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FACTORS AFFECTING FEEDER CATTLE PRICES IN THE SOUTHEAST

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DISSERTATION

A dissertation submitted in partial fulfillment of the
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Abstract

Traditional factors known to affect feeder cattle prices, such as corn prices, have been questioned recently given the volatile nature of agricultural markets and some recent research findings. This work utilizes two very current and unique datasets to examine feeder cattle pricing relationships from Kentucky internet auctions and Certified Preconditioned for Health (CPH) sales. In addition to examining traditional pricing factors, factors that affect feeder cattle basis were also examined. Basis questions are of great interest in the southeast as transportation costs to major cattle feeding areas have been impacted by rising fuel prices and increased market volatility. Finally, price premiums were examined for cattle selling as age and source verified and natural.

Results suggested that traditional factors were still found to influence feeder cattle prices, with some evidence that the magnitude of these effects may be smaller. Basis factors were found to be relevant; specifically fuel price was found to have a negative effect on basis in internet sales. This finding was also consistent with weaker basis in areas further away from the Midwest. Finally, premiums for age and source verification were moderate, roughly $11 per head for age and source verified calves, $17 per head for natural calves, and about $32 per head for cattle with both attributes.

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Chapter One: Introduction, Background, and Motivation

Background

The beef marketing system is one of the most complex in agriculture. While many livestock marketing systems have moved towards vertical integration, with entities owning multiple industries within the sector, this type of system is much less prominent in beef cattle. While there are excellent examples of vertical integration and coordination, the mainstream beef market remains largely segmented. As one might imagine, this segmentation creates both challenges and opportunities for operations within the sector.

Generally, the system is composed of four primary types of operations: (1) cow-calf operations who own cows and produce weaned calves, (2) backgrounding / stocker operations who purchase weaned calves, add additional weight, and sell feeder cattle, (3) feedlots who purchase feeder cattle and market cattle ready for slaughter, and (4) processors who purchase slaughter cattle and sell boxed beef into wholesale and retail markets. While calves may sometimes bypass the backgrounding production phase, or be backgrounded by the cow-calf operator, most calves will pass through at least three phases of production.

Since beef cattle markets are not as integrated as other meat systems, multiple markets, for cattle and beef at multiple stages, exist within the beef sector. For the most part, demand for cattle at any level is a derived demand. The value of cattle is largely affected by their eventual value further downstream and the costs associated with moving them to that stage of production. In the case of cow-calf operations and feeder cattle markets, the most immediate downstream segment is generally the feedlot sector.

As of January 2011, it was estimated that there were over 31 million beef cows in production in the United States (NASS, 2011). Cows are spread throughout the United States with a large concentration of cows in mid-west and plains and another fairly sizable concentration in the southeast. Cattle finishing operations tend to be located in the corn-belt, which creates a challenge for cow-calf operations located in areas like the southeast. Kentucky has more cows in production than any other state in the southeast and is also a key player in the southeast feeder cattle market due to its highly developed feeder cattle marketing system.

Kentucky's beef cattle industry is one of the most significant contributors to the state's agricultural economy, typically generating well over $500 million in receipts annually (NASS, 2010). The state has over one million beef cows (NASS, 2011), a healthy and likely growing backgrounding industry, a large number of livestock auction facilities (including one of the largest in the United States), and a very well developed network of order buyers. As tobacco production has dwindled in Kentucky over the last ten years, the importance of beef cattle and other enterprises has increased. With the decline of tobacco, beef cattle production is likely the most common type of farming operation in the commonwealth.

Kentucky's cow-calf operations tend to be relatively small, averaging around 30 cows (NASS, 2008). The small average size is part of the reason why Kentucky has such a large number of auction markets. Auction markets provide a place for producers to bring cattle and for buyers to assemble groups of cattle that can be sent west to finishing and grazing operations. This is also part of the reason why Kentucky's backgrounding and stockering industries continue to thrive. There is a large pool of calves to be purchased and grown, sometimes on purchased feeds, but often by utilizing a large amount of pasture acres.

This study was not intended to be focused solely on the southeast, although many of the implications are largely for that part of the country. Cattle producers in the southeastern United States do face a unique set of challenges due to the distance from downstream market segments, their small size, and the very segmented nature of the beef sector overall. Generally rising feed, fuel, and fertilizer prices clearly present a major challenge to all beef producers, but especially so for producers in the southeast. The primary purpose of this work was to examine multiple pricing issues in feeder cattle markets, many of which have major implications for producers in the southeast.

Feeder Cattle Fundamentals

The fundamental factors that drive feeder cattle markets have been questioned over the last several years. Traditionally, it was assumed that feeder cattle prices were driven primarily by their expected value as slaughter cattle in the future and the price of inputs purchased by feedlots during the finishing phase. This is consistent with a basic derived demand framework that most economists are comfortable with.

As the expected value of slaughter cattle increases, the competitive nature of the cattle feeding business should lead to higher feeder cattle prices as feedlots bid these profits back into the price of feeder cattle. Further, as feed price increases, greater expenses at the feedlot level should lead to lower feeder cattle prices as those additional costs work through the system. Of course the reverse of both these relationships should also hold, leading one to expect a positive relationship to exist between feeder cattle price and expected slaughter cattle price, and a negative relationship between feed prices and feeder cattle prices.

However, there is antidotal evidence that has led to questions about these basic assumptions. The year 2008 was an excellent example of this. Kentucky feeder cattle prices fell during the fall of 2008 (Kentucky Department of Agriculture, 2008-2011). As expected, this coincided with mounting concern about the health of the US economy. What was unusual about this particular drop in feeder cattle was that it occurred as corn prices were dropping as well. This led many to question whether the basic fundamental relationship between corn price and feeder cattle price was operating as it had in the past.

This skepticism was further amplified when recovery began in commodity markets. During the fall of 2010 and into the spring of 2011, Kentucky feeder cattle prices showed impressive price rallies at the same time that corn prices were also increasing (Kentucky Department of Agriculture, 2008-2011). To the casual observer, these two major movements in feeder cattle and corn markets provided evidence that the inverse relationship that had existed between the two commodities for years had changed.

Of course, seldom do empirical observations tell the complete story. When analysts speak of the relationship between feeder cattle prices and corn prices, they are generally making the assumption that everything else is held constant. At times in the past, observers have actually been able to observe changes in corn prices, while most other factors stayed relatively static. In the mid 1990’s, massive drought led to a sharp rally in corn price that quickly translated into drastic declines in feeder cattle prices. Similarly, a massive 2004 corn crop (a record 11.8 billion bushel as the time), resulted in steep corn price declines and led to sizeable rallies in feeder cattle prices. But, the markets of recent years have been much more dynamic and are best analyzed with statistical methods, rather than casual observations.

During 2008, as both corn and feeder cattle prices fell, live cattle futures also dropped sharply. Given that, it is possible that the negative effect from decreasing live cattle futures simply offset the positive price effect associated with decreasing corn prices. Conversely, as corn and feeder cattle prices were both increasing during 2010 and 2011, live cattle prices were also setting records. If the effect of live cattle futures offset the effect of corn price, it could mean that feeder cattle market are still operating as they were ten years ago, we are just seeing multiple derived demand factors moving at the same time.

To be fair to the casual observer, it is by no means implausible that a major structural change has occurred in the feeder cattle market. Much recent discussion has centered around the role of speculators and hedge funds in commodity markets. Speculators can be loosely defined as investors who buy and sell commodity futures, but do not have physical commodities to back those futures positions up. This is in contrast with hedgers who own commodities and use the futures markets as a way to manage price risk on physical commodities such as feeder cattle. As the role of speculators has continued to grow, volatility in futures markets has seemed to increase. And, there is certainly a link between futures market prices and cash prices seen in local feeder cattle markets.

Another type of futures market investor that has received a great deal of attention recently has been hedge funds. Hedge funds invest in commodities as part of an investment portfolio; this strategy is often considered an inflation hedge. Hedge funds are generally long (meaning they buy) a basket of commodities. As the futures contacts they own approach expiration, they are sold and the next contract month is purchased. Since hedge funds often buy futures of many different commodities, it is logical that they would tend to cause multiple commodity markets to move in tandem. This would certainly be an explanation for the perceived positive relationship between feeder cattle prices and corn prices, and if it were the case it could totally change the way that feeder cattle producers perceive their markets.

It is also very possible that feeder cattle and corn price relationships are different because agriculture is in a completely different corn price environment now than it was ten years ago. Ten years ago, livestock feed was the primary demand driver of corn price. According to the August 2011 World Agricultural Supply and Demand Estimates (WASDE), nearly 40% of the 2011 corn crop will be used for production of ethanol and its byproducts, slightly more than is projected to be used for feed and residual (World Agricultural Outlook Board, 2011). This is part of the reason why we have seen corn price more than double in recent years. Just as economists expect own-price elasticities to change as prices change, it is very possible that feeder cattle price relationships may be different now simply because corn price can be driven to levels beyond where its feed value would have taken it. As corn prices get higher, over the long term one would expect feeder cattle markets to adjust. Alternative feeds may become attractive, more weight may be gained at pre-feedlot stages, or markets may adjust in other ways. The end result could well be less response to changes in corn price than what has been seen historically.

Since the real world seldom operates ceteris paribus, there is a role that research can play in addressing these types of questions. A key piece of this work will be to examine the basic price relationships that have been known to exist in Kentucky feeder cattle markets for years with a current set of price data that covers this volatile time period. By examining these relationships with recent price data, it can be determined if the recent pricing relationships represent a structural change in feeder cattle markets. Much of this work will be dedicated to examining these traditional factors to determine how much differently feeder cattle prices react today than they were found to react in the past.

Value Added Markets

December 23rd, 2003 is a date that many cattle producers and beef industry stakeholders remember well. As many were making final plans for the Christmas holiday, the news broke that a Canadian born dairy cow in Washington State tested positive for Bovine Spongiform Encephalopathy (BSE). The immediate market impacts were large as both fed cattle and feeder cattle prices dropped overnight due to loss of export markets. While this incident occurred years ago and much of the impact has long been forgotten by consumers and producers, it is impossible to deny the impact that BSE has had on the beef marketing system.

Since BSE was first found in the United States in December of 2003, age and source verification have been at the forefront of feeder cattle marketing. Many credited the push towards age and source verification as a marketing tool to reach export markets, but that was really only part of the reason for its rise. Certainly, many trading partners began asking for age and source verification as a way to document low risk levels for BSE from US imports. Japan and Korea were especially adamant in the early years and the US beef system made great strides in restoring those shattered markets. However, there was also a practical domestic reason for age and source verification.

In additional to reaching export markets, the USDA began requiring that all specified risk materials (SRM's) must be removed from cattle over 30 months of age at slaughter. Specified Risk Materials are items like brain and spinal tissue and are perceived to pose the greatest health risk if consumed from BSE infected carcasses. For this reason, there is a value to age and source verification of cattle, regardless of whether their beef is consumed inside or outside the United States.

Due to these requirements, and the potential impact on exports, cattle that can be verified to be of a certain age do command a premium in the marketplace. In the years following BSE, numerous alliances and market networks began pushing for age and source verification in the cattle that they purchased. Similarly, many certified feeder cattle sales began to include age and source verification as part of their basic requirements in hopes of capturing that additional layer of value.

In the beginning, it was not clear how much actual price benefit producers would receive from selling cattle that met age and source verification requirements. Many dollar amounts have been discussed at the packer level, and clearly there are many packers that are paying significant premiums for these types of cattle. However, it has not been clear how much of this premium is actually flowing back to the feeder calf level. Since most Kentucky producers do not retain ownership and sell finished cattle, they are primarily interested in how much of this is retained in Kentucky.

While the market for age and source verified cattle has continued to develop, so has the process being used to document and audit the system. In Kentucky, a Process Verified Production (PVP) system has been set up where producers maintain a certain level of records to document age and source. While a specific record keeping system is not mandated, producers are subject to random audits to verify that they do in fact have a verifiable system in place to document birthdates of calves. This will sometimes be a computer software program, in some cases it may be a paper record book, and in other cases it may be a calendar system.

While the market has matured and the PVP system has evolved, many producers have questioned whether these additional record keeping requirements have truly resulted in higher feeder cattle prices. While the additional requirements are no overly burdensome, there certainly is a need to quantify the price benefit that is received for the producer's efforts. In addition to the question of whether the benefit exceeds the cost, additional questions center around the future of the age and source verification benefit. Korea has moved back to a 30 month rule, where they had been requiring beef to be from cattle less than 20 months of age. There is at least some speculation that Japan will do the same. Given these changes, it is possible that the size of this value-added market may be decreasing rather than increasing.

Of course age and source verification are not the only value-added opportunities that exist in the feeder cattle markets. It has been well-established that markets exist for cattle that are raised according to unique production standards. One of the most common in the southeast has been "natural". To be sold as natural cattle, no implants or ionophores can be used. Further, vaccines are acceptable, but antibiotics for treatment are not. These cattle are ultimately sold into markets aimed at consumers willing to pay more for beef produced from these types of cattle.

In the same way that it is important to understand the price benefit that comes from age and source verification, it is also important to understand the price benefit that comes from selling natural cattle. In the case of age and source verification, the additional costs are primarily associated with time and effort. In the case of natural, the producer is likely to see some negative production effects as well since cattle do not gain as well without the use of implants. This makes the additional value especially important. In light of these questions, another objective of this work will be to evaluate the level of price benefit that farmers are receiving for marketing age and source verified cattle and for cattle sold as natural. As a better understanding of these markets develops, producers can make better informed decisions about participation.

Basis as a Challenge

As previously discussed, Kentucky's beef cattle sector consists primarily of cow-calf operations and backgrounding operations. This is true for much of the southeastern United States. Beef cattle producers in Kentucky, and other southeastern states, face a unique set of challenges that result from their location and the large variation in size between operations. First, the overwhelming majority of Kentucky feeder cattle are fed in other states (NASS, 2011). For this reason, feeder cattle prices in Kentucky tend to be lower than prices in major cattle feeding areas as a result of trucking costs. Essentially, producers in the southeast pay trucking costs in one of two ways. They either pay trucking costs directly, or they pay in the form of reduced bids for feeder cattle. Since retained ownership remains the exception rather than the norm, most producers see lower feeder cattle prices as a result of transportation costs. Clearly, recent changes in fuel prices would be expected to have an impact on this price differential.

This differential is also very closely related to the concept of basis, the difference in local feeder cattle prices and prices on the Chicago Mercantile Exchange. Having an understanding of basis is critical as Kentucky beef cattle producers consider forward pricing, futures and options, and insurance as price risk management tools. A better understanding of how various factors affect basis would enhance their ability to protect prices and generally market feeder cattle.

The most commonly used basis estimation method is monthly historical data. However, as conditions change over time, one would expect basis to change as well. Most previous studies have focused on live cattle basis, and some basis prediction tools do not include transportation costs in their estimates (KSU BeefBasis, 2011). This work would provide stakeholders with a much better grasp of basis as it is related to producers in the southeast, with clear implications for price risk management.

Challenges also exist as a result of the wide variation is size across cow calf operations, in addition to their location. According to the 2007 Census of Agriculture, nearly 84% of Kentucky beef cattle operations have fewer than fifty cows. Further, nearly 95% have fewer than 100 cows (NASS, 2008). This large number of small operations is precisely why Kentucky's beef cattle marketing system exists in its current state. Small scale operations are unable to market load lots of feeder cattle on their own; Kentucky's auction and order buying system exists to serve these small scale producers.

However, this system does present pricing challenges as additional marketing services are provided before cattle are transported west. The grouping, logistical, and service functions provided by order buyers add value to cattle that is difficult for small Kentucky producers to capture. In effect, this makes price differentials even more variable as we consider the wide range in herd size across the state as these additional costs are also factored into the system, whereby affecting basis.

Co-mingled sales, such as CPH-45, are common ways that this has been addressed. Cattle from multiple producers are managed according to a specific health protocol and then sorted and grouped prior to sale. While it would be unrealistic to expect that buyers would be indifferent between CPH cattle and single-owner cattle managed similarly, it is generally accepted that CPH sales have returned higher prices than small groups at local stockyards. Part of these price premiums are the result of an expected improvement in feedlot health performance, but clearly another key component of this price premium stems from co-mingling these smaller groups of cattle into more uniform load lots. As this is done, basis tends to improve, holding all other factors constant.

Regardless of how Kentucky cattle are marketed, increased volatility is greatly increasing producer interest in price risk management tools such as forward contracting, futures and options, and Livestock Risk Protection (LRP) insurance. While these tools offer great potential, one of the major hurdles to increasing their use is helping producers understand the concept of basis. A final objective of this work will be to statistically evaluate factors that affect basis for feeder cattle in Kentucky (and the southeast). Like the other objectives of this work, developing a better understanding of factors that affect basis will lead to better decision making and improved expectations for producers.

Chapter Two: Literature Review

Feeder Cattle Pricing Factors

Feeder cattle pricing factors have been dealt with extensively in agricultural economic journals, extension publications, and other outlets. Demand for feeder cattle is derived from fed cattle, so much of what is known about derived demand applies to the feeder cattle market. Generally, derived demand theory would suggest output prices and input costs would be the primary drivers of feeder cattle value. In this case, slaughter cattle are the primary output and feed is the primary input into the cattle finishing phase of the beef system. However, numerous other factors have also been shown to affect feeder cattle prices. The following pages will summarize previous work in the area of feeder cattle pricing factors.

Corn price has long been thought to be one of the most significant factors affecting feeder cattle prices. Not surprisingly, this has also been established in previous work on feeder cattle pricing. Generally speaking, a negative price relationship (as corn price increases, feeder cattle price decreases) has been found to exist, but the magnitude of the effect has been somewhat variable.

Early work on the effect of corn price on feeder cattle prices was centered around how corn price and weight affects the breakeven price that feedlots can pay for feeder cattle under the assumption that competition will push economic profit towards zero over time. Buccola (1980) used a breakeven simulation to estimate the effect that corn price had on the breakeven price for feeder cattle. While his work was largely focused on weight relationships, he did find that rising feed prices tended to decrease the breakeven price for feeder cattle (Buccola, 1980).

Buccola's empirical work found that a one dollar per bushel increase in corn price was associated with a decrease in feeder cattle price of $8.33 per cwt. Buccola was also able to demonstrate that this impact was greater for lighter calves than for heavier feeder cattle, as the slope increased for lighter calves. This general finding has held in most work over the last 30 years.

An interesting note to Buccola's 1980 work is that it combined a simulated breakeven analysis with an empirical analysis using actual feeder cattle prices from

Virginia. While basic results have been discussed, it is also noteworthy that he found that the breakeven simulation did quite well predicting the direction of the impact of changes in corn and fed cattle prices, but the magnitude of the impact was found to be higher in the simulation than in the empirical results. This finding was consistent with the 2000 work of Anderson and Trapp who looked specifically at the feeder cattle price responses to changes in corn price (Anderson and Trapp, 2000).

Anderson and Trapp (200) found that simple breakeven analysis, which is the foundation for many of the general rules of thumb that are used to predict impact of corn price changes, ignores the fact that many other changes may be made in the system in response to changes in corn price. As corn price increases, other feeds become more attractive and thus are more readily included in feeding rations. Secondly, as corn price increases, changes are made in the placement weights of feeder cattle. These adjustments were most likely the reason they found actual responses to changes in corn price of lower magnitude than budget derived responses, and why Buccola (1980) found the same basic difference in his two approaches.

In the mid-2000’s several studies supported the negative relationship between corn price and feeder cattle price in Kentucky. In 2003, an application to the Holstein feeder steer market found roughly a negative 8:1 relationship to exist between corn price and heavy (above 700 lbs) Holstein feeder steer prices (Burdine, 2003). The same work found a much larger magnitude in the relationship between corn price and lighter cattle, which was consistent with the work of Buccola (1980) and Trapp and Eilrich (1991) from many years earlier, and more recent work by Dhuyvetter and Schroeder (2000). Using a different Kentucky dataset, Eldrige (2005) found the same negative relationship, but his results suggested that the impact was greater for heavier feeder cattle. This was an unexpected result and may have been partially due to the fact that little corn price variation was present during the time period that dataset covered (Eldridge, 2005).

More recent work outside Kentucky has cast doubt on the relationship between feeder cattle prices and corn prices. Schultz et al. stressed the importance of using current data due to the rapidly changing beef environment. In a hedonic model using Kansas and Missouri data for fall 2008 and spring 2009, they found that corn price was not a significant factor in explaining feeder cattle price in that dataset. This unexpected finding is consistent with casual observations of today's market behavior (Schultz et al., 2010).

Tejada and Goodwin looked at causality relationships across many commodity markets from 1998 to 2009, dividing the data into two groups separated by the 2005 Energy Act. They did not find that corn prices Granger caused feeder cattle prices in either of the two periods, but did find weak evidence to suggest that a long term negative relationship existed (Tejada and Goodwin, 2011). The recent work of Tejada and Goodwin (2011) and Schultz et al. (2010) both suggest that there is good reason to evaluate the existing price relationship between corn and feeder cattle prices and evaluate the possibility of a structural change in feeder cattle markets over the last few years.

In addition to corn price effects, the impact of expected fed cattle prices on feeder cattle is also well established in the literature. A large number of studies have found a positive and significant relationship to exist between expected fed cattle price and feeder cattle prices. This is also consistent with derived demand theory that would suggest that as output price increases, the price of the input would increase as well.

Buccola's work in 1980 found that as slaughter steer prices increase, feeder cattle prices also tended to increase. That work also found that, in addition to being associated with an increase in average feeder cattle prices, rising fed cattle prices also tended to increase the premium on lighter calves, effectively increasing the price differentials by weight. In that study, Buccola actually used current live cattle futures prices to proxy expected slaughter prices for the feeder cattle lots included in the Virginia dataset. Despite the fact that Buccola's results were consistent with theoretical expectations, more recent work has moved away from using current live cattle prices.

In the case of feeder cattle, it is important to remember that there is a significant time lag between when feeder cattle are actually placed on feed and when they are harvested by packers. Therefore, it is unreasonable to expect that current slaughter cattle prices should have a direct effect on current feeder cattle prices. Rather, it is the expectation of slaughter cattle prices in the future that are most likely to affect current feeder cattle prices. Despite this theoretical flaw, the 1980 work of Buccola was a highly significant addition to the literature and is still referenced commonly in work today.

Further, Buccola's results were still relevant, as current live cattle futures likely moved similarly to deferred live cattle futures at the time anyway.

Trapp and Eilrich (1991) moved the literature in this direction as they considered the work of Buccola (1980), suggesting that different deferred live cattle futures' contract months would affect feeder cattle prices of various weights differently. This basic idea is why the more recent convention in the literature has been to use deferred live cattle futures for the time period that the feeder cattle are expected to be finished as an indicator of fed cattle price expectations (Dhuyvetter and Schroeder, 2000, Burdine, 2003, Eldridge, 2005, Bulut and Lawrence, 2007).

Using deferred live cattle futures has been shown repeatedly to work well in explaining feeder cattle prices in various locations. This positive relationship has been found to exist using Kansas price data from 1987 to 1996. The same study also found that as expected fed cattle prices increased, the spread between cattle of different weights tends to widen (Dhuyvetter and Schroeder, 2000), which was consistent with Buccola's finding using current live cattle futures. Trapp and Eilrich (1991) and Dhuyvetter and Schroeder (2000) found this same tendency; live cattle futures had more effect on calves than on larger feeder cattle. Stated another way, price differentials by weight increased as fed cattle prices increased.

The work of Eldridge in 2005, using Kentucky auction price data, found this same positive relationship to exist. His work, consistent with previous studies, found that as feeder cattle weights increased, the relationship between deferred live cattle futures and feeder cattle prices decreased in magnitude. The relationship moved from roughly 2:1 for calves, down to nearly 1:1 for heavier feeders (Eldrige, 2005). The same general relationships were also found to exist between deferred live cattle futures and Holstein feeder steer prices in Kentucky from 1995 to 2003 (Burdine, 2003). The traditional effects of corn and deferred live cattle futures were well established in the literature, and were only recently questioned.

While corn price and expected fed cattle price have largely been considered the primary factors that affect feeder cattle price, many other factors have also been well established to be influential as well. Factors such as weight, sex, breed, uniformity, health and many others have been found to affect price levels. Multiple studies and articles have examined these factors, often while attempting to address other questions about pricing.

Initially, someone unfamiliar with feeder cattle markets will question why lighter cattle tend to sell for a higher price per pound than heavier cattle in a typical market. Some of the early work in this area dealt with this question directly. Buccola (1980) found that breakeven purchase prices were higher for lighter cattle (as cattle weight increased, breakeven price decreased). Although his nominal prices look very low by today's standards, this general finding has been supported in a great deal of other work and still explains why feeder cattle price slides are generally negative. This finding is almost universally supported in more recent work on feeder cattle price determinants (Dhuyvetter and Schroeder, 2000, Burdine, 2003, Eldridge, 2005, Bulut and Lawrence, 2007, Schultz et al., 2010).

Sex has also been well established to have an impact on the price of feeder cattle. Generally speaking, steers will gain weight more efficiently than their female counterparts, which results in lower finishing costs when compared to heifers. Lower finishing costs lead to higher breakeven purchase prices for steers in the marketplace. This was originally demonstrated in the work of Buccola (1980) as heifers were found to sell at a discount to steers. Buccola (1980) also found that the heifer discount became smaller as feeder cattle got heavier.

While some variation in the steer-heifer price differential is common, the general finding is also very well established in more recent work. In addition to the discount itself, there is also evidence in the literature to suggest that the price differential between steers and heifers tends to narrow as the weight of the feeder cattle increases (Dhuyvetter and Schroder, 2000, Eldridge, 2005, Schultz et al., 2010). This tendency is logical since these price differentials are largely driven by feed conversion. One would expect less price impact from cost of gain differences as cattle move closer to finished weight.

Lot size is another factor that has been shown to affect feeder cattle prices. Feeder cattle move in truck load lots due to trucking efficiencies (ie: transportation costs per head are lower when trucks are full). The idea that diseconomies of transportation efficiency has price impacts has been supported in the literature as increasing lot size is often associated with increases in feeder cattle prices, especially for groups over 500 lbs

(Eldridge, 2005). It is also common for researchers to find a negative effect on the square of the lot size variable or otherwise find concavity in this relationship (Dhuyvetter and Schroeder, 2000, Bulut and Lawrence, 2007, Schultz et al., 2010). This suggests that the initial price impacts associated with lot size are greatest and the positive impact on price decreases in magnitude as lot size increases. In other words, moving from a lot size of 10 to 20 would be expected to have a greater price impact that moving from 40 to 50, holding everything else constant.

Genetic factors can also have a major impact on feeder cattle prices. Breed / Color are generally included in feeder cattle pricing studies as they often account for a portion of price differences among groups of cattle. One of the challenges in reviewing the work that has been done in this area is that breed pricing differentials are often regional, meaning certain breeds tend to be more popular in certain areas. And, classification of cattle is often inconsistent across regions. In some cases, color is the primarily classification that is made and one is left to infer the most likely breed for those cattle.

Recent work using Missouri and Kansas price data found that Angus and Angus cross feeder calves sell at a premium to Hereford based cattle. These price differentials were moderate, in the $2-$3 per cwt. range. At the same time, Longhorns and feeder cattle with dairy influence were found to be associated with much lower price levels, in the neighborhood of $10 to $12 per hundredweight less. Given this, it is not surprising that black, white, and mixed cattle were found to sell at a price premium to red cattle (Schultz et al, 2010). Earlier work out of Kansas broke cattle into only three groups, but found that mixed and continental cattle sold at a discount to English based cattle (Dhuyvetter and Schoeder, 2000).

Work in Kentucky has found largely similar results. Black cattle and black / white faced cattle (predominantly Angus) have been associated with small price premiums, generally $1 to $3 per cwt. Kentucky’s discount associated with Holsteins was similar to what was seen in other states for heavier feeders. As expected, the discount was found to be much greater for groups of calves with lower average weights (Eldridge, 2005).

Another commonality among most feeder cattle pricing studies involves the element of seasonality. In some fashion, most work has attempted to account for seasonal differences in marketing time. Due to supply and demand tendencies, weather, feed prices, and other factors, the time of the year appears to be significant in explaining variation in feeder cattle prices. Generally speaking, winter has been found to be associated with lower feeder cattle prices, while prices have been found to be higher in spring and summer months. This is a result that has largely held true both inside and outside Kentucky (Dhuyvetter and Shroeder, 2000, Burdine, 2003, Eldridge, 2005, Schultz et al., 2010).

Feeder cattle health is also considered to be a key factor that affects profitability, so it is no surprise that healthy cattle, and those managed according to an accepted health program, have been found to sell for higher prices than their cohorts. Price data from Kansas and Missouri found more than a $6 discount per cwt to be associated with feeder cattle that trained evaluators deemed as unhealthy (Schultz et al., 2010). A more recent Iowa study, using data from 2005 and 2006, found more than a $6 premium to be associated with preconditioned feeder cattle. Premium levels in that study were decreased by roughly half if the claim was not verified by a third party (Bulut and Lawrence, 2007).

These premium levels were generally larger than those found for Kentucky CPH-45 sales in recent work (Lunsford, 2005). Lunsford (2005) found premium levels of less than $2 per cwt, while Eldridge (2005) found premium levels above $5 for light calves, but premiums quickly decreased as feeder cattle weight increased. Since the time of these studies, many CPH sales in Kentucky have incorporated age and source verification into their requirements. Kentucky CPH prices have not been examined since this change, but a recent Oklahoma study did suggest that age and source verification were associated with higher feeder cattle prices in some sales (Donnell and Ward, 2008).

While most work has focused on external factors and actual cattle characteristics, some factors affecting feeder cattle prices relate to the way in which feeder cattle are marketed. In cases where there is some uncertainty about weight, cattle are typically marketed using a base weight of some type, and a price slide is offered by which the price can be adjusted downward if cattle weight exceeds the base weight. The price slide is intended to protect the buyer from paying a higher price for cattle based on a weight that the seller underestimated. However, due to information asymmetry, sellers are in a much better position to estimate the likely weight of the cattle than buyers.

The work of Brorsen et al. (2001) looked specifically at the impact of these price slides on prices of feeder cattle in Superior Livestock Auctions. Their findings suggested that these price slides did affect the prices for feeder cattle. Of specific interest, the slides offered in the auctions were not steep enough to provide a disincentive for sellers to underestimate weight. In other words, sellers were generally better off to sell more pounds at the lower, slide adjusted, price. Consequently, sellers did appear to underestimate the weight of the cattle. However, the authors found that by offering a larger slide, higher sale prices more than offset the negative effects of the price slide, suggesting that higher price slides lead to higher sale prices for feeder cattle (Brorson et al., 2001).

Basis and Factors Affecting Basis

As price volatility has increased in recent years, so has interest in price risk management tools such as the futures and options market. Numerous studies have found evidence that using futures and options markets can reduce price risk for producers marketing feeder cattle (Trapp and Eilrich, 1991, Buhr, 1996, Routt, 2005). Generally, this work has evaluated price risk management tools on the basis of a decrease in variation in either prices, returns, or both.

It is also generally accepted in the literature that geographic differences do affect hedging effectiveness; however the extent of this effect has not been super consistent. Feeder cattle in the southeast are probably the most likely to be impacted due to their large distance from major cattle feeding areas and perceived lack of uniformity. Brake, Anderson, and Coffey (2006) examined the effectiveness of hedging Georgia feeder cattle and found that spatial differences impacted hedging effectiveness, but the impacts were much less than expected. Further, they were able to determine that regional differences in effectiveness were significant in only a couple months and that other factors were more important than location (Brake, Anderson, and Coffey, 2006).

Work using South Carolina feeder cattle data compared the risk management effects of hedging with futures, and purchasing out-of-the-money put options to a naïve strategy of relying solely on the cash market. Some evidence was found that the use of futures and options did provide risk protection in some cases, but this was not especially robust. The authors were also correct to note that during the time period of their study (1998 to 2004), cattle numbers were generally decreasing and prices generally increasing. Therefore, this dataset may not have been the best to use for evaluation of downside feeder cattle price risk (Nardi et al., 2006).

Some work has also found little benefit to hedging for producers in the Southeast and it is important to be aware of these findings as well. A recent study using data from January 2006 to August 2010, found little benefit from hedging for producers in Louisiana and Mississippi. This study simulated fall calving operations who were selling calves the following spring, which is not a typical cattle operation in the Southeast and certainly not representative of Kentucky operations (Pruitt and Riley, 2011).

One of the major factors affecting hedging effectiveness is basis, and most any discussion of hedging and price risk will eventually lead to a discussion of basis. In fact, most work that has found hedging to be an effective risk management tool has been based on finding that variance in returns or profits can be reduced through hedging. When cattle (or any commodity) are hedged using the futures' market, price risk is replaced with basis risk. Thus, predictability of basis becomes paramount to the discussion.

Basis is a generic term that is used to describe the difference between prices on a local or cash market and the futures price. The conventional formula is basis equals cash price, minus futures. So a negative basis implies that local prices are below the futures price and vice versa (Mintert et al, 2002). For the purposes of this discussion, basis will refer to the difference in local price as determined by the dataset being examined and prices for the nearby feeder cattle futures contract on the Chicago Merchantile Exchange. Many farmers choose to ignore basis as they make feeder cattle pricing decisions, but they are likely making a mistake when doing so.

As producers look to manage price risk, they often choose to do so when they find the futures price attractive at a given time. Understanding basis is crucial because it is the adjustment that producers must make to futures price to understand what the futures market may be offering them at any given time. The basic theory behind using futures markets as a price risk management tool is an assumption that there is less variation in basis levels over time than in the absolute price levels, which is substantiated in much of the literature (Bailey, Gray, and Rawls, 2002, Trapp and Eilrich, 1991). Recent work examining Kentucky feeder cattle markets suggested that hedging did reduce price risk for Kentucky's more liquid cattle markets by reducing variance in price (Routt, 2006). As the largest in the state, Bluegrass Stockyards easily fell into this category, making basis prediction important to Kentucky producers.

Given the importance of basis, an understanding of factors that determine basis levels is beneficial for livestock producers. First, it is important to frame the concept of basis for what it is. Factors that affect overall feeder cattle prices should only be expected to affect basis if there is difference in the way that those factors affect the futures market and the local market. For example, a change in expected fed cattle price will most likely affect both the feeder cattle futures price and the local price. If both were affected by the exact same magnitude, basis may not be affected at all. However, because feeder cattle pricing factors tend to affect various types of cattle in varying locations differently, many of the same factors that affect feeder cattle prices have also been show to affect basis. For the purpose of this section of the literature review, discussion will be largely focused on factors that have been found to truly affect basis.

Historical basis tables were considered to be the basis prediction tool of choice for many years and do show up in the literature quite frequently. They are still commonly used today and provide very useful information about seasonal basis patterns. They have also been shown to explain a fair amount of variation in basis levels. Some studies have suggested that three years worth of monthly or weekly averages are the most reliable historical basis tools as market conditions change regularly (Mintert, 2002, Tonsor et al., 2004). Using data in this way captures the seasonal tendencies that are also well established factors determining basis levels (Bailey, Gray, and Rawls, 2002, Routt, 2006). Seasonal tables have also outperformed more complicated basis prediction models in out of sample testing in recent Kentucky work (Routt, 2006).

There has also been a great deal of literature devoted to factors that affect basis beyond what can be captured in seasonal or historical relationships. As was discussed in the introduction, the potential drawback to using historical basis tables is their inability to adjust with current conditions. If current market conditions are similar to market conditions during the historical period, one would expect historical basis tables to be quite accurate in their estimates. However, changing market conditions would likely mean that basis estimates based on historical data would be less accurate than a prediction tool that could adjust estimates for current conditions. This is perhaps one of the reasons for the inconsistency in the predictive power of basis prediction models compared to other tools in the past.

One approach to address the challenge of current information exclusion has been to include recent basis levels into prediction models (Tonsor, Dhuyvetter, and Mintert, 2004). This research suggested that including current basis levels as an explanatory variable did increase forecasting accuracy over time horizons twelve weeks and less. Along the same lines, other work has found that including a one-period lag of basis is also significant as general basis levels tend to trend; if basis is low at time t, it will most likely be low at time t + 1 (Parcell, Schroeder, and Dhuyvetter, 2000, Bailey, Gray, and Rawls, 2002). Of course both of these approaches have their drawbacks. Using current basis information means that changes in factors between the current time period and the prediction period are unaccounted for and using a one-period lag is only useful for predicting basis over very short time horizons.

Other studies have looked at specific factors that affect basis and as one might imagine, many of the same factors that affect feeder cattle price levels have also been show to affect feeder cattle basis. As was discussed earlier, corn and live cattle futures' price effects tend to be amplified when measured on lighter feeder cattle prices. Since feeder cattle futures prices are based on 7wt weight feeder steers, basis for lighter weight cattle would be expected to be affected by these changes. This assertion is supported in the literature as fed cattle and corn price parameters, measuring the effect on basis, tend to become larger as feeder cattle weight increases (Trapp and Eilrich, 1991, Bailey, Gray, and Rawls, 2002). Specifically, basis for light weight feeder cattle tends to become more positive as corn price decreases and deferred live cattle futures increase. Similarly, basis for lighter feeder cattle tends to decrease as corn prices increase and deferred live cattle futures decrease.

Trapp and Eilrich (1991) found better explanatory power in lighter cattle, but more recent work has suggested that basis becomes less predictable as we move further away from contract specifications (Brake, Anderson, and Coffey, 2006, Dhuyvetter et al., 2008). Work has also suggested that predictive power is greatest over shorter time periods, which is logical given that less uncertainty exists (Dhuyvetter et al., 2008). Another finding worth discussion from that same 2008 work was that using feeder cattle futures as an explanatory variable was less successful than using live cattle futures and corn price. Their hedonic prediction model was able to outperform simple averages in out-of-sample testing, which is the true test of forecasting ability and lends strong credence to the notion that incorporating current information can improve basis forecasting accuracy.

Finally, there is by nature a geographic aspect to basis because we are considering the local price relative to a futures price. Transportation costs to and from feeding and processing locations are often cited as a key factor in determining feeder cattle basis (Bailey et al., 2002). However, with the exception of using different locations as binomial variables or estimating separate models for different locations, no work had attempted to build transportation costs into basis forecasting models until the 2008 work of Dhuyvetter et al. This study did include diesel price as an explanatory and predictive factor and found it to be a significant factor affecting basis levels, although results were not robust across states. This is an area in the literature that seems ripe for further exploration.

While the body of literature examining feeder cattle pricing factors is quite large, it is also a literature that has continually evolved. Given the volatility we are seeing in today's markets, taking a fresh look at factors affecting feeder cattle prices, seems well warranted. Additionally, most work has seemed to focus on major cattle production areas; much less work has focused on the southeast. Finally, surprisingly little work has looked at price affects for age and source verified cattle and for cattle in other value added systems. This work will address these areas that seem to be in need of additional research and have implications for producers as they make management and marketing decisions.

Chapter 3: Methodology, Data, and Diagnostics

Introduction

Data is perhaps the most important aspect of any quality research project. The quality of the data will inevitably determine the quality and usefulness of the results. While methodology is also crucial, it is not able to make up for problems or inadequacies in the data itself. In current times, data is generally much more readily through a wide range of sources. However, it also makes the quality of the data an especially important consideration for the researcher as stakeholders are likely to compare results and implications of findings based partially on the quality and reliability of the datasets from which they were generated.

One of the clear strengths of this work was the unique and reliable dataset that it utilized. While no dataset is perfect, this dataset is based on actual cattle sales from a very large marketing company, includes a very comprehensive compilation of pricing factors, and has not previously been used in academic research. The primary dataset was made available to the author by the management of Bluegrass Stockyards, LLC, based in Lexington, KY. Bluegrass Stockyards is one of the largest auction markets in the United States.

The management at Bluegrass Stockyards was especially interested in learning more about the premium levels associated with cattle being sold as “age and source verified” and cattle being sold as “natural”. Both practices require some additional work and in some cases, some additional cash costs. In the case of age and source verification, the primary costs to the producers are in the form of record keeping and compliance with random audits as age and source verified cattle are regularly enrolled in a Process Verified Production (PVP) system. In the case of cattle sold as natural, paperwork requirements exist but additional management requirements such as the prohibition of implants may increase production costs, making the premium levels especially important. Of course, data to examine these questions would be crucial to answering them.

As the feeder cattle market has evolved in the Southeastern United States, the marketing strategies of Bluegrass Stockyards have evolved with it. Bluegrass holds a bi-monthly internet video auction where cattle are purchased by buyers all over the United

States. Beginning in January 2008 and continuing through April 2011, the results of these internet sales were made available. In order to provide prospective buyers with needed information on the cattle being offered, a relatively comprehensive catalog is put together for each sale. In addition to basic weights and prices, the information from these sale catalogs was also made available for the purposes of this work. This included descriptions of the cattle, locations, selling conditions, and other factors included to inform potential buyers.

The result was a very large and rich dataset with over 1,600 observations and a wide range of information about the cattle that helped to explain the prices received. This dataset would be used to examine the premium levels for age and source verified cattle as well as cattle selling as natural. A quality examination was made possible by the size of the dataset, the depth of information, and the fact that cattle falling both in and out of those categories were included.

In addition to answering those questions for the stakeholder, this presented an opportunity to estimate some basic price relationships and to examine factors affecting feeder cattle basis with some very recent data. As mentioned in Chapter 1, this dataset could also be used to look at the relationship between corn price and feeder cattle price as well as the effect of fuel prices on feeder cattle price and feeder cattle basis. The latter opportunity was further enhanced by another set of data that was made available by the managers at Bluegrass Stockyards, LLC.

Bluegrass Stockyards, LLC also made available transaction level data from each of their Kentucky Certified Pre-conditioned for Health (CPH) sales from January 2008 to April 2011. CPH sales are held between four and seven times per year and targeted towards producers who wish to sell cattle managed under a uniform health program. General requirements include that calves be weaned a minimum of 45 days, be bunk and trough broke, be castrated, dehorned and healed, and have received 2 rounds of shots, the second of which is required to be modified live. In addition, there is a monetary guarantee that no heifers are bred and no males are in-tact.

As a marketing program, CPH has a long history dating back to the 1980's. Interest in CPH-45 sales increased considerably during the 1990's and the first part of the 2000's as beef cattle increased in importance and Phase I tobacco monies provided an opportunity for more producers to have quality cattle handling facilities. Although cattle numbers have decreased over the last few years, CPH-45 prices have generally been well received by producers. Part of the price benefit is due to the uniform health program, but another very important piece is the co-mingling that occurs prior to the sale. Calves from multiple producers are put together in uniform groups, which allows smaller producers to receive prices associated with larger groups of cattle. The CPH sale dataset for the same time period was also large, with more than 1,300 observations. By having access to both these datasets, the author was able to look for consistencies across results, thereby checking for robustness in what was learned.

Data for the CPH sales was available electronically by sale and combined into a single data set using Microsoft Excel and Microsoft Access. Data for the internet sales was available electronically by sale and combined similarly, but also had to be augmented with sale catalogs to include additional information This manual data entry process was time consuming, but added additional explanatory power to the models. It also helped the author to become familiar with the dataset, something that had multiple benefits as the research moved forward. The following sections will describe the data that were available in these two datasets and how this data was used by the author.

Internet Sale Data Description

As mentioned earlier, there were over 1,600 groups of cattle in the internet sale dataset. Since the market was an internet auction market, there was some uncertainty about each group of cattle that was offered for sale. Cattle were not seen in the flesh, weight was only an estimate, and specifications were largely determined by the seller, not a third party. For this reason, several things had to be considered when using the internet sale data.

Generally speaking, cattle were sold via video auction and delivered within a week or two of the sale. A range of delivery dates were sometimes listed in the sale catalog, but the range could be anywhere from two or three days to two weeks. So, in most cases the actual date of delivery was not known. Cattle were assumed to be delivered 10 days after their sale date as that was deemed logical after examining the sale catalogs.

Cattle that were delivered more than 3 weeks after sale were excluded from the analysis. This was a small percentage of the cattle and was done in order to make certain that prices for groups were determined by current market conditions. For example, cattle sold in January, for June delivery, are not purchased based on January market conditions, but rather the expectation of market conditions in June. By dropping the forward contracted cattle, this potential disconnect was eliminated.

For each group of cattle, a base weight was advertised for each lot that represented the seller's estimate of the average weight of the cattle on the delivery date. Due to shrink, uncertain delivery time, and other factors, delivery weight would often be off by several pounds. The uncertainty with respect to weight was dealt with by the auction system through the use of a price slide.

A price slide is an adjustment that is made for groups of cattle that weigh more than their advertised base weight. In some cases, an upward price adjustment is made for cattle that weight less than their advertised weight, but this is not common and was not seen in this dataset. With only one or two exceptions, there was a slide for cattle that weighed less than 50 pounds above their base weight and a steeper price slide that applied to cattle that weighed more than 50 pounds above their base weight. Cattle that weighed less than their advertised base weight would sell for their bid price. Cattle that weighed more than their base weight would see downward price adjustments based on the slides advertised. This process provided buyers with confidence that weight underestimation was less likely, and that when it occurred, price was adjusted accordingly.

The sale level data provided by the stockyards did not include the bid price, but rather the final price after any price slide adjustments. For that reason, the author used the delivery weight, base weight, and price slide information to calculate a bid price. It was determined that the bid price was most important as that is what the buyer was willing to pay based on the information available to him or her on the day of the sale. The final price would not have been known until after the cattle were delivered.

Weigh conditions are also crucial variables when considering data from an internet sale. In most all cases, sellers would report how far the cattle would be hauled to the weigh station. In some cases, certified scales were available on the farm; in other cases, cattle were hauled a great distance before being weighed. This distance to the scales was important for two reasons. First, the longer the distance, the more weight the cattle would lose before being weighed. And secondly, the longer the distance, the more stress on the cattle.

A related concept that was also important was the pencil shrink. Because cattle weighed on the farm were known to weigh more than cattle hauled for a distance and then weighed, a shrink was sometimes assigned to groups of cattle. A shrink is a weight discount factor applied after the animals are weighed. In most cases, it would range from 0% to 3%.

The internet sale data also included a basic description, which is another very important factor in determining value. Each group of cattle included a listing of the number of head in the lot, the gender of the group, the color or breed description of the cattle, and their location. All four of these factors were determined to be important in a thorough review of the literature discussed in Chapter 2. In some cases, mixed gender groups were offered for sale with a steer / heifer price differential imposed on the group. Given this artificial parameter, mixed groups were eliminated from the dataset.

In terms of the breed / color description, cattle were either determined to be black / black and white faced (bbwf), Charolais, Holstein, or Red. In cases where cattle fell into more than one of these categories, they were classified according to the majority; most were highly uniform in terms of color. In cases where no classification represented 50% of the cattle, a mixed classification was created. In either case, the vast majority of groups were black / black and white faced.

Location was important as most feeder cattle move to the mid-west for finishing. One of the unique features of the internet sales was that cattle sold originating in 9 different states. In order to allow for these spatial differences, a binomial variable was created for each of the ten states. More groups of cattle originated from Tennessee than any other state, although Virginia and Kentucky were not far behind.

Another factor of interest was whether or not the cattle had been implanted. The sales included a good mix of implanted and non-implanted cattle. Implants are used by cattle producers to improve feed conversion, but their impact on marbling has been questioned in the past. Secondly, buyers generally believe that subsequent implants have decreasing affects. Both these perceptions suggest that the practice of implanting could affect the price of cattle. In sale catalogs, consignors specified whether or not cattle had been implanted.

Finally, sellers specified whether cattle were “age and source verified” and whether they were “certified natural”. These variables were of primary interest to Bluegrass Stockyards and were entered as binomials, either yes or no. Ultimately, four categories were created, (1) cattle that were age and source verified, (2) cattle that were natural, (3) cattle that were both age and source verified and natural, and (4) cattle that were neither age and source verified or natural. It is also important to note that being “certified natural” had a deeper meaning than simply a lack of implants. Natural prohibits the use of hormones, ionophores, and antibiotics. There were more non-implanted cattle selling non-natural than as natural. So, these variables should be considered accordingly.

CPH Sale Data Description

The depth of information in the CPH dataset was not as great as in the internet sales, but it provided a crucial second opportunity to examine pricing factors. CPH sales were physical sales where cattle were weighed as they entered the yards. They were then co-mingled into uniform groups and sold with a 2% pencil shrink. So, many of the pricing factors that were crucial to understanding the internet sales were not present in the CPH sales as sale and weigh conditions were constant across all cattle.

Weight reported was the pay weight after the 2% pencil shrink. This was also the weight advertised at sale, so no adjustment was necessary. Similarly, available prices were actual auction sale prices for the respective groups of cattle and all cattle were physically sold at Bluegrass Stockyards Lexington, KY location. While cattle did originate from different locations, they were all hauled to, and weighed in, Lexington.

Lot size was likely more important in the CPH sales as the average was much lower (between 19 and 20) and there was more variation. For the most part, the internet cattle sold in load lot groups, but this was not the case for the CPH cattle. Lots ran from as small as 1 head to as many as 286, making it a crucial variable in understanding price. For the most part, the internet sale data provided a chance to examine the price impacts of single load lots compared to multiple load lots. The CPH sales provided the opportunity to examine the price impacts from partial loads to full loads, and in some cases, to multiple loads.

Cattle descriptions were similar, although not identical, to cattle going through the internet sales. Groups were sorted according to gender, as well as color / breed. Classification in the CPH sales included black, black cross, Charolais cross, smoked, small framed, and mixed. It is worth noting that sorting in the CPH sales occurred by stockyards staff, where categorization in the internet sales occurred based on the descriptions in the sale catalog. Ultimately, the black sort of the CPH sales was likely much more uniform than the bbwf sort of the internet sales.

Finally, buyer data was available for cattle selling through the CPH sales. In most cases, cattle were purchased by one of four major order buying firms, although numerous other buyers were active. Some of the other buyers may have been less active order buyers, backgrounders, cow-calf operators, etc. There was some potential for cattle price to differ depending on which firm purchased the feeder cattle so this potential pricing factor was included as well.

External Data Utilized

While the depth and quality of the datasets made available were generally quite good, additional information was needed to increase the understanding of the prices received for the cattle in the sales. As discussed in Chapter 2, variables like corn price, deferred live cattle futures, and fuel prices can also have major impacts on feeder cattle prices. These data were crucial in understanding price and basis relationships, and also for the purpose of isolating the effects of variables of interest.

Daily feeder cattle and corn futures prices were available from the Livestock Marketing Information Center (Livestock Marketing Information Center, 2011), which databases futures prices from the Chicago Mercantile Exchange (CME). In the case of both the internet and CPH sales, the closing price for the nearby corn and feeder cattle futures contract on the day of the sale was used. Basis was calculated as sale price of an individual group of cattle minus the futures close on that same day.

Since feeder cattle are likely to be on-feed for several months, a determination had to be made as to which deferred live cattle contract to include. Secondly, since cattle of different weights sold each day, multiple deferred live cattle futures contracts were relevant on any given sale day. In order to determine the appropriate live cattle futures contract to include, assumptions had to be made about slaughter weight and average daily gain.

In addition to housing futures prices, the Livestock Marketing Information Center tracks data from Kansas State University's Focus on Feedlots Survey. This is a monthly survey of feedlots that serves as an excellent source of information about the cattle finishing industry. During the time period of the data, average steer slaughter weight was 1337 lbs, while average heifer slaughter weight was 1216 lbs (Kansas State University, 2008-2011). So, these became the assumed slaughter weights for cattle in the dataset. Steers were assumed to gain 3.5 lbs per day and heifers were assumed to gain 3.15 lbs per day (a 10% discount). The assumed slaughter weight, combined with the average daily gain allowed the author to make an estimate of slaughter date for the group of cattle. Once the estimated slaughter date was determined, the next expiring live cattle futures contract to that date was used.

Finally, an external source for fuel prices was needed to capture the potential effects of transportation costs on groups of feeder cattle. Historical diesel fuel price data were available from the Energy Information Administration (EIA) and included in the analysis. According to EIA, their data are collected each Monday through a phone survey. Since this was weekly data, it was assumed that the Midwest diesel price from the EIA survey applied to any cattle sales that occurred during that week (Energy Information Administration, 2011).

Methodology

In order to accomplish the goals of this research, statistical analysis was utilized. A hedonic model, using Generalized least squares (GLS) was the primary method of analysis. Hedonic models are common in the literature (Shultz et al., 2010, Bulut and Lawrence, 2007) and generalized least squares was attractive because it was deemed to be sufficient to answer the questions, but at the same time provided results with intuitive interpretation. This type of analysis is better received by non-economist stakeholders who are interested in specific questions and want tangible answers. The hedonic approach allowed for examination of factors associated with changes in feeder cattle prices in both datasets, examining factors affecting prices and basis levels.

In order to further evaluate the premium of age and source verification and certified natural, a Heckman model was used. The Heckman model is a two-stage sample selection model that combines a probit model with a standard regression. The rationale behind using the Heckman model is that individuals select themselves into groups (Heckman, 1979). In the case of consignors selling age and source verified cattle, the first choice made was to sell cattle as age and source verified.

The use of the Heckman model not only allowed the author to examine the impact of factors on feeder cattle prices, but also the factors that affect the decision to place cattle into premium targeted programs. In the first stage, a probit model is used with a binary dependent variable for whether a group of cattle in the internet sales were sold as age and source verified. In the second stage, regression is conducted using only those groups of cattle that were sold as age and source verified. So, stage one examines the factors that influence the decision to sell cattle as age and source verified and stage two examines the factors that affect the price of age and source verified groups of cattle.

Descriptive statistics for the two datasets can be found in Tables 3.1, 3.2, 3.3 and 3.4. In order to better understand the meaning and definition of variables in these four tables and in the analysis, the following is a comprehensive list of variables with explanations.

Description of Individual Variables – Internet Sales

Bid price – the price the cattle actually sold for on the day of the internet sale. This does not include any price slide adjustments. This was calculated using the final price, actual weight, and advertised slide.

Feeder futures – this is the closing price of the nearby feeder cattle futures contract on the day of the sale.

Internet Basis – calculated as bid price minus feeder cattle futures.

Corn futures – the closing price of the nearby corn futures contract on the day of the sale.

Lot size – number of cattle in the internet sale lot.

Base weight – the advertised weight of the cattle in the internet sale catalog.

Slide – price adjustment per 100 lbs for cattle that weigh above their specified base weight.

Live futures – the closing price of the relevant live cattle futures contract on the day of the sale. The relevant live cattle futures contract month was determined by making an assumption about days on feed based on average slaughter weight and average daily gain as discussed previously.

Diesel price – the weekly published diesel price from the Energy Information Administration (EIA) for the week of the sale.

Mileweigh – the number of miles the cattle were to be hauled to certified scales.

Time – continuous time variable. A 1 is assigned to the first internet sale date, 2 following day, and so on. Time can be thought of as days from the first sale date.

Steer – binomial variable, 1 if steer, 0 if otherwise.

Heifer – binomial variable, 1 if heifer, 0 if otherwise.

Imp – binomial variable, 1 if cattle were implanted, 0 otherwise.

Jan – binomial variable, 1 if sale in January, 0 if otherwise.

Feb – binomial variable, 1 if sale in February, 0 if otherwise.

March – binomial variable, 1 if sale in March, 0 if otherwise.

April – binomial variable, 1 if sale in April, 0 if otherwise.

May – binomial variable, 1 if sale in May, 0 if otherwise.

June – binomial variable, 1 if sale in June, 0 if otherwise.

July – binomial variable, 1 if sale in July, 0 if otherwise.

Aug – binomial variable, 1 if sale in August, 0 if otherwise.

Sept – binomial variable, 1 if sale in September, 0 if otherwise.

Oct – binomial variable, 1 if sale in October, 0 if otherwise.

Nov – binomial variable, 1 if sale in November, 0 if otherwise.

Dec – binomial variable, 1 if sale in December, 0 if otherwise.

Al – binomial variable, 1 if location in Alabama, 0 if otherwise.

GA – binomial variable, 1 if location in Georgia, 0 if otherwise.

IND – binomial variable, 1 if location in Indiana, 0 if otherwise.

KY – binomial variable, 1 if location in Kentucky, 0 if otherwise.

NC – binomial variable, 1 if location in North Carolina, 0 if otherwise.

OH – binomial variable, 1 if location in Ohio, 0 if otherwise.

TN – binomial variable, 1 if location in Tennessee, 0 if otherwise.

VA – binomial variable, 1 if location in Virginia, o if otherwise.

WV – binomial variable, 1 if location in West Virginia, 0 if otherwise.

Bbwf – binomial variable, 1 if cattle were predominantly black or black / white faced, 0 if otherwise.

Char – binomial variable, 1 if cattle were predominantly Charolais, 0 if otherwise.

Red – binomial variable, 1 if cattle were predominantly Red, 0 if otherwise.

Hols – binomial variable, 1 if cattle were predominantly Holstein, 0 if otherwise.

Mixed – binomial variable, 1 if cattle were mixed, 0 if otherwise.

PVP – binomial variable, 1 if cattle were PVP enrolled (age and source verified) and not natural, 0 otherwise.

Nat - binomial variable, 1 if cattle were certified natural and not PVP enrolled, 0 otherwise.

Pvpandnat – binomial variable, 1 if cattle were both PVP enrolled and certified natural, 0 otherwise.

Description of Individual Variables – CPH Sales

Sale price – the price the cattle sold for on the day of the CPH sale.

Feeder futures – this is the closing price of the nearby feeder cattle futures contract on the day of the sale.

CPH Basis – calculated as sale price minus feeder cattle futures.

Corn futures – the closing price of the nearby corn futures contract on the day of the sale.

Lot size – number of cattle in the CPH sale lot.

Weight – the average weight of the lot of CPH cattle.

Live futures – the closing price of the relevant live cattle futures contract on the day of the sale. The relevant live cattle futures contract month was determined by making an assumption about days on feed based on average slaughter weight and average daily gain as discussed previously.

Diesel price – the weekly published diesel price from the Energy Information Administration (EIA) for the week of the CPH sale.

Time – continuous time variable. A 1 is assigned to the first CPH sale date, 2 to the following day, and so on.

Steer – binomial variable, 1 if steer, 0 if otherwise.

Heifer – binomial variable, 1 if heifer, 0 if otherwise.

Jan – binomial variable, 1 if sale in January, 0 if otherwise.

Feb – binomial variable, 1 if sale in February, 0 if otherwise.

March – binomial variable, 1 if sale in March, 0 if otherwise.

April – binomial variable, 1 if sale in April, 0 if otherwise.

June – binomial variable, 1 if sale in June, 0 if otherwise.

Nov – binomial variable, 1 if sale in November, 0 if otherwise.

Dec – binomial variable, 1 if sale in December, 0 if otherwise.

Black – binomial variable, 1 if cattle were sorted as blacks, 0 if otherwise.

Blackx – binomial variable, 1 if cattle were sorted as black cross, 0 if otherwise.

Charx – binomial variable, 1 if cattle were sorted as Charolais cross, 0 if otherwise.

Smoke – binomial variable, 1 if cattle were sorted as smokes, 0 if otherwise.

Mix – binomial variable, 1 if cattle were sorted as mixed, 0 if otherwise.

Small - binomial variable, 1 if cattle were sorted as small framed, 0 if otherwise.

Buyer 1 - binomial variable, 1 if cattle were purchased by buyer 1, 0 if otherwise.

Buyer 2 - binomial variable, 1 if cattle were purchased by buyer 2, 0 if otherwise.

Buyer 3 - binomial variable, 1 if cattle were purchased by buyer 3, 0 if otherwise.

Buyer 4 - binomial variable, 1 if cattle were purchased by buyer 4, 0 if otherwise.

Other buyers - binomial variable, 1 if cattle were purchased by any other buyer, 0 if otherwise.

The Models

The models below were estimated using SAS (Statistical Analysis Software). Expectation of results and justification of the models can be found in the next section.

3.1) Bid price = B_0 + B_1 *lot size* + B_2 *lot size*^{2} + B_3 *base weight* + B_4 *live futures* + B_5 *corn futures* + B_6 *diesel price* + B_7 *heifer* + V_8 month + V_9 location + B_{10} *slide1* + B_{11} *imp* + V_{12} cattle type + B_{13} *mileweigh* + B_{14} *shrink* + B_{15} *PVP* + B_{16} *Nat* + B_{17} *PVPandNat* + B_{18} *PVPxTime* + b_{19} *time*,

3.2) Internet Basis = B_0 + B_1 *lot size* + B_2 *lot size*^{2} + B_3 *base weight* + B_4 *live futures* + B_5 *corn futures* + B_6 *diesel price* + B_7 *heifer* + V_8 month + V_9 location + B_{10} *slide1* + B_{11} *imp* + V_{12} cattle type + B_{13} *mileweigh* + B_{14} *shrink* + B_{15} *PVP* + B_{16} *Nat* + B_{17} *PVPandNat* + B_{18} *PVPxTime* + b_{19} *time*,

3.3) Internet Basis = B_0 + B_1 *lot size* + B_2 *lot size*^{2} + B_3 *base weight* + B_4 *feeder futures* + B_5 *diesel price* + B_6 *heifer* + V_7 month + V_8 location + B_9 *slide1* + B_{10} *imp* + V_{11} cattle type + B_{12} *mileweigh* + B_{13} *shrink* + B_{14} *PVP* + B_{15} *Nat* + B_{16} *PVPandNat* + B_{17} *PVPxTime* + b_{18} *time*,

where all variables are specified as described in the previous section. $V_{7,\,8}$ month is series of binomial variables for each month excluding January. $V_{8,\,9}$ location is a series of binomial variables for each state in which cattle originated except Tennessee. $V_{11,\,12}$ cattle type is a series of binomial variables for each cattle type except *Bbwf*.

3.4) CPH price = B_0 + B_1 *lot size* + B_2 *lot size*^{2} + B_3 *weight*^{2} + B_4 *live futures* + B_5 *corn futures* + B_6 *diesel price* + B_7 *heifer* + V_8 month + V_9 buyers + V_{10} cattle sort + B_{11} *time*,

3.5) CPH basis = B_0 + B_1 *lot size* + B_2 *lot size*^{2} + B_3 *weight*^{2} + B_4 *live futures* + B_5 *corn futures* + B_6 *diesel price* + B_7 *heifer* + V_8 month + V_9 buyers + V_{10} cattle sort + B_{11} *time*,

3.6) CPH basis = B_0 + B_1 *lot size* + B_2 *lot size*^{2} + B_3 *weight*^{2} + B_4 *feeder futures* + B_5 *diesel price* + B_6 *heifer* + V_7 month + V_8 buyers + V_9 cattle sort + B_{10} *time*,

where all variables are specified as described in the previous section. $V_{7,\,8}$ month is a series of binomial variables for each month excluding January. $V_{8,\,9}$ buyers is a series of binomial variables for each major order buyer, $V_{8,9}$ cattle sort is a series of binomial variables for each CPH cattle sort group except *Black*.

The following two-stage Heckman Model was estimated using STATA:

3.7a) PVP = B_0 + B_3 *base weight* + B_7 *heifer* + V_9 location + V_{12} cattle type + B_{16} *Nat* + + b_{19} *time*,

3.7b) Bid price = B_0 + B_1 *lot size* + B_2 *lot size*^{2} + B_3 *base weight* + B_4 *live futures* + B_5 *corn futures* + B_6 *diesel price* + B_7 *heifer* + V_8 month + V_9 location + B_{10} *slide1* + B_{11} *imp* + V_{12} cattle type + B_{13} *mileweigh* + B_{14} *shrink* + B_{15} *PVP* + B_{16} *Nat* + B_{17} *PVPandNat* + B_{18} *PVPxTime* + b_{19} *time*,

where all variables are specified as described in the previous section. V_8 month is a series of binomial variables for each month excluding January. V_9 location is a series of binomial variables for each state in which cattle originated except Tennessee. V_{12} cattle type is a series of binomial variables for each cattle type except *Bbwf*. Also, note that equation 3.7b estimates the model using only cattle that were PVP (age and source verified).

Diagnostics

Diagnostics are a crucial, yet often underappreciated element of any research project. Most datasets will exhibit some violations of basic assumptions of the models derived from them. Correctly addressing these violations, or at least acknowledging their affect on the results of the work, greatly improves the validity of the research and the interpretation of the results. The models discussed in the previous section presented multiple challenges for the author. Diagnostics were examined using SAS (Statistical Analysis Software).

Lack of spherical disturbances are very common violations of the OLS (Ordinary Least Squares Assumptions). Heteroskedasticity is present when the assumption that the variances across individual observations are uniform is violated. Similarly, autocorrelation is present when correlation is found to exist in the disturbances between observations when ordered by time. A Durbin Watson Test yielded a t-statistic outside the accepted range, suggesting the presence of autocorrelation. And, a regression of the squared-residuals from the models against dependent and independent variables suggested the presence of heteroskedasticity. Both problems are common violations of assumptions of the variance-covariance matrix and inflate standard errors of parameter estimates.

The solution to these problems chosen was to estimate the models using the robust estimator in SAS. This statistical procedure corrects for both heteroskedasticity and autocorrelation by adjusting the variance-covariance matrix. This was attractive for a couple of reasons. First, the robust estimator did not introduce bias into the model. So, parameter estimates are unaffected. The only effect on the results was a slight decrease in efficiency. When comparing the OLS standard errors to the GLS standard errors, the standard errors were increased slightly in the robust estimation. The effect of larger standard errors was that null hypotheses were harder to reject. However, in large datasets, like both used in this work, the effect on the significance of individual variables was very small. Hence, the author was willing to trade some efficiency in order to eliminate the affects of autocorrelation and heteroskedasticity.

The second reason had more to do with the initial motivation for the work, than the results. By continuing to use a linear estimation, the results are easier to explain to audiences outside the economics profession. Parameter estimates can be more easily interpreted and utilized by livestock market stakeholders. Again, a slight decrease in efficiency seemed like a good trade for maintaining this benefit.

In addition to autocorrelation and heteroskedasticity, multi-collinearity presents a challenge in many economic models. Multi-collinearity is present when two or more variables exhibit a largely linear relationship. This was of special concern since it has already been discussed that many of these commodity markets such as corn futures and live cattle futures have been moving together. In all likelihood, the large nature of the two datasets helped mitigate this potential problem.

The models were tested for multi-collinearity through a variance of inflation (VIF) test. A loose rule of thumb for VIF test is that a result greater than ten suggests a problem and less than ten does not. The two initial variables of concern were corn price and deferred live cattle futures. VIF statistics for these two variables were between 10 and 20 in the equations in which they were both present. Since the problem suggested was small, and both were crucial variables explaining feeder cattle price, excluding one of them seemed inappropriate.

The only case where VIF statistics suggested major concern were in initial model specifications where both *slide1* and *slide2* were included. For clarity, *slide1* is the price slide for the first 50 lbs over the base weight and *slide2* is the price slide once the payweight exceeds 50 lbs over the base weight. Further, VIF statistics were so high (greater that 200) that not addressing this problem did not seem to be an option. The only logical solution to the problem was to exclude the second slide variable, *slide2,* from the model. Once deleted, VIF statistics returned to highly acceptable levels.

Excluding *slide2* most likely had little effect on the model. First, most cattle came in reasonably close to their base weight as, on average, cattle weighed only two lbs above their base. Secondly, we are ultimately looking at the auction price, which was determined before actual weight was known. Therefore, if buyers expected the cattle to weigh within 50 lbs of their base weight, they would place little emphasis on the second, steeper price slide.

Expectation of Results

Much of the results expectations were indirectly discussed in Chapter 2 as comparable literature were discussed. The purpose of this section is to more formally discuss the expected effects of individual variables in the model. Tables 3.5 -3.7 summarize what is discussed in this section, listing the expected sign of each parameter estimate from equations 3.1 through 3.7.

It is well established that larger groups of cattle tend to bring higher prices as feeder cattle groups tend to move West in load lot (50,000 lb) units. For that reason, *Lot size* is expected to have a positive effect on the price of both internet and CPH cattle, as well as a positive effect on basis in all models. Conversely, *Lot size*^{2} is expected to have a negative sign as the return to additional calves in a lot is likely to show diminishing marginal effects.

The parameter estimates on *weight* and *base weight* are expected to have a significant negative sign in both pricing models. It is well established that heavier cattle tend to bring less per pound and this dataset should exhibit that same tendency. Further, the parameter estimate on these variables in the four basis models is also likely to be negative as the futures price is always based on seven weight feeder steers.

As described in chapter 2, the effect of corn price and deferred live cattle futures price on feeder cattle has been examined numerous times in the literature. *Corn futures* is expected to be associated with a negative price impact for both internet and CPH cattle, while *live futures* is expected to be associated with a positive impact on price in both datasets. While the expected effect on basis is less intuitive, feeder cattle in the southeast are likely to be more affected than feeder cattle in the west. Therefore, c*orn futures* is expected to have a negative effect on basis, while *live futures* is expected to have a positive effect on basis.

Diesel price should negatively affect prices of cattle in the southeast. Therefore, the parameter estimate on *diesel price* is expected to be negative for both price models. Further, since feeder cattle futures cash settle to prices to the west, a negative relationship is also expected in the four basis models.

Heifer is a binomial variable; steer is the base in all models. Heifers almost always sell at a price discount to steers due to their lower feed efficiency. For this reason, the parameter estimate on *heifer* is expected to be negative in both price models, all four basis models, and in the Heckman model.

Seasonality is expected to be a factor affecting price and basis. So, the monthly seasonal dummy variables are expected to be significant. In the case of all models, January is treated as the base. Generally speaking, feeder cattle prices are strongest in the spring and summer and weakest in the fall and winter. Given that expectation, a positive sign is expected on spring and summer months and a negative sign was expected on fall and winter months.

The binomial variables for cattle type are slightly different between the two datasets. However, in each case, the baseline chosen was the sort that is expected to be associated with the highest price. In the case of the internet sales, *bbwf* is chosen as the base; negative parameter estimates are expected for *char*, *hols*, *red*, and *mix*. In the case of the CPH sales, *black* is the base and negative parameter estimates are expected for *blackx*, *charx*, *small*, *smoke*, and *mix*.

The binomial variables for state of origin are unique to the internet sales, and are expected to have a significant impact on price. For the most part, as the distance from major cattle feeding areas in the mid-west increases, the lower cattle prices tend to be. In the case of the state variables, Tennessee had the most observations and therefore was used as the base case. So, since most states are further to the south and / or east most states will likely be associated with lower prices. Indiana has a small farmer feeder industry and is closest to cattle feeding areas in Illinois. Therefore, it would not be surprising to find a positive parameter estimate on *IND*.

Slide1 and *shrink* are variables also unique to the internet data set. Since *slide1* is the price adjustment for cattle that weigh more than advertised, it is expected that a higher price slide should be associated with higher prices (ie: a positive sign) as buyers will bid with increased confidence in the advertised weight. Similarly, since *shrink* is assigned after the cattle are actually weighed, buyers are likely to pay more for cattle with greater pencil shrink. So, like *slide1*, a positive parameter estimate is expected.

The final variables unique to the internet sales were of special interest to the management at Bluegrass Stockyards: the binomial variables for age and source verification (*PVP*) and natural (*Nat*). Generally, these cattle were expected to be associated with higher prices. Of course, the magnitude of these differences was the primary interest of stakeholders. It would be expected that the parameter estimate for *nat* exceed that of *pvp* and the parameter estimate for cattle that are both *pvp* and natural be larger than either.

The only remaining variable to be discussed are the buyers from the CPH sales. The four order buying firms that purchased most of the CPH calves are listed as *buyer 1*, *buyer 2, buyer 3,* and *buyer 4.* All other buyers are rolled together as the base of the model. Due to the competitive market environment, it was possible that no significant relationship would be found to exist between the buyer and the cattle price. However, there was also a possibility that buying firms would tend to buy certain types or quality of cattle. For this reason, it was expected that a significant difference would exist between buyer number and the price of the CPH lot.

Table 3.1 Descriptive Statistics (Internet Sales: Continuous Variables)

Variable	Mean	St. Dev	High	Low
bid price	$94.64	$12.40	$131.46	$61.00
feeder futures	$104.18	$9.52	$132.20	$87.35
basis	-$9.54	$9.23	$13.94	-$42.63
lotsize	73.61	39.14	639.0	10.0
corn futures	$4.56	$1.17	$7.55	$3.06
base weight	799.69	111.72	1075.0	420.0
live futures	$95.88	$9.62	$123.10	$80.82
diesel price	$3.15	$0.74	$4.67	$1.99
slide 1	$4.35	$0.92	$10.00	$4.00
slide 2	$6.35	$0.92	$12.00	$4.00
mileweigh	11.45	14.02	125.0	0.0
time	511.38	327.73	1203.0	1.0

Table 3.2 Descriptive Statistic (Internet Sales: Binomial Variables)

Variable	% of Observations
Heif	22.7%
Steer	87.3%
Jan	12.2%
Feb	7.8%
Mar	7.6%
Apr	7.6%
May	7.4%
June	8.1%
July	9.4%
Aug	10.7%
Sept	9.3%
Oct	8.0%
Nov	7.7%
Dec	4.0%
AL	1.7%
GA	5.1%
IND	0.1%
KY	23.1%
NC	4.7%
OH	4.5%
TN	31.2%
VA	26.2%
WV	3.3%
Imp	50.2%
bbwf	72.9%
char	3.6%
mix	12.0%
red	0.1%
hols	11.4%
pvponly	7.3%
natonly	0.009%
pvpandnat	2.8%

Table 3.3 Descriptive Statistics (CPH Sales: Continuous Variables)

Variable	Mean	St. Dev	High	Low
sale price	$95.32	$17.39	$169.00	$41.00
feeder futures	$102.40	$11.75	$132.70	$87.20
basis	-$7.08	$13.05	$36.30	-$52.95
lotsize	19.47	36.11	286.0	1.0
corn futures	$4.54	$1.29	$7.54	$3.18
weight	615.93	145.84	1063.97	314.0
live futures	$94.82	$11.03	$123.75	$81.05
diesel price	$2.97	$0.61	$4.57	$2.03
time	547.26	348.11	1190.0	1.0

Table 3.4 Descriptive Statistics (CPH Sales: Binomial Variables)

Variable	% of Observations
Heif	47.5%
Steer	52.5%
Jan	18.2%
Feb	14.1%
Mar	11.8%
Apr	13.0%
June	13.1%
Nov	10.2%
Dec	19.7%
black	25.7%
blackx	16.3%
charx	24.8%
mix	5.2%
small	7.2%
smoke	20.9%
buyer 1	15.1%
buyer 2	11.5%
buyer 3	31.1%
buyer 4	19.5%
other buyers	22.7%

Table 3.5 Expected Sign of Parameter Estimates: Internet Sales

Variable Name	Eq. 3.1	Eq. 3.2	Eq. 3.3
Lot size	Positive	Positive	Positive
Lot size^2	Negative	Negative	Negative
Base Weight	Negative	Negative	Negative
Live Futures	Positive	Positive	Positive
Corn Futures	Negative	Negative	Negative
Diesel Price	Negative	Negative	Negative
Slide1	Positive	Positive	Positive
Mileweigh	Negative	Negative	Negative
Shrink	Positive	Positive	Positive
Implant	Negative	Negative	Negative
Heifer	Negative	Negative	Negative
Feb	Positive	Positive	Positive
Mar	Positive	Positive	Positive
Apr	Positive	Positive	Positive
May	Positive	Positive	Positive
June	Positive	Positive	Positive
July	Positive	Positive	Positive
Aug	Positive	Positive	Positive
Sept	Positive	Positive	Positive
Oct	Negative	Negative	Negative
Nov	Negative	Negative	Negative
Dec	Negative	Negative	Negative
AL	Negative	Negative	Negative
GA	Negative	Negative	Negative
FL	Negative	Negative	Negative
IN	Positive	Positive	Positive
KY	Positive	Positive	Positive
NC	Negative	Negative	Negative
OH	Positive	Positive	Positive
VA	Negative	Negative	Negative
WV	Negative	Negative	Negative
Char	Negative	Negative	Negative
Hols	Negative	Negative	Negative
Red	Negative	Negative	Negative
Mix	Negative	Negative	Negative
PVP	Positive	Positive	Positive
PVPxTime	Positive	Positive	Positive
Nat	Positive	Positive	Positive
Time	Positive	Positive	Positive

Table 3.6 Expected Sign of Parameter Estimates: CPH Sales

Variable Name	Eq. 3.4	Eq. 3.5	Eq. 3.6
Lot size	Positive	Positive	Positive
Lot size^2	Negative	Negative	Negative
Weight^2	Negative	Negative	Negative
Live Futures	Positive	Positive	Positive
Corn Futures	Negative	Negative	Negative
Diesel Price	Negative	Negative	Negative
Heifer	Negative	Negative	Negative
Feb	Positive	Positive	Positive
Mar	Positive	Positive	Positive
Apr	Positive	Positive	Positive
June	Positive	Positive	Positive
Nov	Negative	Negative	Negative
Dec	Negative	Negative	Negative
Order buyer 1	Positive	Positive	Positive
Order buyer 2	Positive	Positive	Positive
Order buyer 3	Positive	Positive	Positive
Order buyer 4	Positive	Positive	Positive
Blackx	Negative	Negative	Negative
Char	Negative	Negative	Negative
Hols	Negative	Negative	Negative
Red	Negative	Negative	Negative
Mix	Negative	Negative	Negative
Time	Positive	Positive	Positive

Table 3.7 Expected Sign of Parameter Estimates: Heckman Model

Variable Name	Eq. 3.7	Eq. 3.8
Lot size	Positive	
Lot size^2	Negative	
Base Weight	Negative	Negative
Live Futures	Positive	
Corn Futures	Negative	
Diesel Price	Negative	
Slide1	Positive	
Mileweigh	Negative	
Shrink	Positive	
Implant	Negative	
Heifer	Negative	Negative
Feb	Positive	
Mar	Positive	
Apr	Positive	
May	Positive	
June	Positive	
July	Positive	
Aug	Positive	
Sept	Positive	
Oct	Positive	
Nov	Positive	
Dec	Negative	
GA	Negative	
KY	Positive	
NC	Negative	
OH	Positive	
VA	Negative	
WV	Negative	
Char	Negative	Negative
Red	Negative	Negative
Mix	Negative	Negative
Nat	Positive	Positive
Time	Positive	Positive

Chapter 4: Results and Overlying Themes

As was discussed previously, having access to two different datasets, covering the same period in time, allowed for examination of factors affecting feeder cattle prices on a deeper level. Consistencies among, and differences between, the results from the two datasets provided insight that would not have been possible with a single dataset. Overall, much was learned from the analysis and common themes emerged that appeared to affect prices in both the internet sales and the CPH sales held in Lexington. Results from the internet sales will be discussed first; then results from the CPH sales will be discussed. Once the results from equations 3.1-3.6 have been discussed, common themes will be examined. Finally, results from the Heckman model of PVP cattle from the internet sales will be considered.

Results: Internet Sales

The model examining the factors affecting feeder cattle prices in the internet sales (equation 3.1) had extremely high explanatory power. A model F-statistic over 450 and an R^2 of nearly 92% suggested that the explanatory variables included were highly significant in explaining a great deal of variation in prices for groups of cattle from the internet sales. Just as important as the explanatory power of the model, variables of interest were found to have logical effects, suggesting that the models were working well in explaining price variation in a practical sense.

Lot size and *lot size^2* were both found to be significant factors explaining price. The parameter estimate on *lot size* of 0.02 suggests that an increase of roughly two cents per cwt was associated with each additional head in a lot. The parameter estimate on *lot size squared* was very small, but negative. This suggested the non-linear nature of this variable. A significant positive sign on *lot size*, but a significant negative sign on *lot size squared*, suggests a diminishing marginal effect of this variable. As lot size increases, the marginal affects associated with each additional calf decrease. In other words, an increase in lot size from 10 head to 20 head would be associated with a greater price affect than an increase in lot size from 50 to 60 head. This is consistent with both the literature and the logic of cattle markets. Lot size will be further discussed in the Overlying Themes section that follows later in this chapter.

Also, as expected, *base weight* had a significant effect on price. The parameter estimate of (0.025) suggested that an increase in the base weight of one pound was associated with a decrease in price of about 2.5 cents per cwt. This is a bit lower that might have originally expected, but is most likely due to two primary factors. First, the average weight of the internet sale lots was nearly 800 lbs. Price slides tend to tighten as weights increase and use of a non-linear specification would seem to be a logical approach. However, multiple non-linear specifications were examined, but including both *base weight* and *base weight squared* introduced severe multi-collinearity into the model. Since both could not be included, *base weight* was chosen, as it had greater explanatory power.

Secondly, corn price averaged over $4.50 per bushel during the time period of this dataset. Most historical work on price-weight relationships was based on time periods when corn prices were significantly lower. Higher corn prices tend to be associated with feedlot preference for heavier cattle, hence the small price-weight relationships that were found in this analysis. This concept will also be further discussed in the Overlying Themes section.

Both deferred *live cattle futures* and *corn futures* impacted price as expected in Table 3.5. An increase in live cattle futures of $1 per cwt was associated with an increase in the price of lots in the internet sale by $1.12 per cwt. An increase in corn price by $1 per bushel was associated with a decrease in the prices of cattle by $2.97 per cwt. The magnitude of these parameter estimates was a bit less than might have been expected, but again, it is important to note that the time period from which this dataset was derived was associated with overall high price levels for both corn and live cattle futures prices. Further, the heavier weight of the cattle in the internet dataset also likely limited the size of these estimates.

Fuel price was one of the variables of interest for this work as many feeder cattle pricing models have neglected to consider this factor. As expected, it was associated with a significant negative change in price. A one dollar increase in diesel fuel price per gallon was associated with a decrease in price of $0.76 per cwt. This is evidence that as transportation costs increase, downstream entities respond by paying a bit less for feeder cattle.

The parameter estimate on *heifer* was negative, also as expected given their lower expected feed conversion. While this result is in no way surprising, it is encouraging in that it suggests the model is working as would be expected. In the internet sale model, equation 3.1, heifers were associated with a lower price by $6.99 per cwt. The magnitude of the impact is also logical as the steer / heifer differential tends to narrow as calves get heavier.

Seasonal effects were significant, as expected, although monthly parameter estimates were slightly different. The parameter estimates for the months of February and March were not significantly different from January. The months of April through August were all associated with higher prices than January. It is interesting to note that parameter estimates shifted from significant and positive to significant and negative as we moved from *Aug* to *Sept*. The months of September through December were all associated with significantly lower price levels suggesting a relatively steep price decline from August to September and a more gradual move upward from December to April.

Parameter estimates on cattle type were also largely as expected. The base case was black and black and white-faced cattle and all other classifications were either statistically equal to the base case (as in the case of *char* or *red*) or associated with lower prices. Cattle with the *mix* classification were associated with a lower price by $1.29, while Holsteins were associated with a lower price of $22.69 compared to the base. The large negative impact of the *hols* variable is most likely a function of lower expected dressing percentages and an overall decline in market desire for backgrounded Holstein steers.

Several variables unique to the internet sale dataset were very useful in explaining price variation. Binomial variables for state of origin suggested that spatial effects were at play. With Tennessee as the base, states closer to major cattle feeding areas, such as Kentucky and Indiana, were associated with higher prices. States like Georgia, Florida, Virginia, North Carolina, and West Virginia were associated with lower prices. Also consistent with this logic, the state located furthest away from the Midwest, Florida, was associated with the largest negative parameter estimate. In addition to the greater transportation costs, cattle being hauled greater distances are also likely to be more stressed and therefore buyers may have also expected higher morbidity and mortality.

It is also not surprising that the parameter estimate on Indiana was larger than other states, but the magnitude was larger than expected. It is worth noting that there were only two observations from Indiana in the internet dataset. Most likely, the extremely high nature of this parameter estimate was primarily due to outlying nature of these two observations.

While parameter estimates on binomial variables associated with the state cattle originated from were no doubt heavily linked to transportation costs, it important that one understand other factors that may have been involved. Binomial variables can capture any effects that are not otherwise included in the model. In this particular study, cattle were consigned from states as far away from each other as Indiana and Florida. Clearly, transportation and the associated stresses are important, but there may have also been differences in the type and quality of the cattle in different states that may have affected price. For example, cattle in warmer climates such as Florida likely had more Brahman influence, which may also explain some of the price impacts that were seen. It would be inappropriate to interpret state binomial variables in terms of proximity to cattle feeding areas without discussing possible influences of cattle type as well.

The variables *shrink* and *mileweigh* are somewhat related in the models. As discussed in Chapter 3, *mileweigh* is the number of miles that cattle were hauled before weighing and *shrink* is the percentage reduction from the actual weight of the cattle to the pay weight. Generally, cattle hauled further distances were not shrunk near as much, if at all. Cattle weighed on the farm were usually shrunk 2%, 3% in a few cases but this was generally when cattle were expected to be a bit muddy. *Shrink* was found to be insignificant in explaining price variation, but the distance the cattle were hauled was significant. A one mile increase in the distance hauled prior to weighing was associated with a significantly lower price by about two cents per hundredweight. This, small but significant, effect is most likely due to the perceived stress on the calves from travel. It is also important to note that most haul distances were quite small, with the average being about 11 miles.

The *slide1* variable, which was the adjustment to price for cattle that came in above the base weight, was also significant in the model. As expected, higher slides were associated with higher prices for cattle in the internet sales. A one dollar per cwt increase in *slide1* was associated with a $0.49 increase in price. This is evidence that bidders bid with more confidence when they encounter steeper price slides.

The positive sign on *imp* was unexpected. In table 4.1, cattle that had been implanted were associated with a higher price of more than $0.39 per cwt. As discussed in Chapter 3, a negative sign was expected as feedlots were likely to expect a greater implant response from cattle that had not previously been implanted. After contemplating these results, it is plausible that the *imp* variable may be capturing more than expected.

One possible explanation for the positive sign on the *imp* variable is that buyers may have expected some lingering positive effects from the implants administered. Implant dates were not available, so this hypothesis cannot be tested. While this is possible, consignors would have most likely timed implant administration for their maximum benefit, rather than downstream entities.

A more logical explanation for the positive price impact of the *imp* variable has to do with the perceived management or overall appearance of the implanted cattle. It is important to be aware that factors outside those available in the sale catalog or summary report could not be considered. Perhaps buyers felt that consignors who implanted cattle were better managers. If they were, quality factors outside of those measured might result in higher bid prices in the internet sales. Additionally, implanted cattle may have appeared to be heavier muscled, or at least perceived to be heavier muscled, than their non-implanted counterparts. This would also likely have resulted in stronger bids from feedyards and may explain the positive parameter estimate that resulted.

The final variables to be discussed in the internet sale model (4.1) involve the added-value estimates for *PVP* and natural cattle. As expected, *PVP* cattle, natural cattle, and cattle with both attributes were associated with higher price levels than cattle that were neither *PVP* nor natural. *PVP* cattle were associated with a $1.35 higher price than the base, natural cattle were associated with a $2.18 higher price than the base, and cattle with both attributes were associated with a higher price of $3.97 above the base.

Also of interest was the potential effect on time as it related to age and source verification. An interaction term was included between the time element and the *PVP* binomial variable to see if the premium for age and source verification trended over time. The parameter estimate was found to be statistically equal to zero at the 95% confidence level, suggesting there was likely no time effect on the *PVP* variable over the period considered. The same approach was attempted with the natural variable, however including the time interaction term resulted in lost significant on the *nat* variable. So, the decision was made to exclude this interaction term from the analysis. Regardless, it does not appear that *time* has had a significant influence on these premium levels when everything else, including *time* itself, was held constant.

Finally, it is important for the reader to be aware that a time trend was found to be associated with price. A one day change in *time* was associated with an increase in price of about nine-tenths of one cent per cwt. This sounds like a very small effect, but it is important to realize that this dataset covered over three years. At its mean, the *time* variable has a value of over 500, suggesting that this time trend is something to remember as results are interpreted. The overall feeder cattle market was clearly trending upward when all other factors in this analysis were held constant.

Both models seeking to explain basis in the internet sales, equations 3.2 and 3.3, did an excellent job. The model including feeder cattle futures, rather than *corn futures* and deferred *live futures* saw a slightly higher coefficient of determination and a slightly higher F value. Both approaches had been taken in previous literature and results typically are very similar.

For the most part, significant variables are quite consistent between the two basis models. Parameter estimates on *lot size*, *lot size*^{2}, *base weight*, *heifer*, *slide1*, *implant*, and cattle type are very similar when rounded to the nearest dollar and consistent with results from the price models. This robustness is taken as a positive sign that the models are capturing the various affects appropriately.

Binomial variables on state of origin appear to make intuitive sense. States further away from cattle feeding areas appear to be associated with lower (more negative) parameter estimates. This is consistent with the results from equation 3.1. The single surprise from the state variables was Indiana, which was associated with a considerably higher price in Table 4.1, but now is not statistically different from the base Tennessee. Again, with only two observations from *IN*, results should be taken with care. Secondly, it's also worth noting that *IN* remains the most positive parameter estimate of the state dummies, albeit significantly equal to zero. It is also not surprising that parameter estimates on *PVP*, *nat*, and *pvpandnat* are all positive and in the same order of magnitude as in Table 4.1.

The interesting results as one compares the two basis models centers around the impact of *feeder futures*, *corn price*, *live futures*, and *diesel price*. Note first, that in Table 4.3 the feeder cattle futures price is significant in explaining basis. As feeder futures increases, basis tends to decrease or weaken. In this same model, a one dollar increase in diesel fuel prices is associated with a $0.46 decrease in basis. When examining Table 4.2, live cattle futures and *diesel price* are found to be significant, but *corn price* is not. All these variables were significant in the price model.

Theoretically, *corn futures* and *live futures* should be the primary drivers of feeder cattle futures. In Table 4.2, live cattle futures were found to be significant in explaining basis, while corn price was not. The smaller parameter estimate on *live futures* suggests that feeder cattle futures prices are also moving in response to changes in deferred live cattle futures, and the net result is a much smaller change in basis than would be seen on price.

The insignificant result for corn was unexpected as previous work had generally found some affect on basis from changes in corn. However, note the highly significant, larger parameter estimate on *diesel price* in the same model. While it is difficult to say with certainty, the relationship between *corn price* and fuel price is likely coming into play here. Since both were not included in the equation 3.3, this was not found to be an issue. Further discussion of this will ensue in the Overlying Themes section and in Chapter 5.

Results: CPH Sales

In general, explanatory power of the CPH models were lower than explanatory power of the internet sales models. This was not surprising as much more information was available for cattle in the internet sales. Still, explanatory power was relatively strong with a coefficient of variation just under 78% for the CPH sale price model and in the low 60%'s for the two CPH basis models. Additional insight was gained by comparing model results from the two datasets.

General results for impact of *lot size* and *weight* on price were consistent across the two datasets. In the CPH price model, Table 4.4, a one head increase in *lot size* was associated with a little more than a $0.09 per cwt increase in price. The magnitude of this effect was much higher than in the internet sales, but an important distinction must be made. For the most part, cattle in the internet sales were sold in load lot quantities already. So, it is not surprising that the marginal impact of lot size in those sales was smaller than in the CPH sales, where smaller groups are often sold.

Simply comparing the magnitudes of the *lot size* variables may also be insufficient as it ignores to simultaneous impacts of the lot *size*^{2} variable. The negative sign on *size*^{2} is consistent across the two datasets and suggests a decreasing return to the increased *lot size*. Lot size will be discussed in more detail in the overlying themes, following this section of Chapter 4.

As expected, weight was significant in explaining price variation for groups of calves in the CPH sale. A squared variation of weight was chosen as it improved explanatory power of the CPH model. Including both *weight* and *weight*^{2} was determined to be inappropriate as doing so introduced considerable multi-collinearity. As expected, in the CPH sale model, an increase in weight was associated with a decrease in price for calves. Since a different specification was used, parameter estimates for *base weight* in the Table 4.1 and *weight*^{2} in Table 4.4 cannot be directly compared.

The effect of *corn futures* and *live futures* was also very much as expected and very consistent with results from internet sales. A $1 per cwt increase in deferred live cattle futures was associated with a $1.21 increase in price for groups of cattle in the CPH sales. A $1 per bushel increase in corn price was associated with a decrease in price of $4.20.

The magnitude of the impact from changes in live cattle futures was very consistent across the two datasets. However, the parameter estimate on *corn futures* was about 40% higher. At first glance, this seems like a large difference considering the models were derived from data covering the same basic time period. However, it is important to note that, on average, CPH cattle were more than 150 lbs lighter than cattle from the internet sales. The weight difference likely explains the differing magnitudes.

Another possible explanation for the larger magnitude on *corn futures,* would be the surprising result that *diesel price* was insignificant in explaining price in the CPH sales. It is possible since corn and diesel tend to move together that the *corn futures* variable may be capturing both potential effects. Another possible explanation would involve the demand for CPH calves. One could argue that the "brand" identity of CPH calves had escalated to the point that buyers were not deterred by factors such as shipping costs. However, if this were the case, one would expect similar evidence in other traditional factors such as feed and slaughter cattle prices.

All but one of the remaining explanatory variables were binomial, and for the most part, results were as expected. With steers being the base of the model, a negative sign was expected on *heifer*. As can be seen in Table 4.4, heifers were associated with nearly a $11 lower price per cwt. The magnitude of the parameter estimate on *heifer* was much larger in CPH sales than in internet sales, but again, differences in cattle weights most likely explain the difference. Since heifers typically sell for lower prices than steers due to feed conversion, there is logic in the result that the discount is steeper for the lighter CPH sale cattle.

Seasonal variation was also logical and very consistent with results from the internet sales. For clarity, one should note that CPH sales were only held in seven months out of the year; no sales were held in May, July, August, September, or October. With January as the base, the remaining first quarter months of February and March were not found to be statistically different. The spring and summer months of April and June were associated with higher prices than January by $2.69 and $2.30 respectively. Conversely, the fall and winter months of November and December were associated with lower prices than January by $3.84 and $3.21 respectively.

The parameter estimates on cattle sorts all had the expected sign. Since *black* was the base, all other sorts were expected to be associated with lower prices. The surprise to many readers will likely be the magnitude of some of the impacts. In order to understand these magnitudes, it is important to remember that in sales such as CPH, uniformity and critical mass become crucial. For many of the sorts such as mix or small, sufficient numbers to put together uniform load lots most likely did not exist as both these sorts accounts for less than 10% of total CPH cattle. Further, results would suggest that the uniformity of the *black* and *smoke* sort was preferred over the *blackx* sort, which was associated with a considerably lower price.

It was also an interesting and unexpected finding that one of the large order buying firms was associated with lower prices than the others. The base of the model was cattle purchased by individuals and companies outside of the largest four. Groups of cattle that were purchased by *order buyer 3* were associated with lower prices of $1.82.

Finally, since it was determined that *time* was a significant factor affecting internet sale prices, there was merit in including it in the CPH models as well. And, consistent with results from the internet sales, a *time* trend was found to exist. Each additional day was associated with higher CPH prices by just under one cent per cwt. Again, while this seems small, with data covering over three years the *time* element should not be ignored. Perhaps the greatest advantage to including *time* is to eliminate inflation of parameter estimates that might exist had it not been included.

As with the internet basis models, results from CPH basis models were largely consistent. Once again, slightly greater explanatory power was found when the basis models included *feeder futures* rather than *corn futures* and *live futures*. However, both were able to explain more than 60% of the variation in basis. As in the case of the price models, Tables 4.1 and 4.4, explanatory power was likely higher for the internet basis models due to the additional information that was available.

Parameter estimates for the effect of $weight^2$, *lot size*, $lot\ size^2$, and *heifer* are all as would be expected and consistent with results from Table 4.4. Estimated affects from cattle type are also consistent with results from 4.4, with stronger basis existing for black cattle, followed by *smoke*, then *small*, mixed, and more variable cattle types. *Diesel price*, which was found to be insignificant in explaining CPH price, was also not significant in explaining basis for CPH calves either.

For the most part, seasonal variables were also consistent. In all models, no statistical difference was found to exist between the first quarter months. Prices were generally stronger in spring and summer months and weaker in fall and early winter months. The base of January, and the months of February and March were comfortably between the spring / summer and fall price effects.

A couple unexpected and interesting findings exist from Tables 4.5 and 4.6. First, note that neither *corn futures* nor live cattle futures were significant in explaining CPH basis in Table 4.6. Signs on the parameter estimates were as expected, but standard errors were too large to suggest significance. This is not inconsistent with table 4.2 as only deferred live cattle futures were significant in explaining internet basis. However, in both the case of internet sales and CPH sale, feeder cattle futures do appear to be negatively related with basis levels. As futures prices increase, Kentucky basis tends to weaken. While deferred live cattle futures and *corn futures* should move very much in tandem with feeder cattle futures, the models were only weakly able to isolate the individual basis effects of the former.

Basis effects from buyers were less robust than expected. *Order buyer 3*, which was associated with lower price levels earlier, was associated with weaker basis only in Table 4.5. A negative parameter estimate was found in table 4.6, but t-statistics were too low. *Order buyer 2*, which pushed the edge of significance in the price model, was found to be associated with strong basis levels in both basis models. *Order buyer 1* was associated with significantly stronger basis levels only in equation 3.6, but parameter estimates were positive in all cases. The effect of the fourth order buyer was not found to be significantly different from the base in any of the three CPH model.

Overlying Themes

Based on results from price and basis models, several overlying themes surfaced. First, those fundamental factors known to affect feeder cattle prices for years are still very much at play in today's market. Results from this work suggested that feeder cattle prices were negatively affected by corn price despite some recent evidence in the literature that this may have changed (Schultz et al., 2010, Tejada and Goodwin, 2011). While parameter estimates may have been smaller in magnitude than expected, the fundamental relationships were found to exist when holding other factors constant. The magnitude of these corn prices effects are also worth discussion.

Smaller magnitudes could be the result of the uniqueness of these datasets or existing market conditions. The effect of corn price would be expected to be less for heavier feeder cattle and the average weight for both of these datasets was relatively high. This expectation is supported in the literature (Bucolla, 1980, Trapp and Eilrich, 1991, Dhuyvetter and Schroeder, 2000, Burdine, 2003), and in this very study, as the parameter estimate on corn price was larger in the CPH price model than in the internet sale price model.

However, there is another logical explanation that is also likely at play in this recent work. As was mentioned in chapter 1, overall corn price levels were much higher during the time period of this work than in many earlier studies. With higher corn prices, the incentives for feedlots and backgrounders to explore alternative feeds and feeding systems are greater. If alternative feeds become more attractive and their prices do not increase as sharply as corn, the effect of the rising corn price may well be less.

One can also consider how the feeder cattle market chain may have adjusted over the last several years to higher corn prices. Higher corn prices tend to narrow price slides for feeder cattle as feedyards look to place heavier cattle. This potential increased margin provides increased incentive for backgrounders and backgrounding cost of gain may be lower than feedyard cost of gain as backgrounders may have more ability to utilize alternative feeds, including pasture. The increased role of backgrounding and stockering during high feed price times would also tend to decrease the magnitude of corn price effects as substitution comes into play.

Another common theme existed when looking at the effect of *lot size* and *lot size^2* in the two pricing models. Both exhibited very similar lot size effects over the primary range of the data examined. Figures 4.1 and 4.2 estimate the lot size affects, including both *lot size* and *lot size^2*, for the internet and CPH price models respectively. Since both variables were found to be significant and the relationship non-linear, a graphical examination can aid to our understanding. It is also worthwhile to note where the mean of the *lot size* variable exists. In the case of the internet sales, mean lot size was just over 73 head, while mean lot size for CPH sales was only 19 head. Of course estimations are most accurate at and around the mean, but the fact that this specification was found superior to other linear and non-linear specifications suggests that the overall implications are useful.

Note first, that both graphs exhibit a positive relationship between lot size and price and this positive relationship exists well beyond the mean in both cases. On average, increasing *lot size* is associated with increasing prices. It's also interesting to note that the maximum price affect occurs between \$3.00 and \$3.50 per cwt for the internet sales and between \$4.00 and \$5.00 for the CPH sales. This is most likely because most the vast majority of the internet cattle were in load lots to begin with. This was not the case with the CPH cattle, hence more benefit was possible.

Figure 4.1: Lot Size Effects on Internet Sale Prices (\$ per cwt)

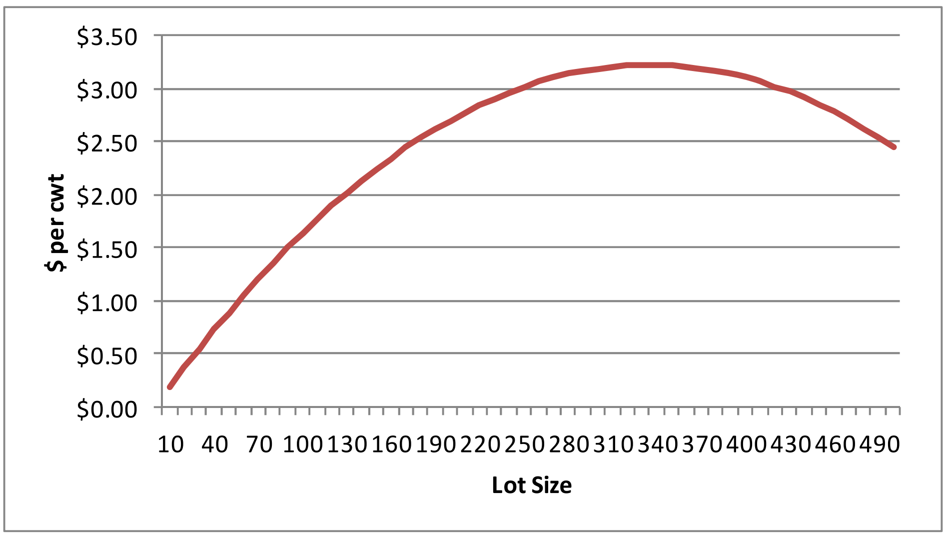
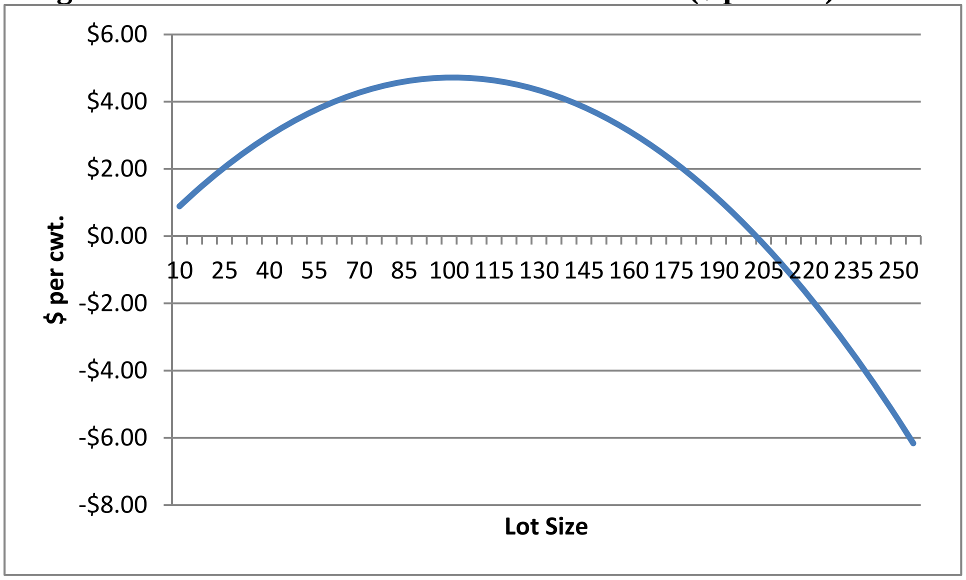


Figure 4.2: Lot Size Effects on CPH Sale Prices ($ per cwt)



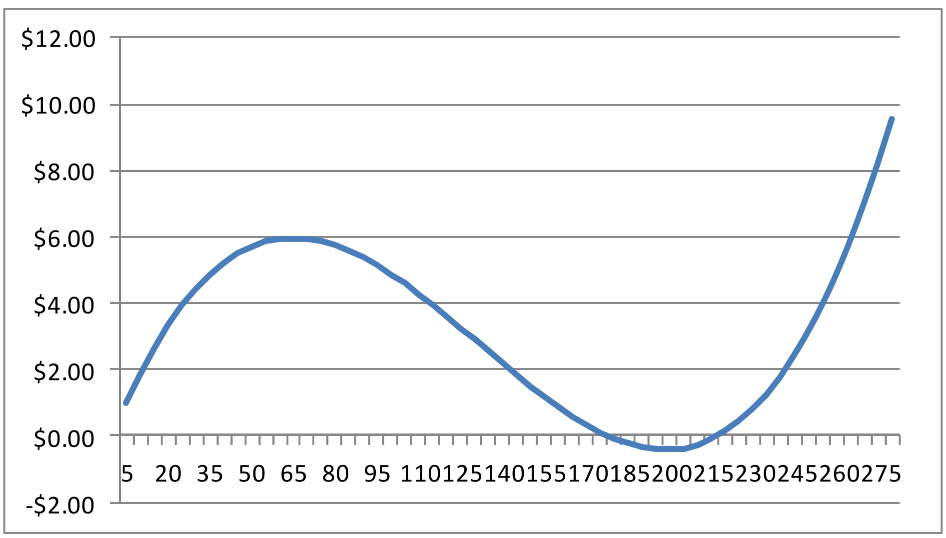
In terms of where the maximum price benefit is achieved, it appears to be at a much higher lot size for the internet sales. Again, familiarity with the data may help aid understanding. Maximum *lot size* in internet sales was 639; maximum *lot size* in CPH sales was 286. Smaller lot sizes were much more common in the CPH sales, but in both cases, observations on the upper end of the range were very unusual. While fewer observations clearly imply less confidence as one moves further to the right on those graphs, the overall shape in figure 4.1 most likely captures price effects in the internet sales reasonably well.

In the case of the CPH-sales, figure 4.2 not only suggests that lot size begins to negatively affect price around 100 head, but that price effects turn negative within the rage of the data. For this reason, a bit more exploration was necessary to better understand the lot size effects in the CPH price model. First, an examination of residuals provided a better picture of model fit. In an attempt to best fit the data, which was heavily concentrated at smaller lot size, the prices of extremely large lot sizes were being underestimated. Specifically, lot sizes over 200 head were being overestimated by $2.50 per cwt.

It is also noteworthy that some alternative specifications were explored in an attempt to better model the lot size / price relationship in the CPH sales. A logical approach would have been to explore using a *lot size*^{3}, in addition to *lot size* and *lot size*^{2}. The cubed term would allow the graph to flatten out, or even turn positive at higher lot sizes. However, this specification was not chosen for two reasons. First, the addition of the *lot size*^{3} variable introduced a great deal more multi-collinearity as VIF statistics for *lot size*, *lot size*^{2}, and *lot size*^{3} increased to 28.1, 122.1, and 50.0 respectively.

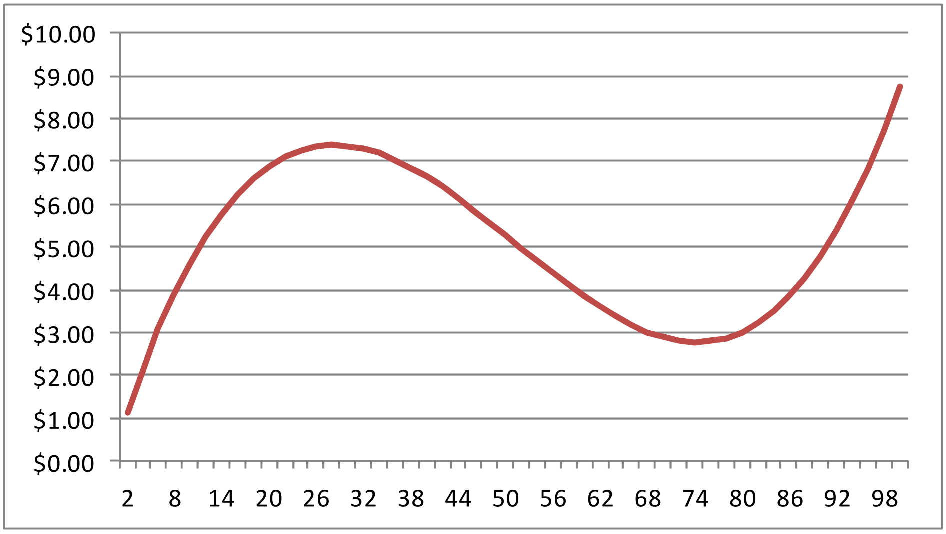
However, the presence of multi-collinearity was not a sufficient reason to rule out this specification as all three lot size variables retained their significance and parameter estimates on other key variables were relatively robust. Ultimately, it was decided that a graphical representation of the lot size relationship when including the *lot size*^{3} variable was not logical. A graphical depiction of this relationship can be found in figure 4.3 below. The sharp decrease in price effect beyond lot sizes of 65 seem illogical, as did the rapid increase of price effect for lot sizes exceeding 200 head.

Figure 4.3: Lot Size Effects on CPH Sale Prices ($ per cwt) including *lot size*^{3}



Another logical approach was to use break to CPH data up into groups and use an interaction term between lot size and a binomial variable for lot size scale. As can be seen in figure 4.2 maximum price benefit in CPH sales appeared to occur around 100 head, so that was chosen as the break between large and small lot sizes. Effectively, this approach allowed for different lot size effects for groups of cattle under 100 head and over 100 head. This specification was rejected for a couple reasons. VIF statistics suggested an even greater presence of multi-collinearity. And, graphical representation did not do a good job explaining the lot size effects. As can be seen in figure 4.4 below, this approach estimated maximum price benefit for lots under 100 to be around 30 head and a local minimum was found to exist around 70 head. Neither of these two results are logical given trucking efficiencies in the cattle business.

Figure 4.4: Lot Size Effects on CPH Sale Prices ($ per cwt) binomial variable approach

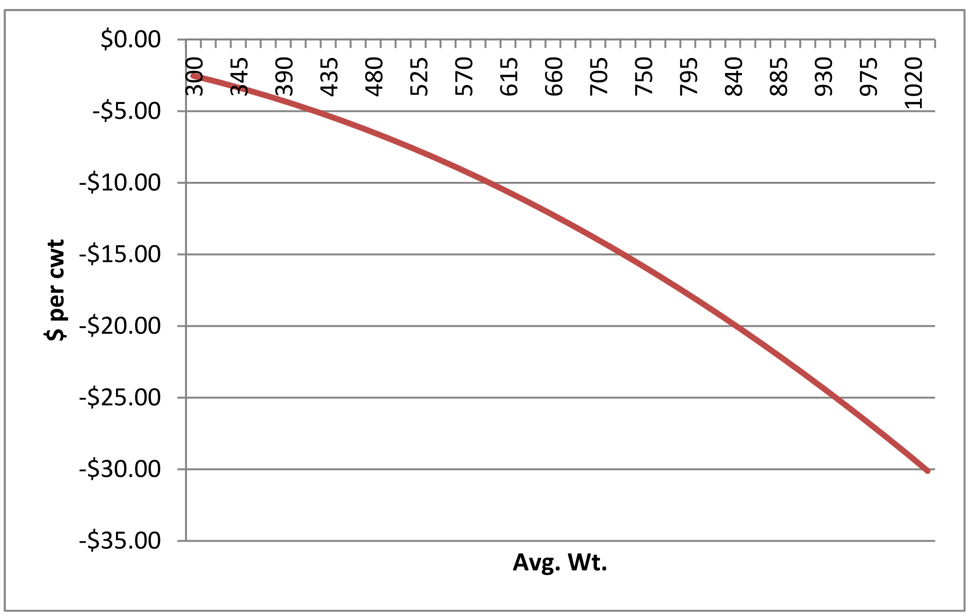


While no specification was perfect, the initial specification described in figure 4.2 was chosen as the most representative, although the model is clearly underestimating price for extremely large lot sizes. One common theme that emerged in all specifications was that a maximum price benefit did appear to exist. Some would initially question why the *lot size* effect would start to decrease at any point. However, extremely large groups of cattle do limit the potential buyers somewhat due to diseconomies of size. Small farmer feeders often can handle no more than a few groups at a time. And, even if we think about the system as working through order buyers, extremely large groups require additional logistical challenges if larger groups are further sorted and sold to multiple buyers. While one can argue about where the maximum level is reached, its existence can be rationalized.

Another traditional factor that merits additional discussion is *weight*, specifically the average *weight* of the groups of cattle that were sold in the internet and CPH sales. The fact that a negative relationship was found to exist between *weight* and price is hardly worth mentioning. However the specifications chosen do offer some insights into these models. As was mentioned before, including both *weight* and $weight^2$ was not possible due to the introduction of severe multicollinearity. So, in each price model, the best specification was chosen based on explanatory power. It is also worth mentioning that logs of *weight* were also considered as a possible specification, but found to possess less explanatory power.

As can be seen from the equations in Chapter 3, a linear weight relationship worked best for the internet sales and a squared weight term worked best for CPH sales. While the linear relationship can be easily visualized, it would be irresponsible not to discuss the price-weight relationships in the CPH sales in a bit more detail. Figure 4.5 below expresses this relationship quite well.

Figure 4.5: Weight Effects on CPH Sale Prices ($ per cwt)



The mean weight of CPH sale groups was just under 616 lbs. So as before, it's important to note that estimation is most accurate around that mean. However, many observers will likely be surprised by the fact that this specification, and the concave shape of the relationship, was found to have the highest explanatory power. To be specific, this graph suggests that as cattle get heavier the marginal decreases in price actually get larger. In practice, we usually see price slides narrow as cattle reach heavier weights. Again, a firm understanding of the data is required to make sense of this finding.

KY CPH-45 is a preconditioning program. Calves are managed according to a uniform set of guidelines with the intent to decrease morbidity and mortality in the feedlot. For this reason, CPH calves typically sell at a price premium to non-CPH calves and those premiums are typically largest for lighter calves. This is logical because health problems tend to decrease as cattle get larger. So, the primary price benefit occurs for lighter calves, rather than yearlings, although both do appear in CPH sales.

This is likely why this concave specification had higher explanatory power. As cattle get heavier, traditional slides do tend to tighten, but in the case of CPH cattle, the advantage to the health programs tends to decrease. Lighter cattle receive more price premium than heavier cattle, so as cattle weight increases, decreasing price premium offsets the tightening price relationships. Hence, we have some evidence that CPH price slides may actually increase (become more negative) at an increasing rate.

One of the unique aspects of the internet sales is the element of uncertainty that is present. The cattle are not seen in the flesh, weight is not known with certainty, and other factors are largely only known to the extent that they are visible via video or revealed by the consignor. This allows for analysis of some unique factors. For example, Brorsen et al. (2001) found that price slides were typically not large enough to provide a disincentive to underestimate weight. Hence, they found evidence that cattle typically weighed more than advertised in Superior Internet Auctions. However, little evidence of weight underestimation was present in the dataset employed in this analysis.

In the bluegrass internet sales, cattle actually weighed on average only two lbs over the advertised *base weight* compared to 15 to 20 lbs in the Brorsen study. Pay weight was available, but was not included in regressions as it was not known until after the auction. One could argue that reputation and repetitive procurement relationships explain this. One could also suggest that after ten years the cattle market has evolved and moved towards a more efficient system. However, it is also possible that market conditions have changed such that this incentive that Brorsen et al. found in 2001 may not be near as prevalent today.

As mentioned before, the average weight of cattle in the internet sale dataset was just under 800 lbs. The absolute smallest price slide offered in the internet dataset was $4 per cwt. In order for an incentive to exist for producers to underestimate weight, the actual price slide in the market would need to exceed $4 per cwt. While this likely was the case in 2001, our data suggests that it did not exist from 2008 to 2011. Note the parameter estimate on the weight variable; a one hundred pound increase in weight was associated with a price decrease of only $2.54 per cwt. In other words, cattle advertised as weighing 800 lbs, but actually weighing 850 lbs would bring a lower price than the same group of cattle advertised at 850 from the very beginning.

Effects of Age and Source Verification and Natural

As the price effects of age and source verification were the initial motivation for this work and the primary interest of stakeholders, further exploration of this value added opportunity was well warranted. Results in Table 4.1 provided evidence that price premium existed. A positive price relationship was found to exist of more than $1 per cwt for age and source verification alone, more than $2 per cwt for natural alone, and nearly $4 for cattle that were both natural and age and source verified. In the interest of thoroughness, it should be noted that while all parameter estimated were found to be statistically different from zero at the 90% level or greater, only the parameter estimates on *PVP* ($1.35) and *PVPandNat* ($3.97) were found to be statistically different from each other.

In order to further examine the market for age and source verified cattle, a two-stage Heckman model was employed. Results from the Heckman model are presented in Table 4.7. Results from the first stage, the probit model, are found in the first two columns of Table 4.7. The probit portion of the Heckman model examines factors that impact the probability of cattle being age and source verified. The first column reports parameter estimates directly from the probit model. The magnitude of these parameter estimates cannot be compared directly; only the sign and significance are useful in explaining the likelihood of a group of cattle being age and source verified. For this reason, marginal effects are included in the second column. Marginal effects do have a more intuitive interpretation and may therefore be more useful to the reader. Marginal effect can be thought of as the percentage change in the probability of a group of cattle being age and source verified. As an illustration, the marginal effects on the variable *heifer* were estimated to be (0.028). This means that heifers are 2.8% less likely to be PVP enrolled than the base of the model.

Note that all variables were not included in the first stage, only variables that likely would have affected the decision to enroll cattle in a *PVP* program. Specifically, since this decision was made well in advance of the sale date, only factors known at that time were included. For example, market factors such as *corn futures*, *live futures*, and *diesel price* were not known at decision time and were therefore excluded. Also excluded were variables that captured sale conditions and seasonality. It was determined that the factors most likely to affect the decision to PVP cattle were the weight of the cattle, their state of origin, sex, cattle type, *time*, and whether the cattle were also natural.

A negative relationship was found to exist between *base weight* and the decision to enroll cattle in a PVP program. This is logical as heavier cattle are more likely to be put-together and therefore less likely to potentially be age and source verified to begin with. In most cases, it is cow-calf producers who participate in PVP programs, which explains the negative sign on the *base weight* variable. It was also learned that heifers in the dataset were 2.8% less likely to have been age and source verified than their male counterparts.

It was also expected that cattle type would have some effect on the binomial variable PVP. The author expected black cattle (the base) to be more likely to be age and source verified and hence expected negative parameter estimates on the other cattle types. In reality however, very little effect was found. The only cattle type that was found to differ significantly from black cattle was *red*. Interestingly, *red* cattle were found to be nearly 70% more likely to be age and source verified than black. However, since black cattle dominated the dataset and only 2 groups out of more than 1600 were *red*, one should not read a great deal into this finding.

As expected, state of origin did appear to have an impact on the likelihood of a group of cattle being sold as age and source verified. With TN as the base, Kentucky and

North Carolina were associated with higher likelihoods. KY cattle were 8.7% more likely to be age and source verified, while North Carolina cattle were more than 17% more likely be to age and source verified. While the author is not as familiar with available resources in *NC*, Kentucky has implemented programs designed to aid producers who want to reach this value-added market. These results could be linked to the perceived difficulty of participation from one state to the next.

Of special interest was the effect that *time* may be having on *pvp* participation. It was hypothesized that cattle were more likely to be age and source verified as time progressed through this dataset (January 2008 to April 2011). Surprisingly, no statistically significant relationship was found to exist. Based on these results, it does not appear that a group of cattle in the internet dataset was any more, or less, likely to be sold as age and source verified through the course of the study period. This result is consistent with the finding that the price increase associated with the *PVP* variable in Table 4.1 also did not increase or decrease over time.

Finally, results suggested that cattle sold as natural were 57% more likely to be age and source verified than the base. This was not surprising given that, on average, about 75% of cattle sold as natural were also PVP. This is also consistent given the finding in table 4.1 that additional price increases were associated with both traits. It appears that some overlap likely exists between these two value-added markets.

Stage 2 of the Heckman model provided an opportunity to examine factors affecting price for the *pvp* cattle alone. It was generally hypothesized that significant variables would be very consistent between the second stage of the Heckman and Table 4.1, which reports results for the entire group of internet cattle. Overall, the consistency among the signs of the parameter estimates was nearly perfect. However, there were some magnitude differences that may be worth discussion.

First, the negative effect of *base weight* on price was considerably higher in the *pvp* group, $3.40 versus $2.54. Similarly, the price discount associated with heifers was nearly $10 per cwt in the second stage of the Heckman model compared to around $7 for the internet sales as a whole. Both these differences most likely can be explained by differences in the group of cattle. The average base weight for *pvp* calves was 697 lbs, compared to nearly 800 lbs for the internet dataset. Heavier cattle would be expected to see narrower price slides and smaller heifer discounts per the logic earlier in this chapter.

Monthly binomial variables follow a logical pattern of positive in the spring and summer, then turning negative in the fall and winter. One obvious surprise was the highly significant and largely positive parameter estimate on February, only one month after the base. However, further examination reveals that February represents the month with the fewest number of *PVP* cattle, less than 2.5% of the PVP set. The surprising result is most likely due to a small number of observations, rather than a monthly trend.

One clear surprise from the Heckman model was that the variable *natural* was found to be insignificant in explaining price in the second stage. This is generally inconsistent with results from Table 4.1, which found additional price premium for both variables. While the lack of significance was a surprise, the parameter estimate on the *natural* variable was positive and in a range that would be consistent with table 4.1.

Table 4.1 Regression Results: Factors Affecting Internet Bid Price (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	20.312***	2.674
lot size	0.019***	0.0044
lot size^2	-0.000029***	0.0000090
base weight	-0.025***	0.0014
Live Futures	1.116***	0.039
Corn Futures	-2.968***	0.273
Diesel Price	-0.756**	0.328
Heifer	-6.988***	0.272
Feb	0.505	0.406
Mar	-0.477	0.398
Apr	1.639***	0.391
May	3.419***	0.417
Jun	2.588***	0.465
July	1.772***	0.417
Aug	0.915**	0.443
Sept	-2.355***	0.414
Oct	-3.356***	0.496
Nov	-3.854***	0.428
Dec	-2.203***	0.453
slide 1	0.495***	0.185
AL	-1.142	0.763
FL	-5.324***	0.970
GA	-1.302***	0.476
IND	4.855***	0.683
KY	0.425*	0.248
NC	-1.262***	0.466
OH	0.176	0.466
VA	-1.003***	0.258
WV	-1.160**	0.524
Imp	0.394*	0.207
Char	-0.508	0.479
Hols	-22.693***	0.414
Red	-1.209	0.904
Mix	-1.286***	0.283
Mileweigh	-0.019**	0.0083
Shrink	-0.111	0.117
PVP	1.354*	0.748
Nat	2.176***	0.623
PVPandNat	3.966***	0.717
PVPxTime	0.00102	0.0013
Time	0.00952***	0.00044
R^2	91.92%	
F Value	452.83	

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

Table 4.2 Regression Results: Factors Affecting Internet Basis (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	15.873***	2.374
lot size	0.010***	0.0041
lot size^2	-0.000033***	0.0000083
base weight	-0.031***	0.0013
Live Futures	0.078**	0.034
Corn Futures	-0.304	0.227
Diesel Price	-1.751***	0.295
Heifer	-7.416***	0.243
Feb	-1.017***	0.361
Mar	-0.643*	0.339
Apr	1.122***	0.333
May	1.542***	0.396
Jun	2.743***	0.382
July	0.274	0.370
Aug	1.123***	0.372
Sept	-0.206	0.337
Oct	1.640***	0.447
Nov	0.634*	0.364
Dec	1.614***	0.396
slide1	0.420***	0.161
AL	-0.579	0.589
FL	-5.210***	0.789
GA	-1.140***	0.428
IND	1.127	1.615
KY	0.622***	0.228
NC	-1.320***	0.411
OH	0.217	0.427
VA	-0.588**	0.231
WV	-1.567***	0.456
Imp	0.324*	0.183
Char	-1.062***	0.395
Hols	-22.718***	0.397
Red	-1.967***	0.417
Mix	-1.192***	0.258
Mileweigh	-0.013*	0.007
Shrink	-0.0062	0.108
PVP	1.326**	0.659
Nat	1.824***	0.644
PVPandNat	3.349***	0.551
PVPxTime	0.00077	0.0011
Time	-0.00089**	0.00038
R^2	88.17%	
F Value	297.15	

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

Table 4.3 Regression Results: Factors Affecting Internet Basis (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	24.614***	1.993
Lot size	0.0201***	0.0041
lot size^2	-0.000034***	0.0000085
base weight	-0.032***	0.0013
Feeder futures	-0.070***	0.0210
Diesel Price	-0.457*	0.248
Heifer	-7.431***	0.244
Feb	-0.650*	0.357
Mar	-0.633*	0.343
Apr	1.271***	0.331
May	1.825***	0.400
Jun	2.699***	0.379
July	0.575*	0.334
Aug	1.529***	0.325
Sept	-0.120	0.312
Oct	1.186**	0.466
Nov	0.409	0.356
Dec	0.901**	0.413
slide1	0.389**	0.164
AL	-0.585	0.587
FL	-4.863***	0.773
GA	-1.125***	0.427
IND	1.918	1.655
KY	0.621***	0.226
NC	-1.254***	0.415
OH	0.269	0.438
VA	-0.589**	0.232
WV	-1.510***	0.460
Imp	0.306*	0.184
Char	-1.026**	0.400
Hols	-22.702***	0.393
Red	-1.402***	0.433
Mix	-1.217***	0.256
Mileweigh	-0.014*	0.007
Shrink	-0.031	0.107
PVP	1.485**	0.652
Nat	1.752***	0.627
PVPandNat	3.479***	0.563
PVPxTime	0.00043	0.001
Time	0.0013***	0.00048
R^2	88.22%	
F Value	306.02	

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

Table 4.4 Regression Results: Factors Affecting CPH Bid Price (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	17.420***	5.551
Lot size	0.093***	0.018
Lot $size^2$	-0.00046***	0.000093
$Weight^2$	-0.000028***	0.0000016
Live Futures	1.207***	0.092
Corn Futures	-4.204***	0.643
Diesel Price	0.331	0.898
Heifer	-10.822***	0.475
Feb	0.932	0.817
Mar	-1.080	0.896
Apr	2.690***	0.908
Jun	2.304***	0.819
Nov	-3.840***	0.873
Dec	-3.213***	0.874
Order Buyer 1	0.179	0.751
Order Buyer 2	1.379	0.908
Order Buyer 3	-1.819***	0.716
Order Buyer 4	0.048	0.866
Blackx	-11.042***	0.968
Charx	-9.595***	0.796
Small	-21.176***	1.328
Smoke	-1.577**	0.675
Mix	-17.613***	1.422
Time	0.0083***	0.0011
R^2	77.94%	
F Value	202.08	

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

Table 4.5 Regression Results: Factors Affecting CPH Basis (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	32.941***	3.951
Lot size	0.077***	0.018
Lot size^2	-0.00042***	0.000088
Weight^2	-0.000034***	0.0000015
Feeder Futures	-0.168***	0.056
Diesel Price	0.740	0.741
Heifer	-11.266***	0.472
Feb	-0.201	0.792
Mar	0.631	0.882
Apr	2.055**	0.912
Jun	1.750**	0.776
Nov	-2.908***	0.899
Dec	-3.165***	0.898
Order Buyer 1	1.115	0.760
Order Buyer 2	2.161**	0.880
Order Buyer 3	-1.209*	0.719
Order Buyer 4	-0.128	0.872
Blackx	-11.696***	0.945
Charx	-10.192***	0.774
Small	-21.703***	1.323
Smoke	-2.071***	0.660
Mix	-18.296***	1.398
Time	0.0014	0.0014
R^2	60.77%	
F Value	97.57	

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

Table 4.6 Regression Results: Factors Affecting CPH Basis (Dollars / cwt.)

Variable	Parameter Estimate	Standard Error
Intercept	19.742***	5.642
Lot size	0.076***	0.018
Lot size^2	-0.00041***	0.000088
Weight^2	-0.000033***	0.0000016
Live Futures	0.052	0.094
Corn Futures	-0.972	0.651
Diesel Price	-0.182	0.891
Heifer	-11.263***	0.472
Feb	-0.787	0.800
Mar	0.738	0.870
Apr	2.011***	0.918
Jun	1.718**	0.785
Nov	-2.248**	0.872
Dec	-1.950**	0.877
Order Buyer 1	1.387*	0.753
Order Buyer 2	2.278***	0.881
Order Buyer 3	-1.088	0.728
Order Buyer 4	-0.097	0.870
blackx	-11.760***	0.954
charx	-10.293***	0.779
small	-21.748***	1.327
smoke	-2.146***	0.664
mix	-18.502***	1.403
Time	-0.0025**	0.0011
R^2	60.54%	
F Value	92.29	

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

Table 4.7 Heckman Results for PVP Cattle

Variable	Parameter Estimate Probit	Marginal Effects Probit	Parameter Estimate OLS
Intercept	1.557***		29.871***
Lot size			0.134***
Lot size^2			-0.00045**
Base weight	-0.00403***	-0.00047***	-0.034***
Live Futures			0.976***
Corn Futures			-1.514*
Diesel Price			-1.379
Slide1			0.210
Mileweigh			-0.063
Shrink			1.007**
Imp			0.890
Heifer	-0.270**	-0.028**	-9.846***
Feb			7.090***
Mar			-2.371
Apr			0.622
May			4.314***
June			6.193***
July			2.027
Aug			-0.568
Sept			-0.633
Oct			-1.061
Nov			-2.534**
Dec			-3.832**
GA	-0.17	-0.013	-0.137
KY	0.587***	0.087***	4.897**
NC	0.875***	0.177**	1.544
OH	0.259	0.036	4.851***
VA	0.042	0.005	0.790
WV	0.303	0.044	0.079
Char	0.142	0.018	-5.894***
Red	2.260**	0.696**	0.899
Mix	-0.230	-0.023	-3.807***
Time	-0.00019	-0.000022	0.013***
Nat	1.940***	0.567***	1.592

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

Chapter 5: Conclusions, Implications, and Further Study

In any discipline, the existing literature can be thought of as a body of evidence. As research is conducted, the knowledge base increases, leading to additional research to further expand the knowledge base. Through repetition, alternative approaches, additional data sets, and other means, evidence builds and certainty levels increase with respect to key questions. This work combined a practical approach and two very recent data sets that had not previously been utilized in feeder cattle pricing research. In doing so, the literature on factors affecting feeder cattle prices was enhanced and the knowledge base was expanded. Perhaps more importantly, an opportunity to serve the needs of an industry was identified and capitalized upon.

This work was, first and foremost, a partnership between an extension specialist and PhD candidate at the University of Kentucky and some highly innovative beef cattle marketing professionals. In a casual conversation, a need for information and a potential source of data were identified and found to be consistent with a research interest. Entering into a partnership such as this is largely one of trust and responsibility. University personnel are ultimately entrusted with data that are confidential and relied upon to perform appropriate analysis to attain the answers needed by industry stakeholders. From there, University personnel have a responsibility to conduct a thorough and objective analysis, give unbiased results, and be driven by the needs of the client rather than their own professional goals. This is not always easy in a professional environment where success is measured largely by publishing more often in more highly touted journals rather than the application of their findings in the field.

Given this relationship, and the resulting expectations, it would be the end rather than the means that would determine how successful this endeavor was. Further, the level of satisfaction derived by the marketing professionals would dictate whether future work would be possible using these and other datasets and whether interesting questions such as this would be posed to university personnel in the future. Regardless of how complex the methods, how publishable the findings, or how much was added to the existing body of Agricultural Economics literature, the ultimate measure of quality would be how useful the results of the work were to the stakeholders involved. That is not necessarily to say that the findings related to value-added marketing programs, such as age and source verification or natural, were more important than any other findings. It is simply to say that it is the former upon which the ultimate reviewer of this work would write his or her review. Therefore it is appropriate that discussion of implications begin there.

If stakeholders were expecting a drastic price impact from age and source verification, they were most likely disappointed. The $1.35 per cwt price difference associated with *pvp* amounted to about $11 per head on an 800 pound steer. While certainly significant, it is probably less than would have been expected and perhaps not sufficient to draw a great deal of additional interest from producers. The fact that the premium levels did not appear to be increasing over time is also consistent with the finding that the likelihood of cattle being sold as age and source verified has not increased over time. Producers respond to price incentives and this study would suggest that price incentives were not sufficient to bring about increased interest throughout the time period of this study. At the time of this writing, changes were taking place in the marketplace relative to trade with Japan that could potentially decrease the market incentive for age and source verification, rather than increase it. If that's the case, interest in age and source verification from a producer perspective is likely to decrease, rather than increase.

While the price premium for cattle selling as natural appeared to be greater than that associated with age and source verified cattle, it may actually be less appealing to producers. As was mentioned previously, the primary cost associated with age and source verification is time. In the case of selling cattle as natural, the primary cost is likely lost production. Without the aid of implants, rates of gain, and ultimately pounds sold, are likely to be lower, resulting in lower revenues. The inability to use medicated feed can potentially result in similar gain effects or more health problems. And undoubtedly, the prohibition of antibiotics forces producers to make tough decisions about management of calves that were originally targeted towards natural markets.

As producers wrestle with these decisions, the price premium is the only true incentive that exists in the marketplace. While the $2.18 price differential is significant, it may not be sufficient to entice a great deal of producer participation. As the producer considers the cost-benefit of selling natural calves, this data suggests that the benefit may only be around $17 per head on an 800 pound steer. This benefit must be carefully weighed against the additional feed costs needed to compensate for slightly lower feed conversion, potentially higher medical costs, and the probability of calves getting sick, needing antibiotic treatment, and becoming ineligible for the program after all. Finally, the two value-added opportunities together provide additional opportunities, but parameter estimates suggest only slightly more than the two individually.

Ultimately, it will be a specific type of producer who will choose to participate in these programs and price premium may only be a piece of that decision. In truth, the internet sales only represent a portion of the age and source verified and natural cattle that are sold. Many other markets exist for these types of calves and the premiums that result from access to those markets is not observed in this study. This work addresses the question of price premiums that were found to exist within the internet sales and does not place a value on additional markets that may be available to producers selling age and source verified cattle.

Regardless, having a better understanding of the premiums for age and source verification and natural should aid managers of the internet sales as they consign cattle. No doubt, the question regularly arises as to what these price differentials tend to be. This research should provide an objective assessment that can be used by managers as they target cattle for the sales and consignors as they consider the best options for cattle they wish to market.

While the initial motivation for this work may have been on value-added markets, the opportunity to analyze two very unique and recent datasets provided additional opportunity to add to the existing literature. As was discussed in Chapter one, there was clear antidotal evidence to cast doubt upon some of the long held relationships between feeder cattle and corn prices. Adding to these empirical observations was recent work by Schultz et al. (2010), who found no statistical relationship between corn price and feeder cattle prices and Tejeda and Goodwin (2011), who did not find the negative short-term relationship that would have been expected between feeder cattle and corn prices. However, the results from this study were more in line with earlier work, finding the traditional negative price relationship to exist between these two variables.

Schultz et al. (2010) utilized two separate, two month time periods in late 2008 and the spring of 2009. It is very possible that sufficient variation was not present during these short time periods to capture significant relationships through a hedonic approach. Tejada and Goodwin (2011) analyzed data over a longer period of time, but utilized daily price for Oklahoma City feeder cattle, Chicago corn, and other variables of interest. The short time period between observations likely made capturing short-term relationship more difficult; a long-term negative relationship was found to exist between feeder cattle and corn price which is an important caveat to their short term findings.

In a few cases, magnitudes of common price impacts were slightly different from previous Kentucky work, but not by enough to suggest significant structural change. Parameter estimates on corn price were a bit less than were found in the 2003 work of Burdine, which focused on Holstein steers rather than native steers, but were largely consistent with the 2005 work of Eldridge. Parameter estimates on live cattle futures were only found to be slightly lower than Eldridge in the same study. Further, both previous studies excluded the potential impact of fuel prices and did not have the benefit of as much information about groups of cattle being sold. In short, while volatility has seemed to change the pace of the feeder cattle marketing system, it appears that the market itself is driven by a very similar set of fundamental factors.

Other findings may have more micro-level implications for the marketing system as a whole. The uncertain nature of weight in the internet sales creates a real marketing challenge for consignors, buyers, and sale administrators. Price slides have been used for years to deal with weight uncertainties and they remain the tool of choice today. However, in an age where information is power, this is an area where savvy individuals can capitalize on incentives and disincentives in the marketplace.

For years, producers were told that price slides wouldn't hurt them; they would always be better off to sell more lbs at reasonable prices slides. However, this adage is partially true, at best, in today's market environment. The ultimate reason for the difference is that price slides (as they are used to adjust prices to weight differences) have not evolved with the actual price-weight relationships in the marketplace. Brorsen et al. (2001) noted that price slides amounted to an "option" for sellers. When price slides are less steep than actual price-weight relationships in the market, consignors have incentive to deliver heavier cattle and they found a tendency towards this in their work. It would appear that this incentive has changed over the last several years and is evidenced by a much smaller tendency to underestimate weight in this work.

As was discussed in Chapter 4, current price discounts by weight are actually less dramatic than price slides offered in sale catalogs. In theory, one would want those to be equal in order for neither party to have a marketing advantage. In one sense, the market is more efficient than it used to be as sellers do not have this same incentive today. However, due to the flexible nature of the delivery times, the current system may offer some perverse incentives to the buyer.

In most cases, the buyer has some control over delivery times, generally within some window of time. Given the current conditions, it may actually benefit the buyer to delay receipt of cattle as they gain weight. Examination of sale catalogs from 2008 through 2011 suggests that most delivery ranges are about one week, but two or three weeks were offered in some cases. In cases were a great deal of flexibility is available, it would not be surprising to see delivery dates pushed back and cattle weights start to increase. Of course this incentive is probably less of a problem than the one that Brorsen et al. (2001) discovered as consignors can simply tighten up delivery windows. But to do this, they must be aware of why doing so makes economic sense.

As sale managers work with consignors, they should make them aware that, in most cases, the price discount for heavier cattle is likely to be lower in magnitude than the common price slides of $4 and $6 per cwt. One option would be reducing the magnitude of the price slides offered, but results suggest that doing so would negatively affect price. Short of doing that, sellers should be aware that pricing incentives will favor cattle that come in close to *base weight* in the current environment.

Another interesting result involved the effect of lot size on price in both datasets, but especially the CPH sales. The specification using a linear and a squared *lot size* variable offered greater explanatory power than other specifications. When fitted to the existing data, lot size effects actually turned negative within the range of the data. While it was discussed that extremely high lot sizes were further from the mean and likely less reliable, this work clearly provided some evidence that it may be possible for lot sizes to become too large and adversely affect price.

This problem can be overcome by producers selling cattle in the internet sales by simply selling smaller groups: two and three load lot groups rather than six or seven load lot groups. The problem becomes more of a challenge in co-mingled sales, such as the CPH data that was utilized in this study. However, this is the type of sale where it is probably most important. And, producers will occasionally comment when attending CPH sales and seeing extremely large groups of cattle sell for less than was expected. Despite the clear possibility that prices might be highest by selling multiple single load groups rather than one large multi-load group, actual implementation in CPH and CPH-type sales is not easy.

As was discussed earlier, one of the attractive elements of CPH sales is that cattle are co-mingled from multiple producers. Through co-mingling of cattle in these sales, producers who are too small to sell in load lot quantities on their own are able to receive prices comparable to those of cattle moving in larger groups. If a sale location were to consider grouping and selling multiple smaller lots of cattle of similar weight, it would be inevitable that one group would bring a bit more or less than another. This would lead to questions about why this happened, quality of one group versus the other, how it was determined which producer's calves were placed in which group, which group was sold first, etc. So, from a sale management perspective it is most likely easier to sell calves as they are currently sold.

Still, the possibility that some extremely large groups may see slightly depressed prices is worth consideration and critical thinking about the sale process. It would seem that finding additional ways to sort extremely large groups would be warranted. This might include an additional sort on the *black* sort group, use of ultrasound technology, or tightening the weight range on cattle in especially large sorts. This final strategy would seem like the easiest the implement.

In most CPH sales, cattle weight tends to cluster around the 600 to 650 lb range. So it tends to be the 600 to 700 lb sort that sees the largest groups in the sale. That was supported in CPH data used in this analysis as average weight was in the low 600 lb range. In cases where the 600 to 700 lb grouping was especially large, it would seem worth consideration to have a 600 lb to 650 lb sort and a 650 lb to 700 lb sort. It seems this approach would result in less producer complaints than simply having two 600 lb to

700 lb sorts. Tighter weight breaks would also decrease the inefficiency that occurs when producers with multiple average weights within the breaks are all paid a single price based on the average weight of the entire sort.

Potential for Further Study

As would be expected with any research project, a great deal of extensions and areas for further study were identified. Predictive power of the basis models was actually pretty encouraging, especially for the internet sales. So, a basis prediction model would seem like a logical follow-up to this work. This was attempted in 2004 by Routt, but results from this study suggest that including factors such as fuel price may improve predictability. While fuel prices were incorporated in the 2008 work of Dhuyvetter, et al., this potential factor has not been included as a prediction parameter in beefbasis.com. It is likely that one of the factors holding back use of price risk management tools is lack of understanding of and predictability of basis. This work hopefully addressed the former and a basis prediction model would likely help address the latter.

Another extension of this work would be to examine the premiums for age and source verification and natural as observed outside of internet sales. While this data provided an excellent opportunity to estimate these effects in a well controlled environment, a logical follow-up question would center around the transferability of these results to normal weekly cattle sales. Ultimately, the internet data set used in this analysis consisted almost exclusively of load lots of cattle. So, results can be best interpreted in that context. It would be interesting to look at this same question for smaller groups of cattle moving through regular auctions. If similar data were available for regular sales, this estimation would be possible.

It would also seem that a decision tool might be in order to help producers with the decision of whether to sell cattle into these value added systems in the first place. While this work does address the question of price differences, it would seem that an interactive spreadsheet model might serve as a useful aid in weighing the many related factors that could affect production costs, especially for selling natural cattle. Lost production is often the easiest cost to overlook, and in situations where producers are unable to utilize implants and ionophores, lost production may be the single biggest cost.

A decision tool would potentially offer a way to quantify those factors and compare them against the price premium that may exist.

The data available from the internet sales would also seem like logical fit for a spatial model. Results from this work certainly suggest that location impacted feeder cattle prices. The existence of such information should make modeling possible that would further examine how prices in different locations are affected by changes in key factors. Southeast feeder cattle markets offer unique opportunity to study such relationships since the vast majority of cattle move west for the next phase of production and the cost of doing so continues to increase.

Another extension of this work would be to examine the seasonality that likely exists in the effects of corn price on feeder cattle prices. While corn price, weight, and seasonality effects have surfaced in numerous feeder cattle market studies, the three factors have not often been considered interactively. In chapter 4, it was discussed that increased backgrounding likely was a contributing factor to the relatively small corn price effect in this work. However, it is also logical that the availability of pasture in the spring would result in different corn price effects in the spring versus the fall. Additionally, one would expect these effects to be different for lighter stocker cattle than for heavier feeders. It would seem that exploring this topic would be both timely and useful for Kentucky beef cattle producers.

Finally, as one considers additional work that could be done as follow-up to this work, the most important may be that coming from the stakeholders themselves. Ideally, the results from this work will spark additional questions and desire for follow-up work to further serve marketing professionals. It is the sincere hope of the author that he and his colleagues continue to be considered the first contact in addressing these types of questions in the future.

Both beef cattle marketing professionals and university extension specialists and researchers identify problems (questions) and work to find solutions (answers). It only seems logical that these two groups should look for ways to work together in this capacity. It would seem that projects such as the one discussed in the preceding pages would be the norm, rather than the exception in Agricultural Economic research. To that end, perhaps the most positive result from this work will be a continued working relationship between industry stakeholders and University of Kentucky personnel.

As information has increased in value, so has the premium on the timeliness of information and related services. There are a large number of consultants available to serve the needs of agribusinesses and they are generally in a better position than universities to provide timely analysis due to their ability to focus completely on a single clientele for a period of time and the current staffing and budget challenges faced by many universities around the country. This trend makes it even more important that universities seize opportunities such as this to validate their role in the agriculture industry.

In truth, there is a lot that universities can bring to the table. The thoroughness and accuracy of their work are assets, as well as their ability to remain truly objective and provide unbiased information and recommendations to the clientele that they serve. Finally, there is the ability of universities to educate and train individuals with tools necessary to conduct these types of analyses. However, without partnerships like the one that led to this work, universities are in danger of seeing their importance fade in today's agricultural environment.

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