

$$\frac{dv}{d\delta} = p\left[\frac{\frac{\partial D}{\partial a}\frac{\partial S}{\partial p} + \frac{\partial D}{\partial p}\frac{\partial S}{\partial \delta}}{-\frac{\partial S}{\partial p} + \frac{\partial D}{\partial p}}\right] + q\left[\frac{\frac{\partial S}{\partial \delta} + \frac{\partial D}{\partial a}}{-\frac{\partial S}{\partial p} + \frac{\partial D}{\partial p}}\right].$$

Treating this in the same manner as above

(17) $$\frac{dv}{d\delta} = p\left[\frac{\frac{\partial D}{\partial a}(e+1) + \frac{\partial S}{\partial \delta}(\eta+1)}{\eta - e}\right].$$

From a classical sense, welfare analysis examines changes in consumer and producer surplus and the net effect of these changes on social welfare. It might be interesting to note Marshall refers to the horizontal sum of individual producers marginal cost curves as "particular expenses curve". His definition of producer's surplus is that difference between aggregate variable costs of production and aggregate revenue. In the absence of external economies or diseconomies or externalities, producer surplus, the excess of producer revenue over costs may be defined as:

$$PS = v - \int_0^q S^{-1}(x)dx ,$$

where PS is producer surplus, q is the equilibrium level of supply, and $S^{-1}(x)$ is the inverse (price dependant) form of the industry supply function. Along the same logic, consumer surplus will be:

$$CS = \int_0^q D^{-1}(x)dx - v ,$$

where $D^{-1}(x)$ is the inverse form of the industry demand. Thus the measure of social welfare, SW by its classical definition is:

$$SW = CS + PS.$$

To facilitate this examination, it will be necessary to assume a specific functional form. A constant elasticity form, implying a constant relationship, is assumed here. It is further assumed these functions are continuous and differentiable.

(18) $$q = Ap^{\eta}a^{\gamma}$$

(19) $$q = Bp^{\varepsilon}\delta^{\tau}$$

where A and B are constants, γ and τ are elasticities of advertising and research respectively, and p is the farm-packer level price for the commodity output (Figure III-1).

Beginning with (18) and solving for price given the inverse demand function:

$$p = q^{1/\eta}A^{-1/\eta}a^{-\gamma/\eta}.$$

Thus consumer surplus is classically defined as the area under the inverse demand curve from 0 to q^* less the product of p^* and q^* where $p*$ and $q*$ are the equilibrium price and quantity. However, since the integral of the constant elasticity functional form from 0 to q^* will be positive infinity. It will be necessary to truncate that portion closest to the y-axis to some small positive number q_0:

$$CS = \int_{q_0}^{q^*} x^{1/\eta}A^{-1/\eta}a^{-\gamma/\eta}dx - (q^* - q_0)p^*.$$

Performing the integration yields

(20) $$CS = \frac{\eta}{\eta+1}A^{-1/\eta}a^{-\gamma/\eta}(q^{*(\eta+1)/\eta} - q_0^{(\eta+1)/\eta}) - (q^* - q_0)p^*.$$

Now taking the industry supply and solving for p results in

$$p = q^{1/e} B^{-1/e} \delta^{-\tau/e}.$$

The producer surplus is the product of p^* and $q^* - q_0$ minus the area under the inverse supply curve from q_0 to q^*:

$$PS = (q^* - q_0)p^* - \int_{q_0}^{q^*} x^{1/e} B^{-1/e} \delta^{-\tau/e} dx.$$

Again, performing the integration and evaluating it

(21) $$PS = (q^* - q_0)p^* - \frac{e}{e+1} B^{-1/e} \delta^{-\tau/e} (q^{*(e+1)/e} - q_0^{(e+1)/e}).$$

Assume the demand effect brought about by generic coalition advertising is the product $\sigma\phi$ where σ is the advertising multiplier e.g. one dollar of advertising produces x dollars of effect and ϕ is the dollars per cwt of demand spent on advertising. Thus if the checkoff were terminated this would produce a parallel shift in demand, implying a group of homogeneous consumers all making the same choices. The shift in inverse demand becomes:

(22) $$p' = q^{1/\eta} A^{-1/\eta} a^{-\gamma/\eta} - \sigma\phi.$$

From the supply side for beef, a new equilibrium price after terminating the checkoff would become:

(23) $$p' = q^{1/e} B^{-1/e} \delta^{-\tau/e} - t/(\omega/100)$$

where t is the mean level of the compounded checkoff amount and ω is the average weight of fed cattle in pounds. For pork assessments are computed on a rate per one hundred dollars of live animal value, and may be expressed as:

(23a) $$p' = q^{1/e} B^{-1/e} \delta^{-\tau/e} - \psi$$

where $\psi = \{[p(\theta/100)/100]t\}/(\theta/100)$ and θ is the annual average live weight for slaughter hogs (Table 5).

Equations (22) and (23) or (23a) may be now be solved simultaneously to determine p^{**} and q^{**}. Evaluating consumer surplus sans checkoff then would become:

$$(24) \qquad CS' = \frac{\eta}{\eta+1} A^{-1/\eta} a^{-\gamma/\eta} (q^{**(\eta+1)/\eta} - q_0^{(\eta+1)/\eta}) - (q^{**} - q_0)\sigma\phi - (q^{**} - q_0)p^{**}.$$

Producer surplus for the beef industry without the checkoff would then be:

$$(25) \quad PS' = (q^{**} - q_0)p^{**} - \frac{e}{e+1} B^{-1/e} \delta^{-\tau/e} (q^{**(e+1)/e} - q_0^{(e+1)/e}) - [t/(\omega/100)](q^{**} - q_0)$$

because the checkoff is assessed on a per head basis. However, producer surplus for the pork industry sans checkoff could be expressed as:

$$(25a) \qquad PS' = (q^{**} - q_0)p^{**} - \frac{e}{e+1} B^{-1/e} \delta^{-\tau/e} (q^{**(e+1)/e} - q_0^{(e+1)/e}) - \psi(q^{**} - q_0).$$

Given this assumed functional form and a dissolution of that generic program, value to the producer (v) will change as supply shifts to right (increase) from decreased marginal costs of individual producers and demand shifts to the left (decrease) as follows:

$\frac{\partial D}{\partial a} = \gamma A p^{\eta} a^{\gamma-1}$ and $\frac{\partial S}{\partial \delta} = \tau B p^{e} \delta^{\tau-1}$. Substituting back into (15) and (17):

$$(26) \qquad \frac{dv}{da} = p\left[\frac{\gamma A p^{\eta} a^{\gamma-1}(e+1) + \tau B p^{e} \delta^{\tau-1}(\eta+1)}{e-\eta}\right] \text{ and}$$

$$(27) \qquad \frac{dv}{d\delta} = p\left[\frac{\gamma A p^{\eta} a^{\gamma-1}(e+1) + \tau B p^{e} \delta^{\tau-1}(\eta+1)}{\eta-e}\right].$$

If $-1 < \eta < 0$, $e > 0$, $\gamma > 0$, and $\tau > 0$, then equation 26 will be unambiguously positive and equation 27 will be unambiguously negative. However if $\eta < -1$, $e > 0$, $\gamma > 0$, and $\tau > 0$, both equations are ambiguous in sign.

Model

A simulation of the model was developed using a Microsoft Excel spreadsheet. Figure III-1 shows the initial equilibrium of curves S and D with equilibrium price p^* and quantity q^* followed by the equilibrium changed by dissolution of the checkoff at S' and D'. In the changed scenario, equilibrium price is represented by p^{**} and the quantity by q^{**}. Assuming that demand and supply have constant elasticity functional form, (18) and (19) are solved for A and B respectively given values of p, q, e, η, γ, τ, a, and δ.

Previous research in generic promotion and research have dealt mostly with three functional forms: linear (Freebairn, Davis, and Edwards), constant elasticity (Nerlove and Waugh; Azzam and Schroeter)[5], and equilibrium displacement (Holloway; Wohlgenant 1993 and 1999; and Chung and Kaiser)[6]. Mean equilibrium prices and quantities are employed from data series available on Livestock Marketing Information Center's (LMIC) website (Table 3). Research and promotion expenditures (a and δ) are utilized from both the Beef Board and Pork Board (Table 4). For beef, levels of the compounded checkoff amount (t) represent a mean value of the checkoff amount on a per head basis. In the case of the beef checkoff, annual slaughter of commercial federally inspected cows and bulls in head was subtracted from total annual assessments. The resulting difference was divided by total annual slaughter of federally inspected steers plus heifers to obtain a multiple of how many times each animal is charged with the checkoff amount from birth to slaughter. For example, it is not uncommon for weaned

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[5] This functional form has been used substantially in research. However, its weakness may be seen if a or δ becomes zero with the dissolution of the beef or pork checkoff. All computations use the term $\sigma\phi$ as a demand shifter and $t/(\omega/100)$ as a supply shifter for beef and ψ for pork under dissolution of the generic promotion and research program. This implies both demand and supply undergo parallel but not necessarily equal shifts (Figure III-1).

[6] The equilibrium displacement model has, as its underlying foundation, a linear functional form. Though oft used, this functional form's weakness is that it is unlikely a linear model fits the market structure.

calves to be sold at a weight of 350-400 pounds as stockers to graze out wheat pasture. Then cattle are sold again off wheat as feeders into a feedlot at 600-800 pounds. Finally, the fed animal is sold to the beef packer. At each sale the $1.00 is collected under the beef checkoff. In our simple example, the compounded checkoff amount would be three (3) sales at $1.00 checkoff at each sale or $3.00. For beef, the computed compounded checkoff amount is $2.74. In other words with a one dollar per head checkoff, each slaughter animal is assessed 2.74 times in its life. For the pork case, t is given in dollar per one hundred dollars of animal value; at the time of this writing the assessment is $0.40 per $100.00 of live animal value.

Prices and quantities (Table III-5), research and promotion expenditures (Table III-4), and checkoff averages are averaged across observations from 1998 through 2002 to obtain a mean value.

Ranges for own price elasticity of demand, supply elasticity, and production taxes (checkoff assessments) are used to compute a distribution of changes in industry output value, consumer and producer surplus, and net social welfare (Wohlgenant 1993; Tomek and Robinson; Chung and Kaiser). These are shown in Table III- 6. The ranges for demand and supply elasticities were arrived at using Wohlgenant's values $e = 0.15$ and $\eta = -0.78 \pm 0.1$ for both demand and supply. Values used for constants A and B in (18) and (19) are shown in Table III- 7.

Elasticities of advertising $\gamma = 0.006$ for beef (Brester and Schroeder) and $\gamma = 0.005$ for pork (Sellen, Goddard, and Duff) are used throughout all simulations. Elasticity of research for beef $\tau = 0.36$ was used in all simulations (Widmer, Fox, and Brinkman). It is noted here this elasticity was computed for the Canadian beef industry, however this was the only study found treating that subject. Pork elasticity of research was taken to be τ = 0.015 short-run and τ = 0.020 long-run (Davis et al.). Returns to generic commodity promotions for beef used were 5.74 (Ward and Lambert) and 6.12 for pork promotions (Sellen, Goddard, and Duff).

Given a specific t, a, δ, p^*, q^*, e, η, γ, and τ in each simulation, initial consumer and producer surplus and social welfare using (20) and (21) was computed. Assuming that the checkoff program was eliminated i.e. t was reduced to zero, (22) and (23) or (23a) are solved simultaneously for p^{**} and q^{**} and resulting consumer and producer surplus and net social welfare sans checkoff was computed with (24) and (25) or (25a). The initial values of variables are shown in Table III- 8.

Results

Beef

Simulations for beef show what would happen for alternative combinations of supply and demand elasticities and values of t if the beef checkoff assessment collections and expenditures were stopped at a point in time. Results of beef simulations across all referenced ranges of e, η, and t are shown in Table III- 9. Summary statistics for these simulation results are shown in Table III- 11. Results of the changes of net social welfare are further displayed in Figure III-2. All changes in net social welfare are negative. It is of interest to note that all values of net change of industry product (Δv) are only negative numbers in all beef simulations and results (Figure III-5). Since changes in industry product and social welfare are negative, this implies that dissolution of the research and promotion program is an economic "bad", that the program has both consumer and producer value.

Figures 3 and 4 reflect the change in net social welfare as a distribution. The quantile-quantile (QQ) plot and histogram of the change in social welfare shows the distribution to be non-normal. Figures 6 and 7 show the distribution of change in total value of the product v and indicate a non-normal distribution in both the QQ-plot and histogram, though the more central data falls along the 45-degree line in groups, the tails drift away from the line. Statistical theory teaches hypothesis testing in the presence of non-normal data may be problematic at best.

A QQ plot is a graphical technique for determining if two data sets come from populations with a common distribution (1.3.3.24. Quantile-Quantile Plot). This is a plot of the quantiles of the first data set against the second data set. The definition in use of a quantile is that fraction or percent of points below the given value. For example at the 30% quantile, 30% of the data points below this quantile while 70% of the data points fall above this quantile. A 45-degree line is also plotted as a reference. If both samples come from the same distribution the data points should line up along the 45-degree line. The greater the departure from the line the more evidence the two samples did not come from the same distribution. QQ plots may be used to detect shifts in location, shifts in scale, changes in symmetry, differences in the tails, and the presence of outliers.

Pork

Likewise as with the beef simulations above, simulations of the pork model show what would happen if the pork checkoff were struck down and assessments and expenditures were stopped immediately. Individual simulations are shown in Table III-10 with summary statistics shown in Table III-12.

It may be noted that both the change in value of industry product (Δv) and change in social welfare (ΔSW) all have negative values (Figures 11 and 8). This implies that dissolution of the pork checkoff and a general cessation of assessment collections along with promotion and research disbursements cause a negative impact to both industry producers and consumers.

In examining the distribution of the change in social welfare for pork, it is readily apparent that it is non-normal (Figures 9 and 10). However, the distribution of change in value of the industry product the QQ-plot (Figure III-12) shows a distribution that is close to normal than other distributions of results. The histogram also appears somewhat mound shaped (Figure III-13).

General

Results discussed above also agree with (26) and (27). In this case where $-1 < \eta < 0$, $e > 0$, $\gamma > 0$, and $\tau > 0$, (26) is unambiguously positive, this is a reduction in industry value for a corresponding reduction in advertising. However, with respect to the beef checkoff, there can't be checkoff funded research prior to harvest, thus there is no an effect on supply with respect to research, $\frac{\partial S}{\partial \delta} = 0$. The pork checkoff is not so constrained with its expenditures so $\frac{\partial S}{\partial \delta}$ may not necessarily equal zero. This may explain why Δv and ΔSW are more negative for beef than for pork. However, this is only speculation.

Summary and Conclusions

What then may be said in general about generic promotion and research orders? With respect to the first objective, it appears the degree of regulation in the marketing order under scrutiny may be a discriminating factor. The more an industry is regulated with production quotas, quality control, packaging standards, and production requirements the more likely that order is to withstand a decision on its constitutionality. Orders that so collectivize producers such that they are granted an anti-trust exemption appear more likely to withstand a constitutional review.

This may, in fact, stem from an observation made by Crespi in his 2003 paper that under the game theoretic model, a duopoly model does not yield a Nash equilibrium in which a rational individual producer will contribute to a promotion and research program if that program does not contain compelled association (mandatory coalition). Under this model, producers would tend to be "free riders", desiring to enjoy benefits of the paying coalition while not being subjected to its costs. Given this incentive indicated by the Nash model, a mandatory association must be required by legislation for all producers in that industry.

Another way of viewing a first amendment constitutionality issue would be as long as marketing orders are a part of a more broad regulatory regime, as in the case of "tree fruit" or any of the AMAA orders, free speech is only a small part of the independence producers give up. Therefore, under the restrictive weight of an AMAA order the loss of completely free speech is not as large an issue.

What then might we say? Has agriculture changed enough such that instead of producing a commodity are we now in transition to an industry whose focus is production of a differentiated product? An example of this could be organic products, non-genetically modified products, and branded products. If this is the case, might a generic program of promotion and research that forces the industry together into a single mold be stifling that industry's expansion toward differentiation? These questions are beyond the scope of this research but certainly need to be addressed.

Another issue needing attention deals with individual producers and consumers and their related producer and consumer surplus. Surplus is obviously greater for lower cost producers and consumers with higher reservation prices. Thus producers and consumers at the margin, i.e. closer to the equilibrium, will not receive as much surplus. In the case of this study, there is more emphasis on producer surplus and total value of the product for the industry than on consumer surplus.

Beef

With respect to the beef checkoff and the second objective of this study directly, several conclusions may be seen. First, it is clear retained ownership increases producer surplus for the industry by decreasing assessment costs, in general. In other words, if the initial cow-calf producer retains his/her produced calves through the stocker, feeder, and finally fed cattle phase, then the producer assessment declines.

Second, when observing the industry's change in total value of the product (v), all 125 observations in the simulations resulted in a negative change in v, it is obvious that elimination of the checkoff program would yield a negative effect for producers. This confirmed the hypothetical result. Simultaneously, all observations of the change in net social welfare are also negative indicating unambiguously that dissolution of the program would be a "bad" for the economy as a whole. This implies the beef checkoff has a positive effect both for producers and for consumers. Having said this, it should be pointed out that the analysis shown here is merely a snapshot of the industry at a point in time. It has been indicated earlier in the study that advertising effects are commonly believed to produce effects lasting over, perhaps, a nine-month or three-calendar quarter window (Cox). If this is the case, then what effect dissolution of the program will have after that window is "pure" speculation.

Pork

Also with respect to the second objective of this analysis, it is obvious the pork checkoff has been successful in its objectives. Results imply industry value of product and social welfare are reduced if the program is dissolved; hence consumer and producer's welfare is improved with this generic promotion and research program. It may be that demand and/or price have not increased but perhaps the program has prevented decreases of erosion.

As a second observation and perhaps pure speculation also, it may be of benefit if the beef checkoff allowed prior harvest research as does the pork program. It has been said that production research generates greater returns to producers than market based research (Wohlgenant 1993).

Contrary to the case of beef, pork producers will not profit from retained ownership. Calculation of the assessment differs under each program, thus there is no incentive to retain ownership under the pork checkoff.

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CHECKOFF

APPENDIX

Table III-1. Beef Checkoff vs Pork Checkoff vs Fresh California Tree-fruit vs Fresh Mushroom Comparison

Criteria	Beef checkoff	Pork checkoff	Fresh CA tree-fruit	Fresh mushroom
Name of administering authority	Cattlemen's Beef Promotion & Research Board	National Pork Producers	Nectarine Administrative Committee; Peach Commodity Committee (federal marketing orders) and CA Plum Marketing Board (state marketing order)(California Tree Fruit Agreement administers all three programs)	Mushroom Council (federal marketing and promotion order
Enabling authority	Beef Promotion & Research Act of 1985 7 USC 2901	Pork Promotion, Research & Consumer Information Act of 1985 7 USC 4801	Agriculture Marketing Agreement Act of 1937 (AAMA) nectarines and peaches 7 USC 601-674 For plum CA Marketing Act of 1937 7CFR Parts 916, 917	Federal Law 7 USC 6101-6112 Mushroom Promotion, Research and Consumer Information Act of 1990; 7 CFR Part 1209
Most funds raised are spent for generic advertising	Yes—59%	Yes-53%	Yes	Yes
Per capita consumption has increased in last 7 years	Fairly flat	Slightly	Unknown	No

Table III-1. Beef Checkoff vs Pork Checkoff vs Fresh California Tree-fruit vs Fresh Mushroom Comparison

Criteria	Beef checkoff	Pork checkoff	Fresh CA tree-fruit	Fresh mushroom
Limitation on spending for non-marketing	None	No	None	Yes. 85% must be marketing
Jurisdiction	National	National and state	2 national, 1 state (plum)	National
Compelled assessment	Mandatory	Yes	Recommended by committees annually and approved by USDA Secretary	Recommended by Committees annually and approved by USDA Secretary (now allows for voluntary assessment for promotional funds)
Central advertising message is disagreed with	Yes, U.S. beef is superior to imported beef	No, "Pork the other white meat"	No, "California Summer Fruits" are wholesome, delicious and attractive	Yes Mushrooms associated with alcohol and touted as an aphrodisiac (United Foods)
Authority prohibits disparaging messages re other agricultural commodity	No	Yes	Yes	Yes
Generic advertising program's beneficial effect is proportionate to tax	Yes	Yes	Yes	Yes
Generic program tends to promote some brands but not others	No	No	No	No

Table III-1. Beef Checkoff vs Pork Checkoff vs Fresh California Tree-fruit vs Fresh Mushroom Comparison

Criteria	Beef checkoff	Pork checkoff	Fresh CA tree-fruit	Fresh mushroom
Compels financing of advertising for benefit of competitors	No	No	No	No
Assessment used for inspection	No	No	Yes	No
Assessment necessary to make voluntary speech by importers non-misleading to consumers	No	No	No	No
Scheme includes inspection	No	No	Yes	No
License and bond requirements; accounting and record keeping requirements; disciplinary code	Yes-7 USC 2901-2911 Sec. 5 Part 7	Yes	Yes-PACA 7 CFR Part 46	Yes- PACA 7CFR Part 46
Packaging regulations	No	No	Yes	No
Package marking	No	No	Yes	No
Mandatory product grading	No	No	Yes	No
Maturity standards	No	No	Yes-set by committees and collective members	No
Volume or price controls	No	No	Yes-authorized under AMAA 1937 (currently not implemented)	No

Table III-1. Beef Checkoff vs Pork Checkoff vs Fresh California Tree-fruit vs Fresh Mushroom Comparison

Criteria	Beef checkoff	Pork checkoff	Fresh CA tree-fruit	Fresh mushroom
Regulate flow of product to market	No	No	Yes	No
Size requirements	No	No	Yes	No
Allotment of quantity to be marketed	No	No	Yes	No
Apportioning production	No	No	Yes	No
Provides for reserve pools and control and distribution of surplus	No	No	Yes-AMAA authorized but not in present order	No
Exempt from Antitrust law	No	No	Yes	No
Displaces competition in favor of collective action	No	No	Yes	No
Reimbursement of govt. costs	Yes	Yes	Yes	Yes
Regulatory scheme constrains freedom to act independently	No	No	Yes	No
Promotional activities	Yes	Yes	Yes	Yes

Table III-1. Beef Checkoff vs Pork Checkoff vs Fresh California Tree-fruit vs Fresh Mushroom Comparison

Criteria	Beef checkoff	Pork checkoff	Fresh CA tree-fruit	Fresh mushroom
Product must meet mandatory min. grade requirements	No-subject to USDA Federal standards	No	Yes	No-mushrooms are subject to voluntary USDA grades
Method for implementing democratic safeguards not programs against abuse	Yes	No	Yes	Yes
Elected committees	Yes	Yes	Yes	Yes
Producer referendum/continuance referendum	Yes	Yes	Yes	Yes
Assessed importers have board representation	Yes	Yes	No-importers are not assessed	Yes
Importer referendum continuance referendum	No	No	No	Yes

Table III-2. Relevant Timeline For Promotion and Advertising Programs and Litigation

Year	Happening	Result
1936	United States v. Butler	Only Congress or states may tax
1936	United States v. David Buthick Co	Ruled tax and market order provisions of AAA were inseparable
1937	Agricultural Marketing Agreement Act (AMAA) passed	
1939	United States v. Rock Royal Coop, Inc.	Found in favor of USDA
1954	AMAA amended	Added "marketing development projects"
1977	Abood v. Detroit Board of Education	Found for Abood
1980	Central Hudson Gas & Electric v. Public Service Commission of New York	Found for Central Hudson
1985	Beef Promotion & Research Act and Pork Promotion, Research, and Consumer Information Act	Created beef and pork checkoff
1989	United States v. Frame	3rd Circuit Court of Appeals found for USDA
1990	Mushroom Promotion, Research, and Consumer Information Act	Created mushroom checkoff
1993	Cal-Almond v. U.S. Department of Agriculture	
1996	Goetz v. Glickman	Found for USDA, not carried to Supreme Court
1996	Glickman, Secretary of Agriculture v. Wileman Brothers & Elliott, Inc.	Found for USDA
2001	United States v. United Foods, Inc.	Found for United Foods and struck down the research and promotion order

Table III-3. Description Of Data Series Used In Analysis

Data Description[a]
Weekly average live weight of fed cattle, Texas/Oklahoma Panhandle
Monthly fed cattle slaughter, (NASS report)
Weekly average steer price, Western Kansas feedlots, Choice 2-3, 1000-1100 lbs., 4% pencil shrink
Weekly U.S. hog slaughter; federally inspected and commercial by class and weight
Iowa/Minnesota daily direct prior day hog report based on plant delivery

[a] All data series obtained at LMIC website.

Table III-4. Annual Research and Promotion Expenses For Beef and Pork

Year	Beef[a]		Pork[b]	
	Research[cd]	Promotion[d]	Research[d]	Promotion[d]
1998	$ 4.704.02	$ 28,332.14	$ 11,809.25	$ 30,231.68
1999	3.741.63	25,010.94	11,097.58	25,609.80
2000	4.284.07	29,028.70	13,299.84	34,912.08
2001	5.132.91	29,976.38	18,399.36	42,712.80
2002	5.099.22	25,714.45	10,955.34	35,355.87
Mean	4.592.37	27,612.52	11,809.25	30,231.68

[a] Beef research and promotion expenditures from Cattlemen's Beef Promotion and Research Board annual report.
[b] Pork research and promotion expenditures from National Pork Board annual report.
[c] Under the Beef Act. all research must be post-harvest. All research and promotion are summed to give just promotion expenses.
[d] Thousands (1.000) of dollars.

Table III-5. Initial Equilibrium Quantities, Prices, and Average Live Weights For the U.S. Beef and Pork Industry

	Beef			Pork		
Year	Quantity[a]	Price[b]	Avg. live wt.[c]	Quantity[a]	Price[b]	Avg. live wt.[c]
1998	33,153.02	$ 61.80	1,170	24,466.25	$ 43.23	257
1999	34,352.12	65.75	1,174	24,855.48	44.48	259
2000	34,813.03	69.69	1,176	24,442.69	59.44	263
2001	33,883.25	72.21	1,190	24,628.89	61.49	264
2002	35,142.58	67.45	1,217	25,328.45	47.67	265
Mean	34,268.80	67.38	1,186	24,744.35	51.26	262

[a] Quantity is in million (1,000,000) of pounds.
[b] Price in dollars per hundredweight.
[c] Live weight in pounds.

Table III-6. Parameter Values for the U.S. Beef and Pork Industries

Parameter or variable	Range	
	Beef	Pork
Checkoff amount (t)	\$1.00 thru \$5.00[a]	\$0.20 thru \$0.60[b]
Own-price elasticity of demand (η)	-0.68 thru –0.88	-0.55 thru –0.75
Elasticity of supply (e)	0.05 thru 0.25	0.3 thru 0.5
Elasticity of advertising (γ)	0.006	0.005
Elasticity of research (τ)	0.36	0.02

[a] Dollars per animal, compounded amount.
[b] Dollars per \$100.00 live animal value.

Table III-7. Values Of Constants A and B For Discrete Values Of e and η For Beef and Pork

	Beef				Pork		
η	A^a	e	B^a	η	A^b	e	B^b
-0.68	3,757.26	0.05	27,761.92	-0.55	211,293.17	0.30	13,113.32
-0.73	4,637.36	0.10	22,492.95	-0.60	257,275.10	0.35	10,780.20
-0.78	5,723.64	0.15	18,224.11	-0.65	313,280.98	0.40	8,862.66
-0.83	7,064.43	0.20	14,765.54	-0.70	381,499.79	0.45	7,286.58
-0.88	8,719.35	0.25	11,963.41	-0.75	464,599.37	0.50	5,991.11

[a] The values of γ and τ are 0.006 and 0.36 respectively.
[b] The values of γ and τ are 0.005 and 0.02 respectively.

Table III-8. Initial Variable Values For The Beef and Pork Simulations

Variable	Initial value[a]	
	Beef	Pork
p^*	67.38	51.26
q^*	34,269	24,744
v^*	23,091	12,685
CS	34,725,352	47,496,789
PS	21,985	8,523
SW	34,747,377	47,505,312

[a] p^* is dollars per hundredweight; q^* is millions of pounds; all other initial values are in millions of dollars.

Table III-9. Results of Simulations For Beef

t	e	η	p^{**a}	q^{**b}	ΔV^c	ΔCS^c	ΔPS^c	ΔSW^c
1	0.05	-0.68	67.30	34,260	-35.08	-7,327	-58	-7,385
1	0.05	-0.73	67.30	34,260	-35.04	-7,323	-58	-7,381
1	0.05	-0.78	67.30	34,260	-34.99	-7,318	-58	-7,376
1	0.05	-0.83	67.30	34,260	-34.94	-7,313	-58	-7,371
1	0.05	-0.88	67.30	34,260	-34.89	-7,308	-58	-7,366
1	0.10	-0.68	67.30	34,252	-40.33	-7,846	-58	-7,904
1	0.10	-0.73	67.30	34,252	-40.30	-7,843	-58	-7,900
1	0.10	-0.78	67.30	34,252	-40.25	-7,838	-58	-7,896
1	0.10	-0.83	67.30	34,252	-40.19	-7,832	-58	-7,890
1	0.10	-0.88	67.30	34,252	-40.12	-7,825	-58	-7,883
1	0.15	-0.68	67.30	34,245	-44.81	-8,289	-58	-8,347
1	0.15	-0.73	67.30	34,245	-44.82	-8,290	-58	-8,348
1	0.15	-0.78	67.30	34,245	-44.80	-8,289	-58	-8,346
1	0.15	-0.83	67.30	34,245	-44.76	-8,285	-58	-8,342
1	0.15	-0.88	67.30	34,245	-44.71	-8,279	-58	-8,337
1	0.20	-0.68	67.30	34,239	-48.66	-8,670	-58	-8,728
1	0.20	-0.73	67.30	34,239	-48.73	-8,677	-58	-8,735
1	0.20	-0.78	67.30	34,239	-48.76	-8,680	-58	-8,738
1	0.20	-0.83	67.30	34,239	-48.76	-8,680	-58	-8,738
1	0.20	-0.88	67.30	34,239	-48.73	-8,677	-58	-8,735
1	0.25	-0.68	67.30	34,235	-51.97	-8,998	-58	-9,055
1	0.25	-0.73	67.30	34,234	-52.12	-9,012	-58	-9,070
1	0.25	-0.78	67.30	34,234	-52.22	-9,022	-58	-9,080
1	0.25	-0.83	67.30	34,234	-52.27	-9,027	-58	-9,085
1	0.25	-0.88	67.30	34,234	-52.28	-9,028	-58	-9,086
2	0.05	-0.68	67.21	34,262	-62.63	-13,908	-116	-14,023
2	0.05	-0.73	67.21	34,262	-62.58	-13,903	-116	-14,018
2	0.05	-0.78	67.21	34,262	-62.53	-13,898	-116	-14,013
2	0.05	-0.83	67.21	34,262	-62.47	-13,892	-116	-14,008
2	0.05	-0.88	67.21	34,262	-62.41	-13,887	-116	-14,002
2	0.10	-0.68	67.21	34,256	-66.70	-14,309	-116	-14,425
2	0.10	-0.73	67.21	34,256	-66.64	-14,304	-116	-14,419
2	0.10	-0.78	67.21	34,256	-66.57	-14,297	-116	-14,413
2	0.10	-0.83	67.21	34,256	-66.50	-14,289	-116	-14,405
2	0.10	-0.88	67.21	34,256	-66.41	-14,281	-116	-14,397
2	0.15	-0.68	67.21	34,250	-70.14	-14,649	-116	-14,765
2	0.15	-0.73	67.21	34,251	-70.10	-14,646	-116	-14,761
2	0.15	-0.78	67.21	34,251	-70.05	-14,640	-116	-14,756
2	0.15	-0.83	67.21	34,251	-69.97	-14,633	-116	-14,748
2	0.15	-0.88	67.21	34,251	-69.88	-14,624	-116	-14,739
2	0.20	-0.68	67.21	34,246	-73.07	-14,938	-116	-15,054
2	0.20	-0.73	67.21	34,246	-73.07	-14,939	-116	-15,054
2	0.20	-0.78	67.21	34,246	-73.04	-14,936	-116	-15,051

Table III-9. Results of Simulations For Beef

t	e	η	p^{**a}	q^{**b}	Δv^c	ΔCS^c	ΔPS^c	ΔSW^c
2	0.20	-0.83	67.21	34,246	-72.98	-14,930	-116	-15,045
2	0.20	-0.88	67.21	34,246	-72.90	-14,922	-116	-15,037
2	0.25	-0.68	67.21	34,242	-75.56	-15,185	-116	-15,300
2	0.25	-0.73	67.21	34,242	-75.61	-15,190	-116	-15,305
2	0.25	-0.78	67.21	34,242	-75.62	-15,190	-116	-15,306
2	0.25	-0.83	67.21	34,242	-75.59	-15,187	-116	-15,303
2	0.25	-0.88	67.21	34,242	-75.52	-15,181	-116	-15,297
3	0.05	-0.68	67.13	34,264	-90.18	-20,489	-173	-20,663
3	0.05	-0.73	67.13	34,264	-90.12	-20,484	-173	-20,657
3	0.05	-0.78	67.13	34,264	-90.07	-20,478	-173	-20,652
3	0.05	-0.83	67.13	34,264	-90.01	-20,472	-173	-20,646
3	0.05	-0.88	67.13	34,264	-89.94	-20,466	-173	-20,640
3	0.10	-0.68	67.13	34,259	-93.07	-20,774	-173	-20,947
3	0.10	-0.73	67.13	34,259	-92.99	-20,766	-173	-20,940
3	0.10	-0.78	67.13	34,260	-92.90	-20,758	-173	-20,931
3	0.10	-0.83	67.13	34,260	-92.81	-20,749	-173	-20,922
3	0.10	-0.88	67.13	34,260	-92.71	-20,739	-173	-20,912
3	0.15	-0.68	67.13	34,256	-95.48	-21,011	-173	-21,185
3	0.15	-0.73	67.13	34,256	-95.40	-21,004	-173	-21,177
3	0.15	-0.78	67.13	34,256	-95.30	-20,994	-173	-21,167
3	0.15	-0.83	67.13	34,256	-95.19	-20,983	-173	-21,157
3	0.15	-0.88	67.13	34,256	-95.07	-20,971	-173	-21,145
3	0.20	-0.68	67.13	34,253	-97.49	-21,210	-173	-21,383
3	0.20	-0.73	67.13	34,253	-97.42	-21,203	-173	-21,376
3	0.20	-0.78	67.13	34,253	-97.33	-21,194	-173	-21,367
3	0.20	-0.83	67.13	34,253	-97.21	-21,183	-173	-21,356
3	0.20	-0.88	67.13	34,253	-97.08	-21,169	-173	-21,343
3	0.25	-0.68	67.13	34,250	-99.17	-21,375	-173	-21,549
3	0.25	-0.73	67.13	34,250	-99.12	-21,370	-173	-21,544
3	0.25	-0.78	67.13	34,250	-99.04	-21,362	-173	-21,536
3	0.25	-0.83	67.13	34,251	-98.92	-21,351	-173	-21,525
3	0.25	-0.88	67.13	34,251	-98.79	-21,338	-173	-21,511
4	0.05	-0.68	67.04	34,266	-117.73	-27,072	-231	-27,303
4	0.05	-0.73	67.04	34,266	-117.67	-27,066	-231	-27,297
4	0.05	-0.78	67.04	34,266	-117.61	-27,060	-231	-27,291
4	0.05	-0.83	67.04	34,266	-117.54	-27,053	-231	-27,284
4	0.05	-0.88	67.04	34,266	-117.48	-27,047	-231	-27,278
4	0.10	-0.68	67.04	34,263	-119.45	-27,241	-231	-27,472
4	0.10	-0.73	67.04	34,263	-119.35	-27,231	-231	-27,462
4	0.10	-0.78	67.04	34,263	-119.24	-27,220	-231	-27,451
4	0.10	-0.83	67.04	34,264	-119.13	-27,209	-231	-27,440
4	0.10	-0.88	67.04	34,264	-119.01	-27,198	-231	-27,429
4	0.15	-0.68	67.04	34,261	-120.83	-27,376	-231	-27,607
4	0.15	-0.73	67.04	34,261	-120.70	-27,364	-231	-27,595

Table III-9. Results of Simulations For Beef

t	*e*	*η*	*p***[a]	*q***[b]	*Δv*[c]	*ΔCS*[c]	*ΔPS*[c]	*ΔSW*[c]
4	0.15	-0.78	67.04	34,261	-120.57	-27,351	-231	-27,582
4	0.15	-0.83	67.04	34,262	-120.42	-27,336	-231	-27,567
4	0.15	-0.88	67.04	34,262	-120.27	-27,321	-231	-27,552
4	0.20	-0.68	67.04	34,259	-121.93	-27,484	-231	-27,715
4	0.20	-0.73	67.04	34,260	-121.79	-27,471	-231	-27,702
4	0.20	-0.78	67.04	34,260	-121.63	-27,455	-231	-27,686
4	0.20	-0.83	67.04	34,260	-121.46	-27,438	-231	-27,669
4	0.20	-0.88	67.04	34,260	-121.27	-27,420	-231	-27,651
4	0.25	-0.68	67.04	34,258	-122.79	-27,569	-231	-27,801
4	0.25	-0.73	67.04	34,258	-122.64	-27,555	-231	-27,786
4	0.25	-0.78	67.04	34,259	-122.47	-27,538	-231	-27,769
4	0.25	-0.83	67.04	34,259	-122.28	-27,519	-231	-27,750
4	0.25	-0.88	67.04	34,259	-122.07	-27,498	-231	-27,729
5	0.05	-0.68	66.96	34,268	-145.29	-33,655	-289	-33,944
5	0.05	-0.73	66.96	34,268	-145.23	-33,649	-289	-33,938
5	0.05	-0.78	66.96	34,268	-145.16	-33,642	-289	-33,931
5	0.05	-0.83	66.96	34,268	-145.09	-33,635	-289	-33,924
5	0.05	-0.88	66.96	34,268	-145.02	-33,628	-289	-33,917
5	0.10	-0.68	66.96	34,267	-145.84	-33,709	-289	-33,998
5	0.10	-0.73	66.96	34,267	-145.72	-33,697	-289	-33,986
5	0.10	-0.78	66.96	34,267	-145.59	-33,685	-289	-33,973
5	0.10	-0.83	66.96	34,267	-145.46	-33,672	-289	-33,961
5	0.10	-0.88	66.96	34,268	-145.33	-33,659	-289	-33,948
5	0.15	-0.68	66.96	34,266	-146.19	-33,743	-289	-34,032
5	0.15	-0.73	66.96	34,267	-146.02	-33,727	-289	-34,016
5	0.15	-0.78	66.96	34,267	-145.84	-33,709	-289	-33,998
5	0.15	-0.83	66.96	34,267	-145.66	-33,692	-289	-33,981
5	0.15	-0.88	66.96	34,267	-145.48	-33,673	-289	-33,962
5	0.20	-0.68	66.96	34,266	-146.38	-33,762	-289	-34,051
5	0.20	-0.73	66.96	34,266	-146.17	-33,741	-289	-34,030
5	0.20	-0.78	66.96	34,267	-145.95	-33,720	-289	-34,008
5	0.20	-0.83	66.96	34,267	-145.72	-33,697	-289	-33,986
5	0.20	-0.88	66.96	34,267	-145.48	-33,674	-289	-33,963
5	0.25	-0.68	66.96	34,266	-146.43	-33,767	-289	-34,056
5	0.25	-0.73	66.96	34,266	-146.18	-33,743	-289	-34,031
5	0.25	-0.78	66.96	34,267	-145.92	-33,717	-289	-34,006
5	0.25	-0.83	66.96	34,267	-145.65	-33,690	-289	-33,979
5	0.25	-0.88	66.96	34,268	-145.36	-33,662	-289	-33,951

[a] Dollars per hundredweight ($/cwt).
[b] Millions (1,000,000) of pounds.
[c] Millions (1,000,000) of dollars.

Table III-10. Results of Simulations For Pork

t	e	η	p^{**a}	q^{**b}	ΔV^c	ΔCS^c	ΔPS^c	ΔSW^c
0.20	0.30	-0.55	51.16	24,719	-38.49	-15,369	-51	-15,420
0.20	0.30	-0.60	51.16	24,721	-37.52	-15,274	-51	-15,325
0.20	0.30	-0.65	51.16	24,723	-36.42	-15,168	-51	-15,219
0.20	0.30	-0.70	51.16	24,725	-35.22	-15,051	-51	-15,102
0.20	0.30	-0.75	51.16	24,728	-33.94	-14,926	-51	-14,977
0.20	0.35	-0.55	51.16	24,719	-38.38	-15,358	-51	-15,409
0.20	0.35	-0.60	51.16	24,721	-37.30	-15,253	-51	-15,304
0.20	0.35	-0.65	51.16	24,723	-36.08	-15,134	-51	-15,185
0.20	0.35	-0.70	51.16	24,726	-34.74	-15,004	-51	-15,055
0.20	0.35	-0.75	51.16	24,729	-33.30	-14,863	-51	-14,914
0.20	0.40	-0.55	51.16	24,720	-37.89	-15,310	-51	-15,361
0.20	0.40	-0.60	51.16	24,722	-36.70	-15,195	-51	-15,245
0.20	0.40	-0.65	51.16	24,725	-35.35	-15,064	-51	-15,114
0.20	0.40	-0.70	51.16	24,728	-33.87	-14,919	-51	-14,970
0.20	0.40	-0.75	51.16	24,731	-32.28	-14,763	-51	-14,814
0.20	0.45	-0.55	51.16	24,721	-37.08	-15,231	-51	-15,282
0.20	0.45	-0.60	51.16	24,724	-35.78	-15,104	-51	-15,155
0.20	0.45	-0.65	51.16	24,727	-34.30	-14,961	-51	-15,012
0.20	0.45	-0.70	51.16	24,730	-32.68	-14,802	-51	-14,853
0.20	0.45	-0.75	51.16	24,733	-30.92	-14,631	-51	-14,682
0.20	0.50	-0.55	51.16	24,724	-36.01	-15,126	-51	-15,177
0.20	0.50	-0.60	51.16	24,726	-34.58	-14,987	-51	-15,038
0.20	0.50	-0.65	51.16	24,730	-32.97	-14,830	-51	-14,881
0.20	0.50	-0.70	51.16	24,733	-31.20	-14,657	-51	-14,708
0.20	0.50	-0.75	51.16	24,737	-29.28	-14,471	-51	-14,521
0.30	0.30	-0.55	51.11	24,724	-48.68	-22,164	-76	-22,240
0.30	0.30	-0.60	51.11	24,726	-47.63	-22,063	-76	-22,139
0.30	0.30	-0.65	51.11	24,728	-46.47	-21,950	-76	-22,026
0.30	0.30	-0.70	51.11	24,730	-45.21	-21,828	-76	-21,905
0.30	0.30	-0.75	51.11	24,733	-43.87	-21,698	-76	-21,775
0.30	0.35	-0.55	51.11	24,724	-48.31	-22,129	-76	-22,205
0.30	0.35	-0.60	51.11	24,727	-47.14	-22,015	-76	-22,091
0.30	0.35	-0.65	51.11	24,729	-45.84	-21,889	-76	-21,965
0.30	0.35	-0.70	51.11	24,732	-44.43	-21,752	-76	-21,828
0.30	0.35	-0.75	51.11	24,735	-42.92	-21,606	-76	-21,682
0.30	0.40	-0.55	51.11	24,726	-47.60	-22,059	-76	-22,135
0.30	0.40	-0.60	51.11	24,728	-46.30	-21,934	-76	-22,010
0.30	0.40	-0.65	51.11	24,731	-44.86	-21,794	-76	-21,870
0.30	0.40	-0.70	51.11	24,734	-43.29	-21,642	-76	-21,718
0.30	0.40	-0.75	51.11	24,737	-41.62	-21,479	-76	-21,555
0.30	0.45	-0.55	51.11	24,728	-46.59	-21,961	-76	-22,037
0.30	0.45	-0.60	51.11	24,730	-45.16	-21,823	-76	-21,899
0.30	0.45	-0.65	51.11	24,734	-43.58	-21,669	-76	-21,745

Table III-10. Results of Simulations For Pork

t	e	η	p^{**a}	q^{**b}	ΔV^c	ΔCS^c	ΔPS^c	ΔSW^c
0.30	0.45	-0.70	51.11	24,737	-41.85	-21,502	-76	-21,578
0.30	0.45	-0.75	51.11	24,741	-40.01	-21,322	-76	-21,398
0.30	0.50	-0.55	51.11	24,730	-45.33	-21,839	-76	-21,915
0.30	0.50	-0.60	51.11	24,733	-43.77	-21,687	-76	-21,763
0.30	0.50	-0.65	51.11	24,737	-42.03	-21,519	-76	-21,595
0.30	0.50	-0.70	51.11	24,740	-40.14	-21,335	-76	-21,411
0.30	0.50	-0.75	51.11	24,744	-38.12	-21,139	-76	-21,215
0.40	0.30	-0.55	51.06	24,728	-58.87	-28,962	-102	-29,064
0.40	0.30	-0.60	51.06	24,731	-57.75	-28,854	-101	-28,955
0.40	0.30	-0.65	51.06	24,733	-56.52	-28,736	-101	-28,837
0.40	0.30	-0.70	51.06	24,736	-55.20	-28,608	-101	-28,710
0.40	0.30	-0.75	51.06	24,738	-53.81	-28,474	-101	-28,575
0.40	0.35	-0.55	51.06	24,730	-58.25	-28,902	-101	-29,004
0.40	0.35	-0.60	51.06	24,732	-56.99	-28,781	-101	-28,882
0.40	0.35	-0.65	51.06	24,735	-55.61	-28,648	-101	-28,749
0.40	0.35	-0.70	51.06	24,738	-54.13	-28,504	-101	-28,606
0.40	0.35	-0.75	51.06	24,741	-52.55	-28,352	-101	-28,453
0.40	0.40	-0.55	51.06	24,731	-57.31	-28,812	-101	-28,913
0.40	0.40	-0.60	51.06	24,734	-55.91	-28,676	-101	-28,778
0.40	0.40	-0.65	51.06	24,737	-54.37	-28,528	-101	-28,629
0.40	0.40	-0.70	51.06	24,740	-52.72	-28,368	-101	-28,469
0.40	0.40	-0.75	51.06	24,744	-50.96	-28,198	-101	-28,299
0.40	0.45	-0.55	51.06	24,734	-56.10	-28,695	-101	-28,796
0.40	0.45	-0.60	51.06	24,737	-54.56	-28,545	-101	-28,647
0.40	0.45	-0.65	51.06	24,740	-52.86	-28,381	-101	-28,483
0.40	0.45	-0.70	51.06	24,744	-51.03	-28,205	-101	-28,306
0.40	0.45	-0.75	51.06	24,748	-49.09	-28,017	-101	-28,118
0.40	0.50	-0.55	51.06	24,737	-54.66	-28,555	-101	-28,657
0.40	0.50	-0.60	51.06	24,740	-52.96	-28,391	-101	-28,492
0.40	0.50	-0.65	51.06	24,744	-51.10	-28,211	-101	-28,312
0.40	0.50	-0.70	51.06	24,748	-49.10	-28,017	-101	-28,119
0.40	0.50	-0.75	51.06	24,752	-46.98	-27,812	-101	-27,913
0.50	0.30	-0.55	51.01	24,733	-69.07	-35,763	-127	-35,890
0.50	0.30	-0.60	51.01	24,736	-67.87	-35,648	-127	-35,775
0.50	0.30	-0.65	51.01	24,738	-66.58	-35,524	-127	-35,651
0.50	0.30	-0.70	51.01	24,741	-65.20	-35,392	-127	-35,518
0.50	0.30	-0.75	51.01	24,744	-63.76	-35,252	-127	-35,379
0.50	0.35	-0.55	51.01	24,735	-68.20	-35,680	-127	-35,806
0.50	0.35	-0.60	51.01	24,738	-66.85	-35,550	-127	-35,677
0.50	0.35	-0.65	51.01	24,741	-65.39	-35,409	-127	-35,536
0.50	0.35	-0.70	51.01	24,744	-63.83	-35,259	-127	-35,386
0.50	0.35	-0.75	51.01	24,747	-62.19	-35,101	-127	-35,228
0.50	0.40	-0.55	51.01	24,737	-67.04	-35,568	-127	-35,695

Table III-10. Results of Simulations For Pork

t	e	η	p^{**a}	q^{**b}	ΔV^c	ΔCS^c	ΔPS^c	ΔSW^c
0.50	0.40	-0.60	51.01	24,740	-65.53	-35,423	-127	-35,550
0.50	0.40	-0.65	51.01	24,743	-63.89	-35,266	-127	-35,392
0.50	0.40	-0.70	51.01	24,747	-62.15	-35,098	-127	-35,225
0.50	0.40	-0.75	51.01	24,750	-60.32	-34,921	-127	-35,048
0.50	0.45	-0.55	51.01	24,740	-65.62	-35,432	-127	-35,559
0.50	0.45	-0.60	51.01	24,743	-63.95	-35,271	-127	-35,398
0.50	0.45	-0.65	51.01	24,747	-62.15	-35,097	-127	-35,224
0.50	0.45	-0.70	51.01	24,751	-60.22	-34,912	-127	-35,039
0.50	0.45	-0.75	51.01	24,755	-58.19	-34,716	-127	-34,843
0.50	0.50	-0.55	51.01	24,743	-64.00	-35,276	-127	-35,403
0.50	0.50	-0.60	51.01	24,747	-62.16	-35,099	-127	-35,226
0.50	0.50	-0.65	51.01	24,751	-60.18	-34,908	-127	-35,034
0.50	0.50	-0.70	51.01	24,755	-58.06	-34,704	-127	-34,831
0.50	0.50	-0.75	51.01	24,759	-55.83	-34,489	-127	-34,616
0.60	0.30	-0.55	50.96	24,738	-79.27	-42,567	-152	-42,719
0.60	0.30	-0.60	50.96	24,741	-78.00	-42,445	-152	-42,598
0.60	0.30	-0.65	50.96	24,743	-76.64	-42,315	-152	-42,468
0.60	0.30	-0.70	50.96	24,746	-75.21	-42,178	-152	-42,330
0.60	0.30	-0.75	50.96	24,749	-73.71	-42,034	-152	-42,186
0.60	0.35	-0.55	50.96	24,740	-78.15	-42,460	-152	-42,612
0.60	0.35	-0.60	50.96	24,743	-76.71	-42,322	-152	-42,474
0.60	0.35	-0.65	50.96	24,746	-75.17	-42,174	-152	-42,326
0.60	0.35	-0.70	50.96	24,749	-73.54	-42,018	-152	-42,170
0.60	0.35	-0.75	50.96	24,753	-71.83	-41,854	-152	-42,006
0.60	0.40	-0.55	50.96	24,743	-76.76	-42,327	-152	-42,479
0.60	0.40	-0.60	50.96	24,746	-75.15	-42,173	-152	-42,325
0.60	0.40	-0.65	50.96	24,750	-73.42	-42,007	-152	-42,159
0.60	0.40	-0.70	50.96	24,753	-71.59	-41,832	-152	-41,984
0.60	0.40	-0.75	50.96	24,757	-69.68	-41,648	-152	-41,800
0.60	0.45	-0.55	50.96	24,746	-75.15	-42,173	-152	-42,325
0.60	0.45	-0.60	50.96	24,750	-73.36	-42,001	-152	-42,153
0.60	0.45	-0.65	50.96	24,754	-71.44	-41,817	-152	-41,969
0.60	0.45	-0.70	50.96	24,757	-69.41	-41,623	-152	-41,775
0.60	0.45	-0.75	50.96	24,762	-67.29	-41,419	-152	-41,571
0.60	0.50	-0.55	50.96	24,750	-73.34	-42,000	-152	-42,152
0.60	0.50	-0.60	50.96	24,754	-71.37	-41,811	-152	-41,963
0.60	0.50	-0.65	50.96	24,758	-69.26	-41,608	-152	-41,761
0.60	0.50	-0.70	50.96	24,762	-67.03	-41,395	-152	-41,547
0.60	0.50	-0.75	50.96	24,767	-64.70	-41,171	-152	-41,323

[a] Dollars per hundredweight ($/cwt).
[b] Millions (1,000,000) of pounds.
[c] Millions (1,000,000) of dollars.

Table III-11. Summary Statistics of Simulation Results For Beef

	t	e	η	Δv^a	ΔCS^a	ΔPS^a	ΔSW^a
Mean	3	0.15	-0.78	-94.92	-20,958	-173	-21,132
Variance	2.016	0.00504	0.00504	1,312.69	81,864,267	6,731	83,354,379
Minimum	1	0.05	-0.88	-146.43	-33,767	-289	-34,056
Maximum	5	0.25	-0.68	-34.89	-7,308	-58	-7,366
Number of simulations	125						

[a] Millions (1,000,000) of dollars.

Table III-12. Summary Statistics of Simulation Results For Pork

	t	e	η	Δv^a	ΔCS^a	ΔPS^a	ΔSW^a
Mean	0.40	0.40	-0.65	-54	-28,493	-101	-28,594
Variance	0.02016	0.07010	0.00504	193	91,652,461	1,293	92,341,971
Minimum	0.20	0.30	-0.75	-79	-42,567	-152	-42,719
Maximum	0.60	0.50	-0.55	-29	-14,471	-51	-14,521
Number of simulations	125						

[a] Millions (1,000,000) of dollars.

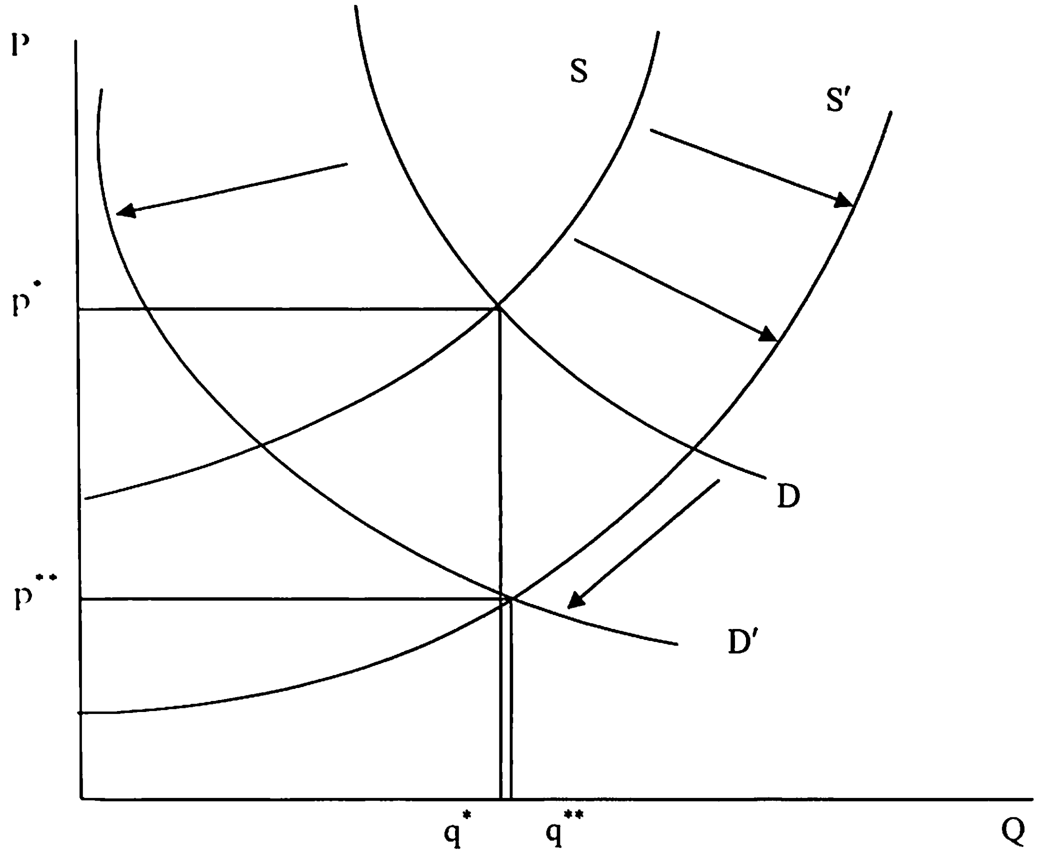

Figure III-1. Equilibrium before and after dissolution of generic promotion and research program

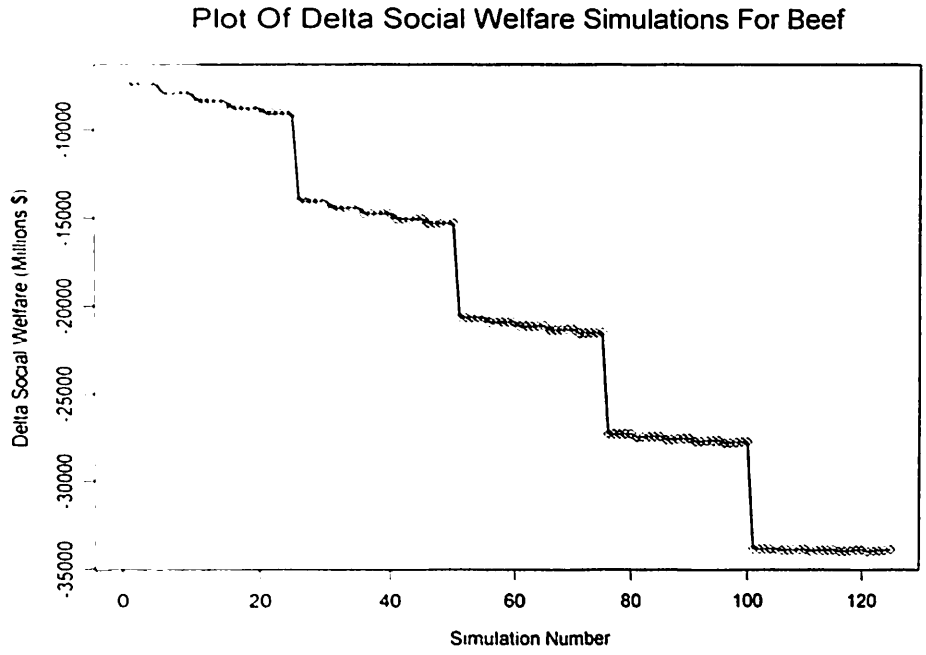

Figure III-2. Plot of the change in net social welfare after dissolution of beef checkoff

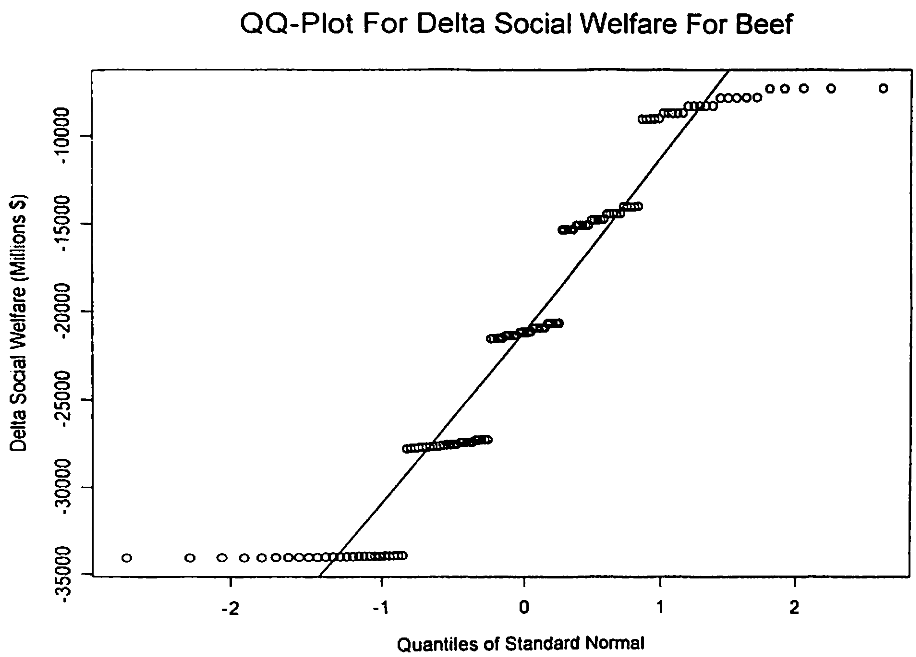

Figure III-3. QQ-plot of distribution net social welfare simulations for beef

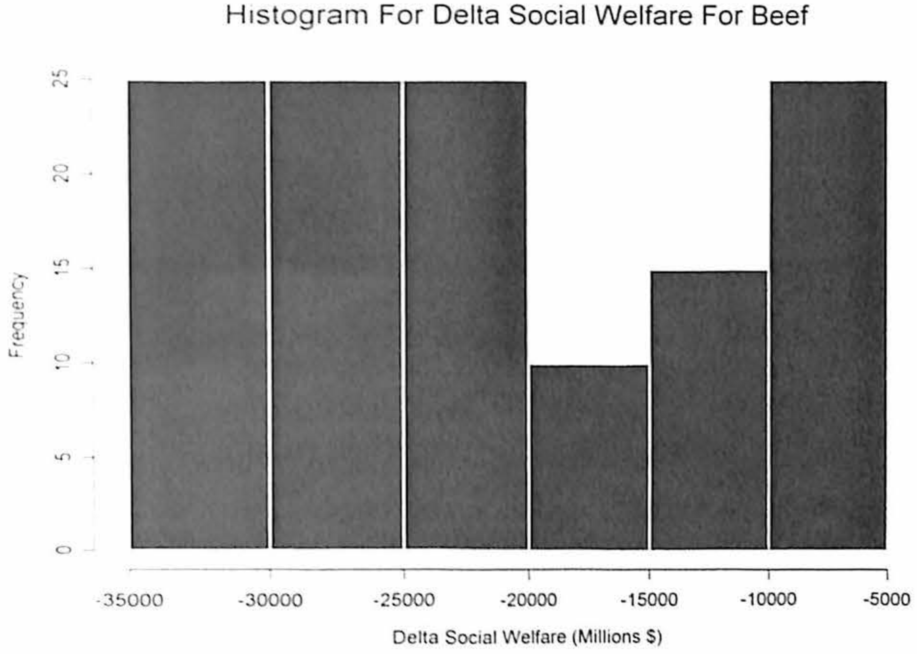

Figure III-4. Histogram of net social welfare simulations for beef

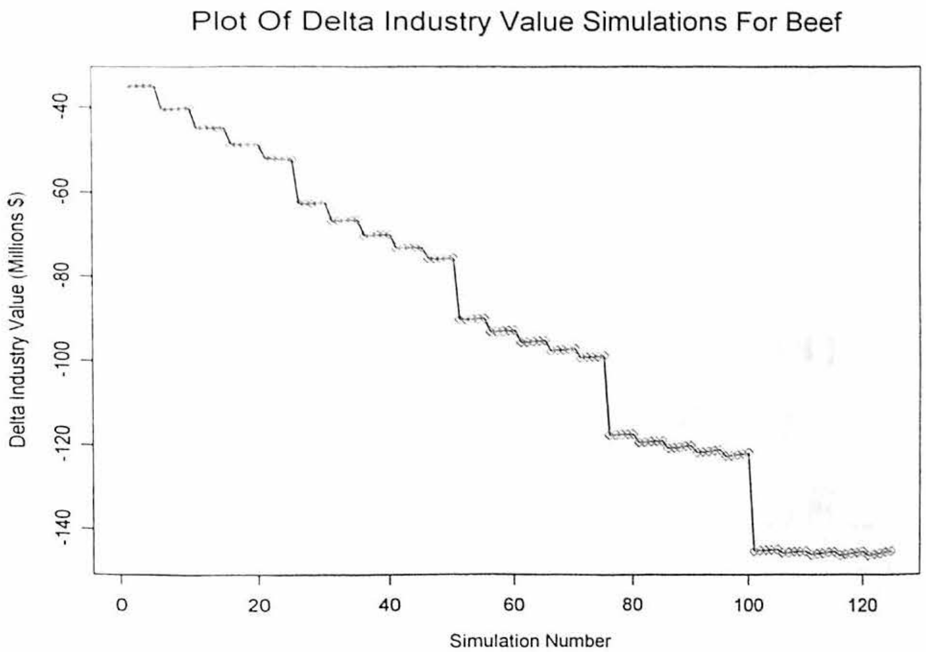

Figure III-5. Plot of the change in net value of industry product for beef without checkoff

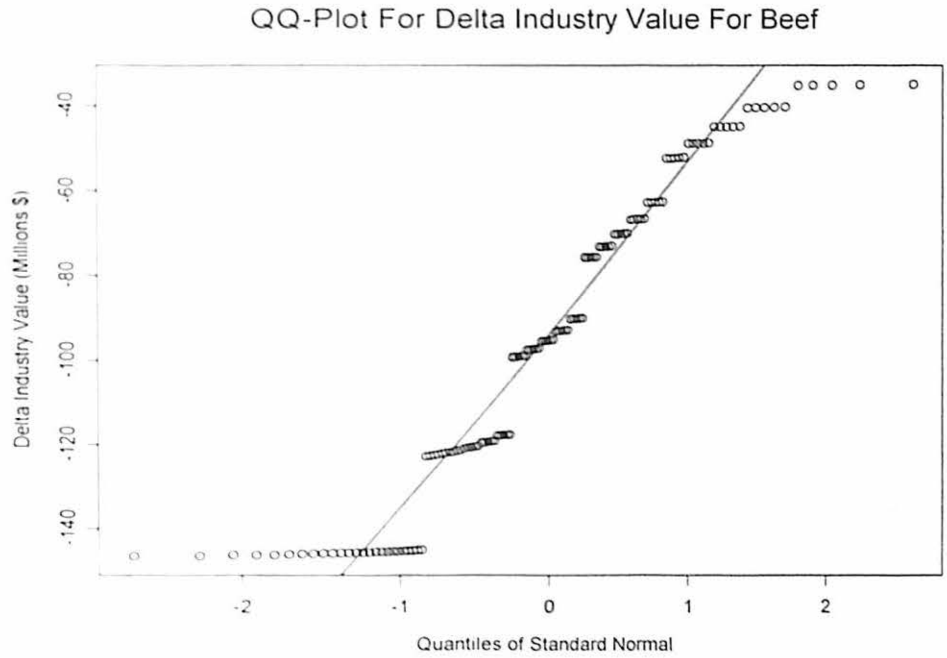

Figure III-6. QQ-plot of distribution of change in net value of industry product

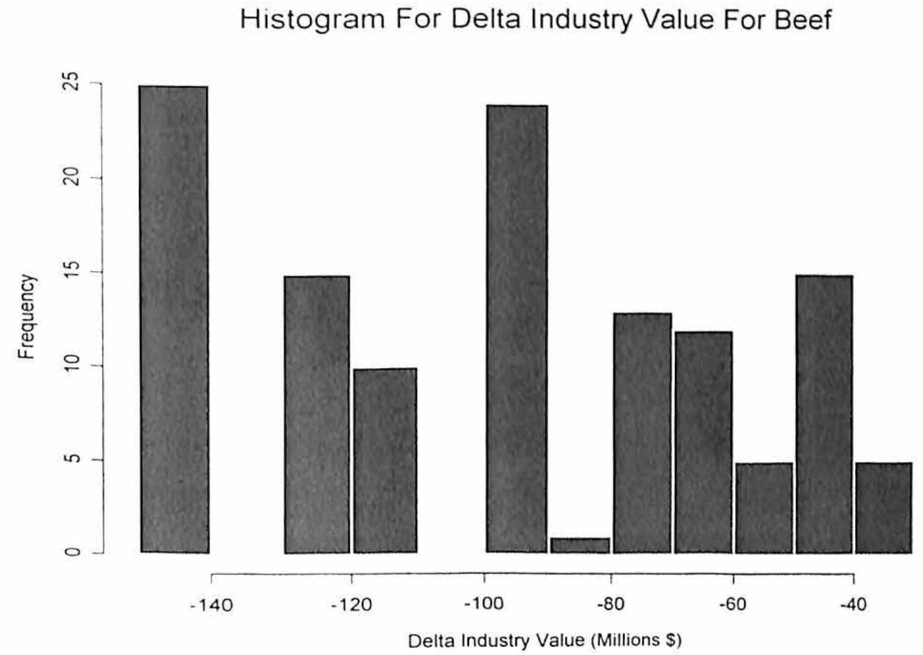

Figure III-7. Histogram of change in net value of industry product

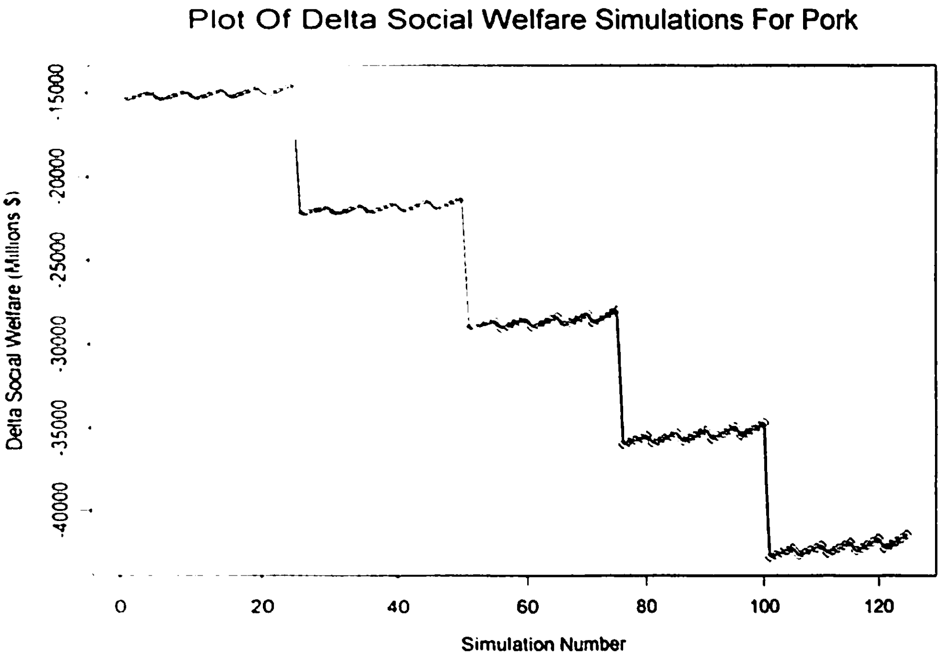

Figure III-8. Plot of the change in net social welfare after dissolution of pork checkoff

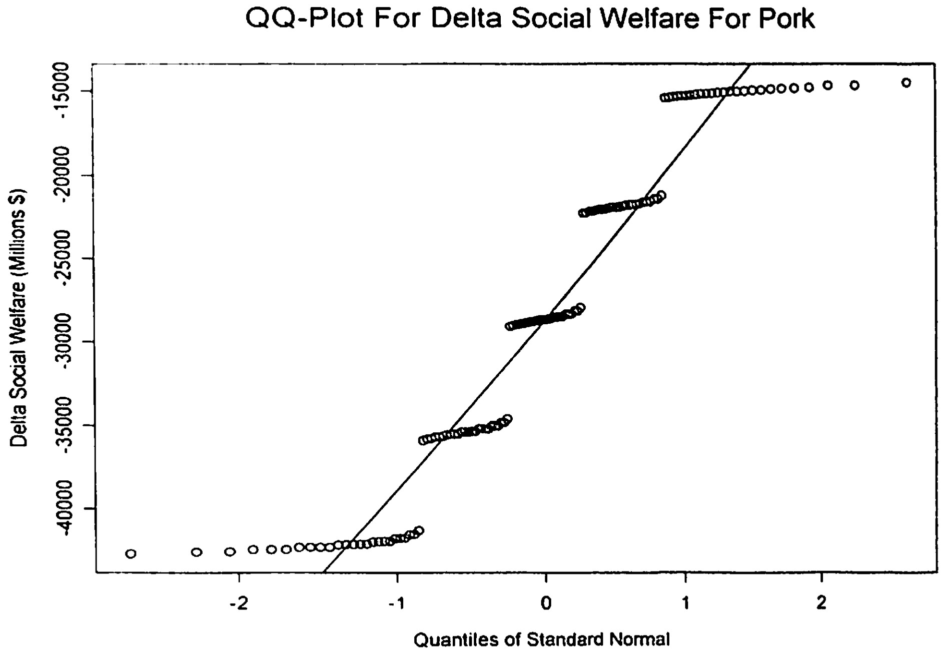

Figure III-9. QQ-plot of distribution of net social welfare simulations for pork

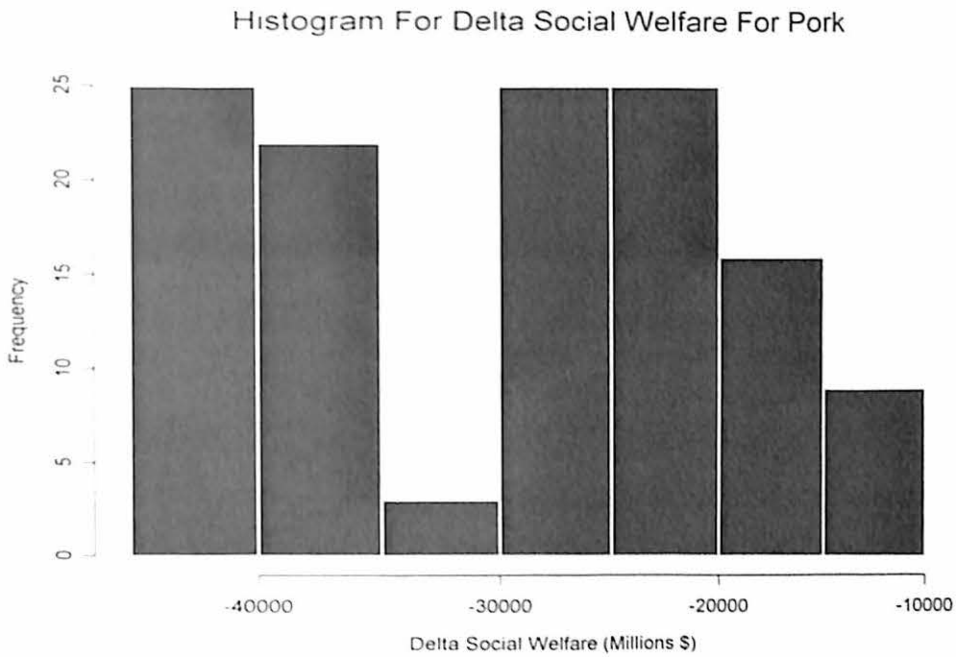

Figure III-10. Histogram of net social welfare simulations for pork

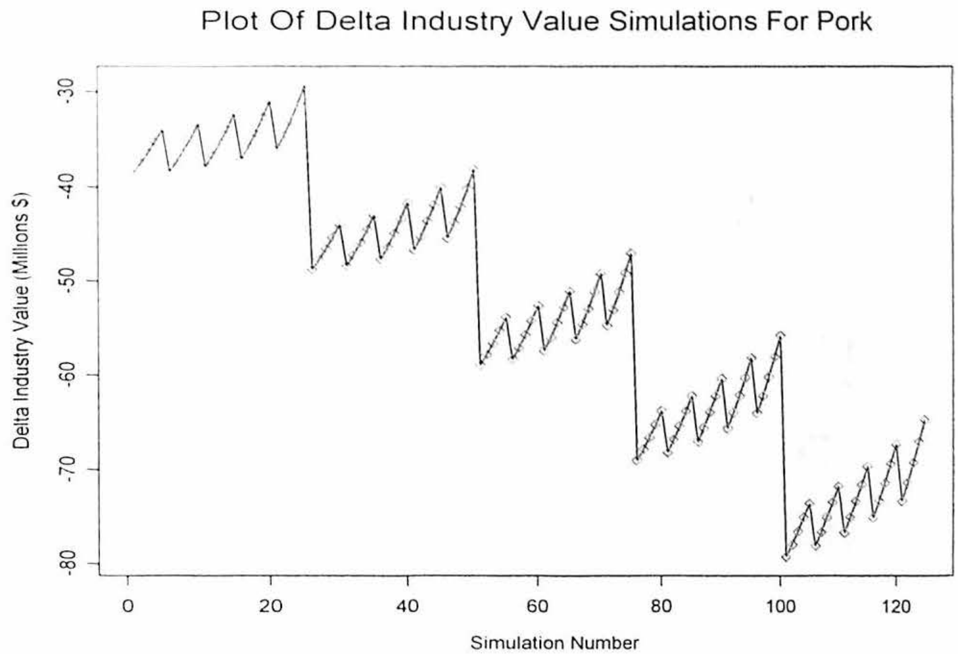

Figure III-11. Plot of the change in net value of industry product for pork without checkoff

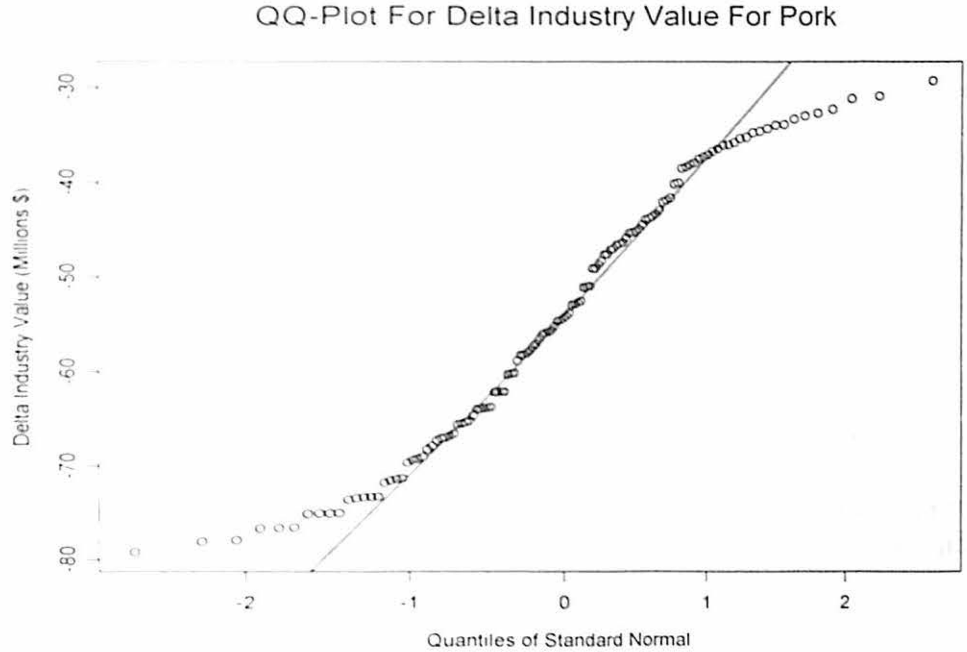

Figure III-12. QQ-plot of distribution of change in net value of industry product for pork

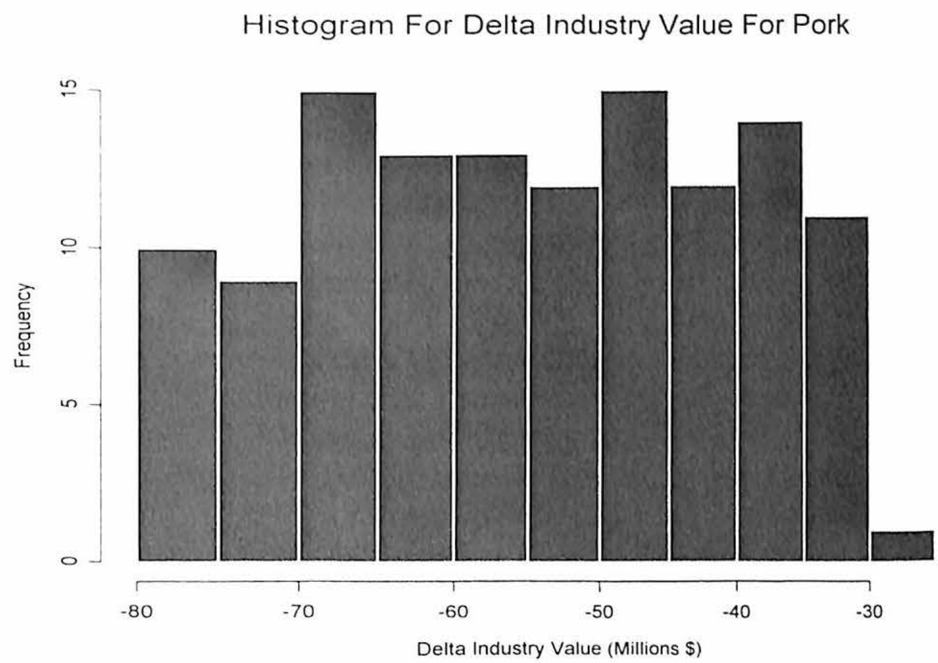

Figure III-13. Histogram of change in net value of industry product for pork

VITA

Robert Jefferson Hogan, Jr.

Candidate for the Degree of

Doctor of Philosophy

Thesis: GENETICS, CARCASS DISCOUNTS, AND GRID PRICING IN THE FED CATTLE MARKET AND WELFARE IMPACTS OF BEEF AND PORK CHECKOFF PROGRAMS

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