THE MEAT PACKING PLANT MANAGEMENT SIMULATOR: THE DEVELOPMENT OF AN EXPERIENTIAL AGRIBUSINESS SIMULATOR

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Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 1997

THE MEAT PACKING PLANT MANAGEMENT SIMULATOR:

THE DEVELOPMENT OF AN EXPERIENTIAL

AGRIBUSINESS SIMULATOR.

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ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to my advisor, Dr. James Trapp, for his expert guidance throughout my Ph.D. program. I also would like to thank the members of my advisory committee, Dr. Clem Ward, Dr. Derrell Peel, and Dr. H. Glen Dolezal for their help and guidance in the development of the simulator. In addition, I would like to thank Excel Corporation for their financial support and their involvement in the development and validation of the simulator.

I would like to thank my parents, Chester and Juanita for their support. Their confidence and belief in me was, at times, the only thing that made me believe I could accomplish this undertaking.

I would like to thank my aunt and uncle, Lloyd and Geneva Laurent for their support. I dedicate this work to the memory of my favorite uncle.

I would like to thank all of the people who took the time to help make the test runs of the simulator. Their help was crucial in developing the simulator.

Finally, I would like to thank the other graduate students for their help throughout my Ph.D. program.

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CHAPTER I

INTRODUCTION

Overview

The beef packing industry of the 1990's is characterized as an industry with a few, large firms purchasing inputs of live cattle and supplying meat products to numerous buyers. By 1994, the four largest packers (IBP, ConAgra, Excel, and Beef America) accounted for about 82% of all steer and heifer slaughter (Azzam and Anderson, 1996). As individual packers have increased in size and market share, the ability of packing firms to influence input prices (i.e. fed cattle prices) has risen. Also, these larger firms generally have advantages in operating costs creating considerable barriers to entry into the industry by smaller firms.

The movement in the beef packing industry continues to be toward fewer and larger plants (Ward and Sersland, 1986). Existing firms are usually characterized by large slaughter and processing plants which allow them to capture economies of size in production. By the 1990's, plants slaughtering over 500,000 head accounted for 66% of all beef slaughter (Azzam and Anderson, 1996). Increased productivity and efficiency have evolved, not only with increased plant size, but also through improved layout and design of plants.

Considerable attention has been given to the beef packing industry with regard to its competitiveness.

Decreased packer numbers and increased size of existing firms has generated concern over the impact of increased market power on cattle producers and fed cattle suppliers. The focal point of this concern has been the question of whether packers are able to distort transaction prices for fed cattle. Additionally, attention has been given to the role of captive supplies in the industry.

Captive supplies refer to those cattle that are either packer owned or forward or basis contracted. The fear is that captive supplies fail to properly transmit price signals in the market, therefore, potentially reducing the effectiveness of the market in setting prices.

Regardless of the size of the firm, the basic operations of the beef packing firm can be categorized into three distinct phases. The first phase is cattle procurement. The cattle needed as inputs for the production of "boxed beef" or sub-primal meat products must be purchased from a supply of cattle over which packers have little or no control.

Most of the cattle are purchased from independent cattle feeders. With so few packers, cattle feeders must accept the price offered or be left with large numbers of market ready cattle with no market outlet. For cattle feeders, holding onto cattle after they have reached a market ready status is very costly. As cattle become heavier, their average daily gain and feed conversion efficiency decreases, therefore, increasing per head costs of supplying those cattle. Also, feedlots are constrained in the number of cattle they can have on feed at any one time. Not selling market ready cattle, therefore, limits the number of new cattle that can be placed on feed.

While packers may be able to influence the price of fed cattle, they, for the most part, have exercised very little influence on the type of cattle they purchase. Packers most often simply purchase the cattle available in order to meet their demand. Pen lots of cattle are often comprised of various types and qualities of cattle making it difficult for cattle buyers to target one specific animal type when purchasing cattle.

In order to have more control over the type of cattle they process, some packers have vertically integrated by feeding their own cattle to meet their input demand. While this gives packers considerably more control over the type of cattle they process and the time these animals will be market ready, there has been no significant trend toward this method of controlling supply. As of 1993, only 6.71% of all cattle slaughtered were fed by packers (Azzam and Anderson, 1996).

However, packers have engaged in other methods of assuring sufficient cattle supplies. Forward contracting has become a common strategy for many packers. As of 1993, 14.84% of cattle slaughtered were forward contracted (Ward, et al., 1996). Forward contracting involves packers establishing agreements with feedlots on prices for cattle that will be supplied by the feedlot at a future date. While forward contracting can be used to ensure that packers will have enough cattle to process to meet their boxed beef demand and to reduce some price risk, it does not assure packers of the type of cattle they will process (i.e. the yield and quality grade of the cattle).

The second phase of the meat packer is slaughtering and processing (i.e. fabrication). As mentioned, the trend in slaughter plants has been toward larger, more efficient plants capable of slaughtering high volumes of cattle. In previous years, these plants were mainly located near large demand regions because it was more efficient to ship cattle to these plants rather than trying to ship processed meat. However, developments in transportation technology have made it economical to ship fresh and processed meats. That, along with lower wages, cheaper land, and new sources of fed cattle in the Western Corn Belt and Southern Plains gave rise to plants being located nearer to these supply regions (Azzam and Anderson, 1996). It was found to be more efficient to process cattle in supply regions and then ship meat products to the demand regions.

The role of the slaughter and processing phase is to convert the input of live cattle, along with other inputs, into sub-primal or "boxed beef" products. The number of sub-primal cuts produced by packers is well over 100 individual products ranging from tenderloins to short ribs to brisket. This figure does not include other products such as trimmings (ground beef), fat, bone, and other variety items such as kidney, sweet bread, etc. Also, the demand for either higher quality products or leaner products has given rise to specialty lines and branded lines that produce products within specific, usually strict guidelines.

The final phase of the meat packing firm is that of sales. The individual sub-primal products, trimmings, fat, bone, specialty items, hides and offal are sold to generate packer revenue. Unlike in cattle procurement, for the most part, packers are price takers for their products. A large number of buyers make it difficult for packers to control these prices.

Buyers of meat products can be generally categorized into three groups (Kenny, 1996). The three groups are 1) Hotel and Restaurants (i.e. Food Service), 2) Retail Chains, and 3) Export Buyers. Usually, each group will demand different types and qualities of products. For example, hotel and restaurant buyers will usually demand a higher quality product than do other buyers. The differentiation in the type and quality of meat products demanded has resulted in packers offering several different products and different qualities of the same product (i.e. specialty or branded product lines).

Problem Statement

With packing firm mergers, trends toward larger, more efficient plants, and new specialized product lines, the challenge for meat packers has been to coordinate all production phases. The ability of a firm to coordinate all phases declines as the size and diversity of the firm increases.

Through better coordination, firms can increase efficiency and, therefore, increase profits. Attempts to increase operational efficiency by beef packers have often focused on individual production phases (procurement, slaughtering and processing, and sales), rather then on the whole firm. Advances in killing and processing facilities have allowed packers to decrease per unit costs while increasing output. With better accounting systems in tracking cattle through the production system, packers have been able to determine which sizes and grades of cattle are more profitable. However, often, individual goals in the separate production phases have been inconsistent with the firm's overall goal of profit maximization.

Often, activities in the procurement and processing phases create large inventories of beef products that must be sold by the sales division[1]. As a result, price

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[1] For example, the fabrication division often strives to maximize product yield by producing bone-in products despite market demand signals suggesting more demand for boneless products.

discounts, often below breakeven levels, must be given in order to move product. These discounts could be a result of low seasonal demand for certain beef products, limitations in storage facilities, or combinations of these and other factors.

A major concern has been a lack of agreement by the three production phases over the cause of low revenue periods. This uncertainty makes it difficult for packers to use past experiences in determining how to prepare for and deal with these problem situations. In order to better understand what strategies can be used in times such as these, there is a need for a better understanding by packers of the coordination process between their procurement, slaughtering and processing, and marketing divisions.

Packers have attempted to remedy some of the coordination problems with more advanced training of employees. By giving employees knowledge of current conditions and knowledge in dealing with changes in these conditions, packers have been able to coordinate production phases. However, there has been a lack of training tools that truly use a whole firm approach. For example, if employees in the procurement phase have a better understanding of the problems that the sales division faces day to day, procurement strategies can be developed to alleviate some of the pressure faced by the sales division in having to sell large quantities of product. Likewise, if employees in the slaughtering and processing division can gain insight into responses that will more adequately satisfy market demand for various beef products they can develop strategies that will interface between procurement and sales more effectively.

The primary motive of studying packing firm operations is to establish guidelines for managers to follow in reacting to various market conditions. As a result, several avenues could be used to achieve this end. Optimization models could be developed to explore optimal responses in purchasing cattle, in producing meat products, or in selling meat. Econometric models could be used to establish relevant relationships, such as price determinants for various meat products that would give managers an idea of what information is most relevant in selling meat products.

The selection of a simulation model was based on its ability to simulate a wider range of market conditions then other methods of study. Also, it is felt that managers may obtain as much knowledge from simulating/experiencing poor decisions as from optimal decisions.

Another issue in selecting a simulation model is the ability it gives to facilitate role playing within an experiential learning framework. In the role playing application of the simulator developed here, participants are given the opportunity to make the same decisions that managers of a beef packing plant would make. The simulation model then simulates the collective consequences of the decisions made by the participants and provides feedback to the participant about the results of their decisions. Through this simulated feedback, participants feel the same fear, greed, and ego that is often present in the real world. As a result, a great deal of emotion is generated through the use of the simulator. This emotion makes the learning experience more interesting to participants and allows for the element often missing in other methods of study, human interaction. Markets are made up of people and their beliefs, fears, and personalities affect the industry, in many cases, as much or more than underlining economic principles.

Role playing and experiential learning also provides participants an opportunity to discover the knowledge and skills they need in order to be successful. Participants are able to determine the type of information they need in order to make sound decisions. Also, they come to realize that even with this knowledge, often what determines their success is the ability to communicate this information to others as well as their ability to work with others. As a result, simulators used in an experiential learning framework have an additional advantage of increasing interpersonal skills.

One problem with the simulation model is that it does not truly result in optimal responses. However, it does give participants insight into what responses performed better under certain market conditions than did other responses. Another benefit of the simulation model is that it does facilitate cooperation among simulation participants. One of the concerns within the packing firm is the lack of coordination among its production phases. The simulator gives an opportunity for participants to work together in making decisions and therefore aids participants in improving communication skills that will facilitate better coordination.

There is, however, a high degree of complexity required in properly simulating the actions of a whole firm within an industry. This degree of complexity is needed to ensure that the simulator will be realistic. A major difficulty in achieving the realism needed is that there are several components of the beef packing industry that have not yet been addressed in research (i.e. there structure has never been quantitatively modeled). Therefore, the difficulty in developing a whole firm simulator is not only in assembling individual components into a valuable training tool, but also, in developing these components.

Nevertheless, the development and use of an experiential simulator can be an effective tool to increase the coordination of all phases of meat processing. The ultimate goal of profit maximization can be more easily attained if all phases of production realize what can be done within their phase that will assure increased firm profits.

In addition, the use of experiential simulators has been found to be highly beneficial in a classroom or extension program framework (Koontz, et al., 1996, Babb, 1985, Trapp, 1989). The use of such simulators can be used to give participants practical experience in applying marketing and management methods and theory to realistic situations. This affords students/employees/extension clientele an opportunity to react to situations of uncertainty and risk without the cost associated with improper business decisions.

Objectives

The objective of this study is to develop a Meat Packing Plant Management (MPPM) simulator that will be beneficial to packer employees, students, and extension clientele in understanding market structure by providing such individuals with an opportunity to develop and apply marketing and management strategies under realistic market conditions. Three basic steps are needed to achieve this objective:

1) Determine the principle components needed in the development of the MPPM simulator,

2) Synthesize all components of the meat packing firm into a usable training tool,

3) Determine the realism and appropriateness of the MPPM simulator through testing the sensitivity of the simulator to market changes and using it with actual participants.

Procedure Overview

Several components needed to be determined before the simulator could be developed. Each phase of the packing firm required estimation of key technical and behavioral relationships. To simulate the cattle procurement phases, the type and quantity of cattle offered to the simulated packers was needed. This required determining a range of live cattle weights, the number of each of four yield grades[2] of cattle to offer and the number of both U.S. Choice and U.S. Select cattle. Along with determining the type of cattle that would comprise the available supply, the total number of cattle to be supplied in any given week is also needed.

In order to properly characterize the fabrication phase, technical relationships had to be determined. The first relationship to be determined was the conversion of live cattle weights to carcass weights. The conversion factor determined needed to be a function of both live animal weight and yield grade. As the live weight and yield grade of animals changed, the corresponding carcass weight could also be expected to change. The other conversion factor required was converting the beef carcass into the individual sub-primal products. As with the live weight to carcass weight conversion, the conversion of the carcass to

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[2] Cattle are separated into four yield grades. The yield grades included were Yield Grade 1, Yield Grade 2, Yield Grade 3, and Yield Grade 4.

sub-primal cuts has to be dependent on yield grade. However, in addition, it must be dependent on the processing option (how the primal was processed) chosen by the packer.

Costs for slaughtering and processing cattle were also determined. Processing costs were needed 1) on a per head basis and 2) for each of the fabrication options available to packers. Likewise, slaughter costs per head were also determined.

In order to simulate the sales phase, demand for each of the sub-primal products, fat, and bone was needed. In addition to being able to determine the quantity demanded of each cut given current market conditions, the seasonality of the products was needed to properly simulate fluctuations in demand over a simulated year of operations.

Other components needed in the sales division included estimates of storage capacities for the packing firms as well as baseline quantities and prices for all products sold.

Once the simulation was completed, testing was done to ensure that realistic results were obtained. Several key statistics were examined to determine the realism of the simulator. Statistics/relationships examined included U.S. Choice-Select price spreads, breakeven prices for live cattle, carcass values for yield grade 2 cattle, and packer profits.

These statistics/variables were examined for their reaction to changes in the market. Changes in live cattle supply, type of cattle supplied, and demand for meat products were examined for their impact.

Literature Review

Several studies have been conducted that examine various issues within the meat packing and beef industries. Those studies relevant to this study can be separated into three general categories. The first of which is studies regarding market performance. These studies include those examining packer concentration, industry competitiveness, marketing margins, etc. The second category is that regarding the demand and price analysis. These studies include those on wholesale beef demand, elasticity and flexibility estimation, etc. The final category of research relevant to this study is research utilizing simulation models. In particular that research utilizing simulators in an experiential learning framework is relevant to this effort.

Market Structure and Performance

Determining how packers react to changing market conditions is crucial in properly simulating the meat packing industry. Research in the area of packer behavior has generally focused on packer decisions in purchasing live cattle. Included in this research is the impact of packers on fed cattle prices, the impact of cattle supplies on these prices, and the impact of captive supplies on the market in transmitting price signals.

The decision about the price packers pay for live cattle is essentially determined by the packer's profit maximization problem. The first order conditions, required to assure a maximum solution, can be converted into the packer's demand for live cattle. If packers possess market power, then the transaction price paid for live cattle will be less then the marginal value of the cattle[3].

Rogers and Sexton (1994) developed a theoretical model to examine the importance of oligopsony power in agricultural markets. Most research in the literature regarding market power dealt with seller market power (i.e. monopoly or oligopoly markets). The authors felt that the dismissal of the relevance of buyer market power was unwarranted as many of the reasons in doing so did not apply to many of the agricultural markets. Among the reasons for not examining this issue was the belief that competition for inputs would be greater then the competition for the products these inputs produced. It was believed that other firms in other industries would compete for the same inputs and, therefore, make the input market highly competitive. This is clearly not the case in the beef packing industry as

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[3] In a pure competition industry, the transaction price would be expected to be equal to the marginal value of the input. Firms in a competitive market make decisions about the amount of inputs to purchase by equating marginal value of the input to its marginal cost.

the inputs of fed cattle are not used by firms outside the industry.

The authors used a simple theoretical model to show that buyer concentration, costly product transport, and noncompetitive buyer conduct may interact to produce large farm-to-retail price spreads.

In empirically addressing the issue of packer market power, Azzam and Schroeter (1991) felt that the two major methodologies of examining concentration and oligoposonistic competition effects on the fed cattle market had shortcomings. The Structure-Conduct-Performance (SCP) methodology was viewed as inferring the degree of competition in cattle procurement markets through ad hoc models that were not explicitly connected to behavior at the firm level. Also, the models and estimation procedures failed to test or impose important restrictions implied by theory. The second approach, the conjectural variation approach, was viewed as not adequately addressing the fact that relevant cattle procurement markets are regional and not national in scope.

The authors based their work on the profit maximization objective function of the packer. It was assumed that packers, with market power, would internalize the effect that its choice of quantity would have on regional quantity and in turn on regional cattle price. The authors expressed oligopsony price distortions as a function of a multiple of the firms proportionate quantity response (rivals' quantity responses was assumed to be a constant multiple of the firms own response), the regional quantities, and concentration indices (measured as a Herfindahl index). The authors first set baseline values for these parameters and then simulated the impact of changes in these parameters on the price distortion.

Price distortions were found to be less then 1% of the price level for fed cattle. This compares to 1.2% to 2.5% found in other studies. Fairly dramatic changes in the concentration ratio (i.e. changes in the Herfindahl index) only resulted in quantity and price effects of 1.08% and .64%, respectively. Also, changing from Cournot conduct (i.e. competitive condition) to that of pure monopsony only resulted in quantities falling by 1.55% and prices falling by .93%.

Koontz, et al. (1993) also attempted to determine the impact of oligopsony power on fed cattle markets. The authors felt that most of the research done with a conjectural variations approach had two significant shortcomings. The first is that little attention was given to understanding the optimal pricing strategies in oligopoly/oligopsony behavior. Specifically, no model was offered to show that behavior along the continuum between pure competition and monopoly/monopsony is optimal. Further, conjectural variation research often focused on long-run relationships, grouped packers of all red meat species, and has not examined regional markets, which are most relevant in fed cattle procurement.

In an attempt to determine short-run impacts, the authors utilized a non-cooperative repeated pricing game between n players with complete but imperfect information. The authors determined logical switching points at which packers would transform from operating in a cooperative manner with other firms to operating in a non-cooperative fashion. The switching points were thought to be determined by trigger prices that, once reached, would influence packers in changing their behavior. Results indicated that noncooperative margins were between 59.6% to 63.1% of the cooperative margins in one period, but fell in the next period indicating an increase in the exercise of market power. The authors further found that the behavior observed in the meat packing industry was consistent with the trigger pricing strategies.

Finally, two other interesting results were found. The first is that the presence of cooperative pricing strategies supports the notion that market power has been exercised in fed cattle markets. The second is that market power was found to vary over time and was not uniform over space.

One of the reasons that market power may vary over time is the supply of live cattle. When cattle supplies are tight, it may be expected that packers would have to pay more than they normally would, therefore, reducing the amount of price distortion. Stiegert, et al. (1993) examined the effect of supply changes of fed cattle on the markdown pricing. The authors utilized a variation of the NEIO (new empirical industrial organization) methodology which incorporated the responses of firms to both anticipated and unanticipated changes in cattle supply.

The authors first determined the impact of changes in unanticipated and anticipated changes in supply on the markdown. Results indicated that markdown responded in a manner consistent with Average Processing Cost (APC) pricing in which packers establish cattle bid prices by subtracting average processing costs from the price received for carcass or "boxed beef". As anticipated supply decreased (increased), the markdown increased (decreased).

The authors then took estimates of the markdown in analyzing the impact on profits and demand for fed cattle. The results indicated that fed cattle were priced significantly below their marginal value during most of the time period examined, implying market power. This translated to a benefit of about $1.54 for every 100 pounds of retail beef sold and about 62 million dollars to the industry.

Another concern within the meat packing industry has been the role of captive supplies. Captive supplies can be used by packers to ensure sufficient supplies of cattle and to reduce price risk. However, the concern with captive supplies is that they prohibit the market from sending accurate price signals and therefore reduce the pricing efficiency of the market.

Ward, et al. (1996) examined the role of captive supplies in beef packing. Captive supplies essentially take on three forms. The first is packer feeding in packer-owned feedlots and commercial feedlots. The second is fixed price and basis forward contracting. The last form of captive supplies is exclusive marketing agreements between packers and commercial feedlots.

The authors examined both short and long run implications of captive supplies. Feedlot revenue was separated into two areas with revenue coming from forward contracted cattle and revenue from cash cattle. By solving the profit maximization problem of the feedlot, both the supply of forward contracts and of cash market cattle were determined.

The demand for forward and cash market cattle originates from the packers. The demand for contracts was assumed to be a function of contract prices while the demand for cash cattle was assumed to be a function of spot cash prices. By equating supply and demand in both the cash cattle and contract market, equilibrium prices for both markets were determined.

Empirical results indicated that the relative price difference between spot cash and contract prices played a significant role in determining the amount of contracts in the larger firms but not the smaller firms. Plant utilization was also found to influence the amount of cattle that were contracted. Smaller firms were found to be particularly influenced by plant utilization as their costs increase considerably when not operating at capacity and, therefore, would tend to contract more cattle to ensure sufficient supplies of cattle.

As indicated by Ward, et al. (1996), the size of the firm plays a significant role in determining the degree to which forward contracting is used. Also, large firm size is often attributed to the increased market power seen in the industry. However, increased firm size also increases the efficiency with which firms operate as economies of size are realized.

Ward and Sersland (1986) examined the packer costs for both cattle slaughtering and carcass fabrication. Packer surveys indicated that larger plants did have definite advantages in cost (i.e. lower average costs) over smaller firms. Also, findings indicated that those plants that were operated closer to capacity levels had lower average costs. These results indicated that economies of size and scale existed, therefore, leading to fewer and larger processing and kill plants.

Azzam and Schroeter (1995) looked at the tradeoffs between increasing efficiency through increasing plant size, therefore, capturing economies of scale, versus the increased market power associated with large firm size. A simple tradeoff model was employed. The first component of the tradeoff model was an inverse consumer demand function. The second was a inverse raw material supply function. The final was a inverse raw material input derived demand function, which was set as the inverse consumer demand curve net of marginal processing cost.

With increased plant size and efficiency, savings (i.e. reduced marginal costs) in costs could be expected. As a result, the raw material input demand function shifts upward. With the shift in the input demand function, changes in consumer and producer surplus and in social welfare would be expected.

Given the simple tradeoff model established, the authors set out to develop a model of oligopsony pricing. A price distortion function was established which was dependent on the market share weighted average of a firm's marginal costs, the Herfindahl index (measure of regional concentration), a common value of firm's conjectural elasticities (represents the belief of the firm toward the response of rivals to changes in its output), and the regional supply elasticity. Setting baseline values of these parameters, the authors then simulated impacts of altering these variables on the level of price distortion, quantity of input, and price of fed cattle. They were then also able to determine changes in social welfare and to determine the savings in costs from increased concentration required to have a net effect on social welfare of zero.

Results indicated that cost reductions of 2.4% were required for social welfare to remain unchanged when concentration increased by 50%. It was hypothesized that the actual cost savings from an increase in concentration (i.e. increase in the size of the plant) would be closer to 4%. This would imply that the gained efficiency in increasing plant size and increasing concentration were more than enough to offset possible impacts of increased market power.

Demand and Price Analysis

Analysis of the demand for wholesale or sub-primal products has been severely limited due to data limitations. While prices for sub-primal cuts are readily available and are reported daily, the quantity of sub-primal products sold is not reported. The only source of this quantity data is the packing firms themselves. Proprietary issues make obtaining this information nearly impossible. Further, experiences with packing firms have indicated that firms retain this data for only short periods of time.

While numerous studies have examined demand for beef in aggregate, very few have examined the demand for individual cuts. Those studies that do examine individual product demand have been at the retail rather then the wholesale market level.

Capps and Nayga (1991) utilized scanner data from retail chain grocery stores to estimate demand for several retail products. The authors also examined effects of advertising on the demand for each of these meat products. Pounds of each product purchased per 1000 customers was set as a function of prices, prices of other meats (poultry, pork, and fish), a weighted average of prices for convenience beef products (i.e. frozen dinners, etc.), advertising variables and seasonal dummy variables.

Results indicated that the demand for these retail cuts were elastic. Own price elasticities for the retail products of brisket, chuck, ground beef, loin, rib and round were -5.738, -2.467, -1.174, -1.966, -2.176, -3.376, respectively. These were found to be in accordance with other similar retail demand studies.

In an attempt to overcome the data problems with conducting research on wholesale demand for beef products, Capps, et al. (1994) estimated quantity values for 12 primal and sub-primal cuts. Per capita beef consumption from fed steer and heifers were proportioned as percentages of the carcass to obtain individual wholesale primal cuts.

Inverse demand equations were estimated for each of the twelve cuts with prices depending on the quantity of the same cut, quantities of other cuts, quantities of pork and chicken, lagged prices, and an index of marketing costs. All own price flexibilities were found to be significant and negative. Short run flexibility values ranged from -.2430 to -.5603. Long run flexibilities were found to be considerably larger with values ranging from -.6925 to -2.1844.

With changes in the demand for primal or sub-primal beef products, it would be expected that the demand for live cattle would also change. Basic price analysis states that the demand for an input will be dependent on the price of the finished good or output. This would suggest that there should be some observable link between wholesale cut prices and fed cattle.

Owen, et al. (1991) examined the link between certain fabricated (sub-primal) cuts and imputed carcass values (ICV) with fed cattle prices. A trend that had developed in the industry was to move away from reporting carcass quotes to reporting an computed carcass value or "boxed beef cut-out" price. Because boxed beef cuts are priced through negotiation, rather than a formula, the ICV price was thought to be a more sensitive and accurate gauge of supply and demand conditions.

By equating supply and demand equal in each of three markets (Fed Cattle, Carcass, and Boxed Beef), the authors determined reduced form inverse demand functions for each market. Results indicated the ICV appeared to reflect market conditions more quickly than any individual cut. However, three cuts were found to be dominant cuts (Strip Loin, Bottom Round, and Top Round) in helping to predict either live cattle or carcass prices. Strip loins were found to be leading indicators of fed cattle prices. Results implied that strip loin prices appear to lead fed cattle prices by one day.

Beshear and Trapp (1996) examined seasonal price patterns for beef carcasses of various yield and quality grades. The authors recognized that fed cattle are increasingly being sold on carcass merit rather than an average price for a entire pen of cattle. Using a Boxed Beef Calculator (Dolezal, et al., 1994), the authors established carcass values for four yield grades of cattle and two quality grades. They then examined seasonal patterns of these derived carcass values.

Results indicated, that as with fed cattle, carcass values also exhibited seasonal patterns. Also, the spread between yield grades of carcasses was found to have a slight seasonal pattern. Spreads between various yield grades of carcasses ranged from $4.34 per cwt. to $10.04 per cwt. The spread between yield grade 2 and 3 carcasses seemed to be the most stable staying close to $5.00 per cwt. The spread between U.S. Choice and U.S. Select carcasses were also examined. Seasonal patterns were also indicated with the

U.S. Choice-Select spreads. An interesting discovery was that the derived spread was actually found to invert for short periods of time (i.e. U.S. Select worth more than U.S. Choice). However, it was not determined whether the seasonal patterns observed were a function of changing demand of beef or of changing supply of cattle.

While boxed beef prices have been found to be useful in predicting fed cattle prices, several other factors can influence prices. Cattle are usually sold in pen lots which contain 100 to 200 head. Each pen lot will consist of different types and sizes of cattle. If one pen type is comprised, on the whole, of better quality cattle, then that pen would be expected to be sold at a higher price.

Jones, et al. (1992) used an ICM (Input Characteristic Model) framework to determine the impact of pen characteristics on the transaction prices for fed cattle. The authors hypothesized that factors such as percentage of U.S. Choice cattle in a pen, live weight, etc. would impact the price paid by packers for the pen of cattle.

The differences between transaction prices for pens of cattle and the average price paid were regressed against several selected pen characteristics. Results indicated pen characteristics did influence fed cattle prices. Specifically, the percentage of U.S. Choice cattle in a pen was found to have a positive impact on price. Live weight of cattle also was found to positively impact prices. As the pens increased in weight, the price paid for the pen increased. Finally, the number of U.S. Select cattle times the U.S. Choice-Select spread for boxed carcass equivalent price was found to have a negative effect. Meat produced from U.S. Select cattle is a lower value product and, therefore, packers paid less for pens with a high percentage of U.S. Select cattle.

Simulation And Experiential Learning

Simulators have been utilized in applied research to answer various empirical questions. Often, simulators are used to determine the impact of changes in critical parameters to the performance of an entire industry or market. Also, simulators have been used to generate data that could not be obtained elsewhere.

Anderson (1974) describes several stages that should be followed in the development of a simulation model. The first two stages involve determining the goal of the simulation model (i.e. what should be accomplished or learned through its use) and then determining the relevant structure of the environment that is to be modeled. Identifying the system's structure involves determining all important features and components that should be incorporated into the model and to determine how they interact and function.

The third stage of the simulation process is synthesizing all information into a coherent and logical structure. This stage is broken into two sub-stages. The first is stochastic specification, which involves the explicit consideration of the probabilistic features of the system. The second sub-stage is model implementation. This involves actually programming the model into a usable computer program.

The fourth stage involves determining if the model is realistic and meaningful. Verification of the model deals with making sure that the model does what is was designed to do. Validation deals with insuring that the model is realistic. This will usually involve seeking expert advice to see if the results generated by the model are in fact what would be recognized in the real world.

The final stage is termed model analysis. This stage can be separated into three sub-stages. The first sub-stage is sensitivity analysis. This involves changing parameters in the model to see how the model reacts. The second sub-stage is that of model experimentation which involves using the model to answer questions. The final sub-stage is that of interpretation which involves taking the results from the simulator and determining their meaning and implications.

In recent years, simulators have been found to be useful as training and teaching tools. Simulators can be used to give participants practical experience in applying economic theory to realistic situations. Koontz, et al. (1995) developed a market simulator that allows participants to react in a realistic industry. The Fed Cattle Market Simulator (FCMS) is used to realistically represent the transactions between feedlots and beef packers. The FCMS has been found to be extremely effective as a training tool for packing firms and other firms within the beef industry.

On-the-job training has been found to be a very effective cross training tool (Koontz, et al., 1995). As a result, the experiential nature of the FCMS makes it an appropriate cross training tool. The FCMS allows participants to gain a better understanding of the market conditions that cause changing cattle and boxed beef prices. Also, the FCMS allows for improvement of communication skills, which is critical in coordinating production in large size firms.

The FCMS creates a closed market for fed cattle. It models the structure of the fed cattle market and records market activity. Participants role play as feedlot managers and meatpacking plant managers. Participants provide the economic conduct or behavior of the market. Cross training is enhanced by rotating participants into each of two roles, both as a cattle feedlot manager and as a meatpacking plant manager.

The use of the FCMS in both the private industry and in academia and extension programs has resulted in beneficial results. Participants were found to increase their knowledge of the industry and of their own company. Also, participants gained a better understanding of market psychology and dynamics of price discovery as well as supply and demand effects on price determination. Finally, participants found that the FCMS promoted teamwork in decision making.

Babb (1984) introduced four agribusiness simulators that were useful in training students and teaching economic and business concepts. Babb stated that simulators represent an extension of case study methods of teaching. Students normally make a sequence of decisions where changing market conditions, competitors' behavior, and other factors must be considered. There is feedback from each set of information from earlier decisions. In contrast, case studies are usually static.

The four simulators discussed by Babb (1984) were the supermarket chain simulator, the farm supply center simulator, and the grain elevator simulator (cooperative and proprietary firm versions). Each simulator was developed to model the environment in which firms (teams of students) compete for business. Each simulator requires team members to make decisions regarding normal business transactions. Feedback for each decision is given to students to allow them to see how their decisions impacted overall firm performance.

Trapp (1989) described the use of a commodity market simulation game. The Market Risk Game is designed to give its participants realistic practice in making decisions in a risky market environment. It focuses on the use of hedging and commodity put options as risk reducing marketing alternatives for livestock and grain producers.

The Market Risk Game allows for participants to engage in activity in either the beef cattle or wheat markets. In the beef cattle market, players are assumed to own a feedlot and are given the opportunity to purchase cattle and then hedge those cattle on the futures market. In the wheat market, players are assumed to own 5000 bushels of wheat in storage. As with the cattle simulator, players in the wheat simulator are allowed to sell cash wheat or to hedge wheat in the futures market to reduce price risk.

The Market Risk Game was found to provide realistic experience in analyzing market situations, taking action, and then evaluating the consequence of actions as they evolve. Misconceptions about the market situation of the mechanisms of hedging and using put options lead to unexpected game results. Through repeat play of the game, these misconceptions can be resolved. The strength of the Market Risk Game lies in the fact that through repeated playing of the game, the stochastic properties present in the game give the player a perspective of the amount of risk present in the cash market versus the risk remaining after a hedge or put option has been used. An intuitive understanding also evolves with regard to the differences in the opportunities and risks remaining when a hedge versus a put option is used to reduce market risk.

Other forms of experiential learning have also been found to be highly effective. The common thread in these methods is that each give participants practical experience in applying strategies. Tierney (1989) described student commodity pools in which students contribute their own funds as an alternative to traditional teaching methods for commodity markets. The students were allowed to research and develop commodity trade recommendations, present the recommendations and execute approved trades. The appeal of this is that students gain a more "practical" sense of how the market operates, the information needed and available in making sound decisions, and the risk involved.

Tierney (1989) stated that there are sound philosophical and psychological reasons for this type of learning activity. Trading games enhance the relevance of the accompanying theory and analytical principles taught in marketing courses. Further, commodity trading games provide students with an opportunity to consider how individual values and personality characteristics may impinge on the decision making process.

Another interesting observation was with producer groups. It was seen that most producers would not implement marketing strategies learned through traditional extension programs due to their fear of making mistakes and their intimidation by the apparent complexity of many of these techniques. It was found that without an opportunity to practice these techniques, most farmers would never consider using them in their own farm operations.

CHAPTER II

THEORETICAL AND CONCEPTUAL CONSIDERATIONS

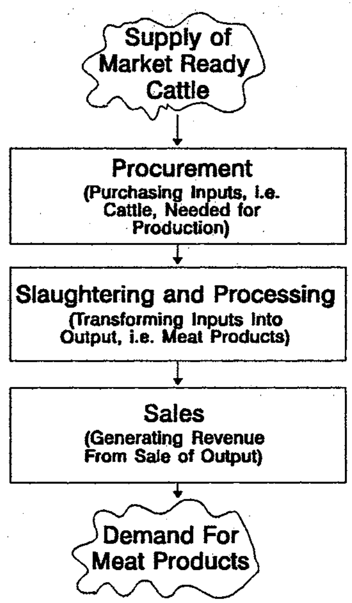
The structure of the beef packing industry is one that can best be described as an oligopsony market. Few firms make up the largest portion of the industry and, therefore, may have a great deal of power in determining input prices. This chapter is organized such that the overall conceptual framework of the beef packing industry and, therefore, the structure of the MPPM simulator, will be discussed. As the discussion progresses, theoretical considerations regarding specific model components will be discussed.

The typical beef packing firm is structured in such a way that it can be easily categorized into three distinct phases (i.e. Cattle Procurement, Slaughtering and Processing, and Sales). Each phase is highly dependent on the actions of the other. The procurement phase purchases inputs (i.e. live cattle) needed in the slaughtering and processing phase. Sub-primal or wholesale meat cuts produced in the slaughtering and processing phase are needed in the sales phase to meet the demand of customers. Often times the ability of one phase to accomplish set goals may be severely limited by the actions of another phase.

General Structure

One of the concerns in developing simulators is that the design will contain too much complexity, thus severely limiting the applicability of the simulator as a research or teaching tool. The general conceptual structure of the MPPM simulator is given in Figure 2.1. In order to simplify the structure of the beef packing firms and the industry in which they operate, firms are assumed to purchase exogenous and fixed supplies of cattle from cattle suppliers. Packers do, however, have the ability to determine the amount and the type of cattle they purchase.

Figure 2.1 Conceptual Design of the MPPM Simulator.



On the other end of the spectrum, packers supply meat to an exogenous buyer who purchases meat based on an exogenous demand model.

The amount of each product the buyer purchases depends on prices and quantities offered by packers. The buyer is assumed to demand a certain level of each meat product at given base prices[4]. The buyer will deviate from purchasing these base quantities of meat only when prices offered by the packers are above or below the base prices.

The endogenous segments of the MPPM simulator are the three phases of the packer. Operation of each phase is the responsibility of game participants. While theory gives insight into how these phases should be operated, no constraints are imposed on how the participants actually perform. It is assumed that by allowing participants to freely make decisions, either profitable or non-profitable, they will be able to gain a sense of those strategies that are appropriate (or not appropriate) given changing market conditions.

Procurement

Packers use live cattle as the chief input in their production process. Packers usually give their cattle buyers fairly broad instructions when purchasing cattle. These instructions are usually geared toward the price that the buyers should pay for cattle. The type of cattle that are available to be purchased is usually not within the control of the packer. Packers basically buy those cattle that are currently market ready.

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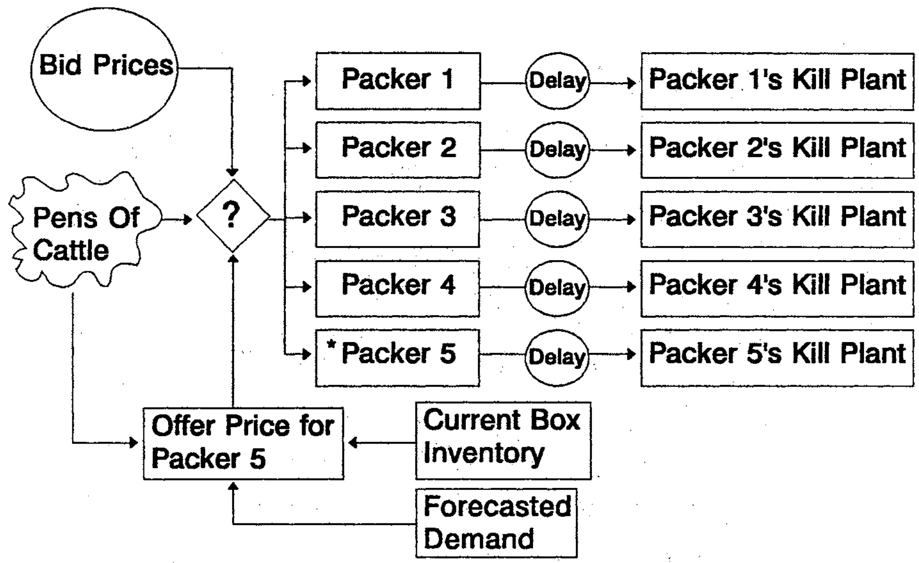
[4] The demand for meat products is based on base quantities and prices. These base values represent the amount of meat the buyer would purchase on average each week.

Participants in the procurement phase have a fixed supply of cattle each week from which they can make bids to purchase. The quantity and type of cattle offered are exogenous to the decision process of the packers and, rather, their decision is simply a decision about the number of pens to purchase and the price for which they will buy the cattle.

Each simulated period in the procurement phase (Figure 2.2) of the MPPM simulator is a half-week in the real world. Most packers attempt to get the cattle they need purchased early in the week, and then buy cattle later in the week that are viewed as good bargains. By separating a week into two periods, the MPPM simulator allows packers to make bids for cattle in the first period and then to adjust those bids in the last half of the week depending on how successful they were in purchasing cattle in the initial period.

The success of a packer in acquiring the amounts of fed cattle needed depends on its price and quantity bids as well as the bids of its rivals. Cattle are sold to the packer that bids the highest price for a particular pen of cattle and then the remaining pens are sold to other packers according to the price each bid. However, to prevent packers from buying cattle at extremely low prices, a floor price for each pen of cattle is set. This floor price represents the price that would result in enough packer profit to provide an incentive for a new, smaller packer to

Figure 2.2 Conceptual Design of the Procurement Phase.



enter the market. The floor price is simulated through a fifth packer[5]. Therefore, the other participating packers must bid higher than packer five in order to purchase cattle.

Once cattle are purchased, packers can decide to delay some or all of the cattle from entering their killing and processing plants. In an attempt to smooth out the stream of meat production, packers can determine the amounts of cattle that are processed in any half-week period. Also, by delaying cattle, packers can come closer to efficiently utilizing their kill and slaughter plants. If packers are

[5] Packer 5 is completely computer driven and is incorporated in the MPPM simulator as a precaution to prevent collusion among participant packers.

able to purchase cattle cheaply, it may be beneficial to purchase more cattle then their optimal[6] number and then delay some of these cattle from moving into the slaughtering and processing phase.

Slaughtering and Processing

Cattle purchased by packers in the procurement phase are used as inputs in the production of several sub-primal or wholesale meat products. Packers take the raw product of live cattle and, with other inputs such as labor, equipment, etc., add value to the animal by processing it into several products whose value, as a whole, is greater than that of the live animal.

The MPPM simulator's slaughter and processing phase (Figure 2.3) is also designed as a two-period process for a given simulated week. Packers' decisions revolve around how to process each of the animals that are supplied by the procurement phase. Several fabrication options are available for packers to process cattle. For each primal[7], any where from 2 to 4 different fabrication options are available. Each fabrication option may result in producing

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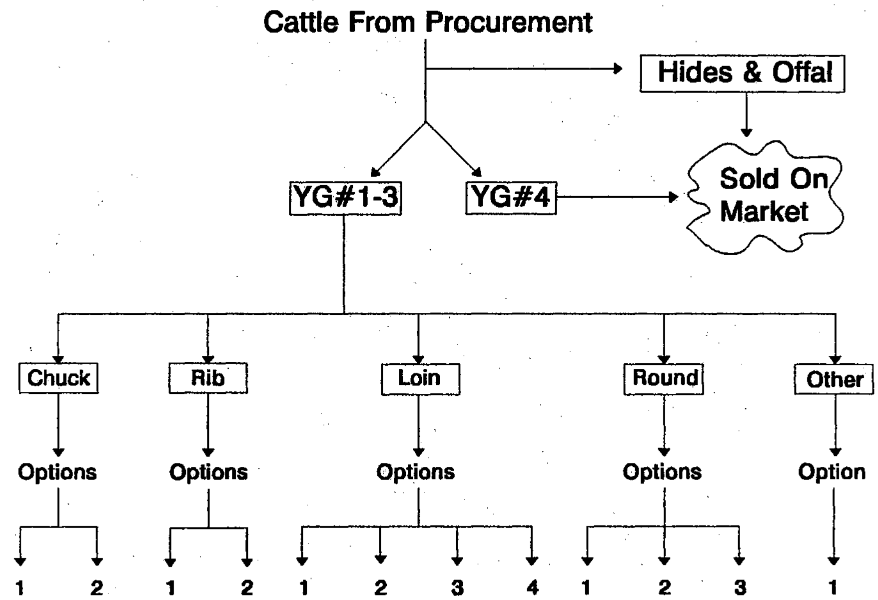
[6] Optimal numbers refer to packers being able to produce at the lowest point of their U-shaped cost curves. The cost structure of the packers will be discussed in more detail in later sections.

[7] The beef carcass can be separated into 5 major products or primals. The five primals considered in this study are Rib, Chuck, Loin, Round, and Other. The primal designated as Other is comprised of the brisket, plate, and flank.

Figure 2.3 Conceptual Design of the Slaughtering and Processing Phase.



different sub-primal products or different quantities of the same product.

The fabrication options are closely related to the amount of fat, trim, and bone produced. For each primal, one option can be viewed as a close trim option and the other can be viewed as a commodity trim option. The differentiation between each option is the amount of fat, trim, and bone produced. For the close trim option, meat products produced generally will have less external fat and many will be boneless. The commodity trim options, on the other hand, produce more bone-in products with a higher degree of external fat.

Utilizing different fabrication options will result in different operating costs for the packer. As the packer relies more heavily on those fabrication options that produce more fat and bone (i.e. more boneless cuts), costs of processing those cattle will rise. The more fat that has to be trimmed and the more cuts that are boneless, the longer it takes for workers to prepare the final product and, therefore, higher costs are incurred.

Additionally, per head processing costs will vary depending on the number of cattle processed. Packers are assumed to have U-shaped cost curves. There are, therefore, certain numbers of cattle processed each week that will minimize packer processing costs. Per head processing costs decrease as the number of cattle processed per half week period increases until the optimal number is reached. As packers continue to process cattle beyond that point, costs then begin to rise. The low cost number varies from packer to packer, therefore, resulting in an industry comprised of packers with different sizes and production capabilities.

Given the different fabrication options, packers decide on how to process each of three yield grades of cattle (yield grades 1 to 3). Packers decide among cutting styles to process each of the yield grades separately. Packers are given the opportunity to process the different yield grades under different fabrication options as it may be more profitable for a packer to process one yield grade in a different manner then the other yield grades. For example, it may be more profitable to process yield grade 1 cattle using those options that remove more fat and bone from the sub-primal cuts because yield grade 1 cattle are characterized with having less external fat then the other yield grades.

Yield grade 4 cattle are not processed by packers in the MPPM simulator[8]. Often, yield grade 4 cattle do not result in "market accepted" sizes of the sub-primal cuts. Generally, there are specifications of cuts in terms of size and weight that are market acceptable.

Another consideration in the processing of yield grade 4 cattle is the cost effectiveness of processing these carcasses. Often, it is inefficient for plants to process yield grade 4 carcasses. Yield grade 4 cattle often possess a high degree of external fat that must be trimmed, therefore, increasing total processing time and processing costs. As a result, packers are assumed to sell yield grade 4 carcasses on a whole-carcass basis and not to process them any further than slaughtering.

By-products are also produced in this phase of the MPPM simulator. By-products are lumped into two categories, hides and offal. All by-products and specialty products are lumped into the offal category. By-products consist of

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[8] The MPPM Simulator includes four different yield grade categories: Yield Grade 1, Yield Grade 2, Yield Grade 3, and Yield Grade 4. Yield Grade 5 cattle generally make up only a small portion of the total number of cattle processed and, therefore, were included in the Yield Grade 4 category.

intestines, stomach, etc. while the variety products consisting of sweet bread, liver, tongue, etc.

In order for packers to make informed decisions on which fabrication option to utilize, they must have knowledge of the conversion of the live cattle to sub-primal or wholesale cuts. The conversion of live cattle to wholesale cuts relies on several physical relationships. The first of which is the conversion of live cattle to carcasses. The conversion can be depicted in the following:

$$DP_i = f_i(LW_i, YG_i) \tag{2.1}$$

where: DP_i is the dressing percentage of the *i*th animal, (the dressing percentage is the ratio of carcass to live weight),

LW_i is the live weight of the *i*th animal,

YG_i is the yield grade of the *i*th animal.

The dressing percentage depends on both the weight of the animal and its yield grade. If live weight is held constant, dressing percentages will increase with an increase in yield grade. Likewise, with an increase in live weight, holding yield grade constant, the dressing percentage will be expected to increase. The dressing percentage can, therefore, be used to determine the carcass weight of an animal of any live weight and yield grade[9].

Once carcass weight is known, the next conversion is from the carcass to the primals. Each primal is assumed to be a fixed proportion of the carcass weight. Therefore, the weight of each primal can be expressed as:

$$PR_i = \alpha_i * CW_i \tag{2.2}$$

where: PR_i is the weight of the *i*th primal,

α_i is the conversion coefficient for the *i*th primal (α_i is assumed to be constant and between 0 and 1.),

CW is the weight of the *i*th carcass.

The only constraint on the conversion coefficients (α_i's) is that they must sum to 1 (i.e. $\Sigma\ \alpha_i = 1$). As a result, a carcass can be divided into five primals with each being a fixed proportion of that carcass. The weight of each primal is, therefore, only dependent on the weight of the carcass and not on the yield grade or quality grade of the animal producing the carcass.

The final conversion of importance is primal to sub-primal or wholesale cut. The weight or amount of each cut produced is determined by a cut-out percentage for each cut. The cut-out percentage for each cut in each primal depends

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[9] Carcass weight is determined by multiplying the dressing percentage of the animal by its live weight. Mathematically, the carcass weight of an animal (CW_i) is simply: $CW_i = DP_i * LW_i$.

on the yield grade of the animal and the processing option chosen. Therefore, the cut-out percentage of each cut can be expressed as:

$$COP_{ijlk} = f_i(POC_{kjl}, YG_j) \tag{2.3}$$

where: COP_{ijlk} is the cut out percentage of the *i*th cut of the *j*th primal of the *l*th yield grade using the *k*th fabrication option,

POC_{kjl} is the *k*th fabrication option chosen in fabricating the *j*th primal of the *l*th yield grade,

YG_j is the yield grade of the *j*th primal.

Cut-out percentages are dependent on yield grade because primal weights increase from yield grade 1 cattle to yield grade 3. The most significant factor in increased primal weight is the increased levels of external fat. Usually, yield grade 3 cattle will possess a higher degree of external fat than yield grade 1 cattle. As a result, the carcasses of yield grade 3 cattle will be heavier. Remembering that the primal weight is a fixed proportion of the carcass weight, primal weights also increase from yield grade 1 versus yield grade 3 cattle. Because most of the increased weight is attributable to higher levels of fat, the cut-out percentage for a particular meat product falls when comparing yield grade 1 versus yield grade 3 cattle. While the weight or size of the primal may not change in any measurable amount with yield grade changes, its contribution to total primal weight (i.e. cut-out percentage) falls.

Another factor in determining cut-out percentages is the fabrication option chosen by the packer. As mentioned earlier, different fabrication options will result in different products being produced or different quantities of the same product. In fact, depending on the cut and option chosen, there may exist a situation where the cut-out percentage under one option is a non-zero value while under another option the cut out percentage for the same product is zero[10].

The cut-out percentages are then used to determine the weight or amount of each cut produced. The amount of each cut produced can be expressed in the following mathematical expression of known parameters:

$$CUT_i = \sum_{j=1}^{n} \sum_{l=1}^{m} \sum_{k=1}^{p} PW_{jl} * POC_{jlk} * COP_{ijlk} \qquad \textbf{(2.4)}$$

where: CUT_i is the quantity of the *i*th cut produced,

PW_{jl} is the total weight of *j*th primal of the *l*th yield grade,

[10] Cut-out percentages are constrained to be positive (i.e. $COP_{ijlk} \geq 0$) and the sum of the cut-out percentages for a given yield grade, primal, and fabrication option must be less than 1 (i.e. $\Sigma_i \ COP_{ijlk} < 1$). The sum of cut-out percentages are constrained to be less than one to allow for the shrink and loss in weight in the conversion from the carcass to the individual cuts. Shrinkage ranges from 0.2 to 0.82 percent of the total primal weight.

$PPOC_{jk}$ is the percentage of the total weight of the *j*th primal to be processed using the *k*th fabrication option,

COP_{ijlk} is the cut out percentage of the *i*th cut for the *j*th primal of the *l*th yield grade using the *k*th fabrication option.

Packers determine how many cattle from each yield grade will be processed under a specific fabrication option. This essentially gives the portion of total primal weight that will be processed under each option. Multiplying total primal weight (PW_{jl}) by the percentage chosen to be processed under a given option ($PPOC_{jk}$) results in total primal weight for a given yield grade that can be processed under a specific fabrication option. The cut-out percentage is a function of the fabrication option chosen, therefore, there exists a specific cut-out percentage for the chosen fabrication option. Summing the amount of each cut produced over all yield grades of cattle results in the total amount produced of a given meat product (i.e. CUT_i). Each cut will be a different quality grade (either U.S. Choice or U.S. Select). The amount of each cut produced, therefore, is separated into both U.S. Choice and U.S. Select quality grades.

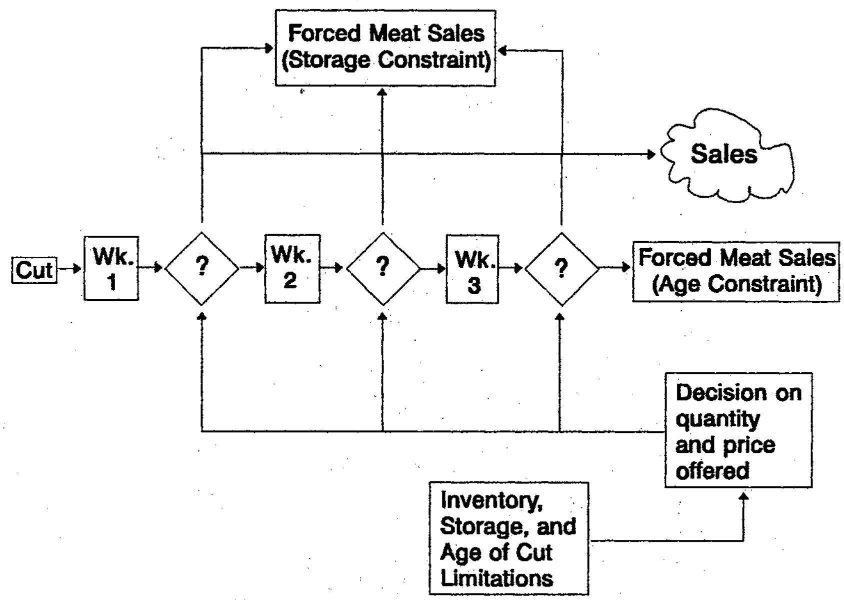
The number of fabrication options for a particular primal vary depending on the primal. For example, the number of fabrication options available in processing the rib primal will differ from the number available in processing the loin primal. There are, for each primal, a specific number of sub-primal cuts that can be produced. The number of sub-primal cuts produced from each primal varies among the primals and, therefore, the number of fabrication options required to produce all cuts will vary.

The number of fabrication options available to game participants were simplified in the MPPM simulator relative to actual packing plant conditions. For each primal, there are certain cuts that help determine and drive the prices for other cuts within the primal. Fabrication options were, therefore, chosen so as to, at least, include those primary cuts. This allowed simplification of the processing options as well as resulted in different numbers of processing options for each primal.

Sales

Meat products, hides, and offal produced in the slaughtering and processing phase are the output that packers sell in order to generate revenue (Figure 2.4). As mentioned earlier, the demand for these products is exogenous to packers. However, an individual packer's response to demand (i.e. how much meat the packer offers to sell) will result in reaction by other packers. The success of a packer in getting product sold is, therefore, highly dependent on the actions of its rivals. Packers offer a price to the buyer for a given quantity of meat product it wishes to sell. The price offered by a packer will be the

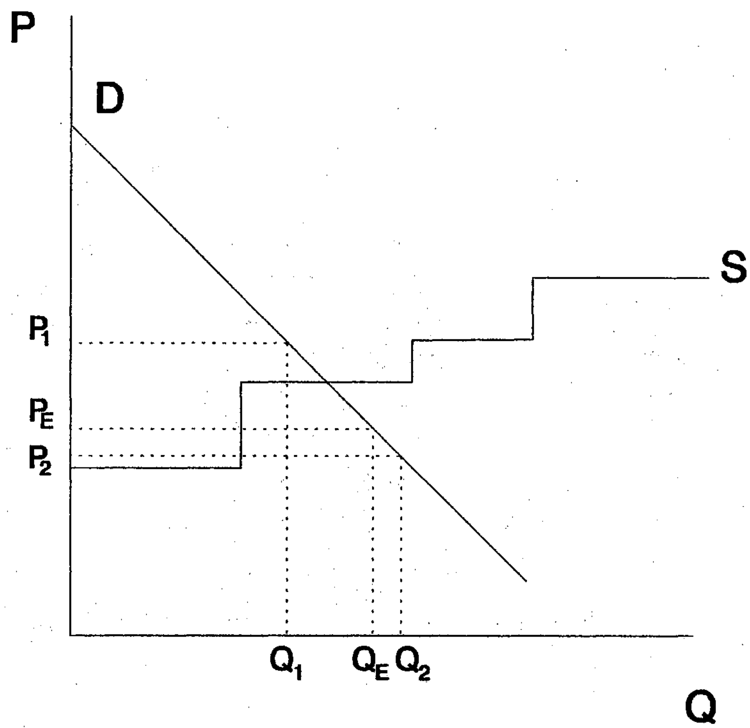
Figure 2.4 Conceptual Design of the Sales Phase.



transaction price for the meat, given that the buyer is willing to purchase meat at that price. Packers, therefore, are assured of their offer price, but are not assured of selling the quantity of meat that was offered. In fact, depending on rivals' offers, the packer may not be able to sell any of the meat offered.

Meat is first purchased from the packer which offered the lowest price. If, after the buyer purchases meat from the low price packer, the buyer has not been able to purchase meat in quantities sufficient to meet its demand, then sales are made to the packer with the next lowest offer price. This process continues until the buyer has purchased quantities of meat equal to its demand.

Figure 2.5 Theoretical Determination of Equilibrium Price and Quantity.



The quantity of each cut demanded by the buyer is found by equating supply and demand at the average of all prices offered by packers. Figure 2.5 gives a theoretical depiction of the determination of quantity demanded.

The industry supply of a given meat product is the summation of each packer's supply. Due to differences in cost structures, packers are expected to offer different quantities of the same cut at different prices. This results in a non-continuous, non-differentiable industry supply curve resembling a set of "stair steps" with each step being one packer's quantity offer (i.e. each segment of the industry supply curve is the individual supply of a given packer, beginning with the packer that offers the lowest price). Given that an industry demand curve exists, the equilibrium price and quantity of the meat product can be determined.

A weighted average price for the cut can be determined from the packers' offers of price and quantity and is assumed to be the prevailing market price. Letting (P_1) be the weighted average price determined, the buyer will purchase a quantity of Q_1. At that quantity, the buyer would be purchasing all of the first packer's quantity and a small portion of the second packer's quantity (i.e. approximately one-fourth of the quantity offered by the second packer). However, remaining packers are essentially left out of the market as their offer price eliminates them from making sales.

However, with the buyer purchasing only Q_1, the weighted average price of its purchases will be considerably below P_1 at a level very near the price of the lowest offer price of all four packers. At a level of Q_1, the buyer purchases only from the first two packers. Recall, that the transaction price for meat sales is the price offered by the packer. The price received by the first packer is, therefore, a price corresponding to the first segment of the supply curve. Likewise, the price received by the second packer is the price corresponding to the second segment of the supply curve. Obviously, if the weighted average price of these two prices was calculated, it would be smaller than P_1. Therefore, the buyer paid less than he/she was willing to pay to purchase quantity Q_1. As a result, the buyer would be willing to purchase more meat then Q_1 (i.e. at price P_2 he/she would be willing to buy quantity Q_2).

The question then is what price and quantity combination results in the buyer purchasing the quantity demanded and paying the price he/she was willing to pay for that quantity. Essentially what happens is that the buyer moves up and down the demand curve until reaching the price/quantity combination of (P_E,Q_E). At this combination, the buyer finds that the weighted average price of its purchases is P_E and he/she has no incentive to attempt to purchase more or less meat.

Packers make their sales price and quantity offers with two constraints. The first is a storage constraint. Packers are assumed to have a certain quantity of meat they are able to hold in inventory. This quantity of meat is usually expressed in terms of number of days of normal kill. Typically, packers have inventory capacities equal to the amount of meat that would result from killing and processing two days worth of cattle under average or "normal" conditions.

The normal kill of each packer can be thought of as being the packer's market share of the industry's normal kill. The MPPM simulator creates a closed market for fed cattle and boxed beef. As a result, no other participants are allowed in the market except four participant packers and a computer driven packer 5. Therefore, the normal kill for the industry is the sum of each packer's kill.

The normal kill of the industry is assumed to be 40 pens of cattle. The cattle that comprise these 40 pens are assumed to be from the middle of the weight/yield grade range of cattle offered in the MPPM simulator.

For any given packer, there exists a number of cattle processed that will result in the packer being on the low point of its average cost curve. Assuming that the packer will operate in such a manner as to be on that low cost point, the packer's normal kill can be expressed as:

$$CPCTY_{ij} = IND_i * (NP_j / NPI) \quad \textbf{(2.5)}$$

where: $CPCTY_{ij}$ is the capacity of the *i*th meat cut for the *j*th packer,

IND_i is the industry capacity of the *i*th meat cut,

NP_j is the number of pens of cattle processed in a normal week by the *j*th packer (NP_j is set at the low cost level for each packer),

NPI is the number of pens of cattle processed in a normal week by the entire industry.

Equation 2.5 gives the capacity constraint of an individual cut for a particular packer. However, it is assumed that the packer will consider total inventory rather than the inventory of individual cuts. As a result, the total capacity of a packer is found by simply summing the capacity constraint of each meat cut for the packer[11]. The packer, therefore, must sell meat once its total inventory exceeds its total capacity. When faced with having to sell excess meat, the packer is assumed to sell any meat products that are over their individual capacity level, starting with the meat that has been in inventory the longest.

The second constraint is an age limitation on meat products. In the industry, meat products over three weeks of age must usually be sold at discount prices. The time span from when buyers purchase meat from the packer until it reaches the final consumer may range from a week to a month. As a result, to assure that the wholesale buyer of these meat products will not have discolored meat by the time it reaches their customers, buyers usually demand meat products no more than three weeks old.

If a packer exceeds the limits set by one or both of the inventory constraints, excess meat is sold for that packer at discounted prices. Unlike the meat sales process described above, the packer has no control over the price it receives in the sale of excess meat. The packer must accept the price as given. Also, in some situations, the packer

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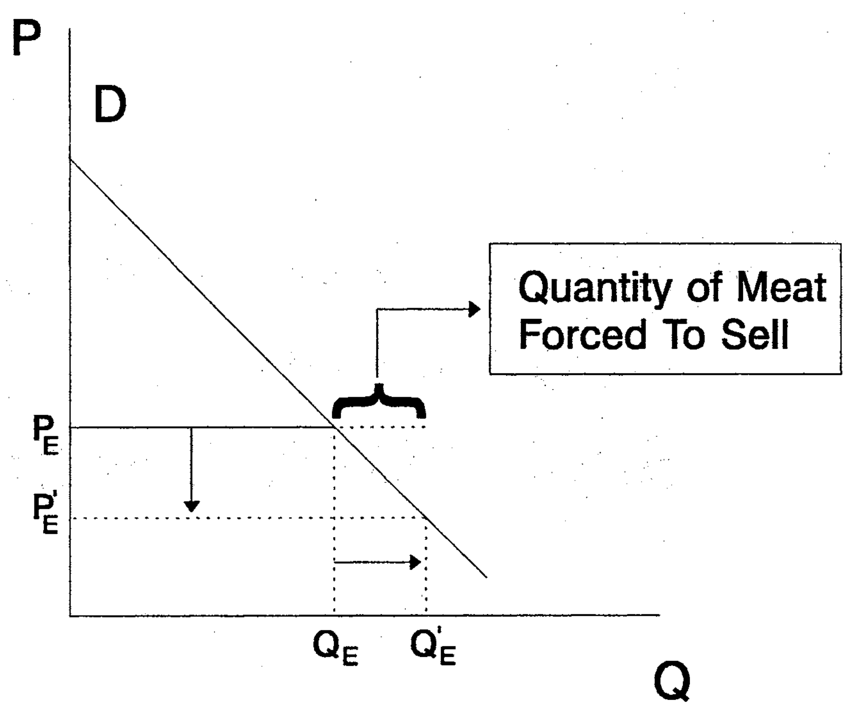
[11] The total capacity of a packer is found by simply summing the individual cut capacities. Mathematically, this is simply: $\sum_{i=1} CPCTY_{ij}$, $i = 1,...,50$.

may not receive anything for this excess meat. In essence, it is assumed that the packer must discard this quantity of meat.

Figure 2.6 gives a theoretical depiction of the determination of the transaction price for excess meat. Assume that the point/quantity combination (P_E,Q_E) is the equilibrium price and quantity of a particular cut given the packers' offers of price and quantity. Also assume that after this quantity of meat (Q_E) has been purchased from the packers that there is still meat in the industry which must be sold in order to adhere to either one or both inventory

Figure 2.6 Theoretical Determination of "Forced" Meat Transaction Price.



constraints. The extra meat that must be sold is over and above what the buyer is willing to purchase at a price of P_E. As a result, it must be sold at a price that is considerably lower then the original transaction price (P_E). The price which will cause the buyer to purchase the original quantity (Q_E) plus the excess meat ($Q'_E - Q_E$) is given by P'_E. If packers would have lowered their offer prices to this level in their sales phase, the buyer would have purchased enough meat so that neither constraint was violated.

Remember, however, that this price is an industry weighted average price. Therefore, for the industry weighted average price to fall to P'_E from the original average price of P_E, the price paid for the excess meat must be considerably lower than P'_E. The price paid for excess meat must be sufficiently low so that the resulting weighted average price from the amount of excess meat and the price and quantity combination of P_E and Q_E is P'_E. While, mathematically, the prices paid for excess meat could be negative, they are constrained to be positive in the MPPM simulator.

Revenue is also generated through the sale of yield grade 4 carcasses and by-products. The price received by packers for yield grade 4 cattle is influenced by the industry average price for the individual meat cuts. Carcass values are generated from the prices received for these cuts by summing the value of each cut produced from a single carcass. These carcass values can then be used to determine the value of the yield grade 4 carcasses.

The carcass value generated by the prices received for the individual cuts are for carcasses generally viewed as being more valuable then the yield grade 4 carcasses[12]. As a result, the price or value at which yield grade 4 carcasses are sold must be a discounted value of the carcass value generated from the prices for individual cuts. This discount factor can be expected to vary depending on the total quantity of yield grade 4 carcasses on the market. As the number of yield grade 4 carcasses increases, the discount factor can be expected to increase, therefore, resulting in a lower price received for those carcasses. Likewise, if the number of yield grade 4 carcasses is low, the discount factor will fall, therefore, making yield grade 4 carcasses more valuable.

The price paid for by-products are assumed to be constant. All packers receive the same price for by-products and that price remains constant from week to week. This assumption is employed because packers do not have control over the sale of by-products in the MPPM simulator. Since packers cannot decide on how much of the by-products

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[12] Since the individual cuts are produced from yield grade 1 to 3 carcasses, the resulting carcass values found will be higher then those expected for yield grade 4 carcasses.

to sell and the price they will receive for them, setting the price equal for all packers does not give any competitive advantage to any packer.

Demand For Meat Products

Demand for individual meat products is an essential ingredient in determining how much meat is sold in each period. Demand theory gives insight into how the buyer should react to changes in price and quantity. The demand for each product is derived from the buyer's (i.e. consumer) utility maximization problem. The buyer attempts to maximize utility given the limitations imposed by a budget constraint. The utility maximization problem can be solved by setting up a constrained Lagrangian:

$$\underset{(x_1,\ldots,x_n,\lambda)}{Max} \quad \mathcal{L} = U - \lambda\left(\sum_{i=1}^{n} p_i x_i - Y\right) \tag{2.6}$$

where: U is the utility function, $U=f(x_1,\ldots,x_n)$,

p_i is the price of the *i*th good,

x_i is the quantity of the *i*th good,

Y is income,

λ is the Lagrangian Multiplier.

Solving this problem requires taking the first order conditions and setting them equal to zero.

From the first order conditions, the Marshallian demands for goods (i.e. $x_1,\ldots,x_n$) can be determined. If the first order conditions are solved for the respective goods, the following Marshallian demands can be found:

$$x_i = g_i(\boldsymbol{P}, Y) \tag{2.7}$$

where: x_i is the quantity demanded of the ith good,
$\mathbf{P}$ is a price vector of all related goods,
Y is income.

The demand for a particular meat product will depend on the price of that cut as well as the price of all other cuts and income[13].

Demand functions are assumed to adhere to certain properties. Economic theory outlines several general restrictions on demand. These restrictions are based on the rational behavior of consumers in purchasing goods.

Four general restrictions are given by theory. These restrictions can be written in the form of elasticities and budget shares. The four restrictions are:

$$\sum_{i=1}^{n} w_i \eta_i = 1 \tag{2.8}$$

$$e_{ij} = \frac{w_j}{w_i} e_{ji} - w_j(\eta_i - \eta_j) \tag{2.9}$$

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[13] This is assuming that the meat products are weakly separable from other meat products, as well as other food and non-food goods.

$$\sum_{j=1}^{m} e_{ij} = -\eta_i \qquad (2.10)$$

$$e_{ii}^{*} < 0 \qquad (2.11)$$

Equation 2.8 is the "adding-up" or Engel Aggregation condition which simply states that the sum of the budget shares (w_i) times the income elasticities (η_i) must equal one. The adding-up condition originates from the contention that consumers' purchases of goods cannot exceed their budget or income level.

Equation 2.9 is the symmetry condition. The symmetry condition states that the cross price elasticity[14] of one good (e_{ij}) must equal the ratio of the two goods' budget shares (w_j/w_i) times the cross price elasticity of the second good (e_{ji}) minus the second good's budget share (w_j) times the difference in the two goods' income elasticities ($\eta_i - \eta_j$). The symmetry condition originates from Young's Theorem contention that, given continuous derivatives exist, cross price derivatives of the Hicksian, or compensated, demands are identical and therefore symmetric.

Equation 2.10 is the homogeneity condition. The condition states that the sum of a good's cross price elasticities (e_{ij}) must equal the negative of its income

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[14] The cross price elasticity is defined as the percent change in the quantity demanded of one good when the price of another, related good changes by one percent.

elasticity (η_i). The homogeneity condition originates from the contention of no money illusion. Technically, this implies that the demand functions in question are all homogenous of degree zero. In terms of consumer behavior, the homogeneity condition states that if both prices and income are increased by the same proportion, there will be no change in demand. While consumers may have more money to spend on goods (i.e. an increase in income), the goods themselves have also gotten more expensive and, therefore, consumption is unchanged.

The final restriction is the negativity condition. The restriction states that the own price Hicksian elasticity of a good must be negative. The only implication of this restriction is that if the price of a good increases, the quantity demanded of that good should decrease.

The Role of Packer Five

A fifth packer incorporated into the MPPM simulator serves two major roles. The first role of the packer is that of "watch-dog" for the industry. Packer Five helps to prevent other packers from colluding in setting fed cattle prices. If given the opportunity, other packers may make agreements to purchase fed cattle at prices significantly below realistic levels. By setting Packer Five's bid price as the lowest acceptable price, the other packers must pay realistic prices in order to purchase cattle.

Also, the inclusion of Packer Five represents potential entry into the industry by a new firm. If packers attempt to set fed cattle and/or boxed beef prices such that exorbitant profits can be obtained, Packer Five will become more active in both markets. Economic theory indicates that industries in which existing firms make considerable profits will be attractive to new firms and, therefore, entry into the industry by new firms can be expected.

The other role played by Packer Five is as a buyer for yield grade 4 carcasses. Even though other packers sell yield grade 4 carcasses on a whole carcass basis, the meat from those carcasses can be expected to impact the demand for individual cuts. Packer Five, therefore, purchases those carcasses from the other packers, processes the carcasses, and sells the meat products to the same buyer as the other packers.

The challenge in developing Packer Five is designing it to have enough knowledge that its decisions are rational and result in profits for the packer. The actions of one packer cannot be thought to impact only that particular packer. In contrast, in an oligopsonistic market, the packer's decisions must be made realizing that its decisions impact the decisions of its competitors.

In order to determine the price that Packer Five will pay for live cattle, the impact of the other packers is considered. Packer Five must essentially forecast the revenue it can generate from the cattle it is purchasing. This requires Packer Five to forecast the demand for meat products that will be produced from the cattle it buys.

The forecast is made difficult because Packer Five must determine how other packers will act in selling meat. If meat from Packer Five was the only meat in the industry, then the forecast would be fairly straight forward. However, when Packer Five attempts to sell meat, revenue generated will be affected by how other packers priced their products and how much meat they attempted to sell. If Packer Five is able to forecast the revenue that can be generated from cattle to be purchased, the price that it can pay for cattle can be calculated as that price which causes Packer Five to break even.

The only question to answer with regard to Packer Five purchasing cattle is the price to be paid. While determining the quantity of cattle to purchase is crucial for the other packers, Packer Five is assumed to be willing to purchase all cattle available. This assumption was made to simplify Packer Five's decision process. However, Packer Five's decision on the price to pay for cattle recognizes that the bid is for all cattle available.

CHAPTER III

THE MPPM SIMULATOR

Overview

The MPPM simulator is designed to realistically represent the beef packing industry. The operations of four meat packing firms are simulated from cattle procurement to the sale of meat products. The firms within the simulated industry are operated by game participants acting as firm managers, who make decisions that determine the operations of the packing firm. In doing so, participants are generally given complete freedom in making decisions. Therefore, simulated industry conduct is established by participants within each packing firm.

The packing industry is designed as a closed system with five packers. Four of the packers are operated by game participants. The fifth packer is computer driven and reacts to decisions made by other packers in making its decisions. Participants are grouped into four teams (i.e. one team per packer) with each team having between three and 12 members. Members within each team are grouped into one of three production phases (i.e. Cattle Procurement, Slaughtering and Processing, and Sales), therefore, resulting anywhere from one to four members operating each phase.

The three production phases possess a high degree of interdependence. Collectively, the phases form a three-stage set of sequenced events required to transform live cattle into fifty wholesale meat products. Because the output of one phase becomes the input for the next phase, the decisions made in one production phase will, in part, determine the possible strategies in other phases. Each team is allowed, and encouraged, to communicate among themselves to discuss strategies across phases that will benefit the entire firm. Teams are not, however, told how to arrange members in each phase (i.e. who will operate which phase) and are not told how to set strategies for each phase. Part of the learning experience, it is assumed, is for participants to determine who is better suited for each phase and to communicate with each other in formulating strategies.

The time dimension of the MPPM simulator is centered around a week in the real world. Each week is divided into sub-periods or half-weeks. The completion of each half-week constitutes one round of the simulator[1]. Management decisions are made during each half-week round. To ensure that the simulator is operated in a timely fashion, participants are given an allotted time in which to make these decisions.

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[1] Two rounds constitute a week in the real world. Each round is assumed, therefore, to be a half-week. The two half-week periods are differentiated into a "Mid Week" and an "End Week". The "Mid Week" round is assumed to take the packer from the beginning of the week until the middle of the week. The "End Week" round is assumed to finish the week's transactions.

The decision period of each half-week or round of the simulator is timed. A game manager[2] will decide on the amount of time that should be allotted to participants. Generally, the allotted time is initially set at 8 to 10 minutes. After participants become more familiar with input forms and the decisions to be made, the allotted time can be reduced to 4 to 6 minutes per round.

In making decisions, participants are required to complete input forms (see Appendix C) during each half-week period or round. These input forms allow the participants to relay their decisions to the game manager who then inputs this information into the simulator. Information on each input form is given to help facilitate participant decisions. The amount and type of information required by the input forms differs from phase to phase.

Once decisions are entered, the simulator can then determine the performance of each packer as well as that of the industry for each of three phases. Firm and industry performance is reported to participants at the end of each round through computer printed output forms (see Appendix C). Participants are then given an opportunity to analyze their performance in relation to that of the industry.

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[2] The MPPM simulator is operated by a game manager. The game manager is generally involved with entering participant's decisions into the simulator, however, the manager does have the ability to make changes to key parameter's within each phase of the simulator. Those parameters over which the game manager has some control will be discussed later in the chapter.

To facilitate the learning experience of game participants, the simulator is generally operated, at the outset, phase by phase with all team members participating in the decisions for each phase and observing the output summarizing the results of these decisions. By doing so, participants can gain a better understanding of how each phase interacts with other phases. However, after the initial period of familiarization is completed, the three phases are operated simultaneously to better represent the time dynamics of the meat packing industry.

The ability to operate the three phases simultaneously is accomplished with the use of several delay systems. Prior to beginning a round in each phase, the simulator requires certain information[3] to initiate the round. Delays between each phase allow this information to be present at the beginning of each round for each phase, therefore, allowing all phases to be operated simultaneously.

There are two delays that are utilized in the MPPM simulator. The first is a delay from cattle procurement to slaughtering and processing[4]. Participants make decisions

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[3] The information needed differs for each phase. Information needed ranges from the supply of cattle in the procurement phase to the number of cattle to process in the slaughtering and processing phase to the amount of meat added to inventory in the sales phase.

[4] The delay from procurement to slaughtering and processing represents the delivery time of cattle. Often, it may take packers several days to get cattle they have

on the amount and type of cattle that will enter the slaughtering and processing phase one period ahead. Cattle purchased will enter the slaughtering and processing phase in either the subsequent round or in two rounds from the time they were purchased. As a result, the number and type of cattle that will be processed in a particular round of the slaughtering and processing phase is known prior to starting that round.

The other delay is from slaughtering and processing to sales[5]. The delay process is a simple half-week (or one round) delay. The meat produced in one round in the slaughtering and processing phase is not placed into inventory until the next round. Therefore, meat produced cannot be sold until a half week after it was produced.

The remainder of this chapter describes, in detail, the functions and design of each production phase. Detailed discussion of the management decisions required of game participants in each phase will also be given.

Procurement

Participants operating the procurement phase of the MPPM simulator must determine the type, quality, and

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purchased to their kill plants. Also, the delay process allows packer's to smooth their production flow in an attempt to operate near capacity.

[5] The delay from the slaughtering and processing phase to the sales phase represents carcass chill time. Carcasses are generally chilled anywhere from 24 to 72 hours prior to being processed into various sub-primal cuts.

quantity of cattle to purchase as well as the price at which these cattle will be purchased. These decisions, therefore, differ depending upon several conditions, including current meat inventories, slaughter plant operating capacity, and meat demand. Additionally, the decision on the amount and type of cattle to purchase is a function of the supply of cattle.

The supply of fed cattle is exogenous to decision making within the simulator. Depending on the week in which participants are currently operating, the MPPM simulator will offer a specific quantity and quality of cattle. The composition of cattle offered is generated by selecting combinations of pens from ten different pen types incorporated into the MPPM simulator. Each of the ten pen types consists of 100 head of cattle, but differs in live weight and percentages of cattle grading in each of the yield and quality grade categories.

The range of live weights of the cattle in the ten pen types were set from 1000 to 1240 pounds. The range was chosen with the assumption that this range would represent the majority of cattle considered market ready. Cattle with live weights below 1000 pounds will generally not be market ready (i.e. do not possess a high enough degree of external fat and marbling to grade U.S. Choice) and those with live weights over 1240 pounds may result in carcasses too big for packers to efficiently handle. With an average dressing percentage between 62% and 64%[6], the carcasses resulting from this range of cattle would fall in a 600 to 900 pound range.

To determine the number of cattle grading in each of the yield grade and quality grade categories for each pen type, data were obtained from the Cattlemen's Carcass Data Service (CCDS)[7]. The data consisted of weights, yield grades, and quality grades for over 8000 steer, heifer, cow, and bull carcasses. Table 3.1 gives the breakdown of the carcasses by various categories.

Carcass weights ranged from 305 lbs. to 1108 pounds. However, over 90% of the carcasses were within a weight range of 600 to 900 pounds. Within that range, most of the carcasses fell within a 700 to 800 pound range (40.630%).

Steers made up the majority of cattle slaughtered (65.352%). Heifer slaughter constituted 34.159% of all cattle slaughtered. Cow and bull slaughter made up less then one percent of the 8000 carcasses.

Yield grade 2 and 3 carcasses made up the majority of the carcasses. Yield grade 1 carcasses constituted about 12% of the carcasses while yield grade 4 carcasses were about eight percent of all carcasses. Yield grade 5

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[6] Thomas (1986) stated that the majority of U.S. Choice cattle with live weights between 1000 and 1500 pounds possess dressing percentages from 62 to 64 percent.

[7] The Cattlemen's Carcass Data Service is a service of the National Cattlemen's Beef Association. The data was collected on from February 1993 to December 1993.

Table 3.1 Breakdown of Carcass Numbers by Weight, Animal Type, Quality Grade and Yield Grade.

Category	Number of Carcasses	Percent of Total
Carcass Weight		
Less than 400 lbs.	2	0.024
400 to 499 lbs.	35	0.427
500 to 599 lbs.	399	4.871
600 to 699 lbs.	2,039	28.189
700 to 799 lbs.	3,328	40.630
800 to 899 lbs.	1,955	23.868
900 to 999 lbs.	394	4.810
over 1000 lbs.	39	0.476
Animal Type		
Steer	5,353	65.352
Heifer	2,798	34.159
Cow/Bull	40	.488
Quality Grade		
Prime	105	1.282
Choice	3,901	47.625
Select	3,828	46.734
Standard	289	3.528
Commercial	41	0.501
Utility	27	0.330
Yield Grade		
Yield Grade 1	973	11.879
Yield Grade 2	3,652	44.586
Yield Grade 3	2,874	35.087
Yield Grade 4	614	7.496
Yield Grade 5	78	0.952

Average Carcass Weight = 748, Average Yield Grade = 2.86

[a] Source: Cattlemen's Carcass Data Service.

Table 3.2 Breakdown of Steer Carcass Numbers by Weight, Quality Grade and Yield Grade.

Category	Number of Carcasses	Percent of Total
Carcass Weight		
Less than 400 lbs.	1	0.019
400 to 499 lbs.	8	0.149
500 to 599 lbs.	141	2.634
600 to 699 lbs.	959	17.915
700 to 799 lbs.	2,252	42.070
800 to 899 lbs.	1,612	30.114
900 to 999 lbs.	348	6.501
over 1000 lbs.	32	0.598
Quality Grade		
Prime	66	1.233
Choice	2,515	46.983
Select	2,543	47.506
Standard	203	3.792
Commercial	16	0.299
Utility	10	0.187
Yield Grade		
Yield Grade 1	595	11.115
Yield Grade 2	2,358	44.050
Yield Grade 3	1,945	36.335
Yield Grade 4	406	7.585
Yield Grade 5	49	0.915

Average Carcass Weight = 770, Average Yield Grade = 2.87

[a] Source: Cattlemen's Carcass Data Service.

carcasses were not very prevalent making up less then one percent of the carcasses.

The majority of the carcasses graded either choice or select (nearly 95% of all carcasses). Only a small percentage of the carcasses graded either higher or lower than U.S. Choice and Select with just over one percent grading U.S. Prime and just under six percent grading either U.S. Standard, Commercial or Utility. The split between U.S. Choice and Select was nearly even with a slightly higher percentage grading U.S. Choice.

The MPPM simulator assumes that only steers will be purchased and slaughtered, therefore, only carcass data for steers was examined. Table 3.2 gives the breakdown of steer carcasses by size, yield grade, and quality grade. As in Table 3.1, just over 90% of the carcasses weighed within a 600 to 900 pound range. Again, carcasses were fairly evenly separated between U.S. Select and Choice quality grades, however, unlike in Table 3.1, there were slightly more steer carcasses grading U.S. Select. The yield grades of the carcasses followed closely the results in Table 3.1. The majority of the carcasses had a yield grade of 2. When yield grades 2 and 3 are combined, they constitute just over 80% of all steer carcasses.

While Table 3.2 gives some insight as to what characteristics steer carcasses should possess on average, developing the ten pen types required segmenting steer carcass data into groupings that corresponded to the live weights specified in the MPPM simulator. Using dressing percentages[8] obtained from Dr. H. Glen Dolezal, Meat Scientist in the Oklahoma State University Animal Science

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[8] Determination of dressing percentages will be discussed in more detail later in this chapter.

Department, corresponding carcass weights for the range of cattle offered in the MPPM simulator were calculated. Steer carcass data were then separated into categories that corresponded to those carcass weights. Tables 3.3 and 3.4 show the breakdown of steer carcasses by selected groupings.

Each grouping corresponds to a specific live weight in the simulator with the 620 to 635 pound category corresponding to a 1000 pound live weight[9]. Each subsequent category corresponds to a live weight that is 20 pounds heavier then the previous so that the final category of 789 to 806 pounds corresponds to a live weight of 1240 pounds.

Table 3.3 shows the percentage breakdown of carcasses among yield grades. Since the data indicated yield grade 5 steer carcasses made up less then one percent of all steer carcasses, they were included in the yield grade 4 category. For the most part, with increases in carcass weights, there is a decline in the number of yield grade 1 carcasses and a increase in the number of yield grade 4 carcasses. Also, yield grade 2 and 3 carcass numbers stayed fairly stable as carcass weights changed.

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[9] Carcass weight varies for a given live weight due to dressing percentages changing over different yield grades. As a result, steers with live weights of 1000 pounds could have carcass weights from 620 to around 635 pounds depending on the yield grade. This point will be discussed in more detail later in this chapter.

Table 3.3 Breakdown of Selected Steer Carcasses by Yield Grade.[a]

Carcass Weights (lbs.)	Percent Yield Grade 1	Percent Yield Grade 2	Percent Yield Grade 3	Percent Yield Grade 4[b]
620 to 635	20.339	57.627	17.797	4.237
636 to 650	18.750	52.679	25.893	2.679
651 to 663	12.230	53.237	26.619	7.679
664 to 676	10.596	60.265	27.815	1.325
677 to 690	15.493	48.826	31.455	4.225
691 to 705	13.389	50.628	30.126	5.858
706 to 718	10.924	48.319	36.975	3.782
719 to 732	17.296	44.969	31.761	5.975
733 to 746	11.184	50.000	33.553	5.263
747 to 760	8.455	47.522	37.609	6.414
761 to 775	10.511	43.466	38.636	7.386
776 to 788	9.779	39.117	41.009	10.095
789 to 806	10.619	40.929	39.159	9.292
All Steers	12.227	47.087	34.314	6.371

[a] Source: Cattlemen's Carcass Data Service.
[b] Includes yield grade 5 carcasses.

Figure 3.4 Breakdown of Selected Steer Carcasses by Quality Grade.[a]

Carcass Weights (lbs.)	Percent U.S. Choice Carcasses[b]	Percent U.S. Select Carcasses[c]
620 to 635	38.136	61.864
636 to 650	40.179	59.821
651 to 663	45.324	54.676
664 to 676	39.073	60.927
677 to 690	38.967	61.033
691 to 705	46.444	53.556
706 to 718	49.160	50.840
719 to 732	43.082	56.918
733 to 746	43.750	56.250
747 to 760	50.729	49.271
761 to 775	48.295	51.705
776 to 788	49.527	50.473
789 to 806	48.009	51.991
All Steers	45.843	54.157

[a] Source: Cattlemen's Carcass Data Service.
[b] Includes U.S. Prime and U.S. Choice carcasses.
[c] Includes U.S. Standard and all lower grades in addition to U.S. Select carcasses.

Table 3.4 reports the U.S. Choice/Select quality grade distribution (by weight) of the carcass data collected. Select carcasses include all carcasses grading U.S. Select or worse (i.e. Select, Standard, Commercial, or Utility). Choice carcasses include those carcasses grading U.S. Choice or better (i.e. Choice or Prime). Due to the small percentage of carcasses grading other than U.S. Select and Choice, all quality grades were grouped into either U.S. Choice or Select. While the breakdown of carcasses among the two quality grades was fairly stable with changing carcass weights, more of the lighter carcasses graded select while more of the heavier carcasses graded choice.

Using the information from Tables 3.3 and 3.4 as a basis, ten pen types (see Appendix A) were developed. The percentages in Tables 3.3 and 3.4 were used to determine the number of cattle in each pen qualifying for each of the yield and quality grade categories. While the results of Tables 3.3 and 3.4 were used as a basis, the pen types determined were subjectively adjusted so that a recognizable pattern could be observed when moving from pen type to pen type. Table 3.5 gives the breakdown of the ten pen types by pen weight, yield grade, and quality grade.

Each pen type consists of 100 head of steers. The type of cattle that comprises each pen differs from pen type to pen type. The live weight of each animal within a specific pen was determined on an arbitrary basis. The only

Table 3.5 Breakdown of the Ten Pen Types Offered in the MPPM Simulator.

Pen Type	Total Pen Weight (lbs.)	Yield Grade 1 (%)	Yield Grade 2 (%)	Yield Grade 3 (%)	Yield Grade 4 (%)	U.S. Choice (%)	U.S. Select (%)
1	103,280	16	54	27	3	42	58
2	106,300	14	54	28	4	44	56
3	109,700	14	51	28	7	46	54
4	112,980	13	49	30	8	48	52
5	116,300	11	47	32	10	50	50
6	117,260	11	46	32	11	52	48
7	118,380	10	45	33	12	54	46
8	120,480	10	46	31	13	56	44
9	121,420	10	44	33	13	58	42
10	123,100	9	41	37	13	60	40
Base	116,180	11	46	35	8	51	49

consideration in determining the live weights of the cattle within each pen was that the total weight of each pen type differed from others and that pens would get progressively heavier from pen type to pen type.

Starting with pen type one, total pen weight is the lightest at 103,280 pounds resulting in an average weight per animal of 1033 pounds. Moving from pen one through pen ten, pen weights get progressively heavier and reach a maximum level of 123,100 pounds with an average weight per animal of 1231 pounds.

As the pen type changes, there are also changes in the quality of cattle that comprise each pen. The percentage of each yield grade changes when moving from pen type one to pen type ten. The pen types were comprised so that the most observable changes would be in the percentages for yield grades 1 and 4. With lighter cattle, the percentage of yield grade 1 cattle is expected to be higher than that of yield grade 4 cattle. As cattle get heavier, the number of cattle grading yield grade 4 would be expected to increase and those grading yield grade 1 would be expected to decrease. The percentages of yield grades 2 and 3 cattle also changed, but were designed to stay within a narrower range than that of the yield grade 1 and 4 cattle (see Table 3.5).

Percentage of cattle in each pen type grading in each quality grade was altered considerably from what was found in the carcass data described in Tables 3.3 and 3.4. Pen types were designed so that as heavier pens were offered, the percentage of the cattle grading U.S. Choice also increased. As cattle get heavier, it is generally due to the amount of external fat that the animal deposits. With higher levels of external fat, the likelihood of that animal grading U.S. Choice increases. To represent this occurrence, the pen types were designed so that the lighter pens consisted of larger numbers of U.S. Select cattle and the heavier pens had more U.S. Choice cattle. Moving from pen type one to pen type two corresponds to a decrease in the number of U.S. Select cattle (two less) and an increase in the number of U.S. Choice cattle (two more). The same trend (i.e. reducing the number of Select and increasing the number of Choice cattle by two) is observable in the comparison of any two pen types in succession. The resulting range of U.S. Choice cattle in the pen types is 42 in pen type one to 60 in pen type ten. Similarly, the range of U.S. Select cattle is 40 in pen type ten to 58 in pen type one.

The base pen type found in Table 3.5 is assumed to be the type of cattle that would be killed and processed in a normal or average week. The base pen type was determined by averaging the weights and grades of the middle range of pen types (i.e. pen types four, five, six, and seven). After finding the average of the middle pen types, the base pen was altered slightly so that the percentage of carcasses grading in each yield grade category, among the quality grades, followed those percentages found from results of the National Beef Quality Audit.

These pen types are believed to represent the full range of cattle that will be offered in the industry. However, not all pen types are offered in a given week. The type of pens offered and the number of pens offered follow a scenario which is dependent on the week number. Table 3.6 shows the pens offered in each week of a simulated year.

During most of the year, 40 pens of cattle will be offered per week. However, the types of pens (i.e. pen types one through ten) are generally set at four different allotment scenarios. As a result, ten pens of each of the

Table 3.6 Weekly Cattle Supply in the MPPM Simulator.

Week	Pen 1	Pen 2	Pen 3	Pen 4	Pen 5	Pen 6	Pen 7	Pen 8	Pen 9	Pen 10	Total
1	0	0	0	10	10	10	10	0	0	0	40
2	0	0	0	10	10	10	10	0	0	0	40
3	0	0	0	10	10	10	10	0	0	0	40
4	0	0	0	10	10	10	10	0	0	0	40
5	0	0	0	0	0	10	10	10	10	0	40
6	10	0	0	0	0	0	0	10	10	10	40
7	10	10	10	0	0	0	0	0	0	10	40
8	0	10	10	10	10	0	0	0	0	0	40
9	0	0	0	10	10	10	10	0	0	0	40
10	0	0	0	10	10	10	10	0	0	0	40
11	0	0	0	10	10	10	10	0	0	0	40
12	0	0	0	10	10	10	10	0	0	0	40
13	0	0	0	10	10	10	10	0	0	0	40
14	0	0	0	9	9	9	11	0	0	0	38
15	0	0	0	8	8	8	11	0	0	0	35
16	0	0	0	9	9	9	10	0	0	0	37
17	0	0	0	10	10	10	10	0	0	0	40
18	0	0	0	10	10	10	12	0	0	0	42
19	0	0	0	11	11	11	12	0	0	0	45
20	0	0	0	11	11	11	11	0	0	0	44
21	0	0	0	10	10	10	10	0	0	0	40
22	0	0	0	10	10	10	10	0	0	0	40
23	0	0	0	10	10	10	10	0	0	0	40
24	0	0	0	10	10	10	10	0	0	0	40
25	0	0	0	10	10	10	10	0	0	0	40
26	0	0	0	10	10	10	10	0	0	0	40
27	0	0	0	0	0	10	10	10	10	0	40
28	10	0	0	0	0	0	0	10	10	10	40
29	10	10	10	0	0	0	0	0	0	10	40
30	0	10	10	10	10	0	0	0	0	0	40
31	0	0	0	10	10	10	10	0	0	0	40
32	0	0	0	10	10	10	10	0	0	0	40
33	0	0	0	10	10	10	10	0	0	0	40
34	0	0	0	10	10	10	10	0	0	0	40
35	0	0	0	10	10	10	10	0	0	0	40
36	0	0	9	9	9	11	0	0	0	0	38
37	8	8	8	11	0	0	0	0	0	0	35
38	0	9	9	9	10	0	0	0	0	0	37
39	0	0	0	10	10	10	10	0	0	0	40
40	0	0	0	0	10	10	10	12	0	0	42
41	0	0	0	0	0	0	11	11	11	12	45
42	0	0	0	0	0	11	11	11	11	0	44
43	0	0	0	10	10	10	10	0	0	0	40
44	0	0	0	10	10	10	10	0	0	0	40
45	0	0	0	10	10	10	10	0	0	0	40
46	0	0	0	10	10	10	10	0	0	0	40
47	0	0	0	10	10	10	10	0	0	0	40
48	0	0	0	10	10	10	10	0	0	0	40
49	0	0	0	0	0	10	10	10	10	0	40
50	10	0	0	0	0	0	0	10	10	10	40
51	10	10	10	0	0	0	0	0	0	10	40
52	0	10	10	10	10	0	0	0	0	0	40

four pen types must be offered to get a total supply of 40 pens.

The supply of fed cattle changes in the MPPM simulator in two ways. First is by changing the type of cattle offered (i.e. pen types offered). The other change is in the total number of pens offered.

In the initial training/teaching use of the simulator, when the supply of cattle is changed, only one of the two available methods is used to change supply (i.e. supply can be changed by changing the type of cattle or changing the total number offered). If both total supply and the type of cattle are changed, participants may find it difficult to ascertain the impact of each supply shock. However, if each supply shock is observed separately, participants can more easily determine the impact of each on live cattle prices.

At the outset, the supply of live cattle is kept constant (weeks one to four). This allows participants to get a basic understanding of how the MPPM simulator operates prior to changing the fed cattle supply. After this initial stage, pen types offered in a week are altered while keeping total supply constant (weeks five to eight and then again in weeks 27 to 30). This allows participants to gain an understanding of how their decisions should change in response to different types of cattle being offered.

In weeks 13 to 19, the total supply of fed cattle is changed. The total number of pens are allowed to range from a low of 35 pens to a high of 45 pens[10]. While the total number of pens are changed, the type of cattle being offered is kept constant. In this time span, pen types four, five, six, and seven are offered. This combination of pens is very similar to the base pen, which is assumed to be "normal" cattle supply.

After participants have been exposed to independent changes in pen types and pen numbers, the supply scenario then simulates simultaneous changes in pen numbers and type. In weeks 36 to 42, total cattle supply ranges from 35 to 45 pens, however, unlike earlier, the type of cattle offered is also changed. When total cattle supply is low (i.e. 35 pens), the type of cattle supplied are from the lower pen types (pen types one, two, three, and four), which are lighter weight pen types. When supplies are low, packers tend to purchase cattle of lighter weights and lower quality than normal. Similarly, when total cattle supply is high (i.e. 45 pens), the type of cattle supplied are from the higher pen types (pens seven, eight, nine, and ten), which are heavier weight and higher quality pen types. When supplies are high, feedlots tend to hold cattle to heavier weights than normal.

Given the week number, therefore, the MPPM simulator will offer a specific quantity and quality of cattle to the

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[10] Total cattle supply is changed from a base of 40 pens by ± 12.5 percent.

packers. It is assumed that the supply of cattle is fixed for the entire week. Recall, that the MPPM simulator requires two full periods (i.e. half-weeks) to complete a week's worth of transactions. Cattle supplied at the beginning of the week (or the first period in the week), are assumed to be the only cattle that can be purchased for that particular week. No other cattle come available in the second period or half-week. If packers purchase all available cattle in the beginning of the week, there are no cattle to purchase at the end of the week.

At the beginning of each week (i.e. first round of the week), packers are given input forms (see Appendix C) with which they can make bids for the cattle supplied. The bids include a dollar value per cwt. for each pen type that the packer wishes to purchase. Also, the packer must specify the number of pens of each pen type offered that it will purchase at its bid price. Therefore, for any given week, the packer may specify up to four prices (one for each of the four pen types offered) as well as the number of pens of each pen type it wishes to purchase.

The MPPM simulator records bids and determines the number of pens each packer is able to purchase. The MPPM simulator determines how the pens of each pen type are allocated among the packers by the packers' bid prices. The packer that bids the highest price for a particular pen type will be awarded the sale of all the pens it offered to buy or all the pens available, which ever is less. If, after that packer has purchased the pens it desired, there are still pens remaining, the packer that bid the next highest price is awarded pens in the same manner. This process continues until either all packers get there desired number of pens purchased or the supply of that particular pen type is exhausted.

An integral component to this process is the price offered by Packer Five. As mentioned earlier, Packer Five is computer driven. The price that Packer Five offers for the cattle is determined by calculating a breakeven price based on its forecast of demand for boxed beef or sub-primal meat products[11]. Packer Five's bid prices essentially become price floors for live cattle, therefore, no cattle can be purchased at prices below Packer Five's bid. However, the game manager has the ability to change Packer Five's bid prices if it is believed prices are too low or too high. Also, the game manager may wish to see how participants react to a high price floor (i.e. will they attempt to match that price and run the risk of losing money, or will they simply stay out of the market).

Packers are allowed to bid for the live cattle twice in a simulated week. Recall that a week is separated into two periods (or rounds), one that brings the packer to the

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[11] The computer based system used in the determination of bid prices for live cattle by Packer 5 will be discussed in more detail later in this chapter.

middle of the week and the other that brings the packer to the end of the week. In the first period, the four participant packers must bid prices higher than that of Packer Five in order to purchase cattle. If the other packers bid below Packer Five, the simulator will first attempt to sell cattle to Packer Five. Packer Five will always offer to buy all the cattle supplied. Therefore, if allowed, the MPPM simulator would sell all the cattle to Packer Five. However, Packer Five is not allowed to purchase any cattle in the first period of a week. This allows the other packers to adjust their bid prices in an attempt to purchase cattle in the second period. Therefore, the price Packer Five bids essentially becomes a price floor for the fed cattle in the first period.

If packers do, however, bid higher then Packer Five in the first round, cattle are sold depending on the bid prices of each packer. At the end of the first round, the MPPM simulator will report to each packer the number of pens of each pen type that it was able to purchase. Also, the MPPM simulator will report the number of pens of each pen type still remaining after the first period transactions and the range of prices for cattle purchased. Packers can then take this information and adjust their initial offers in the second period in an attempt to purchase the remaining cattle.

In the second round, Packer Five is allowed to purchase cattle. As in the first period, the other packers must bid higher then Packer Five in order to purchase cattle. If Packer Five has the highest bid price, it will be able to purchase all the remaining cattle.

At the end of the second period, the MPPM simulator will again report to each packer the number of pens each purchased in the period. Additionally, the MPPM simulator will report the total number of pens purchased, both in the first and second period, total cattle costs, and per unit costs (both dollars per head and dollars per hundred weight).

In each period or half-week, participants must determine when the cattle purchased will be delivered to the slaughtering and processing phase. The MPPM simulator does not allow for cattle purchased in one period to be slaughtered and processed in the same period. Often, it may take several days for cattle to be shipped from the feedlot to the packer. As a result, the earliest that a packer can begin to slaughter and process the cattle just purchased is in the next half-week period. However, packers may wish to further delay the time cattle reach their kill plants.

There could be a variety of reasons that a packer may want to delay delivery of cattle. One may be that the packer was able to purchase cattle cheaply enough to purchase more than the kill and processing plants can process at one time. Also, as mentioned earlier, the packer's processing and killing cost depend on the number of pens processed and that each packer has a level that minimizes those costs. By delaying cattle, the packer may be able to come closer to remaining at or close to that low cost level.

Regardless of the reason for delaying cattle, the MPPM simulator allows packers to delay cattle for an additional half-week period. Therefore, cattle purchased in one period will be delivered to the kill plants either in the next half-week period (if not delayed) or after two half-week periods (if delayed). The packer must process the cattle purchased within two half-week periods (which is one simulated week). Therefore, if cattle purchased in one period are delayed from being processed in the next period, they must be processed in the second period following their purchase.

Input forms (see Appendix C) are given to the packer in each period that allows for these delay decisions to be made. The input form has three major components. The first component reports the number of pens of each pen type the packer purchased (this is the same information found on the output forms given after cattle sells have been made). The second component specifies the number of pens of each pen type that must be processed. As mentioned earlier, the packer must process cattle within two periods after their purchase. Therefore, if some cattle were delayed from being processed in the period after their purchase, they must be processed in the second period after their purchase. The final component is an input area in which the packer decides the number of each pen purchased that it will delay. The packer can delay any portion of the cattle purchased. For example, if a packer purchased two pens, the packer can delay none, one, or both pens. Also, the packer is given the ability to delay half pens. If the packer delays half of a pen of a particular pen type, that pen type is divided equally into two pens with 50 head of cattle in each[12].

Since the packer cannot process cattle purchased until the next period, the decisions made about delaying cattle affect the slaughtering and processing phase in the next two half-week periods. Packers are essentially determining the number of pens they will process one period in advance. The packer can determine the number of each pen type that it will process in the next period by adding the number purchased to the number that must be processed and subtracting the number delayed. The total number of pens processed is, then, the sum of the number of each pen type processed.

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12 Each packer has an optimum number of pens it should purchase and process each period. For some packers, the optimum number of pens is an odd number. Therefore, by allowing packers to process half pens, it allows those packers to operate at their optimum number.

Slaughtering and Processing

Cattle purchased in the procurement phase of the MPPM simulator are sent to the slaughtering and processing phase for production of sub-primal meat cuts. At the beginning of the slaughtering and processing phase, packers are given forms (see Appendix C) that indicate the number and type of cattle that are to be processed in the current period. As with the procurement phase, this phase is also segmented into two half-week periods per simulated week. In each period, cattle are imported into the kill plants and must be processed.

Each animal slaughtered produces a certain carcass weight depending on the animal's live weight and yield grade. In order to determine the conversion from live weight to carcass weight, dressing percentages for each animal weight and yield grade combination possible were determined (Table 3.7).

Dressing percentages are the ratio of live weight to carcass weight. The dressing percentages were obtained from Dr. H. Glen Dolezal, Meat Scientist within the Animal Science Department at Oklahoma State University. The dressing percentages range from 62 to 64.7 percent. The dressing percentages increase by a tenth of a percent as live weight increases by 20 pounds. Also, the dressing percentage increases by a half of a percent as the yield grade increases by one grade.

Table 3.7 Dressing Percentages of All Animal Live Weights and Yield Grades.

Animal Weight (lbs.)	Yield Grade 1 (%)	Yield Grade 2 (%)	Yield Grade 3 (%)	Yield Grade 4 (%)
1000	62.00	62.50	63.00	63.50
1020	62.10	62.60	63.10	63.60
1040	62.20	62.70	63.20	63.70
1060	62.30	62.80	63.30	63.80
1080	62.40	62.90	63.40	63.90
1100	62.50	63.00	63.50	64.00
1120	62.60	63.10	63.60	64.10
1140	62.70	63.20	63.70	64.20
1160	62.80	63.30	63.80	64.30
1180	62.90	63.40	63.90	64.40
1200	63.00	63.50	64.00	64.50
1220	63.10	63.60	64.10	64.60
1240	63.20	63.70	64.20	64.70

[a] Source: Dr. H. Glen Dolezal, Meat Scientist at Oklahoma State University.

Dressing percentages can then be used to determine the associated carcass weight of every live weight/yield grade combination. The carcass weight is found by simply multiplying the live weight of an animal by its corresponding dressing percentage. Table 3.8 gives the carcass weights of each animal type processed in the MPPM simulator.

Carcass weights in the MPPM simulator vary from a low of 620 pounds to a high of 802.28 pounds. These carcass weights also correspond to the weight categories found in Tables 3.3 and 3.4. Those weight categories were chosen to correspond with the carcass weights used in the MPPM

Table 3.8 Carcass Weights For Each Animal Live Weight and Yield Grade Combination.

Animal Weight (lbs.)	Yield Grade 1 (lbs.)	Yield Grade 2 (lbs.)	Yield Grade 3 (lbs.)	Yield Grade 4 (lbs.)
1000	620.00	625.50	630.00	635.00
1020	633.42	638.52	643.62	648.72
1040	646.88	652.08	657.28	662.48
1060	660.38	665.68	670.98	676.28
1080	673.92	679.32	684.72	690.12
1100	687.50	693.00	698.50	704.00
1120	701.12	706.72	712.32	717.92
1140	714.78	720.48	726.18	731.88
1160	728.48	734.28	740.08	745.88
1180	742.22	748.12	754.02	759.92
1200	756.00	762.00	768.00	774.00
1220	769.82	775.92	782.02	788.12
1240	783.68	789.88	796.08	802.28

simulator so that the yield grades and quality grades of each pen type reflected the cattle being processed in the real world.

The amount of each primal produced is directly related to carcass weight. Each carcass can be divided into five major sections or primals. Each primal is assumed to be a fixed proportion of the carcass (Table 3.9).

The percentages for each primal are assumed constant regardless of the size of the carcass or the yield grade of the carcass. There will, however, be differences in the weight of each primal depending on the carcass weight and the yield grade. Since the primal weight is found by multiplying its percentage by carcass weight, the weight of a particular primal will change as carcass weight changes.

Table 3.9 Percentage of Carcass for Each Primal.

Primal		Percent of Carcass
Rib		11.11
Loin		21.14
Chuck		29.29
Round		22.22
Other		16.24
Brisket	(5.26)	
Short Plate	(7.42)	
Flank	(3.56)	

Further, since carcass weight is a function of yield grade, primal weight is indirectly dependent on the yield grade of the carcass.

Each primal has a unique percentage. The sum of these percentages equal one, indicating that there is no loss in conversion from the carcass to the primal. The last primal, denoted as other, is separated into three components. This primal is separated because each one of its components can be thought of as an unique primal. This becomes important when these primals are processed into sub-primal or wholesale cuts. Because of the uniqueness of the brisket, flank, and short plate, they could not be lumped into one primal[13].

To this point, all the discussion has revolved around conversion relationships from live weights to primal weights. While important to the packer, the packer has no

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[13] The reason that each of these are considered separately becomes more evident in the discussion of the determination of each sub-primal cut and the fabrication options.

control over these conversions. The packer simply considers these conversion factors as exogenous to their decision process. However, packers have control over how much of each sub-primal cut is produced. Each packer is given several different options in processing these sub-primal cuts.

Within the simulator, participants are able to process each primal from two to four different ways (in reality, even more fabrication options are available). Each different option results in producing a different sub-primal cut or different amounts of the same product. The basis for these cutting options are the USDA Standard Cutting Options obtained from personnel at a participating meat packing firm. The USDA has established several standard cutting options for each primal. Tables 3.10 - 3.14 give the USDA standard cutting options.

Cutting options are expressed in percentage terms. Therefore, the amount of each sub-primal product produced is a proportion of the total weight of the primal. Each option results in one major sub-primal cut being produced along with several other products. Options are organized in such a way that the product with the least amount of processing required is produced under the first option. The major sub-primal cuts produced in the remaining options usually require more processing and are usually produced from disassembling the major sub-primal cut produced under the

Table 3.10 USDA Cutting Options for the Rib Primal.

Rib Components	Option 1 (%)	Option 2 (%)	Option 3 (%)	Option 4 (%)
109A Rib Roast-Ready	51.42	0.00	0.00	0.00
Bone-in Lip-on Ribeye	0.00	39.71	0.00	0.00
112A Lip-on Ribeye	0.00	0.00	30.16	0.00
107 3x4 Ribeye	0.00	0.00	0.00	62.49
123A Short Rib	8.74	8.86	8.04	9.44
Blade Meat	7.56	7.29	7.84	4.15
50% Trimmings	17.49	15.46	16.89	15.63
124 Back Rib	0.00	0.00	8.50	0.00
Fat	5.46	15.84	15.69	3.31
Bone	8.73	12.46	12.28	4.72
Shrink	0.60	0.38	0.60	0.26
Total Percentage	100.00	100.00	100.00	100.00

Table 3.11 USDA Cutting Options for the Chuck Primal.

Chuck Components	Option 1 (%)	Option 2 (%)	Option 3 (%)	Option 4 (%)	Option 5 (%)	Option 6 (%)
114 Shoulder Clod	18.87	0.00	0.00	0.00	0.00	0.00
116A Chuck Roll	25.87	0.00	0.00	0.00	0.00	0.00
126 3-Way Chuck	0.00	80.24	0.00	0.00	0.00	0.00
113B Square Cut Neck-Off	0.00	0.00	74.71	0.00	0.00	0.00
Semi-Boneless Neck-Off	0.00	0.00	0.00	53.18	0.00	0.00
113A Square Cut Chuck	0.00	0.00	0.00	0.00	87.63	0.00
115 2-pc Boneless Chuck	0.00	0.00	0.00	0.00	0.00	69.09
Chuck Tender	2.76	0.00	0.00	0.00	0.00	0.00
Shank Meat	8.59	0.00	5.84	9.51	6.08	8.44
Boneless Short Rib	1.93	0.00	0.00	0.00	0.00	0.00
75% Trimmings	11.74	0.00	10.65	18.42	1.51	4.34
50% Trimmings	4.36	0.00	0.00	0.00	0.00	5.85
Cap and Wedge Meat	0.00	0.00	0.00	0.00	0.00	0.00
Fat	6.12	0.94	2.12	6.63	0.75	3.74
Bone	18.95	18.25	6.28	11.82	3.83	8.07
Shrink	0.82	0.57	0.40	0.44	0.20	0.47
Total Percentage	100.00	100.00	100.00	100.00	100.00	100.00

Table 3.12 USDA Cutting Options for the Round Primal.

Round Components	Option 1 (%)	Option 2 (%)	Option 3 (%)	Option 4 (%)	Option 5 (%)
168 Top Inside Round	26.95	26.94	0.00	0.00	26.94
170 Gooseneck Round	32.30	32.28	0.00	0.00	0.00
167 Knuckle	13.27	0.00	0.00	0.00	0.00
167A Peeled Knuckle	0.00	11.47	0.00	0.00	11.47
160 Round Shank-Off	0.00	0.00	79.53	0.00	0.00
161 Round Boneless	0.00	0.00	0.00	72.66	0.00
171B Outside Round	0.00	0.00	0.00	0.00	16.06
171C Eye of Round	0.00	0.00	0.00	0.00	7.10
Heel	0.00	0.00	0.00	0.00	3.57
Peeled Shank	5.49	5.48	5.73	5.69	5.48
75% Trimmings	1.01	1.23	0.00	0.00	0.00
50% Trimmings	1.92	2.51	0.99	1.45	5.59
Fat	2.85	4.21	4.30	4.59	7.84
Bone	15.93	15.63	9.18	15.39	15.63
Shrink	0.28	0.25	0.27	0.22	0.33
Total Percentage	100.00	100.00	100.00	100.00	100.00

Table 3.13 USDA Cutting Options for the Flank, Brisket, and Short Plate Primal.

Flank, Brisket, and Plate Components	Option 1 (%)	Option 2 (%)	Option 3 (%)
193 Flank Steak	13.96	0.00	0.00
120 Brisket	0.00	53.94	0.00
Inside Skirt	0.00	0.00	7.24
Outside Skirt	0.00	0.00	4.16
Pastrami	0.00	0.00	17.58
75% Trimmings	5.88	0.00	0.00
65% Trimmings	0.00	0.00	10.35
50% Trimmings	30.41	16.59	37.69
Cap and Wedge Meat	0.00	0.00	3.88
Fat	49.30	13.44	4.80
Bone	0.00	15.71	13.99
Shrink	0.45	0.32	0.31
Total Percentage	100.00	100.00	100.00

Table 3.14 USDA Cutting Options for the Loin Primal.

Loin Components	Option 1 (%)	Option 2 (%)	Option 3 (%)	Option 4 (%)	Option 5 (%)	Option 6 (%)
172A Diamond Cut Loin	0.00	0.00	0.00	0.00	0.00	74.49
3-Piece Loin	0.00	0.00	0.00	0.00	51.17	0.00
174 Short Loin	0.00	30.02	0.00	0.00	0.00	0.00
175 Strip Loin	0.00	0.00	25.11	0.00	0.00	0.00
180 Strip Loin	18.51	0.00	0.00	18.51	0.00	0.00
184 Top Butt	16.21	16.10	16.21	0.00	0.00	0.00
Bone-in Top Butt	0.00	0.00	0.00	22.26	0.00	0.00
189A Tenderloin	6.88	0.00	6.88	6.88	0.00	0.00
185A Flap	3.05	3.05	3.05	3.04	3.05	1.50
185B Ball Tip	2.35	2.35	2.35	2.35	2.22	0.00
185C Tri Tip	2.89	2.89	2.89	2.89	2.87	0.00
Butt Tender	0.00	4.58	0.00	0.00	0.00	0.00
Steak Tail	2.93	2.93	2.17	2.93	2.90	2.22
Hanging Tender	1.57	1.61	1.61	1.58	1.52	1.90
75% Trimmings	1.97	1.70	1.08	1.38	1.76	1.70
50% Trimmings	8.73	8.28	7.54	8.42	8.01	1.60
Kidney	0.90	0.90	0.66	0.90	0.90	0.85
Fat	21.15	18.29	21.74	21.40	18.42	15.10
Bone	12.35	7.04	8.41	7.00	6.84	0.39
Shrink	0.51	0.26	0.30	0.46	0.34	0.25
Total Percentage	100.00	100.00	100.00	100.00	100.00	100.00

first option. For each fabrication option, percentages of primal for each product do not sum to one. Rather, shrinkage from the primal to the sub-primal cuts is observed.

The percentages given by the USDA cutting options are assumed to be for yield grade 2 carcasses. The percentages will vary among yield grades generally due to the amount of fat associated with primals of each yield grade. Generally, yield grade 1 primals will possess less fat than yield grade 2 primals. Likewise, yield grade 2 primals will have less fat then yield grade 3 primals which will have less fat then yield grade 4 primals. Since the percentage is actually a ratio of sub-primal to primal weight, if the primal weight increases, holding the sub-primal weight constant, the ratio will decrease. Therefore, while the sub-primal weight may not change considerably from yield grade to yield grade, the ratio may change considerably.

As a result, similar cutting options needed to be determined for the other yield grades. In order to adjust the USDA cutting option percentages to reflect those for the other yield grades, cutout percentages for several sub-primal cuts from the four yield grades were obtained from the Oklahoma State University Boxed Beef Calculator[14]. The calculator was developed by utilizing cutout percentages calculated from cutting tests in a commercial packing plant on 341 steers carcasses ranging from 626 to 979 pounds. The calculator can determine the pounds of twenty-one different products that will be produced from a specific weight, yield grade and quality grade of carcass.

Table 3.15 shows the cutout percentages of selected meat products in the OSU Boxed Beef Calculator. The selected cuts represent a wide array of products from each of the primals discussed earlier. The cutout percentages are affected by the yield grade of the carcass from which

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[14] Dolezal, H. Glen, et al., OSU Boxed Beef Calculator. Oklahoma Agricultural Experiment Station, 1995.

Table 3.15 Cut-out Percentages for Selected Sub-Primal Products by Yield Grade[b].

Boxed Beef Cuts	Yield Grade 1	Yield Grade 2	Yield Grade 3	Yield Grade 4
	Percent			
112A Ribeye	3.74	3.43	3.18	3.04
114 Shoulder Clod	5.94	5.87	5.77	5.76
116A Chuck Roll	8.73	8.60	8.46	8.28
120 Brisket	3.49	3.30	3.16	3.19
167 Knuckle	3.15	2.98	2.84	2.89
168 Inside Round	6.59	6.18	5.82	5.60
170 Gooseneck Round	8.30	7.73	7.43	7.11
180 Strip Loin	3.87	3.78	3.69	3.71
184 Top Butt	3.45	3.49	3.47	3.53
185A Bottom Sirloin Flap	1.01	1.00	0.96	0.96
185B Bottom Sirloin Ball Tip	0.62	0.65	0.61	0.51
185C Bottom Sirloin Tri Tip	0.88	0.88	0.87	0.83
189A Tenderloin	1.75	1.62	1.50	1.43
193 Flank Steak	0.51	0.51	0.50	0.47
Inside Skirt	1.24	1.21	1.11	1.12
Cap & Wedge Meat	5.05	4.46	4.02	3.69
Back Ribs	1.69	1.66	1.62	1.61
75% Lean Trim	8.88	9.07	9.02	8.48
50% Lean Trim	5.04	5.00	5.06	5.63
Edible Tallow	12.14	14.73	17.04	18.45
Bone	13.94	13.86	13.88	13.69
Total Product	100.00	100.00	100.00	100.00

[a] Source: OSU Boxed Beef Calculator.
[b] Yield grades represent the midpoint of each grade (i.e. 1.5, 2.5, etc.)

they are produced. As yield grade goes from 1 to 4, the cut-out percentages decrease for nearly every product. The only cut-out percentages that do not decrease throughout is those for the 75% and 50% trimmings. Trimmings, which are nothing more than ground beef, would be expected to increase with yield grades as the cuts would have to be processed more due to increased external fat. Also, as mentioned earlier, the amount of fat (edible tallow) produced increases as the yield grade goes from 1 to 4.

These percentages were then utilized to determine processing options for all four yield grades. As mentioned earlier, the USDA cutting options were for yield grade 2 carcasses. Therefore, these options were adjusted to determine cutting options for other yield grades.

Cutting options for yield grades 1, 3, and 4 were determined by using percent changes (Table 3.16) in the cutting options found in the OSU Boxed Beef Calculator. The percent change in cut-out percentages were determined as yield grade changed from yield grade 2 to the other yield grades.

Because meat products found in the OSU Boxed Beef Calculator were not identical to those found in the USDA cutting options, a specific percent change could not be calculated for every meat cut. As a result, the average percent change of the primal was also calculated. It was assumed that those cuts included in the USDA cutting options that were not in the OSU Boxed Beef Calculator would change in the same manner of the primal's average.

Using percent changes in the cut-out percentages found in the OSU Boxed Beef Calculator, fabrication options for each yield grade were calculated. To simplify the simulator, however, not all options found in the USDA cutting options were included. Each primal was examined to

Table 3.16 Percent Changes in Cut-out Percentages from Yield Grade 2 Cut-out Percentages.

BOXED BEEF CUTS	YIELD GRADE 1	YIELD GRADE 3	YIELD GRADE 4
		PERCENT	
112A Ribeye	9.19	-7.18	-11.26
114 Shoulder Clod	1.14	-1.74	-1.87
116A Chuck Roll	1.49	-1.69	-3.72
120 Brisket	5.67	-4.18	-3.24
167 Knuckle	5.71	-4.67	-2.89
168 Inside Round	6.62	-5.92	-9.34
170 Gooseneck Round	7.37	-4.00	-8.06
180 Strip Loin	2.30	-2.33	-1.80
184 Top Butt	-1.26	-0.57	1.26
185A Bottom Sirloin Flap	1.00	-3.21	-4.12
185B Bottom Sirloin Ball Tip	-4.31	-5.69	-21.38
185C Bottom Sirloin Tri Tip	0.00	-1.03	-5.35
189A Tenderloin	7.89	-7.46	-11.95
193 Flank Steak	0.19	-3.51	-7.60
Inside Skirt	2.32	-8.29	-7.04
Cap & Wedge Meat	13.45	-9.85	-17.26
Back Ribs	1.81	-2.05	-2.84
75% Lean Trim	-2.04	-0.56	-6.52
50% Lean Trim	0.82	1.30	12.57
Edible Tallow	-17.57	15.74	25.30
Bone	0.53	0.11	-1.21
Rib Average	6.73	-5.47	-8.46
Chuck Average	5.36	-4.43	-7.62
Round Average	6.57	-4.86	-6.76
Loin Average	1.14	-3.51	-7.18
Other Average	2.73	-5.33	-5.96

find those options that should be in the MPPM simulator based on the importance of the products produced under the option. Generally, there are specific cuts within each primal that drive the prices of the other cuts within that primal. Care was taken to include those products that drive the value of the other cuts within the primal. By doing so, several options could be eliminated.

The number of options for each primal were reduced from the number of options found in the USDA cutting options. Tables 3.17 - 3.21 indicate the processing options for each primal found in the MPPM simulator.

In addition to reducing the number of options, the number of cuts produced with each option was reduced. For each processing option, there is a meat product labeled as thin meats. The thin meat category is one that was used to combine several products from each primal into one product. Based on conversations with personnel within a meat packing firm, those products that could be sliced into a thin meat product were lumped into one category. All the cuts in this product category were similar in their make-up allowing them to be placed into one category.

Observing the MPPM fabrication options in Tables 3.17 - 3.21 shows that cut-out percentages for the yield grade 2 fabrication options are the same as the USDA standard cutting options. The fabrication options for the other yield grades were determined using the percentage changes discussed earlier.

Fabrication options are not differentiated by quality grade (i.e. U.S. Choice or Select). It is assumed that a particular cut will have the same cut-out percentage regardless of whether the primal from which it was produced

Table 3.17 MPPM Simulator Fabrication Options for the Rib Primal by Yield Grade.

	Opt.1 Yld.1 (%)	Opt.1 Yld.2 (%)	Opt.1 Yld.3 (%)	Opt.1 Yld.4 (%)	Opt.2 Yld.1 (%)	Opt.2 Yld.2 (%)	Opt.2 Yld.3 (%)	Opt.2 Yld.4 (%)
112A Lip-On Ribeye	32.93	30.16	28.00	27.06	0.00	0.00	0.00	0.00
107 3X4 Ribeye	0.00	0.00	0.00	0.00	62.93	62.49	61.86	61.21
123A Short Rib	8.19	8.04	7.87	7.81	9.61	9.44	9.25	9.17
124 Back Rib	8.65	8.50	8.33	8.26	0.00	0.00	0.00	0.00
Thin Meats	7.88	7.84	7.76	6.49	4.17	4.15	4.11	3.43
75% Trim	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50% Trim	17.03	16.89	17.11	18.34	15.76	15.63	15.83	16.97
Fat	12.78	15.69	18.00	19.19	2.70	3.31	3.80	4.05
Bone	12.29	12.28	12.29	12.13	4.73	4.72	4.73	4.66
Total	99.75	99.40	99.36	99.28	99.89	99.74	99.57	99.49

Table 3.18 MPPM Simulator Fabrication Options for the Chuck Primal by Yield Grade.

	Opt.1 Yld.1 (%)	Opt.1 Yld.2 (%)	Opt.1 Yld.3 (%)	Opt.1 Yld.4 (%)	Opt.2 Yld.1 (%)	Opt.2 Yld.2 (%)	Opt.2 Yld.3 (%)	Opt.2 Yld.4 (%)
113B Square-Cut,Neck-Off Chuck	75.09	74.71	73.94	73.82	0.00	0.00	0.00	0.00
2-pc Boneless Chuck	0.00	0.00	0.00	0.00	70.05	69.09	68.34	67.16
Thin Meats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75% Trim	16.82	16.49	16.25	16.07	12.90	12.78	12.62	12.46
50% Trim	0.00	0.00	0.00	0.00	5.90	5.85	5.93	6.59
Fat	1.63	2.12	2.64	3.08	2.88	3.74	4.52	5.06
Bone	6.31	6.28	6.29	6.27	8.11	8.07	8.08	8.05

Table 3.19 MPPM Simulator Fabrication Options for the Round Primal by Yield Grade.

	Opt.1 Yld.1 (%)	Opt.1 Yld.2 (%)	Opt.1 Yld.3 (%)	Opt.1 Yld.4 (%)	Opt.2 Yld.1 (%)	Opt.2 Yld.2 (%)	Opt.2 Yld.3 (%)	Opt.2 Yld.4 (%)
168 Top Inside Round	27.20	26.95	26.66	26.05	0.00	0.00	0.00	0.00
170 Gooseneck Round	32.74	32.30	31.81	31.31	0.00	0.00	0.00	0.00
167 Knuckle	13.42	13.27	13.12	13.02	0.00	0.00	0.00	0.00
167A Peeled Knuckle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
161 Round Boneless	0.00	0.00	0.00	0.00	73.80	72.66	71.31	69.93
171B Outside Round	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
171 Eye Of Round	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thin Meats	5.50	5.49	5.44	5.39	5.70	5.69	5.64	5.59
75% Trim	0.97	1.01	1.00	0.94	0.00	0.00	0.00	0.00
50% Trim	1.94	1.92	1.98	2.32	1.46	1.45	1.50	1.75
Fat	2.15	2.85	3.50	4.28	3.46	4.59	5.63	6.90
Bone	15.94	15.93	16.07	15.93	15.40	15.39	15.53	15.39

	Opt.3 Yld.1 (%)	Opt.3 Yld.2 (%)	Opt.3 Yld.3 (%)	Opt.3 Yld.4 (%)
168 Top Inside Round	27.19	26.94	26.65	26.04
170 Gooseneck Round	0.00	0.00	0.00	0.00
167 Knuckle	0.00	0.00	0.00	0.00
167A Peeled Knuckle	11.60	11.47	11.34	10.79
161 Round Boneless	0.00	0.00	0.00	0.00
171B Outside Round	16.79	16.06	14.96	14.56
171 Eye Of Round	7.50	7.10	6.54	6.62
Thin Meats	9.46	9.05	8.88	8.89
75% Trim	0.00	0.00	0.00	0.00
50% Trim	5.64	5.59	5.77	6.74
Fat	5.91	7.84	9.62	10.22
Bone	15.64	15.63	15.77	15.44

Table 3.20 MPPM Simulator Fabrication Options for the Brisket, Flank, and Short Plate Primal by Yield Grade.

	Opt.1 Yld.1 (%)	Opt.1 Yld.2 (%)	Opt.1 Yld.3 (%)	Opt.1 Yld.4 (%)	Opt.2 Yld.1 (%)	Opt.2 Yld.2 (%)	Opt.2 Yld.3 (%)	Opt.2 Yld.4 (%)
193 Flank Steak	13.99	13.96	12.77	12.06	0.00	0.00	0.00	0.00
120 Brisket	0.00	0.00	0.00	0.00	56.13	53.94	51.68	49.98
Pastrami	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thin Meats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75% Trim	5.82	5.88	5.82	5.56	0.00	0.00	0.00	0.00
50% Trim	32.00	30.41	30.74	30.89	16.73	16.59	16.77	18.18
Fat	47.82	49.30	50.29	51.32	11.08	13.44	15.42	16.84
Bone	0.00	0.00	0.00	0.00	15.79	15.71	15.73	14.52

	Opt.3 Yld.1 (%)	Opt.3 Yld.2 (%)	Opt.3 Yld.3 (%)	Opt.3 Yld.4 (%)
193 Flank Steak	0.00	0.00	0.00	0.00
120 Brisket	0.00	0.00	0.00	0.00
Pastrami	17.95	17.58	16.90	15.81
Thin Meats	11.63	11.40	10.80	9.43
75% Trim	5.12	5.18	5.13	4.89
50% Trim	47.13	46.75	47.26	49.54
Fat	3.96	4.80	5.51	6.01
Bone	14.02	13.99	14.02	13.82

Table 3.21 MPPM Simulator Fabrication Options for the Loin Primal by Yield Grade.

	Opt.1 Yld.1 (%)	Opt.1 Yld.2 (%)	Opt.1 Yld.3 (%)	Opt.1 Yld.4 (%)	Opt.2 Yld.1 (%)	Opt.2 Yld.2 (%)	Opt.2 Yld.3 (%)	Opt.2 Yld.4 (%)
174 Short Loin	0.00	0.00	0.00	0.00	30.71	30.02	29.32	27.86
175 Strip Loin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180 Strip Loin	18.94	18.51	18.08	17.44	0.00	0.00	0.00	0.00
184 Top Butt	16.01	16.21	16.12	16.22	15.90	16.10	16.01	16.30
Bone-In Top Butt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
189A Tenderloin	7.42	6.88	6.37	6.06	0.00	0.00	0.00	0.00
Thin Meats	8.22	8.29	8.03	6.86	13.16	12.87	12.27	10.91
75% Trim	7.03	6.47	6.02	6.05	6.82	6.24	5.78	5.83
50% Trim	8.80	8.73	8.84	9.48	8.35	8.28	8.39	8.99
Fat	20.25	22.05	23.60	25.51	17.55	19.19	20.83	22.97
Bone	12.91	12.35	12.36	11.71	7.36	7.04	7.05	6.67

	Opt.3 Yld.1 (%)	Opt.3 Yld.2 (%)	Opt.3 Yld.3 (%)	Opt.3 Yld.4 (%)	Opt.4 Yld.1 (%)	Opt.4 Yld.2 (%)	Opt.4 Yld.3 (%)	Opt.4 Yld.4 (%)
174 Short Loin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
175 Strip Loin	25.69	25.11	24.53	23.65	0.00	0.00	0.00	0.00
180 Strip Loin	0.00	0.00	0.00	0.00	18.94	18.51	18.08	17.25
184 Top Butt	16.01	16.21	16.12	16.22	0.00	0.00	0.00	0.00
Bone-In Top Butt	0.00	0.00	0.00	0.00	21.98	22.26	22.13	22.32
189A Tenderloin	7.42	6.88	6.37	6.06	7.42	6.88	6.37	6.06
Thin Meats	8.22	8.29	8.03	6.86	8.21	8.28	8.02	6.85
75% Trim	5.35	4.86	4.48	4.54	6.47	5.89	5.44	5.51
50% Trim	7.60	7.54	7.64	8.19	8.49	8.42	8.53	9.14
Fat	20.75	22.40	24.09	25.92	20.66	22.30	23.91	25.80
Bone	8.79	8.41	8.42	7.97	7.32	7.00	7.01	6.64

was U.S. Choice or Select. Therefore, the fabrication options are used to determine the amount of both U.S. Select and Choice meat produced[15].

Finally, if percentages for each fabrication option/yield grade combination are summed, the result would be less then one. A degree of shrinkage is observable in the conversion from the primal to the sub-primal cuts. In addition, the amount of shrink differs for each yield grade. Yield grade 1 primals are assumed to experience the least amount of shrink while yield grade 4 primals experience the highest level of shrink.

Using the fabrication options, packers are able to change the products produced from period to period. At the beginning of each period, each packer is asked complete a processing input form (see Appendix C) which requires the packer to decide how to process each primal. The packer can choose to process a primal using only one fabrication option or any combination of fabrication options. For example, the packer may choose to process a third of the rib primals under option one and the remaining two-thirds under option two. The only restriction to choosing the amount of each

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[15] The total number of meat products produced is 50. Of this number, there are 23 sub-primal cuts of which there are both U.S. Select and Choice grades, as well as two trimmings, one fat, and one bone product. In reality, there are over 120 different meat products produced by most meat packing firms.

option to use in processing the primals is that the sum of the percentages of each option used must sum to one.

The decision on how to process various primals is made some what more difficult by having the packers decide how to process the primals for each of the yield grades. Processing some yield grades under specific processing options may not be as cost effective as others[16]. Therefore, it may be beneficial for the packer to process certain yield grades under specific processing options. As a result, the packer may process the primals from one particular yield grade in one way and then process the same primals from another yield grade in a totally different manner.

For the four participant packers, the decision on how to process cattle is made for yield grade 1 to 3 carcasses. As mentioned in Chapter Two, the four packers do not process yield grade 4 cattle. Rather, yield grade 4 cattle are sold on a whole carcass basis. However, the MPPM simulator has processing options for yield grade 4 cattle. The reason being that yield grade 4 cattle are processed by Packer Five, the computer driven packer.

It is assumed that Packer Five buys the yield grade 4 carcasses from the other four packers and processes them. The reason this is done is so the impact of meat products

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[16] Processing costs vary by the fabrication option chosen and by yield grade of the animal. This point will be discussed in later in this chapter.

from those carcasses can also be felt in the boxed beef market. If the yield grade 4 carcasses were never processed into various sub-primal cuts, their impact on the boxed beef market would never be felt. Therefore, packers could purchase large levels of yield grade 4 cattle and never worry about the large levels affecting the demand for their sub-primal products. As a result, Packer 5 represents the buyer of these yield grade 4 carcasses and then processes these carcasses into the various sub-primal products which affect boxed beef demand.

In making the decision on how to process cattle sent from the procurement phase, packers will consider the costs associated with each fabrication option. While processing costs are largely determined by the number of cattle processed, there are also differences in costs according to how the cattle are processed.

Processing costs for each packer were obtained from the study by Koontz, et al (1994). In their Fed Cattle Market Simulator, the authors developed cost curves for four meat packing firms of different sizes. These costs were based on costs found by Duewer and Nelson (1991). These costs were used as a basis for developing costs curves utilized in the MPPM simulator.

The problem with directly utilizing the cost curves from Koontz, et al. (1994) was that their costs were strictly dependent on the number of animals processed and not on how packers fabricated carcasses. Also, the cost curves combined both killing and processing costs. The problem with this is that the packers in the MPPM simulator do not process yield grade 4 cattle and, therefore, only incur kill costs for yield grade 4 cattle.

The cost curves were, therefore, adjusted to better fit the needs of the MPPM simulator. The first step in adjusting the cost curves was to separate the costs into those for killing and those for processing cattle. Duewer and Nelson (1991) determined the portion of total variable costs that were attributable to killing and processing. It was found that processing costs on average comprised 70.71% of all variable costs while kill costs comprised 29.29% of the costs. Using these values, the cost curves in Koontz, et al. (1994) were separated into two cost curves with one corresponding to kill costs and the other to processing costs. Table 3.22 shows the kill costs for each packer as the number of pens processed changes.

Packer kill costs vary depending upon the number of pens killed. The kill cost curves range from 1 to 20 pens per week, however, packers are allowed to kill and process more then 20 pens. If packers kill more then 20 pens of cattle in a given week, the kill cost incurred by the packer is equal to that of killing twenty pens. When developing the cost curves, Koontz, et al. (1994) assumed that packers would have to contract the processing of cattle to other

Table 3.22 Kill Costs by the Number of Pens Processed Per Week for Each Packer in the MPPM Simulator.

Number Pens Processed	Packer 1 ($/hd.)	Packer 2 ($/hd.)	Packer 3 ($/hd.)	Packer 4 ($/hd.)
1	$97.38	$96.38	$94.92	$94.30
2	$53.21	$52.21	$50.74	$50.20
3	$38.48	$37.48	$36.02	$35.47
4	$31.12	$30.12	$32.09	$32.75
5	$25.76	$26.92	$28.83	$29.71
6	$22.71	$23.81	$25.91	$26.92
7	$20.77	$21.44	$23.39	$24.44
8	**$20.08**	$19.93	$21.32	$22.31
9	$20.82	**$19.41**	$19.77	$20.57
10	$23.17	$19.97	$18.80	$19.28
11	$27.27	$21.73	**$18.46**	$18.47
12	$29.29	$24.83	$18.82	**$18.19**
13	$29.29	$29.29	$19.93	$18.48
14	$29.29	$29.29	$21.86	$19.40
15	$29.29	$29.29	$24.66	$20.98
16	$29.29	$29.29	$28.39	$23.27
17	$29.29	$29.29	$29.29	$26.32
18	$29.29	$29.29	$29.29	$29.29
19	$29.29	$29.29	$29.29	$29.29
20	$29.29	$29.29	$29.29	$29.29

[a] Source: Koontz, et al (1994).

plants once they went over 50% of their low cost level. Therefore, costs for processing pens of cattle over 50% of their low cost level are considered to be the same as processing twenty pens because it is assumed those pens would have to be contracted out[17].

[17] The point at which the packer is assumed to contract out the processing of cattle differs for each simulated packer in the MPPM simulator. The number of pens at which packers will begin to contract out cattle are 12, 13, 17, and 18 for Packers One, Two, Three, and, Four, respectively.

Each packer has a specific number of pens to process that minimize its costs. Packer One is assumed to be the smallest of the packers minimizing its average kill cost by killing 8 pens per week. On the other hand, Packer Four is assumed to be the largest packer minimizing its average costs by killing 12 pens per week. It is assumed that the economies of scale exist in terms of kill costs as Packer 4 has the lowest per head cost of all packers operating at their low cost level.

In the same sense that kill costs were found, processing costs for different numbers of pens processed were found using the cost curves from Koontz, et al. (1994). However, the problem with using cost curves that only depend on the number of pens processed is that they do not reflect the differences in costs resulting from different fabrication options or the differences in processing cost associated with processing different yield grades of cattle.

Each fabrication option results in different cuts being produced. As indicated previously, often the difference in a cut produced under one option and another produced under a different option is the degree of processing required to produce the cut. One cut may require more trimming or may require a larger cut to be separated into several parts. When more time and effort is spent in producing one cut versus another, there can be expected to be differences in costs associated with the production of each cut. Also, the different yield grades will contain different levels of external fat. The more external fat, the more trimming involved and, therefore, the higher the costs and the lower the percentage yields.

Per head processing costs for producing sub-primal cuts under each fabrication option and yield grade[18] in the MPPM simulator were obtained from Dr. H. Glen Dolezal, Meat Scientist with the Animal Science Department at Oklahoma State University. These costs were based on tests conducted at a commercial meat packing plant and personal experiences. These per head costs were assumed to be associated with a large meat packing firm processing numbers of cattle that minimized costs.

Given that assumption, cost estimates obtained from the Dr. H. Glen Dolezal were assumed to be for Packer Four[19] processing 12 pens of cattle per week. In order to determine the per head costs for the other packers producing at their low cost level, the data obtained from the Dr. Dolezal were adjusted using information from Koontz, et al. (1994).

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[18] The per head processing costs were obtained for each of the fabrication option/yield grade combinations in Tables 3.16-3.20.

[19] Since the cost obtained from Dr. H. Glen Dolezal were assumed to be those for a large firm processing at the low point of its cost curve, these costs were taken to be the costs for the largest packer in the MPPM simulator producing at its low cost level. From Table 3.21, it can be seen that Packer Four is the largest packer and that the number of pens that minimize costs is 12 pens per week.

As indicated earlier, cost curves for each packer from Koontz, et al. (1994) were separated into two cost curves, one for killing and one for processing. The per head processing cost associated with processing the low cost number of pens was found for each packer. Then, the percent difference between per head costs at the low point of the cost curve for the other packers and Packer Four were calculated. Therefore, estimates of the difference in per head costs between Packer Four and each of the other packers were used to adjust the cost figures obtained from Dr. Dolezal to obtain lowest per head cost for each fabrication option/yield grade combination for Packers One, Two, and Three. The costs calculated were the costs associated with Packer One processing eight pens, Packer Two processing nine pens and Packer Three processing 11 pens.

After these calculations, costs for each packer were known for processing only their individual low cost level number of pens. Costs were needed that reflected the differences when different number of pens were processed. To do this, the processing cost curves for each packer derived from Koontz, et al. (1994) were again used. The percent differences in costs between processing the low cost number of pens and the costs associated with processing all other numbers of pens were calculated for each packer.

These percent differences were then used to adjust the cost values previously calculated that related the cost for each packer processing their optimal number of pens. Therefore, cost curves for each packer could be calculated that reflected the differences in costs associated with changes in the number of pens processed, the processing option chosen, and the yield grade of the cattle (Appendix B).

Processing costs for processing each primal were determined for each packer. Processing costs are also differentiated by the fabrication option chosen to process the primal and the yield grade of the carcass producing the primal. As with kill costs, each packer has a specific number of pens that it can process that will minimize the costs associated with each fabrication option/yield grade combination for each primal. Therefore, packers can attempt to minimize costs by processing that specific number of pens.

Packers can also reduce processing costs by choosing those fabrication options that have lower associated costs. For each primal, a fabrication option can be found that has the lowest costs of processing that primal. If a packer wanted to minimize its costs, it could simply choose to process all of a particular primal under that lowest cost fabrication option[20]. The packer would process all of the

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[20] By minimizing the cost of processing cattle, the packer does not, however, necessarily generate the greatest profit. While costs decrease, the products generated are generally lower valued.

primal by that low cost fabrication option regardless of the yield grade of the primal. Examining the cost figures finds that if a fabrication option is the lowest cost for processing one yield grade of a primal then it is also the lowest cost for processing all yield grades of the primal.

Packers are given input forms (see Appendix C) at the start of every period that allow each packer to specify their fabrication options to the game manager. The four participant packers have the freedom to choose among the fabrication options. Any combination of fabrication options can be utilized by the packers as long as the percentages of the primal processed under all fabrication options sum to one. Packer Five sets its fabrication options by taking an average of the fabrication options used by the other four packers. Therefore, Packer Five will produce, on average, the same products as other packers.

After the packers' fabrication options are entered, the MPPM simulator reports the amount of each of the meat products generated. As mentioned earlier, both U.S. Choice and Select meat products are produced depending on the quality grade of the animal from which they were produced. Therefore, the MPPM simulator reports to each packer its production of both U.S. Select and Choice sub-primal products.

Along with the report of meat production, the MPPM simulator reports the costs associated with producing that particular quantity of meat. Processing costs described earlier are used to determine both processing and killing costs for the cattle processed.

The kill and processing cost curves are based on a weeks worth of kill. Since the MPPM simulator is designed with half-week rounds, packer costs per half week had to be determined. A simple way of doing this is to divide weekly costs by one-half. However, the MPPM simulator makes use of the cost curves described by assuming that the packer will process the same amount of cattle in both half-week rounds.

The MPPM simulator, therefore, assumes that the number of pens processed in a half-week period represents half of the cattle that will processed for the entire week. As a result, <u>per head</u> costs for cattle processed in a half-week period are assumed to be the costs of processing double that amount. Therefore, per head costs charged to each packer is that cost for double the amount it is currently processing.

To determine per head costs, the MPPM simulator searches up and down the cost curves until the cost is determined for the particular amount of cattle that is being processed. The per head cost curves described earlier are expressed in terms of full pens of cattle. Per head cost can be determined directly from the cost curves for processing any whole number of pens from 1 to 20. However, packers are allowed to kill and process half pens. Also, since the packers do not process yield grade 4 cattle, the number of cattle that are processed (i.e. yield grade 1 to 3) may not be a full pen. As a result, a linear interpolation method is utilized to determine the cost associated with processing portions of pens.

The easiest way to convey how the linear interpolation process works is with an example. Assume that the number of pens that a packer will process is 2.3 pens (i.e. 230 head of cattle). The MPPM simulator first doubles that number to bring the number of cattle processed into a weekly basis. Therefore, the MPPM simulator would apply a per head cost associated with 4.6 pens (460 head) which is double the number of cattle actually processed. As mentioned earlier, however, the cost curves are expressed in terms of full pens. There are no costs specifically associated with 4.6 pens.

The cost per head is obviously somewhere within a range of costs for processing four and five pens of cattle. Therefore, the MPPM simulator takes a linear interpolation to determine the per head costs associated with 4.6 pens. The form of the linear interpolation is (in terms of the example):

$$\text{Cost/Hd} = \text{Cost}_L + ((\text{Cost}_H - \text{Cost}_L) * \%\text{Interval}) \tag{3.1}$$

where: Cost/Hd is the cost per head for processing or killing the given pens of cattle (i.e. 4.6 pens),

$Cost_L$	is the cost per head for processing or killing the lower end of the range (i.e. 4 pens)
$Cost_H$	is the cost per head for processing or killing the upper end of the range (i.e. 5 pens)
% Interval	is the percentage of the interval that must be traveled.

The % Interval is the distance traveled within the range. The distance traveled within the range is simply the portion of the pen. In the example, the distance traveled is 60 percent.

Given the per head costs, the total cost of processing the cattle can be determined. While calculating total kill cost is determined simply by multiplying per head cost by total head, determining total processing costs is considerably more difficult. The problem arises in that there is a cost for each of the fabrication options and yield grade combinations. Therefore, costs are determined first by determining the costs of processing cattle under each fabrication option and then summing these values to get a total processing cost. To determine total costs for utilizing each fabrication option for each yield grade of cattle, the following equation is utilized:

$$PROC_{ijk} = (NUM_k * POC_{ijk} * PHC_{ijk}) \quad (3.2)$$

where: $PROC_{ijk}$ is the total processing cost of utilizing the *i*th fabrication option in processing the *j*th primal of the *k*th yield grade,

NUM_k is the number of cattle processed of the *k*th yield grade,

POC_{ijk} is the percentage of the *j*th primal of the *k*th yield grade to be processed under the *i*th fabrication option,

PHD_{ijk} is the per head cost of utilizing the *i*th fabrication option in processing the *j*th primal of the *k*th yield grade.

The above equation, therefore, gives the cost of processing a primal from carcasses of a particular yield grade using a certain option.

To determine the total costs of processing all cattle of a particular yield grade, the MPPM simulator sums the values found from equation 3.2 by yield grade. This value is then divided by the number of cattle of the particular yield grade to determine a per head processing cost for processing all primals of all carcasses within that yield grade. Therefore, the MPPM simulator is able to report per head costs of processing each yield grade of carcasses as well as the per head kill cost of killing each yield grade of animal.

Finally, costs per pound of salable product is given for each carcass yield grade. To determine these values, total processing and killing costs for a particular yield grade are divided by the amount of meat produced from that carcass yield grade.

Costs are reported for each half-week period. As mentioned earlier, per head costs for each half-week period are determined by doubling the amount of cattle actually slaughtered and processed. This is done to put costs on a whole week basis. However, at the end of the final period of the week, the MPPM simulator determines costs for each packer for the entire week of operations in the slaughtering and processing phase.

To determine costs for the entire week, the MPPM simulator takes a weighted average of costs from each of the two half-week periods. Determining costs for the entire week are, therefore, straight forward if the packer has processed cattle in both half-week periods. However, if the packer did not process cattle in one of the half-week periods, the determination of costs for the entire week is a little more involved.

If a packer did not process cattle in one half-week period, the costs incurred by the packer are fixed costs (Table 3.23). As with the variable costs discussed above, fixed costs are based on a whole week's operations. As a result, the fixed costs for a half week are assumed to be half of the costs for the entire week.

Since costs are reported to packers by each yield grade, the fixed costs are divided among the yield grades depending on the ratio of the yield grade to the total number of carcasses processed. Once fixed costs are divided

Table 3.23 Fixed Kill and Processing Costs for Packers in the MPPM Simulator.

Packer	Kill Cost ($)	Processing Cost ($)	Total Fixed Cost ($)
Packer 1	8,834.43	26,230.09	35,064.52
Packer 2	9,606.70	28,523.17	38,129.87
Packer 3	11,167.65	33,158.01	44,325.66
Packer 4	12,003.18	35,638.90	47,642.08

among the yield grades, the costs from the half-week in which the packer did process carcasses are added to these to get a cost for the entire week. If the packer did not process carcasses in any of the half-week periods, costs for the entire week are simply the sum of the fixed costs from each half-week period.

Packer Five also kills and processes cattle in each half-week period. The per head total costs for Packer Five are assumed to be constant regardless of the number of cattle processed and regardless of the fabrication option chosen. Packer Five's kill costs are assumed to be $20.50 per head while processing costs are assumed to be $82.97 per head.

The cost values for Packer Five figures can be changed by the game manager at any time during the simulation. The game manager may wish to either increase or decrease Packer Five's cost. If the game manager wishes for Packer Five to become less involved in the fed cattle market, increasing its costs will reduce the price Packer Five will bid for cattle. Likewise, if its costs are reduced, Packer Five will become more aggressive in its bidding for live cattle.

Unlike the other packers, Packer Five does not have any fixed costs because Packer Five will always be processing cattle. Packer Five is assumed to purchase and process all yield grade 4 carcasses from other packers. Since each pen type has yield grade 4 cattle, Packer Five will always be processing cattle. The yield grade 4 cattle that are processed by Packer Five are in addition to the cattle that Packer Five is able to purchase in the procurement phase. Therefore, Packer Five will process all cattle it purchases (included the yield grade 4's) as well as the yield grade 4 cattle purchased by the other packers in the industry.

SALES

Meat produced in the slaughtering and processing phase is available for sale the period after it is produced. A half-week delay is incorporated into the MPPM simulator from the slaughtering and processing phase to the sales phase to represent the carcass chill time required. Therefore, meat produced in one period cannot be sold until the next period.

Several decisions must be made by the packers in the sales phase. For each of the 50 meat products produced, packers must determine how much of each to sell and the offer price. At the beginning of each period, packers are given updated inventories that report the total amount and inventory age of each cut in inventory (see Appendix C).

From this information packers are asked to determine the pounds of each meat product to sell and its sell/offer price.

During each period, input forms are given to packers to relay their decisions to the game manager. These input forms also report the price at which the packer offered each item last period and the amount of each product it was able to sell at that price. If the packers are satisfied with the results from last period, the packer simply leaves the input form blank. The MPPM simulator then assumes that the quantity sold last period and the price offered last period reflect the packer's current offer. However, the packer can adjust the price and quantity of any of the meat products it wishes. Prices can be adjusted without adjusting the quantity offered as well as quantities being adjusted without the offer prices being changed. Finally, adjustments can be made for a single product or several products without changing the offers for the other products.

In making decisions about prices and quantities, a packer is constrained by two limiting factors. The first of which is a storage limitation. Each packer is assumed to be able to store a finite supply of meat products. It is assumed that each packer can store about 2 to 3 days of normal kill in its coolers. If a packer has more quantity than it is able to store, it is assumed that the packer will be forced to sell meat at discounted prices.

The storage constraint is based on a packer's normal kill. Normal kill refers to the amount of meat that a packer produces during an average week. To determine the normal kill of each packer, the initial step was to determine the normal kill for the simulated industry. The simulated industry is based on selling and processing 40 pens of cattle per week. With 40 pens of cattle, each packer should be able to purchase the number of pens that will result in them producing at the low points of their cost curves[21].

Forty pens of cattle, therefore, constitute the normal amount of cattle that would be killed and processed in a week. The forty pens, however, could consist of a variety of animal types and sizes. Therefore, a base pen of cattle was determined that was assumed to represent the type of cattle purchased in a normal week. The base pen (Appendix A) was developed by taking an average of the middle ranges of pen types (i.e. Pen Types 4, 5, 6, and 7). When developing the base pen type, care was taken to ensure that the type of cattle within the pen were consistent with those found in the carcass data from the Cattlemen's Carcass Data

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[21] Each packer has a specific number of pens of cattle that result in them being on the low point of their cost curves. Looking at Tables 3.21 to 3.41 will show that the number of pens that result in low costs are 8, 9, 11, and 12 for Packers One, Two, Three, and Four, respectively. Adding up the pens for each packer results in a 40 pen per week industry total (i.e. 8+9+11+12=40). Packer Five is assumed to not be involved in the industry as long as the other packers purchase cattle at their low cost level.

Service data set discussed earlier. Also, the number of cattle grading in each yield grade within the two quality grades (i.e. the number of yield grade 1 cattle that are U.S. Select) was based on data obtained from the National Beef Quality Audit to ensure the realism of the base pen type.

Assuming that the base pen type represented the type of cattle that would be killed and processed in a normal week, the amount of meat that would be produced in a normal week could be determined. As mentioned earlier, there exists a number of ways in which cattle may be processed. Therefore, a base set of fabrication options had to be determined.

The base set of fabrication options was assumed to be, on average, the manner in which cattle were processed. Interviews with Dr. H. Glen Dolezal, Meat Scientist at Oklahoma State University, were conducted to obtain estimates of these base fabrication options. Based on experience with the packing industry and several test studies, Dr. Dolezal was able to provide a set of options that would normally be utilized in processing cattle. Table 3.24 gives the percentage of each option used in processing primals in a normal week's operations. Percentages represent the portion of the primals that are to be processed under the specific fabrication option.

The base fabrication options given in Table 3.24 are assumed to be applicable to all yield grades of cattle.

Table 3.24 Percentages of Each Fabrication Option Utilized In Processing Cattle in a Normal Week.

Primal	Option 1 (%)	Option 2 (%)	Option 3 (%)	Option 4 (%)
Rib	80.00	20.00	NA[a]	NA
Loin	50.00	30.00	10.00	10.00
Chuck	20.00	80.00	NA	NA
Round	45.00	10.00	45.00	NA
Other	100.00[b]	100.00[b]	100.00[b]	NA

[a] Indicates that the fabrication option is not available for the particular primal.
[b] The classification called "Other" is made up of three primals. This classification can be thought of as three distinct primals with each having one fabrication option.

Recall that packers must determine how to process each primal for each of the yield grades of cattle. Therefore, it is assumed that the base fabrication options are the same regardless if processing yield grade 1 cattle or yield grade 4 cattle.

Utilizing these fabrication options to process 40 pens of the base pen type allows determining the amount of each meat product produced in a normal week by the entire industry. Therefore, the amount of meat that each packer is assumed to produce in a normal week can be thought of as being a portion of total industry production.

The amount of meat production for each packer is determined by calculating what percentage of total industry production is attributable to each packer. Since 40 pens of the same type of cattle (i.e. base pen type) were assumed to constitute a normal week's kill and since all 40 pens are assumed to processed in the same manner, the packer's contribution to the industry total can be thought of as the number of pens that the packer would have purchased of these 40 pens.

As mentioned earlier, each packer has a number of pens that will minimize its kill and processing costs. Assuming a packer would attempt to purchase that number of pens, its portion of the industry's meat production is the same as its portion (or market share) of the total 40 pens it is assumed to have purchased.

The amount of each product produced by each packer in a normal week can, therefore, be determined by multiplying the industry total by the packer's market share. This can be expressed in the following equation:

$$NORM_{ij} = NORM_i * PER_j \tag{3.3}$$

where: $NORM_{ij}$ is the amount of the *i*th meat product produced by the *j*th meat packer in a normal week,

$NORM_i$ is the amount of the *i*th meat product produced by the industry in a normal week,

PER_j is the percentage of the industry's total attributable to the *j*th packer.

The percentage (market share) of the industry's total attributable to each packer (PER_j) is the number of pens assumed each packer will purchase of the 40 available in the industry. The normal market shares are 20%, 22.5%, 27.5%, and 30% for Packers One, Two, Three, and Four, respectively.

The normal market shares are simply the ratio of each packers purchases to the industry total. For example, Packer One is assumed to purchase 8 of the 40 pens which is a 20% market share. The total amount of meat produced by the packer in a normal week is determined by summing the amount of each cut produced in a normal week for a given packer ($NORM_{ij}$) over all cuts[22].

Given the amount of each cut produced by each packer in a normal week, a capacity level can be determined for each cut and each packer. As mentioned earlier, the amount of meat that a packer can hold in inventory is assumed to be two to three days of normal kill. Since the normal kill is expressed in terms of weeks, the capacity level had to also be converted on a weekly basis. Assuming a packer operates a 5 day week, the amount that a packer could hold in inventory would range anywhere from 40% to 60% of there normal weekly kill (i.e. 2/5=40% and 2/5=60%).

Initial verification of the simulator suggested that determining a capacity limit was extremely important. If the capacity limit was set too restrictive, participants would have very little ability to hold on to meat in hopes of demand increasing in coming periods. Also, if the limit was set too leniently, participants would not have to worry about having to sell meat at discounted prices and,

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[22] The total amount of meat produced by a packer in a normal week ($NORM_j$) can be found with by summing the individual cut amounts: $NORM_j = \sum_{i=1} NORM_{ij}$.

therefore, severely dampening the impact of the storage constraint. An inventory capacity of 66% of normal weekly kill is believed to be somewhat larger than the capacity typically present in the industry. However, daily sales decisions are present in reality, while the MPPM simulator only permits two sales periods. Hence, it was deduced that a slightly larger and more flexible inventory capacity was reasonable to have given the restriction of adjusting sale offer prices and quantities only twice per week.

The capacity limit imposed was 66% of weekly kill. It was found that this limit was lenient enough to allow packers to carry inventories long enough to possibly benefit from changing demand as well as being restrictive enough so that if packers were lapsed in their inventory control that penalties would accrue.

Tables 3.25-3.28 give the capacity levels for each cut for the four participant packers. The tables also give the weekly kill for the entire industry. The first four columns of Tables 3.25-3.28 give the base quantities and prices. The base quantities are the amount of each product that would be produced in the industry in a normal week. Likewise, base prices are the prices that would be received for these products in a normal week[23].

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[23] Base quantities and prices are used in the determination of meat sales to each packer in each half-week period. The process with which sales are determined in the MPPM simulator will be discussed in more detail later in the chapter.

The next two columns are the amount of each product that the particular packer would produce in a normal week. These numbers are determined using Equation (3.3). The final two columns are the amount of each cut that the packer can hold in inventory at any one time. These values are found by simply multiplying the normal week's kill value by 66%.

As may be expected, Packer Four has the most storage capabilities. Since Packer Four is assumed to process 12 of the 40 pens processed in a week, it follows that it would be able to store more meat than other packers. This can be seen more clearly in Table 3.29.

Table 3.29 gives the total amount of meat produced by each packer in a normal week and the total amount of meat that each packer can hold in inventory at any one time. The capacity of the packers increase by 50% from Packer One to Packer Four. The production level for Packer Five is the same as that for the industry. Packer Five enters the live cattle market only when other packers do not purchase all cattle available or do not offer prices high enough to purchase cattle. However, Packer Five is assumed to be willing to purchase all cattle supplied if no other packer bids higher than his reservation price.

Given that each packer can hold 66% of their normal kill in inventory, this requires each packer to sell at least 34% of its normal kill each week in order to free cold

Figure 3.25 Packer One Storage Capacities by Individual Meat Product.

	-U.S. Select- Base Quantity	Base Price	-U.S. Choice- Base Quantity	Base Price	Weekly Kill Select	Weekly Kill Choice	Capacity Select	Capacity Choice
127A Lip-On Ribeye	38,315	$3.64	38,911	$4.22	7,663	7,782	5,058	5,136
107 3X4 Ribeye	20,010	$2.23	20,791	$3.53	4,002	4,158	2,641	2,744
123A Short Rib	13,301	$2.49	13,775	$3.43	2,660	2,755	1,756	1,818
124 Back Rib	10,871	$0.62	11,259	$0.61	2,174	2,252	1,435	1,486
174 Short Loin	27,319	$1.47	28,221	$1.64	5,464	5,644	3,606	3,725
175 Strip Loin	7,624	$2.27	7,880	$2.52	1,525	1,576	1,006	1,040
180 Strip Loin	33,716	$2.65	34,845	$3.36	6,743	6,969	4,451	4,600
184 Top Butt	44,328	$1.66	46,232	$1.95	8,866	9,246	5,851	6,103
Bone-In Top Butt	6,778	$1.25	7,069	$1.47	1,356	1,414	895	933
Tenderloin	14,494	$6.47	14,723	$6.95	2,899	2,945	1,913	1,943
113B Square-Cut Neck-Off	63,080	$0.85	65,576	$0.86	12,616	13,115	8,327	8,656
115 2-Pc. Boneless Chuck	233,399	$0.99	242,246	$1.00	46,680	48,449	30,809	31,976
Top Inside Round	77,603	$1.38	80,570	$1.42	15,521	16,114	10,244	10,635
170 Gooseneck Round	46,499	$1.16	48,222	$1.19	9,300	9,644	6,138	6,365
167 Knuckle	19,131	$1.29	19,868	$1.33	3,826	3,974	2,525	2,623
167A Peeled Knuckle	16,493	$1.50	17,103	$1.55	3,299	3,421	2,177	2,258
161 Round, Boneless	23,220	$1.28	24,055	$1.31	4,644	4,811	3,065	3,175
171B Outside Round	22,813	$1.30	23,303	$1.33	4,563	4,661	3,011	3,076
Eye of Round	10,092	$1.31	10,289	$1.34	2,018	2,058	1,332	1,358
193 Flank Steak	6,958	$2.66	7,108	$2.65	1,392	1,422	919	938
120 Brisket	40,621	$0.94	41,746	$0.93	8,124	8,349	5,362	5,510
Pastrami	18,601	$1.79	19,147	$1.77	3,720	3,829	2,455	2,527
Thin Meats	74,968	$1.81	77,292	$1.83	14,994	15,458	9,896	10,203
75% Trimmings	174,331	$0.74			34,866		23,012	
50% Trimmings	335,297	$0.50			67,059		44,259	
Fat	337,033	$0.21			67,407		44,488	
Bone	321,852	$0.16			64,370		42,484	

Figure 3.26 Packer Two Storage Capacities by Individual Meat Product.

	-U.S. Select-		-U.S. Choice-		Weekly Kill		Capacity	
	Base Quantity	Base Price	Base Quantity	Base Price	Select	Choice	Select	Choice
127A Lip-On Ribeye	38,315	$3.64	38,911	$4.22	8,621	8,755	5,690	5,778
107 3X4 Ribeye	20,010	$2.23	20,791	$3.53	4,502	4,678	2,971	3,087
123A Short Rib	13,301	$2.49	13,775	$3.43	2,993	3,099	1,975	2,046
124 Back Rib	10,871	$0.62	11,259	$0.61	2,446	2,533	1,614	1,672
174 Short Loin	27,319	$1.47	28,221	$1.64	6,147	6,350	4,057	4,191
175 Strip Loin	7,624	$2.27	7,880	$2.52	1,715	1,773	1,132	1,170
180 Strip Loin	33,716	$2.65	34,845	$3.36	7,586	7,840	5,007	5,174
184 Top Butt	44,328	$1.66	46,232	$1.95	9,974	10,402	6,583	6,865
Bone-In Top Butt	6,778	$1.25	7,069	$1.47	1,525	1,590	1,007	1,050
Tenderloin	14,494	$6.47	14,723	$6.95	3,261	3,313	2,152	2,186
113B Square-Cut Neck-Off	63,080	$0.85	65,576	$0.86	14,193	14,755	9,367	9,738
115 2-pc. Boneless Chuck	233,399	$0.99	242,246	$1.00	52,515	54,505	34,660	35,974
Top Inside Round	77,603	$1.38	80,570	$1.42	17,461	18,128	11,524	11,965
170 Gooseneck Round	46,499	$1.16	48,222	$1.19	10,462	10,850	6,905	7,161
167 Knuckle	19,131	$1.29	19,868	$1.33	4,304	4,470	2,841	2,950
167A Peeled Knuckle	16,493	$1.50	17,103	$1.55	3,711	3,848	2,449	2,540
161 Round, Boneless	23,220	$1.28	24,055	$1.31	5,225	5,412	3,448	3,572
171B Outside Round	22,813	$1.30	23,303	$1.33	5,133	5,243	3,388	3,461
Eye of Round	10,092	$1.31	10,289	$1.34	2,271	2,315	1,499	1,528
193 Flank Steak	6,958	$2.66	7,108	$2.65	1,566	1,599	1,033	1,055
120 Brisket	40,621	$0.94	41,746	$0.93	9,140	9,393	6,032	6,199
Pastrami	18,601	$1.79	19,147	$1.77	4,185	4,308	2,762	2,843
Thin Meats	74,968	$1.81	77,292	$1.83	16,868	17,391	11,133	11,478
75% Trimmings	174,331	$0.74			39,224		25,888	
50% Trimmings	335,297	$0.50			75,442		49,792	
Fat	337,033	$0.21			75,832		50,049	
Bone	321,852	$0.16			72,417		47,795	

Figure 3.27 Packer Three Storage Capacities by Individual Meat Product.

	-U.S. Select-		-U.S. Choice-					
	Base Quantity	Base Price	Base Quantity	Base Price	Weekly Kill Select	Weekly Kill Choice	Capacity Select	Capacity Choice
127A Lip-On Ribeye	38,315	$3.64	38,911	$4.22	10,537	10,701	6,954	7,062
107 3X4 Ribeye	20,010	$2.23	20,791	$3.53	5,503	5,718	3,632	3,774
123A Short Rib	13,301	$2.49	13,775	$3.43	3,658	3,788	2,414	2,500
124 Back Rib	10,871	$0.62	11,259	$0.61	2,989	3,096	1,973	2,043
174 Short Loin	27,319	$1.47	28,221	$1.64	7,513	7,761	4,958	5,122
175 Strip Loin	7,624	$2.27	7,880	$2.52	2,097	2,167	1,384	1,430
180 Strip Loin	33,716	$2.65	34,845	$3.36	9,272	9,582	6,119	6,324
184 Top Butt	44,328	$1.66	46,232	$1.95	12,190	12,714	8,045	8,391
Bone-In Top Butt	6,778	$1.25	7,069	$1.47	1,864	1,944	1,230	1,283
Tenderloin	14,494	$6.47	14,723	$6.95	3,986	4,049	2,631	2,672
113B Square-Cut Neck-Off	63,080	$0.85	65,576	$0.86	17,347	18,033	11,449	11,902
115 2-pc. Boneless Chuck	233,399	$0.99	242,246	$1.00	64,185	66,618	42,362	43,968
Top Inside Round	77,603	$1.38	80,570	$1.42	21,341	22,157	14,085	14,623
170 Gooseneck Round	46,499	$1.16	48,222	$1.19	12,787	13,261	8,440	8,752
167 Knuckle	19,131	$1.29	19,868	$1.33	5,261	5,464	3,472	3,606
167A Peeled Knuckle	16,493	$1.50	17,103	$1.55	4,536	4,703	2,994	3,104
161 Round, Boneless	23,220	$1.28	24,055	$1.31	6,386	6,615	4,214	4,366
171B Outside Round	22,813	$1.30	23,303	$1.33	6,274	6,408	4,141	4,230
Eye of Round	10,092	$1.31	10,289	$1.34	2,775	2,830	1,832	1,868
193 Flank Steak	6,958	$2.66	7,108	$2.65	1,914	1,955	1,263	1,290
120 Brisket	40,621	$0.94	41,746	$0.93	11,171	11,480	7,373	7,577
Pastrami	18,601	$1.79	19,147	$1.77	5,115	5,265	3,376	3,475
Thin Meats	74,968	$1.81	77,292	$1.83	20,616	21,255	13,607	14,028
75% Trimmings	174,331	$0.74			47,941		31,641	
50% Trimmings	335,297	$0.50			92,207		60,856	
Fat	337,033	$0.21			92,684		61,172	
Bone	321,852	$0.16			88,509		58,416	

Figure 3.28 Packer Four Storage Capacities by Individual Meat Product.

	-U.S. Select-		-U.S. Choice-		Weekly Kill		Capacity	
	Base Quantity	Base Price	Base Quantity	Base Price	Select	Choice	Select	Choice
127A Lip-On Ribeye	38,315	$3.64	38,911	$4.22	11,494	11,673	7,586	7,704
107 3X4 Ribeye	20,010	$2.23	20,791	$3.53	6,003	6,237	3,962	4,117
123A Short Rib	13,301	$2.49	13,775	$3.43	3,990	4,133	2,634	2,728
124 Back Rib	10,871	$0.62	11,259	$0.61	3,261	3,378	2,152	2,229
174 Short Loin	27,319	$1.47	28,221	$1.64	8,196	8,466	5,409	5,588
175 Strip Loin	7,624	$2.27	7,880	$2.52	2,287	2,364	1,510	1,560
180 Strip Loin	33,716	$2.65	34,845	$3.36	10,115	10,453	6,676	6,899
184 Top Butt	44,328	$1.66	46,232	$1.95	13,298	13,870	8,777	9,154
Bone-In Top Butt	6,778	$1.25	7,069	$1.47	2,033	2,121	1,342	1,400
Tenderloin	14,494	$6.47	14,723	$6.95	4,348	4,417	2,870	2,915
113B Square-Cut Neck-Off	63,080	$0.85	65,576	$0.86	18,924	19,673	12,490	12,984
115 2-pc. Boneless Chuck	233,399	$0.99	242,246	$1.00	70,020	72,674	46,213	47,965
Top Inside Round	77,603	$1.38	80,570	$1.42	23,281	24,171	15,365	15,953
170 Gooseneck Round	46,499	$1.16	48,222	$1.19	13,950	14,466	9,207	9,548
167 Knuckle	19,131	$1.29	19,868	$1.33	5,739	5,960	3,788	3,934
167A Peeled Knuckle	16,493	$1.50	17,103	$1.55	4,948	5,131	3,266	3,386
161 Round, Boneless	23,220	$1.28	24,055	$1.31	6,966	7,217	4,598	4,763
171B Outside Round	22,813	$1.30	23,303	$1.33	6,844	6,991	4,517	4,614
Eye of Round	10,092	$1.31	10,289	$1.34	3,027	3,087	1,998	2,037
193 Flank Steak	6,958	$2.66	7,108	$2.65	2,088	2,132	1,378	1,407
120 Brisket	40,621	$0.94	41,746	$0.93	12,186	12,524	8,043	8,266
Pastrami	18,601	$1.79	19,147	$1.77	5,580	5,744	3,683	3,791
Thin Meats	74,968	$1.81	77,292	$1.83	22,490	23,188	14,844	15,304
75% Trimmings	174,331	$0.74			52,299		34,518	
50% Trimmings	335,297	$0.50			100,589		66,389	
Fat	337,033	$0.21			101,110		66,733	
Bone	321,852	$0.16			96,556		63,727	

Table 3.29 Total Meat Production and Storage Capacity for Packers in a Normal Week of Operations.

Packer	Normal Weekly Kill (Select and Choice) (lbs.)	Storage Capacity (Select and Choice) (lbs.)
Packer 1	587,796	387,945
Packer 2	661,270	436,438
Packer 3	808,219	533,425
Packer 4	881,694	581,918
Packer 5	2,938,979	1,939,726

storage area for a normal kill. However, recall that packers have an optimum number of pens to process. If packers process half of this number in each half-week period, packers will be adding to inventory about 50% of their normal week's kill per half-week period. Therefore, if packers are starting with no inventory, packers would be about 16% below their capacity level after adding one-half week of normal kill. Therefore, the packer would need to sell at least 34% of their normal kill to make cooler space available for another normal kill. Thus, within the simulator, packers have some capacity to reduce their sales volume in the short-run and maintain normal kill levels, but in the long-run (i.e. over more than a few weeks), packers must sell what they kill, unless kill volumes become very small.

The other constraint faced by packers is an age limit on inventoried meat products. It is assumed that each packer has 3 weeks to sell meat products from the time it is added to inventory. If a cut remains in inventory after three weeks of sales have been completed, then that cut is sold at a discounted price.

As with the other two phases, the sales phase is separated into two half-week periods. In each period of the week, packers are allowed to attempt to sell meat products. After making offers of price and quantity, packers are given reports that relay the amount of each product they were able to sell.

Internal in the MPPM simulator is a demand system for all meat products being produced. The MPPM simulator takes prices and quantities offered by the packers and uses the demand system to determine the amount of each product that it will purchase from each packer.

The methodology used in determining meat sales is similar to that described in Trapp (1989). The demand system is driven by a set of own price and cross price elasticities (Appendix D) for each of the 50 meat products sold. Due to data limitations, empirical estimation of these elasticities were not possible. As a result, estimates of elasticities from previous studies were utilized. Capps, et al. (1994) estimated flexibilities for several U.S. Choice sub-primal products. These flexibilities were then inverted to obtain elasticities. The own price elasticities ranged from a low of -1.04 to a high of -4.12.

Chapter Two. The general restrictions are expressed in terms of elasticities and budget shares. Therefore, budget shares for each of the 50 cuts were needed. To do this, base quantities and prices were used. Determining the revenue generated from each cut (i.e. multiplying base quantity times base price), the budget share for a given cut was determined as the ratio of the revenue from the cut to the revenue from all cuts. Also, it was assumed that the income elasticity of each cut was one.

Own price elasticities were determined using the results of the study by Capps, et al. (1994). The cross price elasticities in the upper diagonal portion of the matrix were determined using the assumptions expressed above. By imposing the general restrictions of demand, the lower diagonal cross elasticities were determined.

Once the elasticities were determined, the next step in the procedure was to specify demand curves for each of the 50 cuts. Cobb-Douglas demand equations were determined for each cut. The first step in specifying the demand curves is determining the intercepts of each curve. By rearranging the Cobb-Douglas demand curve, intercepts can be expressed as:

$$a_i = Q_i / (P_1^{e_{i,1}} * \ldots P_{50}^{e_{i,50}}) \tag{3.4}$$

where: a_i is the intercept for the demand curve of the *i*th meat product,

Q_i	is the base quantity for the *i*th meat product,
P_1 to P_{50}	are the base prices for each of the 50 meat products,
$e_{i,1}$ to $e_{i,50}$	are own and cross price elasticities.

The intercepts are determined using the base quantities and prices described earlier[24]. Once these intercepts are determined, demand curves can be specified for each of the 50 meat products. The demand curves are of the form:

$$Q_i = a_i^* P_1^{e_{i,1}} * \ldots * P_{50}^{e_{i,50}}) \qquad (3.5)$$

where:

Q_i	is the quantity demanded of the *i*th meat product,
a_i^*	is the intercept calculated from the base quantities and prices,
$P_1 \ldots P_{50}$	are offer prices for each of the meat products,
$e_{i,1} \ldots e_{i,50}$	are own and cross price elasticities.

Given prices, the quantity demanded for each product can be determined using demand equations of the form of Equation (3.5).

Prices used in determining the quantity demanded of each meat cut are determined based on the prices and

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[24] Base quantities were obtained by processing 40 pens of the base pen type using the base processing options. Base prices are 1995 average weekly prices obtained from the USDA publication: *Livestock, Meat, Wool Market News Weekly Summary and Statistics*.

quantities offered by the packers. Each packer offers a given quantity of a meat product for sale at a given price. Therefore, for each cut, five price and quantity offers are given, one from each packer. From these offers, a single weighted average price must be calculated to use in equation (3.5) in determining the quantity demanded. If, for any reason, all packers in the industry fail to make offers for a particular item, the weighted average price would be zero. With zero prices the demand system defined earlier is undefined. Therefore, if no offer is made for a particular item, the simulator defaults the weighted average price to the base price for that particular item.

A weighted average price is, therefore, determined for each meat cut from offers by each packer and is assumed to be the transaction price of the meat sold. Weighted average prices are then plugged into equation (3.5) to determine the quantity demanded for each cut. Prices are calculated using the following equation:

$$WAP_i = \sum_{j=1}^{n} PO_{ij} * (QO_{ij} / TQ_i) \tag{3.6}$$

where: WAP_i is the average weighted price of the *i*th meat product,

PO_{ij} is the offer price for the *i*th meat product by the *j*th packer,

QO_{ij} is the quantity of the *i*th meat product offered for sale by the *j*th packer,

TO_i is the quantity of the *i*th meat product offered for sale by the entire industry.

Weighted average prices for all 50 cuts are then plugged into each demand equation to determine the quantity demanded given a set of prices.

The quantity demanded determined with the calculated prices are the initial levels given these initial prices. However, the quantity demanded will not generally match the quantities offered. Thus, an iterative process is used to determine the actual quantity that will be purchased by the simulator. The iterative process begins by finding the initial demand quantities for all 50 cuts.

These initial quantities can be thought of as a first offer of purchase by a buyer (which is the simulator). Therefore, the initial values found for the quantities demanded represent the total amount of each cut the buyer is willing to purchase. The buyer will purchase meat from several packers until it has purchased that total amount. The MPPM simulator will purchase meat first from the packer that offered the meat at the lowest price. If the buyer is not able to purchase the total amount demanded from the first packer, it will purchase from the packer that offered the meat at the next lowest price. The buyer will continue this process until it has purchased a quantity of meat equal to the value found for quantity demanded. Unless the buyer purchases all of the meat offered, the average price of its purchases will be lower then the price calculated from the packers' offers (i.e. the price calculated in Equation 3.6). This follows since the lowest price meat is purchased by the buyer first.

If the buyer is willing to purchase a quantity greater than that offered by the industry (i.e. the sum of all packers' offers), the iterative process is completed. At the initial weighted price, the buyer is willing to buy more than that supplied by the packers, but is restricted to buying what is offered.

However, if the quantity that the buyer is willing to purchase is less then the total amount supplied by the packers, the iterative process begins. The next step in the iterative process is to calculate new weighted average prices for the quantities of meat selected for purchase. The new weighted average prices are calculated by the following equation:

$$NWAP_i = \sum_{j=1}^{n} PO_{ij} * (QP_{ij} / TP_i) \qquad (3.7)$$

where: $NWAP_i$ is the new average weighted price of the *i*th meat product,

PO_{ij} is the offer price for the *i*th meat product by the *j*th packer,

QP_{ij} is the quantity of the *i*th meat product the buyer is willing to purchase from the *j*th packer,

TP_i is the total quantity of the *i*th meat product the buyer is willing to purchase.

These new prices are then substituted into the demand equations to determine new values for the quantities demanded. As with the initial prices and quantities demanded, the MPPM simulator will make offers to purchase from the packers amounts that equal the new quantities demanded for each product.

New weighted average prices are calculated and the process continues. The process continues until the average weighted prices determined in two consecutive iterations are the same. When prices in two consecutive iterations are the same, resulting values for quantity demanded will also be the same. This indicates that at that price, the demand system is in equilibrium.

Search algorithms such as the iterative process discussed often use conversion criterions that specify a stopping point for the iterative process. The entire demand system is in equilibrium when the quantity demanded for each cut is the same for two consecutive iterations. However, often it is more practical in terms of computer time, to allow the iterative process to stop just prior to reaching a true equilibrium. The conversion criterion in the MPPM simulator is set so that when the absolute value of the total difference in quantities demanded for two consecutive iterations are less then .001, the iterative solution process stops.

However, as discussed in Chapter Two, since the industry supply curve is a discontinuous step function, there are times when the iterative process may not reach a true equilibrium. In this case, if not stopped, the iterative process could continue indefinitely. Therefore, to avoid this situation, the iterative process is stopped if the total number of iterations exceeds 100.

When the iterative process stops, the values for quantity demanded represent the amount of each cut that the buyer will purchase. The amount of meat that each packer is able to sell is determined by the prices that were offered. The buyer will purchase a particular meat product from the packer that offered it at the lowest price. If after purchasing meat from the that first packer, the buyer has not yet purchased the amount determined as the quantity demanded, the buyer will purchase meat from the packer with the next lowest price. This continues until the buyer has purchased a total quantity equal to that solved for as the quantity demanded at the prices offered. Note that the packer, therefore, will receive the price that it offered but may not be able to sell the quantity that it offered.

At the completion of the iterative process, packers are given a report showing the amount of each cut it was able to sell. The report also shows the amount of revenue generated from the sale of each cut as well as the total revenue received from all sales. In addition, the packer is given an industry summary which gives the average weighted price that each cut was sold at and the total quantity of each cut that was sold.

Other information relayed to packers is a carcass value for U.S. Choice and Select yield grade 2 carcasses. The USDA often reports beef prices in terms of composite carcass values. These values are often used in the industry to determine how strong or weak demand for boxed beef is and to establish a basis for bid prices on live cattle. A general rule of thumb is that packers should buy live cattle at a price that is equal to around 62% or less of the composite carcass price.

While the USDA reports are for composite carcass values, which are usually for a mixture of yield grade 2 and 3 values, the carcass value reported in the MPPM simulator is a value for yield grade 2 carcasses only. The reason for this is that the yield grade 2 cattle are the predominate cattle sold in the MPPM simulator. For each pen type, the largest percentage of the cattle within the pen is always yield grade 2 cattle.

The yield grade 2 carcass values are determined using the transaction price of the meat products sold in the industry. The amount of each meat product that would be produced from a U.S. Choice and Select yield grade 2 steer was determined assuming that it was processed using the base processing options discussed earlier. The weighted average prices are then multiplied by the amount of the corresponding meat products produced from a yield grade 2 steer to determine a total value of meat products from the steer. This is done for both U.S. Choice and Select carcasses. The values are then the carcass values reported by the MPPM simulator.

Also, along with the report on the amount of each product sold by the packer, is a report on the amount of inventory remaining after sales. The MPPM simulator will examine the inventory after sales to determine if any forced sales must be done.

Forced sales refers to selling meat that is either in excess of the storage capacity or the age limitation or both. If forced meat sales are required, a process very similar to the sales process described previously is utilized. The regular sales round was based on quantity dependent demand curves, however, the forced sales are based on price dependent demand curves.

Unlike with the regular sales where elasticities were utilized, in the forced sales, flexibilities are utilized. In order to determine the flexibilities, the elasticity matrix calculated is inverted[25]. Once the flexibilities

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[25] Some discussion in the literature exists regarding the appropriateness of using inverted elasticity matrices as estimates of flexibility matrices. However, it was found that both forms of the demand equations (i.e. price dependent and quantity dependent) resulted in the same price/quantity combination.

were determined, intercepts for the price dependent demand equations were determined using the following equation:

$$b_i = P_i / (Q_1^{f_{i,1}} * \ldots Q_{50}^{f_{i,50}}) \tag{3.8}$$

where: b_i is the intercept for the demand curve of the *i*th meat product,

P_i is the base price for the *i*th meat product,

Q_1 to Q_{50} are the base quantities for each of the 50 meat products,

$f_{i,1}$ to $f_{i,50}$ are own and cross price flexibilities.

Intercepts are determined using the same base quantities and prices described earlier. Once these intercepts are determined, demand curves can be specified for each of the 50 meat products. The demand curves are of the form:

$$P_i = b_i^* Q_1^{f_{i,1}} * \ldots * Q_{50}^{f_{i,50}}) \tag{3.9}$$

where: P_i is the price at which the quantity of the *i*th meat product would be purchased,

b_i^* is the intercept calculated from the base quantities and prices,

$Q_1 \ldots Q_{50}$ are the quantities that must be sold each of the meat products,

$f_{i,1} \ldots f_{i,50}$ are own and cross price flexibilities.

Given quantities of each product that must be sold, the price at which the buyer would be willing to purchase that level can be determined using demand equations of the form of Equation (3.9).

Determining the amount of each cut that must be sold is based on the meat known to be in excess as well as the amount of meat that was sold in the regular sales round. The general principle is that packers were able to sell, collectively, a certain level of meat during regular sales activity. However, in order to adhere to the constraints, packers should have sold more meat then they did. At the prices offered by the packers, the buyer was willing to buy a certain level of meat. To persuade the buyer to purchase more then it had intended, the price for the extra meat must be at a considerable discount. Therefore, the amount of each cut that must be sold (Q_1, ..., Q_{50}) is the amount that was sold in the regular sales plus the amount that is in excess of the constraints.

The quantity of excess meat is determined by examining the inventories of the packers after regular sales have been completed. The manner in which the MPPM simulator checks inventory is somewhat different depending on what part of the week the simulator is currently in (i.e. if currently in the first half-week period or the second half-week period).

In the first half-week period, the MPPM simulator checks inventories purely for the storage constraint. The

MPPM simulator first checks if total inventory exceeds the total capacity level. If total inventory is below the total capacity level, no forced sales are required, even if a particular cut is above its capacity level. This is based on the assumption that a packer will not discount a particular meat product if it is over capacity as long as their is still room in storage, even though the space allocated for the product is full.

If total inventory is above the total capacity level, however, forced sales are required. The MPPM simulator will then go cut by cut and sell any amount that is over the cut's capacity level, selling meat first that has been in inventory the longest.

In the second half-week, the MPPM simulator will check the age limitation in addition to the storage limitation. Any meat that has been in inventory for three weeks is sold. If not sold, this meat would be in inventory for four weeks at the beginning of the next week, which is a violation of the age limitation.

After determining the amount of meat that must be sold due to the age limitation, the MPPM simulator checks the storage limitation. The storage limitation must be checked after the age limitation because by forcing the sale of old meat, the inventory may fall below the storage level. As with the first half-week, the storage capacity is checked by first checking if total inventory remaining is greater then total capacity. If total inventory exceeds capacity, each cut is checked to see if its inventory exceeds its capacity.

Given these quantities, the price dependent demand equations can then be used to determine a price at which the buyer will purchase that quantity of meat. However, this is not the price for which packers sell their excess meat. It is assumed that the sales made in the regular round are binding. Therefore, the quantity purchased by the buyer in the regular sales and the price at which it was purchased is assumed to remain. Therefore, the weighted average price of the meat sold in the regular sales and the price at which the excess meat is sold must be equal to the price solved from the price dependent demand equations. This translates to the following equation:

$$P_i^* = WAP_i * (QS_i / TQS_i) + PFM_i * (EM_i / TQS_i) \tag{3.10}$$

where: P_i^* is price solved from the price dependent equation for the *i*th meat product,

WAP_i is the equilibrium price for the *i*th meat product found in the regular sales,

QS_i is the equilibrium quantity of the *i*th meat product found in the regular sales,

TQS_i is the total quantity of the *i*th meat product that must be sold in forced sales ($TQS_i = QS_i + EM_i$),

EM_i is the amount of the *i*th meat product that is in excess,

PFM_i is the price at which the *i*th meat product is sold.

The price at which excess meat is sold can then be found by rearranging equation (3.10). Solving (3.10) for the price of the excess meat (PFM_i) results in the following equation:

$$PFM_i = (P_i^* - WAP_i * (QS_i / TQS_i)) * (TQS_i / EM_i). \tag{3.11}$$

The price at which the forced meat is sold, therefore, must be low enough to bring the equilibrium price from WAP_i to P_i^*. Depending on the amount of excess meat that is to be sold, the price (PFM_i) may be considerably lower then WAP_i. In fact, it is conceivable that the price at which the excess meat is sold can be zero[26].

Along with the sale of meat products, the packers also generate revenue from the sale of yield grade 4 carcasses and by-products. The price received for yield grade 4 carcasses is based on the yield grade 2 carcass values discussed earlier. The value determined for the yield grade 2 carcasses are discounted and assumed to be the price for yield grade 4 carcasses. Based on work done by Beshear and Trapp (1996), the range of discounts for yield grade 4 carcasses versus yield grade 2 carcasses was determined.

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[26] In actuality, from equation (3.11) the price at which excess meat is sold (PFM_i) could be negative. However, the MPPM simulator restricts that this price (PFM_i) be greater than or equal to zero. If the price was allowed to be negative, this would be an indication of net positive packer cost in disposing of the excess meat.

The average discount price for U.S. Choice yield grade 4 carcasses was $17 per cwt. below the price for U.S. Choice yield grade 2 carcasses.

To allow the prices received for yield grade 4 carcasses to change with the total volume of carcasses sold, a discount equation was determined. The normal volume of yield grade 4 carcasses sold is assumed to be the percentage of yield grade 4 carcasses in the base pen type. Eight percent of the cattle in the base pen type are yield grade 4 cattle. Therefore, if eight percent of the cattle killed were yield grade 4 cattle, the discount for yield grade 4 carcasses would be $17 per cwt. If the percentage of cattle killed that are yield grade 4 differs from eight percent, the discount value also fluctuates. As the percentage of yield grade 4 cattle falls, the discount value also falls and therefore the price received for yield grade 4 carcasses increases. The discount equation is:

$$DISYG4 = 17+((PERYG4 - 8\%)*2) \tag{3.12}$$

where: DISYG4 is the discount for U.S. choice yield grade 4 carcasses,

PERYG4 is the percent of the cattle killed that are yield grade 4 cattle.

Given the pen types, the percentage of cattle that are yield grade 4 cattle ranges from 3% to 13%. As a result, the percentage of cattle killed that are yield grade 4 will always be within this range. Given this range, the discount values for U.S. Choice yield grade 4 carcasses ranges from $7 per cwt. to $27 per cwt. This range was specified to correspond with the range of discounts found in the work done by Beshear and Trapp (1996).

The discount value for U.S. Select yield grade 4 carcasses are set at $3.50 per cwt. above the discount found for the U.S. Choice carcasses, which is the average discount between the quality grades found by Beshear and Trapp (1996).

The other revenue generated by the packer is from the sale of by-products. By-products include hides and offal. A set price of $8.59 per cwt. of live animal weight is received by the packers for their by-products. The value received for the by-products was taken from the OSU Boxed Beef Calculator developed by Dolezal, et al (1995) and is the USDA's drop credit.

Most of the sub-primal cuts experience some seasonality in demand. During certain times of the year, the demand for a cut will be stronger than other timed during the year. In order to simulate this seasonality, the demand for these cuts must be changed. There are two ways in which demand can be changed. The first is by completely changing the elasticity matrix during certain periods of a simulated year. However, this process is fairly cumbersome.

Demand was chosen to be altered by changing the intercept of the demand equations. This can be done by changing the prices used as the base prices. Using a seasonality index developed by Beshear and Trapp (1996), prices for each cut for each week in a year were determined.

Given the relative complexity of the MPPM simulator, it was decided not to allow the base prices to change week by week. The fear was that participants would never be able to get a sense of current demand if it was continuously changing. Rather, it was decided to have four distinct demand changes in a year, with one change per quarter.

Ideally, a time of the year would be selected and the associated prices calculated from the seasonal index would be used. However, it was decided that the change be dramatic enough so that participants could ascertain the change within a reasonable time frame. Therefore, those weeks that exhibited relatively large changes were used as the demand shifts.

In determining what price series to use as the demand shifter, consideration was given to those cuts that generate the most revenue. As with determining budget shares, the revenue generated by each cut was determined using base quantities and prices. These were ranked with the those cuts that generated the highest revenue being first. After these cuts were determined, their seasonal price patterns were examined to find periods within a year in which fairly dramatic changes occurred. Those weeks were then used to act as demand shifters.

At the end of each week, packers are given cash flow reports. The reports are separated into three categories, Cattle Costs, Processing Costs, and Revenue. Cattle costs are reported in total costs, costs per head, and costs per cwt. Also, total number of cattle purchased are given.

Processing costs are given in total costs, per head processing costs, and per head kill costs. Along with costs, total meat production is also given.

Meat revenue from the sale of sub-primal meat products, fat, and bone is reported. In addition, revenue from the sale of yield grade 4 carcasses and by-products is reported. Also, the average price received per cwt. for meat products is reported along with the average yield grade 2 carcass values from both half-week periods.

A net cash flow is reported as well as a net cash flow per unit of capacity. The net cash flow per unit of capacity is simply the cash flow divided by the low cost number of cattle processed for the packer. In addition, a cumulative net cash flow is reported.

Development of Packer Five

Throughout the discussion of the three production phases, reference was made to the actions of Packer Five. Packer Five was included in the MPPM simulator for several reasons. First was to represent the threat of entry into the industry of a new firm. As mentioned earlier, Packer Five is designed to act as only a residual player in the live cattle market. If the other packers make realistic offers for live cattle, they should purchase all the cattle supplied in the industry. As a result, as long as packers attempt to purchase quantities of cattle that keep them on the low point of their cost curves, Packer Five will not enter the live cattle market. However, as soon as packers attempt to buy cattle at below acceptable market prices, Packer Five enters the market and buys cattle. This is consistent with economic theory which states that as existing firms generate economic profits, the likelihood of new firms entering the market increases.

Packer Five also acts as the buyer of yield grade 4 carcasses. Since other packers do not process yield grade 4 cattle, there was a need to allow the meat products produced from these carcasses to impact demand for boxed beef. Packer Five purchases these carcasses and then processes and sells the meat from these carcasses. Therefore, the meat produced from the yield grade 4 carcasses is allowed to impact packer meat sales by proportionally increasing industry meat supplies.

As with the other packers, Packer Five must decide what cattle to purchase, how to process these cattle, and what meat products to sell. Packer Five makes these decisions with the benefit of knowing the decisions made by other packers.

In the procurement phase, Packer Five must decide the price it should bid for each pen type. Unlike the other packers that must decide on the amount of cattle to buy, Packer Five is assumed to be willing to purchase all of the cattle supplied in the industry.

The decision of what price to bid for cattle is based on Packer Five's ability to forecast or predict prices that it could receive for the meat produced from the cattle in question. Given the ability to properly predict prices, Packer Five can determine its expected revenue from the cattle and, therefore, determine a breakeven price for the live cattle.

The process utilized to predict prices is essentially the same as the process for determining forced sales. Given the price dependent demand equations described earlier, the price at which meat can be sold can be determined, assuming that the quantity offered of each meat product is known.

The most difficult component in forecasting prices is determining the supply of meat when the meat from the cattle in question would enter the market[27]. There are two major sources of meat that can potentially be offered for sale. The first is, obviously, the meat from the cattle in question. This quantity of meat is fairly easily determined

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[27] Packer Five can only buy cattle in the last period of the week. Because of the delays between the production phases, the meat produced from these cattle will not be able to be sold for an entire week (i.e. two half-week periods) after cattle are purchased.

by assuming a set of fabrication options and then processing the cattle into meat products[28].

The second source of meat is that offered by other packers. Determining this quantity of meat is very difficult to do with a high level of accuracy. The problem that occurs is knowing how much meat packers will have in inventory when the meat from the cattle in question enters the market. If Packer Five purchases all cattle supplied in a week, then it is known that the other packers were not able to purchase any cattle. Therefore, the meat that other packers have is the meat they had in inventory at the beginning of the week plus any meat they processed from cattle purchased in the previous week.

The question then is how much of this meat will the packer still have when the meat from cattle purchased by Packer Five enters the market. Packer Five knows the amount of meat that other packers had in inventory starting the week, and knows how much meat they will add to their inventory during the week[29]. Given this total amount of meat, Packer Five assumes that only a portion of this meat

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[28] Given a set of fabrication options, the amount of meat produced from the cattle in question can be determined.

[29] Packer Five knows, with certainty, the amount of cattle that are to be processed by the other packers during the week. Assuming that the packers process the cattle in the same way they processed cattle in the previous week, Packer Five can determine the amount of meat that will be added to the inventories of the other packer during the week.

will still be available for sale by the time the meat from the cattle it purchased enters the market.

The portion of meat that Packer Five assumes will still be in the market is determined by the capacity limits of the packers. Packer Five determines the ratios, for each cut, of the calculated inventories to the capacity levels of the other packers. If the ratio is greater then one, the packers, collectively, have more meat than their capacity allows and, therefore, will have to sell much of their meat prior to the time meat from Packer Five will enter the market. If the ratio is very low, packers have low inventories and may hold on to meat in the hope of strengthened demand. Also, with low inventories, packers may try to increase their prices on meat products and not get much meat sold. As a result, the packers may have much of the meat in inventory remaining when Packer Five's meat enters the market.

Specifically, if the ratio of meat inventories to capacity is equal to or greater than one, Packer Five assumes that 16% of the industry's normal kill will remain when its meat enters the market. In doing so, Packer Five contends that the other packers will attempt to get inventories back in line so that if they add more meat to inventory in the next period, they will have storage space (i.e. in a period, a packer is assumed to add to inventory 50% of its normal kill, therefore, if it adds 50% to the 16%

in inventory, it would still be within its storage constraint).

If the ratio of meat inventories to capacity is between .5 and 1, Packer Five assumes that 30% of the inventory will remain when Packer Five's current cattle purchases reaches the market. Likewise, if the ratio is between .2 and .49, Packer Five assumes that 60% of that inventory will remain. Finally if the ratio is below .2, Packer Five assumes that 90% of the inventory will remain. In making these decisions, Packer Five contends that as the inventories of the other packers fall, the packers will either hold onto meat in the hope of strengthening demand or will price their meat products sufficiently high so that they will not be able to sell any significant quantities.

Once the supply of meat is determined, it can be used to determine the expected prices for each meat cut. The estimated supply of each meat product is plugged into the price dependent demand equations to determine the expected sale price for each cut. Once these prices are determined, the revenue from the meat of the cattle in question can be determined.

The meat produced from the cattle purchased by Packer 5 is determined by assuming a set of fabrication options. The fabrication options used to process the cattle are the weekly average of the processing options used by the other packers in the industry in the previous week. The amount of each meat product produced is then determined by each pen type.

Recall, that bid prices for live cattle are for each of the pen types offered. Therefore, the expected revenue from each pen type is needed to determine separate breakeven prices. Once the amount of meat produced from each pen type is calculated and estimated sale prices are determined, the revenue from each pen type is found by multiplying the price of each cut by its quantity and then summing across all cuts.

Processing costs are determined for processing the cattle in question. As mentioned earlier, Packer Five's processing and kill costs are assumed to be constant, regardless of the number of pens fabricated. The cost for killing and processing each pen type of cattle is then determined.

Breakeven price for each pen type is then calculated. The breakeven price for each pen type is determined by subtracting processing and kill costs from expected revenue[30]. This value represents net returns above processing costs, only, and is, therefore, the amount of money that Packer Five can pay for the particular pen type. The breakeven price per cwt. for each pen type is then

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[30] Expected revenue is the revenue from the sale of meat products as well as the revenue from by-products. The revenue from by-products is calculated for each pen type. The price received for the by-products is $0.859 per pound (or $8.59 per cwt) of cattle live weight.

calculated by dividing net returns over processing costs by total weight.

Once the estimated breakeven prices are calculated, Packer Five then adjusts these prices downward to ensure profits. The breakeven prices are adjusted downward anywhere from 1% to 5%. A uniform number generator, with a range of 0.01 to 0.05, is used to determine the percentage by which the prices are adjusted downward.

Packer Five's bid prices are calculated once a week. At the end of a week and before the start of the next week, Packer Five determines its bid prices for the next week. Unlike other packers which may alter their bid prices, the price set by Packer Five at the beginning of the week is kept for the entire week.

Other decisions made by Packer Five are how to process cattle from week to week and how much meat to sell each week. In setting it's fabrication options, Packer Five is assumed to process cattle, on average, in the same way as other packers. For each period, the average of the fabrication options from the other four packers are determined. This average set of options are then used to process Packer Five's cattle.

The final decision that Packer Five must make is how much meat to sell and its sale price. Packer Five attempts to sell whatever is in its inventory. However, if the quantity offered by Packer Five of each cut is greater than

50% of the capacity level of the cut for Packer Four, Packer Five is restricted to trying to sell a quantity equal to 50% of Packer Four's capacity level. Packer Five offers a price equal to the average of the prices offered by the other four packers. Therefore, Packer Five will always be in the middle of the packers when they are ranked by their offer price. If Packer Five was allowed to sell extremely high levels of meat, it would keep many of the packers from selling meat. Therefore, the quantity that Packer Five can offer for sale in any period is limited to Packer Four's capacity level.

CHAPTER IV

SIMULATION VERIFICATION AND VALIDATION

Introduction

Model validation and verification are critical components in the development of any useful simulator. Anderson (1974) defined model verification as testing the model to ensure it operates in the manner in which it was designed. Testing of the MPPM simulator extended beyond Anderson's definition and into what Trapp (1985) has defined as "establishing creditability" of the simulator. Trapp defines four tests of credibility: a) logical structure (i.e. internal consistency), b) predictive capability, c) clarity (i.e. the model's logic can be explained), and d) workability (i.e. the model can be ran and its output used by others).

Initial testing of the model focused upon determining if the model's calculations were correct. Output of the model was then analyzed to determine if the specified parameters generated output consistent with observed actual industry relationships. Consistency with actual industry data did not automatically follow from just verifying that the model's calculations were correct. The model was developed component by component, and thus there was no guarantee that patterns that were dependent on system wide relationships (such as the live cattle U.S. Choice/Select price spread) would resemble actual industry patterns.

Finally, testing of the MPPM simulator was unique in that special attention had to be given to the ability of participants to interact, (i.e. use the model) since the major purpose of the simulator was for teaching/training of students and various adult learners from the packing industry and other related agricultural firms. This was done by actual use of the simulator with a class of undergraduate students consisting of a mix of Agricultural Economics and Animal Science students.

The remaining portion of this chapter will be devoted to describing a number of validation tests performed with the MPPM simulator to ascertain the "creditability" of its system wide structure in terms of internal logic, predictive capability and clarity. Predictive capability as referenced here does not refer to actually tracking time series data for given prices and quantities as is often done with traditional econometric models. Rather, it refers to the generation by the simulator of price spreads and price/quantity relationships that change in the directions and magnitudes generally observed in the industry and in a manner consistent with logic held by experts (i.e. individuals knowledgeable of the industry). This point will be made clearer through the validation cases considered. The chapter will end with a brief summary of the lessons learned and modifications made to the simulator from using it with a group of undergraduate students (i.e. does the simulator pass Trapp's fourth validation test, that being the test of workability).

Validation of System Performance

Each of the system's three major components (i.e. Procurement, Slaughtering and Processing, and Sales) were tested. The three tests conducted consisted of a) changing cattle supplies, b) calculating the profitability of different fabrication options under different fabrication mixes, and c) analyzing the impact of implementing shifts in seasonal demand for different wholesale meat products.

Supply Change Validation Testing

Changing cattle supply is accomplished in the simulator in two ways; first by changing the total supply of cattle offered for sale, and second by changing the type of cattle offered by changing the pen types offered.

To determine how the MPPM simulator reacts to changing cattle supply, U.S. Choice carcass values were determined when the industry processed and sold meat from different numbers of cattle. The value of the U.S. Choice carcasses are directly affected by the market clearing prices of the individual meat products. If the industry produces more meat products due to processing more cattle, the market clearing prices can be expected to fall and, therefore, the U.S. Choice carcass values will also fall.

Increased meat supply can be a result of more cattle being processed or heavier cattle being processed. The supply change simulation conducted consisted of changing the number of pens offered/processed over a range of 20 to 60 pens. The base processing options were used and all pens were the base pen type.

Once the amount of meat from each level of cattle supply[1] was calculated, the market clearing price for each meat product under each supply level was determined. Prices were calculated using the price dependent demand equations used in the forced sales round[2]. The price dependent demand equations allow for the determination of prices given quantities supplied for each of the meat products. Therefore, once the quantities produced from the particular number of cattle were calculated, they could be entered into the price dependent demand equations to determine a market clearing price for each product[3].

Once prices were determined, resulting U.S. Choice carcass values could be determined. Three different U.S. Choice carcass values were calculated. The first was a yield grade 2 U.S. Choice carcass value. To determine this value, the amount of meat produced from just the U.S. Choice

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[1] Nine different supply levels were examined. The number of pens of cattle supplied ranged from 20 to 60, which is ± 50% of the normal supply of 40 pens.

[2] The price dependent demand equations used in forced sales were discussed in Chapter 3.

[3] This process is very much similar to the process described in the discussion of how Packer 5 determines a bid price for live cattle.

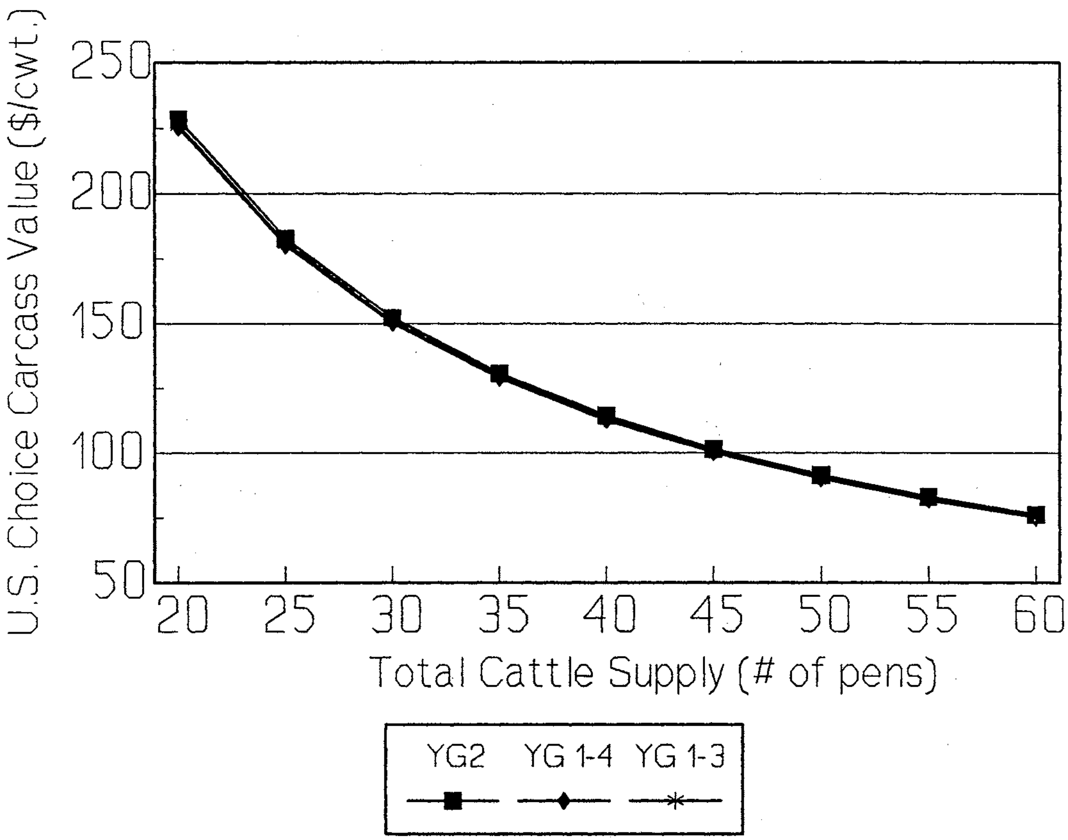
yield grade 2 cattle was determined and then the market clearing prices were used to calculate a total revenue. This revenue then was divided by the total carcass weight from the U.S. Choice yield grade 2 cattle and multiplied by 100 to determine a carcass value per hundredweight.

The other two U.S. Choice carcass values determined were composite carcass values. Carcass values for yield grade 1 through 3 carcasses and yield grade 1 through 4 carcasses were determined. The composite carcass values were determined by calculating the revenue generated by each of the two composites. The revenue generated was calculated by determining the amount of meat produced from the yield grades within each of the two composites and then using the market clearing prices.

Figure (4.1) shows U.S. Choice carcass values for different levels of cattle supply. The MPPM simulator seems to be very sensitive to changing numbers of cattle supplied and processed in the industry. The U.S. Choice yield grade 2 carcass values ranged from $76.17 per cwt for 60 pens of cattle to $228.50 per cwt. for 20 pens of cattle. While, at first glance, this range may seem rather extensive, it should be noted that the two extremes represent plus or minus 50 percent of the normal number pens of cattle.

A more relevant test of price sensitivity is to observe the change in carcass value between the normal level of 40 pens to that of 35 and 45 pens. These two levels are plus

Figure 4.1 U.S. Choice Carcass Values with Changing Cattle Supply.



or minus 12.5 percent from the normal level. When the pens of cattle are decreased from 40 pens to 35 pens, the U.S. Choice yield grade 2 carcass value increases from $114.25 to $130.57 per cwt., which is a 14.28 percent increase. Likewise, if the pens of cattle are increased from 40 pens to 45 pens, the carcass value decreases to $101.56, a 11.11 percent decrease.

Examining the carcass values for each of the three yield grade classifications shows that the values are very similar. However, for each supply level, the choice yield base pen type[4]. The pens were changed by altering the number of cattle within each pen that were assumed to grade U.S. Choice and Select.

As discussed earlier, the meat produced from the 40 pens are determined and then market clearing prices for this quantity of meat are calculated. After the revenue from the meat is determined for each of the yield grade categories, carcass values can be determined for both U.S. Choice and Select carcasses.

Figure 4.2 shows the U.S. Choice-Select spread with changing levels of cattle grading U.S. Choice. The relationship between the spread and the percentage of cattle processed grading U.S. Choice was found to be linear. It would be expected that as the number of U.S. Choice cattle increased, the amount of U.S. Choice meat products produced would increase and, therefore, the prices for U.S. Choice meat would fall. Also, with the increase in U.S. Choice meat, the U.S. Select meat must decrease, and therefore raise the prices for U.S. Select meat products. As a result, it would be expected that the U.S. Choice-Select spread would tighten as the amount/percent of U.S. Choice cattle increased.

In fact, the U.S. Choice-Select spread actually inverts indicating that the U.S. Select carcasses are more valuable

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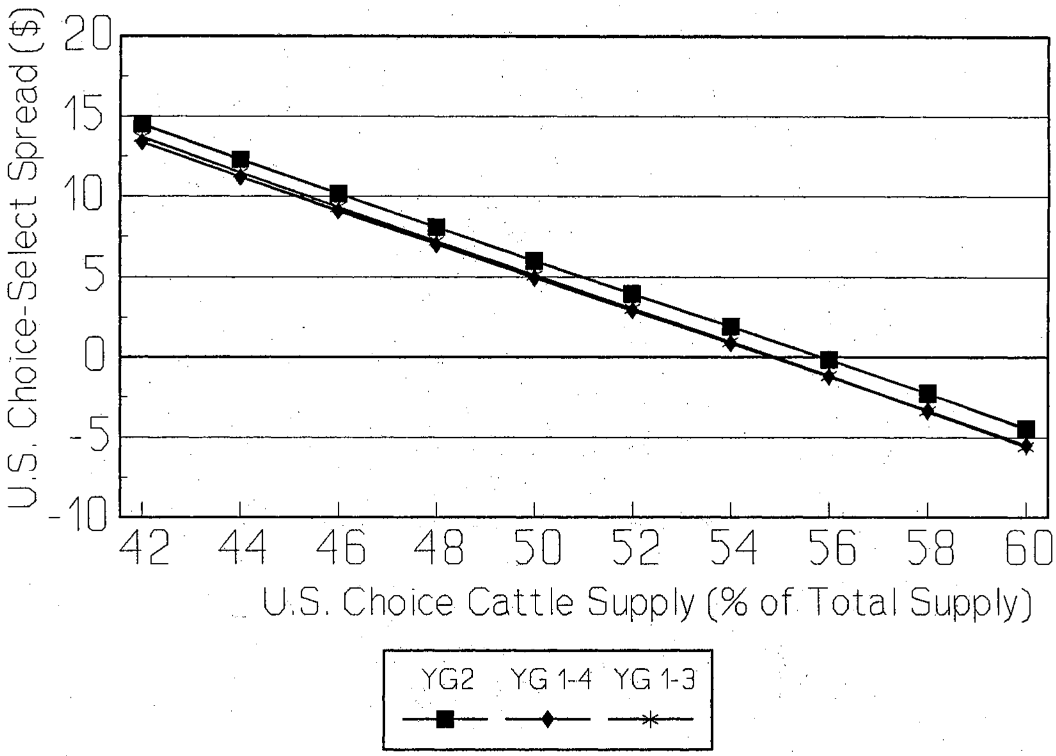
[4] The breakdown of cattle into the 4 yield grades are 11% yield grade 1, 46% yield grade 2, 35 % yield grade 3, and 8% yield grade 4.

Figure 4.2 U.S. Choice-Select Spreads with Increased U.S. Choice Cattle Supply.



than U.S. Choice carcasses. This occurs when the percentage of cattle grading choice reaches over about 55 percent[5]. While this may not seem realistic, Beshear and Trapp (1996) also found this spread to invert in their work with carcass grid pricing.

As in Figure 4.1, the three yield grade categories seem to move in the same manner. The spreads for the yield grade

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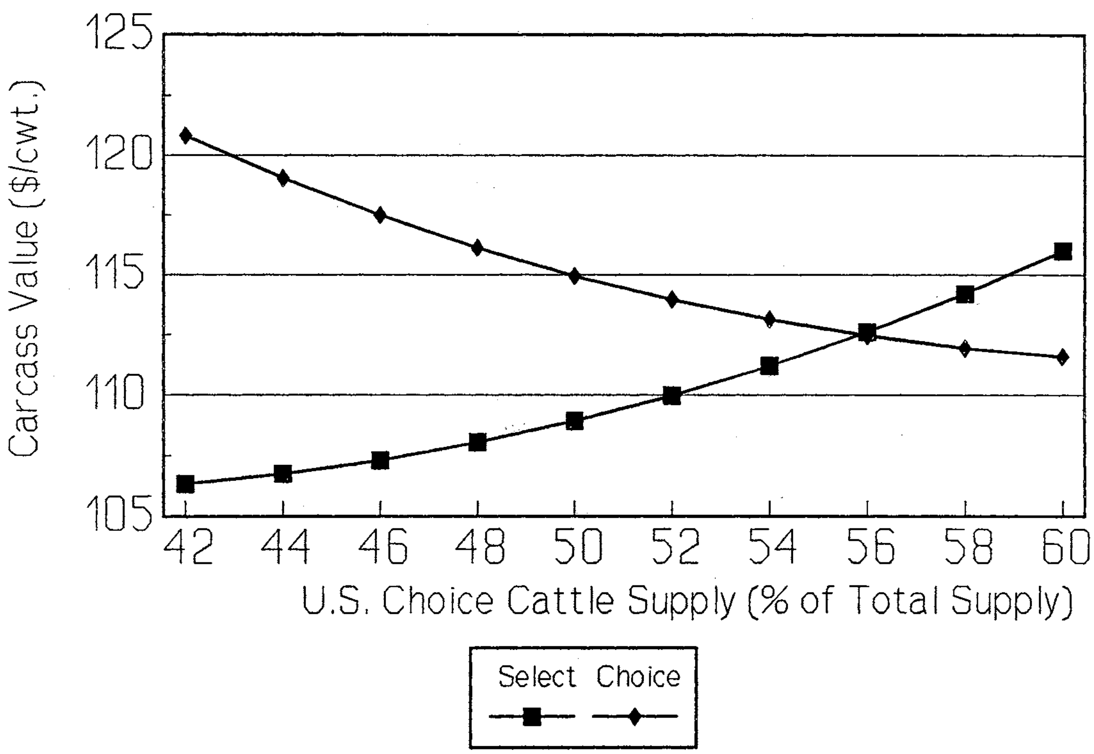
[5] U.S. Choice-Select spreads also were calculated for individual yield grades (i.e. yield grades 1, 2, 3, and 4). However, the pattern found was nearly identical to that found in Figure 4.2.

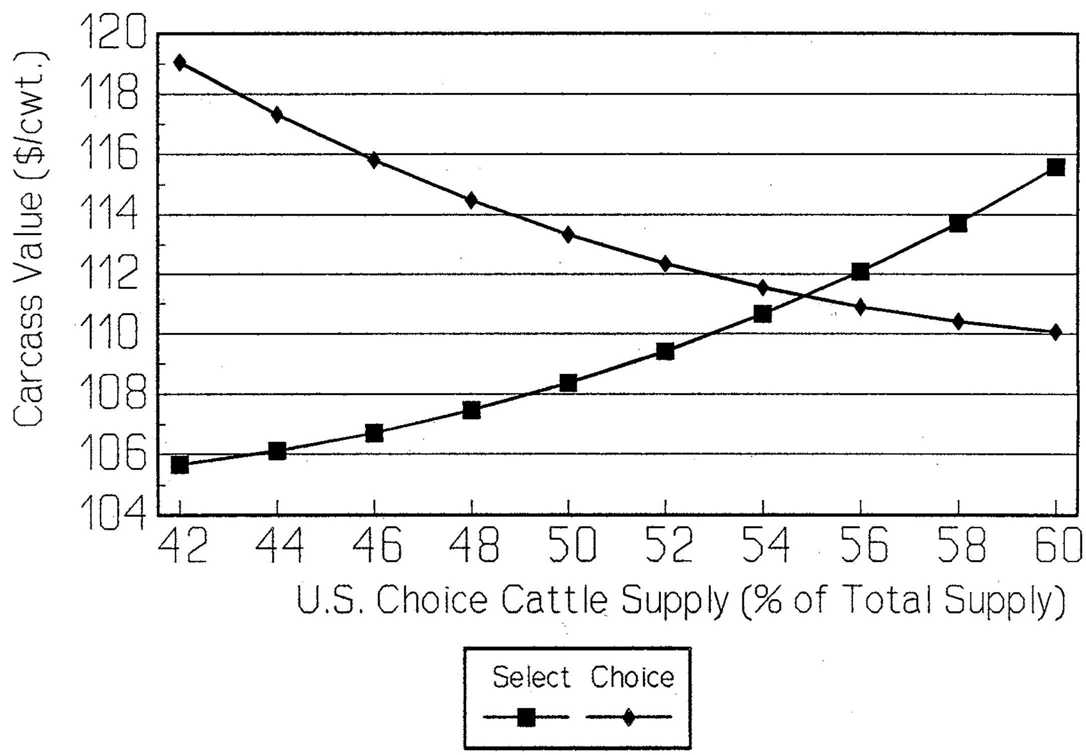
Figure 4.3 U.S. Choice and Select Yield Grade 2 Carcass Values with Increased U.S. Choice Cattle Supply.



2 carcasses were found to be higher than those for the composite carcass values. Considering that yield grade 2 cattle make up the largest percentage of cattle processed, it may be expected that the spread for these carcasses would be the greatest.

Figures 4.3 to 4.5 show the U.S. Select and Choice carcass values for each of the three yield grade groupings. The yield grade 2 carcass values are shown to invert at about 56% of the cattle grading U.S. Choice. The two

Figure 4.4 U.S. Choice and Select Composite Carcass Values with Increased U.S. Choice Cattle Supply[a].

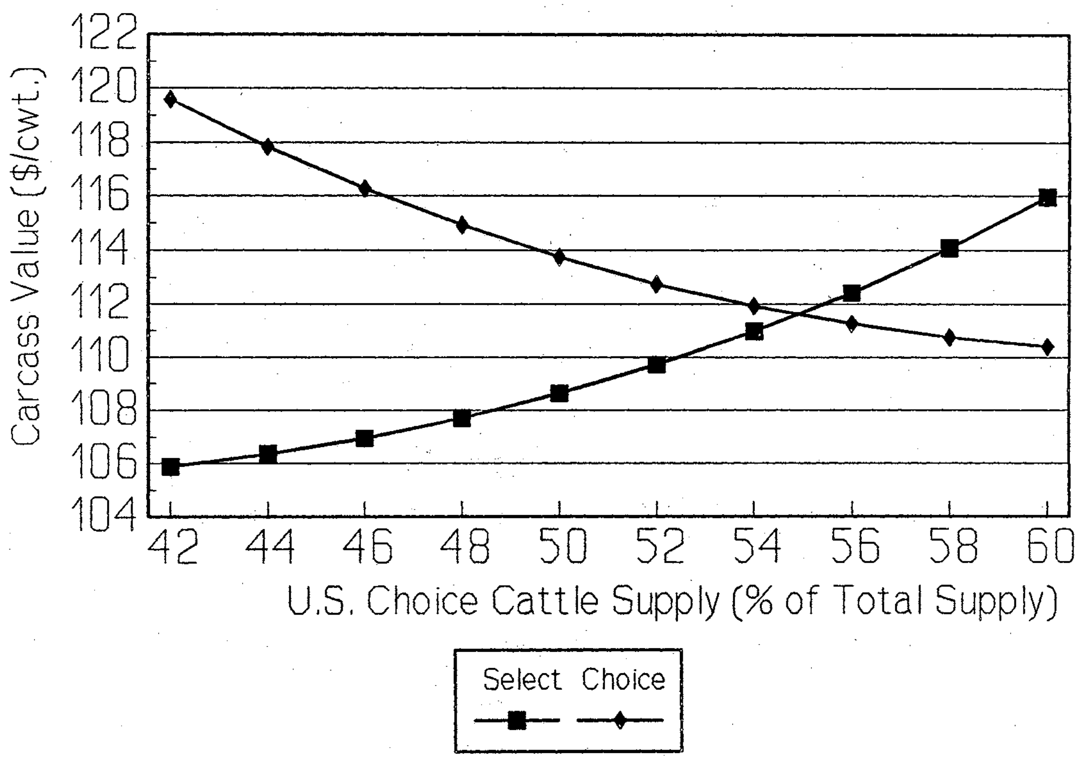


[a] The carcass values are composite values for yield grades 1 through 3.

composite carcass groupings are shown to invert with about 55 percent of the cattle grading U.S. Choice.

While the results indicated that the U.S. Choice-select spread actually inverted, keep in mind that the only difference in the pens under the different scenarios was the percentage of the cattle grading U.S. Choice. The percentage of the cattle grading in each yield grade was kept constant as well as the live weight of the cattle.

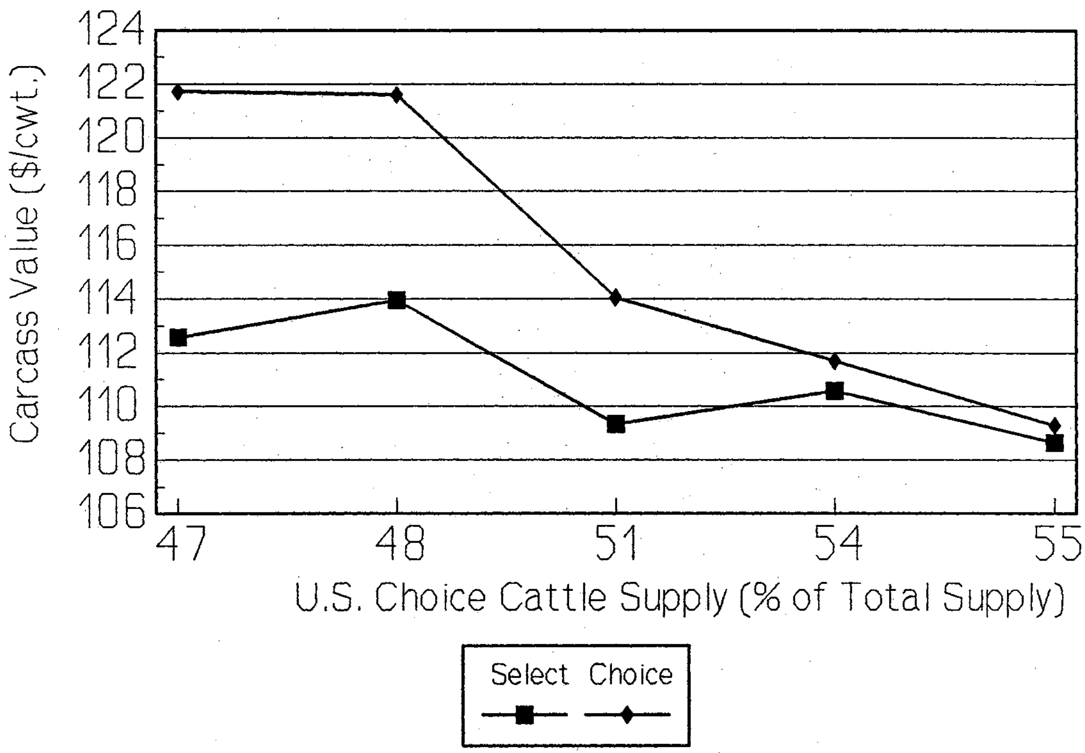
Figure 4.5 U.S. Choice and Select Composite Carcass Values with Increased U.S. Choice Cattle Supply[a].



[a] The carcass values are composite values for yield grades 1 through 4.

However, when running the MPPM simulator, the participants will be faced with changing types of cattle, not only in the percentage of cattle grading U.S. Choice, but also in the percentage of cattle grading in each yield grade and changes in live weights. To consider this fact, the U.S. Choice-Select spread was also calculated using the pen types used in the MPPM simulator.

Figure 4.6 U.S. Choice and Select Yield Grade 2 Carcass Values with Increased U.S. Choice Cattle Supply.



Recall that for a given week, the MPPM simulator will offer 4 pen types of cattle for sale. Each of the combination of pen types offered in the MPPM simulator were examined to determine how the U.S. Choice-Select spread for yield grade 2 carcasses changed with changing percentages of cattle grading U.S. choice (Figure 4.6).

Five different combinations[6] of pen types are offered by the MPPM simulator. For each of the five combinations, the percentage of cattle grading U.S. Choice were calculated. The percentage of U.S. Choice cattle ranged from 47% to 55%.

Unlike with U.S. Choice-Select spreads calculated with pens of cattle with constant live weights and percentages of yield grades, the U.S. Choice-Select spreads in Figure 4.6 do not invert. These values correspond to the pen types that participants will be allowed to purchase in the MPPM simulator.

Also, unlike in Figures 4.3-4.5, it can be seen that the U.S. Choice and Select values do not follow a smooth pattern. In fact, U.S. Select carcass values move up and down rather than steadily increasing as the percentage of cattle grading U.S. Choice increases. The major reason for this is that, even while the percentage of U.S. Choice cattle increase, the percentages of cattle grading in each yield grade is also changing and so are live weights. Therefore, the carcass values reflect changes in total meat production (i.e. with heavier cattle and heavier pens, the amount of meat produced will increase) in addition to changing the percentage of U.S. Choice cattle.

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[6] The five different combinations were, ranked from lowest to highest percentage of choice cattle : 1) Pen Types 2, 3, 4, & 5; 2) Pen Types 1, 2, 3 & 10; 3) Pen Types 4, 5, 6, & 7; 4) Pen Types 1, 8, 9, & 10; and 5) Pen Types 6, 7, 8, & 9.

Seasonal Demand Validation Testing

The next area in which the MPPM simulator was validated was that of seasonal demand for the sub-primal meat products. Using seasonal price indices, developed by Beshear and Trapp (1996), prices were calculated for all 50 meat products for each of 52 weeks. As mentioned in Chapter Three, base prices are replaced with a selected week's prices to simulate the shift in demand. By replacing the base prices, intercepts of the demand equations are altered and, therefore, the demand for the products are changed.

Four seasonal demand shifts were incorporated into the MPPM simulator. Four weeks among the 52 week price series calculated were chosen to be demand shifts. The four weeks were chosen so that the demand shift would be recognizable to the participants.

Tables 4.1 and 4.2 show the seasonal prices for U.S. Select and Choice products, respectively. These prices represent the price at which the base quantities would be sold. Therefore, they represent the market clearing prices of each cut for a supply of meat products equal to the base quantities. In selecting the price series among the 52 weeks, care was taken so that if the demand for products from one primal decreased in one period, it increases in another period.

This can be more easily seen in Table 4.3. Table 4.3 gives the percentage change in prices from the base prices.

Table 4.1 Seasonal Prices for U.S. Select Meat Products.

	Base	Week 10	Week 23	Week 33	Week 45
112A Lip-On Ribeye	$3.64	$3.21	$3.50	$3.79	$4.38
107 3X4 Ribeye	$2.23	$2.03	$2.18	$2.26	$2.45
123A Short Rib	$2.49	$2.24	$2.43	$2.53	$2.81
124 Back Rib	$0.62	$0.56	$0.61	$0.63	$0.70
174 Short Loin	$1.47	$1.28	$1.72	$1.53	$1.37
175 Strip Loin	$2.27	$2.00	$2.86	$2.35	$2.07
180 Strip Loin	$2.65	$2.28	$3.09	$2.74	$2.49
184 Top Butt	$1.66	$1.59	$1.96	$1.82	$1.41
Bone-In Top Butt	$1.25	$1.30	$1.40	$1.23	$1.13
Tenderloin	$6.47	$6.48	$6.56	$6.31	$6.57
113B Sq-Cut Neck	$0.85	$0.89	$0.77	$0.83	$0.89
115 2-pc. Bnls Chk	$0.99	$1.05	$0.91	$0.95	$1.02
168 Top Inside Rnd	$1.38	$1.40	$1.38	$1.36	$1.29
170 Gooseneck Rnd	$1.16	$1.31	$1.05	$1.05	$1.20
167 Knuckle	$1.29	$1.35	$1.21	$1.20	$1.29
167A Peel Knuckle	$1.50	$1.55	$1.42	$1.41	$1.52
161 Round, Bnls	$1.28	$1.36	$1.20	$1.22	$1.26
171B Outside Rnd	$1.30	$1.38	$1.23	$1.23	$1.29
171C Eye of Rnd	$1.31	$1.39	$1.24	$1.24	$1.30
193 Flank Steak	$2.66	$2.78	$2.75	$2.56	$2.53
120 Brisket	$0.94	$1.04	$0.88	$0.88	$0.96
Pastrami	$1.79	$1.92	$1.76	$1.70	$1.76
Thin Meats	$1.81	$1.79	$1.98	$1.87	$1.70
75% Trimmings	$0.74	$0.73	$0.75	$0.73	$0.73
50% Trimmings	$0.50	$0.50	$0.52	$0.50	$0.50
Fat	$0.21	$0.21	$0.22	$0.21	$0.21
Bone	$0.16	$0.16	$0.16	$0.16	$0.16

These percent changes are not differentiated among the U.S. Choice and Select products because it is assumed that both sets of prices (i.e. U.S. Choice and Select) will change in the same manner.

In looking at the percentage changes, it can be seen that the prices are altered so that in one or two periods the price may fall, but in other periods the price will rise. In the first quarter demand shift (i.e. Week 10), the rib and loin primals experience reduced prices for their

Table 4.2 Seasonal Prices for U.S. Choice Meat Products.

	Base	Week 10	Week 23	Week 33	Week 45
112A Lip-On Ribeye	$4.22	$3.73	$4.06	$4.39	$5.08
107 3X4 Ribeye	$3.53	$3.22	$3.46	$3.58	$3.88
123A Short Rib	$3.43	$3.08	$3.35	$3.49	$3.87
124 Back Rib	$0.61	$0.55	$0.59	$0.62	$0.69
174 Short Loin	$1.64	$1.42	$1.91	$1.71	$1.53
175 Strip Loin	$2.52	$2.23	$3.18	$2.62	$2.30
180 Strip Loin	$3.36	$2.90	$3.92	$3.48	$3.17
184 Top Butt	$1.95	$1.86	$2.30	$2.13	$1.66
Bone-In Top Butt	$1.47	$1.52	$1.65	$1.45	$1.33
Tenderloin	$6.95	$6.96	$7.04	$6.78	$7.06
113B Sq-Cut Neck	$0.86	$0.90	$0.78	$0.83	$0.90
115 2-pc. Bnls Chk	$1.00	$1.06	$0.92	$0.96	$1.03
168 Top Inside Rnd	$1.42	$1.44	$1.42	$1.40	$1.33
170 Gooseneck Rnd	$1.19	$1.34	$1.07	$1.07	$1.23
167 Knuckle	$1.33	$1.40	$1.25	$1.24	$1.34
167A Peel Knuckle	$1.55	$1.60	$1.47	$1.46	$1.57
161 Round, Bnls	$1.31	$1.40	$1.24	$1.25	$1.30
171B Outside Rnd	$1.33	$1.41	$1.26	$1.26	$1.33
171C Eye of Rnd	$1.34	$1.42	$1.27	$1.27	$1.34
193 Flank Steak	$2.65	$2.77	$2.74	$2.54	$2.52
120 Brisket	$0.93	$1.03	$0.87	$0.87	$0.95
Pastrami	$1.77	$1.90	$1.75	$1.68	$1.74
Thin Meats	$1.83	$1.80	$1.99	$1.89	$1.72

products while the other primals experience increased demand. In the second quarter (i.e. Week 23), again the rib primal experiences decreased prices, but instead of the loin primal, the chuck and round primals experience lower prices. In the third period, the rib primal actually experiences higher prices while the chuck, round, and other primals experience lower prices. In the final period, both the loin and round primals experience some decreases in prices while the rib and chuck primals see higher prices for their meat products.

Table 4.3 Percent Changes in Seasonal Boxed Beef Prices from Base Prices.

	Week 10	Week 23	Week 33	Week 45
112A Lip-On Ribeye	-11.74	-3.85	4.02	20.24
107 3X4 Ribeye	-8.68	-2.01	1.32	9.84
123A Short Rib	-10.23	-2.43	1.77	12.83
124 Back Rib	-10.23	-2.43	1.77	12.83
174 Short Loin	-13.18	16.89	4.14	-6.89
175 Strip Loin	-11.58	26.09	3.86	-8.55
180 Strip Loin	-13.67	16.77	3.60	-5.77
184 Top Butt	-4.65	17.74	9.22	-15.07
Bone-In Top Butt	3.73	12.10	-1.45	-9.84
Tenderloin	0.12	1.34	-2.39	1.50
113B Sq-Cut Neck	4.71	-9.84	-3.12	4.83
115 2-pc. Bnls Chk	6.06	-7.88	-4.23	2.97
168 Top Inside Rnd	1.47	0.46	-1.03	-6.07
170 Gooseneck Rnd	12.59	-9.42	-9.95	3.36
167 Knuckle	4.79	-6.42	-6.78	0.15
167A Peel Knuckle	3.05	-5.36	-6.30	1.12
161 Round, Bnls	6.83	-5.75	-4.78	-0.97
171B Outside Rnd	5.97	-5.42	-5.55	-0.57
171C Eye of Rnd	5.97	-5.42	-5.55	-0.57
193 Flank Steak	4.75	3.59	-3.86	-4.77
120 Brisket	9.90	-6.37	-6.53	1.31
Pastrami	7.32	-1.39	-5.19	-1.73
Thin Meats	-1.44	9.12	3.47	-5.94
75% Trimmings	-1.08	2.50	-0.40	-0.89
50% Trimmings	-1.08	2.50	-0.40	-0.89
Fat	-1.08	2.50	-0.40	-0.89
Bone	-1.08	2.50	-0.40	-0.89
Average	-0.46	1.49	-1.30	0.03

While the change in some individual meat cuts are fairly large, the change in the whole system is fairly small. The average change in prices, from the base prices, were found to range from -1.30% to 1.49%. Therefore, total meat demand is not changing in any considerable amount over the four quarters. However, it is hoped that changes in the individual cut prices are large enough so that participants can recognize the changes.

As mentioned in Chapter Three, the sale of meat products are driven by quantity dependent demand equations and elasticities. In addition, the price that packers receive for the product is, in fact, their offer prices. However, packers may not be able to sell the total quantity offered for sale at their offer price. Therefore, to see the impact of the changes in prices (i.e. demand) for the individual meat products on packer performance, it is necessary to see how successful packers are in selling a fixed quantity of product at the base prices when seasonality in prices exist.

To accomplish this, the MPPM simulator was run to see the amount of each meat product that the industry could sell assuming all packers offered the base prices. Each packer was assumed to want to sell an amount equal to their storage constraint. Recall, that in any one period of the sales round, the demand system is willing to purchase half of the base quantities at the base prices. This is because each period represents a half-week and the base quantities are for a entire week of operation. Therefore, packers are assumed to, collectively, offer more than the system is willing to buy at the base prices.

Tables 4.4 and 4.5 show the amount of meat sold in the industry under different price scenarios (i.e. under the

Table 4.4 Quantities Sold of Each U.S. Select Meat Product Under Each Seasonal Price Pattern.

	Base	Week 10	Week 23	Week 33	Week 45
112A Lip-On Ribeye	19,157	16,716	18,141	20,033	23,744
107 3X4 Ribeye	10,005	9,081	9,684	10,149	11,170
123A Short Rib	6,650	5,925	6,469	6,785	7,576
124 Back Rib	5,435	4,842	5,287	5,545	6,192
174 Short Loin	13,660	11,667	16,211	14,307	12,624
175 Strip Loin	3,812	3,326	4,926	3,979	3,459
180 Strip Loin	16,858	14,278	20,026	17,557	15,745
184 Top Butt	22,164	21,177	26,529	24,591	18,314
Bone-In Top Butt	3,389	3,543	3,826	3,335	3,028
Tenderloin	7,247	7,345	7,172	7,009	7,489
113B Sq-Cut Neck	31,540	33,097	28,243	30,549	33,180
115 2-pc Bnls Chck	116,700	124,475	106,793	111,491	120,378
168 Top Inside Rnd	38,801	39,559	38,976	38,512	35,866
170 Gooseneck Rnd	23,249	26,738	20,693	20,631	24,191
167 Knuckle	9,566	10,062	8,887	8,870	9,585
167A Peel Knuckle	8,247	8,509	7,762	7,692	8,356
161 Round, Bnls	11,610	12,499	10,869	11,032	11,481
171B Outside Rnd	11,407	12,165	10,722	10,736	11,333
171C Eye of Rnd	5,046	5,370	4,752	4,754	5,015
193 Flank Steak	3,479	3,655	3,623	3,342	3,295
120 Brisket	20,311	22,614	18,806	18,864	20,643
Pastrami	9,301	10,065	9,152	8,785	9,124
Thin Meats	37,484	36,839	41,870	39,431	34,612
75% Trimmings	87,165	86,221	89,369	86,840	86,376
50% Trimmings	167,649	165,830	171,898	167,038	166,119
Fat	168,517	166,694	172,748	167,851	167,015
Bone	160,926	159,185	164,964	160,286	159,495

different seasonal demands). The offers of base prices and capacity quantities were assumed to remain constant over all seasonal demand shifts. For each demand shift, the amount of meat that the industry was able to sell would be indicative of the seasonal demand. Since packers are offering more than the demand system wishes to purchase at the base prices, any increase in the amount of the product over the base quantities implies the demand for that cut has

Table 4.5 Quantities Sold of Each U.S. Choice Meat Product Under Each Seasonal Price Pattern.

	Base	Week 10	Week 23	Week 33	Week 45
112A Lip-On Ribeye	19,456	16,329	18,303	20,756	25,333
107 3X4 Ribeye	10,396	9,378	10,157	10,583	11,562
123A Short Rib	6,888	6,090	6,696	7,048	7,904
124 Back Rib	5,629	5,004	5,483	5,750	6,419
174 Short Loin	14,110	11,880	16,908	14,865	13,001
175 Strip Loin	3,940	3,419	5,125	4,124	3,569
180 Strip Loin	17,422	14,121	21,252	18,396	16,166
184 Top Butt	23,116	21,951	28,288	26,299	18,485
Bone-In Top Butt	3,534	3,680	4,002	3,486	3,157
Tenderloin	7,361	7,494	7,137	7,082	7,753
113B Sq-Cut Neck	32,788	34,608	28,984	31,706	34,684
115 2-pc Bnls Chck	121,123	134,175	104,889	113,932	127,110
168 Top Inside Rnd	40,285	40,903	40,913	40,407	36,499
170 Gooseneck Rnd	24,111	28,037	21,285	21,240	25,185
167 Knuckle	9,934	10,449	9,224	9,209	9,954
167A Peel Knuckle	8,552	8,817	8,048	7,976	8,668
161 Round, Bnls	12,028	12,963	11,252	11,433	11,886
171B Outside Rnd	11,652	12,434	10,948	10,967	11,572
171C Eye of Rnd	5,145	5,469	4,850	4,851	5,113
193 Flank Steak	3,554	3,733	3,690	3,413	3,372
120 Brisket	20,873	23,267	19,301	19,376	21,211
Pastrami	9,574	10,369	9,405	9,039	9,394
Thin Meats	38,646	38,001	43,590	40,942	35,342

increased. Likewise, any decrease in the quantity, when compared to the base quantity, is assumed to be due to a decrease in demand for that product.

The first column in both Tables 4.4 and 4.5 are the quantities that the industry was able to sell when offering all meat cuts at their base price when in fact base prices are the current seasonal prices. Therefore, the quantities simulated are equal to one-half of the base quantities (i.e. when the base prices are the current seasonal prices and the packers offer meat at those base prices, they will be able to sell half of the base quantities).

The remaining columns give the quantities of meat that the industry was able to sell when seasonal prices had changed. Packers are still assumed to offer all meat cuts at their base price, however, now the demand for all products have shifted from that defined by the base prices to the demand defined by the seasonal prices (i.e. prices in Weeks 10, 23, 33, and 45).

As mentioned earlier, for those products in which the quantities sold decreased, the implication is that the demand for those products has fallen. If, for example, Tables 4.1 and 4.4 are compared, it should be observable that for a decrease in price, the quantity sold also decreased. At first glance this may seem to contradict economic theory which states that as price for a product decreases, the quantity demanded should increase. However, keep in mind that the prices, in this case, are indicators of the strength of demand for the product. The prices in Tables 4.1 and 4.2 are used to determine the intercepts for the demand equations and, therefore, if the price falls, the intercept will fall implying that the demand curve has shifted downward and that for a given offer price, the buyer would be willing to purchase less quantity.

Tables 4.6 and 4.7 give the percent changes in the quantity sold by the industry in each seasonal demand change

Table 4.6 Percent Changes in Quantities Sold of U.S. Select Meat Products from Quantities Sold Under Base Conditions.

		Week 10	Week 23	Week 33	Week 45
112A Lip-On Ribeye	(S)	-12.74	-5.30	4.57	23.94
107 3X4 Ribeye	(S)	-9.23	-3.21	1.44	11.64
123A Short Rib	(S)	-10.91	-2.73	2.02	13.93
124 Back Rib	(S)	-10.91	-2.73	2.02	13.93
174 Short Loin	(S)	-14.59	18.68	4.74	-7.58
175 Strip Loin	(S)	-12.74	29.22	4.39	-9.27
180 Strip Loin	(S)	-15.30	18.79	4.14	-6.60
184 Top Butt	(S)	-4.45	19.69	10.95	-17.37
Bone-In Top Butt	(S)	4.56	12.90	-1.60	-10.65
Tenderloin	(S)	1.35	-1.04	-3.29	3.34
113B Sq-Cut Neck	(S)	4.94	-10.46	-3.14	5.20
115 2-pc. Bnls Chk	(S)	6.66	-8.49	-4.46	3.15
168 Top Inside Rnd	(S)	1.95	0.45	-0.75	-7.57
170 Gooseneck Rnd	(S)	15.01	-11.00	-11.26	4.05
167 Knuckle	(S)	5.19	-7.10	-7.27	0.20
167A Peel Knuckle	(S)	3.18	-5.88	-6.72	1.33
161 Round, Bnls	(S)	7.66	-6.38	-4.98	-1.11
171B Outside Rnd	(S)	6.65	-6.00	-5.88	-0.64
171C Eye of Rnd	(S)	6.43	-5.83	-5.78	-0.61
193 Flank Steak	(S)	5.04	4.14	-3.94	-5.30
120 Brisket	(S)	11.34	-7.41	-7.12	1.64
Pastrami	(S)	8.21	-1.60	-5.54	-1.91
Thin Meats	(S)	-1.72	11.70	5.19	-7.66
75% Trimmings		-1.08	2.53	-0.37	-0.91
50% Trimmings		-1.08	2.53	-0.36	-0.91
Fat		-1.08	2.51	-0.40	-0.89
Bone		-1.08	2.51	-0.40	-0.89
Average		-0.32	1.50	-1.25	0.09

when compared to the base. If the results of Tables 4.6 and 4.7 are compared to that of Table 4.3, there are several interesting results that can be observed.

First is that the direction of movement (i.e. decrease or increase) in both prices and quantities from the base values are the same. As indicated earlier, a negative change in price indicates a decrease in demand for

Table 4.7 Percent Changes in Quantities Sold of U.S. Choice Meat Products from Quantities Sold Under Base Conditions.

		Week 10	Week 23	Week 33	Week 45
112A Lip-On Ribeye	(C)	-16.07	-5.92	6.68	30.21
107 3X4 Ribeye	(C)	-9.79	-2.30	1.80	11.22
123A Short Rib	(C)	-11.58	-2.79	2.33	14.75
124 Back Rib	(C)	-11.11	-2.59	2.14	14.03
174 Short Loin	(C)	-15.81	19.83	5.35	-7.86
175 Strip Loin	(C)	-13.21	30.08	4.68	-9.42
180 Strip Loin	(C)	-18.95	21.98	5.59	-7.21
184 Top Butt	(C)	-5.04	22.37	13.77	-20.03
Bone-In Top Butt	(C)	4.13	13.23	-1.38	-10.68
Tenderloin	(C)	1.81	-3.05	-3.80	5.32
113B Sq-Cut Neck	(C)	5.55	-11.60	-3.30	5.78
115 2-pc. Bnls Chk	(C)	10.78	-13.40	-5.94	4.94
168 Top Inside Rnd	(C)	1.53	1.56	0.30	-9.40
170 Gooseneck Rnd	(C)	16.28	-11.72	-11.91	4.46
167 Knuckle	(C)	5.18	-7.14	-7.30	0.20
167A Peel Knuckle	(C)	3.10	-5.88	-6.73	1.36
161 Round, Bnls	(C)	7.78	-6.45	-4.94	-1.17
171B Outside Rnd	(C)	6.72	-6.04	-5.88	-0.68
171C Eye of Rnd	(C)	6.31	-5.73	-5.71	-0.61
193 Flank Steak	(C)	5.05	3.84	-3.96	-5.13
120 Brisket	(C)	11.47	-7.53	-7.17	1.62
Pastrami	(C)	8.31	-1.76	-5.58	-1.88
Thin Meats	(C)	-1.67	12.79	5.94	-8.55
75% Trimmings		-1.08	2.53	-0.37	-0.91
50% Trimmings		-1.08	2.53	-0.36	-0.91
Fat		-1.08	2.51	-0.40	-0.89
Bone		-1.08	2.51	-0.40	-0.89
Average		-0.40	1.38	-1.09	0.49

the product and, therefore, less quantity of that product is able to be sold at a given price.

The second observation is that, for the most part, the percent change in quantity is greater then the percent change in price. In fact, the only products that this does not occur is for are the trimmings, fat, and bone. In those cases, the percent change in quantity and price are nearly identical with some of the changes in prices being higher than that for quantities.

The third interesting point is a result of the percent changes in quantities being greater then the changes in prices. The definition of an elasticity is the percent change in quantity divided by the percent change in price. If the results found in tables 4.3, 4.6 and 4.7 are used to calculate elasticities, it can be shown that the elasticities are all around a value of one. However, as discussed in Chapter Three, the own price elasticities used in the MPPM demand system were mostly around values of two and three. Therefore, the value of one would imply that the cross price effects total to a fairly significant effect. Furthermore, it implies that while a meat product may be fairly sensitive to changes in its own price, in terms of the whole system, the sensitivity of demand to changing prices in general may be dampened significantly by the cross effects.

Fabrication Option Validation Testing

The final area in which model validation was performed was in the area of fabrication options and the impact of using different options on the revenue generated by the packer. As mentioned in Chapter Three, the fabrication options for each primal produce different levels of fat and bone. Therefore, the options for a primal can be thought of as either being a close-trimmed or boneless fabrication option, or a commodity trim or bone-in fabrication option. Close trim/boneless fabrication options are those options that produce more fat and bone, while the commodity trim/bone-in fabrication options are those that produce smaller amounts of fat and bone.

In addition to producing different levels of fat and bone, the options also differ in the costs involved in processing cattle. The close-trim/boneless options require more external fat to be removed and require de-boning of products. As a result, it will cost a packer more, per head, to process cattle under these options than under other options.

Intuitively, it may be expected that it may be beneficial for packers to process yield grade 1 cattle under close-trim/boneless fabrication options. Yield grade 1 cattle have less external fat than other yield grades and, therefore, if a packer is going to use close-trim options, it may be beneficial to use those options on those cattle that have less fat to trim in the first place. Likewise, it may be more beneficial for the packer to use commodity-trim/bone-in fabrication options on the yield grade three cattle because they generally possess more external fat then other yield grades.

Table 4.8 shows the difference in the net revenue generated by close trim/boneless and commodity trim/bone-in fabrication options for each primal and each yield grade.

Table 4.8 Differences in Net Revenue for Close Trim/ Boneless and Commodity Trim/Bone-In Fabrication Options for Each Yield Grade Under Base Prices[a].

Primal	Yld 1	Yld 2	Yld 3
Rib	-$24.44	-$31.77	-$37.07
Loin	$4.71	$4.06	$3.47
Chuck	$17.02	$15.07	$14.10
Round	$7.33	$4.79	$2.15

[a] A negative value indicates that more revenue is generated by Commodity Trim options while a positive value indicates that more revenue is generated by Close Trim options.

Table 4.8 was generated by first determining the amount of meat produced under each fabrication option for each primal. Once these were determined, the revenue generated from the meat was determined by multiplying the quantities of meat by their corresponding base price. Total revenue was then determined for each processing option for each primal and each yield grade. Processing cost was then determined for each fabrication option and used to calculate a net return above processing cost for each fabrication option[7]. Then, for each primal, two fabrication options were selected with one being a close trim option and the other being a commodity trim option[8]. The fabrication options selected

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[7] The net return is a net return above processing costs. Kill costs were not subtracted because the kill costs are the same regardless of the processing option chosen.

[8] The options generating the most fat and bone (close trim options) were options 1, 1, 2, and 3 for the rib, loin, chuck, and round, respectively. Those generating the least fat and bone (commodity trim options) were options 2, 4, 1, and 1 for the rib, loin, chuck, and round, respectively.

as the close and commodity trim options were chosen based on the amount of fat and bone, collectively, that the fabrication option produced.

Differences in net revenue generated by the close and commodity trim fabrication options represent the relative benefit of using one option over the other. The close trim fabrication options produce products that are of higher value, however, they cost more to produce. Also, for the most part, the amount of sub-primal cuts produced by the close-trim options is less than with commodity trim[9]. On the other hand, the commodity trim options produce lower value cuts, but are less expensive to produce and produce less of the low valued products of bone and fat.

For all primals except the rib the close trim fabrication options generated more revenue then the commodity trim options. In these cases, revenue generated by the more valuable cuts under the close trim options more then compensated the extra costs involved in processing. Also, for those primals, the revenue generated also more than compensated for the smaller amount of total sub-primal cuts. As mentioned above, the close trim options produce less total sub-primal meat than the commodity trim and

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[9] The close trim options produce fewer total pounds of sub-primal cuts then commodity trim options. This is largely due to the fat and bone removed from the close trim products.

higher levels of trimmings, fat, and bone, which are considerably lower valued then the sub-primal cuts.

On the other hand, for the rib primal, the commodity trim fabrication options dominated the close trim options. In the case of the rib primal, the higher valued products under the close trim option were not able to compensate for the higher processing costs and the higher levels of the lower valued products of trimmings, fat, and bone.

In all primals, the hypothesis of processing yield grade 1 cattle under close trim and the yield grade 3 under commodity trim options seems to hold. In each case where the close trim option dominated, the difference in net revenue generated fell when comparing yield grade 1 and 2 cattle. While the close trim option dominates for all three yield grades, its relative superiority over the commodity trim option falls as one progressed from yield grade 1 to yield grade 3 cattle. As mentioned earlier, the yield grade 1 cattle generally have less external fat than the other yield grades, and therefore are better suited for the close trim option. Yield grade 3 cattle, on the other hand, have considerably more external fat, therefore, reducing the appeal of using the close trim fabrication option.

For the rib primal, the commodity trim option dominates for all three yield grades. Superiority of the commodity trim option also seems to strengthen from yield grade 1 to yield grade 3 cattle. This occurrence follows with the assumption that yield grade 3 cattle are better suited for commodity trim fabrication options. Because of the higher degree of external fat of the yield grade three cattle, processing them under a commodity trim option reduces the processing costs of fabricating those cattle.

A logical strategy, based on the information in Table 4.8, is to process all the cattle with fabrication options that are expected to result in more revenue. Therefore, it may be expected that a participant would decide to process the primals of all cattle under close trim options with the exception of the rib primal. However, the error in this philosophy is that prices received for the meat products would remain constant. Remember, prices used to generate Table 4.8 were the base prices. However, if the entire industry went to a close trim processing strategy, the prices that the industry could expect for the meat will be considerably different than the base prices.

To investigate how different processing strategies would affect packer performance, several processing scenarios were examined and the revenue expected from each primal and each yield grade was calculated. An infinite number of fabrication option combinations are possible for the packer to use. Obviously, it is impossible to determine the impact of each of these combinations. Therefore, it was assumed that the processing strategy used was employed by the entire industry. Also, strategies examined were those in which packers decided to process all three yield grades in the same manner.

Five different scenarios were examined: (1) using the base fabrication options; (2) for the industry to process the loin, chuck, and round primals with a close trim option and the rib primal with a commodity trim option[10]; (3) doing just the opposite of Scenario two (i.e. processing the loin, chuck, and round primals with a commodity trim option and the rib primal under a close trim option); (4) process all primals under a commodity trim option; and (5) process all primals under a close trim option.

For each scenario, market clearing prices were determined assuming the industry had processed 40 pens of the base pen type under the particular processing strategy. For example, under scenario five, market clearing prices were determined for the meat produced from 40 pens of the base pen type using all close trim fabrication options.

Once these prices were determined, they were used to calculate a gross revenue for the each primal. Per head processing cost were determined from the cost curves in Chapter Three for the particular fabrication options used in the scenario. By summing the net revenue for each primal, a total carcass value could then be determined. Finally, a

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[10] The second scenario was determined by selecting those fabrication options that generated the highest revenue under the base processing options (i.e. Scenario 1).

weighted average carcass value was determined by using the percentage of each yield grade found in the base pen type.

Table 4.9 shows the results of the 5 processing scenarios. For each primal, the base fabrication options (i.e. Scenario One) generated the highest value. Therefore, the base fabrication options also generated the highest average carcass value.

Scenario Two was derived by using those fabrication options that generated the most revenue under the base fabrication options (i.e. Scenario One). While it may be expected to generate more total revenue then the first scenario, results show that it produced considerably less revenue because market clearing prices changed from those in Scenario One. Under Scenario Two, the amount of close trim products, (i.e. those cuts produced from the close trim options) greatly increased from those in Scenario One. As a result of the increased supply of those cuts, the price that a buyer would pay to buy that amount is reduced. Therefore, even though the fabrication options were found to be the most favorable in Scenario One, by flooding the market with those products, prices fell and, therefore, the packer would generate less revenue then when using the base fabrication options.

Likewise, the remaining scenarios show that processing all cattle in one particular fabrication option has a large impact on packer revenue. In each scenario, the revenue

Table 4.9 Primal Values for Three Yield Grades Under Selected Fabrication Option Scenarios[a].

Primal	Yield 1	Yield 2	Yield 3	Weighted Average
Rib				
Scenario One	$162.95	$157.04	$152.33	$155.95
Scenario Two	$68.50	$68.40	$68.24	$68.35
Scenario Three	$129.24	$123.56	$119.06	$122.53
Scenario Four	$65.94	$65.79	$65.55	$65.72
Scenario Five	$136.68	$130.92	$126.41	$129.89
Loin				
Scenario One	$247.42	$243.45	$238.55	$242.06
Scenario Two	$221.13	$216.99	$212.08	$215.61
Scenario Three	$156.50	$152.93	$149.08	$151.89
Scenario Four	$157.53	$154.00	$150.13	$152.95
Scenario Five	$220.56	$216.39	$211.49	$215.02
Chuck				
Scenario One	$173.02	$171.37	$170.05	$171.07
Scenario Two	$149.75	$147.92	$146.53	$147.61
Scenario Three	$48.96	$48.53	$48.16	$48.44
Scenario Four	$49.00	$48.56	$48.20	$48.48
Scenario Five	$149.79	$147.96	$146.57	$147.65
Round				
Scenario One	$184.38	$183.12	$181.65	$182.71
Scenario Two	$137.75	$136.32	$135.25	$136.08
Scenario Three	$120.45	$120.47	$120.40	$120.44
Scenario Four	$121.57	$121.60	$121.53	$121.57
Scenario Five	$136.23	$134.84	$133.79	$134.61
All Primals				
Scenario One	$767.76	$754.99	$742.58	$751.79
Scenario Two	$577.13	$569.62	$562.09	$567.66
Scenario Three	$455.16	$445.49	$436.71	$443.31
Scenario Four	$394.05	$389.95	$385.42	$388.72
Scenario Five	$643.26	$630.11	$618.25	$627.17

[a] Scenario One: Base processing options (see Table 3.24).
Scenario Two: Close trim for loin, round, & chuck, Commodity for rib.
Scenario Three: Commodity trim for loin, round, & chuck, Close for rib.
Scenario Four: Commodity trim for all primals.
Scenario Five: Close trim for all primals.

generated by the packer was less than when using the base fabrication options. When the industry produces only specific types of cuts, prices for those cuts fall and, therefore, the packer makes less money.

This does not mean, however, that packers should always process under base fabrication options. What it does show is that the industry cannot, in the long run, operate by processing cattle all under close trim or commodity trim fabrication options. There may be times, for example, when inventory levels of close trim products are high, that it may be beneficial for a packer to process more cattle under a commodity trim option than it would under the base fabrication options. By doing so, the packer can lessen the strain on inventory of the close trim products.

Several other scenarios were examined where there were combinations of close and commodity trim processing used and where not all three yield grades were processed in the same manner. However, no pattern could be ascertained from these scenarios. The difficulty is that for each scenario, the impact on prices will be different. Therefore, it could be that 70% of the cattle were processed under a close trim option in two scenarios and the results would be different. The problem is that depending on the yield grade of cattle processed under each option and the primals processed under each option, the quantities produced of each cut will be different. When the supply of the individual products are different, market clearing prices will differ.

A couple of generalizations were able to be determined, however. The first is that the manner in which yield grade 1 cattle are processed has only small impacts on average carcass revenue. Yield grade 1 cattle make up a small portion of the pen types. As a result, meat from yield grade 1 cattle will be only a small portion of the total meat produced. Therefore, the impact of that meat on market clearing prices may be fairly small, especially when compared to the impact of meat from yield grade 2 and 3 cattle.

The second finding is that while close trim products cost more to be produced than commodity trim products, the increased value of these products more than compensates for the increased costs. For the most part, the prices of the close trim products are less sensitive to changing quantities than are the commodity trim products (i.e. they have smaller elasticities and flexibilities). Therefore, if high supply levels of both close and commodity trim products were on the market, while the prices for both would fall, the price for the close trim product would not fall to as great an extent as the commodity trim products.

Test of System "Workability"

Trapp's final validation test of a simulator is that of model "workability". Workability of the simulator involves determining if participants (i.e. users of the simulator) are able to run the simulator and are they able to gain practical experience in the operations of a meat packing firm.

In an attempt to determine if the MPPM simulator passed the "workability" test, model testing was conducted throughout the MPPM simulator's development and, then, finally in a classroom environment with Agricultural Economics and Animal Science students[11]. While the model validation discussed in the previous section was useful in determining the realism of the MPPM simulator, it did not ensure the usefulness of the simulator as a teaching tool. Classroom testing of the simulator gave an excellent opportunity, not only in testing internal consistency (i.e. is the model structure logical) of the simulator, but also to determine if the MPPM simulator was "user friendly".

In the development of the MPPM simulator, much consideration was taken to ensure that all critical components of the meat packing industry were included. However, by making test runs and seeing how the simulator worked as a system, adjustments in model components were determined as well as new components that should be added.

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[11] On five different occasions, the MPPM simulator was tested for two simulated weeks (i.e. four periods or trading rounds) with faculty members, industry personnel, and graduate students. In addition, the simulator was tested for four simulated weeks (i.e. eight periods or trading rounds) with undergraduate students.

Likewise, until participants operate the packing firms, there will, inevitably, be certain conditions that may result in unrealistic market behavior that will go unnoticed. For example, in the early stages of the MPPM simulation, packers were not allowed to delay half pens of cattle. However, after making test runs, it was observed that, for those packers that minimize processing costs when fabricating 9 and 11 pens of cattle, these packers would never be allowed to operate at these levels unless they were allowed to delay half pens of cattle (this occurs because packers must slaughter half of their optimal number of pens in each half-week period).

Another model parameter that was altered as a result of the test runs was the storage capacity level of the packers. The storage capacity for each packer was initially set at 33% of normal kill. However, the test showed that this was too tight a restriction. Packers were severely limited in their ability to manage inventory because they were continuously exceeding their storage capacity.

As a result, the MPPM simulator was designed so that such model parameters could be changed while in a simulation round. This gives the game manager the ability to observe the behavior of the participants and then make adjustments as they become appropriate.

In addition to specifying model components and parameters, test runs allowed for the determination of the proper mix of input and output information given to participants. As mentioned in Chapter Three, participants are given input and output forms (Appendix C) in each period. The input forms allow participants to relay their decisions to a game manager who then inputs these decisions in the MPPM simulator. The output forms summarize for the participants the impact of their decisions on their packer's performance as well as the industry's performance. In the early stages of developing the MPPM simulator, these input and output forms were designed to give all the relevant information participants needed in making decisions. However, there was no way to know exactly what information participants would most effectively utilize in making their decisions. The test runs gave some indication of the type and amount of information needed by participants to make informed decisions. In addition, the test runs gave an opportunity to re-design the output forms in order to make them more understandable and to make them transmit information more efficiently.

While all of the test runs conducted were beneficial in determining the "workability" of the simulator, the test runs conducted with the undergraduate students offered another benefit. The test runs conducted earlier in the development of the simulator were conducted with participants that had considerable knowledge of the meat packing industry and economic theory. As a result, the behavior of the industry generated by these participants was generally confined to a fairly small range around normal or average behavior. However, with the undergraduate students, the simulated industry behavior was more extreme. The wide range of market conditions generated by their decisions made an excellent test of the MPPM simulator in reacting to extremes of market behavior.

Chapter V

SUMMARY AND LIMITATIONS

Summary

The meat packing industry has undergone several significant trends since its conception. Increased market power has been a trend that has brought considerable attention to the industry. Firms have increased in size through firm mergers and through increasing the size and capacity of their processing facilities. Vertical integration has also allowed packers to have more control over cattle supply and therefore the supply of boxed beef products.

With increases in firm size, it becomes increasingly difficult for packers to coordinate their production phases. Cattle procurement, slaughtering and processing, and sales phases must be properly coordinated to ensure the profitability of the firm. However, proper coordination is difficult as each production phase attempts to accomplish individual goals rather than the firm goal of profit maximization.

Another concern with increased firm size is the inability to pinpoint sources of poor firm performance. Often times, packers may be forced to sell meat products at below breakeven prices. The problem has been, not so much that meat was sold cheaply, but that firms are not able to determine the source of the problem. This inability leaves packers unable to avoid future problems or to determine how to best remedy the problem if it occurs again.

Objectives

The objective of this study was to develop a Meat Packing Plant Management (MPPM) simulator that could be used by packer employees, students, and extension clientele in providing a clearer description of the meat packing industry and to give participants an opportunity to apply marketing and management principles to realistic market conditions. By packer employees gaining a better understanding of the issues faced by each production phase, they will be better equipped to make decisions that increase firm performance and increase the coordination of the production phases. The benefit of the MPPM simulator is that it allows participants to make the same critical decisions they would on the job without the risk and expense of managerial mistakes.

In order to develop the MPPM simulator with enough realism so that participants would be able to gain practical experiences, a clear understanding of the dynamics of each production phase was required. Therefore, a critical step in the model development was determining the individual components needed and the interaction of these components.

Once the model was developed, there was a need for model verification and validation. While a considerable amount of work has been done on the specific production phases, there is virtually no research examining packing firm behavior in a total system approach. Also, because of proprietary issues, there was very little existing knowledge of the dynamics of the boxed beef market. As a result, "test" runs were performed to ensure that the simulator was realistic and that the proper support material was provided to participants.

Sub-Objective One

The first sub-objective was to determine all the necessary components needed to develop a useful teaching tool. Several key components were needed in each of the three production phases.

The supply of cattle was assumed to be exogenous to the packers. Therefore, the MPPM simulator determines the amount and type of cattle that packers are able to purchase in each week simulated. The supply of cattle was accomplished through the use of ten pen types. Each pen type consisted of 100 head of steers ranging in weights from 1000 to 1240 pounds. Pens were differentiated by the live weight of cattle within the pen and the number of cattle grading in each of 4 yield grades and two quality grades.

The pen types were developed using carcass data obtained from the Cattlemen's Carcass Data Service and data from the National Beef Quality Audit. While carcass data served as the basis for creating the pen types, adjustments were made so that observable patterns could be seen in the pens.

Pen types were arranged so that the total pen weight increased from pen to pen. Also, the percentage of cattle grading U.S. Choice was designed to increase as the pens were comprised of heavier cattle. The breakdown of cattle grading in each yield grade was designed so that as the cattle got heavier the number of yield grade 1 cattle decreased and the number of yield grade 3 cattle increased.

After the ten pen types were developed, a base pen type was calculated. The base pen type represents the average or normal type of cattle offered for sale. The base pen type was developed by taking an average of the middle range of the pen types. In doing so, the base pen type was adjusted so that the type of cattle in the pen conformed to the average characteristics found in the caracas data.

While the type of cattle supplied were defined by the pen types, the total number of cattle supplied was designed so that participants would experience both tight and excess supply levels. The MPPM simulator determines the number of pens to supply based on the current simulated week. In each simulated week, the simulator will choose four pen types to offer.

The slaughtering and processing phase takes the cattle purchased in the procurement phase and produces 50 separate meat products. In order to determine the amount of each product produced from the cattle processed, conversion factors from cattle live weight to pounds of each product were needed. Dressing percentages for cattle of each live weight and yield grade combination were obtained from Dr. H. Glen Dolezal, Meat Scientist at Oklahoma State University. With these dressing percentages, cattle can be converted from a live weight to a carcass weight.

Each carcass produced can be divided into 5 primal cuts. The amount of each primal produced was defined as a fixed portion of the total carcass weight. Conversion of carcass to primal was accomplished by applying a fixed percentage to the carcass weight. Therefore, each primal was assumed to be a percentage or portion of the total carcass weight. The percentages were obtained from personnel at a major meat packing firm.

Each primal could then be divided into several sub-primal cuts, trimmings, fat, and bone. The amount of each product produced is dependent on the fabrication options chosen by the packer in fabricating the particular primal. USDA cutting options were used to specify fabrication for each primal. These fabrication options defined the amount of each product produced under each option as a percentage of the primal weight. Six different fabrication options for each primal were specified in the USDA cutting options. However, to simplify the simulation, the number of options available to participants was reduced so that each primal would only have from 2 to 4 different fabrication options available.

The USDA cutting options specified were assumed to be for yield grade 2 cattle. Therefore, these options had to be adjusted for other yield grades of cattle present in the MPPM simulator. The cut-out percentage of each cut was obtained for four yield grades from the OSU Boxed Beef Calculator (Dolezal, et al., 1995). The change in the cut-out percentages for each cut with yield grade changes were used to adjust the USDA cutting options. Because there was not a one for one matching of the cuts in the Boxed Beef Calculator and those specified in the USDA cutting options, those cuts unique to the USDA cutting options were assumed to change with yield grade in the same manner as the average of the cuts within their primal.

Costs involved in slaughtering and processing the cattle were determined using cost curves from the study by Koontz, et al (1994). The curves established by Koontz, et al. (1994) were per head costs for both processing and killing as the number of pens processed increased from 1 to 20 pens per period. However, cost curves needed for the MPPM simulator had to be separated by kill costs and processing cost because the simulated packers did not process yield grade 4 cattle. Also, processing costs needed to be differentiated by the fabrication options.

Koontz, et al. (1994) cost curves were, therefore, separated into two distinct cost curves, one for killing cattle and one for processing. It was assumed, based on the study by Duewer and Nelson (1991), that 71% of the total costs were processing cost and 29% were kill costs. However, this resulted in a single processing cost curve that was not dependent on the fabrication option used. Therefore, the per head costs of processing cattle under each fabrication option for each primal were obtained from Dr. H. Glen Dolezal, Meat Scientist at Oklahoma State University. The cost values obtained were assumed to be for a large packing firm operating at the low point of their cost curves (i.e. processing the number of pens that minimize costs). As a result, the costs obtained were therefore specified as being those cost for the largest firm in the MPPM simulator. Using the percentage changes in costs as the number of pens processed changed from the cost curves from Koontz, et al. (1994), the base cost values from the Dr. Dolezal adjusted to result in separate processing costs for each fabrication option and for each yield grade of cattle.

Once the meat products are produced, the packers are then responsible for selling these products and managing inventory. The buyer of these meat products is simulated by the MPPM simulator. A demand system for each of the 50 meat products produced was defined to represent the buyer of these meat products.

The basis of the demand system is a set of quantity dependent Cobb-Douglas type demand curves. The parameters to be defined for the demand equations were the intercepts and the own and cross price elasticities. Given these parameters, the demand equations can be used to determine the amount of meat the MPPM simulator will purchase given the prices offered by the packers.

The intercepts of the demand curves can be calculated given the elasticities and given a set of base prices and quantities. The base quantities were defined as the meat produced from 40 pens of the base pen type when the cattle are processed under a set of base fabrication options. The base fabrication options were assumed to be those fabrication options that, on average, the industry could be expected to process cattle. Dr. H. Glen Dolezal, Meat Scientist at Oklahoma State University, was interviewed in order to obtain these base fabrication options. The base prices were defined as the yearly average of weekly prices for each cut. The USDA Livestock, Meat, Wool Weekly Summary and Statistics publication was used to obtain weekly prices for each cut. The average weekly prices were then assumed to be the base prices.

The base prices are changed during selected periods of the simulation to introduce seasonality in demand. By changing the base prices, the intercepts of the demand equations are changed and therefore the demand for the meat products are altered. Seasonal prices for 52 weeks were calculated with a seasonal price index developed by Beshear and Trapp (1996). Four weeks, one in each quarter of the year, were selected from the 52 weeks to serve as demand shifters.

Estimates of own price elasticities were obtained from the study by Capps et al. (1994). Due to a lack of reliable data, these elasticities were not able to be estimated as part of this study. While the study by Capps et al. (1994) gave estimates of the own price elasticities, there were no published estimates of the cross price elasticities. Therefore, the cross price elasticities were set with the assumptions that they would be small in magnitude, that the quantity demanded of a particular cut would be more responsive to changes in prices of cuts within the same primal, and that the quantity demanded of a cut would be effected the greatest by the alternative quality grade of the same cut.

Once the estimates of the own and cross price elasticities were defined, the general restrictions of demand (Engel Aggregation, Symmetry, and Homogeneity) were imposed to ensure the elasticity matrix was theoretically sound. In order to impose these restrictions, budget shares were developed using the base prices and quantities. The revenue generated by each cut was calculated and its portion of total revenue was assumed to be the budget share of the particular product. Also, income elasticities were assumed to be unitary (i.e. one) for each product.

By imposing the general restrictions on demand, several of the cross price elasticities were able to be calculated. In fact, all cross price elasticities in the lower diagonal of the elasticity matrix were defined by the general restrictions.

If a packer is not able to sell meat products, an option has been built into the MPPM simulator that will automatically sell meat for the packer at discounted prices. The MPPM simulator determines if it must sell meat for the packer depending on two constraints. The first is a storage constraint. The storage constraint specifies the amount of each meat product the packer can hold in inventory at any one time. The storage constraint was defined as a portion of the packer's normal weekly kill.

The normal weekly kill of a packer was set at a percentage of the normal weekly kill of the industry. Normal weekly kill of the industry was set at the amount of meat produced from processing 40 pens of the base pen type using base fabrication options. The normal kill for a particular packer is then assumed to be a percentage of the industry's total. The percentage or market share set for each packer is the portion of the 40 pens that each packer should process if the packer is operating on the low point on its cost curves.

The normal kill for a packer is then set at the industry kill times its market share. This resulted in a quantity value for each product which was assumed to be the normal production of the cut. The storage capacity was then set at 66% of the normal kill of the packer. Sixty-six percent was chosen as it was found that this storage level was restrictive enough that packers had to pay fairly close attention to inventory but also had some flexibility in their inventory management.

The second constraint is a limit on the age of the meat product at the time of sale. The packers are given three weeks from the time the meat enters the inventory to the time it must be sold. If meat exceeds this age limit, the MPPM simulator will sell the excess for the packer at discounted prices.

If the MPPM simulator is required to force sale meat for the packers, a set of price dependent demand equations are used to determine the price the packer will receive for the meat. The price dependent equations utilize the same base prices and quantities in determining the intercepts. Unlike with the quantity dependent equations, the price dependent equations are based on a matrix of flexibilities. The flexibility matrix was calculated by taking the inverse of the elasticity matrix specified previously.

Along with the revenue generated by the sale of the meat products, the packers also generate revenue though the sale of yield grade 4 carcasses and by-products. The price received for the yield grade 4 carcasses are discounted values of U.S. Choice and Select yield grade 2 carcass values. The yield grade 2 carcass values are determined by the market clearing prices generated in each round of the sales phase. These market clearing prices are used to generate a revenue from meat produced from a U.S. Choice and Select yield grade 2 carcass.

Once the yield grade 2 carcass values are determined, they are discounted to calculate a yield grade 4 value. The extent to which the yield grade 2 carcass value is discounted is dependent on the number of yield grade 4 carcasses that are to be sold. A range of discount values between yield grade 2 and 4 carcasses were obtained from work conducted by Beshear and Trapp (1996). A discount equation was developed that was dependent on the portion of the cattle processed in the industry grading yield grade 4. The discount equation generates a range of discounts that corresponds to the range by Beshear and Trapp (1996) with an average discount of $17 per cwt. when eight percent of the cattle processed by the industry are yield grade 4. The eight percent is the percentage of yield grade 4 cattle in the base pen type and is assumed to be the average amount of yield grade 4 cattle in the industry. As the portion of yield grade 4 cattle increases, the discount value increases and, likewise, as the portion decreases, the discount value also decreases.

The value for the by-products was obtained from the Boxed Beef Calculator. A value of $8.59 per hundredweight (i.e. the USDA drop credit value) of live animal weight was specified as the price all packers would receive for their by-products.

Sub-Objective Two

The second specific sub-objective in this study was to synthesize all of the individual components into a useable and beneficial simulator. This required seeking the expertise of personnel within academia as well as the industry in order to design a simulator that would be realistic as possible but still be simplistic enough so that participants would be able to gain information.

The development of the simulator was actually conducted in three separate phases, with each phase corresponding to the production phases of the packer. Each phase, however, was designed to give participants two opportunities per simulated week to make decisions. The decisions made during the first period of the week could, therefore, be adjusted and changed in the second half of the week.

In the procurement phase, the participants are required to make bids for the cattle supplied by the MPPM simulator. Packer bids consist of dollar per hundredweight prices for each of the pen types offered as well as the number of pens of each pen type wanted. Once the bids from all packers are defined, the MPPM simulator will sell cattle to the packers, selling to the packer that bid the highest price and then the others until the supply of cattle is exhausted or all orders are filled.

Packers are then given reports that give the number of pens of cattle the packer was able to purchase. In addition, the packer is given the total costs of the cattle purchased and is given the number of each type (i.e. live weight, yield grade, and quality grade) of cattle they were able to purchase.

After a packer knows the number of cattle they have purchased, the packer must decide on a delivery date of the cattle to the slaughtering and processing plant. The procurement phase of the MPPM simulator is designed so that the cattle purchased cannot be sent for processing until a half week after they were purchased. However, packers are given the opportunity to delay cattle for an additional half week. Therefore, cattle purchased at the beginning of a week will be processed in the end of the same week, if they are not delayed by the packer; or in the beginning of the next week, if they are delayed.

Once the cattle are sent to the slaughtering and processing phase, the participants must decide how they will process each primal of each of the yield grades. The participants are given the flexibility to process a particular primal with any of the available fabrication options and can use different options in processing the same primal for different yield grades.

Once the participants have made their processing decisions, the MPPM simulator reports the amount of each of the 50 meat products produced. Along with this information, the MPPM simulator reports the cost incurred by the packer in processing the cattle. Per head costs for slaughtering and processing each yield grade of cattle are given in addition to total processing and slaughtering costs.

The meat produced in the slaughtering and processing phase cannot, however, be placed in inventory in the same period. A delay of a half week is incorporated in the MPPM simulator from the time that the meat is produced to the time it can be sold. Therefore, meat produced in the beginning of the week cannot be sold until the end of the week.

Once the meat enters the inventory, the participants are to able to attempt to sell any quantity of meat, up to their inventory levels, at any price. The sales round of the MPPM simulator begins with participants determining the amount of each meat product it wishes to sell and the asking price for each product. Participants are given their current inventory levels to help in making the decision about prices and quantities.

Once the decisions have been made, the MPPM simulator will determine the amount of meat it will purchase from each packer. Weighted average prices are calculated from the offer prices and quantities of the packers. These weighted average prices are then used to determine the quantity the MPPM simulator will purchase from the industry. Once the total quantity of meat that the MPPM simulator will buy is known, that quantity is allocated to the packers depending on their offer prices with the packer offering the lowest price being able to sell meat first.

After the packer has been given the opportunity to sell meat, if the inventory levels of meat remaining exceed either the storage or age limitation, the MPPM simulator will sell the excess in a forced sales round. The MPPM simulator obtains the market clearing price and quantity determined in the regular sales rounds and then adds to that quantity the amount of excess meat. The simulator then determines a new market clearing price for the quantity sold in the regular round and the excess meat. Following this, the simulator determines the price for the excess meat that will lower the original market weighted average clearing price to the new weighted average market clearing price.

After each regular and forced sales round, the MPPM simulator reports, to each packer, the amount of meat that it was able to sell and the transaction price. Along with this information, the MPPM simulator reports updated inventories so participants know exactly the amount of meat they have in inventory at any given time. Finally, at the end of the week, the MPPM simulator reports the costs and returns generated by the packer for the week.

In each of the production phases, participant packers are competing with each other as well as a computer driven packer. Packer Five is completely computer driven and bases its decisions on current market conditions. In setting a bid price for live cattle, Packer Five forecasts the expected revenue that would be generated by the cattle. It does this by predicting the amount of meat that will be in the industry at the time that the meat produced from the cattle in question will enter the market for sale and determines the market clearing prices of that total quantity of meat.

In determining the fabrication options to use, Packer Five is assumed to process cattle in a fashion similar to that of the rest of the industry. The fabrication options are set by taking an average of the fabrication options specified by the other packers in the industry. Also, Packer Five is assumed to process all the yield grade 4 cattle in the industry.

In determining the amount of meat to offer for sale, Packer Five is assumed to be willing to sell it's entire inventory. If Packer Five's inventory is less than 50% of the storage capacity of the largest packer in the industry, it is allowed to sell that quantity. However, if its inventory is larger, it is only able to sell an amount equal to 50% of the storage capacity of the largest packer. This is done so that Packer Five does not flood the market with meat and, therefore, prevent other packers from getting to sell meat.

In setting the offer price at which Packer Five attempts to sell meat, the simulator makes use of the offer prices of the other packers in the industry. The price offered for a particular meat product is set as the average price offered for the same cut by the other four packers.

Sub-Objective Three

The third sub-objective involved validating and verifying the MPPM simulator. Several test runs were conducted in order to ensure that the MPPM simulator operated in the manner intended as well as realistically portraying a meat packing industry.

The model verification entailed several steps. Test runs were conducted to determine if the model calculations made were correct. However, the verification entailed more then simply determining if the simulator operated properly. Verification also entailed determining the proper mix of support material that was needed in conducting a teaching seminar with the MPPM simulator. In addition to determining the proper mix of material, the test runs were also valuable in re-designing input and output forms so that they better relayed information between participants and the game manager.

The model validation involved determining if the results from the MPPM simulator were realistic. Three major areas were tested to ensure this realism. The first was the response of the simulator to changing cattle supply. The trial runs indicated that for a 12.5% increase/decrease in total cattle supply, the U.S. Choice yield grade 2 carcass values changed by -11.11% to 14.28%.

The supply of cattle can also be altered by changing the type of cattle that are offered. Trail runs were conducted to see what impact increasing the number of U.S. Choice cattle processed in the industry would have on U.S. Choice-Select price spreads. The results indicated that with increased numbers of U.S. Choice cattle processed, the U.S. Choice-Select spread tightens and actually inverts. As the number of U.S. Choice cattle processed increases, the amount of U.S. Choice meat increases and the amount of U.S. Select meat decreased, and, therefore, narrows the U.S. Choice/Select price spread. In fact, the U.S. Choice-Select price spread actually inverted at high percentages of U.S. Choice cattle, thus indicating that the U.S. Select carcasses become more valuable then the U.S. Choice carcasses when they are in extremely short supply.

While this finding was somewhat contrary to what was expected, these test runs were conducted on cattle all of the same live weight while the percentage of cattle grading in each yield grade was kept constant. In the actual running of the simulator, the live weight and yield grades will not be constant. As a result, additional trial runs were conducted with the combinations of pen types that are offered by the MPPM simulator. Results indicated that, given the pen types offered by the simulator, the U.S. Choice-Select spread does not invert, but does tighten considerably.

Test runs were also conducted to determine the impact of seasonality on the ability of packers in selling meat products. The packers were assumed to offer a fixed quantity of meat at the base prices. Seasonal prices were substituted for the base prices in calculating the intercepts of the demand equations and, therefore, altered the demand for the individual cuts.

The percent change in the prices used to calculate equation intercepts and percent changes in the quantity sold were determined. Results indicated that while the seasonal price for individual cuts changed from 20.24% to -15.07%, the average change in seasonal prices was only about one percent. The percent change in quantities sold were found to be larger then the change in seasonal prices, however, the average change in quantities sold were also around the one percent value.

Finally, trail runs were conducted to determine the impact of fabrication options on the revenue generated by a packer. Revenues generated by using each fabrication option for each yield grade was calculated with several price scenarios. The first scenario assumed base prices were the current market prices. At those prices, for every primal except the rib, close trim/boneless fabrication options generated more revenue then the commodity trim/bone-in fabrication options. Further, when the base prices were assumed, the close trim options were found to be more favorable for processing yield grade 1 cattle while the commodity trim options were more favorable for processing yield grade 3 cattle.

Other price scenarios assumed that the industry had processed all the cattle under all close trim or commodity trim options or slight variations thereof. Results indicated that, while the close trim options dominated when the base prices were assumed, if all packers went to close trim options it would have a downward effect on close trim product prices, therefore, reducing the revenue generated by the packer, when compared to the base. Combinations of fabrication options were also examined, but no additional distinct pattern was ascertainable.

Limitations

There is a delicate balance that must be kept when developing a simulator to be used as a teaching tool. The simulator must be realistic enough so that it is able to transmit the important information of the industry, but also simplistic enough so that participants can gain knowledge from its use.

In order to simplify the simulator, several potential components were not included. Packers, for example, sell a large degree of their meat products in advance. However, the MPPM simulator does not allow for forward sales. Therefore, sales strategies available for the participants are restricted.

Another simplification is the number of meat products packers are able to produce. Packers in the MPPM simulator are able to produce 50 different products. In reality, packers have well over 120 different products. Also, packers have specialty lines in which the quality of the products are specified within strict guidelines.

The fabrication options available are also simplified in the MPPM simulator. In reality, there are six different fabrication options for each primal. The MPPM simulator offers any where from two to four options per primal. The reduction in fabrication options was in conjunction with reducing the number of meat products available in the MPPM simulator.

Another limitation in the development of the MPPM simulator was that of data issues. Many of the parameters needed in the MPPM simulator were specified as best guesses due to a lack of reliable data.

The dressing percentages for each type of cattle in the MPPM simulator were based on general guidelines specified by Dr. H. Glen Dolezal, Meat Scientist at Oklahoma State University. However, these dressing percentages were not directly estimated[1].

The cut-out percentages of each sub-primal cut were obtained from USDA standard fabrication options, however, these were only available for yield grade 2 cattle. As a result, cut-out percentages had to be estimated for the other yield grades. Cut-out percentages for the other three yield grades were obtained from the OSU Boxed Beef Calculator, however, there was not a one-to-one correspondence of the cuts included in the USDA processing options and those in the OSU Boxed Beef Calculator. As a result, assumptions had to be made about those cuts for which no cut-out percentages were obtainable.

The final, and maybe the largest limitation, was that of the data required for the demand elasticity matrix. The elasticities used were not directly estimated due to a lack of reliable data. Therefore, estimates from previous research were used. However, there were no estimates for some of the products included in the simulator. As a result, it was assumed that, for those cuts for which no

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[1] Actually, data from the National Beef Quality Audit were used to estimate dressing percentages. However, the results indicated that the estimated dressing percentages were not observably different from those dressing percentages obtained from Dr. H. Glen Dolezal.

estimates existed, their elasticities were the same as the cuts within their primal.

In addition, no estimates were available for the cross price elasticities. Therefore, best guesses were used in defining cross price elasticities. However, some guidelines were used in specifying the cross elasticities. Cross elasticities were assumed to be fairly small, when compared to own price elasticities and it was assumed that a cut was more sensitive to prices for cuts within its own primal. Finally, it was assumed that the cross price elasticity with the largest impact was for the same cut but of the other quality grade.

While these limitations are fairly significant, it is hoped that they do not impact the ability of the simulator to be used as a teaching tool. The primary focus of the simulator is to teach participants about the meat packing industry and how their decisions should change given the current market condition. Therefore, the important aspect is that the participants be able to adjust to market conditions, regardless of the market conditions portrayed.

However, these limitations may restrict the applicability of the MPPM simulator as a research tool. The ability to make sound recommendations to industry personnel may be severely limited due to the amount of assumptions made and due to the lack of data in defining key model components.

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APPENDIX A

MPPM SIMULATOR PEN TYPES

Table A.1 MPPM Simulator Pen Type 1.

Animal Weight (Lbs.)	- U.S. Select -				- U.S. Choice -			
	Y1	Y2	Y3	Y4	Y1	Y2	Y3	Y4
1000	2	6	2	0	1	4	1	0
1020	4	11	5	1	3	7	4	0
1040	2	8	5	1	2	6	3	1
1060	1	5	2	0	1	3	2	0
1080	0	1	1	0	0	1	1	0
1100	0	1	0	0	0	1	1	0
1120	0	0	0	0	0	0	0	0
1140	0	0	0	0	0	0	0	0
1160	0	0	0	0	0	0	0	0
1180	0	0	0	0	0	0	0	0
1200	0	0	0	0	0	0	0	0
1220	0	0	0	0	0	0	0	0
1240	0	0	0	0	0	0	0	0

Table A.2 MPPM Simulator Pen Type 2.

Animal Weight (Lbs.)	- U.S. Select -				- U.S. Choice -			
	Y1	Y2	Y3	Y4	Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	2	5	2	0	1	3	2	1
1040	2	7	4	1	2	5	3	0
1060	1	8	4	0	1	5	2	1
1080	1	5	3	0	1	3	1	0
1100	1	5	2	0	1	4	2	0
1120	0	2	1	0	1	2	2	1
1140	0	0	0	0	0	0	0	0
1160	0	0	0	0	0	0	0	0
1180	0	0	0	0	0	0	0	0
1200	0	0	0	0	0	0	0	0
1220	0	0	0	0	0	0	0	0
1240	0	0	0	0	0	0	0	0

Table A.3 MPPM Simulator Pen Type 3.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	2	1	0	0	2	1	0
1060	1	6	3	0	0	5	3	0
1080	1	6	1	2	2	5	4	1
1100	1	5	2	2	2	3	2	0
1120	1	4	2	0	1	3	2	0
1140	3	6	4	1	2	4	3	1
1160	0	0	0	0	0	0	0	0
1180	0	0	0	0	0	0	0	0
1200	0	0	0	0	0	0	0	0
1220	0	0	0	0	0	0	0	0
1240	0	0	0	0	0	0	0	0

Table A.4 MPPM Simulator Pen Type 4.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	1	4	2	0	1	3	1	0
1100	2	5	3	1	1	6	3	0
1120	1	3	2	0	1	4	2	0
1140	1	5	4	2	2	5	3	2
1160	1	5	3	3	1	4	3	0
1180	0	2	2	0	1	3	2	0
1200	0	0	0	0	0	0	0	0
1220	0	0	0	0	0	0	0	0
1240	0	0	0	0	0	0	0	0

Table A.5 MPPM Simulator Pen Type 5.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	0	0	0	0	0	0	0	0
1100	1	2	1	0	1	2	1	1
1120	1	3	2	0	1	4	2	0
1140	1	4	3	0	0	3	2	1
1160	1	3	2	0	0	3	1	1
1180	1	3	2	3	1	8	5	1
1200	2	6	6	3	1	6	5	0
1220	0	0	0	0	0	0	0	0
1240	0	0	0	0	0	0	0	0

Table A.6 MPPM Simulator Pen Type 6.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	0	0	0	0	0	0	0	0
1100	0	0	0	0	0	0	0	0
1120	1	2	2	0	1	2	2	0
1140	1	3	2	1	1	7	3	0
1160	1	4	4	1	3	5	2	0
1180	1	3	2	1	0	5	3	2
1200	1	5	4	1	1	4	3	2
1220	0	3	3	2	0	3	2	1
1240	0	0	0	0	0	0	0	0

Table A.7 MPPM Simulator Pen Type 7.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	0	0	0	0	0	0	0	0
1100	0	0	0	0	0	0	0	0
1120	0	0	0	0	0	0	0	0
1140	0	0	0	0	0	0	0	0
1160	2	8	6	1	2	10	6	2
1180	1	6	5	1	2	5	4	3
1200	1	4	2	1	1	4	3	3
1220	1	3	3	0	0	3	3	1
1240	0	1	0	0	0	1	1	0

Table A.8 MPPM Simulator Pen Type 8.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	0	0	0	0	0	0	0	0
1100	0	0	0	0	0	0	0	0
1120	0	0	0	0	0	0	0	0
1140	0	0	0	0	0	0	0	0
1160	0	2	1	0	0	3	1	0
1180	1	7	5	1	1	6	5	1
1200	1	6	4	1	1	5	4	2
1220	1	3	1	1	3	4	3	3
1240	1	4	4	0	1	6	3	4

Table A.9 MPPM Simulator Pen Type 9.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	0	0	0	0	0	0	0	0
1100	0	0	0	0	0	0	0	0
1120	0	0	0	0	0	0	0	0
1140	0	0	0	0	0	0	0	0
1160	0	0	0	0	0	0	0	0
1180	0	4	2	1	0	5	2	2
1200	1	4	5	1	2	6	5	3
1220	1	5	3	1	2	6	6	3
1240	2	6	5	1	2	8	5	1

Table A.10 MPPM Simulator Pen Type 10.

Animal Weight (Lbs.)	- U.S. Select - Y1	Y2	Y3	Y4	- U.S. Choice - Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	0	0	0	0	0	0	0	0
1100	0	0	0	0	0	0	0	0
1120	0	0	0	0	0	0	0	0
1140	0	0	0	0	0	0	0	0
1160	0	0	0	0	0	0	0	0
1180	0	0	0	0	0	0	0	0
1200	1	2	2	0	0	2	2	1
1220	1	4	3	1	1	7	7	1
1240	2	10	9	5	4	16	14	5

A.11 MPPM Simulator Base Pen Type.

Animal Weight (Lbs.)	- U.S. Select -				- U.S. Choice -			
	Y1	Y2	Y3	Y4	Y1	Y2	Y3	Y4
1000	0	0	0	0	0	0	0	0
1020	0	0	0	0	0	0	0	0
1040	0	0	0	0	0	0	0	0
1060	0	0	0	0	0	0	0	0
1080	0	1	1	0	0	1	0	0
1100	1	2	1	0	1	2	1	0
1120	1	3	1	0	1	3	2	0
1140	0	4	1	0	1	4	2	1
1160	3	6	2	0	0	3	6	1
1180	2	3	2	1	0	3	5	1
1200	1	4	3	1	0	3	5	1
1220	0	2	2	1	0	2	1	1
1240	0	0	0	0	0	0	0	0

Table B.1 Packer 1 Per Head Processing Cost for Processing the Rib Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$34.48	$39.25	$44.01	$30.95	$32.72	$34.48
2	$18.84	$21.44	$24.05	$16.91	$17.88	$18.84
3	$13.63	$15.51	$17.39	$12.23	$12.93	$13.63
4	$11.02	$12.54	$14.07	$9.89	$10.46	$11.02
5	$9.12	$10.38	$11.64	$8.19	$8.65	$9.12
6	$8.04	$9.15	$10.27	$7.22	$7.63	$8.04
7	$7.35	$8.37	$9.39	$6.60	$6.98	$7.35
8	$7.11	$8.09	$9.08	$6.38	$6.75	$7.11
9	$7.37	$8.39	$9.41	$6.62	$7.00	$7.37
10	$8.20	$9.34	$10.47	$7.36	$7.78	$8.20
11	$9.66	$10.99	$12.33	$8.67	$9.16	$9.66
12	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
13	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
14	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
15	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
16	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
17	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
18	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
19	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
20	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37

Table B.2 Packer 1 Per Head Processing Cost for Processing the Chuck Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$81.55	$86.26	$90.97	$90.97	$103.50	$116.03
2	$44.56	$47.13	$49.71	$49.71	$56.55	$63.40
3	$32.23	$34.09	$35.95	$35.95	$40.90	$45.86
4	$26.06	$27.57	$29.07	$29.07	$33.08	$37.08
5	$21.57	$22.82	$24.06	$24.06	$27.38	$30.69
6	$19.02	$20.12	$21.22	$21.22	$24.14	$27.06
7	$17.39	$18.40	$19.40	$19.40	$22.07	$24.74
8	$16.81	$17.79	$18.76	$18.76	$21.34	$23.92
9	$17.44	$18.44	$19.45	$19.45	$22.13	$24.81
10	$19.40	$20.52	$21.64	$21.64	$24.62	$27.60
11	$22.84	$24.16	$25.48	$25.48	$28.99	$32.50
12	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
13	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
14	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
15	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
16	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
17	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
18	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
19	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
20	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90

Table B.3 Packer 1 Per Head Processing Cost for Processing the Round Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$61.85	$65.43	$69.02	$56.49	$60.08	$63.67
2	$33.79	$35.75	$37.71	$30.87	$32.83	$34.79
3	$24.44	$25.86	$27.28	$22.32	$23.74	$25.16
4	$19.77	$20.91	$22.06	$18.05	$19.20	$20.35
5	$16.36	$17.31	$18.26	$14.94	$15.89	$16.84
6	$14.43	$15.26	$16.10	$13.18	$14.01	$14.85
7	$13.19	$13.95	$14.72	$12.05	$12.81	$13.58
8	$12.75	$13.49	$14.23	$11.65	$12.39	$13.13
9	$13.22	$13.99	$14.76	$12.08	$12.85	$13.61
10	$14.71	$15.57	$16.42	$13.44	$14.29	$15.14
11	$17.32	$18.33	$19.33	$15.82	$16.83	$17.83
12	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
13	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
14	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
15	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
16	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
17	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
18	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
19	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
20	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15

Pens Processed	Opt. 3 YG 1	Opt. 3 YG 2	Opt. 3 YG 3
1	$69.02	$78.55	$88.03
2	$37.71	$42.92	$48.10
3	$27.28	$31.04	$34.79
4	$22.06	$25.10	$28.13
5	$18.26	$20.78	$23.28
6	$16.10	$18.32	$20.53
7	$14.72	$16.75	$18.77
8	$14.23	$16.20	$18.15
9	$14.76	$16.80	$18.82
10	$16.42	$18.69	$20.94
11	$19.33	$22.00	$24.65
12	$20.76	$23.62	$26.47
13	$20.76	$23.62	$26.47
14	$20.76	$23.62	$26.47
15	$20.76	$23.62	$26.47
16	$20.76	$23.62	$26.47
17	$20.76	$23.62	$26.47
18	$20.76	$23.62	$26.47
19	$20.76	$23.62	$26.47
20	$20.76	$23.62	$26.47

Table B.4 Packer 1 Per Head Processing Cost for Processing the Flank, Brisket, and Short Plate Primals.

Pens Processed	All Options YG 1	All Options YG 2	All Options YG 3
1	$45.19	$47.82	$50.44
2	$24.69	$26.13	$27.56
3	$17.86	$18.90	$19.93
4	$14.44	$15.28	$16.12
5	$11.95	$12.65	$13.34
6	$10.54	$11.15	$11.77
7	$9.64	$10.20	$10.76
8	$9.32	$9.86	$10.40
9	$9.66	$10.22	$10.79
10	$10.75	$11.37	$12.00
11	$12.66	$13.39	$14.13
12	$13.59	$14.38	$15.17
13	$13.59	$14.38	$15.17
14	$13.59	$14.38	$15.17
15	$13.59	$14.38	$15.17
16	$13.59	$14.38	$15.17
17	$13.59	$14.38	$15.17
18	$13.59	$14.38	$15.17
19	$13.59	$14.38	$15.17
20	$13.59	$14.38	$15.17

Table B.5 Packer 1 Per Head Processing Cost for Processing the Loin Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$65.65	$74.70	$83.75	$58.85	$62.27	$65.65
2	$35.87	$40.81	$45.76	$32.15	$34.02	$35.87
3	$25.94	$29.52	$33.10	$23.26	$24.61	$25.94
4	$20.98	$23.87	$26.76	$18.81	$19.90	$20.98
5	$17.36	$19.76	$22.15	$15.56	$16.47	$17.36
6	$15.31	$17.42	$19.53	$13.73	$14.53	$15.31
7	$14.00	$15.93	$17.86	$12.55	$13.28	$14.00
8	$13.54	$15.40	$17.27	$12.13	$12.84	$13.54
9	$14.04	$15.97	$17.91	$12.58	$13.32	$14.04
10	$15.62	$17.77	$19.92	$14.00	$14.81	$15.62
11	$18.39	$20.92	$23.45	$16.48	$17.44	$18.39
12	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
13	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
14	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
15	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
16	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
17	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
18	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
19	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
20	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
	Opt. 3 YG 1	**Opt. 3 YG 2**	**Opt. 3 YG 3**	**Opt. 4 YG 1**	**Opt. 4 YG 2**	**Opt. 4 YG 3**
1	$62.27	$68.49	$74.70	$62.27	$68.49	$74.70
2	$34.02	$37.42	$40.81	$34.02	$37.42	$40.81
3	$24.61	$27.06	$29.52	$24.61	$27.06	$29.52
4	$19.90	$21.89	$23.87	$19.90	$21.89	$23.87
5	$16.47	$18.11	$19.76	$16.47	$18.11	$19.76
6	$14.53	$15.97	$17.42	$14.53	$15.97	$17.42
7	$13.28	$14.60	$15.93	$13.28	$14.60	$15.93
8	$12.84	$14.12	$15.40	$12.84	$14.12	$15.40
9	$13.32	$14.64	$15.97	$13.32	$14.64	$15.97
10	$14.81	$16.29	$17.77	$14.81	$16.29	$17.77
11	$17.44	$19.18	$20.92	$17.44	$19.18	$20.92
12	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
13	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
14	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
15	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
16	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
17	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
18	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
19	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
20	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46

Table B.6 Packer 2 Per Head Processing Cost for Processing the Rib Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$34.13	$38.84	$43.56	$30.63	$32.38	$34.13
2	$18.49	$21.04	$23.60	$16.59	$17.54	$18.49
3	$13.27	$15.11	$16.94	$11.91	$12.59	$13.27
4	$10.66	$12.14	$13.61	$9.57	$10.12	$10.66
5	$9.53	$10.85	$12.17	$8.56	$9.04	$9.53
6	$8.43	$9.60	$10.76	$7.57	$8.00	$8.43
7	$7.59	$8.64	$9.69	$6.81	$7.20	$7.59
8	$7.06	$8.03	$9.01	$6.33	$6.70	$7.06
9	$6.87	$7.82	$8.77	$6.17	$6.52	$6.87
10	$7.07	$8.05	$9.03	$6.35	$6.71	$7.07
11	$7.69	$8.76	$9.82	$6.91	$7.30	$7.69
12	$8.79	$10.01	$11.22	$7.89	$8.34	$8.79
13	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
14	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
15	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
16	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
17	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
18	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
19	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
20	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37

Table B.7 Packer 2 Per Head Processing Cost for Processing the Chuck Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$80.71	$85.37	$90.04	$90.04	$102.44	$114.84
2	$43.72	$46.24	$48.77	$48.77	$55.49	$62.20
3	$31.39	$33.20	$35.01	$35.01	$39.84	$44.66
4	$25.22	$26.68	$28.14	$28.14	$32.01	$35.89
5	$22.55	$23.85	$25.15	$25.15	$28.62	$32.08
6	$19.94	$21.09	$22.24	$22.24	$25.30	$28.37
7	$17.95	$18.99	$20.03	$20.03	$22.79	$25.54
8	$16.69	$17.66	$18.62	$18.62	$21.19	$23.75
9	$16.25	$17.19	$18.13	$18.13	$20.63	$23.13
10	$16.72	$17.69	$18.66	$18.66	$21.23	$23.80
11	$18.20	$19.25	$20.30	$20.30	$23.10	$25.89
12	$20.80	$22.00	$23.20	$23.20	$26.40	$29.59
13	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
14	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
15	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
16	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
17	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
18	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
19	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
20	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90

Table B.8 Packer 2 Per Head Processing Cost for Processing the Round Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$61.21	$64.76	$68.31	$55.91	$59.46	$63.01
2	$33.15	$35.08	$37.00	$30.28	$32.21	$34.13
3	$23.80	$25.18	$26.56	$21.74	$23.12	$24.50
4	$19.13	$20.24	$21.35	$17.47	$18.58	$19.69
5	$17.10	$18.09	$19.08	$15.62	$16.61	$17.60
6	$15.12	$16.00	$16.87	$13.81	$14.69	$15.56
7	$13.61	$14.40	$15.19	$12.44	$13.23	$14.02
8	$12.66	$13.39	$14.13	$11.56	$12.30	$13.03
9	$12.33	$13.04	$13.76	$11.26	$11.97	$12.69
10	$12.68	$13.42	$14.15	$11.58	$12.32	$13.06
11	$13.80	$14.60	$15.40	$12.61	$13.41	$14.21
12	$15.77	$16.69	$17.60	$14.41	$15.32	$16.24
13	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
14	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
15	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
16	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
17	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
18	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
19	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
20	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15

Pens Processed	Opt. 3 YG 1	Opt. 3 YG 2	Opt. 3 YG 3
1	$68.31	$77.74	$87.12
2	$37.00	$42.11	$47.19
3	$26.56	$30.23	$33.88
4	$21.35	$24.29	$27.23
5	$19.08	$21.72	$24.34
6	$16.87	$19.20	$21.52
7	$15.19	$17.29	$19.38
8	$14.13	$16.08	$18.02
9	$13.76	$15.66	$17.54
10	$14.15	$16.11	$18.05
11	$15.40	$17.53	$19.64
12	$17.60	$20.03	$22.45
13	$20.76	$23.62	$26.47
14	$20.76	$23.62	$26.47
15	$20.76	$23.62	$26.47
16	$20.76	$23.62	$26.47
17	$20.76	$23.62	$26.47
18	$20.76	$23.62	$26.47
19	$20.76	$23.62	$26.47
20	$20.76	$23.62	$26.47

Table B.9 Packer 2 Per Head Processing Cost for Processing the Flank, Brisket, and Short Plate Primals.

Pens Processed	All Options YG 1	All Options YG 2	All Options YG 3
1	$44.73	$47.32	$49.92
2	$24.23	$25.63	$27.04
3	$17.39	$18.40	$19.41
4	$13.98	$14.79	$15.60
5	$12.49	$13.22	$13.94
6	$11.05	$11.69	$12.33
7	$9.95	$10.53	$11.10
8	$9.25	$9.79	$10.32
9	$9.01	$9.53	$10.05
10	$9.27	$9.81	$10.34
11	$10.08	$10.67	$11.26
12	$11.53	$12.19	$12.86
13	$13.59	$14.38	$15.17
14	$13.59	$14.38	$15.17
15	$13.59	$14.38	$15.17
16	$13.59	$14.38	$15.17
17	$13.59	$14.38	$15.17
18	$13.59	$14.38	$15.17
19	$13.59	$14.38	$15.17
20	$13.59	$14.38	$15.17

Table B.10 Packer 2 Per Head Processing Cost for Processing the Loin Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$64.97	$73.93	$82.88	$58.24	$61.63	$64.97
2	$35.19	$40.04	$44.90	$31.55	$33.38	$35.19
3	$25.27	$28.75	$32.23	$22.65	$23.97	$25.27
4	$20.30	$23.10	$25.90	$18.20	$19.26	$20.30
5	$18.15	$20.65	$23.15	$16.27	$17.22	$18.15
6	$16.05	$18.26	$20.47	$14.39	$15.22	$16.05
7	$14.45	$16.44	$18.44	$12.95	$13.71	$14.45
8	$13.44	$15.29	$17.14	$12.04	$12.75	$13.44
9	$13.08	$14.89	$16.69	$11.73	$12.41	$13.08
10	$13.46	$15.32	$17.17	$12.07	$12.77	$13.46
11	$14.65	$16.67	$18.69	$13.13	$13.90	$14.65
12	$16.74	$19.05	$21.36	$15.01	$15.88	$16.74
13	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
14	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
15	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
16	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
17	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
18	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
19	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
20	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74

	Opt. 3 YG 1	Opt. 3 YG 2	Opt. 3 YG 3	Opt. 4 YG 1	Opt. 4 YG 2	Opt. 4 YG 3
1	$61.63	$67.78	$73.93	$61.63	$67.78	$73.93
2	$33.38	$36.71	$40.04	$33.38	$36.71	$40.04
3	$23.97	$26.36	$28.75	$23.97	$26.36	$28.75
4	$19.26	$21.18	$23.10	$19.26	$21.18	$23.10
5	$17.22	$18.93	$20.65	$17.22	$18.93	$20.65
6	$15.22	$16.74	$18.26	$15.22	$16.74	$18.26
7	$13.71	$15.08	$16.44	$13.71	$15.08	$16.44
8	$12.75	$14.02	$15.29	$12.75	$14.02	$15.29
9	$12.41	$13.65	$14.89	$12.41	$13.65	$14.89
10	$12.77	$14.04	$15.32	$12.77	$14.04	$15.32
11	$13.90	$15.28	$16.67	$13.90	$15.28	$16.67
12	$15.88	$17.47	$19.05	$15.88	$17.47	$19.05
13	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
14	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
15	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
16	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
17	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
18	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
19	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
20	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46

Table B.11 Packer 3 Per Head Processing Cost for Processing the Rib Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$33.61	$38.26	$42.90	$30.17	$31.89	$33.61
2	$17.97	$20.45	$22.93	$16.13	$17.05	$17.97
3	$12.75	$14.52	$16.28	$11.45	$12.10	$12.75
4	$11.36	$12.93	$14.50	$10.20	$10.78	$11.36
5	$10.21	$11.62	$13.03	$9.16	$9.69	$10.21
6	$9.18	$10.44	$11.71	$8.24	$8.71	$9.18
7	$8.28	$9.43	$10.57	$7.43	$7.86	$8.28
8	$7.55	$8.59	$9.64	$6.78	$7.16	$7.55
9	$7.00	$7.97	$8.94	$6.28	$6.64	$7.00
10	$6.66	$7.58	$8.50	$5.97	$6.32	$6.66
11	$6.54	$7.44	$8.34	$5.87	$6.20	$6.54
12	$6.66	$7.58	$8.50	$5.98	$6.32	$6.66
13	$7.06	$8.03	$9.01	$6.33	$6.70	$7.06
14	$7.74	$8.81	$9.88	$6.95	$7.34	$7.74
15	$8.73	$9.94	$11.15	$7.84	$8.28	$8.73
16	$10.05	$11.44	$12.83	$9.02	$9.54	$10.05
17	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
18	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
19	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
20	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37

Table B.12 Packer 3 Per Head Processing Cost for Processing the Chuck Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$79.49	$84.08	$88.67	$88.67	$100.88	$113.10
2	$42.49	$44.95	$47.40	$47.40	$53.93	$60.46
3	$30.16	$31.90	$33.65	$33.65	$38.28	$42.91
4	$26.87	$28.43	$29.98	$29.98	$34.11	$38.24
5	$24.14	$25.54	$26.94	$26.94	$30.64	$34.35
6	$21.70	$22.95	$24.21	$24.21	$27.54	$30.88
7	$19.59	$20.72	$21.85	$21.85	$24.86	$27.87
8	$17.85	$18.89	$19.92	$19.92	$22.66	$25.40
9	$16.56	$17.51	$18.47	$18.47	$21.01	$23.56
10	$15.74	$16.65	$17.56	$17.56	$19.98	$22.40
11	$15.46	$16.35	$17.24	$17.24	$19.62	$21.99
12	$15.76	$16.67	$17.58	$17.58	$20.00	$22.42
13	$16.69	$17.65	$18.62	$18.62	$21.18	$23.75
14	$18.30	$19.36	$20.42	$20.42	$23.23	$26.04
15	$20.65	$21.84	$23.04	$23.04	$26.21	$29.38
16	$23.78	$25.15	$26.52	$26.52	$30.18	$33.83
17	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
18	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
19	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
20	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90

Table B.13 Packer 3 Per Head Processing Cost for Processing the Round Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$60.28	$63.78	$67.27	$55.06	$58.56	$62.05
2	$32.22	$34.09	$35.96	$29.43	$31.30	$33.17
3	$22.87	$24.20	$25.53	$20.89	$22.22	$23.55
4	$20.38	$21.56	$22.75	$18.62	$19.80	$20.98
5	$18.31	$19.37	$20.44	$16.73	$17.79	$18.85
6	$16.46	$17.41	$18.37	$15.03	$15.99	$16.94
7	$14.85	$15.71	$16.58	$13.57	$14.43	$15.29
8	$13.54	$14.33	$15.11	$12.37	$13.15	$13.94
9	$12.56	$13.28	$14.01	$11.47	$12.20	$12.93
10	$11.94	$12.63	$13.32	$10.91	$11.60	$12.29
11	$11.72	$12.40	$13.08	$10.71	$11.39	$12.07
12	$11.95	$12.64	$13.34	$10.92	$11.61	$12.30
13	$12.66	$13.39	$14.13	$11.56	$12.30	$13.03
14	$13.88	$14.69	$15.49	$12.68	$13.48	$14.29
15	$15.66	$16.57	$17.48	$14.30	$15.21	$16.12
16	$18.03	$19.08	$20.12	$16.47	$17.52	$18.56
17	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
18	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
19	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
20	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15

	Opt. 3 YG 1	Opt. 3 YG 2	Opt. 3 YG 3
1	$67.27	$76.56	$85.80
2	$35.96	$40.93	$45.87
3	$25.53	$29.05	$32.56
4	$22.75	$25.89	$29.01
5	$20.44	$23.26	$26.06
6	$18.37	$20.90	$23.42
7	$16.58	$18.87	$21.14
8	$15.11	$17.20	$19.27
9	$14.01	$15.95	$17.87
10	$13.32	$15.16	$16.99
11	$13.08	$14.89	$16.69
12	$13.34	$15.18	$17.01
13	$14.13	$16.08	$18.02
14	$15.49	$17.63	$19.76
15	$17.48	$19.89	$22.29
16	$20.12	$22.90	$25.67
17	$20.76	$23.62	$26.47
18	$20.76	$23.62	$26.47
19	$20.76	$23.62	$26.47
20	$20.76	$23.62	$26.47

Table B.14 Packer 3 Per Head Processing Cost for Processing the Flank, Brisket, and Short Plate Primals.

Pens Processed	All Options YG 1	All Options YG 2	All Options YG 3
1	$44.05	$46.61	$49.16
2	$23.55	$24.91	$26.28
3	$16.71	$17.68	$18.65
4	$14.89	$15.76	$16.62
5	$13.38	$14.16	$14.93
6	$12.03	$12.72	$13.42
7	$10.85	$11.48	$12.11
8	$9.89	$10.47	$11.04
9	$9.18	$9.71	$10.24
10	$8.72	$9.23	$9.74
11	$8.57	$9.06	$9.56
12	$8.73	$9.24	$9.75
13	$9.25	$9.79	$10.32
14	$10.14	$10.73	$11.32
15	$11.44	$12.11	$12.77
16	$13.18	$13.94	$14.71
17	$13.59	$14.38	$15.17
18	$13.59	$14.38	$15.17
19	$13.59	$14.38	$15.17
20	$13.59	$14.38	$15.17

Table B.15 Packer 3 Per Head Processing Cost for Processing the Loin Primal

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$63.98	$72.81	$81.63	$57.36	$60.70	$63.98
2	$34.21	$38.92	$43.64	$30.66	$32.45	$34.21
3	$24.28	$27.63	$30.97	$21.76	$23.03	$24.28
4	$21.63	$24.62	$27.60	$19.39	$20.52	$21.63
5	$19.44	$22.12	$24.79	$17.42	$18.44	$19.44
6	$17.47	$19.88	$22.28	$15.66	$16.57	$17.47
7	$15.77	$17.94	$20.11	$14.13	$14.96	$15.77
8	$14.37	$16.35	$18.33	$12.88	$13.63	$14.37
9	$13.33	$15.17	$17.00	$11.95	$12.64	$13.33
10	$12.67	$14.42	$16.17	$11.36	$12.02	$12.67
11	$12.44	$14.16	$15.87	$11.15	$11.80	$12.44
12	$12.68	$14.43	$16.18	$11.37	$12.03	$12.68
13	$13.43	$15.29	$17.14	$12.04	$12.74	$13.43
14	$14.73	$16.76	$18.80	$13.21	$13.98	$14.73
15	$16.62	$18.91	$21.21	$14.90	$15.77	$16.62
16	$19.14	$21.78	$24.42	$17.16	$18.16	$19.14
17	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
18	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
19	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
20	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74

	Opt. 3 YG 1	Opt. 3 YG 2	Opt. 3 YG 3	Opt. 4 YG 1	Opt. 4 YG 2	Opt. 4 YG 3
1	$60.70	$66.75	$72.81	$60.70	$66.75	$72.81
2	$32.45	$35.68	$38.92	$32.45	$35.68	$38.92
3	$23.03	$25.33	$27.63	$23.03	$25.33	$27.63
4	$20.52	$22.57	$24.62	$20.52	$22.57	$24.62
5	$18.44	$20.28	$22.12	$18.44	$20.28	$22.12
6	$16.57	$18.22	$19.88	$16.57	$18.22	$19.88
7	$14.96	$16.45	$17.94	$14.96	$16.45	$17.94
8	$13.63	$14.99	$16.35	$13.63	$14.99	$16.35
9	$12.64	$13.90	$15.17	$12.64	$13.90	$15.17
10	$12.02	$13.22	$14.42	$12.02	$13.22	$14.42
11	$11.80	$12.98	$14.16	$11.80	$12.98	$14.16
12	$12.03	$13.23	$14.43	$12.03	$13.23	$14.43
13	$12.74	$14.02	$15.29	$12.74	$14.02	$15.29
14	$13.98	$15.37	$16.76	$13.98	$15.37	$16.76
15	$15.77	$17.34	$18.91	$15.77	$17.34	$18.91
16	$18.16	$19.97	$21.78	$18.16	$19.97	$21.78
17	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
18	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
19	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
20	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46

Table B.16 Packer 4 Per Head Processing Cost for Processing the Rib Primal

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$33.39	$38.01	$42.62	$29.97	$31.68	$33.39
2	$17.77	$20.23	$22.69	$15.95	$16.86	$17.77
3	$12.56	$14.30	$16.03	$11.27	$11.92	$12.56
4	$11.60	$13.20	$14.80	$10.41	$11.00	$11.60
5	$10.52	$11.97	$13.43	$9.44	$9.98	$10.52
6	$9.53	$10.85	$12.17	$8.56	$9.04	$9.53
7	$8.66	$9.85	$11.05	$7.77	$8.21	$8.66
8	$7.90	$8.99	$10.08	$7.09	$7.50	$7.90
9	$7.29	$8.29	$9.30	$6.54	$6.91	$7.29
10	$6.83	$7.77	$8.71	$6.13	$6.48	$6.83
11	$6.54	$7.44	$8.35	$5.87	$6.20	$6.54
12	$6.44	$7.33	$8.22	$5.78	$6.11	$6.44
13	$6.54	$7.45	$8.35	$5.87	$6.21	$6.54
14	$6.87	$7.82	$8.77	$6.17	$6.52	$6.87
15	$7.43	$8.46	$9.48	$6.67	$7.05	$7.43
16	$8.24	$9.38	$10.52	$7.40	$7.82	$8.24
17	$9.32	$10.61	$11.90	$8.37	$8.84	$9.32
18	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
19	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37
20	$10.37	$11.80	$13.24	$9.31	$9.84	$10.37

Table B.17 Packer 4 Per Head Processing Cost for Processing the Chuck Primal

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$78.97	$83.53	$88.10	$88.10	$100.23	$112.36
2	$42.04	$44.46	$46.89	$46.89	$53.35	$59.81
3	$29.70	$31.42	$33.14	$33.14	$37.70	$42.27
4	$27.43	$29.01	$30.60	$30.60	$34.81	$39.02
5	$24.88	$26.32	$27.75	$27.75	$31.58	$35.40
6	$22.55	$23.85	$25.15	$25.15	$28.62	$32.08
7	$20.47	$21.65	$22.83	$22.83	$25.98	$29.12
8	$18.68	$19.76	$20.84	$20.84	$23.71	$26.58
9	$17.23	$18.22	$19.22	$19.22	$21.87	$24.51
10	$16.14	$17.08	$18.01	$18.01	$20.49	$22.97
11	$15.47	$16.36	$17.25	$17.25	$19.63	$22.00
12	$15.23	$16.11	$16.99	$16.99	$19.33	$21.67
13	$15.48	$16.37	$17.27	$17.27	$19.64	$22.02
14	$16.25	$17.18	$18.12	$18.12	$20.62	$23.11
15	$17.57	$18.58	$19.60	$19.60	$22.30	$25.00
16	$19.49	$20.62	$21.74	$21.74	$24.74	$27.73
17	$22.04	$23.32	$24.59	$24.59	$27.98	$31.36
18	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
19	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90
20	$24.52	$25.94	$27.36	$27.36	$31.13	$34.90

Table B.18 Packer 4 Per Head Processing Cost for Processing the Round Primal

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$59.89	$63.36	$66.84	$54.70	$58.18	$61.65
2	$31.88	$33.73	$35.58	$29.12	$30.97	$32.82
3	$22.53	$23.83	$25.14	$20.58	$21.88	$23.19
4	$20.80	$22.01	$23.21	$19.00	$20.21	$21.41
5	$18.87	$19.96	$21.06	$17.23	$18.33	$19.42
6	$17.10	$18.09	$19.08	$15.62	$16.61	$17.60
7	$15.52	$16.42	$17.32	$14.18	$15.08	$15.98
8	$14.17	$14.99	$15.81	$12.94	$13.76	$14.59
9	$13.07	$13.82	$14.58	$11.93	$12.69	$13.45
10	$12.24	$12.95	$13.66	$11.18	$11.89	$12.60
11	$11.73	$12.41	$13.09	$10.71	$11.39	$12.07
12	$11.55	$12.22	$12.89	$10.55	$11.22	$11.89
13	$11.74	$12.42	$13.10	$10.72	$11.40	$12.08
14	$12.32	$13.03	$13.75	$11.25	$11.97	$12.68
15	$13.32	$14.10	$14.87	$12.17	$12.94	$13.72
16	$14.78	$15.64	$16.50	$13.50	$14.36	$15.22
17	$16.72	$17.69	$18.66	$15.27	$16.24	$17.21
18	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
19	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15
20	$18.60	$19.68	$20.76	$16.99	$18.07	$19.15

	Opt. 3 YG 1	Opt. 3 YG 2	Opt. 3 YG 3
1	$66.84	$76.07	$85.24
2	$35.58	$40.49	$45.38
3	$25.14	$28.61	$32.06
4	$23.21	$26.42	$29.61
5	$21.06	$23.96	$26.85
6	$19.08	$21.72	$24.34
7	$17.32	$19.72	$22.09
8	$15.81	$18.00	$20.17
9	$14.58	$16.60	$18.60
10	$13.66	$15.55	$17.43
11	$13.09	$14.90	$16.69
12	$12.89	$14.67	$16.44
13	$13.10	$14.91	$16.71
14	$13.75	$15.65	$17.54
15	$14.87	$16.92	$18.97
16	$16.50	$18.77	$21.04
17	$18.66	$21.23	$23.79
18	$20.76	$23.62	$26.47
19	$20.76	$23.62	$26.47
20	$20.76	$23.62	$26.47

Table B.19 Packer 4 Per Head Processing Cost for Processing the Flank, Brisket, and Short Plate Primals.

Pens Processed	All Options YG 1	All Options YG 2	All Options YG 3
1	$43.76	$46.30	$48.84
2	$23.29	$24.65	$26.00
3	$16.46	$17.42	$18.37
4	$15.20	$16.08	$16.96
5	$13.79	$14.59	$15.39
6	$12.49	$13.22	$13.94
7	$11.34	$12.00	$12.66
8	$10.35	$10.95	$11.56
9	$9.55	$10.10	$10.66
10	$8.95	$9.47	$9.99
11	$8.57	$9.07	$9.57
12	$8.44	$8.93	$9.42
13	$8.58	$9.08	$9.57
14	$9.00	$9.53	$10.05
15	$9.74	$10.30	$10.87
16	$10.80	$11.43	$12.05
17	$12.22	$12.92	$13.63
18	$13.59	$14.38	$15.17
19	$13.59	$14.38	$15.17
20	$13.59	$14.38	$15.17

Table B.20 Packer 4 Per Head Processing Cost for Processing the Loin Primal.

Pens Processed	Opt. 1 YG 1	Opt. 1 YG 2	Opt. 1 YG 3	Opt. 2 YG 1	Opt. 2 YG 2	Opt. 2 YG 3
1	$63.57	$72.33	$81.10	$56.99	$60.30	$63.57
2	$33.84	$38.50	$43.17	$30.33	$32.10	$33.84
3	$23.91	$27.21	$30.50	$21.43	$22.68	$23.91
4	$22.08	$25.12	$28.16	$19.79	$20.94	$22.08
5	$20.03	$22.79	$25.55	$17.95	$19.00	$20.03
6	$18.15	$20.65	$23.15	$16.27	$17.22	$18.15
7	$16.48	$18.75	$21.02	$14.77	$15.63	$16.48
8	$15.04	$17.11	$19.19	$13.48	$14.27	$15.04
9	$13.87	$15.78	$17.69	$12.43	$13.16	$13.87
10	$13.00	$14.79	$16.58	$11.65	$12.33	$13.00
11	$12.45	$14.17	$15.88	$11.16	$11.81	$12.45
12	$12.26	$13.95	$15.64	$10.99	$11.63	$12.26
13	$12.46	$14.18	$15.89	$11.17	$11.82	$12.46
14	$13.08	$14.88	$16.68	$11.72	$12.41	$13.08
15	$14.14	$16.09	$18.04	$12.68	$13.42	$14.14
16	$15.69	$17.85	$20.01	$14.06	$14.88	$15.69
17	$17.74	$20.19	$22.64	$15.91	$16.83	$17.74
18	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
19	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74
20	$19.74	$22.46	$25.19	$17.70	$18.73	$19.74

	Opt. 3 YG 1	Opt. 3 YG 2	Opt. 3 YG 3	Opt. 4 YG 1	Opt. 4 YG 2	Opt. 4 YG 3
1	$60.30	$66.32	$72.33	$60.30	$66.32	$72.33
2	$32.10	$35.30	$38.50	$32.10	$35.30	$38.50
3	$22.68	$24.95	$27.21	$22.68	$24.95	$27.21
4	$20.94	$23.03	$25.12	$20.94	$23.03	$25.12
5	$19.00	$20.89	$22.79	$19.00	$20.89	$22.79
6	$17.22	$18.93	$20.65	$17.22	$18.93	$20.65
7	$15.63	$17.19	$18.75	$15.63	$17.19	$18.75
8	$14.27	$15.69	$17.11	$14.27	$15.69	$17.11
9	$13.16	$14.47	$15.78	$13.16	$14.47	$15.78
10	$12.33	$13.56	$14.79	$12.33	$13.56	$14.79
11	$11.81	$12.99	$14.17	$11.81	$12.99	$14.17
12	$11.63	$12.79	$13.95	$11.63	$12.79	$13.95
13	$11.82	$13.00	$14.18	$11.82	$13.00	$14.18
14	$12.41	$13.64	$14.88	$12.41	$13.64	$14.88
15	$13.42	$14.75	$16.09	$13.42	$14.75	$16.09
16	$14.88	$16.37	$17.85	$14.88	$16.37	$17.85
17	$16.83	$18.51	$20.19	$16.83	$18.51	$20.19
18	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
19	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46
20	$18.73	$20.60	$22.46	$18.73	$20.60	$22.46

APPENDIX C

MPPM SIMULATOR INPUT AND OUTPUT FORMS

Table C.1 Packer Input Form for the Procurement Phase.

For Week # 7

PACKER 1

	NUMBER AVAILABLE	PRICE BID	NUMBER WANTED
PEN SAMPLE 1	10	______	______
PEN SAMPLE 2	10	______	______
PEN SAMPLE 3	10	______	______
PEN SAMPLE 4	0	______	______
PEN SAMPLE 5	0	______	______
PEN SAMPLE 6	0	______	______
PEN SAMPLE 7	0	______	______
PEN SAMPLE 8	0	______	______
PEN SAMPLE 9	0	______	______
PEN SAMPLE 10	10	______	______

Table C.2 Procurement Output Form Reporting Cattle Purchases.

For Week # 7

PACKER 1

	NUMBER WANTED	PRICE BID	NUMBER PURCHASED	PRICE PAID
PEN SAMPLE 1	2	$81.00	2	$81.00
PEN SAMPLE 2	2	$81.00	2	$81.00
PEN SAMPLE 3	2	$81.00	2	$81.00
PEN SAMPLE 4	0	$0.00	0	$0.00
PEN SAMPLE 5	0	$0.00	0	$0.00
PEN SAMPLE 6	0	$0.00	0	$0.00
PEN SAMPLE 7	0	$0.00	0	$0.00
PEN SAMPLE 8	0	$0.00	0	$0.00
PEN SAMPLE 9	0	$0.00	0	$0.00
PEN SAMPLE 10	2	$81.00	2	$81.00
TOTAL PURCHASED		8		
AVG. PRICE PAID		$81.00		

Table C.3 Procurement Output Form Reporting the Type of Cattle Purchased and Cattle Costs.

Week # 7

800 HEAD	PURCHASED BY PACKER #1								Total Cost of Cattle
	Select				Choice				$716,655.60
Weight	Y1	Y2	Y3	Y4	Y1	Y2	Y3	Y4	
1,000	4	12	4	0	2	8	2	0	Total Weight
1,020	12	32	14	2	8	20	12	2	
1,040	8	34	20	4	8	26	14	2	884,760
1,060	6	38	18	0	4	26	14	2	
1,080	4	24	10	4	6	18	12	2	Avg. Weight
1,100	4	22	8	4	6	16	10	0	Per Head
1,120	2	12	6	0	4	10	8	2	
1,140	6	12	8	2	4	8	6	2	1,106
1,160	0	0	0	0	0	0	0	0	
1,180	0	0	0	0	0	0	0	0	$ Per Head
1,200	2	4	4	0	0	4	4	2	
1,220	2	8	6	2	2	14	14	2	$895.82
1,240	4	20	18	10	8	32	28	10	
									$ Per Cwt.
									$81.00

Table C.4 Industry Summary Report for the Procurement Phase.

For Week # 7

SUMMARY

	NUMBER PURCHASED		NUMBER REMAINING
PEN SAMPLE 1	10		0
PEN SAMPLE 2	10		0
PEN SAMPLE 3	10		0
PEN SAMPLE 4	0		0
PEN SAMPLE 5	0		0
PEN SAMPLE 6	0		0
PEN SAMPLE 7	0		0
PEN SAMPLE 8	0		0
PEN SAMPLE 9	0		0
PEN SAMPLE 10	6		4
TOTALS	36		4
	LOW	HIGH	
PRICE RANGE ON CATTLE PURCHASED	$74.00	$95.00	

Table C.5 Packer Delay Form for the Procurement Phase.

PACKER 1	7	(1) CATTLE BOUGHT THIS PERIOD	(2) CATTLE THAT MUST BE PROCESSED NEXT PERIOD FROM DELAYS (CATTLE ARE THOSE DELAYED LAST PERIOD)	(3) CATTLE TO DELAY FROM PURCHASES THIS PERIOD	TOTAL CATTLE TO PROCESS NEXT PERIOD ((1)+(2)-(3))
PEN TYPE 1		2	0	________	________
PEN TYPE 2		2	0	________	________
PEN TYPE 3		2	0	________	________
PEN TYPE 4		0	0	________	________
PEN TYPE 5		0	0	________	________
PEN TYPE 6		0	0	________	________
PEN TYPE 7		0	0	________	________
PEN TYPE 8		0	0	________	________
PEN TYPE 9		0	0	________	________
PEN TYPE 10		2	0	________	________
TOTAL		0	0		

Table C.6 Packer Input Form for the Fabrication Phase.

PACKER 1

PROCESSING CHOICES FOR WEEK 7

	Yield Grade 1				Yield Grade 2				Yield Grade 3			
PRIMAL	OPT. 1	OPT. 2	OPT. 3	OPT. 4	OPT. 1	OPT. 2	OPT. 3	OPT. 4	OPT. 1	OPT. 2	OPT. 3	OPT. 4
RIB	____	____	NA	NA	____	____	NA	NA	____	____	NA	NA
LOIN	____	____	____	____	____	____	____	____	____	____	____	____
CHUCK	____	____	NA	NA	____	____	NA	NA	____	____	NA	NA
ROUND	____	____	____	NA	____	____	____	NA	____	____	____	NA
F,B,P	100%	100%	100%	NA	100%	100%	100%	NA	100%	100%	100%	NA

Table C.7 Fabrication Output Form Reporting the Amount and Type of Cattle to be Processed.

PACKER 1

700 HEAD TO BE PROCESSED THIS PERIOD

	Select				Choice			
Weight	Y1	Y2	Y3	Y4	Y1	Y2	Y3	Y4
1,000	3	10	3	0	1	5	1	0
1,020	5	10	8	1	4	10	5	0
1,040	3	10	6	1	2	8	4	1
1,060	1	6	3	0	1	4	5	0
1,080	0	3	2	0	0	2	3	0
1,100	0	2	0	0	0	2	3	0
1,120	0	0	0	0	0	0	0	0
1,140	0	0	0	0	0	0	0	0
1,160	0	5	3	0	0	8	2	0
1,180	2	20	18	5	3	20	17	8
1,200	8	15	20	5	7	30	27	15
1,220	8	15	17	7	15	20	20	18
1,240	12	25	30	15	17	50	30	25

Table C.8 Fabrication Output Form Reporting the Amount of Meat Produced and Fabrication Costs.

PACKER #1 TOTAL POUNDS OF WHOLESALE CUTS PAGE 7
WEEK # 7

CUT	PRIMAL	SELECT	CHOICE
(1) 112A Lip-On Ribeye	Rib	5,831	7,037
(2) 107 3X4 Ribeye	Rib	1,652	2,174
(3) 123A Short Rib	Rib	1,826	2,226
(4) 124 Back Rib	Rib	1,666	2,005
(5) 174 Short Loin	Loin	2,787	3,542
(6) 175 Strip Loin	Loin	1,063	1,294
(7) 180 Strip Loin	Loin	5,333	6,398
(8) 184 Top Butt	Loin	5,331	6,604
(9) Bone-In Top Butt	Loin	2,105	2,390
(10) Tenderloin	Loin	2,235	2,694
(11) 113B Sq-Cut Neck-Off	Chuck	23,112	26,024
(12) 115 2-pc. Bnls Chuck	Chuck	19,293	25,394
(13) 168 Top Inside Round	Round	9,089	11,233
(14) 170 Gooseneck Round	Round	3,849	5,066
(15) 167 Knuckle	Round	1,580	2,080
(16) 167A Peeled Knuckle	Round	2,504	2,985
(17) 161 Round, Boneless	Round	7,877	9,104
(18) 171B Outside Round	Round	3,421	4,092
(19) 171C Eye of Round	Round	1,507	1,803
(20) 193 Flank Steak	Flank	966	1,180
(21) 120 Brisket	Brisket	5,653	6,886
(22) Pastrami	Sht Plate	2,595	3,160
(23) Thin Meats	All	10,479	12,749
(24) 75% Trimmings	All	27,691	
(25) 50% Trimmings	All	48,129	
(26) Fat	All	50,563	
(27) Bone	All	48,063	
Yld Grade 4 Carcasses		26,532	52,595

	YG1	YG2	YG3	TOTAL
PROCESSING COST/HD	$88.75	$97.73	$102.45	$98.14
KILL COST/HD	$29.29	$29.29	$29.29	$29.29
# OF CATTLE	92	280	227	700
TOTAL COST	$10,859.67	$35,564.57	$29,903.36	$79,285.49
AVG. COST PER POUND	$0.1595	$0.1726	$0.1757	$0.1515

TOTAL MEAT PRODUCED 444,321

Table C.9 Sales Output Form Reporting Updated Inventory Prior to Meat Sales.

PAGE 9

PACKER 1 Week # 7	IN 1 WEEK		IN 2 WEEKS		IN 3 WEEKS		TOTAL	TOTAL
	SELECT	CHOICE	SELECT	CHOICE	SELECT	CHOICE	SELECT	CHOICE
(1) 112A Lip-On Ribeye	9,086	4,538	0	0	0	0	9,086	4,538
(2) 107 3X4 Ribeye	0	0	0	2,126	0	0	0	2,126
(3) 123A Short Rib	3,625	2,640	1,746	0	0	0	5,371	2,640
(4) 124 Back Rib	1,672	1,004	0	0	0	0	1,672	1,004
(5) 174 Short Loin	3,690	386	3,606	0	0	0	7,296	386
(6) 175 Strip Loin	0	0	1,006	0	0	0	1,006	0
(7) 180 Strip Loin	8,052	3,702	0	0	0	0	8,052	3,702
(8) 184 Top Butt	10,037	5,762	0	0	0	0	10,037	5,762
(9) Bone-In Top Butt	0	0	0	0	0	0	0	0
(10) Tenderloin	3,962	192	0	0	0	0	3,962	192
(11) 113B Square-Cut Neck	12,893	12,030	0	0	0	0	12,893	12,030
(12) 115 2-pc. Boneless Chk	16,204	0	0	0	0	0	16,204	0
(13) 168 Top Inside Round	12,349	5,894	0	0	0	0	12,349	5,894
(14) 170 Gooseneck Round	8,588	6,848	0	0	0	0	8,588	6,848
(15) 167 Knuckle	1,192	4,307	0	0	0	0	1,192	4,307
(16) 167A Peeled Knuckle	521	305	0	0	0	0	521	305
(17) 161 Round, Boneless	9,561	8,370	0	0	0	0	9,561	8,370
(18) 171B Outside Round	165	62	0	0	0	0	165	62
(19) 171C Eye of Round	61	28	0	0	0	0	61	28
(20) 193 Flank Steak	1,490	142	0	0	0	0	1,490	142
(21) 120 Brisket	7,883	8,039	0	0	0	0	7,883	8,039
(22) Pastrami	5,105	360	0	0	0	0	5,105	360
(23) Thin Meats	9,935	2,435	0	0	0	0	9,935	2,435
(24) 75% Trimmings	39,368		0		0		39,368	
(25) 50% Trimmings	81,537		0		0		81,537	
(26) Fat	8,512		0		0		8,512	
(27) Bone	35,895		0		0		35,895	
		Total Quantity Of Meat In Inventory					366,911	

Table C.10 Input Form for the Sales Phase.

PACKER 1	SELECT PRICE WANTED LAST PERIOD	SELECT PRICE WANTED	SELECT QUANTITY SOLD LAST PERIOD	SELECT QUANTITY OFFERED	CHOICE PRICE WANTED LAST PERIOD	CHOICE PRICE WANTED	CHOICE QUANTITY SOLD LAST PERIOD	CHOICE QUANTITY OFFERED
(1) 112A Lip-On Ribeye	$4.60		8,189		$5.20		7,000	
(2) 107 3X4 Ribeye	$3.72		2,641		$3.80		0	
(3) 123A Short Rib	$3.22		10		$4.00		2,000	
(4) 124 Back Rib	$0.77		1,223		$0.77		2,000	
(5) 174 Short Loin	$1.92		0		$1.95		3,057	
(6) 175 Strip Loin	$2.92		0		$3.10		1,040	
(7) 180 Strip Loin	$3.40		10,000		$4.05		7,777	
(8) 184 Top Butt	$2.02		8,000		$2.32		8,000	
(9) Bone-In Top Butt	$1.60		572		$1.76		0	
(10) Tenderloin	$8.10		3,000		$8.30		3,000	
(11) 113B Square-Cut Neck	$0.76		5,574		$0.78		6,047	
(12) 115 2-pc. Boneless Chk	$1.05		38,432		$1.08		40,415	
(13) 168 Top Inside Round	$1.64		15,000		$1.66		15,000	
(14) 170 Gooseneck Round	$1.38		13,760		$1.40		15,000	
(15) 167 Knuckle	$1.33		6,000		$1.60		704	
(16) 167A Peeled Knuckle	$1.92		2,177		$1.97		2,258	
(17) 161 Round, Boneless	$1.25		0		$1.28		0	
(18) 171B Outside Round	$1.47		3,011		$1.46		1,829	
(19) 171C Eye of Round	$1.68		1,332		$1.70		1,116	
(20) 193 Flank Steak	$3.25		0		$3.25		805	
(21) 120 Brisket	$1.07		8,000		$1.08		8,000	
(22) Pastrami	$2.15		2,616		$2.15		4,000	
(23) Thin Meats	$1.70		10,000		$1.80		10,000	
(24) 75% Trimmings	$0.81		30,000					
(25) 50% Trimmings	$0.56		50,000					
(26) Fat	$0.17		40,000					
(27) Bone	$0.17		0					

Table C.11 Sales Output Form Reporting Quantities and Prices of Meat Sold.

PACKER 1
WEEK ===> 9

	SELECT PRICE WANTED	SELECT QUANTITY OFFERED	SELECT QUANTITY SOLD	CHOICE PRICE WANTED	CHOICE QUANTITY OFFERED	CHOICE QUANTITY SOLD
(1) 112A Lip-On Ribeye	$4.60	8,189	8,189	$5.20	4,538 *	7,000
(2) 107 3X4 Ribeye	$3.72	0 *	2,641	$3.80	2,126 *	0
(3) 123A Short Rib	$3.22	2,000	10	$4.00	2,000	2,000
(4) 124 Back Rib	$0.77	1,672 *	1,223	$0.77	1,004 *	2,000
(5) 174 Short Loin	$1.92	3,606	0	$1.95	386 *	3,057
(6) 175 Strip Loin	$2.92	1,006	0	$3.10	0 *	1,040
(7) 180 Strip Loin	$3.40	8,052 *	10,000	$4.05	3,702 *	7,777
(8) 184 Top Butt	$2.02	8,000	8,000	$2.32	5,762 *	8,000
(9) Bone-In Top Butt	$1.60	0 *	572	$1.76	0 *	0
(10) Tenderloin	$8.10	3,000	3,000	$8.30	192 *	3,000
(11) 113B SqCut NckOff	$0.76	5,574	5,574	$0.78	6,047	6,047
(12) 115 2pc. Bnls Chck	$1.05	16,204 *	38,432	$1.08	0 *	40,415
(13) 168 Top Inside Rnd	$1.64	12,349 *	15,000	$1.66	5,894 *	15,000
(14) 170 Goseneck Rnd	$1.38	8,588 *	13,760	$1.40	6,848 *	15,000
(15) 167 Knuckle	$1.33	1,192 *	6,000	$1.60	4,307 *	704
(16) 167A Peeled Kncle	$1.92	521 *	2,177	$1.97	305 *	2,258
(17) 161 Round, Bnls	$1.25	3,065	0	$1.28	3,175	0
(18) 171B Outside Rnd	$1.47	165 *	3,011	$1.46	62 *	1,829
(19) 171C Eye of Rnd	$1.68	61 *	1,332	$1.70	28 *	1,116
(20) 193 Flank Steak	$3.25	1,000	0	$3.25	142 *	805
(21) 120 Brisket	$1.07	7,883 *	8,000	$1.08	8,000	8,000
(22) Pastrami	$2.15	4,000	2,616	$2.15	360 *	4,000
(23) Thin Meats	$1.70	9,935 *	10,000	$1.80	2,435 *	10,000
(24) 75% Trimmings	$0.81	30,000	30,000			
(25) 50% Trimmings	$0.56	50,000	50,000			
(26) Fat	$0.17	8,512 *	40,000			
(27) Bone	$0.17	35,895 *	0			

* Indicates that more was offered then was in inventory

TOTAL REVENUE $593,473.06
YG4 REVENUE $43,013.28

Table C.12 Sales Output Form Reporting Updated Inventory After Meat Sales.

PACKER 1 Week # 7

	IN 1 WEEK		IN 2 WEEKS		IN 3 WEEKS		Totals	
	SELECT	CHOICE	SELECT	CHOICE	SELECT	CHOICE	SELECT	CHOICE
(1) 112A Lip-On Ribeye	897	0	0	0	0	0	897	0
(2) 107 3X4 Ribeye	0	0	0	2,126	0	0	0	2,126
(3) 123A Short Rib	3,625	640	1,736	0	0	0	5,361	640
(4) 124 Back Rib	449	0	0	0	0	0	449	0
(5) 174 Short Loin	3,690	0	3,606	0	0	0	7,296	0
(6) 175 Strip Loin	0	0	1,006	0	0	0	1,006	0
(7) 180 Strip Loin	0	0	0	0	0	0	0	0
(8) 184 Top Butt	2,037	0	0	0	0	0	2,037	0
(9) Bone-In Top Butt	0	0	0	0	0	0	0	0
(10) Tenderloin	962	0	0	0	0	0	962	0
(11) 113B Sqre-Cut Neck-Off	7,319	5,983	0	0	0	0	7,319	5,983
(12) 115 2-pc. Boneless Chk	0	0	0	0	0	0	0	0
(13) 168 Top Inside Round	0	0	0	0	0	0	0	0
(14) 170 Gooseneck Round	0	0	0	0	0	0	0	0
(15) 167 Knuckle	0	3,603	0	0	0	0	0	3,603
(16) 167A Peeled Knuckle	0	0	0	0	0	0	0	0
(17) 161 Round, Boneless	9,561	8,370	0	0	0	0	9,561	8,370
(18) 171B Outside Round	0	0	0	0	0	0	0	0
(19) 171C Eye of Round	0	0	0	0	0	0	0	0
(20) 193 Flank Steak	1,490	0	0	0	0	0	1,490	0
(21) 120 Brisket	0	39	0	0	0	0	0	39
(22) Pastrami	2,489	0	0	0	0	0	2,489	0
(23) Thin Meats	0	0	0	0	0	0	0	0
(24) 75% Trimmings	9,368		0		0		9,368	
(25) 50% Trimmings	31,537		0		0		31,537	
(26) Fat	0		0		0		0	
(27) Bone	35,895		0		0		35,895	

Total Quantity Of Meat In Inventory 136,429

Table C.13 Sales Output Form Reporting Industry Summary of Meat Sales.

SUMMARY WEEK ===> 9	SELECT QUANTITY SOLD	SELECT WEIGHTED AVERAGE PRICE	CHOICE QUANTITY SOLD	CHOICE WEIGHTED AVERAGE PRICE
(1) 112A Lip-On Ribeye	14,638	$4.60	15,880	$5.20
(2) 107 3X4 Ribeye	12,642	$3.60	3,895	$3.33
(3) 123A Short Rib	4,758	$3.06	5,874	$3.95
(4) 124 Back Rib	4,613	$0.76	4,226	$0.77
(5) 174 Short Loin	8,887	$1.87	12,045	$1.94
(6) 175 Strip Loin	2,699	$2.90	3,463	$3.09
(7) 180 Strip Loin	10,993	$3.40	16,964	$3.99
(8) 184 Top Butt	16,969	$2.03	20,795	$2.32
(9) Bone-In Top Butt	1,998	$1.60	3,731	$1.75
(10) Tenderloin	5,150	$8.08	6,878	$8.30
(11) 113B Square-Cut Neck-Off	36,036	$0.73	33,883	$0.77
(12) 115 2-pc. Boneless Chuck	117,270	$1.03	117,026	$1.07
(13) 168 Top Inside Round	31,695	$1.63	36,223	$1.65
(14) 170 Gooseneck Round	19,468	$1.37	20,458	$1.40
(15) 167 Knuckle	13,880	$1.32	5,322	$1.56
(16) 167A Peeled Knuckle	6,158	$1.92	6,798	$1.97
(17) 161 Round, Boneless	12,292	$1.20	13,795	$1.22
(18) 171B Outside Round	9,698	$1.47	8,134	$1.48
(19) 171C Eye of Round	3,732	$1.69	3,601	$1.71
(20) 193 Flank Steak	2,897	$3.20	2,870	$3.23
(21) 120 Brisket	18,534	$1.06	17,572	$1.09
(22) Pastrami	7,870	$2.13	7,685	$2.15
(23) Thin Meats	43,444	$1.70	37,828	$1.76
(24) 75% Trimmings	79,679	$0.81		
(25) 50% Trimmings	151,422	$0.56	CARCASS VALUE FOR:	
(26) Fat	176,751	$0.16	CHOICE YG 2	$129.03
(27) Bone	74,680	$0.16	SELECT YG 2	$122.37

Table C.14 Sales Output Form Reporting the Quantities and Prices of Meat Sold in Forced Meat Sales.

PACKER 1	FORCED MEAT SALES			
	SELECT		CHOICE	
WEEK ===> 9	PRICE GIVEN	QUANTITY SOLD	PRICE GIVEN	QUANTITY SOLD
(1) 112A Lip-On Ribeye	$0.00	0	$0.00	0
(2) 107 3X4 Ribeye	$0.00	0	$0.00	0
(3) 123A Short Rib	$0.00	0	$0.00	0
(4) 124 Back Rib	$0.00	0	$0.00	0
(5) 174 Short Loin	$0.00	0	$0.00	0
(6) 175 Strip Loin	$0.00	0	$0.00	0
(7) 180 Strip Loin	$0.00	0	$0.00	0
(8) 184 Top Butt	$0.00	0	$0.00	0
(9) Bone-In Top Butt	$0.00	0	$0.00	0
(10) Tenderloin	$0.00	0	$0.00	0
(11) 113B SqCut NckOff	$0.00	0	$0.00	0
(12) 115 2pc. Bnls Chck	$0.00	0	$0.00	0
(13) 168 Top Inside Rnd	$0.00	0	$0.00	0
(14) 170 Goseneck Rnd	$0.00	0	$0.00	0
(15) 167 Knuckle	$0.00	0	$0.00	0
(16) 167A Peeled Kncle	$0.00	0	$0.00	0
(17) 161 Round, Bnls	$0.00	0	$0.00	0
(18) 171B Outside Rnd	$0.00	0	$0.00	0
(19) 171C Eye of Rnd	$0.00	0	$0.00	0
(20) 193 Flank Steak	$0.00	0	$0.00	0
(21) 120 Brisket	$0.00	0	$0.00	0
(22) Pastrami	$0.00	0	$0.00	0
(23) Thin Meats	$0.00	0	$0.00	0
(24) 75% Trimmings	$0.00	0		
(25) 50% Trimmings	$0.00	0		
(26) Fat	$0.00	0		
(27) Bone	$0.00	0		

Table C.15 Sales Output Form Reporting Updated Inventory After Forced Meat Sales.

PACKER 1 Week # 7

	IN 1 WEEK		IN 2 WEEKS		IN 3 WEEKS		Totals	
	SELECT	CHOICE	SELECT	CHOICE	SELECT	CHOICE	SELECT	CHOICE
(1) 112A Lip-On Ribeye	897	0	0	0	0	0	897	0
(2) 107 3X4 Ribeye	0	0	0	2,126	0	0	0	2,126
(3) 123A Short Rib	3,625	640	1,736	0	0	0	5,361	640
(4) 124 Back Rib	449	0	0	0	0	0	449	0
(5) 174 Short Loin	3,690	0	3,606	0	0	0	7,296	0
(6) 175 Strip Loin	0	0	1,006	0	0	0	1,006	0
(7) 180 Strip Loin	0	0	0	0	0	0	0	0
(8) 184 Top Butt	2,037	0	0	0	0	0	2,037	0
(9) Bone-In Top Butt	0	0	0	0	0	0	0	0
(10) Tenderloin	962	0	0	0	0	0	962	0
(11) 113B Sqre-Cut Neck-Off	7,319	5,983	0	0	0	0	7,319	5,983
(12) 115 2-pc. Boneless Chk	0	0	0	0	0	0	0	0
(13) 168 Top Inside Round	0	0	0	0	0	0	0	0
(14) 170 Gooseneck Round	0	0	0	0	0	0	0	0
(15) 167 Knuckle	0	3,603	0	0	0	0	0	3,603
(16) 167A Peeled Knuckle	0	0	0	0	0	0	0	0
(17) 161 Round, Boneless	9,561	8,370	0	0	0	0	9,561	8,370
(18) 171B Outside Round	0	0	0	0	0	0	0	0
(19) 171C Eye of Round	0	0	0	0	0	0	0	0
(20) 193 Flank Steak	1,490	0	0	0	0	0	1,490	0
(21) 120 Brisket	0	39	0	0	0	0	0	39
(22) Pastrami	2,489	0	0	0	0	0	2,489	0
(23) Thin Meats	0	0	0	0	0	0	0	0
(24) 75% Trimmings	9,368		0		0		9,368	
(25) 50% Trimmings	31,537		0		0		31,537	
(26) Fat	0		0		0		0	
(27) Bone	35,895		0		0		35,895	

Total Quantity Of Meat In Inventory 136,429

Table C.16 Sales Output Form Reporting Packer Cost and Returns for a Simulated Week.

PACKER # 1
SALES AND COSTS FOR WEEK # =====> 7

COSTS	
PROCUREMENT COSTS	
NUMBER OF CATTLE PURCHASED	400
AVG. COST PER HEAD	$776.80
AVG. COST PER CWT.	$67.62
TOTAL CATTLE COSTS	$310,719.50
PROCESSING COSTS	
TOTAL POUNDS PRODUCED	643,677
PER HEAD KILL COSTS	$25.6030
PER HEAD PROCESSING COSTS	$83.3894
COST PER POUND OF PRODUCTION	$0.1512
TOTAL PROCESSING COST	$103,905.70
TOTAL PROCUREMENT AND PROCESSING COSTS	$414,625.20
SALES	
TOTAL POUNDS SOLD	705,547
TOTAL INVENTORY REMAINING	320,963
TOTAL YLD 4 CARCASS POUNDS	63,180
REVENUE FROM SALES	$903,690.26
REVENUE FROM YG4 CARCASSES	$67,942.70
REVENUE FROM BY-PRODUCTS	$93,905.88
REVENUE PER CWT. SOLD	$128.0837
REVENUE FROM YG4 PER CWT.	$107.5377
CARCASS VALUE OF SELECT YG2	$118.2055
CARCASS VALUE OF CHOICE YG2	$129.8943
TOTAL REVENUE GENERATED	$1,065,538.84
NET REVENUE FOR THE WEEK	
TOTAL	$650,913.64
PER UNIT OF CAPACITY	$813.6421
CUMULATIVE NET REVENUE	
TOTAL	($3,237,454.07)
PER UNIT OF CAPACITY	($337.2348)

Table C.17 Sales Output Form Reporting Industry Cost and Returns for a Simulated Week.

INDUSTRY SUMMARY (WITH PACKER 5)
SALES AND COSTS FOR WEEK # =====> 7

COSTS	
PROCUREMENT COSTS	
NUMBER OF CATTLE PURCHASED	4000
AVG. COST PER HEAD	$806.60
AVG. COST PER CWT.	$69.40
TOTAL CATTLE COSTS	$3,444,470.20
PROCESSING COSTS	
TOTAL POUNDS PRODUCED	3,191,506
PER HEAD KILL COSTS	$19.6841
PER HEAD PROCESSING COSTS	$70.2594
COST PER POUND OF PRODUCTION	$0.1288
TOTAL PROCESSING COST	$411,190.95
TOTAL PROCUREMENT AND PROCESSING COSTS	$3,855,661.15
SALES	
TOTAL POUNDS SOLD	2,649,246
TOTAL INVENTORY REMAINING	1,230,645
TOTAL YLD 4 CARCASS POUNDS	202,747
REVENUE FROM SALES	$3,221,576.21
REVENUE FROM YLD 4 CARCASSES	$218,058.77
REVENUE FROM BY-PRODUCTS	$434,915.14
MEAT REVENUE PER CWT.	$121.6035
YG4 REVENUE PER CWT.	$107.5524
CARCASS VALUE OF SELECT YG2	$121.7693
CARCASS VALUE OF CHOICE YG2	$128.7566
TOTAL REVENUE GENERATED	$3,874,550.12
NET REVENUE FOR THE WEEK	
TOTAL	$18,888.96
PER UNIT OF CAPACITY	$4.7222
CUMULATIVE NET REVENUE	
TOTAL	($7,871,962.17)
PER UNIT OF CAPACITY	($163.9992)

Table C.18 Sales Output Form Reporting Packer Inventory Management.

Packer 1
Inventory Management For Week # ==> 7

Beginning Inventory	294,332
Total Pounds Added To Inventory	778,126
Total Pounds Sold	705,547
Ending Inventory	320,963

Table C.19 Sales Output Form Reporting Industry Inventory Management.

Industry Summary (With Packer 5)
Inventory Management For Week # ==> 7

Beginning Inventory	1,216,069
Total Pounds Added To Inventory	2,882,276
Total Pounds Sold	2,649,246
Ending Inventory	1,230,645

APPENDIX D

MPPM SIMULATOR ELASTICITY MATRIX

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 1	Item 2	Item 3	Item 4
(1) 127A Lip-On Rib(s)	**-2.12950**	0.00700	0.00200	0.00200
(2) 107 3X4 Ribeye(s)	0.00355	**-2.12950**	0.00200	0.00200
(3) 123A Short Rib(s)	0.00047	0.00094	**-2.12950**	0.00700
(4) 124 Back Rib(s)	0.00010	0.00019	0.00143	**-2.12950**
(5) 174 Short Loin(s)	0.00202	0.00399	0.00243	0.01191
(6) 175 Strip Loin(s)	0.00087	0.00171	0.00104	0.00511
(7) 180 Strip Loin(s)	0.00448	0.00884	0.00539	0.02640
(8) 184 Top Butt(s)	0.00106	0.00209	0.00445	0.02181
(9) Bone-In Top Butt(s)	0.00043	0.00084	0.00051	0.00251
(10) Tenderloin(s)	0.00134	0.00265	0.00566	0.02775
(11) 113B SqCut NckOf(s)	0.00008	0.00015	0.00032	0.00159
(12) 115 2pc Bnls Chk(s)	0.00033	0.00065	0.00139	0.00682
(13) Top Inside Round(s)	0.00169	0.00333	0.00710	0.03481
(14) 170 Goosenck Rnd(s)	0.00085	0.00168	0.00359	0.01761
(15) 167 Knuckle(s)	0.00039	0.00077	0.00164	0.00803
(16) 167A Peel Knckle(s)	0.00039	0.00077	0.00165	0.00806
(17) 161 Round, Bnls(s)	0.00047	0.00092	0.00197	0.00965
(18) 171B Outside Rnd(s)	0.00047	0.00092	0.00197	0.00964
(19) Eye of Round(s)	0.00021	0.00041	0.00088	0.00430
(20) 193 Flank Steak(s)	0.00029	0.00058	0.00123	0.00602
(21) 120 Brisket(s)	0.00061	0.00119	0.00255	0.01249
(22) Pastrami(s)	0.00052	0.00104	0.00221	0.01083
(23) Thin Meats(s)	0.00214	0.00423	0.00902	0.04421
(24) 127A Lip-On Rib(c)	0.68117	0.02325	0.01240	0.06076
(25) 107 3X4 Ribeye(c)	0.00299	0.97693	0.00210	0.01027
(26) 123A Short Rib(c)	0.00051	0.00100	0.92440	0.06299
(27) 124 Back Rib(c)	0.00007	0.00015	0.00186	1.04607
(28) 174 Short Loin(c)	0.00298	0.00589	0.00209	0.01026
(29) 175 Strip Loin(c)	0.00128	0.00253	0.00090	0.00441
(30) 180 Strip Loin(c)	0.00756	0.01491	0.00530	0.02599
(31) 184 Top Butt(c)	0.00259	0.00511	0.00409	0.02004
(32) Bone-In Top Butt(c)	0.00067	0.00132	0.00047	0.00231
(33) Tenderloin(c)	0.00294	0.00579	0.00464	0.02271
(34) 113B SqCut NckOf(c)	0.00016	0.00032	0.00068	0.00334
(35) 115 2pc Bnls Chk(c)	0.00069	0.00137	0.00292	0.01430
(36) Top Inside Rnd(c)	0.00123	0.00242	0.00517	0.02535
(37) 170 Goosenck Rnd(c)	0.00062	0.00121	0.00259	0.01270
(38) 167 Knuckle(c)	0.00028	0.00056	0.00120	0.00588
(39) 167A Peel Knckle(c)	0.00029	0.00056	0.00120	0.00590
(40) 161 Round, Bnls(c)	0.00034	0.00067	0.00143	0.00701
(41) 171B Outside Rnd(c)	0.00033	0.00066	0.00141	0.00690
(42) Eye of Round(c)	0.00015	0.00029	0.00063	0.00307
(43) 193 Flank Steak(c)	0.00020	0.00040	0.00085	0.00417
(44) 120 Brisket(c)	0.00042	0.00083	0.00177	0.00866
(45) Pastrami(c)	0.00037	0.00072	0.00154	0.00754
(46) Thin Meats(c)	0.00152	0.00300	0.00640	0.03134
(47) 75% Trimmings	0.00009	0.00018	0.00039	0.00190
(48) 50% Trimmings	0.00012	0.00024	0.00051	0.00250
(49) Fat	0.00003	0.00005	0.00011	0.00052
(50) Bone	0.00002	0.00004	0.00008	0.00038

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 5	Item 6	Item 7	Item 8
(1) 127A Lip-On Rib(s)	0.00700	0.00700	0.00700	0.00200
(2) 107 3X4 Ribeye(s)	0.00700	0.00700	0.00700	0.00200
(3) 123A Short Rib(s)	0.00200	0.00200	0.00200	0.00200
(4) 124 Back Rib(s)	0.00200	0.00200	0.00200	0.00200
(5) 174 Short Loin(s)	**-3.24125**	0.00700	0.00700	0.00700
(6) 175 Strip Loin(s)	0.00301	**-3.24125**	0.00700	0.00700
(7) 180 Strip Loin(s)	0.01552	0.03614	**-3.24125**	0.00700
(8) 184 Top Butt(s)	0.01282	0.02986	0.00578	**-3.24125**
(9) Bone-In Top Butt(s)	0.00148	0.00344	0.00067	0.00081
(10) Tenderloin(s)	0.01631	0.03799	0.00736	0.00891
(11) 113B SqCut NckOf(s)	0.00027	0.00062	0.00012	0.00015
(12) 115 2pc Bnls Chk(s)	0.00115	0.00267	0.00052	0.00063
(13) Top Inside Round(s)	0.00585	0.01362	0.00264	0.00319
(14) 170 Goosenck Rnd(s)	0.00296	0.00689	0.00133	0.00162
(15) 167 Knuckle(s)	0.00135	0.00314	0.00061	0.00074
(16) 167A Peel Knckle(s)	0.00135	0.00315	0.00061	0.00074
(17) 161 Round, Bnls(s)	0.00162	0.00378	0.00073	0.00089
(18) 171B Outside Rnd(s)	0.00162	0.00377	0.00073	0.00088
(19) Eye of Round(s)	0.00072	0.00168	0.00033	0.00039
(20) 193 Flank Steak(s)	0.00101	0.00236	0.00046	0.00055
(21) 120 Brisket(s)	0.00210	0.00489	0.00095	0.00115
(22) Pastrami(s)	0.00182	0.00423	0.00082	0.00099
(23) Thin Meats(s)	0.00742	0.01729	0.00335	0.00405
(24) 127A Lip-On Rib(c)	0.01020	0.02377	0.00460	0.00557
(25) 107 3X4 Ribeye(c)	0.00173	0.00402	0.00078	0.00094
(26) 123A Short Rib(c)	0.00176	0.00411	0.00080	0.00096
(27) 124 Back Rib(c)	0.00026	0.00060	0.00012	0.00014
(28) 174 Short Loin(c)	1.98206	0.02408	0.00466	0.00565
(29) 175 Strip Loin(c)	0.00444	2.07766	0.00200	0.00243
(30) 180 Strip Loin(c)	0.02618	0.06099	1.65007	0.01430
(31) 184 Top Butt(c)	0.02019	0.04703	0.00911	1.77942
(32) Bone-In Top Butt(c)	0.00232	0.00541	0.00105	0.00127
(33) Tenderloin(c)	0.02289	0.05331	0.01033	0.01250
(34) 113B SqCut NckOf(c)	0.00210	0.00490	0.00095	0.00115
(35) 115 2pc Bnls Chk(c)	0.00901	0.02098	0.00406	0.00492
(36) Top Inside Rnd(c)	0.00426	0.00992	0.00192	0.00232
(37) 170 Goosenck Rnd(c)	0.00213	0.00497	0.00096	0.00116
(38) 167 Knuckle(c)	0.00099	0.00230	0.00045	0.00054
(39) 167A Peel Knckle(c)	0.00099	0.00231	0.00045	0.00054
(40) 161 Round, Bnls(c)	0.00118	0.00274	0.00053	0.00064
(41) 171B Outside Rnd(c)	0.00116	0.00270	0.00052	0.00063
(42) Eye of Round(c)	0.00052	0.00120	0.00023	0.00028
(43) 193 Flank Steak(c)	0.00070	0.00163	0.00032	0.00038
(44) 120 Brisket(c)	0.00145	0.00339	0.00066	0.00079
(45) Pastrami(c)	0.00127	0.00295	0.00057	0.00069
(46) Thin Meats(c)	0.00526	0.01226	0.00237	0.00287
(47) 75% Trimmings	0.00032	0.00074	0.00014	0.00017
(48) 50% Trimmings	0.00042	0.00098	0.00019	0.00023
(49) Fat	0.00009	0.00020	0.00004	0.00005
(50) Bone	0.00006	0.00015	0.00003	0.00003

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 9	Item 10	Item 11	Item 12
(1) 127A Lip-On Rib(s)	0.00700	0.00200	0.00020	0.00020
(2) 107 3X4 Ribeye(s)	0.00700	0.00200	0.00020	0.00020
(3) 123A Short Rib(s)	0.00200	0.00200	0.00020	0.00020
(4) 124 Back Rib(s)	0.00200	0.00200	0.00020	0.00020
(5) 174 Short Loin(s)	0.00700	0.00700	0.00020	0.00020
(6) 175 Strip Loin(s)	0.00700	0.00700	0.00020	0.00020
(7) 180 Strip Loin(s)	0.00700	0.00700	0.00020	0.00020
(8) 184 Top Butt(s)	0.00700	0.00700	0.00020	0.00020
(9) Bone-In Top Butt(s)	**-3.24125**	0.00700	0.00020	0.00020
(10) Tenderloin(s)	0.07739	**-3.47000**	0.00020	0.00020
(11) 113B SqCut NckOf(s)	0.00127	0.00011	**-2.64771**	0.00700
(12) 115 2pc Bnls Chk(s)	0.00543	0.00049	0.03001	**-2.64771**
(13) Top Inside Round(s)	0.02774	0.00251	0.00438	0.00102
(14) 170 Goosenck Rnd(s)	0.01403	0.00127	0.00221	0.00052
(15) 167 Knuckle(s)	0.00640	0.00058	0.00101	0.00024
(16) 167A Peel Knckle(s)	0.00643	0.00058	0.00101	0.00024
(17) 161 Round, Bnls(s)	0.00769	0.00070	0.00121	0.00028
(18) 171B Outside Rnd(s)	0.00768	0.00069	0.00121	0.00028
(19) Eye of Round(s)	0.00342	0.00031	0.00054	0.00013
(20) 193 Flank Steak(s)	0.00480	0.00043	0.00076	0.00018
(21) 120 Brisket(s)	0.00995	0.00090	0.00157	0.00037
(22) Pastrami(s)	0.00863	0.00078	0.00136	0.00032
(23) Thin Meats(s)	0.03523	0.00319	0.00556	0.00130
(24) 127A Lip-On Rib(c)	0.04842	0.00438	0.00764	0.00178
(25) 107 3X4 Ribeye(c)	0.00819	0.00074	0.00129	0.00030
(26) 123A Short Rib(c)	0.00837	0.00076	0.00132	0.00031
(27) 124 Back Rib(c)	0.00121	0.00011	0.00019	0.00004
(28) 174 Short Loin(c)	0.04905	0.00444	0.00129	0.00030
(29) 175 Strip Loin(c)	0.02107	0.00191	0.00055	0.00013
(30) 180 Strip Loin(c)	0.12424	0.01124	0.00327	0.00076
(31) 184 Top Butt(c)	0.09582	0.00867	0.00252	0.00059
(32) Bone-In Top Butt(c)	2.13808	0.00100	0.00029	0.00007
(33) Tenderloin(c)	0.10860	1.88085	0.00286	0.00067
(34) 113B SqCut NckOf(c)	0.00999	0.00090	1.47862	0.00220
(35) 115 2pc Bnls Chk(c)	0.04274	0.00387	0.04045	1.06128
(36) Top Inside Rnd(c)	0.02020	0.00183	0.00319	0.00074
(37) 170 Goosenck Rnd(c)	0.01012	0.00092	0.00160	0.00037
(38) 167 Knuckle(c)	0.00469	0.00042	0.00074	0.00017
(39) 167A Peel Knckle(c)	0.00470	0.00043	0.00074	0.00017
(40) 161 Round, Bnls(c)	0.00558	0.00051	0.00088	0.00021
(41) 171B Outside Rnd(c)	0.00550	0.00050	0.00087	0.00020
(42) Eye of Round(c)	0.00245	0.00022	0.00039	0.00009
(43) 193 Flank Steak(c)	0.00333	0.00030	0.00052	0.00012
(44) 120 Brisket(c)	0.00690	0.00062	0.00109	0.00025
(45) Pastrami(c)	0.00601	0.00054	0.00095	0.00022
(46) Thin Meats(c)	0.02498	0.00226	0.00394	0.00092
(47) 75% Trimmings	0.00151	0.00014	0.00024	0.00006
(48) 50% Trimmings	0.00199	0.00018	0.00031	0.00007
(49) Fat	0.00042	0.00004	0.00007	0.00002
(50) Bone	0.00030	0.00003	0.00005	0.00001

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 13	Item 14	Item 15	Item 16
(1) 127A Lip-On Rib(s)	0.00220	0.00220	0.00220	0.00220
(2) 107 3X4 Ribeye(s)	0.00220	0.00220	0.00220	0.00220
(3) 123A Short Rib(s)	0.00220	0.00220	0.00220	0.00220
(4) 124 Back Rib(s)	0.00220	0.00220	0.00220	0.00220
(5) 174 Short Loin(s)	0.00220	0.00220	0.00220	0.00220
(6) 175 Strip Loin(s)	0.00220	0.00220	0.00220	0.00220
(7) 180 Strip Loin(s)	0.00220	0.00220	0.00220	0.00220
(8) 184 Top Butt(s)	0.00220	0.00220	0.00220	0.00220
(9) Bone-In Top Butt(s)	0.00220	0.00220	0.00220	0.00220
(10) Tenderloin(s)	0.00220	0.00220	0.00220	0.00220
(11) 113B SqCut NckOf(s)	0.00220	0.00220	0.00220	0.00220
(12) 115 2pc Bnls Chk(s)	0.00220	0.00220	0.00220	0.00220
(13) Top Inside Round(s)	**-3.01071**	0.00700	0.00700	0.00700
(14) 170 Goosenck Rnd(s)	0.00354	**-3.75172**	0.00850	0.00700
(15) 167 Knuckle(s)	0.00161	0.00387	**-4.12023**	0.00700
(16) 167A Peel Knckle(s)	0.00162	0.00321	0.00703	**-4.12023**
(17) 161 Round, Bnls(s)	0.00194	0.00384	0.00842	0.00838
(18) 171B Outside Rnd(s)	0.00194	0.00383	0.00840	0.00836
(19) Eye of Round(s)	0.00086	0.00171	0.00375	0.00373
(20) 193 Flank Steak(s)	0.00038	0.00075	0.00165	0.00164
(21) 120 Brisket(s)	0.00079	0.00156	0.00342	0.00341
(22) Pastrami(s)	0.00068	0.00135	0.00297	0.00295
(23) Thin Meats(s)	0.00279	0.00552	0.01212	0.01206
(24) 127A Lip-On Rib(c)	0.00384	0.00759	0.01665	0.01657
(25) 107 3X4 Ribeye(c)	0.00065	0.00128	0.00282	0.00280
(26) 123A Short Rib(c)	0.00066	0.00131	0.00288	0.00286
(27) 124 Back Rib(c)	0.00010	0.00019	0.00042	0.00042
(28) 174 Short Loin(c)	0.00065	0.00128	0.00281	0.00280
(29) 175 Strip Loin(c)	0.00028	0.00055	0.00121	0.00120
(30) 180 Strip Loin(c)	0.00164	0.00325	0.00712	0.00709
(31) 184 Top Butt(c)	0.00127	0.00250	0.00549	0.00547
(32) Bone-In Top Butt(c)	0.00015	0.00029	0.00063	0.00063
(33) Tenderloin(c)	0.00144	0.00284	0.00623	0.00620
(34) 113B SqCut NckOf(c)	0.00079	0.00157	0.00343	0.00342
(35) 115 2pc Bnls Chk(c)	0.00339	0.00670	0.01470	0.01463
(36) Top Inside Rnd(c)	2.19517	0.01900	0.04169	0.04149
(37) 170 Goosenck Rnd(c)	0.00482	2.43579	0.02088	0.02079
(38) 167 Knuckle(c)	0.00223	0.00441	2.93783	0.00963
(39) 167A Peel Knckle(c)	0.00224	0.00442	0.00970	2.93741
(40) 161 Round, Bnls(c)	0.00266	0.00525	0.01152	0.01147
(41) 171B Outside Rnd(c)	0.00262	0.00517	0.01134	0.01129
(42) Eye of Round(c)	0.00116	0.00230	0.00505	0.00502
(43) 193 Flank Steak(c)	0.00026	0.00052	0.00114	0.00114
(44) 120 Brisket(c)	0.00055	0.00108	0.00237	0.00236
(45) Pastrami(c)	0.00048	0.00094	0.00207	0.00206
(46) Thin Meats(c)	0.00198	0.00392	0.00859	0.00855
(47) 75% Trimmings	0.00012	0.00024	0.00052	0.00052
(48) 50% Trimmings	0.00016	0.00031	0.00069	0.00068
(49) Fat	0.00003	0.00007	0.00014	0.00014
(50) Bone	0.00002	0.00005	0.00010	0.00010

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 17	Item 18	Item 19	Item 20
(1) 127A Lip-On Rib(s)	0.00220	0.00220	0.00220	0.00220
(2) 107 3X4 Ribeye(s)	0.00220	0.00220	0.00220	0.00220
(3) 123A Short Rib(s)	0.00220	0.00220	0.00220	0.00220
(4) 124 Back Rib(s)	0.00220	0.00220	0.00220	0.00220
(5) 174 Short Loin(s)	0.00220	0.00220	0.00220	0.00220
(6) 175 Strip Loin(s)	0.00220	0.00220	0.00220	0.00220
(7) 180 Strip Loin(s)	0.00220	0.00220	0.00220	0.00220
(8) 184 Top Butt(s)	0.00220	0.00220	0.00220	0.00220
(9) Bone-In Top Butt(s)	0.00220	0.00220	0.00220	0.00220
(10) Tenderloin(s)	0.00220	0.00220	0.00220	0.00220
(11) 113B SqCut NckOf(s)	0.00220	0.00220	0.00220	0.00220
(12) 115 2pc Bnls Chk(s)	0.00220	0.00220	0.00220	0.00220
(13) Top Inside Round(s)	0.00700	0.00700	0.00700	0.00220
(14) 170 Goosenck Rnd(s)	0.00700	0.00700	0.00700	0.00220
(15) 167 Knuckle(s)	0.00700	0.00700	0.00700	0.00220
(16) 167A Peel Knckle(s)	0.00700	0.00700	0.00700	0.00220
(17) 161 Round, Bnls(s)	**-3.01071**	0.00700	0.00700	0.00220
(18) 171B Outside Rnd(s)	0.00699	**-2.99371**	0.00700	0.00220
(19) Eye of Round(s)	0.00312	0.02296	**-3.01071**	0.00220
(20) 193 Flank Steak(s)	0.00137	0.02006	0.00308	**-1.95965**
(21) 120 Brisket(s)	0.00285	0.02174	0.00640	0.01452
(22) Pastrami(s)	0.00247	0.02131	0.00554	0.01259
(23) Thin Meats(s)	0.01008	0.02997	0.02264	0.01615
(24) 127A Lip-On Rib(c)	0.01385	0.03237	0.03111	0.02220
(25) 107 3X4 Ribeye(c)	0.00234	0.02241	0.00526	0.00375
(26) 123A Short Rib(c)	0.00239	0.02249	0.00538	0.00384
(27) 124 Back Rib(c)	0.00035	0.01908	0.00078	0.00056
(28) 174 Short Loin(c)	0.00234	0.02240	0.00525	0.00375
(29) 175 Strip Loin(c)	0.00100	0.02018	0.00226	0.00161
(30) 180 Strip Loin(c)	0.00592	0.02839	0.01331	0.00950
(31) 184 Top Butt(c)	0.00457	0.02613	0.01026	0.00732
(32) Bone-In Top Butt(c)	0.00053	0.01938	0.00118	0.00084
(33) Tenderloin(c)	0.00518	0.02714	0.01163	0.00830
(34) 113B SqCut NckOf(c)	0.00286	0.02327	0.00642	0.00458
(35) 115 2pc Bnls Chk(c)	0.01222	0.03891	0.02746	0.01960
(36) Top Inside Rnd(c)	0.03466	0.05708	0.07789	0.00926
(37) 170 Goosenck Rnd(c)	0.01736	0.03783	0.03902	0.00464
(38) 167 Knuckle(c)	0.00804	0.02745	0.01807	0.00215
(39) 167A Peel Knckle(c)	0.00807	0.02748	0.01813	0.00216
(40) 161 Round, Bnls(c)	1.80176	0.02917	0.02153	0.00256
(41) 171B Outside Rnd(c)	0.00943	1.82393	0.02119	0.00252
(42) Eye of Round(c)	0.00420	0.00420	1.92432	0.00112
(43) 193 Flank Steak(c)	0.00095	0.00095	0.00214	0.87895
(44) 120 Brisket(c)	0.00197	0.00198	0.00443	0.01898
(45) Pastrami(c)	0.00172	0.00172	0.00386	0.01653
(46) Thin Meats(c)	0.00714	0.00716	0.01605	0.01145
(47) 75% Trimmings	0.00043	0.00043	0.00097	0.00069
(48) 50% Trimmings	0.00057	0.00057	0.00128	0.00091
(49) Fat	0.00012	0.00012	0.00027	0.00019
(50) Bone	0.00009	0.00009	0.00019	0.00014

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 21	Item 22	Item 23	Item 24
(1) 127A Lip-On Rib(s)	0.00220	0.00220	0.00220	0.98830
(2) 107 3X4 Ribeye(s)	0.00220	0.00220	0.00220	0.01000
(3) 123A Short Rib(s)	0.00220	0.00220	0.00220	0.00250
(4) 124 Back Rib(s)	0.00220	0.00220	0.00220	0.00250
(5) 174 Short Loin(s)	0.00220	0.00220	0.00220	0.00250
(6) 175 Strip Loin(s)	0.00220	0.00220	0.00220	0.00250
(7) 180 Strip Loin(s)	0.00220	0.00220	0.00220	0.00250
(8) 184 Top Butt(s)	0.00220	0.00220	0.00220	0.00250
(9) Bone-In Top Butt(s)	0.00220	0.00220	0.00220	0.00250
(10) Tenderloin(s)	0.00220	0.00220	0.00220	0.00250
(11) 113B SqCut NckOf(s)	0.00220	0.00220	0.00220	0.00250
(12) 115 2pc Bnls Chk(s)	0.00220	0.00220	0.00220	0.00250
(13) Top Inside Round(s)	0.00220	0.00220	0.00220	0.00250
(14) 170 Goosenck Rnd(s)	0.00220	0.00220	0.00220	0.00250
(15) 167 Knuckle(s)	0.00220	0.00220	0.00220	0.00250
(16) 167A Peel Knckle(s)	0.00220	0.00220	0.00220	0.00250
(17) 161 Round, Bnls(s)	0.00220	0.00220	0.00220	0.00250
(18) 171B Outside Rnd(s)	0.00220	0.00220	0.00220	0.00250
(19) Eye of Round(s)	0.00220	0.00220	0.00220	0.00250
(20) 193 Flank Steak(s)	0.00700	0.00700	0.00220	0.00250
(21) 120 Brisket(s)	**-1.78976**	0.00700	0.00220	0.00250
(22) Pastrami(s)	0.00607	**-1.87471**	0.00220	0.00250
(23) Thin Meats(s)	0.00779	0.00898	**-1.85965**	0.00250
(24) 127A Lip-On Rib(c)	0.01070	0.01235	0.00302	**-2.12450**
(25) 107 3X4 Ribeye(c)	0.00181	0.00209	0.00051	0.00070
(26) 123A Short Rib(c)	0.00185	0.00213	0.00052	0.00288
(27) 124 Back Rib(c)	0.00027	0.00031	0.00008	0.00042
(28) 174 Short Loin(c)	0.00181	0.00208	0.00051	0.00070
(29) 175 Strip Loin(c)	0.00078	0.00090	0.00022	0.00030
(30) 180 Strip Loin(c)	0.00458	0.00528	0.00129	0.00178
(31) 184 Top Butt(c)	0.00353	0.00407	0.00100	0.00137
(32) Bone-In Top Butt(c)	0.00041	0.00047	0.00011	0.00016
(33) Tenderloin(c)	0.00400	0.00462	0.00113	0.00156
(34) 113B SqCut NckOf(c)	0.00221	0.00255	0.00062	0.00086
(35) 115 2pc Bnls Chk(c)	0.00945	0.01090	0.00267	0.00368
(36) Top Inside Rnd(c)	0.00447	0.00515	0.00126	0.00174
(37) 170 Goosenck Rnd(c)	0.00224	0.00258	0.00063	0.00087
(38) 167 Knuckle(c)	0.00104	0.00119	0.00029	0.00040
(39) 167A Peel Knckle(c)	0.00104	0.00120	0.00029	0.00040
(40) 161 Round, Bnls(c)	0.00123	0.00142	0.00035	0.00048
(41) 171B Outside Rnd(c)	0.00121	0.00140	0.00034	0.00047
(42) Eye of Round(c)	0.00054	0.00062	0.00015	0.00021
(43) 193 Flank Steak(c)	0.00441	0.00509	0.00021	0.00029
(44) 120 Brisket(c)	0.63164	0.01056	0.00043	0.00059
(45) Pastrami(c)	0.00797	0.72366	0.00038	0.00052
(46) Thin Meats(c)	0.00552	0.00637	0.41214	0.00215
(47) 75% Trimmings	0.00033	0.00039	0.00009	0.00008
(48) 50% Trimmings	0.00044	0.00051	0.00012	0.00010
(49) Fat	0.00009	0.00011	0.00003	0.00002
(50) Bone	0.00007	0.00008	0.00002	0.00002

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 25	Item 26	Item 27	Item 28
(1) 127A Lip-On Rib(s)	0.00900	0.00150	0.00150	0.00900
(2) 107 3X4 Ribeye(s)	0.99075	0.00150	0.00150	0.00900
(3) 123A Short Rib(s)	0.00150	1.04488	0.00900	0.00150
(4) 124 Back Rib(s)	0.00150	0.00900	1.05158	0.00150
(5) 174 Short Loin(s)	0.00150	0.00150	0.00150	2.08950
(6) 175 Strip Loin(s)	0.00150	0.00150	0.00150	0.00900
(7) 180 Strip Loin(s)	0.00150	0.00150	0.00150	0.00900
(8) 184 Top Butt(s)	0.00150	0.00150	0.00150	0.00900
(9) Bone-In Top Butt(s)	0.00150	0.00150	0.00150	0.00900
(10) Tenderloin(s)	0.00150	0.00150	0.00150	0.00900
(11) 113B SqCut NckOf(s)	0.00150	0.00150	0.00150	0.00150
(12) 115 2pc Bnls Chk(s)	0.00150	0.00150	0.00150	0.00150
(13) Top Inside Round(s)	0.00150	0.00150	0.00150	0.00150
(14) 170 Goosenck Rnd(s)	0.00150	0.00150	0.00150	0.00150
(15) 167 Knuckle(s)	0.00150	0.00150	0.00150	0.00150
(16) 167A Peel Knckle(s)	0.00150	0.00150	0.00150	0.00150
(17) 161 Round, Bnls(s)	0.00150	0.00150	0.00150	0.00150
(18) 171B Outside Rnd(s)	0.00150	0.00150	0.00150	0.00150
(19) Eye of Round(s)	0.00150	0.00150	0.00150	0.00150
(20) 193 Flank Steak(s)	0.00150	0.00150	0.00150	0.00150
(21) 120 Brisket(s)	0.00150	0.00150	0.00150	0.00150
(22) Pastrami(s)	0.00150	0.00150	0.00150	0.00150
(23) Thin Meats(s)	0.00150	0.00150	0.00150	0.00150
(24) 127A Lip-On Rib(c)	0.00250	0.01000	0.01000	0.00250
(25) 107 3X4 Ribeye(c)	**-2.12450**	0.01000	0.01000	0.00250
(26) 123A Short Rib(c)	0.01022	**-2.12450**	0.01000	0.00250
(27) 124 Back Rib(c)	0.00148	0.00145	**-2.12450**	0.00250
(28) 174 Short Loin(c)	0.00250	0.00244	0.01685	**-3.23625**
(29) 175 Strip Loin(c)	0.00107	0.00105	0.00724	0.00430
(30) 180 Strip Loin(c)	0.00632	0.00619	0.04269	0.02533
(31) 184 Top Butt(c)	0.00488	0.00477	0.03292	0.01953
(32) Bone-In Top Butt(c)	0.00056	0.00055	0.00379	0.00225
(33) Tenderloin(c)	0.00553	0.00541	0.03731	0.00553
(34) 113B SqCut NckOf(c)	0.00305	0.00298	0.02059	0.00305
(35) 115 2pc Bnls Chk(c)	0.01305	0.01277	0.08810	0.01307
(36) Top Inside Rnd(c)	0.00617	0.00604	0.04164	0.00618
(37) 170 Goosenck Rnd(c)	0.00309	0.00302	0.02086	0.00309
(38) 167 Knuckle(c)	0.00143	0.00140	0.00966	0.00143
(39) 167A Peel Knckle(c)	0.00144	0.00140	0.00969	0.00144
(40) 161 Round, Bnls(c)	0.00171	0.00167	0.01151	0.00171
(41) 171B Outside Rnd(c)	0.00168	0.00164	0.01133	0.00168
(42) Eye of Round(c)	0.00075	0.00073	0.00504	0.00075
(43) 193 Flank Steak(c)	0.00102	0.00099	0.00686	0.00102
(44) 120 Brisket(c)	0.00211	0.00206	0.01422	0.00211
(45) Pastrami(c)	0.00184	0.00180	0.01239	0.00184
(46) Thin Meats(c)	0.00763	0.00746	0.05149	0.00764
(47) 75% Trimmings	0.00028	0.00027	0.00187	0.00028
(48) 50% Trimmings	0.00037	0.00036	0.00246	0.00037
(49) Fat	0.00008	0.00007	0.00052	0.00008
(50) Bone	0.00005	0.00005	0.00037	0.00005

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 29	Item 30	Item 31	Item 32
(1) 127A Lip-On Rib(s)	0.00900	0.00900	0.00400	0.00900
(2) 107 3X4 Ribeye(s)	0.00900	0.00900	0.00400	0.00900
(3) 123A Short Rib(s)	0.00150	0.00150	0.00150	0.00150
(4) 124 Back Rib(s)	0.00150	0.00150	0.00150	0.00150
(5) 174 Short Loin(s)	0.00900	0.00900	0.00900	0.00900
(6) 175 Strip Loin(s)	2.10511	0.00900	0.00900	0.00900
(7) 180 Strip Loin(s)	0.00900	2.02709	0.00900	0.00900
(8) 184 Top Butt(s)	0.00900	0.00900	2.05299	0.00900
(9) Bone-In Top Butt(s)	0.00900	0.00900	0.00900	2.12718
(10) Tenderloin(s)	0.00900	0.00900	0.00900	0.00900
(11) 113B SqCut NckOf(s)	0.00150	0.00150	0.00150	0.00150
(12) 115 2pc Bnls Chk(s)	0.00150	0.00150	0.00150	0.00150
(13) Top Inside Round(s)	0.00150	0.00150	0.00150	0.00150
(14) 170 Goosenck Rnd(s)	0.00150	0.00150	0.00150	0.00150
(15) 167 Knuckle(s)	0.00150	0.00150	0.00150	0.00150
(16) 167A Peel Knckle(s)	0.00150	0.00150	0.00150	0.00150
(17) 161 Round, Bnls(s)	0.00150	0.00150	0.00150	0.00150
(18) 171B Outside Rnd(s)	0.00150	0.00150	0.00150	0.00150
(19) Eye of Round(s)	0.00150	0.00150	0.00150	0.00150
(20) 193 Flank Steak(s)	0.00150	0.00150	0.00150	0.00150
(21) 120 Brisket(s)	0.00150	0.00150	0.00150	0.00150
(22) Pastrami(s)	0.00150	0.00150	0.00150	0.00150
(23) Thin Meats(s)	0.00150	0.00150	0.00150	0.00150
(24) 127A Lip-On Rib(c)	0.00250	0.00250	0.00250	0.00250
(25) 107 3X4 Ribeye(c)	0.00250	0.00250	0.00250	0.00250
(26) 123A Short Rib(c)	0.00250	0.00250	0.00250	0.00250
(27) 124 Back Rib(c)	0.00250	0.00250	0.00250	0.00250
(28) 174 Short Loin(c)	0.01000	0.01000	0.01000	0.01000
(29) 175 Strip Loin(c)	**-3.23625**	0.01000	0.01000	0.01000
(30) 180 Strip Loin(c)	0.05896	**-3.23625**	0.01000	0.01000
(31) 184 Top Butt(c)	0.04547	0.00771	**-3.23625**	0.01000
(32) Bone-In Top Butt(c)	0.00523	0.00089	0.00115	**-3.23625**
(33) Tenderloin(c)	0.05154	0.00874	0.01133	0.09849
(34) 113B SqCut NckOf(c)	0.00711	0.00121	0.00156	0.01358
(35) 115 2pc Bnls Chk(c)	0.03042	0.00516	0.00669	0.05814
(36) Top Inside Rnd(c)	0.01438	0.00244	0.00316	0.02748
(37) 170 Goosenck Rnd(c)	0.00720	0.00122	0.00158	0.01377
(38) 167 Knuckle(c)	0.00334	0.00057	0.00073	0.00637
(39) 167A Peel Knckle(c)	0.00335	0.00057	0.00074	0.00639
(40) 161 Round, Bnls(c)	0.00398	0.00067	0.00087	0.00760
(41) 171B Outside Rnd(c)	0.00391	0.00066	0.00086	0.00748
(42) Eye of Round(c)	0.00174	0.00030	0.00038	0.00333
(43) 193 Flank Steak(c)	0.00237	0.00040	0.00052	0.00452
(44) 120 Brisket(c)	0.00491	0.00083	0.00108	0.00939
(45) Pastrami(c)	0.00428	0.00073	0.00094	0.00817
(46) Thin Meats(c)	0.01778	0.00302	0.00391	0.03398
(47) 75% Trimmings	0.00065	0.00011	0.00014	0.00123
(48) 50% Trimmings	0.00085	0.00014	0.00019	0.00163
(49) Fat	0.00018	0.00003	0.00004	0.00034
(50) Bone	0.00013	0.00002	0.00003	0.00024

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 33	Item 34	Item 35	Item 36
(1) 127A Lip-On Rib(s)	0.00400	0.00040	0.00040	0.00150
(2) 107 3X4 Ribeye(s)	0.00400	0.00040	0.00040	0.00150
(3) 123A Short Rib(s)	0.00150	0.00040	0.00040	0.00150
(4) 124 Back Rib(s)	0.00150	0.00040	0.00040	0.00150
(5) 174 Short Loin(s)	0.00900	0.00150	0.00150	0.00150
(6) 175 Strip Loin(s)	0.00900	0.00150	0.00150	0.00150
(7) 180 Strip Loin(s)	0.00900	0.00150	0.00150	0.00150
(8) 184 Top Butt(s)	0.00900	0.00150	0.00150	0.00150
(9) Bone-In Top Butt(s)	0.00900	0.00150	0.00150	0.00150
(10) Tenderloin(s)	2.18823	0.00150	0.00150	0.00150
(11) 113B SqCut NckOf(s)	0.00150	1.57002	0.00900	0.00150
(12) 115 2pc Bnls Chk(s)	0.00150	0.00900	1.53162	0.00150
(13) Top Inside Round(s)	0.00150	0.00150	0.00150	1.77275
(14) 170 Goosenck Rnd(s)	0.00150	0.00150	0.00150	0.00900
(15) 167 Knuckle(s)	0.00150	0.00150	0.00150	0.00900
(16) 167A Peel Knckle(s)	0.00150	0.00150	0.00150	0.00900
(17) 161 Round, Bnls(s)	0.00150	0.00150	0.00150	0.00900
(18) 171B Outside Rnd(s)	0.00150	0.00150	0.00150	0.00900
(19) Eye of Round(s)	0.00150	0.00150	0.00150	0.00900
(20) 193 Flank Steak(s)	0.00150	0.00150	0.00150	0.00150
(21) 120 Brisket(s)	0.00150	0.00150	0.00150	0.00150
(22) Pastrami(s)	0.00150	0.00150	0.00150	0.00150
(23) Thin Meats(s)	0.00150	0.00150	0.00150	0.00150
(24) 127A Lip-On Rib(c)	0.00250	0.00250	0.00250	0.00250
(25) 107 3X4 Ribeye(c)	0.00250	0.00250	0.00250	0.00250
(26) 123A Short Rib(c)	0.00250	0.00250	0.00250	0.00250
(27) 124 Back Rib(c)	0.00250	0.00250	0.00250	0.00250
(28) 174 Short Loin(c)	0.00250	0.00250	0.00250	0.00250
(29) 175 Strip Loin(c)	0.01000	0.00250	0.00250	0.00250
(30) 180 Strip Loin(c)	0.01000	0.00250	0.00250	0.00250
(31) 184 Top Butt(c)	0.01000	0.00250	0.00250	0.00250
(32) Bone-In Top Butt(c)	0.01000	0.00250	0.00250	0.00250
(33) Tenderloin(c)	**-3.46500**	0.00250	0.00250	0.00250
(34) 113B SqCut NckOf(c)	0.00138	**-2.64271**	0.00250	0.00250
(35) 115 2pc Bnls Chk(c)	0.00590	0.01070	**-2.64271**	0.00250
(36) Top Inside Rnd(c)	0.00279	0.00506	0.00118	**-3.74672**
(37) 170 Goosenck Rnd(c)	0.00140	0.00253	0.00059	0.00125
(38) 167 Knuckle(c)	0.00065	0.00117	0.00027	0.00232
(39) 167A Peel Knckle(c)	0.00065	0.00118	0.00027	0.00233
(40) 161 Round, Bnls(c)	0.00077	0.00140	0.00033	0.00276
(41) 171B Outside Rnd(c)	0.00076	0.00138	0.00032	0.00272
(42) Eye of Round(c)	0.00034	0.00061	0.00014	0.00121
(43) 193 Flank Steak(c)	0.00046	0.00083	0.00019	0.00041
(44) 120 Brisket(c)	0.00095	0.00173	0.00040	0.00085
(45) Pastrami(c)	0.00083	0.00150	0.00035	0.00074
(46) Thin Meats(c)	0.00345	0.00625	0.00146	0.00309
(47) 75% Trimmings	0.00013	0.00023	0.00005	0.00011
(48) 50% Trimmings	0.00017	0.00030	0.00007	0.00015
(49) Fat	0.00003	0.00006	0.00001	0.00003
(50) Bone	0.00002	0.00004	0.00001	0.00002

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 37	Item 38	Item 39	Item 40
(1) 127A Lip-On Rib(s)	0.00150	0.00150	0.00150	0.00150
(2) 107 3X4 Ribeye(s)	0.00150	0.00150	0.00150	0.00150
(3) 123A Short Rib(s)	0.00150	0.00150	0.00150	0.00150
(4) 124 Back Rib(s)	0.00150	0.00150	0.00150	0.00150
(5) 174 Short Loin(s)	0.00150	0.00150	0.00150	0.00150
(6) 175 Strip Loin(s)	0.00150	0.00150	0.00150	0.00150
(7) 180 Strip Loin(s)	0.00150	0.00150	0.00150	0.00150
(8) 184 Top Butt(s)	0.00150	0.00150	0.00150	0.00150
(9) Bone-In Top Butt(s)	0.00150	0.00150	0.00150	0.00150
(10) Tenderloin(s)	0.00150	0.00150	0.00150	0.00150
(11) 113B SqCut NckOf(s)	0.00150	0.00150	0.00150	0.00150
(12) 115 2pc Bnls Chk(s)	0.00150	0.00150	0.00150	0.00150
(13) Top Inside Round(s)	0.00900	0.00900	0.00900	0.00900
(14) 170 Goosenck Rnd(s)	2.56901	0.00900	0.00900	0.00900
(15) 167 Knuckle(s)	0.00900	2.97376	0.00900	0.00900
(16) 167A Peel Knckle(s)	0.00900	0.00900	2.97428	0.00900
(17) 161 Round, Bnls(s)	0.00900	0.00900	0.00900	1.85612
(18) 171B Outside Rnd(s)	0.00900	0.00900	0.00900	0.00900
(19) Eye of Round(s)	0.00900	0.00900	0.00900	0.00900
(20) 193 Flank Steak(s)	0.00150	0.00150	0.00150	0.00150
(21) 120 Brisket(s)	0.00150	0.00150	0.00150	0.00150
(22) Pastrami(s)	0.00150	0.00150	0.00150	0.00150
(23) Thin Meats(s)	0.00150	0.00150	0.00150	0.00150
(24) 127A Lip-On Rib(c)	0.00250	0.00250	0.00250	0.00250
(25) 107 3X4 Ribeye(c)	0.00250	0.00250	0.00250	0.00250
(26) 123A Short Rib(c)	0.00250	0.00250	0.00250	0.00250
(27) 124 Back Rib(c)	0.00250	0.00250	0.00250	0.00250
(28) 174 Short Loin(c)	0.00250	0.00250	0.00250	0.00250
(29) 175 Strip Loin(c)	0.00250	0.00250	0.00250	0.00250
(30) 180 Strip Loin(c)	0.00250	0.00250	0.00250	0.00250
(31) 184 Top Butt(c)	0.00250	0.00250	0.00250	0.00250
(32) Bone-In Top Butt(c)	0.00250	0.00250	0.00250	0.00250
(33) Tenderloin(c)	0.00250	0.00250	0.00250	0.00250
(34) 113B SqCut NckOf(c)	0.00250	0.00250	0.00250	0.00250
(35) 115 2pc Bnls Chk(c)	0.00250	0.00250	0.00250	0.00250
(36) Top Inside Rnd(c)	0.00250	0.01000	0.01000	0.01000
(37) 170 Goosenck Rnd(c)	**-3.74672**	0.01000	0.01000	0.01000
(38) 167 Knuckle(c)	0.00463	**-4.11523**	0.01000	0.01000
(39) 167A Peel Knckle(c)	0.00465	0.01003	**-4.11523**	0.01000
(40) 161 Round, Bnls(c)	0.00552	0.01192	0.01188	**-3.00571**
(41) 171B Outside Rnd(c)	0.00543	0.01173	0.01169	0.00984
(42) Eye of Round(c)	0.00242	0.00522	0.00520	0.00438
(43) 193 Flank Steak(c)	0.00082	0.00177	0.00177	0.00149
(44) 120 Brisket(c)	0.00170	0.00368	0.00367	0.00309
(45) Pastrami(c)	0.00148	0.00321	0.00320	0.00269
(46) Thin Meats(c)	0.00617	0.01332	0.01328	0.01118
(47) 75% Trimmings	0.00022	0.00048	0.00048	0.00041
(48) 50% Trimmings	0.00030	0.00064	0.00064	0.00054
(49) Fat	0.00006	0.00013	0.00013	0.00011
(50) Bone	0.00004	0.00010	0.00010	0.00008

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 41	Item 42	Item 43	Item 44
(1) 127A Lip-On Rib(s)	0.00150	0.00150	0.00150	0.00150
(2) 107 3X4 Ribeye(s)	0.00150	0.00150	0.00150	0.00150
(3) 123A Short Rib(s)	0.00150	0.00150	0.00150	0.00150
(4) 124 Back Rib(s)	0.00150	0.00150	0.00150	0.00150
(5) 174 Short Loin(s)	0.00150	0.00150	0.00150	0.00150
(6) 175 Strip Loin(s)	0.00150	0.00150	0.00150	0.00150
(7) 180 Strip Loin(s)	0.00150	0.00150	0.00150	0.00150
(8) 184 Top Butt(s)	0.00150	0.00150	0.00150	0.00150
(9) Bone-In Top Butt(s)	0.00150	0.00150	0.00150	0.00150
(10) Tenderloin(s)	0.00150	0.00150	0.00150	0.00150
(11) 113B SqCut NckOf(s)	0.00150	0.00150	0.00150	0.00150
(12) 115 2pc Bnls Chk(s)	0.00150	0.00150	0.00150	0.00150
(13) Top Inside Round(s)	0.00900	0.00900	0.00150	0.00150
(14) 170 Goosenck Rnd(s)	0.00900	0.00900	0.00150	0.00150
(15) 167 Knuckle(s)	0.00900	0.00900	0.00150	0.00150
(16) 167A Peel Knckle(s)	0.00900	0.00900	0.00150	0.00150
(17) 161 Round, Bnls(s)	0.00900	0.00900	0.00150	0.00150
(18) 171B Outside Rnd(s)	1.83923	0.00900	0.00150	0.00150
(19) Eye of Round(s)	0.00900	1.87318	0.00150	0.00150
(20) 193 Flank Steak(s)	0.00150	0.00150	0.84655	0.00900
(21) 120 Brisket(s)	0.00150	0.00150	0.00900	0.63788
(22) Pastrami(s)	0.00150	0.00150	0.00900	0.00900
(23) Thin Meats(s)	0.00150	0.00150	0.00150	0.00150
(24) 127A Lip-On Rib(c)	0.00250	0.00250	0.00250	0.00250
(25) 107 3X4 Ribeye(c)	0.00250	0.00250	0.00250	0.00250
(26) 123A Short Rib(c)	0.00250	0.00250	0.00250	0.00250
(27) 124 Back Rib(c)	0.00250	0.00250	0.00250	0.00250
(28) 174 Short Loin(c)	0.00250	0.00250	0.00250	0.00250
(29) 175 Strip Loin(c)	0.00250	0.00250	0.00250	0.00250
(30) 180 Strip Loin(c)	0.00250	0.00250	0.00250	0.00250
(31) 184 Top Butt(c)	0.00250	0.00250	0.00250	0.00250
(32) Bone-In Top Butt(c)	0.00250	0.00250	0.00250	0.00250
(33) Tenderloin(c)	0.00250	0.00250	0.00250	0.00250
(34) 113B SqCut NckOf(c)	0.00250	0.00250	0.00250	0.00250
(35) 115 2pc Bnls Chk(c)	0.00250	0.00250	0.00250	0.00250
(36) Top Inside Rnd(c)	0.01000	0.01000	0.00250	0.00250
(37) 170 Goosenck Rnd(c)	0.01000	0.01000	0.00250	0.00250
(38) 167 Knuckle(c)	0.01000	0.01000	0.00250	0.00250
(39) 167A Peel Knckle(c)	0.01000	0.01000	0.00250	0.00250
(40) 161 Round, Bnls(c)	0.01000	0.01000	0.00250	0.00250
(41) 171B Outside Rnd(c)	**-3.00571**	0.01000	0.00250	0.00250
(42) Eye of Round(c)	0.00445	**-3.00571**	0.00250	0.00250
(43) 193 Flank Steak(c)	0.00151	0.00340	**-1.95465**	0.00250
(44) 120 Brisket(c)	0.00314	0.00705	0.00519	**-1.78476**
(45) Pastrami(c)	0.00273	0.00614	0.01807	0.00871
(46) Thin Meats(c)	0.01136	0.02553	0.01877	0.00905
(47) 75% Trimmings	0.00041	0.00093	0.00068	0.00033
(48) 50% Trimmings	0.00054	0.00122	0.00090	0.00043
(49) Fat	0.00011	0.00026	0.00019	0.00009
(50) Bone	0.00008	0.00018	0.00013	0.00006

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 45	Item 46	Item 47	Item 48
(1) 127A Lip-On Rib(s)	0.00150	0.00150	0.00010	0.00010
(2) 107 3X4 Ribeye(s)	0.00150	0.00150	0.00010	0.00010
(3) 123A Short Rib(s)	0.00150	0.00150	0.00010	0.00010
(4) 124 Back Rib(s)	0.00150	0.00150	0.00010	0.00010
(5) 174 Short Loin(s)	0.00150	0.00150	0.00010	0.00010
(6) 175 Strip Loin(s)	0.00150	0.00150	0.00010	0.00010
(7) 180 Strip Loin(s)	0.00150	0.00150	0.00010	0.00010
(8) 184 Top Butt(s)	0.00150	0.00150	0.00010	0.00010
(9) Bone-In Top Butt(s)	0.00150	0.00150	0.00010	0.00010
(10) Tenderloin(s)	0.00150	0.00150	0.00010	0.00010
(11) 113B SqCut NckOf(s)	0.00150	0.00150	0.00010	0.00010
(12) 115 2pc Bnls Chk(s)	0.00150	0.00150	0.00010	0.00010
(13) Top Inside Round(s)	0.00150	0.00150	0.00010	0.00010
(14) 170 Goosenck Rnd(s)	0.00150	0.00150	0.00010	0.00010
(15) 167 Knuckle(s)	0.00150	0.00150	0.00010	0.00010
(16) 167A Peel Knckle(s)	0.00150	0.00150	0.00010	0.00010
(17) 161 Round, Bnls(s)	0.00150	0.00150	0.00010	0.00010
(18) 171B Outside Rnd(s)	0.00150	0.00150	0.00010	0.00010
(19) Eye of Round(s)	0.00150	0.00150	0.00010	0.00010
(20) 193 Flank Steak(s)	0.00900	0.00150	0.00010	0.00010
(21) 120 Brisket(s)	0.00900	0.00150	0.00010	0.00010
(22) Pastrami(s)	0.73372	0.00150	0.00010	0.00010
(23) Thin Meats(s)	0.00150	0.56025	0.00010	0.00010
(24) 127A Lip-On Rib(c)	0.00250	0.00250	0.00010	0.00010
(25) 107 3X4 Ribeye(c)	0.00250	0.00250	0.00010	0.00010
(26) 123A Short Rib(c)	0.00250	0.00250	0.00010	0.00010
(27) 124 Back Rib(c)	0.00250	0.00250	0.00010	0.00010
(28) 174 Short Loin(c)	0.00250	0.00250	0.00010	0.00010
(29) 175 Strip Loin(c)	0.00250	0.00250	0.00010	0.00010
(30) 180 Strip Loin(c)	0.00250	0.00250	0.00010	0.00010
(31) 184 Top Butt(c)	0.00250	0.00250	0.00010	0.00010
(32) Bone-In Top Butt(c)	0.00250	0.00250	0.00010	0.00010
(33) Tenderloin(c)	0.00250	0.00250	0.00010	0.00010
(34) 113B SqCut NckOf(c)	0.00250	0.00250	0.00010	0.00010
(35) 115 2pc Bnls Chk(c)	0.00250	0.00250	0.00010	0.00010
(36) Top Inside Rnd(c)	0.00250	0.00250	0.00010	0.00010
(37) 170 Goosenck Rnd(c)	0.00250	0.00250	0.00010	0.00010
(38) 167 Knuckle(c)	0.00250	0.00250	0.00010	0.00010
(39) 167A Peel Knckle(c)	0.00250	0.00250	0.00010	0.00010
(40) 161 Round, Bnls(c)	0.00250	0.00250	0.00010	0.00010
(41) 171B Outside Rnd(c)	0.00250	0.00250	0.00010	0.00010
(42) Eye of Round(c)	0.00250	0.00250	0.00010	0.00010
(43) 193 Flank Steak(c)	0.01000	0.00250	0.00010	0.00010
(44) 120 Brisket(c)	0.01000	0.00250	0.00010	0.00010
(45) Pastrami(c)	**-1.86971**	0.00250	0.00010	0.00010
(46) Thin Meats(c)	0.01039	**-1.85465**	0.00010	0.00010
(47) 75% Trimmings	0.00038	0.00009	**-1.14866**	0.12812
(48) 50% Trimmings	0.00050	0.00012	0.02160	**-1.04866**
(49) Fat	0.00010	0.00003	0.00003	0.00002
(50) Bone	0.00007	0.00002	0.00002	0.00001

Table D.1 MPPM Simulator Own and Cross Price Elasticities.

Meat Item	Item 49	Item 50
(1) 127A Lip-On Rib(s)	0.00005	0.00005
(2) 107 3X4 Ribeye(s)	0.00005	0.00005
(3) 123A Short Rib(s)	0.00005	0.00005
(4) 124 Back Rib(s)	0.00005	0.00005
(5) 174 Short Loin(s)	0.00005	0.00005
(6) 175 Strip Loin(s)	0.00005	0.00005
(7) 180 Strip Loin(s)	0.00005	0.00005
(8) 184 Top Butt(s)	0.00005	0.00005
(9) Bone-In Top Butt(s)	0.00005	0.00005
(10) Tenderloin(s)	0.00005	0.00005
(11) 113B SqCut NckOf(s)	0.00005	0.00005
(12) 115 2pc Bnls Chk(s)	0.00005	0.00005
(13) Top Inside Round(s)	0.00005	0.00005
(14) 170 Goosenck Rnd(s)	0.00005	0.00005
(15) 167 Knuckle(s)	0.00005	0.00005
(16) 167A Peel Knckle(s)	0.00005	0.00005
(17) 161 Round, Bnls(s)	0.00005	0.00005
(18) 171B Outside Rnd(s)	0.00005	0.00005
(19) Eye of Round(s)	0.00005	0.00005
(20) 193 Flank Steak(s)	0.00005	0.00005
(21) 120 Brisket(s)	0.00005	0.00005
(22) Pastrami(s)	0.00005	0.00005
(23) Thin Meats(s)	0.00005	0.00005
(24) 127A Lip-On Rib(c)	0.00005	0.00005
(25) 107 3X4 Ribeye(c)	0.00005	0.00005
(26) 123A Short Rib(c)	0.00005	0.00005
(27) 124 Back Rib(c)	0.00005	0.00005
(28) 174 Short Loin(c)	0.00005	0.00005
(29) 175 Strip Loin(c)	0.00005	0.00005
(30) 180 Strip Loin(c)	0.00005	0.00005
(31) 184 Top Butt(c)	0.00005	0.00005
(32) Bone-In Top Butt(c)	0.00005	0.00005
(33) Tenderloin(c)	0.00005	0.00005
(34) 113B SqCut NckOf(c)	0.00005	0.00005
(35) 115 2pc Bnls Chk(c)	0.00005	0.00005
(36) Top Inside Rnd(c)	0.00005	0.00005
(37) 170 Goosenck Rnd(c)	0.00005	0.00005
(38) 167 Knuckle(c)	0.00005	0.00005
(39) 167A Peel Knckle(c)	0.00005	0.00005
(40) 161 Round, Bnls(c)	0.00005	0.00005
(41) 171B Outside Rnd(c)	0.00005	0.00005
(42) Eye of Round(c)	0.00005	0.00005
(43) 193 Flank Steak(c)	0.00005	0.00005
(44) 120 Brisket(c)	0.00005	0.00005
(45) Pastrami(c)	0.00005	0.00005
(46) Thin Meats(c)	0.00005	0.00005
(47) 75% Trimmings	0.00005	0.00005
(48) 50% Trimmings	0.00005	0.00005
(49) Fat	**-3.20700**	2.20131
(50) Bone	2.20292	**-3.20700**

VITA

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Doctor of Philosophy

Thesis: THE MEAT PACKING PLANT MANAGEMENT SIMULATOR: THE DEVELOPMENT OF AN EXPERIENTIAL AGRIBUSINESS SIMULATOR

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