

ABSTRACT OF THESIS

A DETAILED SECTOR ANALYSIS OF THE HOLSTEIN BEEF MARKET

The Holstein beef sector is a fascinating and integral part of the United States beef system; however, it has been largely overlooked in academic research. Holstein beef has long suffered from perceptions that it is of poor quality. Recent changes in slaughter industry structure, marketing systems, and production models have made the Holstein system unbelievably complex. Coupled with econometric modeling, this sector analysis uses a semi-structured interview approach to evaluate the reality of these perceptions, the impact of these changes, and to determine what truly drives the Holstein beef market. Results suggest that many of the perceptions of Holstein beef are inaccurate; the market for Holstein steers was found to be quite similar to the market for native steers. Recent changes in production systems appear to have been driven by changes in market preferences. Finally, the driving forces behind the Holstein market are not that different from the driving factors in the native cattle market, although some of the impacts were found to be different.

KEYWORDS: Livestock Marketing, Holstein Beef, Sector Analysis, Price Analysis, Econometric Modeling

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THESIS

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The Graduate School
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A DETAILED SECTOR ANALYSIS OF THE HOLSTEIN BEEF MARKET

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
College of Agriculture
at the University of Kentucky

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CHAPTER ONE

INTRODUCTION, BACKGROUND, AND PURPOSE

The Holstein beef market is a fascinating and integral part of the beef supply chain. It is extremely complex due to multiple production systems and various end product targets. It is extremely complicated due to the large number of individuals who are involved. The Holstein beef sector has perhaps the most segmented production system in all of agriculture. Much is being learned about the production and marketing of Holstein beef on multiple fronts, but little has been done to examine how these multiple pieces fit together to form the existing production and marketing system.

Insiders know their part of the Holstein beef system, but few know the entire system. Understanding the Holstein beef market is necessary if one truly wants to understand the overall beef market. Holsteins play a key role in the beef supply chain and if current trends continue, may become even more important in the future.

The purpose of this paper is to conduct a detailed sector analysis that will examine the Holstein beef system and the multiple industries that exist within it. This research will produce a description of the overall system, an examination of the various enterprises that compose the system, and a statistical analysis of the Holstein prices at the feeder steer and finished steer levels. This will allow those within the sector to gain a better understanding of the system and improve the basis for their decisions. There is a clear need to understand and document this sector of the beef industry for the sake of industry stakeholders, extension personnel, and academic researchers.

An important component of this work is to produce a comprehensive description of the Holstein beef sector. Insight for this description was gathered by reviewing written material and conducting telephone and personal interviews with individuals within the sector. Subsequent parts of the thesis include an econometric analysis of the price structure and a comparison of the markets for traditionally finished Holstein steers and calf finished Holstein steers.

Like many agricultural sectors, the Holstein beef sector is becoming highly specialized. The most prominent example is in the processing industry where large meat packers are starting to stake their claim on the Holstein beef market by purchasing plants that are well suited for processing Holstein steers. However, specialization is not limited to the processing industry.

Similar shifts are occurring in the finishing and backgrounding industries as professional cattle producers are focusing their efforts on producing Holstein beef.

For many years, dairy beef has suffered from a perception problem. Beef from dairy-type steers, such as Holsteins, has been considered to be of low quality and primarily ground into hamburger. This perception has existed for a long time because many plants that slaughter cull cows also slaughter Holstein steers. However, it is questionable whether this stereotype is accurate.

Holstein beef is becoming a very popular case-ready product, and in many retail situations, sits in the meat case with beef from colored cattle. Because artificial insemination is widespread and Holsteins have long been selected for milk production, less variation exists within the breed. A more consistent meat product is at the top of the list of attributes retail stores desire in their meat case (Larson).

For the purposes of this paper, the Holstein beef sector will be broken down into four primary industries. These industries are: dairy and baby calves; backgrounding; finishing; and slaughter and processing. Since the intent is to examine the beef system, very little effort will be devoted to the milk production industry. A more in-depth discussion will examine the finishing and processing industries because they are the industries that have the most potential variation in production systems and the greatest impact on the end meat product.

The typical Holstein steer will pass through each of these production stages during his lifetime. A Holstein steer is born on a dairy operation and left with his mother for a matter of days. Depending on the dairy operation, the steer may be weaned on the farm or sold to another operation that specializes in weaning dairy calves. This process of weaning the calf and preparing him for higher forage and concentrate diets is often referred to as the “starter” phase.

From the starter phase, the steer may go to a backgrounding operation for a period of time. At the backgrounding stage, the calf will consume a primarily forage diet and be prepared to enter a feedlot. Each year, a growing number of dairy steers are sold directly to feedlots and skip this stage of production. While at the feedlot, steers are fed a high protein, concentrate based diet as they are finished. Once the steer leaves the feedlot, he will be sold to a processing plant for fabrication and harvest. From the plant, boxed beef is shipped to retailers and foodservice entities across the United States.

Each of these production levels will be examined and discussed in detail. An effort will be made to provide information practical enough to aid market participants in making day-to-day management decisions, but still keep the analysis within the context of how it relates to other industries within the Holstein system.

Given that Holstein production is highly segmented and multiple marketing levels are present, one can easily see how many potential production systems could emerge. The traditional model, which still exists, is losing prominence in the United States. This production model involves an extensive backgrounding system, which means that steers are not placed on full feed until they are heavy feeder steers weighing between 800 and 1000 pounds. The resulting carcasses are extremely heavy when the steers are slaughtered at sixteen to twenty-four months of age. Carcasses from steers produced under this system will weigh between 800 and 1100 pounds.

The alternative model, which originated in the western United States, is quite different. A “calf-fed” system involves placing Holstein steers directly into feedlots when they leave the “starter” phase. The calf-fed program allows the Holstein steer to reach lighter finished weights, typically 1200 to 1400 pounds (700 to 900 pound carcass weights). This also means that the animal is slaughtered at a younger age, usually less than eighteen months old.

A calf-fed system also places the Holstein steer on a high concentrate diet for a longer period of time. Whereas backgrounded cattle are on feed 150 to 210 days, Holstein calves placed directly on feed may remain in the feedlot for over 300 days. The most notable example of this program is Ralph’s California Beef program, which is an alliance program in California designed to provide Ralph’s grocery stores with a consistently high-quality brand of case-ready beef (Tronstad). Although primarily associated with the West, this production model is becoming more common in the Northeast.

At the conclusion of this paper, the reader should have a much better understanding of where Holsteins fit into the existing beef marketing system. The paper will address and discuss the factors that drive the overall market for Holstein beef and how those differ from what drives the market for traditional beef. This should provide the reader with a clearer understanding of the economic differences between Holstein steers and colored steers. It will also focus on what implications these differences hold for producers of Holstein beef.

On a more tactical level, the paper will evaluate the status of individual industries within the Holstein beef sector. It will examine the shift from the traditional finishing model to the calf-fed model to determine its impact on these individual industries. Finally, the paper will include discussion of indicators that individual producers can use as they make decision on when and what types of Holsteins to buy, and how long to keep those Holsteins before selling them.

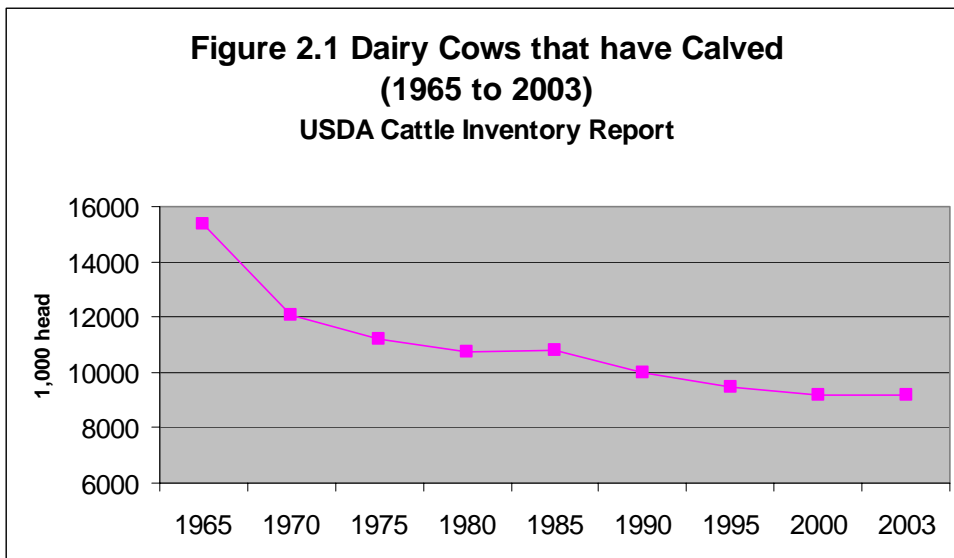
This work will be much different from a typical thesis. It will begin by painting a picture of the marketing system that currently exists and distinguish that system from the mainstream beef system. It will then focus on why recent changes have occurred and how they have affected the individual entities that operate within the Holstein system. Finally, it will provide some specific implications for these individuals as they make day-to-day management and marketing decisions.

CHAPTER TWO

DESCRIPTION OF THE HOLSTEIN BEEF SYSTEM

Dairy and Baby Calves

Like many sectors of the farm economy, the United States dairy sector has seen its share of changes over the past few decades. Since 1965, the number of dairy cows in the United States has declined by more than 40% (see chart below). At the same time, milk production has steadily increased due to large gains in the amount of milk produced per dairy cow. In 2002, United States milk production reached 169.7 billion pounds, an average of 18,571 pounds per cow (NASS Milk Production). It is the milk production industry that feeds the Holstein beef market by producing the young steer calves that eventually reach the beef channel.



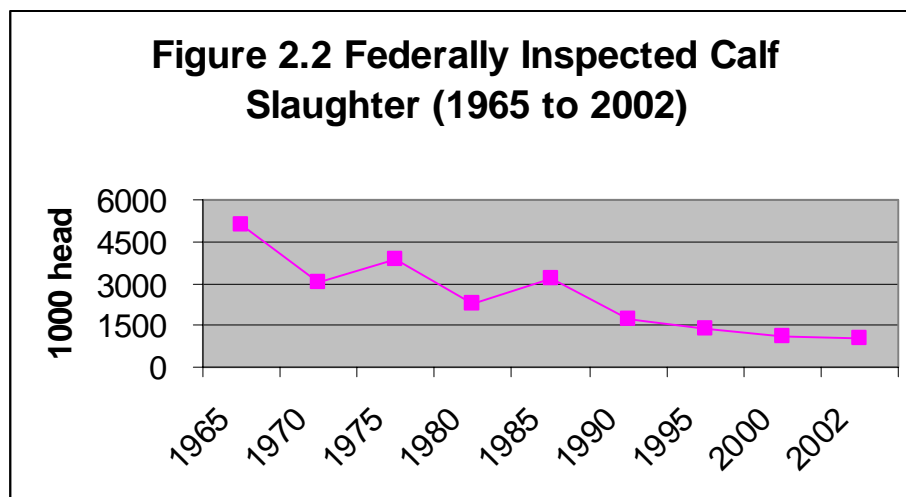
The first piece of the Holstein beef puzzle was determining the size of the market for Holstein steers. Since inventory data was not available for Holstein steers specifically, general USDA semi-annual inventory data were utilized. Assumptions were made from these data in order to estimate the number of Holstein steers that reach the market each year. Examination began by considering the number of cows in United States' dairy herds.

According to the 2003 USDA Cattle Inventory report, there were approximately 9.1 million dairy cows in the United States as of July 1, 2003. According to the Animal and Plant Health Inspection Service (APHIS), Holstein cows represent 92.4% of the United States dairy

herd. From these figures, it was estimated that there were 8.41 million Holstein cows in the United States.

According to the same APHIS report, the calving rate for dairy cows (as a percentage of dairy cow inventory) was 88.8% on a national average. Therefore, it was assumed that 7.47 million Holstein calves were born each year. Assuming that 50% of all calves born are male, it was estimated that approximately 3.73 million Holstein steers are born in the United States annually. The United States calf crop was approximately 38 million head in 2003; Holstein steers accounted for slightly less than 10% of the US calf crop (NASS Cattle Inventory Report).

However, all of these Holstein steers do not enter the beef market as finished steers. In order to estimate this number, Holstein steers entering into veal and bob calf programs must be considered. The National Agricultural Statistics Service estimated that in 2002 commercial calf slaughter was around one-million head. Federally inspected calf slaughter has been decreasing since the mid-sixties and is shown in Figure 2.2. According to staff at the Livestock Marketing Information Center, Holstein steers represent more than 90% of this market. Based on these assumptions, it was concluded that around three-million Holstein steers are actually slaughtered in the United States each year after finishing. This is still a substantial number of steers and drives home the importance of studying this sector individually.



In a sense, Holstein steer calves are by-products of commercial dairy operations. Heifers are much more valuable than their male counterparts, so the efforts of the commercial dairymen are focused on his or her heifer crop. Most dairy farm managers keep the better heifers for replacements, while others are sold as replacements on the open market. Few dairies choose to keep steer calves any longer than is necessary, so most are sold at a very young age.

After Holstein steers are born, they are usually left with their mothers' for three to five days so the baby calf can receive its mother's colostrum. It is recommended that the calf receive at least two quarts of colostrum immediately after birth and another quart within a couple of hours. Colostrum is the first milk available from the mother and is crucial for the development of the calf's immune system and for vitamins and minerals. Colostrum is the first step in making sure that the calf gets off to a good start (Siemens 1996).

Although colostrum is critical to calf development, many dairymen prefer not to allow calves to nurse directly. These dairymen will milk the cow themselves and bottle feed the calf during the first days of its life. The primary advantage of bottle-feeding is that it is much easier to measure the amount of colostrum the calf receives (Moore). When nursing, it is impossible to know how much colostrum is consumed.

On the first day of their lives, calves are vaccinated and treated for lice; this is also when castration and implantation would normally occur. Calves are generally offered a starter feed immediately. Calves learning to eat need continual access to fresh feed despite possible wastefulness. Unused starter feed is often fed to older calves to limit this waste (Moore).

If calves are allowed to nurse, three to five days is the accepted time frame within which milk from the cow should not be marketed. After three to five days, the milk can again be sold and the calf will be switched to a milk replacement. Shortly thereafter, the calf will be introduced to grain. At this point in the calf's life, the dairy operator is faced with the decision of whether to sell the calf or retain it through the weaning process. There are many producers who specialize in weaning Holstein calves and are willing to buy these calves at three to five days of age. This decision depends on many factors including the current market for baby calves, the cash flow needs of the dairy operation, and the resource base of the farm.

Regardless of who owns the calves during the weaning process, calves are usually placed in individual pens. Starter calf producers try to limit nose-to-nose contact, which lowers the possibility of disease. Calves perform best in pens that are kept clean, dry, and draft free.

Calves are under a great deal of stress during this time, so every effort is made not to further stress the calf.

By the time the calf reaches two weeks of age, it should be eating grain daily (Ely and Guthrie). Most dairymen try to hold the amount of milk calves consume constant and increase the amount of feed they consume during this starter period. This is done in an attempt to keep feed costs down and move the animals towards weaning as quickly as possible (Siemens). The second through the fourth week of life is crucial to the calf's development as its adrenaline gland is not yet functioning.

Calves can be weaned when they are consuming around two pounds of dry feed per day, which can occur as early as four or five weeks of age. The common practice at weaning is to gradually reduce the amount of powder the calf receives over four or five days, while keeping the fluid volume constant. Producers see that fresh starter feed and clean water is available to all calves during and after weaning (Siemens).

For the most part, alternative systems for producing Holstein beef will be similar until this point in the life of the calf. It is not uncommon for calves to go on grass for a short time after weaning before they are moved from the "starter" phase into the second phase of production. This starter phase of production is crucial as it should leave the calf healthy and ready to move into a backgrounding or finishing operation.

Given the high level of management required to wean Holstein steers, it is not surprising that many dairy operators choose not to focus their efforts in this area. Starter production is an industry in and of itself, being essential to the healthy development of the calf. For this reason, several processors of Holstein steers have started large starter operations which are used to funnel calves into feedlots that supply them with steers. The process is very much the same as was previously described and allows them to have control of the calves during this critical time.

Backgrounding Holstein Steers

Backgrounding refers to the market function that is performed by buying lightweight stocker calves (300 to 500 pounds), placing them on a high forage diet, and allowing them to grow slowly for a period of several months before they are placed on full feed. The backgrounder attempts to put inexpensive gain on calves during this time by utilizing his or her

available resource base. It is generally a high-risk enterprise, especially when extremely young calves are purchased. A backgrounder must be a good manager of health and nutrition in order to make a backgrounding enterprise profitable.

The backgrounding industry is a margin industry, like many industries within the beef sector. The backgrounder turns his stock over completely in a matter of months. This is attractive to many because the backgrounder can be profitable regardless of the overall level of the cattle market. It does not matter if calves are expensive when he or she buys, as long as they are equally expensive when he or she sells. Rather, the backgrounder is extremely susceptible to quick swings in the market that affect his or her buy and sell margin.

It is important that the academic researcher understand the Holstein backgrounding industry and the function that it serves. Historically, backgrounders have bought calves that were not yet ready to go on full feed, allowed them to grow slowly for a period of time, and resold them for placement into feedlots. Backgrounding is popular in Kentucky for many reasons. First, Kentucky has a strong forage base that is available for grazing. With pasture being the primary input to a backgrounding operation, Kentucky producers have moved to capitalize on these profit opportunities. Kentucky could potentially be the low-cost producer of backgrounded feeder cattle in the eastern United States.

Another explanation for the popularity of backgrounding Holsteins may explain why some producers with a forage base choose to background Holstein steers rather than native steers. Holstein steers are cheaper than traditional steers, usually ten to fifteen dollars per hundredweight on heavy feeders (700 to 800 pounds) and as much as fifteen to twenty dollars per hundred on lighter calves (400 to 600 pounds) (Burdine). Therefore, less cash outlay is required, if forage is the limiting factor of production. If capital is the limiting production factor, then a larger number of head can be purchased and production risks can be spread over a larger number of head.

Another factor may involve the “starter” phase whereby most Holsteins are weaned. Holstein steers are usually eating grass and grain by the time they leave the starter phase of production. Conversely, many non-dairy calves are sold immediately after weaning and have not been exposed to any nutritional source except their mothers’ milk. This transition can make the early stages of the backgrounding phase very risky and management intensive. It is reasonable

to assume that backgrounding of Holstein steers may be less management intensive than backgrounding of native cattle because most Holsteins have been through a starter program.

A large number of Holstein steers reach the market each year shortly after weaning and are purchased by backgrounders. Backgrounders typically keep Holstein steers until they reach 800 to 1000 pounds. At this point, they are ready to enter feedlots and be placed on a high concentrate ration. The length of the backgrounding period depends on many factors including market prices of Holstein feeder calves, the financial situation of the backgrounding operation, the cost of inputs such as hay and grain, and the availability of non-cash inputs such as pasture.

Many producers suggest that Holstein steers are the pulse of the cattle industry, meaning that they respond first to changes in the market. This is especially true when considering the prices received by backgrounders for Holstein feeder calves. Previous work in this area has shown that Holstein prices are often more affected than non-dairy cattle prices when fundamental changes in demand occur (Burdine).

The overall price level of United States feeder cattle is indexed through the CME Feeder Cattle Index. The CME Feeder Cattle Index is a seven day weighted average of USDA feeder calf prices, from a twelve state region. This is the same index that is used to cash settle CME feeder cattle futures contracts that are open at the close of trading on the final day. This index is the best indicator available of the overall feeder calf market.

The prices of Holstein feeder steers and non-dairy feeder steers have been shown to move in the same direction as the CME Feeder Cattle Index. However, the magnitude of this pattern appeared to be different. Both heavy and lightweight Holstein feeders showed similar, but smaller, movements with the overall cattle market. When the overall market improved, prices of Holsteins increased, but not as much as the price of non-dairy steers. Conversely, when the overall market declined, the price of Holstein steers did not suffer as much as native feeder steers (Burdine).

Changes in input prices are commonly known to have a negative relationship with price. However, because Holstein steers are less efficient and require more corn to reach finished weights, they have been shown to be more vulnerable to these changes. This has been shown to be true for traditionally heavy feeder steers. Holstein prices will respond quickly to increased corn prices, and the magnitude will be greater than non-dairy steers.

Finally, seasonal price differences have been found to exist between Holsteins and non-dairy steers that backgrounders are well aware of. Spring is commonly known to be the seasonal peak in the feeder calf market. There are fewer calves on the market because fall calving is less popular, and backgrounders are placing calves on grass for the summer and are bidding prices upward. Fall is widely known to be the seasonal trough of the feeder cattle market for the same reason. Spring calving herds are liquidating their calf crop, which means there are a large number of light feeders and stockers on the market. Also, backgrounders who purchased calves in the spring are selling them in the fall, which increases the number of heavy feeders on the market.

Holstein feeder steers have shown similar price patterns to these. Prices for heavy Holstein steers are highest in the spring and summer and lowest in the fall. However, Holstein prices have not been shown to rally in the winter like non-dairy feeder calf prices do (Burdine). This is most likely due to the difficulties of wintering Holsteins in comparison with traditional feeder cattle. Holstein steers are not known to perform well under harsh conditions and require a great amount of management and investment in facilities for winter backgrounding programs to be successful.

A recent trend in the Holstein system has been a shift towards a calf-fed production model. This model is discussed in much detail in the following section. In a calf-fed system, calves are moved directly from the “starter” phase into a feedlot; the backgrounding stage is eliminated completely. This is intended to lower the finished weight of the animal and make him comparable to a non-dairy steer at harvest. This movement away from backgrounding is likely to continue as it is being driven by the retail and foodservice industries (Vanlanan).

Finishing Holstein Steers

The Holstein finishing industry is one of the most challenging in agriculture. Like other industries, it has seen numerous changes over the past several years. It is within the finishing industry that true differences in Holstein production systems become apparent. Placement weight, age of the calf, and length of time on feed can drastically affect the type of finished steer that arrives at the packing plant. This, in turn, has implications on the type and quality of meat that eventually arrives in the meat case.

There are many different finishing systems that can be used to target a group of Holstein steers to a particular market. Depending on the size and condition of the feeder calves when placed on feed and the intent of the feedlot operator, the steer may follow one of many paths before it reaches the meat case. At the same time, the market environment for processing is changing rapidly as fewer processors control larger shares of the market. Complexity and consolidation places the Holstein feedlot operator in a challenging marketing environment.

For the most part, Holsteins are considered good feedlot animals, being very docile and easy to handle. One potential drawback to finishing Holsteins is that they are not considered to be very hardy. They struggle in cold or muddy conditions and may require additional management inputs such as bedding or windbreaks during the winter and early spring months. Wintering Holsteins requires higher levels of management than wintering native steers (Grant). This has been hypothesized to be the reason that Holstein feeder steer prices do not rally in the winter like prices for non-dairy feeder calves (Burdine).

The traditional finishing model has been to buy Holstein feeder calves weighing between 700 and 1000 pounds. These feeder steers have been grown slowly in a dry lot or on pasture for several months prior to placement. They are finished much like traditional non-dairy calves, sometimes eating side-by-side in feedlots. Under a traditional finishing system, Holstein steers will grow faster and finish heavier than their non-dairy counterparts. They will usually consume more feed and convert feed less efficiently than non-dairy steers.

Holsteins are relatively efficient at converting feeds to live weight gain at weights under 1100 pounds. However, once they reach this weight, feed conversion drops considerably (Larson). Traditionally finished Holstein steers will reach finished weights of 1400 to 1800 pounds. These heavy carcasses create problems for retail and foodservice clients, much of which is discussed in the slaughter and processing section. It is because of these challenges that it has become more common to place younger Holstein steers on feed at much lighter weights.

The calf-fed model is quickly becoming the preferred finishing model in Holstein sector. Steers enter the feedlot immediately after leaving the starter phase of production. At this point, they weigh 300 to 400 pounds and are immediately placed on feed. They continue consuming a high concentrate diet until they reach their finished weights.

Because dairy steers are managed differently than non-dairy steers from birth, they can handle this shift much like pre-conditioned native steers that are much older. The starter phase

of production prepares the steers for high concentrate diets. By the time most dairy steers are weaned, their digestive system is used to these types of feeds and the animals are ready for the transition. Colored calves placed on feed directly after weaning would likely not respond as well to immediate placement in feedlots.

The primary reason for the shift towards the calf-fed system was to eliminate the extremely heavy carcass weights that result from the traditional Holstein finishing model. The actual feeding period is longer as steers will most likely remain on feed for 10-14 months. However, the backgrounding stage is eliminated completely, which results in a younger steer being harvested.

In a calf-fed system, feed efficiency is improved and finished weights will be closer to what has become common in the beef industry. Finished weights will average between 1200 and 1400 pounds; this is above what is expected from native cattle, but much lighter than finished weights from traditionally fed Holstein steers. The calf-fed system allows the feedlot operator to market finished steers sooner than under any other production system, despite the fact that the feeding period is longer (Chester-Jones 1996).

A successful calf-fed program begins with a group of healthy and uniform 300-400 pounds steers coming out of a good “starter” program. During the feeding process steers will continually increase their feed intake, but at the same time conversion will be steadily declining. Highest feed efficiencies occur between 400 and 700 pounds. Backgrounded feeder steers have not yet been placed on high concentrate diets at this stage in their life (Chester-Jones 1996). By placing the calves on feed immediately after weaning, animals will be consuming high concentrate diets during their most efficient stage.

Many feedlots have successfully shifted from the traditional finishing model to the calf-fed model. However, for others, it has created a challenge for several reasons. First, most feedlots were accustomed to handling backgrounded Holsteins which arrive at the feedlot weighing between 700 and 1,000 pounds. Facilities designed for heavy feeder calves were not ideal for receiving light weaned calves, so many feedlots were forced to make investments in facilities designed to handle smaller animals.

Secondly, a higher level of management is required for a calf-fed program. Calves entering the feedlot for calf-feeding are younger, lighter, and more prone to health problems.

Feedlots that had been receiving Holstein yearlings were not accustomed to dealing with these problems. Finally, many feedlots disliked the calf-fed model because they were unable to turn their inventory over as frequently due to the longer feeding period. It was because of these concerns that a hybrid feeding model surfaced.

An alternative to the calf-fed system is the “two phase” feeding approach. As the name implies, the two phase feeding system breaks the finishing system into two periods and allows the calves to be managed differently during each period. The goal of the two-phase system is to produce a carcass similar to that of a true calf-fed while allowing feedlots to specialize in the area which they are best suited.

During the first phase, calves are fed a high concentrate diet with possible forage supplementation for three to five months. This is usually referred to as the “grower” phase of production. Feedlot owners who operate “grower” lots must be excellent managers of herd health and prepare the calves for the next phase of production, leaving this grower phase weighing between 600 and 700 pounds (Anderson 1991). From the grower phase, they are sent to another feedlot to begin the second phase of the finishing program.

During phase two, from 600 to 700 pounds until finished, the steers are placed on a high energy finishing ration similar to the one described in the traditional finishing model. Steers gain around three pounds per day over a period of 8 to 12 months. Feedlot operators who specialize in this phase of production must be competent at efficiently and economically finishing animals (Vanlanan). The two-phase feeding approach is accepted in the industry, but is not as desirable as a true calf-fed program.

Slaughter weights will be slightly higher under the Two Phase feeding program and the total number of days in the feeding period will be somewhat longer (Anderson 1991). If all feedlots were similar in management and facilities, a two-phase system would not be needed. However, since certain feedlots have their own competencies, it is a reasonable alternative to calf-fed finishing during the transition period.

Holstein Slaughter and Processing

The Holstein slaughter and processing industry is rapidly changing and extremely interesting. Consolidation is occurring within the overall beef slaughter industry, and the Holstein market is no different. Holstein beef is a specialized sector of the beef market and may even be consolidating at a faster rate than the native beef market. The Holstein slaughter market is also seeing movement towards alliances and other forms of vertical coordination similar to what is being seen in the native cattle sector.

There has been a long-standing perception that the quality of Holstein beef is lower than that of traditional beef. Some of these perceptions are due to the appearance of the Holstein animal. Dairy breeds, such as the Holstein, look different than traditional English breeds. They have less shapely carcasses and lower lean-to-bone ratios (Larsen). They also have larger frames, put on fat differently, and do not get the same finished look that is associated with colored cattle.

This is part of the reason that Holsteins typically sell at lower prices than non-dairy steers. However, the primary reason has to do with their lower dressing percentages. Holstein steers will have dressing percentages 6-8% lower than native steers. Although live weight gain is higher for Holsteins, when dressing percentage is considered, Holsteins usually gain less efficiently than their non-dairy counterparts (Grant, Stock, and Mader).

In the beef sector, quality is measured through USDA quality grades. Quality grades are based on a measure of the amount of intramuscular fat that exist within the muscle tissue of the carcass. Choice is the second highest quality grade attainable and has become the baseline from which most carcasses are judged. The perception exists that Holsteins are less likely to grade Choice than native cattle. However, this is only true when comparing the two types of cattle at similar weights. The growth patterns of Holstein steers are quite different from native steers. Holstein steers are just as likely to reach the Choice grade when finished to their physiological endpoint; it just takes longer for them to reach this endpoint.

Most Holsteins will not reach the Choice grade until they weigh 1400 to 1600 pounds. As discussed earlier, feed efficiency has dropped considerably by this point in the animal's life, and many Holsteins are slaughtered before they are actually ready for market. As the shift towards a calf-fed production model became more prominent, early selling became more of a problem. In order to avoid large discounts for heavy carcasses, feedlot operators were shipping

traditionally fed Holstein steers before they reached true finished weight. When finished to their optimal weight, Holstein meat is considered to be of good quality and more uniform than meat from other breeds of cattle. It will readily grade Choice and often produces more Prime carcasses than native cattle (Van Lannen).

The Holstein market has been viewed for many years as a ground beef market, similar to that of cull cows. It is not clear how this perception came to exist, but there are a couple possible reasons. Since Holsteins are larger than non-dairy steers, they do not fit well in most processing plants. Many plants are not properly equipped to handle Holstein carcasses on their railing systems. Slaughter facilities want carcasses between 600 pounds and 900 pounds so that plant efficiency can be maximized. This is evidenced by discounts applied to heavy and light carcasses on most grids.

Due to carcass size differences, plants tend to specialize in the slaughter and fabrication of Holstein carcasses. At the same time, plants that are suited to handle large Holstein carcasses are also suited to handle large cull cow carcasses and therefore many process both (Kooystra). However, this does not necessarily mean that Holstein beef ends up in the same market channels as beef from cull cows.

Another reason that the poor perception of Holstein beef may exist involves the handling of ground beef in the past. Many years ago, Holstein meat was used to upgrade ground beef produced from cows. This co-mingling may have worked to fuel the notion that Holstein beef and beef from cull cows move through the same market channels (Tritle).

Still, the primary reason that plants specialize in the slaughter and processing of Holstein steers is marketing opportunities. Processing plants develop markets for specific products and focus their production efforts accordingly. The best example of this phenomenon in the Holstein beef sector is Sunland Beef and Ralphs' California Beef Program.

Ralph's Grocery Company is the largest supermarket chain in Southern California. Ralph's management was dealing with a large number of customer complaints about their meat department. In order to address these concerns, they developed a vertically coordinated production system that provided them with a consistent flow of Holstein beef for their retail grocery stores. Holsteins were chosen to be the primary breed due to their consistency, tenderness, and cutability. Sunland Beef, like many other plants, has developed a strong market for beef from Holstein steers.

Recent estimates by the Grain Inspection, Packers and Stockyards Administration place the four firm cattle slaughter concentration ratio at slightly less than 70% and place the eight firm concentration ratio at slightly less than 80%. The steer and heifer slaughter industries are thought to be more concentrated while cow and bull slaughter industries are considerably less concentrated (GIPSA October 2002). No such data are available for Holstein steers but we can infer a great deal by examining the major players.

The largest processor of Holstein steers is Smithfield Foods of Smithfield, Virginia. Smithfield, which is widely known to be the largest pork processor in the world, did not enter the beef processing industry until 2001. In April 2001, Smithfield purchased Moyer Packing of Souderton, Pennsylvania. Moyer's plant was described as quite modern, with a slaughter capacity of 2,375 head per day (Van Lannen).

Only six months later, Smithfield acquired Packerland Holdings, which at the time was one of the five largest beef processors in the U.S. Packerland was a leading supplier of finished Holstein beef and consisted of four packing plants with total capacity of over 6000 head per day. These plants are located in Green Bay, Wisconsin; Plainwell, Michigan; Tolleson, Arizona; and Gering, Nebraska. These two acquisitions propelled Smithfield deep into the beef packing industry. Only Tyson, ConAgra, Excel, and Swift have a larger share of the beef processing market. More importantly, the two mergers gave Smithfield a very large share of the Holstein steer market (Meat and Poultry October 2002).

Smithfield slaughters Holstein steers at four of its five processing plants; however, none of the plants are devoted exclusively to Holstein slaughter. All plants slaughter a large amount of native cattle and cull cows. Based on conversations with company management, it was estimated that Smithfield slaughtered nearly one-million Holstein steers per year in these four plants (Van Lannen). Based on estimates made in the Dairy and Baby Calves section of this study, Smithfield controls about one-third of the Holstein beef market.

Another player in the Holstein beef market is American Foods, which was at one time in merger discussions with Smithfield. However, they remain a separate company and another significant slaughterer of Holstein steers. American Foods operates two plants at the time of this writing. Like Smithfield, their primary operating location is in Green Bay, Wisconsin.

According to sources at American Foods Group, the Green Bay plant has a daily capacity of about 1900 head. In addition to Holstein steers, they process a large number of slaughter

cows. It was estimated that American Foods slaughtered 175,000 Holstein steers per year, which represents slightly less than 6% of the market.

American foods indicated they had been working extensively with the Iowa Cattlemen's Association. This relationship has led to the opening of a second plant which is run by the American Foods Group. This plant opened its doors in the spring of 2003 in Tama, Iowa. The Tama plant is not expected to slaughter Holsteins during its early years of operation, but the potential exist for Holstein capacity in Tama in the future (Kohlbeck).

Other plants actively involved in the slaughter and processing of Holstein steers are IBP/Tyson, Greater Omaha Pack, Rosen Meat Group, and Postville. There is some speculation that IBP may actually be the largest processor of Holstein steers as they are active in the Holstein market in all of their plants. IBP uses Holsteins to fill needs within their existing markets and are almost always purchasing calf-fed steers. Plants that utilize Holstein beef in this manner tend to increase their slaughter of Holsteins when the prices of native cattle get extremely high.

The move towards the calf-fed production model has come from the processing industry and has been driven by a couple factors. The first reason has to do with the processing industry responding to the needs of their retail and foodservice clientele. Holstein steer carcasses are structurally different from carcasses of native steers. Holsteins are not as full-bodied; their loins are more concave and their rounds are more flat. As mentioned previously, Holstein steers have much larger frames, which leads to longer cuts from the loin and ribeye.

The "middle-meats" from Holstein steers often yield cuts too large for retail and foodservice markets. Strips and ribeyes from Holstein steers have to be sliced extremely thin in order to keep portion size at industry standard levels. Calf-fed Holsteins are more similar in size to native cattle and therefore will yield middle-cuts, such as ribeyes and strips, closer in size to what is expected from native cattle (Van Lannan).

The market for traditionally finished Holstein steers still exists in the United States and is heavily dependent on the export market. Asian consumers in Japan and Korea have a strong preference for well-marbled beef. Holsteins finished under a tradition system will produce a high percentage of Choice and Prime carcasses and many of these carcasses are being shipped to Asian markets. These Holsteins will reach slaughter weights between 1600 and 1800 pounds and produce carcasses over 900 pounds. This export market has been dwindling in past years,

which has also provided some push towards the smaller calf-fed steers. Plants that still slaughter a lot of heavy Holsteins tend to have strong markets overseas.

As retail and foodservice preferences have changed, Holstein cattle have not. Traditional models for finishing and processing Holstein steers are unable to deliver the type of beef that is desired in the meat case of today. The shift towards the calf-fed production has allowed the Holstein sector to remain active in those mainstream markets. Had this shift not occurred, those individuals in the Holstein sector would have been fighting to maintain their share of a shrinking market.

CHAPTER THREE

LITERATURE REVIEW

A major goal of this study was to develop an understanding of the factors that drive the Holstein beef market and ultimately determine the prices received for Holstein steers. Very little academic research has examined Holstein steers specifically. Most research has focused on markets for native steers. Therefore, much of what is known about Holstein steers has been derived from parallels drawn between the Holstein market and the traditional beef market. An examination of the literature on price determinants and driving forces in the native cattle markets was necessary to develop an understanding of the same forces in the market for Holstein steers.

Background

The fed cattle market environment has seen many changes in recent years. A 1996 survey of Iowa, Kansas, Nebraska, and Texas cattle finishers was followed up in 2001 to determine trends in beef cattle marketing. During this six year period, there had been a clear increase in marketing agreements and selling cattle through alliance programs. Additionally, the percent of respondents using grid pricing increased more than three-fold (Schroeder 2002). The later trend was substantiated in the 2001 Packers and Stockyards statistical report although the increase was not as large (GIPSA). All indications are that both these trends will continue as more alliance programs surface and emphasis on value based marketing continues.

Recent changes in the beef cattle finishing industry include mandatory price reporting laws and concerns over packer ownership of cattle on feed. Cattle finishers are very aware of the environment within which they operate and are looking for improved marketing information and increased competition for finished cattle. Concerns about pricing always seem to be at the forefront in the beef cattle marketing world. However, many people misunderstand how pricing signals are sent in cattle markets.

Basic economic theory teaches that prices are determined by supply and demand. Markets clear at a price level where supply is equal to demand and the market will constantly move towards this equilibrium. Low price levels are often the result of large supplies relative to demand or low demand relative to supply. High prices result from low supply levels relative to

demand or excessive demand relative to supply. Short-term price variation has many causes including captive supplies, market information, and meat packer concentration.

The process by which demand and supply conditions interact to determine market prices is referred to as price determination. Market prices will settle at the level where the quantity supplied equals the quantity demanded. Supply determinants for fed cattle include feeder cattle prices, grain prices (feed costs), and technology that affect the cost of producing finished cattle. Supply determinants include factors that affect the expected prices of outputs from finishing operations such as the price of finished cattle or boxed beef.

Price discovery is related to price determination, but the two concepts are not the same. Price discovery refers to the process by which actual prices are determined between a buyer and a seller. Discovery is affected by many things, such as the structure, size, and location of the market and the level of concentration and competition among the buyers and sellers. Marketing methods such as live weight, carcass based, or grid pricing also can affect the price discovery process. The timeliness and accuracy of pricing information can be a key factor as well. Finally, risk management alternatives such as insurance or futures markets can affect the price discovery process.

Price discovery begins with a market price and prices tend to fluctuate around that level. When market prices are relatively low, concerns about the price discovery process increase. However, the overall level of market prices is primarily a function of the price determination process. Price discovery is primarily associated with the variability of prices around the overall price level (Ward). A misunderstanding of these concepts has led to many inaccurate conclusions about the source of price changes in cattle markets. Understanding the price determination and discovery process is crucial to understanding what is happening in cattle markets.

Understanding and Predicting Livestock Prices

Cattle producers use price forecasts to make production, market timing, and forward pricing decisions. However, predicting and understanding livestock price relationships has always been a difficult task for the agricultural economist. Previous studies of price and production level forecasting accuracy suggest that agricultural economists are better able to predict production levels than they are prices. This is not surprising given that production levels

are less volatile and data are available from the federal government. Production levels only represent the supply side of price determination; the demand side is more difficult to predict.

There is little evidence to suggest that experience, education, or the use of complex econometric modeling improve price forecasting accuracy. Extension price forecasters have been shown to be slightly more accurate than USDA forecasters. Forecasters who consider price prediction to be a significant part of their job, and who are focused on a specific commodity, have been shown to be generally more accurate in the area of livestock than casual forecasters. However, neither group predicted prices more accurately for all commodities than futures based price forecasts (Kastens Evaluation).

Futures-based methods have become extremely popular for forecasting slaughter and feeder steer prices. The most basic estimate considers the price of the deferred futures contract, adjusted for historical basis, to be the expected cash price in the future. More complex models attempt to model this relationship in ways that capture some of the basis variability that exists from year to year.

An examination of weekly prices from 1982-1996 in various Midwestern locations considered multiple price prediction models. More complex models were actually found to have the lowest level of pricing accuracy for fed and feeder cattle. The most accurate models involved a futures-plus-basis concept using a five-year weighted average for expected basis. Models that allowed for more flexible basis relationships were not necessarily better than the more basic model, but generally were superior to more complicated approaches (Kastens Futures).

Monthly Cattle on Feed reports, released by the USDA, are known to have clear impact on livestock prices. Their impact is primarily seen in live cattle futures markets and it tends to be unanticipated information that has the greatest potential effect. On occasions where the USDA report differs significantly from pre-report survey estimates, futures markets respond to this new information.

For deferred futures contracts, prices have been shown to be affected by both placements and marketings. For near term contracts, prices are only affected by marketings. There is little evidence to support industry concerns that pre-release estimates disrupt the market. However, there was some evidence that prices sometimes over-reacted to unanticipated information on the first day following receipt of the unanticipated information (Grunewald).

Lack of sufficient data to make price predictions is often seen as a challenge faced by the livestock price forecaster. However, even as data availability has improved, only moderate improvements have been made in forecasting accuracy. In 1996, the USDA began reporting cattle-on-feed numbers by various weight groups. It was theorized that this change would work to improve price forecasting accuracy because fed cattle marketings are the most important determinant of fed cattle prices. Without understanding the number of cattle within each weight range, it was difficult to predict the level of fed cattle marketings accurately for a given time period.

The availability of placement weight marketing figures was found to improve marketing forecasts one month ahead, but not over longer time horizons. Placement weight data were not found to be helpful in predicting prices or making price risk management decisions. Due to the short-run benefit of placement weight information, it was considered to be primarily of benefit to feedlots and packers as they attempt to better manage their inventories (Norwood).

Spatial price relationships are also known to exist in livestock markets. These relationships were examined between 28 slaughter plants in 1997. In order to do this, a daily price series was estimated for each of the 28 plants. A hedonic model, using cash market transactions, was used to estimate the expected price each day for a pen of cattle given their various characteristics. The model has clear implications on the pricing patterns of finished cattle.

Heifers were found to be valued at a slight discount to steers, while mixed groups of cattle were valued at a slightly greater discount than heifers. Groups of Holstein steers were associated with discounts of more than \$6.00 per hundredweight under the associated steer price. Also of interest to Holstein industry stakeholders, results suggested that fed cattle prices declined at an increasing rate as carcass weight increased.

A daily carcass beef price was estimated for each plant using the hedonic method. This price was based on a 150 head pen of steers, grading 60% Choice or better, 95% yield grade 1-3's, and an average hot carcass weight of 730 pounds. The average quality adjusted price became the average price paid by that plant on that given day.

Nebraska plants were found to be the price leaders in livestock markets; plants in Texas and Kansas followed prices discovered in Nebraska. About one-third of the deviations from spatial price equilibrium were corrected within one day. Plants in Texas and Kansas reacted

even quicker than this. As expected, plants closer to one another reacted quicker to each others' price movements as do plants operated by the same firm (Schroeder 1997).

Much can also be learned about fed cattle prices by examining pricing impacts on feeder cattle. Both are margin businesses with similar economies and inputs to production. Expected fat cattle prices are a key component to feeder cattle prices in much the same way that boxed beef price is a component of fat cattle prices. Typically, lighter cattle bring more money on a per pound basis. This occurs because the cost of gain is generally less than the value of the additional weight for feeder calves. A "price slide" refers to the relationship between the weight of the animal and its price. Price slides are almost always negative, which reflects the expected cost of gain relative to the expected value of that gain for animals of different weights.

Price slides have been shown to change with market conditions. Data collected from feeder calf sales in Dodge City, Kansas from 1987 through 1996 were examined to determine the extent to which price slides change given market conditions. It was learned that during times of lower corn prices, feeder calf prices per hundredweight declined more rapidly as feeder calf weight increased. Furthermore, price slides at the margin were much wider when examining light feeder calves (500 lbs) than heavy feeder calves (800 lbs).

While corn price affects the cost of finishing cattle, fed cattle prices affect the expected selling price of finished cattle. This, in turn, can affect feeder cattle price spreads. Lower fed cattle prices tend to decrease the price spreads between feeder cattle at various weights. As with increasing corn prices, decreasing fed cattle prices cause price slides to decrease at the margin. This is especially true of light feeder cattle. Variability in corn price and expected fed cattle price were not found to significantly affect feeder cattle price slides (Dhuyvetter).

Price risk is not limited to the beef industry. Like beef cattle producers, hog producers face highly variable prices due to fluctuations in supply and demand. If hog prices could be forecast with reasonable accuracy, producers could adjust their production and marketing strategies accordingly.

Theory suggests that hog producers purchase feeder pigs based on expected demand at the end of the three to four month feeding period and that these demand expectations should be unbiased over time. Therefore, piglet price should be an unbiased estimate of future hog prices with unsystematic errors. However, price prediction models including lagged feeder hog, feeder pig, and feed prices were only found to be slightly more accurate in predicting hog prices in

Nordic markets than a NAÏVE model explaining future hog price as a function of current hog price plus an unsystematic component.

However, the autoregressive models were found to forecast the direction of price movements better than the NAÏVE model. In many situations, actions based on a lower mean square error, but an inaccurate price direction could cost producers more money than acting on a less accurate estimate in the correct direction (Gjolberg). This is especially true when considering the implications for price risk management through the futures market.

Composite forecasts have also been considered in hog price forecasting. A composite forecast was derived by combining the predictions of an econometric model, an empirical model, and a set of expert forecasts and comparing the composite forecast to each of the three individual forecasts. The econometric model considered hog price to be a function of the number of sows in ten states, commercial cattle slaughter, the number of broiler eggs hatched, pork cold storage, and household disposable income. The empirical model used only past hog price data to forecast future prices. The final estimate used was a set of expert forecasts made by Glenn Grimes and Ron Plain.

The composite forecast was compared to the three individual forecasts from 1981 to 1992. An auxiliary logit model was used to derive the composite weights for the models based on the probability that a particular forecast would be correct. The composite forecast was found to accurately predict the direction of price movement over 77% of the time. This was better than any of the three models individually. This work was especially interesting because little actual data or knowledge of forecasting is needed to construct a model such as this and yet model accuracy was quite high (Dorfman).

Additional insight into price determination can be gained from work examining live cattle basis. Basis is the difference in live cattle futures prices and live cash prices. Many of the same factors that affect basis also affect overall price levels. Both fundamental market factors and seasonality have been shown to effect live cattle basis.

An examination of monthly data from January 1990 to July 1997 in Colorado, Kansas, and Texas revealed that commonly known demand shifters, such as prices of substitutes and per capita income, were not affecting basis in any of the three locations. Captive supplies and cold storage were also found to be largely insignificant across locations.

The corn futures price, Choice-Select price spread, and monthly seasonality variables were found to have robust effects across locations. Increases in corn price were associated with a weakening of the basis, while increases in the Choice-Select Price spread were associated with a strengthening of the basis. April and May were associated with narrowing of the basis while the months of July through September were associated with widening of the basis. These seasonal patterns were found to correspond to production levels (Parcel 2000).

Studies Specific to the Holstein Beef Market

Although little work has been done in the area of Holstein steer price analysis specifically, knowledge does exist in the area of Holstein basis. Knowledge of Holstein basis, combined with what is known about native cattle prices can be very useful as one tries to understand movements of Holstein prices. Empirical analysis of Holstein steer basis revealed a great deal of variation relative to levels of variation in native cattle basis. Holstein basis tends to be at its narrowest in May and reaches its widest point during the winter. Holstein basis also tends to widen as native cattle prices increase and basis decreases as native cattle prices decrease (Holt).

Feedlots across the United States are learning to use the futures market to manage price risk for finished cattle. However, there is only one futures contract that is traded for finished cattle, the CME Live Cattle Futures. Since increased volatility exists in basis for Holstein steers, it was not clear that Holstein feedlot operators would be able to successfully utilize futures contracts due to the differences between Holstein steers and native steers.

Brian Buhr examined this question in a 1996 article in the Review of Agricultural Economics. He examined weekly prices for both Holstein steers and native steers in two weight ranges, 1100 to 1300 pounds, and 1300 to 1500 pounds. Data were collected from three locations, South St. Paul Stockyards, Iowa Southern Minnesota Direct, and Sioux City, IA for both Choice and Select grade carcasses.

Buhr used the Generalized Least Squares method to estimate hedge ratios for Holstein and native steers using the following equation, $C_t = \alpha_0 + \beta_1 L_t + \varepsilon_t$. In this equation, C_t refers to the cash price of Holstein or colored steers at time t , α_0 is the regression intercept, β_1 is the hedge ratio, L is the nearby live cattle futures price, and ε_t is the random error term. All hedge ratio estimates were found to be significantly different from zero and more importantly, all hedge

ratios estimated for Holstein Steers were found to be statistically equal to one. These results indicated the existence of an efficient hedging opportunity.

Buhr also wanted to compare hedging risk between Holstein steers and non-dairy steers to determine if risk levels are elevated for Holstein cross-hedging. Results suggested that no increased hedging risk existed for Holstein steers as compared to traditional beef steers except during the month of August. The author was also concerned about the fact that Holsteins are more likely to grade Select rather than Choice. Buhr found that no increased hedging risk existed for Holstein or non-dairy steers that did not reach the choice grade, but cautioned that increased risk may exist when comparing Select Holsteins to non-dairy steers that did grade Choice (Buhr 1996).

Buhr's findings are taken to suggest that many of these same factors that affect prices in native cattle markets are also active in Holstein markets. Although clear differences exist between Holsteins and natives, the driving forces in the two markets are similar. Findings from research discussed in this section were very helpful in setting up the econometric models that were used to explore the Holstein market in greater detail.

CHAPTER FOUR

DATA AND METHODOLOGY

Econometric models are often used to test hypotheses and examine price relationships in livestock markets. Much of what has been learned about how cattle markets move has been learned through the use of econometric modeling. When used appropriately, econometrics can confirm trends and patterns in markets where complexity seems too much to overcome. Discussion of previous work in this area was included in Chapter 3. The econometric modeling employed in this analysis is used to examine the price relationships that exist in the market for finished Holstein steers and Holstein feeder steers.

The primary objective of the analysis is to determine what factors drive the market and affect the prices of finished Holstein steers and different types of Holstein feeder steers. By examining finished Holstein prices, it can be determined whether perceptions of Holstein beef are accurate. For example, the perception that the Holstein beef market is primarily a ground beef market is inconsistent with what was learned in conducting interviews with individuals within the sector. An econometric model will allow this to be more thoroughly examined.

Similar analysis can be performed on Holstein feeder steer prices. Analysis should reveal whether the market for Holstein feeder steers is driven by the same factors as the market for native feeder steers as discovered in previous work. Also, the analysis will allow for examination of the impact of the shift towards a calf-fed production model. Examining price relationships for Holstein feeder calves of various ages should yield insight into this fundamental change in production system. It is quite possible that the market for heavier feeder steers has changed dramatically as the Holstein sector has moved towards the calf-fed model.

Finally, by examining price relationships in the Holstein sector, differences should start to emerge between the market for Holsteins and the market for native cattle. Since much is known about factors that drive the market for native cattle, the results from this analysis can be compared to previous work. At the conclusion of the study, the reader should have a clearer understanding of why it was necessary to examine the Holstein sector in and of itself.

Model Specification

Since little work has been conducted examining the Holstein beef market specifically, model specifications are based on two primary sources of information. The first, and primary source, were semi-structured interviews of individuals who worked within the Holstein sector. These contacts included backgrounders, feedlot operators, managers of packing plants, and buyers of Holstein steers. Some interviews were conducted by telephone, while key interviews were made in person.

Interviewees were told about the project and asked about the role of Holstein beef in their marketing plan. They were also asked about factors that drive the market for Holstein beef and how those factors might affect the price discovery process. Finally, they were engaged in specific discussion of the shift to calf-fed production and how that has affected their company and the overall sector. Although questions were planned beforehand, considerable latitude was given to ensure that the individual stakeholder was driving the conversation.

Personal interviews were supplemented through qualitative literature review on the basic production and marketing aspects of the Holstein sector. This review primarily consisted of extension publications and industry articles that were written for a non-technical audience. Many of these findings are discussed in Chapter 2 as the individual industries within the Holstein sector are described.

A common theme that surfaced through conversations with buyers inside the Holstein sector was that the Holstein market was driven largely by the market for native cattle. Therefore, the second information source for model specification was previous price analysis work conducted in the native cattle markets. It was hypothesized that many of the same factors would be important, although their impacts could be different when considering their effect on the Holstein market. Discussion of price analysis for native cattle is presented in Chapter 3.

After reviewing previous work and discussing model specification with decision makers inside the Holstein sector, the following models of the Holstein beef market were developed.

$$P_{Hfat} = f(P_{CHcut}, Prime, P_{drop}, P_{trim}, market\ structure, seasonality) \text{ and}$$

$$P_{Hfeeder} = f(P_{fut6}, CH/Sel, P_{corn}, P_{trim}, market\ structure, seasonality)$$

where P_{Hfat} is the price of finished Holstein steers and $P_{Hfeeder}$ is the price of Holstein feeder steers. P_{CHcut} refers to the cutout value of Choice beef carcasses, P_{fut6} refers to the price of the fat cattle futures contract six months into the future, $Prime$ refers to the average premium received

for carcasses grading Prime, Ch/Sel represents the Choice / Select price spread, P_{drop} is the drop value (hide and offal) from a beef carcass, P_{trim} represents the price of beef trimmings, and P_{corn} represents the price of corn. *Market Structure* is intended to capture consolidation in the packing industry or major changes in production model such as the shift to the calf-fed program. *Seasonality* is intended to capture the seasonal effects that exist in beef markets.

Data Sources and Expectations

Data for the analysis were obtained from several sources. Price data for finished Holstein steers (P_{Hfat}) was available through the USDA Market News Service in St. Paul, Minnesota. The service was able to provide weekly prices for finished Holstein steers at the South St. Paul auction market. This data was available beginning in January of 1995 and continuing into 2003. Price data was available for two weight groups of Holstein steers, 1100-1300 pounds and 1300-1500 pounds.

The dataset for the heavier steers was more complete and is used in this analysis. The 1100-1300 pound weight group was also suspect following conversations with industry stakeholders. It was discussed that Holstein cattle in that weight range are not likely to have truly reached their physiological endpoint so prices could be difficult to analyze.

Unfortunately, data on the number of head marketed each week was not collected by the Market News Service. Therefore, demand models could not be generated. Rather, the analysis examines the price relationships that exist within the market to determine which factors may be working to affect prices.

Weekly price data for Holstein feeder steers were not available for the same auction market. However, weekly Holstein feeder steer prices were available for the Lexington, KY market. These prices are collected and compiled by the Kentucky Department of Agriculture in their weekly Kentucky Livestock and Grain Market Report. Price data from this report is available from 1993 through 2003. As with the data collected from St. Paul, the number of head sold each week was not available. Therefore, models are examining price relationships in Holstein markets rather than actual demand for Holstein feeder steers.

The price of the Choice cutout (P_{CHcut}) was available through the livestock marketing information center. It was available on a weekly basis for carcasses ranging from 750 to 900 pounds in Dodge City, KS. The Choice cutout represents the price that processors receive for the

composite of cuts from a beef carcass. It is the best estimate available for the expected revenues received from a processed steer, which clearly affects the prices meat processors are willing to pay for slaughter steers. It was hypothesized that as the price of the Choice cutout increased the prices paid for slaughter Holsteins would increase as well.

P_{drop} refers to the value per cwt. of the hide, offal, and byproducts from a beef carcass. This value is reported on a daily basis by the USDA and is databased by the Livestock Marketing Information Center. This “drop value”, as it is often called, is the second element in the revenue stream for beef packers. Therefore, it should also affect their bids for finished steers. The hides from Holstein steers are more valuable than hides from native steers (Van Lannen). So, it is expected that the prices received for Holstein slaughter steers may be affected differently by this factor than the prices received for native steers. It is assumed that this relationship would be positive, as the drop value increases, the prices paid for finished Holstein steers would also increase.

P_{trim} is used to express the wholesale price of 85% beef trimmings as reported by the USDA in their weekly Carlot Report. P_{trim} is available on a weekly basis from the Livestock Marketing Information Center. A sizeable percentage of the typical beef carcass goes into ground beef. This variable is included to explore the perception that the Holstein beef market is driven by ground beef. After conversations with industry stakeholders, a strong relationship between trim price and the price of Holstein steers is not expected.

P_{fut6} refers to the price of the fat cattle futures contract 6 months in advance. It is included in the feeder cattle price model to capture the expected price for finished cattle at the time the feeder steers will reach the market, assuming a 180 day feeding period. This is a key factor in determining the bids made for feeder cattle. It is available on a weekly basis from the Chicago Merchantile Exchange and warehoused by the Livestock Marketing Information Center. Again, a positive relationship is expected as increases in expected future slaughter cattle prices should translate to higher bids for feeder cattle.

P_{corn} is the price of corn reported in Chicago for the given week. Corn prices were also available through the livestock marketing information center. Corn is the primary input to a cattle finishing enterprise and is expected to greatly affect the prices paid for feeder cattle. As corn prices increase, the expected profitability of finishing cattle decreases. Lower profitability expectations should result in lower bids for feeder cattle.

Prime refers to the average premium paid for cattle grading USDA Prime. This number is reported weekly by the USDA in their report “National Weekly Direct Slaughter Cattle – Premiums and Discounts”. In discussions with industry leaders, it was learned that Holstein steers produce more Prime carcasses than native cattle. Therefore, the Prime premium level is included to represent the market reward to higher quality grades. It was hypothesized that the price of finished Holsteins would move in the same direction as the premium paid for Prime carcasses.

CH/Sel represents the price differential that exists in the market between Choice carcasses and Select carcasses. This variable is another measure of the market reward to quality. *CH/Sel* is included in the feeder calf models because it is a figure more readily attainable by cow-calf producers and backgrounders removed from the cattle finishing business. The relationship is hypothesized to be negative, in that, as the discount for Select cattle becomes more severe, the prices paid for Holstein feeder steers is expected to increase. This is expected to be especially true for heavy Holstein feeder steers.

Seasonality is included to capture seasonal impacts on Holstein prices. Seasonal effects exist in most all native cattle markets and are expected to exist in Holstein beef markets as well. Seasonality is usually a result of demand and supply changes at different times of the year. In the model, seasonal effects are captured using binomial variables for summer, spring, and fall. Results are interpreted relative to the winter market which is the base for the model.

Market Structure is included to capture the effect of consolidation and ownership in the beef sector. Variables to capture market structure have been included in previous pricing models (Ward and Koontz). Specifically, in this model, it is used to capture the effect of the merger between Smithfield Foods and Packerland Packing. This merger not only affected market shares in the Holstein sector, but also represented a shift from the traditionally fed Holstein steers to calf-fed Holstein steers for a significant portion of the market. Packerland had always been a major buyer of Holstein steers and when Smithfield took over operations in October 2001, they stopped buying traditionally fed Holsteins all together. It was shown in previous work to have had an effect on the price of Holstein feeder steers in Kentucky (Burdine).

Market structure effects are again captured through the use of binomial variables. The merger between Smithfield and Packerland was finalized on October 25, 2001. A dummy variable is used to capture the effects of all observations following that date. A second binomial

variable is use to represent the time period between September 11, 2001 and the merger between Smithfield and Packerland. This is done to separate the effects of the terrorist attacks on the world trade center and the merger, since they occurred within six weeks of each other and are hypothesized to have similar effects.

Empirical Models

The analyses were conducted using weekly data obtained through the sources discussed in this chapter. Data for the Choice/Select spread and the premium level associated with Prime carcasses was not available until November 1996. Therefore, the time period examined in this analysis is from November 7, 1996 through July 24, 2003. The following five empirical equations were estimated using an OLS regression in SAS.

- 1) $P_{Hfat} = f(P_{CHcut}, Prime, P_{drop}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall),$
- 2) $P_{H34} = f(P_{fut6}, CH/Sel, P_{corn}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall),$
- 3) $P_{H45} = f(P_{fut6}, CH/Sel, P_{corn}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall),$
- 4) $P_{H78} = f(P_{fut6}, CH/Sel, P_{corn}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall) \text{ and}$
- 5) $P_{H8up} = f(P_{fut6}, CH/Sel, P_{corn}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall),$

where P_{Hfat} refers to the price of 1300 lb. to 1500 pound Holstein slaughter steers at South St. Paul, MN and P_{H34} , P_{H45} , P_{H78} , P_{H8up} refers to the price of 300 to 400 pound, 400 to 500 pound, 700 to 800 pound and 800 pounds and above Holstein feeder steers at Bluegrass Stockyards in Lexington, KY.

$Terr$ is a binomial variable representing the time period between September 11, 2001 and October 25, 2001, $smpac$ is a binomial variable representing the time after October 25, 2001. $Summer$ is a binomial variable representing the months of June, July, and August, $spring$ is a binomial variable representing the months of March, April, and May, and $fall$ is a binomial variable representing the months of September, October, and November. Descriptive statistics for all data used in equations (1) through (5) are provided in Table 4.1

Equation (1) provides the opportunity to examine the market for finished Holstein steers. Equations (2) and (3) allow for examination of light Holstein feeder calves between 300 and 500 pounds. These calves could be placed directly on feed in a calf-fed system or they could be placed on grass and backgrounded for a period of several months. Finally, equations (4) and (5) explore the market for the traditional heavy Holstein feeder steers. These steers are ready to be

placed on feed and finished to heavy weights. Results from each of these regression equations will be discussed in Chapter 5. Table 4.2 shows each model and describes the expected sign of the parameter estimates on each explanatory variable.

Table 4.1. Descriptive Statistics: Dependent and Explanatory Variables

Variable	Mean	St. Deviation	Low	High
P _{Hfat} (a)	\$61.78	5.0949	\$51.78	\$75.60
P _{H34} (a)	\$68.02	17.9827	\$28.00	\$101.38
P _{H45} (a)	\$64.96	16.1820	\$28.00	\$96.75
P _{H78} (a)	\$56.56	11.7554	\$27.90	\$78.00
P _{H8up} (a)	\$54.98	10.3751	\$28.50	\$75.45
P _{CHcut} (a)	\$110.78	11.1068	\$91.61	\$149.81
P _{fut6} (a)	\$68.83	4.3131	\$60.50	\$83.26
P _{trim} (a)	\$90.28	12.2208	\$65.00	\$122.31
CH/SeI (a)	\$10.67	4.0952	\$4.00	\$21.00
Prime (a)	\$5.55	0.6218	\$3.69	\$7.91
P _{drop} (a)	\$8.06	0.9296	\$6.28	\$10.10
P _{corn} (b)	\$2.48	0.7194	\$1.68	\$5.23
Terr (c)	0.0134	0.1152	0	1
mpac (c)	0.2058	0.4048	0	1
fall (c)	0.2174	0.4129	0	1
spring (c)	0.2723	0.4457	0	1
summer (c)	0.2586	0.4384	0	1

(a) values expressed in dollars per hundredweight

(b) values expressed in dollars per bushel

(c) binomial variable of value 0 or 1

Table 4.2. Expected Sign of Parameter Estimates by Model

	Dependent Variables				
	P_{Hfat}	P_{H34}	P_{H45}	P_{H78}	P_{H8up}
P_{CHcut}	positive	-----	-----	-----	-----
P_{fut6}	-----	positive	positive	positive	positive
P_{trim}	positive	positive	positive	positive	positive
CH/Sel	-----	positive	positive	positive	positive
Prime	positive	-----	-----	-----	-----
P_{drop}	positive	-----	-----	-----	-----
P_{corn}	-----	negative	negative	negative	negative
terr	negative	negative	negative	negative	negative
smpac	negative	negative	negative	negative	negative
fall	positive	negative	negative	negative	negative
spring	negative	positive	positive	positive	positive
summer	negative	positive	positive	positive	positive

CHAPTER FIVE

DIAGNOSTICS AND RESULTS

Diagnostics

Data were analyzed using SAS Statistical Analysis Software. Before data could be examined using statistical methods, numerous diagnostic tests were employed. The purpose of these tests was to determine if the assumptions associated with the Ordinary Least Squares Method (OLS) held for the dataset. In order to use the OLS method, all assumptions must hold or results can not be assumed unbiased and efficient.

Errors estimated in equations (1) through (5) were found to be normally distributed with mean zero, a key assumption of the OLS model. This was learned through the application of a Chi-squared test. Further, Variance Inflation statistics did not suggest the presence of severe multi-collinearity. Multi-collinearity exists when two or more of the dependent variables are linearly related to one another.

Secondly, a RESET test was performed to determine if a linear model was appropriate. The models failed the RESET test, which suggested that either a linear model was inappropriate or that a key explanatory variable was missing from the equations. Two alternative models were considered, a log-linear model and a double log model, but neither improved the test statistic. Alternative specifications for explanatory variables were also considered such as squared and cubed terms, but were not found to be helpful. Therefore, it was assumed that the RESET test was most likely suggesting omitted variable bias. However, all available variables with theoretical justification were included. It was assumed that the lack of quantity numbers at each weekly sale could be causing this problem. Since the R^2 values on each model were seventy-five percent or greater, analysis went forward despite this potential problem.

Data were found to be auto-correlated through the use of a Durbin-Watson test. Auto-correlation is a common problem among time series data that exists when errors from one time period are related to errors in another time period. All five models exhibited first order autocorrelation and this was corrected in each model by using a first order lag variable of the disturbances. Once this was done, Durbin-Watson statistics were found to be within acceptable ranges for all five models and analysis was able to proceed.

Next, data was examined for possible heteroskedasticity. This was done by saving the residuals from each model and using OLS to regress them against the explanatory variables for that model. In all five cases, the F-statistics were less than one, which indicated that none of the explanatory variables were explaining any variation in the models' residuals. The assumption of Homoskedasticity was determined to hold and no corrective action was needed.

Finally, data was tested for stationarity. This was achieved by using a Dickey-Fuller Unit Root Test. Results of this test indicated possible nonstationarity and the first differencing procedure was implemented to correct this problem. However, results and predictive power of the model were greatly affected by the first differencing process. Many variables with good theoretical reasons for inclusion became insignificant, correlation coefficients became lower, and in some cases, signs on parameter estimates changed.

Since the actual effect of violating the stationarity assumption is unknown, often times the corrective procedure is more harmful than the implications of allowing the problem to exist. Therefore, it was decided not to correct for the problem, but rather to recognize the potential bias as the analysis proceeded. With this in mind, OLS was used to estimate equations (1) through (5) as presented in Chapter 4.

Regression Results

Equation one examined price relationships in the market for finished Holstein steers at South St. Paul in the 1300 to 1500 pound weight range, (1) $P_{Hfat} = f(P_{CHcut}, Prime, P_{drop}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall)$. The explanatory power of this model was quite high, with a coefficient of determination exceeding 95%. Four explanatory variables, plus an intercept term, were found to have a significant relationship with finished Holstein prices at South St. Paul.

The model intercept was found to be significant with a parameter estimate of 9.64, which can be thought of as \$9.64 per hundredweight. Choice cutout value, Prime premium, and byproduct value were all found to have a significant positive relationship with finished Holstein price. A one dollar per hundredweight increase in the Choice cutout price was associated with a \$0.30 per cwt. increase in the price of finished Holsteins. This relationship was found to be significant at the 99% confidence level and was consistent with pre-regression hypothesis.

The premium level associated with Prime carcasses was also found to be significant at the 95% confidence level. This was consistent with the hypothesis developed from conversations with industry leaders. A \$1 increase in the Premium received for Prime carcasses was associated with an increase in the slaughter Holstein price of \$0.49 per cwt. This was taken as some evidence that buyers of Holstein steers acknowledge the fact the Holstein steers will likely produce more Prime carcasses and are bidding on these steers accordingly.

The drop, or byproduct value, was also found to be significantly related to the price of Holstein slaughter steers. The relationship was significant at the 99% confidence level, consistent with hypotheses. An increase in the USDA reported “drop” value by one dollar was associated with an increase in the price of Holstein slaughter steers of \$2.08 per hundredweight.

The last explanatory variable of significance in this equation was the binomial variable used to account for the time period following the merger of Smithfield and Packerland. This variable was found to have a significant relationship at the 95% confidence level. The time period following the merger was associated with a decrease in the price of Holstein slaughter steers of \$1.29 per cwt.

The wholesale price of 85% trim reported by USDA was not found to have a significant relationship with Holstein steers prices. This was the only continuous variable that was found to be insignificant. Also insignificant were binomial variables used to account for seasonality and the September 11th terrorist attacks on the World Trade Center and the Pentagon (Table 5.1).

Equation two examined the price relationships that exist in the market for Holstein feeder steer prices in Lexington, KY in the 300 to 400 pound weight range, (2) $P_{H34} = f(P_{fut6}, CH/Sel, P_{corn}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall)$. The R^2 for equation two was also high at 86.54%. Deferred futures price, corn price, trim price, and seasonality were all found to have a significant relationship with the price of lightweight Holstein feeder steers in Lexington. The intercept was found to be significant at the 99% confidence level and have a value of -40.63.

The six month deferred futures contract was found to be significant at the 99% confidence level. An increase in the futures contract price of \$1 per hundredweight was associated with an increase in the price of 300 to 400 lb. Holstein feeder steers of \$1.99. Trim price was also found to have a significant positive relationship with Holstein feeder steer prices. A \$1 increase in the price of trim was associated with a \$0.19 increase in the price of the feeder calves.

As was expected, corn price exhibited a significant negative relationship with the price of Holstein feeder steers in the 300 to 400 pound weight group. The impact was quite large as an increase in corn price by ten cents per bushel was associated with a decrease in the 300 to 400 pound Holstein feeder steer price of \$1.95 per hundredweight. This speaks to the importance of corn prices on the profitability of feeding cattle.

Seasonal variables also were helpful in explaining variation in 300 to 400 pound Holstein feeder steer prices. Winter was the base for the model; summer and fall were not found to be associated with significantly different price levels than winter. However, the spring months of March, April, and May, were associated with higher prices levels by more than \$4 per hundredweight. This relationship was significant at the 95% confidence level.

Contrary to hypotheses, the level of the Choice / Select price spread was not found to be statistically related to the price of 300 to 400 pound Holstein feeder steers in Lexington, KY. The weeks following the September 11, 2001 terrorist attack and the weeks following the merger of Smithfield and Packerland were not found to be helpful in explaining variation in the feeder calf prices either (Table 5.2).

Equation three was the third equation examined, (3) $P_{H45} = f(P_{fut6}, CH/SEL, P_{corn}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall)$. The price of feeder steers between 400 and 500 pounds was explained quite well by this equation. The coefficient of determination was nearly 90% and most explanatory variables were found to be significant. Again, the intercept term was significantly negative at a value of -32.47.

Deferred futures price and trim price were both found to have a significant positive relationship with 400 to 500 pound feeder steer prices. An increase in the deferred futures contract price of \$1 per cwt. was associated with an increase in the price of 400 to 500 pound feeder steers of \$1.80 per cwt. An increase in trim price of \$1 per cwt. was associated with an increase in feeder calf price of just under \$0.17 per cwt. Both relationships were significant at the 99% confidence level.

As in the model for 300 to 400 pound steers, the prices of 400 to 500 Holsteins moved in the opposite direction of corn price. An increase in corn price of \$0.10 per bushel was associated with a decrease in 400 to 500 pound Holstein price of \$1.68 per hundredweight. The Choice / Select price spread was also found to have a significantly negative relationship with 400 to 500 pound Holstein price. An increase in the Choice / Select spread of \$1 per hundredweight was

associated with a decrease in the price of 400 to 500 pound Holstein by \$0.35. Both of these findings were significant at the 99% confidence level. The negative estimate on the Choice / Select price spread was unanticipated. It was hypothesized that as the reward to higher quality increased, the prices paid for Holstein cattle would also increase, with the assumption that Holsteins are more likely to grade Choice than native steers.

Seasonal variables again added to the understanding of the dependent variable. With winter as the base, spring and summer were found to be associated with higher prices, while fall was associated with lower prices. Spring months of March, April, and May were associated with an increase in 400 to 500 pound Holstein prices by \$2.73 per cwt. Summer months of June, July, and August were associated with higher prices by \$3.17. However, spring and summer price differences were not found to be statistically different from each other. Binomial variables *terr* and *smpac* were not found to be helpful in explaining price variation for 400 to 500 pound Holstein feeders. Regression results from equation (3) are reported in Table 5.3.

Equation four, $P_{H78} = f(P_{fut6}, CH/Sel, P_{corn}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall)$, was examined to explain the price variation for Holstein feeder steers between 700 and 800 pounds. Equation (4) was weaker in explanatory power when compared to the first three equations. However, the coefficient of determination was over 79% for the model, which is still relatively strong. The intercept term was again highly significant at a value of -33.06.

The deferred futures price six months into the future was again very helpful in explaining price. An increase in the futures price by one dollar per hundredweight was associated with an increase in 700 to 800 lb. Holstein price by \$1.37 per hundredweight. The price of trim was also important as an increase in trim price by one dollar per hundredweight was associated with an increase in the 700 to 800 pound Holstein price by \$0.16 per cwt. Both relationships were found to be statistically significant at the 99% confidence level.

As expected, corn price was inversely related to the price of 700 to 800 pound Holstein feeder steers in Lexington. As corn price increased by ten cents, the price of Holstein feeders in this weight range fell by \$0.82 per hundredweight. This relationship will also significant at the 99% confidence level and was consistent with equations (2) and (3) for lighter Holstein feeder calves.

Seasonal variables were also significant in explaining variation in heavy Holstein feeder calf prices. Both summer and spring were found to have a significantly positive impact on prices

for 7-8 wts. Summer was associated with an increased price of \$2.40 per hundredweight, while spring was associated with an increased of \$2.29 per hundredweight. Summer and spring impacts were both significant at the 95% confidence level, but were not found to be statistically different from one another. Fall was not found to be statistically different from the winter base.

The variable *terr* was found to be insignificant once again in equation (4). However, *smpac* once again surfaced with a significant negative impact. The weeks following the merger were found to have been associated with lower prices for 700 to 800 pound Holstein feeder steers by \$2.02 per hundredweight. This impact was significant at the 90% confidence level and was consistent with findings in previous work, although the impact was found to be smaller (Burdine). Results from equation (4) are reported in table 5.4.

Finally, equation (5) was estimated in order to explain variation in the price of Holstein feeder steers weighing more than 800 lbs. in Lexington, KY. (5) $P_{H8up} = f(P_{fut6}, CH/Sel, P_{com}, P_{trim}, terr, smpac, summer, spring, \text{ and } fall)$. Explanatory power was similar to equation (4), as R^2 was found to be slightly more than 79%. Consistently, the intercept was significant at the 99% confidence level at a value of -35.99.

Results from equation five were very consistent with results from equation four. This robustness is not surprising since both equations are examining price relationships for heavy backgrounded Holstein steers. Deferred futures price was again highly significant as an increase in the futures contract price of one dollar per cwt. was associated with an increase in the price of Holstein steers above 800 pounds of \$1.45 per cwt. The price of trim was also found to be significant at the 99% confidence level. An increase in trim price of one dollar per hundredweight was associated with an increase in heavy Holstein feeder steer prices of \$0.12 per hundredweight.

Once again, corn price was a significant contributor to understanding the price of these heavy Holsteins. An increase in corn price of ten cents per bushel was associated with a decrease in the price of feeder steers by \$0.83 per cwt. This relationship was significant at the 99% confidence level, and was extremely consistent in magnitude with results from equation four.

Seasonal binomial variables improved the predictive capacity of the model as fall was again found to be associated with significantly lower prices. Holding everything else constant,

prices of Holstein steers weighing more than 800 pounds were \$2.85 lower than in the rest of the year. Spring and summer prices were not found to be statistically different from winter.

As in the model explaining prices for 700 to 800 lb Holstein feeders steers, the September 11, 2001 terrorist attack did not add to understanding. However, the merger between Smithfield and Packerland was once again found to be significant. In equation (5), the time period following the merger was associated with lower Holstein feeder steer prices in the 800 pound and above weight category by \$1.93 per hundredweight. This relationship was significant at the 90% confidence level as was very similar in magnitude to the effect on Holstein steers in the 700 to 800 pound range. These results are reported in Table 5.5.

Sensitivity Analysis

The parameter estimates reported in tables 5.1 to 5.5 can be misleading when trying to understand the impact that certain variables can have on prices levels. The existence of a larger parameter estimate does not necessarily indicate that a particular explanatory variable is likely to have a larger effect on the dependent variable over time. This likelihood and size of the impact depends on how much movement occurs in the level of the explanatory variable. A significant explanatory variable that has a high parameter estimate has the potential to greatly impact the dependent variable. However, if the value of the dependent variable is relatively constant over time, it may be unlikely to have much practical effect.

To better capture the magnitude of impact that explanatory variables are likely to have on Holstein prices, a sensitivity index is used. The index is calculated by multiplying the parameter estimate from the regression equation by the standard deviation of the explanatory variable. A standard deviation is the range in each direction of the mean within which 68% of the observations fall. So, 68% of the time, the value of the explanatory variable will fall within one standard deviation of the mean. By calculating this index, the parameter estimated is scaled to estimate the expected impact on prices from a movement in the explanatory variable by one standard deviation.

Table 5.6 reports these indices for finished Holstein prices; indices are only reported for continuous variables. It is clear that the price of the Choice Cutout is likely to have a larger impact on Holstein steer prices than the Prime premium level and the byproduct value when considering the amount of variability within each variable. A one standard deviation movement

in the Choice cutout value was associated with a movement in steer prices of \$3.28. Single standard deviation movements in the byproduct value and Prime premium level were associated with movement in steer prices of \$1.93 and \$0.30 respectively.

Similar analysis was conducted for light Holsteins and reported in tables 5.7 and 5.8. Corn price was shown to have the largest potential impact on light Holstein feeder prices when examining both 300 to 400 lb steers and 400 to 500 lb steers. Movements in corn price by one standard deviation were associated with opposite price movements of \$14.02 for 300 to 400 lb steers and \$12.11 for 400 to 500 lb steers.

After corn price, deferred futures price was found to have the second largest potential impact. A one standard deviation movement in deferred futures price was associated with a change in 300 to 400 lb feeder steer prices by \$8.57, and a change in 400 to 500 lb feeder steer prices by \$7.76. Trim price was found to have the smallest impact on the two weight groups. Movement in trim price by one standard deviation was associated with movements of \$2.35 per hundredweight for 300 to 400 pound steers and \$2.07 for 400 to 500 pound steers. The Choice / Select spread was not found to be a significant factor explaining both price levels, but a one standard deviation movement in the spread was associated with an opposite movement in the prices of 400 to 500 pound steers of \$1.45.

Indices were also calculated for Holstein feeder steers in the heavier weight categories. These results are shown in tables 5.9 and 5.10. Deferred futures price and corn price showed similar sized impacts on heavy feeder steer prices. The impact of a one standard deviation move in futures price was associated with a movement of \$5.90 per hundredweight in the 700 to 800 pound feeder steer market and \$6.25 per hundredweight in the 800 pound and above market.

Movement in corn price by one standard deviation was associated with a negative movement in 700 to 800 pound steer prices by \$5.91 per cwt. The same movement in corn price was associated with a negative change in the prices of Holstein feeder steers weighing 800 pounds and above by \$5.96 per cwt. The potential impact of trim prices was smaller, but very significant. A single standard deviation change in the level or trim prices was associated with a movement in 700 to 800 lb feeder steer prices by \$2.00 and a \$1.45 per hundredweight movement in the prices of 800 lb and heavier feeder steers.

Table 5.1 Regression Results: Finished Holstein Steers (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	9.6359***	2.9275
P _{CHcut}	0.2957***	0.0218
P _{trim}	0.0065	0.0148
Prime	0.4886**	0.1930
P _{drop}	2.0815***	0.2910
terr	-1.0359	0.9235
smpac	-1.2895**	0.6313
fall	-0.2478	0.4016
spring	-0.2275	0.3862
summer	-0.4391	0.4443
R ²	0.9525	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively

Table 5.2 Regression Results: 300 to 400 lb. Holstein Feeder Steers (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	-40.6317***	14.4920
P _{fut6}	1.9859***	0.2282
P _{trim}	0.1927***	0.0750
CH/Sel	-0.2049	0.1922
P _{corn}	-19.4850***	2.4396
terr	5.5422	4.1743
smpac	0.7066	2.0333
fall	-2.1365	2.0541
spring	4.2539**	1.6898
summer	2.9056	1.9509
R ²	0.8654	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively

Table 5.3 Regression Results: 400 to 500 lb. Holstein Feeder Steers (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	-32.4746***	11.0251
P _{fut6}	1.8001***	0.1649
P _{trim}	0.1697***	0.0537
CH/Sel	-0.3547***	0.1309
P _{corn}	-16.8336***	1.7758
terr	3.1619	2.8807
smpac	1.6037	1.4912
fall	-2.7928*	1.4490
spring	2.7338**	1.2686
summer	3.1723**	1.4568
<u>R²</u>	<u>0.8972</u>	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively

Table 5.4 Regression Results: 700 to 800 lb. Holstein Feeder Steers (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	-33.0601***	7.6254
P _{fut6}	1.3685***	0.1290
P _{trim}	0.1633***	0.0472
CH/Sel	0.0143	0.1006
P _{corn}	-8.2210***	1.2635
terr	1.2517	2.3440
smpac	-2.0189*	1.0294
fall	-1.3825	1.1642
spring	2.2917**	0.9172
summer	2.4035**	1.1058
R ²	0.7935	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively

Table 5.5 Regression Results: 800 lbs. and Above Holstein Feeder Steers (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	-35.9874***	8.1437
P _{fut6}	1.4487***	0.1304
P _{trim}	0.1183**	0.0467
CH/Sel	0.0657	0.1006
P _{corn}	-8.2807***	1.2784
terr	-0.7795	2.3816
smpac	-1.9283*	1.0703
fall	-2.8498**	1.1829
spring	0.1725	0.9820
summer	0.5902	1.0897
<u>R²</u>	<u>0.7922</u>	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively

Table 5.6 Sensitivity Index: Finished Holstein Steers

Variable	Standard Deviation	Impact on P_{Hfat} per cwt
P_{CHcut}	11.1068	\$3.28
Prime	0.6218	\$0.30
P_{drop}	0.9296	\$1.93

Table 5.7 Sensitivity Index: 300 to 400 lb. Holstein Feeder Steers

Variable	Standard Deviation	Impact on P_{H34} per cwt
P_{fut6}	4.3131	\$8.57
P_{trim}	12.2208	\$2.35
P_{corn}	0.7194	(\$14.02)

Table 5.8 Sensitivity Index: 400 to 500 lb. Holstein Feeder Steers

Variable	Standard Deviation	Impact on P_{H45} per cwt
P_{fut6}	4.3131	\$7.76
P_{trim}	12.2208	\$2.07
P_{corn}	0.7194	(\$12.11)
CH/Sel	4.0952	(\$1.45)

Table 5.9 Sensitivity Index: 700 to 800 lb. Holstein Feeder Steers

Variable	Standard Deviation	Impact on P_{H78} per cwt
P_{fut6}	4.3131	\$5.90
P_{trim}	12.2208	\$2.00
P_{corn}	0.7194	(\$5.91)

Table 5.10 Sensitivity Index: 800 lbs. and Above Holstein Feeder Steers

Variable	Standard Deviation	Impact on P_{H8up} per cwt
P_{fut6}	4.3131	\$6.25
P_{trim}	12.2208	\$1.45
P_{corn}	0.7194	(\$5.96)

CHAPTER SIX

CONCLUSIONS, IMPLICATIONS, AND FURTHER WORK

Since the commercialization of the US dairy Industry, beef from Holstein steers has accounted for a significant portion of the total beef supply. However, Holstein steers have been largely overlooked in agricultural economic research. A large number of studies have examined the markets for native beef cattle and have provided much insight into the Holstein sector. Still, little work has focused on the economics and marketing aspects of Holstein steers specifically.

Much of what was written in non-technical publications was contradicted by conversations with stakeholders working within the Holstein sector. This sector analysis was needed to synthesize and report what is known about the Holstein market and to identify these areas of contradiction. The use of econometric modeling was crucial to test many remaining questions and determine what forces are at work in the Holstein markets.

Conclusions

This study found, first and foremost, little evidence to suggest that the market for finished Holstein steers was being driven by the price of ground beef. The persistent perception that middle-meats from Holsteins are removed and the rest of the carcass is ground into hamburger does not appear to be very accurate. Rather, the market for finished Holsteins appears to be primarily driven by boxed beef prices.

If the perception of Holstein steers as a ground beef market were true, one would expect prices for finished steers to move in relation to trim prices. Instead, regression results suggest that trim prices do not affect the sale prices of Holstein slaughter steers, but that a strong relationship exists between the price of Holstein steers and Choice cutout price. Based on these findings, it is unlikely that this long time perception of Holstein beef has been justified.

Additional insight can be gained by considering the relationship that was found to exist between the premium level paid for Prime carcasses and the price of Holstein slaughter steers. The perception that Holsteins produce leaner cuts and a high percentage of Select carcasses is not consistent with econometric results. This perception was again contradicted through personal interviews with industry personnel and tested through econometric modeling.

If the perception were accurate, one would expect buyers to back away from Holsteins as the premium levels for Prime carcasses increased. However, that is not what was found through modeling. The significant positive relationship that was found to exist between the Prime premium level and slaughter Holstein price is an indication that buyers of Holstein steers recognize the fact that Holsteins are more likely to grade Prime and are paying more for them when this premium level is high. Holsteins have suffered from these perception problems for some time and this study has cast doubt on their validity.

Another interesting note from industry personnel interviews involved the value of hide and offal that are byproducts of the slaughter process. Industry leaders suggested that byproduct price is a strong driver of Holstein steer prices because Holstein hides are highly desirable relative to hides from native cattle. This hypothesis was also validated through econometric modeling as a strong relationship was found to exist between byproduct values and slaughter steer prices. However, this impact is relatively small when compared to the impact of cutout. Byproduct prices should be treated as a secondary price determinant, much like the premium level received for Prime carcasses.

Seasonal variation in slaughter cattle markets has been the subject of many studies and is known to exist in the slaughter markets for native cattle. Slaughter cattle prices peak in the spring and usually reach their trough in the fall. Many within the sector may assume that the same seasonal patterns hold for Holsteins. However, there was no evidence to suggest that prices change seasonality in the slaughter Holstein market. Although parameter estimates for Summer, Spring, and Fall were all negative, they were also insignificant and less than \$0.50 per hundredweight in all cases, suggesting that no seasonal patterns exist.

The final point to be made from the finished Holstein results is related to the merger that occurred between Smithfield and Packerland in October of 2001. The weeks following this merger were found to have been associated with lower fed Holstein prices. The average price of a finished Holstein steer in the dataset was \$61.78. Based on parameter estimates, the time period following this merger saw prices more than 2% lower than expected prior to the merger holding the impact all other variables constant. To many casual observers, this suggests the possibility of increased monopsonistic buying power.

In truth, the possibility that this impact was due to increasing consolidation can not be ignored. However, there is another reasonable explanation that could also be extrapolated from

the data. When Smithfield took over Packerland operations, the conglomerate stopped purchasing traditionally fed Holsteins altogether and made a clear shift to purchasing lighter, calf-fed Holsteins. Since the dataset being examined is for Holstein steers between 1300 and 1500 pounds, it is completely possible that the lower prices received after the merger were simply the result of losing a major buyer for cattle in this weight category. Cattle weighing 1300 to 1500 pounds would likely be on the upper-end of the weight spectrum from which Smithfield would be interested following this shift in purchasing patterns.

The examination of the price relationships that exist within the market for Holstein feeder steers identified key price determinants in that market as well. In this discussion, light Holstein feeder steers refers to steers weighing between 300 and 500 pounds. Calves this size could have been placed on grass and backgrounded for a period of time and later sold as heavy feeders. Alternatively, those calves could have been placed directly on feed in a calf-fed finishing program.

Light feeder steer prices appear to be largely driven by corn price and deferred futures price. Corn price is widely known to be a major factor in determining cattle finishing profitability. However, the impact that corn price appeared to have on Holstein calf prices was larger than expected. Holsteins in these weight ranges would mostly likely be on feed more than 250 days if placed into feedlots immediately. Hence, it is not surprising that prices of Holstein calves are highly sensitive to the market for corn.

Similarly to native feeder steers, futures prices appear to be affecting prices paid for feeder calves. Although the impact of futures prices was not as large as the impact of corn prices, it was still very prominent. Bids for Holstein calves are clearly being based on expectations of prices of finished steers. As in the native markets, it appears that these price expectations are largely coming from commodity futures markets.

Outside of corn and futures, 85% trim price may be a good indicator of what to expect from Holstein calf prices. Holstein calf prices appear to move in the same direction as trim. Why this occurs is difficult to rationalize since trim was not found to be a significant factor in determining finished Holstein prices. Trim price is most likely an indicator as to the overall health of the beef sector. This rationalization is supported by the fact that a relatively strong correlation exists between trim price and futures prices.

Seasonal effects are more difficult to sort out in the calf markets, but some seasonal impacts were clearly present. Spring and summer months seemed to be higher priced months and there was moderate evidence that spring prices were slightly higher than prices in the summer. Conversely, fall and winter were associated with lower price levels with some weak evidence that prices for Holstein calves rally from fall levels during the winter months.

There was no evidence to suggest that Holstein calf prices became lower following the Smithfield / Packerland merger. This sheds doubt on the thought that this union was putting downward pressure on Holstein prices by itself. Rather, it supports the argument that the decline in fed Holstein prices was more a consequence of an industry shift towards calf-fed steers. Hence, prices of calves that were not backgrounded were unaffected.

The market for heavier Holstein feeders is an interesting market to evaluate. The movement towards calf-fed steers has limited the options available for these feeder steers. Much of this is substantiated in these findings. Comparisons of these findings with those from the Holstein calf market provide some clear insight as to how the two markets differ.

The most glaring difference in the two markets is associated with the impact that corn price seemed to have on market prices. A great deal of evidence was found to suggest that corn price was a key price determinant in both markets. However, the magnitude of the effect corn price seemed to have on the two markets was vastly different. Whereas the effect of corn price dwarfed the impact of futures in the Holstein calf market, the potential impacts from the two factors were similar in the heavy Holstein feeder calf market. Results suggested that changes in futures prices of reasonable magnitude led to changes in price levels similar to corn price impacts.

It makes intuitive sense that the impact of changes in corn price is smaller for the backgrounded steers than for Holstein calves. It was discussed earlier how long feeding periods can be for calves placed directly on feed. Feeding periods for backgrounded Holsteins are shorter and less corn is needed for them to reach finished weights.

Less difference was suggested in the movements of Holstein prices in response to changes in deferred futures price. However, there was fairly strong evidence to suggest that heavier feeder calves are less sensitive to those changes. Shorter anticipated feeding periods mean less risk and increased likelihood of profit. Like in the market for Holstein calves, there was evidence that trim price may serve as a market indicator.

Seasonality effects on heavy Holstein prices appeared to be quite similar to those effects on Holstein calves. Results suggested that prices reach their lowest levels in the fall. There was some evidence indicating that winter prices rally from fall levels. As in the market for calves, there was moderate evidence indicating that price levels are at their highest during Spring and Summer.

Implications

Overall, the Holstein sector was not found to be greatly different than the traditional beef sector. Production and marketing differences clearly exist, but the same factors appear to be present in both systems. Holstein beef is being used to fill market needs that native beef cannot readily fill. At the same time, marketers of Holstein beef are finding ways to stay competitive in markets that are typically dominated by native cattle. As individuals within the Holstein sector move forward the results of this study should prove useful.

The market for Holstein steers is not a ground beef market. Holstein beef that is processed into ground beef primarily comes from cull cow and bulls, much like the native markets. Holstein steers are fabricated in the same way as native cattle. Separate markets for their products exist due to quality differences and differences in the size of middle-meat cuts.

The shift towards the calf-fed model has affected the industry as one would expect. Heavy Holstein steers are being discounted on the market as a result of this change. Light Holstein calf prices have been largely unaffected. Concerns by individuals within the industry that consolidation was affecting these prices appear to be oversimplified. As market preferences change, cattle that do not meet the desire of the market will suffer market consequences.

Backgrounders and finishers of heavy Holstein calves must realize first and foremost that they are operating within an industry that is quickly shrinking. Although there will probably always be a market for traditionally fed Holstein steers, it is unlikely that the shift towards the calf-fed model will slow any time soon. If the West Coast model is indeed a model for the future, the calf-fed system may soon dominate Holstein production in the East. Since the market for traditionally fed Holstein steers is heavily dependent on exports, backgrounders must understand the volatility that is likely to exist.

It was shown following the finding of BSE in Canada that Asian consumers have high food safety standards and will quickly change their purchasing behavior when food safety

appears to have been threatened. It is possible that, in the near future, the United States will have to meet additional food safety standards to serve this market. Items such as vaccines, hormones, and byproduct feeds could all be on the horizon as potential targets. The export market is vital to the survival of the traditional system and those individuals who produce these types of cattle must keep these factors in mind.

Outside of macro-economic factors, the usual market indicators of corn price and futures prices serve as good indicators of market direction. However, by-product values and market premiums were also shown to be significant. Although the effect of movement in by-product value and premium levels are likely to be smaller than traditional indicators, these factors are unique to the Holstein market and may provide more insight into how the Holstein market will respond to market conditions relative to the market for native steers.

Producers of starter calves and calf finishers are in a slightly different market environment. Fortunately, they are most likely operating within a market segment that will continue to grow. It is likely that Smithfield will attempt to put a vertically coordinated system in place on the east coast similar to what has been done on the west coast.

The negative aspect of the calf-fed market is that it is very sensitive to factors that affect cattle markets in general. Since calf-fed Holsteins are on feed for a longer period of time and more corn is needed to finish them, market effects seem to be amplified. An incremental increase in corn price or decrease in deferred futures price will have a dramatic effect on Holstein calves whereas the effect on heavier steers would be moderate. The market for light Holstein calves is mostly susceptible to changes in traditionally important market factors, while the market for heavy Holstein feeder steers is probably more susceptible to changes in market structure and consumer preferences.

Further Work

As mentioned early in this study, very little economic work has been focused on the Holstein beef market. Although much was learned through this work, additional study is needed to aid in the understanding of the sector. The qualitative portion of this study was quite extensive; most of the major packers in the Holstein steer market were contacted and several were met with in person. Given the focus of this study, visiting with these individuals was sufficient. Future work might involve expanding these discussions to include companies who are

active in the Holstein cow and bull markets. This work showed differences in markets for meat from Holstein steers and native steers. It would be interesting to determine if similar market differences exist in cow and bull markets.

Secondly, it would be useful to better understand how Holstein beef fits into the marketing plans of companies that are primarily operating in native cattle markets. These companies are active in the Holstein slaughter industry, but their activity appears to be more erratic. There was some indication that larger packers purchase more Holsteins when the native cattle markets get very strong. Learning more about when and why major meat packers reach into the Holstein steer market would add another layer of understanding to the puzzle.

In terms of the econometric model, improvement could be made if improved data sources could be identified. The most glaring need would be for weekly price data to be accompanied by quantity data. While this study has laid the groundwork, a logical next step would be to develop demand equations for Holstein steers. Given the difficulty locating these data from auction market, the cooperative of a meat packer might be essential to make this possible.

Perhaps the largest contribution made by this analysis was the way it evaluated the reasons behind, and the impact of, the shift from traditionally heavy Holsteins to calf-fed Holsteins. Multiple sets of price data for Holstein feeder steers allowed for examination of feeder calves prepared to enter into each system. However, slaughter steer price data did not offer this luxury. If it were possible to obtain a separate dataset for Holstein steers finished under a calf-fed system and steers finished under the traditional system, additional market differences might surface. Again, this may only be possible through the cooperation of a meat processor who is active the Holstein market.

This sector analysis was successful in its primary objective of evaluating the driving forces behind the Holstein beef market. The study combined two evaluation methods that are seldom used in conjunction with one another. Semi-structured interviews with stakeholders in the Holstein sector provided crucial insight to understanding the industry and developing the hypotheses that were tested through econometric modeling. Had this qualitative component not preceded the econometric analysis, models would have been inaccurate and results would have left more questions than answers. However, since industry personnel were willing to share information from the beginning, a much clearer understanding of the sector was developed.

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