AN EVALUATION OF DETERMINANTS OF FED CATTLE BASIS AND COMPETING FORECASTING MODELS

by

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B.S., University of Idaho, 2005

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2012

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Abstract

The objective of this analysis is to develop econometric models for forecasting fed cattle basis as well as compare these models with historic averaging methods of forecasting basis popular in existing literature. The econometric analysis also aims to identify important determinants of fed cattle basis.

Both monthly and weekly models were assessed with data provided by the Livestock Marketing Information Center. All models analyzed the three regions of Nebraska, Kansas, and Texas. Monthly historic average approaches utilized historic fed cattle futures and fed cattle cash price series from January of 1995 through December of 2010. Weekly historic average approaches utilized historic fed cattle futures and fed cattle cash prices series from June of 2001 through December 2010. Data collected post mandatory price reporting implementation in 2001 was used in all econometric models. Overall lags of fed cattle basis, the spread between the nearby live cattle futures contract and the next deferred futures contract, and seasonality regularly proved to explain much of the variation in fed cattle basis in the econometric modeling.

Multiple historic average based models were examined on both monthly and weekly frequencies. Once all competing models were estimated in-sample, out-of sample testing was conducted. The forecasting errors of all weekly models were compared to determine which methods prove to be dominant forecasters of fed cattle basis. This testing suggests historic averaging methods outperform the alternate econometric models in out-of-sample work. The econometric models helped to reveal some of the important factors determining fed cattle basis, however lags in collecting data on these factors may inhibit the forecaster's ability to use these techniques in real time.

One interesting revelation in regards to historic averages is the potential of Olympic averages as forecasters. These methods have not been explored in previous academic literature but tend to perform quite well in comparison with other methods explored.

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Acknowledgements

I would like to acknowledge my major professor Dr. Glynn Tonsor for the guidance he has provided to help me complete this thesis. I would also like to thank him for all the patience, I expect he would have asked Dr. Lambert for a different GRA last fall if he truly knew the severity of the author's tendency to procrastinate.

I would also like to thank my committee members Dr's; Ted Schroeder, and Kevin Dhuyvetter. Throughout my time here as a graduate student at Kansas State they have been more than willing to give advice in relation to this work as well as provide valuable insight and assistance with other projects I have undertaken.

Last I would like to acknowledge Rich Porter for his suggestion experimenting with Olympic historical averages as a fed cattle basis forecaster. This approach does appear to merit further evaluation in basis studies and has to date not been examined in any previous literature.

Chapter 1 - An Overview of the United States Beef Feeding Industry

In the United States most beef comes from animals finished in confined feeding operations fed a concentrated diet consisting of a large amount of grain prior to harvest. This has been the case for much of the industry's recent history. Yet this is not a static industry. Industry participants and managers face many challenges as the beef industry has enjoyed relatively small margins across all stages of production, and has seen increased concentration, and competition.

The beef industry over the past three decades can be characterized by declining national herd size, declining consumer demand, increased production per head, vast improvements in technology, and increased concentration. There have been extended periods of liquidation at the cow calf level beginning in the 1980's due to low prices which could be attributed not only to beef supplies but large declines in demand (Mintert 2003). Over the period from 1980 to 2009 beef demand has declined to almost ½ of 1980 levels. The period between the late 1990's and early 2000's was marked with moderate increases which can be attributed in some part to a spike in the popularity of low carbohydrate diets (Tonsor, Mintert, and Schroeder, 2010).

In this environment a firm understanding of basis, difference between local cash prices and corresponding futures market prices, is critical. A statement which rings true is that without accurate basis forecasts "it is impossible to make fully informed decisions about… whether to accept or reject a given price" [Chicago Board of Trade (CBOT), 1990, p23.]. Basis is a key component for participants forming price expectations, and a keen understanding should prove invaluable when making placement and marketing decisions. Futures prices can be viewed as forecast of prices. Evidence suggests it is difficult for econometric models to improve upon these forecasts (Tomek, 1997). Through the use of forecasted basis, producers can form their own localized price forecasts. Additionally, an accurate forecast of basis is invaluable for any party wishing to use hedging as part of their risk management regime.

This work is intended as an update to previous works which explore fed cattle basis forecasting primarily through two differing approaches: the use of historic averaging, and the use of econometric models focusing on measures of quality and localized supply and demand. This is an important undertaking since many existing studies are now ten years old or older. Another unique aspect of this work is that it will directly compare both approaches rather than focus solely on one method.

Figure 1-1. The Five Market Series Basis for the Period from June 2001 to December 2010

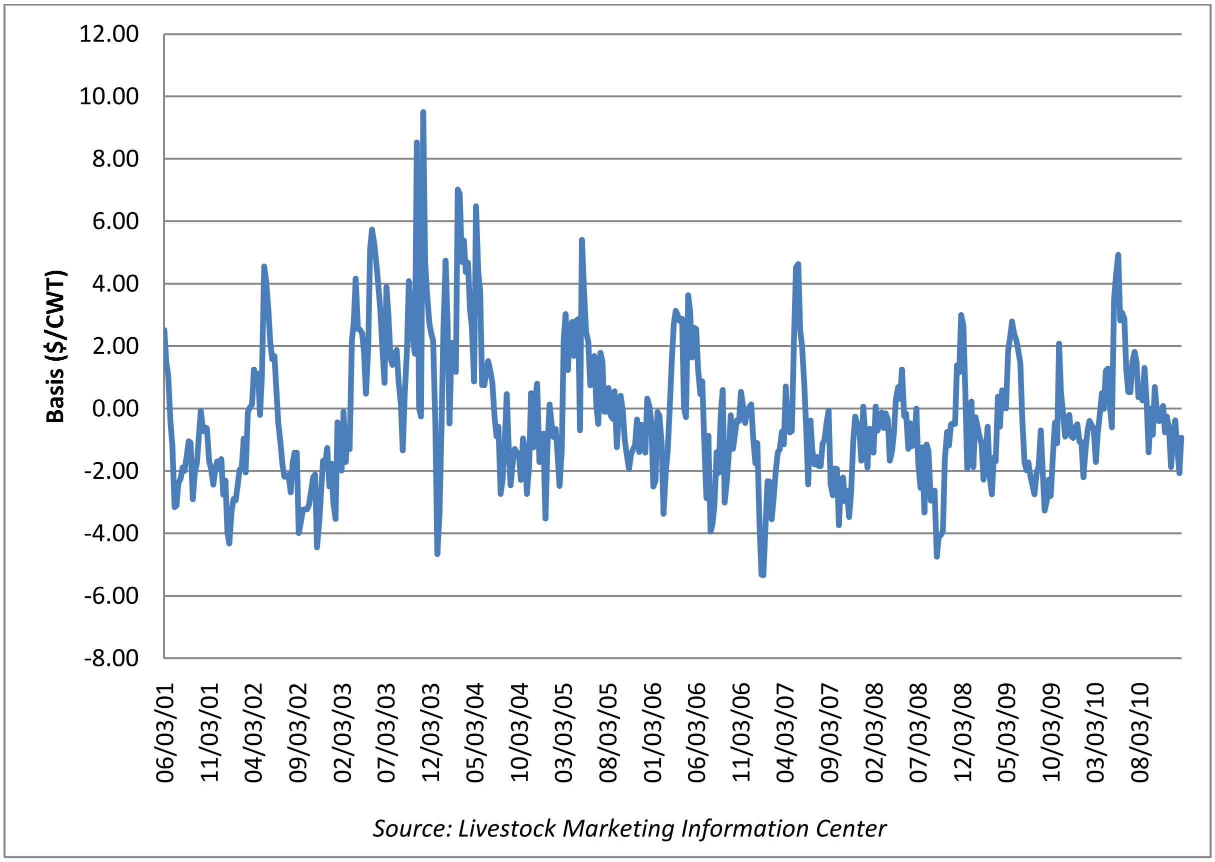


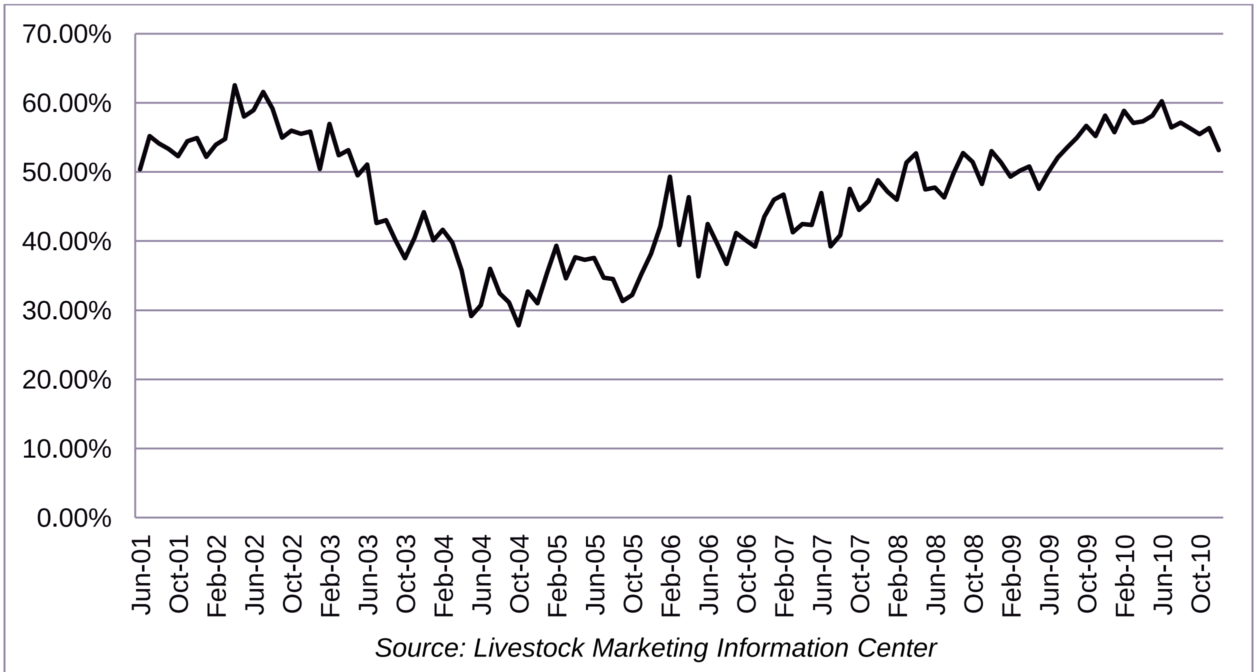
Figure 1-1 gives a picture of fed cattle basis over the past decade. One distinct feature is an apparent pattern across each year with peaks and valleys recurring at around the same times. Models used in this work will attempt to account for these seasonal patterns.

The graph also shows that an average of the five market basis is probably close to zero, as is to be expected in a marketplace where the cash price converges to the futures price at the delivery points, which are located throughout the five markets, at maturity. The majority of the time it appears that basis tends to range anywhere from positive $5/cwt to negative $5/cwt. With fed cattle basis swinging close to $10/cwt there is sufficient variability to warrant interest in further analyzing factors influencing basis. Most of the factors this work will analyze are those identified by Parcell, Schroeder, and Dhuyvetter (2000), which include; carcass weights, captive supplies, local cash corn price, local percentage grading select, local ratio of cattle on feed, and beef stocks held in cold storage.

Captive Supplies:

Packer concentration has increased with the top four firms processing about 36% of beef in 1980 increasing to about 80% of beef in 2003 (GIPSA, 1996; Iowa State University, 2005). Along with increasing concentration there has been an increase in what can be considered captive supplies, or animals committed to packers through marketing agreements, formula pricing, and forward contracts. Packer concentration and captive supplies (illustrated in figure 1-2) tend to be a subject of continual concern for regulators. In 2001 the USDA introduced Mandatory Price Reporting to require twice daily reporting of data from most packers in part to address concerns about market power and transparency. However there are valid arguments that the industry benefits from added efficiency, traceability, and quality associated with these various marketing arrangements. (GIPSA, 2007)

Figure 1-2. Changes in Captive Supply Over the Past Decade



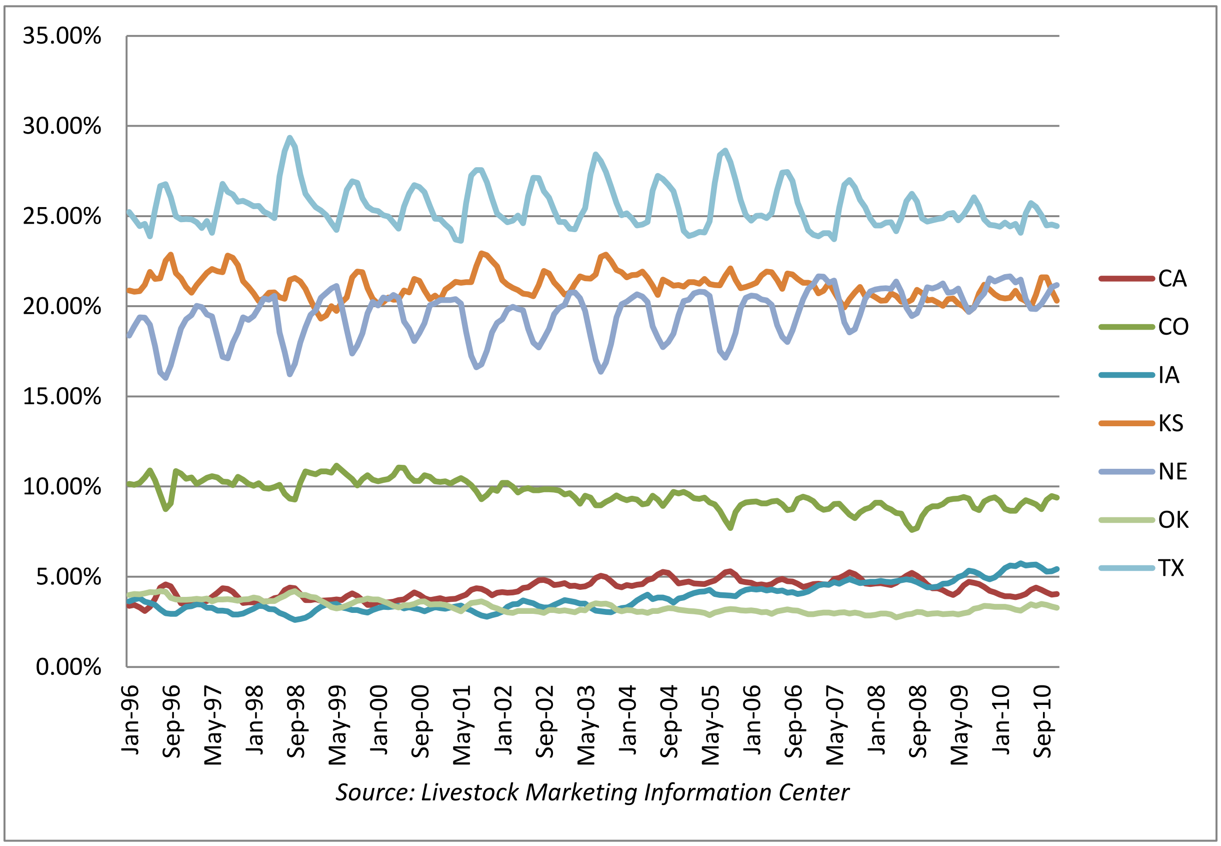
Source: Livestock Marketing Information Center

***Numbers prior to April 2004 may be biased upward due to negotiated grid pricing's inclusion in formula priced series

Cattle Feeding:

Figure 1-3 shows regional trends for feeders in the top seven states. To some extent it can be said that the feeding has been drifting northward. There has been a small decline in the total percentage of cattle on feed in Texas, Oklahoma, and Kansas over the period from 1996 to 2010. The decline has been a relatively more pronounced in Colorado. Although traditionally little is heard about California it has seen a slight increase. Iowa and Nebraska have seen steady increase in percentage cattle on feed over the whole period.

Figure 1-3. Percent Cattle on Feed in the Top Seven States



Beef Attributes:

The argument that quality can be improve through marketing agreements is valid considering the challenges the industry was facing a little more than a decade ago. The 1995 National Beef Quality Audit identified the five main concerns amongst consumers to be; 1) low uniformity and consistency; 2) inadequate tenderness; 3) low palatability; 4) excess external fat; 5) high beef prices relative to value (Smith *et al.*, 1995). One cause of these problems which faced the industry was that price was not sending the appropriate signals to producers (Schroeder, Ward, Mintert, and Peel 1998).

Producers traditionally were primarily paid based on the live weight of the animals and quality grades were not factored into the payment. The percent grading choice had fell off over time as producers made shifts in genetics and feeding practices to try and improve feed efficiency. Moreover, quantity and not quality was primarily rewarded under this system. Since the mid 1990's there has been increasing participation in marketing methods using grids which pay based on the attributes of the harvested carcass, along with increased ties between feeders and packers through marketing agreements and contracting. Recent improvements in carcass quality can possibly be attributed to better pricing signals to producers through the increased use of grid pricing systems and marketing agreements between feeders and packers.

Figure 1-4. Changes in Beef Quality Grades Over Time

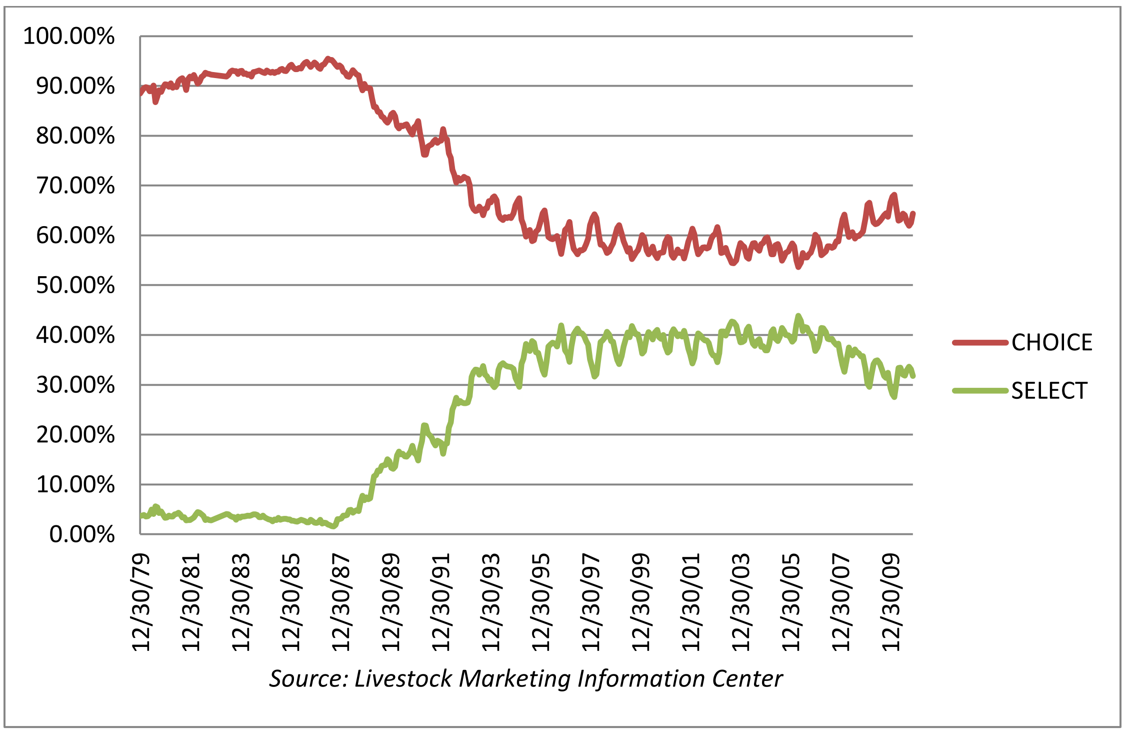
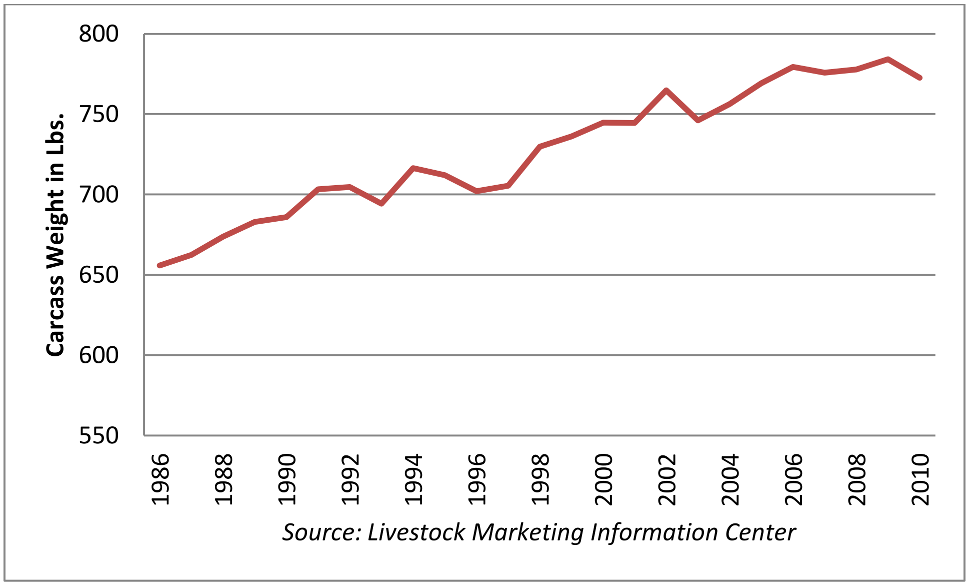


Figure 1-4 shows an improvement in beef quality around the mid-2000's with a slight increase in the percent grading choice. It is important to consider that a few changes were made to the USDA's grading standards over this time frame. In November 1987 the grade "Good" was changed to "Select" and in April 1989 yield and quality grades were uncoupled (Harris, Cross, and Savell, 1996). These changes however probably did not lead to any negative influence on the percentage of carcasses grading choice.

Another important aspect to consider is carcass weights trending upward over time as shown in figure 1-5. Decreases in total beef production have not been as dramatic as looking at the decline in national herd size would suggest. This is due to the amount of beef produced per head seeing sizable increases. Between the mid-1980's and today there has been approximately a 20% increase in carcass weights.

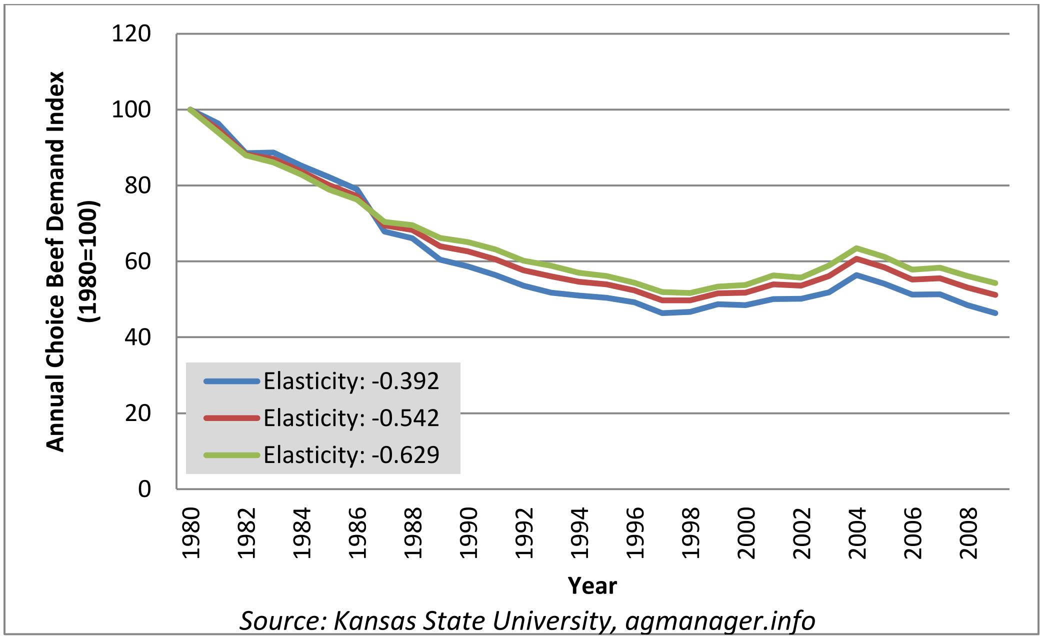
Figure 1-5. Average Carcass Weight for all Cattle Over Time



US Beef Demand:

Figure 1.6 is a demand index for choice beef (Tonsor, 2010) which maps out demand for choice beef over time as opposed to just quantity demanded. The index was derived to relate real beef prices at a constant demand level to the actually transpiring real beef prices for each period. This index should measure changes in demand due to shifts in factors driving consumption other than simply the products own price. Four elements were utilized in the composition of the index; historical beef consumption (lbs/capita), nominal beef prices; a consumer price index, and estimates for beef's own price elasticity taken from recently published articles.

Figure 1-6. Annual Choice Beef Demand Price Index, 1980 to 2009



The rate of change in the beef price index depends upon which elasticity estimate is used, however no matter which elasticity estimate was used the figure tells the same general story. Over the period from 1980 to 2009 beef demand has declined to almost ½ of 1980 levels.

Summary:

The beef industry has undergone several changes and today's landscape is now more competitive than ever. Margins over the past few decades have been tight across all aspects of production. These tight margins have lead to a smaller national herd size which through improved efficiency is providing more meat per head than in the past. Domestic demand for beef has been declining for the past three decades for a host of reasons associated with beef quality and relatively cheap substitutes. The industry has been adapting to take on these challenges via more integrated relationships between feeders and packers as well as new pricing structures to send better signals regarding quality to feeders. All of these changes have made managing price risk, and forming accurate expectations of price an increasingly important matter for feeders and packers. Previous research suggests that the ability to understand basis and making accurate forecasts is an integral piece of this puzzle.

Chapter 2 - A Review of Previous Literature

As stated in chapter one understanding fed cattle basis is important for those involved in the cattle feeding and packing business as it will aid them in making pricing decisions when forward contracting or, hedging, and in forming price expectations. Forming expectations of price is important to agricultural producers to enable them to make profitable production and managerial decisions. There are many arguments as to the most effective method of forming price forecasts. Many agricultural economists agree that futures markets provide the best forecasting tool and play an important role in helping producers form price expectations. Many studies evaluated the performance of agricultural futures markets as price forecasters. One of the first such studies was Just and Rauser (1979) comparing the commercial forecasts prepared by four firms for eight agricultural commodities. The authors found that futures markets outperformed all commercially available econometric models evaluated across all commodities they analyzed.

Futures contracts for live cattle began trading in the 1960's. Storable commodities such as corn have been traded on the futures markets for a much longer period of time. One reason futures contracts for livestock are a relatively new edition is because historically the popular sentiment was that a futures contract for a non-storable commodity could not be successful. Skepticism as to the viability of a contract on non-storable commodities stemmed from the idea that a relationship between cash and futures markets would be difficult to establish since stocks tend to change form over time.

Many studies during the later 1960's and 1970's attempted to identify whether or not a relationship between cash and futures markets for non-storable commodities, particularly fed cattle, existed. Naik and Leuthold (1988) present a very strong argument defending a relationship between cash and futures prices. They make an argument that, if producers can choose how animals are managed, when to make placements, when to market finished animals, and they have the option to participate in the futures markets, then in fact strong futures-cash relationships can exist. The relationship between current cash price and extended futures prices hinges on supply and demand shifters, as well as current and expected feed prices and finishing cost, expected supply, and historic cash prices.

Brorsen and Irwin (1996) suggest agricultural economists make price forecasts that see little use by industry participants. They argue that while using the available information to econometrically forecast prices is possible there is little to be gained through the practice. They looked at some past studies which indicated producers did not rely on extension service very much for information when making marketing decisions. They composed their work as a call to action for extension economist to focus on practical and applicable price forecasting and marketing strategies.

Brorsen and Irwin (1996) note that traditionally economists treated producers as backward looking agents who's social welfare could be improved by price forecasting because backward looking producers would be prone to making systematic forecasting errors. However there has been an evolving thought that producers form rational expectations with the information available. If producers as a whole are making decisions with the available information and rational expectations there is little value to focusing on forecasting prices. The argument that producers have rational expectations resembles Fama's (1970) efficient market hypothesis. They also note that while many deviations from market efficiency are reported in the literature none of these deviations seem to be something that a producer could profitably exploit.

Brorsen and Irwin (1996) suggest that rational expectations may be too strong of an assumption for producers so they suggest an alternative model called "noisy" rational expectations. The conditions of this model are that producers have rational expectations but must learn model parameters and there is a cost to gathering information. They cite Stein (1992) when he states that futures markets speed the convergence to a rational expectations equilibrium because any profitable private information is incorporated in markets by participants. They state that attempting to forecast cash prices via econometric models using available supply and demand information by university extension personnel may not be the most efficient use of their limited resources. They state that past studies have shown futures markets to forecast as well as econometric models and disseminate forecasted prices more expediently than what can be accomplished by extension personnel.

This would suggest that if basis can be forecasted with reasonable accuracy then economists should strive to produce localized price outlooks by forecasting basis and adding it to futures market values. This also provides valuable outlook to those engaged in hedging and trading basis. Assuming reasonably accurate forecasts of basis can be made then it is important that our futures markets give unbiased price expectations.

There has been much work and many conclusions on futures market efficiency. Arguments about bias and efficiency aside, futures markets do provide a cheap, instantaneous and easily available forecast of expectations which can be applied along with basis to aid in forecasting prices at localized levels.

Many methods have been utilized for forecasting basis. One approach which has seen much attention in previous literature is the use of historic averaging. The focus on historic averages follows the fact that they are easy to apply. They can be used quickly by producers, unlike complex time series and econometric models, making them ideal for forming price expectations. Another advantage is that there is no need to update the model from year to year. Dhuyvetter and Kastens (1998) determined the optimal length of historical average to forecast basis for various crops in Kansas, and this concept was revisited as a means of forecasting crop basis by Taylor, Dhuyvetter, and Kastens (2004).

This method has also been applied to feeder and fed cattle by Tonsor, Dhuyvetter, and Mintert (2004).A historic average is used to forecast the week or month in question by using an average of the corresponding week or month over a number of previous years. This simple method of forecasting can be improved upon by incorporating current information regarding the deviation between observed and forecasted basis into the forecast. Taylor, Dhuyvetter, and Kastens (2004) first determined to optimal lengths of simple historic averages and then incorporated forecast deviations to make improved forecasts for crops. Tonsor, Dhuyvetter, and Mintert (2004)used a similar approach for feeder cattle, and fed cattle. In these works the authors found optimal deviation methods offered significant improvements in forecasting accuracy versus simple historic averages.

Tonsor, Dhuyvetter, and Mintert (2004) provide a framework for the historic averaging methods utilized in this study. There were three main objectives to their work. While the focus of this study relates mainly to their second and third objectives the first is worth mentioning because it did address a valid concern.

The first objective was to assess whether accounting for the number of days until contract expiration along with a historical average could enhance forecast performance by adding the component of cash futures convergence to their model. The idea being that as a contract approached delivery there may be some abnormal price movements which effect basis. It could be argued that these are observable in practice but they are short lived and can be considered noise. One might think that if there was a consistent and usable pattern here in regards to price movements going into delivery then the markets would fail Fama's weak form efficiency. This approach to enhancing a forecasting model did little to improve forecast accuracy when examining feeder and fed cattle basis.

Second they determined the optimal number of years to include in a historic average to forecast basis for feeder cattle and fed cattle. This objective is of particular importance because post Tonsor, Dhuyvetter, and Kastens (2004) there has been no published work using historic averages for livestock basis and an update may be in order. After finding the optimal average length, the authors solved for the optimal amount of current deviation to include across each of their forecast horizons. They then assessed the affect of incorporating current information into historic average based forecasts when compared to the base historical average.

They were able to improve on the mean absolute error across both the 4 and 8 week horizons in their live cattle forecasts. Paired t tests also indicated that these two forecasts were statistically different. Across the horizons from 12 to 24 weeks they found that the optimal deviation was zero or that the deviation-adjusted forecast would be the same as the historic average.

The literature is sparse with respect to using econometric methods to forecast fed cattle basis. At the base of this literature is Paul and Wesson (1967) who utilized the theory of the price of storage to explain spot-forward spread in feeder and fed cattle prices as the price of feedlot services. Paul and Wesson (1967) say that the carrying charge in grain can be analogous to the market price of converting a product from one form to another. Their work focused on a spread between feeder cattle and fed cattle to come up with an implied price for feedlot services. They go into much detail on the custom feeding ventures of the day and how some of these relationships were set up. While it may be an interesting read for some, those details are not highly germane to this work.

They do eventually draw a parallel between custom feeding and cattle futures. Their argument is as follows. Say it takes approximately six months to finish an animal. Now say it is December and one wants to supply fed cattle in the following June. There are two options, one can go long in June, and thus procure the animals they wish to supply through a futures contract.

The second option is to purchase feeder cattle and feed in December. Then pay for feedlot services from December to June. If there is opportunity for arbitrage then these two different options should be very closely related with neither having a distinct advantage over one or another.

While this is a little more involved than putting grain in a bin it seems to be a very well thought out analogy. Essentially all that is taking place is a service being provided over time, and while grain may have the advantage of being much more storable, where as fed cattle definitely can only be stored up to some maximum point, the concept provides sufficient argument for a inter-temporal relationship in futures markets. One could go further to suggest that fed cattle also have a price of feeding curve which looks much like the curve demonstrating the supply of grain storage and marginal cost.

One of the earliest fed cattle basis forecasting studies was done by Leuthold (1979) where he modeled basis as a function of number slaughtered, the price of corn, price of steers, price of feeders, cattle on feed and quarterly dummy variables. Leuthold states that in grain marketing basis commonly reflects a payment for storage. In livestock this is more challenging and little work has been done since fed cattle are not considered a storable commodity. He found that his models had a better fit when modeling cash-futures spreads over longer horizons. Feeder steer prices, corn prices, and cattle on feed variables were statistically significant in the work. The work also found some of the seasonal dummy variables to be statistically significant.

Naik and Leuthold (1988) analyzed cash futures price relationships for finished hogs and fed cattle. They used a utility maximization framework to analyze cash-futures correlation for both commodities. This analysis required them to make some assumptions as to a producer's Arrow-Pratt measure of risk aversion and then incorporate it with a producers profit function to use producers marketing behavior as a means to explain basis. Key components of the profit function included output prices and production as well as feed costs. Naik and Leuthold (1988) measured a longer term interaction between cattle futures and cash prices than hog futures and cash prices due to a longer marketing horizon for cattle.

Another component of this work was the estimation of fed cattle basis as a function of lags of fed cattle basis and multiple supply and demand measures including; per capita income, pork in cold storage, the price of corn, and the number of cattle available to market. They modeled hog basis with a similar set of variables however the particulars will be omitted from this discussion.

They found that a substantial portion of basis at a given contracts maturity for both cattle and hogs could be explained one month in advance but as this horizon increased the ability of the variables to explain basis declined. They claim that these findings suggest that livestock maturity basis includes both a risk and a speculative component. They found no seasonality in cattle basis but did find seasonality in hog basis. They found a more predictable relationship between cash and futures prices in hog markets than in cattle and attributed this to the significant seasonality they found.

Liu et al. (1994) take a different approach to modeling fed cattle basis. They modeled basis at a monthly frequency in log-log form as a function of supply variables, demand variables, delivery costs, and futures variables. On the supply side they considered head of beef commercially slaughtered and the change in the number of calves on feed. On the demand side they considered the change in the farm price of young chickens and the change in the number of commercially slaughtered hogs. The change in the consumer price index was used as a proxy to account for delivery costs. Finally they used a lag in the spread of the nearby futures contract versus the next deferred futures contract for live cattle as well as open interest in that contract to assess the relationship between basis and futures markets.

They state that relating basis to storage cost is not applicable since live cattle are not a storable commodity. They state that in the absence of transaction costs if the current futures price is equal to the expected cash price in the future for a specific location then the spread is the expected change in cash price. In their modeling they relax the assumptions of no transaction costs and no delivery costs. The use of futures market variables, particularly futures spread as an explanatory variable will be looked at in this study as previous literature suggests it can contain information alluding to the price of feeding services and the expected change in cash prices.

Liu et al. (1994) employed three models. The first utilized futures variables but no supply and demand variables. This model showed high explanatory power of the spread variable. The open interest and delivery costs variables were also statistically significant.

Their second model considered only supply and demand variables. The authors found cattle on feed to be significant and inversely related with basis as expected. On the demand side they only found farm price for young chickens to be significant. They attributed this finding to the idea that prices of other meats (substitutes) may have more impact on to prices for immediate delivery than prices for future delivery.

The third model was a composite of the first two models. Futures spread, open interest, and chicken price remained statistically significant. Cattle on feed went from being statistically significant to being statistically no different than zero. F-tests failed to reject the null hypothesis that all variables but futures spread and open interest were equal zero in model three.

While Liu et al. (1994) did not give any conclusions as to what the spread variable may be representative of in the feeding industry it may be useful to think of it as proxy for the size of feeder's showlists, or fed cattle in the optimal marketing window. In grains markets the spread between nearby and deferred contracts is considered to represent the marginal price of storage and is influenced by the magnitude of stocks in storage as discussed by Working (1949). While there are no academic articles specifically relating nearby futures spread to showlist size it seems logical to draw a parallel. Bacon et al. (1993) explored the importance of showlists in short-run fed cattle pricing.

Bacon et al. (1993), shows that inventories of market ready cattle, called showlists, have a stronger influence on weekly slaughter cattle prices than slaughter levels. The hypothesis that showlist size is more important than slaughter numbers came from their analysis of a semesters output from Oklahoma State Universities Packer-Feeder game. They used three sources of data to do this analysis, experimental data from the Packer-Feeder game, publicly reported data, and private data from feedlot closeout records.

Bacon et al. (1993) state that cattle are storable within a marketing window, cattle inside this marketing window are said to be the feeder's showlist. In the Packer-Feeder game they noted buyers and sellers monitor the size of showlist closely which indicates they believe it is an important factor in fed cattle pricing. Within the marketing window where sellers will not suffer a price penalty for over or under finished cattle market conditions rather than physical attributes of the animal become the most important factors in marketing decisions. They used public data was pulled from the USDA cattle on feed and federally inspected slaughter reports, and private closeout data from 85 feedyards feeding roughly ¼ of the cattle in the seven state cattle on feed report to test hypothesis from the game.

Analysis of the packer-feeder game data showed a stronger correlation between showlist and price than slaughter and price. Private data was then analyzed to confirm the findings of the experimental data. They found that showlist does cause changes in price. Price and showlist were strongly negatively correlated. All data sets analyzed showed showlist to have a negative correlation with price which was stronger than the negative correlation price and size of slaughter. Noting the importance of showlist size, and the possibility that nearby futures spread may hold information as to showlist size the spread will be considered in this work as a possible explanatory variable for basis.

Following Liu et al. (1994) the most recent work directly addressing fed cattle basis is Parcell, Schroeder, and Dhuyvetter (2000). This work will provide most of the foundation for the econometric models estimated in this study. They estimated basis for three regional markets as a function of lagged basis, cattle on feed by region, choice-select spread, corn price, cold storage, dressed weights, captive supply and monthly dummy variables. The authors focus was to determine which factors may be influencing live cattle basis, determine whether captive supplies have a significant impact on basis, and if the 1995 futures contract specification change had any impact when used in a multivariate model.

Parcell, Schroeder, and Dhuyvetter (2000) analyzed monthly data from Kansas, Colorado, and Texas for the time period from January 1990 to July 1997. The authors found corn price to be an important determinant of basis. The authors also found choice-select spread to have a positive relationship with basis. The 1995 contract change did not affect basis. Seasonal components were also important determinants of basis.

Much has changed in the decade since this work was done. The USDA introduced mandatory price reporting. The discovery of BSE in Canada and later in the United States has changed packing practices. Beef products have became more differentiated in regards to branded products and special labeling such as “natural” or “sustainably raised”. There has also been an increase in beef procured by packers through formula arrangements, marketing agreements, and forward contracts. This raises the question as to how the Parcell, Schroeder, and Dhuyvetter (2000) model would have performed over the last decade.

One idea of interest is the degree to which markets are integrated and how mandatory price reporting may have affected efficiency. Pendell and Schroeder (2006) conducted one of the most recent analyses. They stated that in the two decades prior to their work the beef industry has undergone significant change.

Over the two decades prior to Pendell and Schroeder (2006), both the cattle feeding and packing sectors of the industry underwent significant consolidation. There was a dramatic increase in the use of marketing agreements. This increase in marketing agreements lead to a situation where there were concerns about insufficient data collected on daily negotiated prices in regional markets. In the late 1990's the attitude was that there was possibly a lack of transparency in transactions leading to inefficient market where four packers slaughtering 80% of the beef could be exercising some influence on fed cattle prices. In addition, most marketing agreements involving formula pricing were based off the Ag Marketing Service's (AMS) reported price for live cattle. These concerns that prices may not have been accurate lead to legislation instituting mandatory price reporting (MPR).

The objective of Pendell and Schroeder (2006) was to test how mandatory price reporting might have influenced spatial market integration. Market integration measures how well one region responds to movements in another region. Conceptually the closer regional markets are to moving in unison the better information flow between regional markets must be because any discrepancies would leave opportunity for arbitrage and thus correct themselves. Pendell and Schroeder (2006) were the first study to look at integration using information available from USDA mandatory price reporting (MPR). The previous studies other than Fausti and Diersen's (2004) look at integration using data from South Dakota's earlier independent imposition of mandatory reporting were at least 10 years old.

If MPR had the intended effect it would lead to more highly integrated regional market structure. To test for integration between markets on a pair-wise manner the authors used the Engel-Granger method. To test the whole market they used Johansen's multivariate testing method. They assessed weekly price data for live steers and heifers across the five regional markets from January of 1992 to June 2006. The data came from AMS reports provided by the Livestock Marketing Information Center (LMIC).

Pendell and Schroeder (2006) found that markets were integrated prior to MPR but that post MPR they were closer to full integration or a one to one move in prices between regional markets. They concluded that there has been some increase in integration since MPR was imposed. However this does not make a strong statement that a problem actually existed pre-MPR, tests indicated that markets were very well integrated in this period, and the finding of increased integration could have very well been a statistical anomaly.

The increased integration may perhaps be because more information is available to all parties involved, or there is also a possibility that there were some flaws with the data collection methods prior to MPR and that the data may not be wholly representative of existing market conditions.

Pendell and Schroeder (2006) along with others found only marginal improvements in integration post MPR, suggesting there was adequate flow of market information prior to MPR. One weakness is a need for studies regarding the availability of new information such as reports on captive supplies and market premiums and discounts which MPR has made available.

In the most up to date work dealing with the effects of MPR, Fausti et al. (2010) address how grid pricing may have been affected. They review past grid studies which focused on where a grid may be advantageous for a producer. They elaborate on how grid data were collected before and after MPR, since MPR grid data are collected at the plant level instead of at the firm level, which means there is a possibility for more variance because of differing grids by plant. They also discussed some data collection issues which could have affected the voluntary price reporting grid reports, such as subjective filtering by interviewers and possibly some bias when selecting parties to interview.

They conclude that MPR increased transparency with regards to grid pricing because there is more dispersion or a wider range in reported premiums and discounts because previously the grid discounts and premiums reflected firm averages which were the filtered by surveyors. In summary Fausti et al. (2010) conclude that MPR provides increased information on packer grids which may provide useful information to those engaged in trade.

Bearing in mind that MPR may have lead to some improvements in the data available for this analysis and lead to the availability of some more specific quality and pricing data at regional levels, this study first attempts to replicate the econometric models presented by Parcell, Schroeder, and Dhuyvetter (2000). This study will also assess the effectiveness of incorporating a futures spread variable in these models as previous literature has made a compelling case for using the information it provides to explain basis. Econometric attempts to model basis both on monthly and weekly intervals will be presented in chapter five.

Chapter 3 - Review of Data

Data used in this research are both weekly and monthly in frequency. Unless otherwise noted the data are provided by Livestock Marketing Information Center (LMIC). As discussed in the next chapter both econometric modeling and historic average based approaches are considered. The econometric models follow Parcell, Schroeder, and Dhuyvetter (2000), utilizing more recent monthly data spanning from June of 2001 to December 2010. The historic average analyses follow Tonsor, Dhuyvetter, and Mintert (2004) utilizing monthly data spanning the period from June 1996 through December 2010. Weekly data used in econometric analysis span a range from June 2006 through December 2010, and a range from June 2001 through December 2010 for historic average approaches. An overview of all variables included in this analysis is supplied by table 3.1. A more detailed discussion of the variables follows table 3.1.

Table 3-1. Listing of Variables and a Brief Description

Variable	Definition	Units	Data Source
Futures	Monthly and Weekly Average Futures Settle	$/CWT	LMIC data
Ncash	Monthly and Weekly Average Nebraska Cash Fed Cattle Price	$/CWT	LMIC data
Kcash	Monthly and Weekly Average Kansas Cash Fed Cattle Price	$/CWT	LMIC data
Tcash	Monthly and Weekly Average Texas Cash Fed Cattle Price	$/CWT	LMIC data
Nbasis	Monthly and Weekly Nebraska Cash Price less Futures	$/CWT	LMIC data
Kbasis	Monthly and Weekly Kansas Cash Price Less Futures	$/CWT	LMIC data
Tbasis	Monthly and WeeklyTexas Cash Price Less Futures	$/CWT	LMIC data
Weights	National Monthly and Weekly Average Dressed Weight all Cattle	Pounds	LMIC data
Captive	National Monthly and Weekly Average Percent Captive Supply	Percent	LMIC weekly data averaged across all weeks in a given month for monthly models
Ncorn	Monthly and Weekly Average Omaha Cash Corn Price	$/Bushel	LMIC data
Kcorn	Monthly and Weekly Average Dodge City Cash Corn Price	$/Bushel	LMIC data
Tcorn	Monthly and Weekly Average Texas Triangle Cash Corn Price	$/Bushel	LMIC data

Table 3.1. Continued….

Variable	Definition	Units	Data Source
Nselect	Monthly and Weekly Average Percent Federally Inspected Beef Graded Select in Nebraska	Percent	LMIC weekly data averaged across all weeks in a given month for monthly models
Kselect	Monthly and Weekly Average Percent Federally Inspected Beef Graded Select in Kansas	Percent	LMIC weekly data averaged across all weeks in a given month for monthly models
Tselect	Monthly and Weekly Average Percent Federally Inspected Beef Graded Select in Texas	Percent	LMIC weekly data averaged across all weeks in a given month for monthly models
Npcofd	Monthly Average Percent Cattle on Feed in Nebraska vs. National	Percent	LMIC Monthly data for Head on Feed in Nebraska Divided by National Head on Feed
Kpcofd	Monthly Average Percent Cattle on Feed in Kansas vs. National	Percent	LMIC Monthly data for Head on Feed in Kansas Divided by National Head on Feed
Tpcofd	Monthly Average Percent Cattle on Feed in Texas vs. National	Percent	LMIC Monthly data for Head on Feed in Texas Divided by National Head on Feed
Cold	National Beginning of Month Stocks of Beef in Cold Storage	Millions of Pounds	LMIC Cold Storage data in 1,000's of Pounds divided by 1,000
Spread	Difference between nearby contract and the next contract out	$/CWT	LMIC data
Months	Monthly Dummy Variables with January as Default		

Discussion of Variables:

Futures: The data used for futures market prices were simple average weekly and monthly live cattle futures market closes provided by LMIC.

Cash Prices: There are multiple cash market price variables (Nebraska Cash, Kansas Cash, and Texas Cash) used in this model. These variables represent the weighted average price per hundredweight for live cattle ready for slaughter in each of their respective regions. These prices were provided by weekly and monthly weighted price series maintained by LMIC.

Basis: Basis was defined as local cash price less live cattle futures market price.

Weights: Weights used are average dressed weights in pounds for all cattle. The original data were on weekly intervals. However to estimate the models with monthly frequency a simple average of all weeks in a given month was taken to generate a monthly series.

Captive Supply: Captive supply is a variable which represents the percentage of all cattle slaughtered procured by packers through either, forward contracts, formula pricing, or some marketing agreement. The original data were on weekly intervals. However to estimate the models with monthly frequency a simple average of all weeks in a given month was taken to generate a monthly series. Another potential issue with this data series is that prior to April of 2004 LMIC included cattle marketed on a negotiated grid in with the formula priced series.

Local Corn Price: There were multiple cash corn price variables (Nebraska Corn, Kansas Corn, and Texas Corn) used in the models. These prices are simple weekly and monthly averages for each of the three regions. The Omaha series was used to represent Nebraska corn prices. The Dodge City series was used for Kansas corn prices due to Dodge City's proximity to many Kansas feedyards. Texas Triangle corn prices were used for Texas due to the large number of feeders concentrated in that area of Texas.

Percentage Grading Select: The original data were taken from weekly average percentage of cattle grading Select series by region (Nebraska, Kansas, and Texas). However to estimate the models with monthly frequency a simple average of all weeks in a given month was taken to generate a monthly series.

Cattle on Feed Ratio: These data come from the USDA Monthly Cattle on Feed Report. This report is issued in the middle of every month so in modeling basis, cattle on feed data were associated with the month the report was issued. The cattle on feed numbers used represented the number of head in lots with one time capacity of over 1,000 head on the first day of the month in which it was issued. To show the affects of cattle on feed in one region relative to another the total number of cattle on feed in a region was divided by the national total to give a ratio of each region's inventory relative to the rest of the nation. The changes in cattle on feed in proportion to other regions are expected to explain when a region may have relatively stronger or weaker basis than other regions.

Cold Storage: Cold Storage is taken from the USDA Red Meats Cold Storage Report. The USDA reports estimates in thousands of pounds of meat in cold storage at the end of the month prior to the report. These reports are issued in the middle of the month. In modeling basis, cold storage numbers for a given month were associated with the month they were issued in. To estimate a model with variables of a scale similar to the one estimated in Parcell, Schroeder, Dhuyvetter (2000) cold storage numbers were divided by 1,000 to give cold storage in millions of pounds.

Spread: Spread is calculated using live cattle futures market data obtained from LMIC. The spread was derived to represent the incentive implied by the market to sell or store cattle within the marketing window. This variable is intended as a proxy for the magnitude of feeder's showlists, or cattle considered harvestable. In this calculation the nearby contract was considered the contract closest to the current date as long as that contract was not in delivery, e.g., if it is the first week of December, a delivery month, then February would be considered the nearby and April would be considered the next contract out. This same procedure was used for both weekly and monthly series.

Seasonals: Monthly dummy variables were created, using January as the default month, to capture seasonal patterns.

Lags: A lag of one month's or one week's basis was used in each region to capture any basis inertia in the model.

Summary Statistics for Individual Variables:

Table 3.2 gives summary statistics of the data used in the monthly econometric models of fed cattle basis. These data began in June of 2001 shortly after the implementation of mandatory price reporting and goes through December of 2010.

Table 3-2. Summary Statistics for Data used in Monthly Models June 2001 Through December 2010

Variable	Unit	Average	S.D.	Minimum	Maximum
Nebraska Basis	($/cwt)	-0.40	2.46	-4.99	7.03
Kansas Basis	($/cwt)	-0.08	2.03	-4.47	6.17
Texas Basis	($/cwt)	0.04	2.00	-4.30	5.94
Omaha Corn	($/bu)	2.94	1.15	1.48	6.74
Dodge City Corn	($/bu)	3.08	1.08	1.85	6.84
Texas Triangle Corn	($/bu)	3.28	1.12	2.12	7.11
Cattle on Feed Nebraska/National	(%)	19.81	1.32	16.37	21.66
Cattle on Feed Kansas/National	(%)	21.11	0.69	19.69	22.94
Cattle on Feed Texas/National	(%)	25.47	1.18	23.72	28.63
Nebraska Percentage Select	(%)	27.03	3.82	16.18	33.75
Kansas Percentage Select	(%)	40.76	5.06	29.23	49.48
Texas Percentage Select	(%)	45.88	2.33	33.04	51.69
Captive Supply	(%)	46.83	8.65	27.81	62.52
Average Dressed Weights	(lbs)	769	16.10	731	799
Cold Storage	(million lbs)	429.893	41.514	318.190	525.167
Spread	($/cwt)	0.73	0.397	-11.75	13.68

Table 3.3 gives summary statistics for data used in the weekly econometric models of fed cattle basis. Data for estimating these models were available from the period beginning in June 2001, however June 2006 was chosen as the period to begin estimating the models. This was due to limited data for the three basis series on a weekly interval to be used for the establishment of historical averages. Since five years of historic pricing data was needed to estimate historic averages the first period a five-year historical average could be used to forecast was June 2006.

Table 3-3. Summary Statistics for Data used in Weekly Models June 2006 Through December 2010

Variable	Unit	Average	S.D.	Minimum	Maximum
Nebraska Basis	($/cwt)	-1.13	1.92	-5.80	4.72
Kansas Basis	($/cwt)	-0.59	1.68	-5.16	5.12
Texas Basis	($/cwt)	-0.30	1.73	-5.00	5.17
Omaha Corn	($/bu)	3.85	1.00	1.94	7.16
Dodge City Corn	($/bu)	3.89	1.00	2.16	7.29
Texas Triangle Corn	($/bu)	4.15	0.99	2.42	7.54
Nebraska Percentage Select	(%)	25.75	4.29	15.62%	34.49
Kansas Percentage Select	(%)	37.90	5.19	28.51	50.29
Texas Percentage Select	(%)	44.86	1.96	38.71	50.01
Captive Supply	(%)	47.32	6.79	29.52	62.16
Average Dressed Weights	(lbs)	778	12	746	801
Spread	($/cwt)	1.68	2.46	-3.48	7.67

Historical averages were performed using data which reached further back in time than the data used in the econometric approaches. This is because basis information was needed for five years prior to the period covered by econometric models to estimate a five-year historic average for comparison to the other models. Moreover, the issue of how introduction of mandatory price reporting influenced available variables of interest is mainly relevant in the econometric assessment and less constraining when examining historic average approaches. Table 3.4 is a summary of the basis series for both monthly and weekly data used across the period prior to the period forecasted by econometric approaches. For the monthly series this period ran from January of 1995 to May of 2001, for the weekly series this period ran from June of 2001 to May of 2006.

Table 3-4. Summary Statistics for Additional Variables

Fed Cattle Basis Used in Monthly Historical Averages Jan 1995 Through May 2001					
Variable	Unit	Average	S.D.	Minimum	Maximum
Nebraska Basis	($/cwt)	-0.67	1.55	-3.72	5.08
Kansas Basis	($/cwt)	-0.61	1.41	-3.02	3.61
Texas Basis	($/cwt)	-0.60	1.39	-3.13	3.44
Fed Cattle Basis Used in Weekly Historical Averages June 2001 Through May 2006					
Variable	Unit	Average	S.D.	Minimum	Maximum
Nebraska Basis	($/cwt)	0.21	2.97	-7.52	13.24
Kansas Basis	($/cwt)	0.17	2.55	-14.09	9.55
Texas Basis	($/cwt)	0.17	2.38	-4.39	8.91

***The reported minimum Kansas Basis in the weekly data from June 2001 to May 2006 appears strikingly lower than minimums in Nebraska and Texas. It can be noted this observation occurred in the final week of December 2003, just prior to the discovery of BSE in the U.S. The weekly Kansas cash fed cattle price series provided by LMIC appears to show the effects of this shock one week prior to the shock in fed cattle futures markets and other observed cash markets for fed cattle. The Kansas cash fed cattle price for this week was confirmed through a second series reported by LMIC and thus the data series was left as is.

Supplemental Definitions:

Basis: Prior to any analysis, basis had to be generated for each of the regions studied. While local historic cash bids and CME live cattle contract prices are readily available, there was no historic record of basis at the locales available for study. Basis was generated using equation one:

$$\boldsymbol{Basis_{it} = Price_{it} - Live\ Cattle\ Futures_{t}} \quad \textbf{(1)}$$

Where "*i*" represents region and "*t*" represents month. Monthly average cash prices were used for each region and monthly averages of nearby futures contract closes were used for live cattle futures. The futures contract considered nearby for these purposes was the contract closest to the current month, in the event that the current date fell in a contract's delivery month then that month was considered nearby until contract expiration.

When estimating models the base of comparison or metric which all models are to be compared across is important to consider. In this analysis absolute error and bias were used to assess model performance. Absolute error represented in equation two is examined because it is a straight forward measure of magnitude of error in $/CWT, and is a concept which the end user can easily relate to.

$$\boldsymbol{Absolute\ Error_{it} = Abs(Basis_{it} - Ba\hat{s}is_{it})} \qquad \textbf{(2)}$$

Where *"i"* represents each region and *"t"* represents each month.

Bias was calculated following equation three, is evaluated because many market participants would like to know which side of actual basis the forecast tends to fall on, on average, given their own position in the market. The bias is important because, the direction and not just magnitude of errors will have a positive, or adverse, affects on the profitability of an individual's hedge position.

$$\boldsymbol{Bias = Average(Basis_{it} - Ba\hat{s}is_{it})} \qquad \textbf{(3)}$$

Where *"i"* represents each region and *"t"* represents each month.

Data Limitations:

There was sufficient data available through LMIC for use in these models. Cash price data and futures data made up some of the longer series available. Some of the data were only available beginning around June of 2001. This is mainly due to the implementation of mandatory price reporting in the meat packing industry in April 2001. There were sufficient data to estimate models on a monthly frequency as there were 115 observations between June 2001 and December 2010.

Data on regional grading percentages and captive supply were not available pre-MPR. Dressed weights and grain prices were also available for beginning long before June of 2001. Cattle on Feed and Cold Storage were limiting in the sense that they are only reported on a monthly interval. This limited the first attempt at modeling to a monthly frequency versus a more desirable weekly frequency. Also, given the period which the models were estimated over, there was not a full series of fed cattle price data available for the regions of Iowa/Minnesota and Colorado. Ideally all five major markets would be modeled.

When it came to weekly modeling one limiting factor was the availability of consistent fed cattle price series prior to MPR. While some regions, such as Kansas, have long running data available for weekly prices, other regions did not maintain extensive cash price series prior to MPR. For the sake of comparison between econometric models and historical averages this left only 240 observations across the period between June 2006 and December 2010 to work with.

Chapter 4 - Historic Average Models

This section discusses the array of different historic average based models derived and examined for forecasting fed cattle basis. The models evaluated include simple historic averages, averages placing varying weights across individual years included, Olympic averages, and historic averages with the optimal current deviation incorporated. The base results of these forecasting approaches will be discussed in detail in this chapter and a more detailed econometric comparison of all historic average approaches will follow in chapter 6.

Simple Historic Averages:

Different lengths of historical averages were explored in this study. All the evaluated averages were estimated including one to five years of historic data for each region. The base form for a simple historical average is supplied in equation 4.

$$\boldsymbol{Ba\hat{s}is_{it} = 1/K \sum_{k=1}^{K} Basis_{it-k}} \tag{4}$$

Where "*i*" is equal to region, "*t*" is equal to month or week, "*k*" is equal number of years included in the average.

In the simplest case of a one year historic average, the forecast of basis for any given week or month in the future, is the basis in that period for the previous year. As the length of the averages grows to include additional prior years, less weight is assigned to the period in the most recent year. This method of forecasting has been used in many studies of basis for different commodities as it is easy to apply and understand. Specifically this method was employed by Tonsor, Dhuyvetter, and Mintert (2004).

Weighted Historic Averages:

The weighted average was calculated following the base historic average formula with arbitrary weights assigned to each year expressing less and less weight as we move into more distant history. There is no known previous literature where multi-year historic averages with varying weights have been used in analysis of basis for any agricultural commodity. However the argument that the incorporation of more weight on the most recent periods improving forecast accuracy may be valid given the logic that recent events should have more bearing on the near future than events in the more distant past. Table 4.1 gives the weights used for both monthly and weekly weighted average series. While an infinite array of weighting schemes could be analyzed, those shown in table 4.1 are sufficient for our initial exploration of how time-varying weights compare to the more common simple average approach.

Table 4-1. Matrix of Arbitrary Weights Used in Weighted Monthly Historic Averages from July 2001 to December 2010

	Previous Year	2nd Year	3rd Year	4th Year	5th Year
5 Year	0.50	0.25	0.13	0.08	0.04
4 Year	0.52	0.26	0.13	0.09	
3 Year	0.56	0.28	0.16		
2 Year	0.65	0.35			

Olympic Historic Averages:

Olympic averages were calculated following the same form of simple historic averages with the high and low observation for each period in the historic data series considered being omitted. This approach to forecasting basis has not been covered in any previous analyses of fed cattle basis. This approach does offer some promise of being a simple method to improve upon the simple historical average as removing outliers may improve forecast accuracy.

To obtain an average utilizing five years data with this approach for comparison with the five-year simple historic average requires seven years historic data. Similarly to compute an average utilizing one year's data for comparison with a one-year simple historic average requires the calculation of a three-year Olympic historic average. Fortunately for monthly models there was ample history to construct a seven-year Olympic average to forecast across the same period as historical average models. In the case of weekly models there was not sufficient data to calculate seven-year and six-year Olympic averages as forecast for the period from June 2006 to December 2010 so only five, four and three-year Olympic historic averages were calculated.

Historic Averages with Optimal Deviation:

Historical averages with optimal deviation can also incorporate knowledge regarding the error of a simple historic average in forecasting the current month or week's basis. For instance, if one knows a three-year historic average would have underestimated the current week's basis by $1/cwt, a forecast of basis for next week could incorporate this information to supplement the forecast suggested by a simple three-year historic average. Equation five shows a historic average with optimal deviation is a base historical average with a second term added on which is simply appending a percentage of the current error in the forecast.

$$\boldsymbol{Ba\hat{s}is_{it} = 1/K\sum_{k=1}^{K} Basis_{it} + \varphi\left(Basis_{it-h} - \frac{1}{K}\sum_{k=1}^{K} Basis_{it-h}\right)} \qquad (5)$$

Where "i" is equal to region, "t" is equal to month or week, "k" is equal number of years included in the average, *"h"* is equal to forecast horizon, and "φ" is equal to the optimal percentage of current error. Specifically, this method was employed by Tonsor, Dhuyvetter, and Mintert (2004).

Results, Monthly Simple Historic Averages:

Monthly Historic Averages were constructed and compared with each other. Table 4.2 shows the mean absolute error for the three regions of Nebraska, Kansas, and Texas, as well as the mean absolute error for the Five Market Series. Forecasts for the Texas and the Five Market series show the lowest mean absolute error when using five-year historic averages. Conversely, using a four-year and a three-year historic average produces the lowest mean absolute error in Kansas and Nebraska. It may be expected that a shorter average performs better for Nebraska since the most recent information likely deserves more weight given the changes in the region.

To demonstrate the statistical difference in forecasting performance, p-values from paired t-tests are also displayed in table 4.2. These tests highlight that the absolute errors across models containing two- to five-years are statistically very similar across all regions. However across all regions the one-year historical average produced statistically different and worse forecasts than models incorporating a longer historical series. Given the relative size of the mean absolute error for the one-year historic averages for all regions, the degree to which it is statistically different, and the ease of generating averages using additional historical observations, a key implication is that the use of only data from the previous year is not advised.

Table 4-2. Results from Monthly Simple Historic Averages with Paired T-tests of Absolute Errors ($/CWT)

MAE Nebraska June 2001 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.7361	1.7547	1.7347	1.7751	2.2862
P-values Paired T-Tests				
	4 Year	3 Year	2 Year	1 Year
5 year	0.6489	0.9843	0.6840	0.0003
4 Year		0.7056	0.8067	0.0004
3 Year			0.5202	0.0029
2 Year				0.0091

MAE Texas June 2001 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.3813	1.3865	1.3923	1.4187	1.6419
P-values Paired T-Tests				
	4 Year	3 Year	2 Year	1 Year
5 year	0.8753	0.8393	0.6383	0.0169
4 Year		0.8810	0.6501	0.0120
3 Year			0.6105	0.0044
2 Year				0.0093

MAE Kansas June 2001 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.3865	1.3815	1.4145	1.4344	1.6758
P-values Paired T-Tests				
	4 Year	3 Year	2 Year	1 Year
5 year	0.8812	0.5953	0.5569	0.0095
4 Year		0.4102	0.4775	0.0061
3 Year			0.7085	0.0042
2 Year				0.0069

MAE Five Markets June 2001 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.4355	1.4362	1.4635	1.5027	1.7391
P-values Paired T-Tests				
	4 Year	3 Year	2 Year	1 Year
5 year	0.9840	0.6464	0.4563	0.0184
4 Year		0.5601	0.4133	0.0133
3 Year			0.4962	0.0131
2 Year				0.0201

Results for Monthly Weighted Historic Averages:

In monthly models the weighted historic averages, following the weighting schemes shown in table 4.1, performed much like the other historic averages in the fact that mean absolute error tended to grow as the number of years in the averages was decreased. It is interesting to see that the mean absolute error for the weighted historical averages was very close to the same size as the mean absolute error across all four regions. Seeing this might help reaffirm the assumption that basis tends to be close to the same for a given location and a given time period across different years. That is, it is expected to see a stable basis over time. Moreover, this is consistent with the above finding of similar forecasting accuracy when using two to five years in simple historic averages.

Table 4-3. Mean Absolute Error for Monthly Weighted Historic Averages ($/CWT)

	5 Year	4 Year	3 Year	2 Year
Nebraska	1.7332	1.7463	1.7567	1.8139
Kansas	1.3724	1.3855	1.4032	1.4637
Texas	1.3594	1.3734	1.3865	1.4430
Five Markets	1.4333	1.4506	1.4716	1.5253

Results for Monthly Olympic Average Models:

Table 4.4 gives mean absolute error for monthly Olympic averages. The results for Olympic averages were very similar to the simple historic averages, and in the cases of Nebraska and the Five Market Average offered slightly lower mean absolute error. One interesting, yet somewhat expected, quality of the Olympic averages is that across different lengths the mean absolute error varied by less than it did with simple historic averages. This could be because we were consistently throwing out (and keeping) data from the same years in these averages even though the lengths varied.

Table 4-4. Mean Absolute Error for Monthly Olympic Averages ($/CWT)

	7Year	6Year	5Year	4Year	3Year
Nebraska	1.5828	1.6386	1.6183	1.6081	1.6007
Kansas	1.3839	1.4110	1.3778	1.3707	1.4168
Texas	1.4069	1.4230	1.3995	1.4051	1.4195
Five Markets	1.4032	1.4260	1.3991	1.3997	1.4104

Results for Monthly Simple Historic Averages with Optimal Deviation:

Work with incorporating current deviation into monthly forecasts was carried out using the four-year historic average as the base forecasting model for all four regions. This is due to the four-year average being statistically very similar to the three-year historic average in Nebraska and the five-year historic averages in Texas and the Five Markets. Tonsor, Dhuyvetter, and Mintert (2004) also utilized a four-year historic average. Table 4.5 gives the optimal amount of current deviation to be used for the period for each of the regions on horizons from one to six months. This optimal percentage of current deviation was determined by using excel to solve for the value which minimized in sample mean absolute error in-sample, or within the period previously forecasted by the simple historic averages.

Table 4-5. Percentage Optimal Deviation for Monthly Optimal Deviation Models Across Horizons from One to Six Months

	One Month	Two Months	Three Months	Four Months	Five Months	Six Months
Nebraska	0.7108	0.6014	0.4782	0.4760	0.3970	0.3606
Kansas	0.5413	0.4791	0.2555	0.2662	0.1762	0.2724
Texas	0.5244	0.5185	0.2216	0.2746	0.1477	0.2369
Five Markets	0.6041	0.5577	0.3736	0.3887	0.2696	0.3189

The optimal deviation models contain information given in the simple historic average models and then build upon it by incorporating additional current information. Knowing this, the expectation would be that optimal deviation models should have lower mean absolute error values, particularly in this instance where mean absolute error for each horizon was minimized in-sample. Table 4.6 shows the mean absolute errors for each of the regions across horizons from one to six months and as expected this approach greatly reduces mean absolute error. It should also be noted that as forecast horizon increases, the percentage optimal deviation decreases. This is to be expected as events today should have more bearing on events one month from today than they will on events six months in the future.

Table 4-6. Mean Absolute Error from Monthly Optimal Deviation Models Across Horizons from One to Six Months ($/CWT)

	One Month	Two Months	Three Months	Four Months	Five Months	Six Months
Nebraska	1.3020	1.5075	1.5673	1.6054	1.6879	1.7143
Kansas	1.1602	1.3245	1.3793	1.4177	1.4333	1.4338
Texas	1.1512	1.2787	1.3619	1.3703	1.4114	1.4247
Five Markets	1.1809	1.3180	1.3787	1.4308	1.4874	1.4813

Results, Weekly Averages:

Next weekly historic averages were analyzed. These models may have more value as they forecast for a shorter and more specific window which users may find to be less of a vague generalization. When forecasting using historic averages on weekly basis values two issues not seen with monthly averages arise; one, not every year has fifty two weeks, and two, futures contract expiration may occur in different weeks in different years.

Typically every five years there will be a 53^{rd} week in the weekly historic basis data. For the weekly forecast the 53^{rd} week only occurred twice in the data, this occurred in 2001 and 2006. With no particularly appealing way to deal with these 53^{rd} weeks the decision was made to average the 52^{nd} and 53^{rd} week's basis in these two years and use a composite for the last week in those years.

The second concern of if it is necessary to appropriately pair weeks so that no one week's historic average basis will be calculated across different contract months posed another challenge. Previous literature, particularly Tonsor, Dhuyvetter, and Mintert (2004), addressed the concern of the timing of contract expiration across different years. They found that forecast error between methods simply calculating basis by differencing cash prices and nearby futures series and methods which attempted to account for the time to contract expiration to be very small and statistically insignificant. For this reason in this work weekly basis will simply be calculated by differencing the cash price series for each region and the nearby futures contract series.

Once again, the simple historic average was the first approach explored. The results were similar to the monthly average in the sense that most of the regions tended to favor longer averages. The mean absolute error was also close in magnitude to the monthly simple historic averages for each region. Table 4.7 gives the mean absolute errors for each of the models, as well as P-values from paired T-tests conducted on absolute errors from the models.

Table 4-7. Results from Weekly Simple Historic Averages with Paired T-tests of Absolute Errors

MAE Nebraska June 2006 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.6645	1.7402	1.6593	1.4990	1.5811
P-Values Paired T-Tests				
	4 Year	**3 Year**	**2 Year**	**1 Year**
5 year	0.0386	0.9272	0.0140	0.3072
4 Year		0.0820	0.0000	0.0420
3 Year			0.0010	0.2790
2 Year				0.1266

MAE Texas June 2006 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.4260	1.5040	1.4866	1.4684	1.7134
P-Values Paired T-tests				
	4 Year	**3 Year**	**2 Year**	**1 Year**
5 year	0.0034	0.1548	0.4556	0.0002
4 Year		0.5910	0.4695	0.0038
3 Year			0.6450	0.0005
2 Year				0.0000

MAE Kansas June 2006 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.4602	1.5199	1.5129	1.4742	1.6630
P-Values Paired T-tests				
	4 Year	3 Year	2 Year	1 Year
5 year	0.0311	0.2528	0.8119	0.0090
4 Year		0.8521	0.3762	0.0553
3 Year			0.3404	-0.0273
2 Year				0.0013

MAE Five Markets June 2006 to December 2010				
5 Year	4 Year	3 Year	2 Year	1 Year
1.4382	1.5135	1.4867	1.4199	1.5796
P-Values Paired T-tests				
	4 Year	**3 Year**	**2 Year**	**1 Year**
5 year	0.0082	0.2939	0.7584	0.0606
4 Year		0.4623	0.0713	0.3567
3 Year			0.1030	0.1540
2 Year				0.0039

The results of paired T-tests are displayed in the matrix below the mean absolute errors for each region. These results differ slightly from the results seen using monthly averages. In this case five-year historic averages give the lowest mean absolute error for Kansas and Texas. The two-year historical average gives the best results for Nebraska. Again, due to the changes occurring in Nebraska and the growth in their feeding industry over the period, the expectation is for a shorter average to perform slightly better. In Nebraska the five-year historic average was the worst performer, while in Texas and Kansas the one-year historic average stands out as the poorest. In Kansas and Texas the two-year average was a close second to the five-year historic average. For consistency in methods used to create forecasts with optimal deviation a compromise was made and two-year historic averages were chosen. This lends itself to making apples to apples comparisons of forecast errors from this approach across regions.

Results for Weekly Weighted Historic Average Models:

Weekly weighted historic average forecasting poses some interesting results. Across all four regions, as the mean absolute error decreased the number of years included in the averages tended to decrease It seems that this approach favors the averages with the highest weights on the previous year. One plausible explanation for this finding is the relatively short length of the period modeled with weekly models. The existence of one or two outlier years in a forecasted period only four and a half years long could lead to models which incorporate fewer years' historic data being preferred. Another explanation could be the occurrence of structural change in the markets.

Table 4-8. Mean Absolute Errors of Weekly Weighted Historical Average Models ($/CWT)

	5 Year	4 Year	3 Year	2 Year
Nebraska	1.4932	1.5051	1.4569	1.3947
Kansas	1.4273	1.4327	1.4004	1.3673
Texas	1.4212	1.4282	1.3932	1.3632
Five Markets	1.3872	1.3949	1.3631	1.3303

Results for Weekly Olympic Historic Average Models:

Olympic historic averages were limited to a maximum length of five years due to a lack of consistent pricing data across all regions on a weekly frequency prior to mandatory price reporting. The weekly Olympic historic averages perform much like the other average models in the sense that as the number of years included in the average decreases mean absolute error tends to grow across all three regions. The mean absolute error (table 4.9) for the regions of Kansas, Texas, and The Five Market Series are close to the same magnitude as those given by simple historic averages. In Nebraska the mean absolute error is slightly lower, possibly due to the fact that Nebraska has seen the most structural change and thus may have more dramatic outliers which impede the ability of simple historic averages to forecast.

Table 4-9. Mean Absolute Errors of Weekly Olympic Historic Average Models ($/CWT)

	5 Year	4 Year	3 Year
Nebraska	1.4811	1.5546	1.5401
Kansas	1.3998	1.4612	1.4623
Texas	1.4127	1.4801	1.4650
Five Markets	1.3641	1.4298	1.4135

Results from Weekly Simple Historic Averages with Optimal Deviation:

Finally the historic averages with current deviation were assessed. Table 4.10 shows the percentage optimal deviation to be incorporated for each region at each horizon. As expected, as the forecast horizon increases, the optimal amount of current information incorporated decreases. Around 20 to 24 weeks out there is an anomaly and the optimal current deviation incorporated increases slightly.

Table 4-10. Percentage Optimal Deviation for Weekly Optimal Deviation Models Across Horizons from One to 24 Weeks

	One Week	Four Weeks	Eight Weeks	Twelve Weeks	Sixteen Weeks	Twenty Weeks	Twenty Four Weeks
Nebraska	0.7277	0.2591	0.1459	0.0799	0.0844	0.1689	0.2136
Kansas	0.6961	0.2189	0.1023	0.0683	0.0000	0.0196	0.0283
Texas	0.6828	0.2832	0.0803	0.0801	0.0000	0.1104	0.1058
Five Markets	0.6807	0.4385	0.2625	0.1233	0.1060	0.1443	0.2126

Table 4.11 gives the mean absolute error for the weekly historic averages with optimal deviation. As expected mean absolute error grows as the forecast horizon becomes longer. Although the comparison between simple averages and improved averages gives improved averages an unfair advantage since they encompass the simple average, it is important to note that the mean absolute error for a one week ahead horizon is roughly two thirds the size of the mean absolute error for the simple historic averages for each of the regions.

Table 4-11. Mean Absolute Error from Weekly Optimal Deviation Models Across Horizons from One to 24 Weeks ($/CWT)

	One Week	Four Weeks	Eight Weeks	Twelve Weeks	Sixteen Weeks	Twenty Weeks	Twenty Four Weeks
Nebraska	1.0270	1.4491	1.4773	1.4872	1.4953	1.4888	1.4817
Kansas	1.0453	1.4218	1.4510	1.4411	1.4377	1.4423	1.4457
Texas	1.0262	1.4189	1.4530	1.4368	1.4312	1.4310	1.4279
Five Markets	1.0541	1.4260	1.5153	1.5497	1.5474	1.5437	1.5382

In summary historic averages with optimal deviation incorporated tended to provide forecasts with the lowest point estimates of mean absolute error on both monthly and weekly intervals. This is to be expected as this method is designed to add information to a simple historic average and improve it, and the approach used in this chapter to determine optimal deviation minimized mean absolute error in-sample. Of the two alternative methods considered (Olympic and weighted averages) Olympic averages tended to perform the best. Weighted historic averages may deserve some additional attention from some ambitious future researcher. In this study the weights were arbitrarily chosen and further analysis may find that by using some determined optimal weight their performance could possibly be enhanced. A more complete comparison of the multiple historic average approaches in provided in chapter 6 to identify forecasts with statistically different forecasting performance.

Chapter 5 - Econometric Models

The drivers of fed cattle basis for the regions of Nebraska, Kansas, and Texas were estimated as a system of three equations using seemingly unrelated regression because it is expected that the dependent variable is related across regions. Intuitively this is to be expected as we would expect basis to move in sync across regions in integrated markets. Econometrically, models estimated separately with ordinary least squares (OLS) which share some of the same exogenous variables are likely to be correlated violating the assumption of independence. Estimating the system using Generalized Least Squares (GLS) which includes a term to account for this correlation should improve the efficiency of the estimators (Maddala, and Lahiri, 2009).

Monthly Econometric Models:

The base model from which the evaluation began is similar to the model used by Parcell, Schroeder, and Dhuyvetter model from 2000 is given as equation 6.

$$Basis_{it} = Intercept + \beta_1 Basis_{it-1} + \beta_2 Weights_t + \beta_3 Captive\ Supply_t + \beta_4 Local\ Corn\ Price_{it} + \beta_5 Percent\ Select_{it} + \beta_6 Cattle\ on\ Feed\ Ratio_{it} + \beta_7 Cold\ Storage_t + \beta_{8\ thru\ 19} Month_t \qquad \textbf{(6)}$$

Where "*i*" is equal to region and "*t*" is equal to time. The β coefficients in the model represents a $/cwt change in basis for a one unit change in the respective variable as described in table 3.1.

A brief description of the variables and expected signs of coefficients are given in this section. A lag of basis is included in the model to capture inertia in basis. The sign on lagged basis is expected to be positive, saying basis tends move in the same direction from one period to the next in the absence of outside influences.

The sign expected on the weights coefficient is negative, as weights increase we would expect to see feeders holding cattle longer and having larger show lists, or a greater supply of cattle ready to kill. Increases in supply due to longer feeding periods may have a negative impact on carcass quality via lower yield grades. It is also worth noting that as supplies increase packers will have incentive to bid less aggressively for finished animals.

The coefficient for captive supply is expected to be negative. Increased packer ownership can be associated with decreased short run competition in bidding for fed cattle on the open market (Schroeder, Jones, Mintert, and Barkley, 1993). This has been a particularly controversial issue in the past and the affects of captive supply on packer bids has been the subject of many academic studies.

As local corn price is a proxy for feed costs the expected sign is negative, when feed costs increase short-term supply effectively increases. This is because feeders will cut back on the number of days they feed an animal and move additional animals on the market. Conversely, in times of decreased feeding costs there is an incentive for feeders to hold animals off the market longer due to the higher returns generated by a heavier animal.

The coefficient on percent grading select is expected to be positive as a very strong (high) basis would provide incentive for feeders to market, “green”, or under-finished cattle which would result in larger percentages grading select. This is in agreement with the findings of Parcell, Schroeder, and Dhuyvetter (2000) who found a positive relationship between choice-select spread and basis. It is to be expected that as the ratio of cattle grading select increases the discount for select cattle should grow implying a larger spread.

The coefficient for the cattle on feed ratio is expected to be negative. This variable represent the supply of cattle being finished in a region relative to the nation so an increase in the ratio would be seen as an increase in local supply, relative to national supplies, thus weakening basis.

The coefficient for cold storage is expected to be negative as an increase in inventories would suggest less space to store additional product and thus packer costs increase. Also, the more product packers have on hand to market the less aggressive one would expect them to be when purchasing animals for slaughter. After all, why produce more product than you can readily market and incur interest and storage costs as well as risk unfavorable market movement for boxed beef.

Last a series of monthly dummy variables is included to capture seasonal patterns in basis.

Prior to estimation of the econometric models a Dickey Fuller test was performed on each of the variables to check if the series were stationary. The null hypothesis of the Dickey Fuller test is that a unit root exists. If the test statistic is lower (more negative) than the critical value then we can reject the null hypothesis that a unit root exists. This is important when it comes to estimating the model because data which are not covariance stationary may need to be differenced to avoid problems with spurious regression (Maddala, and Lahiri, 2009).

The Dickey-Fuller test on the variables we are using in our regression reveals some possible unit roots. The test failed to reject the null hypothesis of a unit root for data representing percent captive supply, Kansas percentage select, Texas cash corn price, Kansas cash corn price, Nebraska cash corn price, and Nebraska percentage cattle on feed. More important however is that no unit root in the basis series means that basis is stationary, this is to be expected as trends in basis would indicate a long term lack of convergence between cash and futures. Including a lag of basis as an explanatory variable is effectively differencing this process which can lead to the inclusion of a moving average process in the error term, which may create autocorrelation (Maddala, and Lahiri, 2009). A graphical analysis of basis also reveals no obvious trends. This absence of trend makes the inclusion of a year or trend variable in the models unnecessary.

The model was estimated using first differences of the percent captive supply and the regional corn prices. This should enhance the model by de-trending some of the variables and making them stationary. When the new model is estimated these variables will be interpreted by saying the change across observations tends to impact basis.

The use of a Durbin-Watson test for autocorrelation was inappropriate due to the fact that the test is biased towards not finding autocorrelation in the case of lagged dependent variables (Kennedy, 1994). Residuals for all three series estimated from the system were tested for autocorrelation using Ljung-Box Q test. The null hypothesis that the residuals were white noise was rejected for all three residual series. Autocorrelation in a model with lagged dependent variables is a particularly serious problem as it generates biased estimators. Manual correction is necessary as Stata does not provide a method of estimating a seemingly unrelated regression with corrections for autocorrelation.

Greene (2003) recommends estimating the value of rho, or the correlation in errors across time, with residuals obtained from OLS in each individual equation, and performing a Prais-Winsten transformation before estimating the system as the correct method for correcting the autocorrelation. The first step in this procedure is to estimate the equations separately through ordinary least squares. Post estimation the residuals are captured and then regressed on a lag of themselves with no constant to estimate the value for rho. This rho can be used to perform Prais-Winsten transformations on the data and then the seemingly unrelated regression re-estimated.

Adjusted R-squared is also not provided by Stata and was manually calculated. First values for total sum of squares captured post estimation of the models were calculated. The R-squared value was used to deduce explained sum of squares and residual sum of squares. These pieces of information along with the number of observations and number of exogenous variables could then be put into the adjusted R-squared formula. Formulas used in these calculations are included in appendix-C.

Results:

Table 5-1 presents the results from the base econometric model as represented in equation six. Most of the signs on the coefficients seem to be in agreement with Parcell, Schroeder, and Dhuyvetter (2000). In keeping with expectations the sign on the coefficients for lagged basis, and percent grading select by region were positive. Contrary to Parcell, Schroeder, and Dhuyvetter (2000) the lag of basis was significant across all three regions. The coefficients on local corn price are positive which contradicts the expected negative correlation, however, none of these coefficients were statistically significant.

The coefficients for weights had the expected negative sign but were only statistically significant at the 95% confidence level for Nebraska. Captive supply also had the expected negative sign but was significant at the 95% level only for Nebraska.

Percent grading select had the expected positive coefficients for Nebraska and Kansas yet the coefficient for Texas was negative. Although it seems a little surprising that percent grading select was not statistically significant, it may relate to the continued narrowing of the choice/select spread over time and suggest ample supplies of choice beef have diminished the impact of relative beef quality on fed cattle basis.

Cattle on feed had the expected negative coefficient, yet the coefficient was not statistically significant at the 95% level across all three regions. Cold storage was statistically significant at the 95% confidence level for Nebraska and Texas, and significant at the 90% confidence level for Kansas. The seasonal dummy variables tended to be statistically significant across all three regions for the months of March, May, and November. The positive coefficients on each of these months suggest that basis tends to strengthen around these times of year relative to January levels.

Table 5-1. Results for Base Monthly Econometric Model of Fed Cattle Basis for the Period from June 2001 through December 2010

Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5412	0.5081	0.5322
	(0.000)	(0.000)	(0.000)
Weight	-0.0230	-0.0154	-0.0116
	(0.038)	(0.109)	(0.214)
First Difference Captive Supply	-8.9029	-4.3826	-3.3399
	(0.021)	(0.249)	(0.389)
First Difference Local Corn Price	0.3375	0.2012	0.2768
	(0.315)	(0.481)	(0.343)
Percent graded select	0.4274	1.3070	-0.5673
	(0.852)	(0.140)	(0.755)
Cattle on feed ratio	-13.8204	-2.0056	-6.9521
	(0.129)	(0.822)	(0.205)
Cold Storage	-0.0088	-0.0066	-0.0070
	(0.021)	(0.064)	(0.050)
Monthly Dummy (default = January)			
February	0.6879	0.5562	0.3556
	(0.280)	(0.378)	(0.582)
March	2.5537	1.7301	1.5049
	(0.000)	(0.004)	(0.013)
April	1.2446	0.5115	0.4037
	(0.050)	(0.410)	(0.521)
May	2.7182	2.8388	2.8409
	(0.000)	(0.000)	(0.000)
June	-0.5182	-0.1404	0.0007
	(0.426)	(0.825)	(0.999)
July	-0.5214	-0.8732	-0.8630
	(0.411)	(0.139)	(0.159)
August	0.5575	0.1202	0.2129
	(0.379)	(0.835)	(0.725)
September	-0.1286	0.1139	-0.0308
	(0.837)	(0.844)	(0.959)
October	1.3351	0.8853	0.8609
	(0.026)	(0.124)	(0.144)
November	1.8210	1.1716	1.2486
	(0.002)	(0.038)	(0.029)

Table 5.1. Continued….			
Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
December	0.3972	0.1840	0.4960
	(0.518)	(0.762)	(0.425)
Constant	23.1091	13.9368	13.4320
	(0.003)	(0.060)	(0.055)
RMSE	1.2579	1.2337	1.2361
MAE	1.0179	0.9495	0.9633
R^2	0.7752	0.6776	0.6734
Adj. R^2	0.7326	0.6165	0.6115
Rho	-0.1002	-0.1305	-0.1510
No. Observations	114	114	114

***(p-values are given below coefficients in parenthesis)

A second model is proposed which utilizes additional information ready available from live cattle futures contracts. The goal of this model is to take advantage of any information given by the spread between the nearby futures contract and the next most distant contract. Fed cattle are traditionally thought to be a non-storable commodity because they change form over time, thus making it hard to establish temporal relationships in price. To some extent cattle feeders can lengthen or shorten the number of days an animal is on feed to take advantage of marketing opportunities. This ability to change the intended harvest date of stock provides some justification for a relationship across contract months. The nature of this relationship is similar to the carrying charge relationship in grains and is expected reveal information as the size of feeder's showlists. This new model incorporating futures spread is given in equation seven.

$$Basis_{it} = Intercept + \beta_1 Basis_{it-1} + \beta_2 Spread_t + \beta_3 Weights_t + \beta_4 Captive\ Supply_t + \beta_5 Local\ Corn\ Price_{it} + \beta_6 Percent\ Select_{it} + \beta_7 Cattle\ on\ Feed\ Ratio_{it} + \beta_8 Cold\ Storage_t + \beta_{9\ thru\ 20} Month_t \quad \textbf{(7)}$$

Where "i" is equal to region and "t" is equal to time. The β coefficients in the model represents a change in $/cwt for basis for a one unit change in the respective variable.

The expectations of the signs of the coefficient are the same as they were with the base model. The additional coefficient for the spread variable is expected to be negative in keeping with the negative relationship Bacon et al. (1993) found between showlists and prices. The larger the spread is the larger feeder's showlists are implied to be. Table 5.2 on gives the results from the base model with spread incorporated.

Table 5-2. Results for Base Monthly Econometric Model + Spread for Fed Cattle Basis for the Period from June 2001 through December 2010

Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5629	0.5333	0.5588
	(0.000)	(0.000)	(0.000)
Spread	-0.1289	-0.0942	-0.0923
	(0.001)	(0.012)	(0.013)
Weight	-0.0066	-0.0024	0.0009
	(0.533)	(0.810)	(0.923)
First Difference Captive Supply	-10.3217	-5.5086	-4.4467
	(0.006)	(0.143)	(0.224)
First Difference Local corn price	0.4769	0.2578	0.3263
	(0.133)	(0.351)	(0.243)
Percent graded select	-0.2247	1.2638	-0.5723
	(0.913)	(0.132)	(0.750)
Cattle on feed ratio	-12.6173	-2.1910	-7.2339
	(0.119)	(0.793)	(0.159)
Cold Storage	-0.0064	-0.0050	-0.0054
	(0.062)	(0.132)	(0.104)
Monthly Dummy (default = January)			
February	0.2781	0.2641	0.0861
	(0.671)	(0.682)	(0.895)
March	2.2713	1.5246	1.3182
	(0.000)	(0.009)	(0.024)
April	1.1295	0.4220	0.3327
	(0.064)	(0.485)	(0.584)
May	3.0953	3.0926	3.1052
	(0.000)	(0.000)	(0.000)
June	0.0557	0.2167	0.3681
	(0.933)	(0.740)	(0.576)
July	0.0127	-0.5637	-0.5417
	(0.984)	(0.343)	(0.375)
August	1.0181	0.4176	0.5305
	(0.100)	(0.467)	(0.373)
September	-0.0789	0.1237	0.0013
	(0.895)	(0.826)	(0.998)

Table 5.2. Continued….

Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
October	1.4124	0.9145	0.9164
	(0.015)	(0.104)	(0.109)
November	1.9401	1.2573	1.3559
	(0.000)	(0.021)	(0.014)
December	0.5041	0.2558	0.5830
	(0.417)	(0.676)	(0.348)
Constant	9.3388	3.2958	3.1088
	(0.217)	(0.672)	(0.671)
RMSE	1.1971	1.1931	1.1895
MAE	0.9583	0.9241	0.9344
R^2	0.8221	0.7205	0.7205
Adj. R^2	0.7861	0.6640	0.6640
Rho	-0.2029	-0.1967	-0.2206
No. Observations	114	114	114

***(p-values are given below coefficients in parenthesis)

There is a notable improvement in goodness of fit in terms of adjusted R-squared, and modest decrease in mean absolute errors versus the base model. One surprising observation is that outside Nebraska the only coefficients that were statistically significant at the 95% level are the lag of live cattle basis, the spread variable, and some of seasonal dummies. The seasonal dummies were consistent with the base model in the fact that March, May, and November were significant at the 95% level across all three regions. Again the coefficients on these months were positive giving an indication that a stronger basis versus January can be expected during these times of year.

This begs the question just how much advantage this model might have versus a simplified model with a lag of basis, the futures spread, and seasonal dummy variables. For this reason the model was estimated following equation eight, with only a lag of basis, the spread variable and the seasonal dummy variables.

$$Basis_{it} = Intercept + \beta_1 Basis_{it-1} + \beta_2 Spread_t + \beta_{3\ thru\ 13} Month_t \qquad \textbf{(8)}$$

Where "*i*" is equal to region and "*t*" is equal to time. The β coefficients in the model represents a change in $/cwt for basis for a one unit change in the respective variable.

Again the expectation is that lagged basis will have a positive coefficient while spread will have a negative coefficient. The following table shows the results from estimating a model stripped down to a lag of basis, the spread variable, and seasonal components.

The stripped model varies little in terms of goodness of fit and coefficients from the larger model which incorporated additional variables. Across all three econometric models one can note that the sign and significance of seasonal components are all very similar. While the stripped model is slightly lower in goodness of fit (R-squared) than the larger model including spread it is important to note that this is a measure of the models performance in-sample. Later chapters will cover out-of-sample testing of the models with the goal of truly evaluating which model may perform the best in real time situations across varying horizons. It is possible the stripped model may have an advantage in out-of-sample situations given the smaller amount of information needed to forecast.

Table 5-3. Results for Stripped Monthly Econometric Model of Fed Cattle Basis for the Period from June 2001 through December 2010

Variable	Dependent Variable (basis, \$/cwt)		
	Nebraska	Kansas	Texas
Lagged Basis	0.6924	0.6491	0.6645
	(0.000)	(0.000)	(0.000)
Futures Spread	-0.1425	-0.1093	-0.0951
	(0.000)	(0.000)	(0.001)
Monthly Dummy (default = January)			
February	0.1284	0.2016	0.1238
	(0.855)	(0.764)	(0.855)
March	2.7493	1.7922	1.6519
	(0.000)	(0.002)	(0.004)
April	0.9556	0.3373	0.3185
	(0.130)	(0.578)	(0.601)
May	3.5767	3.4480	3.4167
	(0.000)	(0.000)	(0.000)
June	-0.3083	-0.0694	0.0126
	(0.639)	(0.911)	(0.984)
July	0.2899	-0.5139	-0.7116
	(0.635)	(0.379)	(0.225)
August	1.3452	0.5695	0.4677
	(0.026)	(0.324)	(0.420)
September	0.0575	0.1979	-0.2394
	(0.923)	(0.728)	(0.967)
October	1.6432	1.0320	0.9541
	(0.006)	(0.073)	(0.101)
November	1.7851	1.1770	1.2529
	(0.002)	(0.033)	(0.024)
December	0.0576	0.0431	0.3883
	(0.932)	(0.947)	(0.548)
Constant	-1.0436	-0.6272	-0.5578
	(0.016)	(0.130)	(0.180)
RMSE	1.2464	1.2005	1.2047
MAE	1.0006	0.9462	0.9569
R^2	0.8241	0.7406	0.7315
Adj. R^2	0.8012	0.7069	0.6966
Rho	-0.2739	-0.2716	-0.2771
No. Observations	114	114	114

***(p-values are given below coefficients in parenthesis)

Weekly Econometric Model Results:

Next a series of weekly models were estimated. Weekly models may be more desirable when making marketing decisions because there is a lower degree of aggregation in the data, and they are applicable to decisions made across a smaller and more specific horizon. The three differing econometric models were once again estimated as a system by seemingly unrelated regression.

Prior to estimating the models each data series was tested using a Dickey Fuller test for unit roots. The test failed to reject the null hypothesis of a unit root at the 95% confidence level for weights, captive supply, and local corn prices. To stabilize the data prior to modeling each of these series was first differenced.

The first model (equation nine) is analogous to the base model estimated on a monthly frequency. This model is essentially the same as the base model in the monthly estimations minus the two series which are reported on a monthly frequency (Cold Storage and Cattle on Feed).

$$Basis_{it} = Intercept + \beta_1 Basis_{it-1} + \beta_2 Weights_t + \beta_3 Captive\ Supply_t + \beta_4 Local\ Corn\ Price_{it} + \beta_5 Percent\ Select_{it} + \beta_{6\ thru\ 16} Month_t \qquad \mathbf{(9)}$$

Where "*i*" is equal to region and "*t*" is equal to time. The β coefficients in the model represents a change in $/cwt for basis for a one unit change in the respective variable.

The coefficients for lagged basis and percentage grading select are expected to be positive while the signs for the other coefficients excluding the seasonal dummies are expected to be negative. In all monthly models it was found that the months of March, May, and November were statistically significant at the 95% confidence level across all regions so the same expectation will hold for the weekly models.

The lagged dependent variable in the model made the use of a Durbin-Watson test for autocorrelation inappropriate. Residuals for all three series estimated from the system were tested for autocorrelation using Ljung-Box Q test. The null hypothesis that the residuals were white noise was rejected for all three residual series.

Similar to the monthly models, Prais-Winsten transformations were performed on the data the seemingly unrelated regression was re-estimated. Adjusted R-squared was calculated in using values for total sum of squares and R-squared captured post estimation. Formulas used in these calculations are included in the appendix-C. Results from the estimation are provided in table 5.4.

Table 5-4. Results for Base Weekly Econometric Model of Fed Cattle Basis for the Period from June 2006 through December 2010

Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5718	0.5958	0.6066
	(0.000)	(0.000)	(0.000)
Weight	0.01706	-0.0094	-0.0006
	(0.386)	(0.647)	(0.977)
Local Cash Corn Price	0.2377	-0.0973	-0.1248
	(0.198)	(0.400)	(0.409)
Captive Supply	-1.6824	-1.5418	-0.9020
	(0.237)	(0.300)	(0.555)
Percent Select	-0.3387	1.1640	-1.8272
	(0.743)	(0.029)	(0.286)
February	0.2449	0.3908	0.2944
	(0.476)	(0.256)	(0.384)
March	0.9993	0.3829	0.2291
	(0.003)	(0.250)	(0.482)
April	1.8112	0.7455	0.5713
	(0.000)	(0.029)	(0.085)
May	2.5416	1.8516	1.7959
	(0.000)	(0.000)	(0.000)
June	1.0859	0.6533	0.6828
	(0.003)	(0.059)	(0.045)
July	0.5460	-0.1504	-0.2110
	(0.098)	(0.643)	(0.507)
August	0.9211	0.4869	0.3338
	(0.004)	(0.126)	(0.286)
September	0.1968	0.0113	-0.1073
	(0.549)	(0.972)	(0.739)
October	0.7490	0.5108	0.5478
	(0.019)	(0.108)	(0.081)
November	1.3563	0.8544	0.8444
	(0.000)	(0.008)	(0.008)

Table 5.4. Continued….

Variable	Dependent Variable (basis, \$/cwt)		
	Nebraska	Kansas	Texas
December	0.7153	0.3297	0.6302
	(0.026)	(0.303)	(0.047)
Constant	-1.3327	-1.1856	0.2324
	(0.000)	(0.000)	(0.766)
RMSE	0.9974	1.0296	1.0399
MAE	0.7925	0.8143	0.8277
R Squared	0.7991	0.6844	0.6897
Adj. R^2	0.7846	0.6616	0.6672
Rho	-0.0015	-0.0472	-0.0930
No. Observations	238	238	238

***(p-values are given below coefficients in parenthesis)

The coefficients on lags of basis were positive and significant across all three regions. Percent grading select was positive and significant at the 95% confidence level in Kansas which seems to be in agreement with expectations. The coefficients seem to be in agreement with the findings in the monthly work as far as sign, yet some of the values went from statistically significant to not significant and vice versa. The coefficients for March, May, and November are still positive and significant at the 95% confidence level. The signs of the other explanatory variables also seem to be in agreement with expectations and findings in monthly models.

The second weekly model estimated is similar to the second monthly model in that it incorporated futures spread information as a proxy for the magnitude of feeder's showlists. The weekly model including spread is described in equation ten.

$$Basis_{it} = Intercept + \beta_1 Basis_{it-1} + \beta_2 Spread_t + \beta_3 Weights_t + \beta_4 Captive\ Supply_t + \beta_5 Local\ Corn\ Price_{it} + \beta_6 Percent\ Select_{it} + \beta_{7thru\ 17} Month_t \quad \textbf{(10)}$$

Where "*i*" is equal to region and "*t*" is equal to time. The β coefficients in the model represents a change in \$/cwt for basis for a one unit change in the respective variable.

In keeping with the monthly models including spread, the expectation is for the coefficient on spread to be negative. Again lagged basis is expected to have a positive sign while the other coefficients excluding seasonal dummies are expected to be negative. Table 5.5 gives results when the base econometric model is estimated with the addition of a spread variable calculated in the same was as it was in the monthly work.

Table 5-5. Results for Base Weekly Econometric Model + Spread for Fed Cattle Basis for the Period from June 2006 through December 2010

Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5710	0.5917	0.6116
	(0.000)	(0.000)	(0.000)
Spread	-0.0721	-0.0867	-0.0618
	(0.049)	(0.017)	(0.080)
Weight	0.0189	-0.0073	0.0008
	(0.332)	(0.717)	(0.968)
Local Cash Corn Price	0.2429	-0.0948	-0.1409
	(0.190)	(0.413)	(0.353)
Captive Supply	-1.7036	-1.5795	-1.0001
	(0.229)	(0.282)	(0.511)
Percent Select	-0.4226	0.9930	-1.8003
	(0.681)	(0.062)	(0.295)
February	-0.0952	-0.0160	-0.0012
	(0.802)	(0.966)	(0.997)
March	0.6827	0.0038	-0.0384
	(0.062)	(0.992)	(0.914)
April	1.6346	0.5382	0.4126
	(0.000)	(0.118)	(0.220)
May	2.3981	1.6844	1.6561
	(0.000)	(0.000)	(0.000)
June	1.1785	0.7735	0.7460
	(0.001)	(0.024)	(0.027)
July	0.6505	-0.0247	-0.1312
	(0.049)	(0.939)	(0.678)
August	0.7828	0.3218	0.2119
	(0.016)	(0.313)	(0.499)
September	0.0861	-0.1168	-0.1994
	(0.794)	(0.719)	(0.534)
October	0.6376	0.3806	0.4498
	(0.047)	(0.229)	(0.149)
November	1.2984	0.7908	0.7866
	(0.000)	(0.013)	(0.012)

Table 5.5. Continued….

Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
December	0.6468	0.2553	0.5654
	(0.043)	(0.418)	(0.071)
Constant	-1.0942	-0.8653	0.4144
	(0.003)	(0.009)	(0.603)
RMSE	0.9911	1.0184	1.0341
MAE	0.7913	0.8145	0.8294
R Squared	0.8045	0.6955	0.7019
Adj. R^2	0.7894	0.6720	0.6789
Rho	-0.0100	-0.0563	-0.1125
No. Observations	238	238	238

***(p-values are given below coefficients in parenthesis)

The spread variable was significant across Nebraska and Kansas at the 95% level and was significant at the 90% level for Texas. Goodness of fit in terms of R-squared and adjusted R-squared improved although not quite as dramatic as the improvement seen from incorporating spread in monthly models. The signs and significance of all variables remained roughly the same as the base weekly model.

The final weekly model estimated, as shown in equation 11, was similar to the final monthly model with basis as a function of lagged basis, spread, and seasonal dummies. This gives an idea of the value of including the variables for weights, corn price, captive supply, and percent graded select. Again the signs for lagged basis are expected to be positive and the signs for spread are expected to be negative.

$$Basis_{it} = \; Intercept + \beta_1 Basis_{it-1} \; + \beta_2 Spread_t + \beta_{3\;thru\;13} Month_t \qquad \textbf{(11)}$$

Where "i" is equal to region and "t" is equal to time. The β coefficients in the model represents a change in $/cwt for basis for a one unit change in the respective variable.

Performance of the stripped weekly model as shown in table 5.6 is very comparable to the other two econometric models estimated. Goodness of fit and MAE vary little from the previous two reported models. The signs and significance of all seasonal variables are also comparable. However the coefficients for spread on Nebraska and Texas are only significant at the 90% confidence level, while it remains significant at the 95% level for Kansas. Once again this gives a good indication of which variables bear the most importance when assessing changes to basis, but the true test of relative forecasting ability will be carried out in chapters 6 and 7 when errors from each model are econometrically compared.

Table 5-6. Results for Stripped Weekly Econometric Model for the Period from June 2006 through December 2010

Variable	Dependent Variable (basis, $/cwt)		
	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5764	0.5979	0.6289
	(0.000)	(0.000)	(0.000)
Spread	-0.0693	-0.0924	-0.0602
	(0.064)	(0.012)	(0.090)
February	-0.0373	-0.0796	-0.0010
	(0.923)	(0.834)	(0.979)
March	0.6938	-0.0875	-0.0480
	(0.063)	(0.811)	(0.892)
April	1.5762	0.5133	0.3879
	(0.000)	(0.139)	(0.248)
May	2.3849	1.6553	1.6111
	(0.000)	(0.000)	(0.000)
June	1.2685	0.7907	0.6878
	(0.000)	(0.018)	(0.033)
July	0.6547	-0.0044	-0.1587
	(0.046)	(0.989)	(0.608)
August	0.8330	0.2993	0.1806
	(0.011)	(0.348)	(0.560)
September	0.1411	-0.1535	-0.2452
	(0.667)	(0.634)	(0.434)
October	0.6453	0.3661	0.3726
	(0.048)	(0.253)	(0.230)
November	1.3364	0.7617	0.7194
	(0.000)	(0.017)	(0.019)
December	0.6407	0.2294	0.4623
	(0.051)	(0.477)	(0.141)
Constant	-1.2154	-0.4455	-0.3413
	(0.000)	(0.091)	(0.178)
RMSE	0.9961	1.0137	1.0331
MAE	0.7966	0.8154	0.8337
R Squared	0.7959	0.6963	0.7054
Adj. R^2	0.7841	0.6788	0.6884
Rho	0.0083	-0.0412	-0.1057
No. Observations	239	239	239

***(p-values are given below coefficients in parenthesis)

Chapter 6 - An In-Sample Comparison of Models

Errors from simple historic average models were compared in chapter four in a pair-wise manner using paired t-tests to determine which model statistically performed best between two options. To make further statements about the performance of models estimated in this work, comparison between all alternatives needs to be made. However the use of paired t-tests with such a large number of models across many regions becomes undesirable due to the large number of comparisons to be made and the confusion which would ensue.

This chapter will deal with a comparison of all models estimated in this work by stacking the individual "in-sample" errors and regressing them against dummy variables for each region and model. Kastens, Schroeder, and Plain (1998) used this method to compare multiple USDA and extension price and production forecasts.

It is important to note that evaluating the models in these circumstances unfairly favors the regression based approaches. This statement is made because the use of historical averages is truly an out-of-sample forecast since only past information is utilized to forecast the future. When using a regression based approach in sample such as all models estimated in chapter 5, information known today is used to explain the supposed unknown variable today. Hence regression based forecasting approaches are assuming knowledge of information which cannot possibly be known when forecasting in real time. This testing is still worthwhile even considering the fact that it favors econometric approaches. If these in sample test were to favor historic average methods over econometric approaches then it would be an indication that the econometric approaches deserve no further consideration and historic averaging methods would be the dominant approach. Moreover, the comparison of multiple historic average approaches is easily facilitated by this regression analysis in a manner easier to interpret than a presentation of multiple t-test matrices.

Monthly Models:

Fourteen monthly models are evaluated in this section as potential forecasters of basis. This testing is necessary to evaluate all historic average methods, and the econometric models in comparison to each other. Testing was done through the regression of absolute errors from all competing models against each other with the model outlined in equation 12. Under this model

Kansas was assumed to be the default region and the base econometric model with no spread variable added was used as the default model. Acknowledging that this is not an ideal comparison, since the optimal deviation model was optimized in sample, table 6.1 gives a comparison of each of the selected models ability to forecast basis.

$$Absolute\ Error = Intercept + \beta_{1thru2}Region + \beta_3 Year + \beta_{4thru16}Model \quad \textbf{(12)}$$

Note that weighted historical averages were not included in this comparison due to their lack of attention in any previous literature, the arbitrary nature of the weights considered, and the very small difference in magnitude of their mean absolute errors in comparison to simple historical averages.

Table 6-1. In-Sample Comparison of Absolute Errors Across All Monthly Models

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	0.2380	5.28	0.000
Texas	0.0032	0.07	0.943
Year	-0.0590	-8.83	0.000
Five Year Hist. Average	0.5257	5.40	0.000
Four Year Hist. Average	0.5358	5.50	0.000
Three Year Hist. Average	0.5446	5.60	0.000
Two Year Hist. Average	0.5774	5.93	0.000
One Year Hist. Average	0.9015	9.26	0.000
Four Year Hist. Average W/Optimal Deviation (One Month Ahead)	0.2276	2.34	0.190
Seven Year Olympic Average	0.4841	4.97	0.000
Six Year Olympic Average	0.5188	5.33	0.000
Five Year Olympic Average	0.4901	5.04	0.000
Four Year Olympic Average	0.4880	4.97	0.000
Three Year Olympic Average	0.5113	5.33	0.000
Stripped Spread Model	-0.0090	-0.09	0.926
Full Model With Spread	-0.0380	-0.39	0.697
Constant	119.2805	8.89	0.000
RMSE			1.2727
R^2			0.0614
No. Observations			4788

The estimated model indicates minor and not statistically significant difference between the Texas and Kansas forecasting models. The Nebraska models have larger absolute error than Kansas and the difference is statistically significant. This is to be expected as Nebraska has seen the most structural change over the period. The results from a comparison of all models also aligned with expectations.

All historic average methods tested were found to be statistically different with larger absolute error than the base econometric model. The size of the error also increased as the length of the average decreased. The historic average with optimal deviation had slightly larger error than the base econometric model but the difference was not statistically significant. Finally the two alternative econometric models had smaller absolute error than the base model but the difference was not statistically significant. These tests suggest that one of the alternative models may be our best method. Again this test favors the econometric models over average methods so out-of-sample testing is needed to correctly decide on a best model.

The models were also tested in terms of squared error using the same approach as was used to test absolute error. The model used is given in equation 13.

$$Squared\ Error = \ Intercept + \beta_{1thru2} Region + \beta_3 Year + \beta_{4thru16} Model \qquad \textbf{(13)}$$

Under this model Kansas was assumed to be the default region and the base econometric model with no spread variable added was used as the default model.

Squared error is important to look at because it gives valuable information regarding the variability of forecast errors. Models with higher squared errors have more variable error and may not be favored by individuals who have a high degree of risk aversion. Table 6.2 provides an assessment of monthly models based on squared error.

Table 6-2. In-Sample Comparison of Squared Errors Across All Monthly Models

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	1.4260	5.33	0.000
Texas	-0.0845	-0.32	0.752
Year	-0.3572	-9.00	0.000
Five Year Hist. Average	2.6916	4.66	0.000
Four Year Hist. Average	2.6796	4.64	0.000
Three Year Hist. Average	2.7722	4.80	0.000
Two Year Hist. Average	3.0218	5.23	0.000
One Year Hist. Average	4.8254	8.36	0.000
Four Year Hist. Average W/Optimal Deviation (One Month Ahead)	1.0625	1.84	0.066
Seven Year Olympic Average	2.3838	4.13	0.000
Six Year Olympic Average	2.5217	4.37	0.000
Five Year Olympic Average	2.4799	4.29	0.000
Four Year Olympic Average	2.4512	4.25	0.000
Three Year Olympic Average	2.7345	4.74	0.000
Stripped Spread Model	-0.1203	-0.21	0.835
Full Model With Spread	-0.0622	-0.11	0.914
Constant	717.5598	9.02	0.000
RMSE			7.5505
R^2			0.0543
No. Observations			4788

The results are similar to the testing done in terms of absolute error. Nebraska forecasts have higher squared errors than Kansas while Texas is slightly lower but the difference is not statistically significant. The negative coefficient on the variable for year indicates squared error has decreased over the period from June 2001 to December 2010. The models including spread have slightly lower, but not statistically significant coefficients versus the base econometric models.

The historical average model including optimal deviation was the best performer amongst historic averaging methods which is to be expected since this approach required the minimization of mean absolute error in sample. Olympic averages had slightly lower squared error when compared to their respective historic averages. This does not come as a surprise since the Olympic averages do not include outliers and thus should reduce variability.

Another important aspect of error to evaluate across models is bias, or the average of the actual values less the forecasts. This gives an idea of whether or not a model consistently under or overshoots when forecasting. Different parties may prefer to error more to one side versus the other given the positions they are taking in the cash and futures markets. The bias may also give an indication of two models which may perform together as a composite well by offsetting each other's weaknesses. A summary of the bias of each of the 14 models is given in table 6.3.

Table 6-3. Bias of Monthly Fed Cattle Basis Forecasting Models Evaluated in Chapter 6

Period from July 2001 to December 2010 Bias (Basis - Forecast) Historical Average			
	Nebraska	**Kansas**	**Texas**
5 Year	-0.0705	0.0850	0.1933
4 Year	-0.0474	0.0675	0.1701
3 Year	-0.0306	0.0505	0.1429
2 Year	-0.0186	0.0483	0.1224
Previous Year	-0.0977	0.0677	0.1247
Optimal Deviation	-0.0172	0.0255	0.0903
Bias (Basis - Forecast) Olympic Average			
7 Year	0.1914	0.2382	0.3353
6 Year	0.1689	0.1867	0.2831
5 Year	0.1565	0.1386	0.2324
4 Year	0.1771	0.1248	0.2142
3 Year	0.2147	0.1011	0.1812
Bias (Basis - Forecast) Econometric Models			
Base	0.0000	0.0000	0.0000
Spread + Base	0.0000	0.0000	0.0000
Stripped Spread	0.0000	0.0000	0.0000

All econometric methods yielded unbiased forecasts, which is to be expected as this is one of the assumptions key to econometric approaches. The methods using historical and Olympic averages tended to give estimates with a positive bias except for historical average based forecast for Nebraska. It is worth noting that the forecasts using Olympic average methods consistently have a larger positive bias across all regions than their historical average based counterparts.

In the case of a positive bias a short hedger may not be best served by the model. The positive bias as defined in equation three indicates the feeder who is short hedging is consistently seeing a stronger basis than what is being forecasted. This scenario would lead to unexpected gains from hedging for the short hedger, and unexpected losses for those who take the long position, typically packers. The converse of this is true for forecasts with a negative bias.

Monthly Historic Average Based Models Only:

Table 6-4 provides a comparison of historic average based models. This comparison seems appropriate as the only formal statistical comparison of historic average models in chapter 4 was the use of paired t-test to evaluate simple historic averages. The testing of historic average models alone will magnify the differences in these individual models to a larger degree than what is seen when their absolute errors are grouped with those from econometric models.

Table 6-4, Comparison of Absolute Errors for Only Historic Average Models (Monthly)

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	0.2890	5.24	0.000
Texas	0.0009	0.02	0.987
Year	-0.0666	-8.13	0.000
Five Year Hist. Average	-0.3757	-3.56	0.000
Four Year Hist. Average	-0.3658	-3.46	0.001
Three Year Hist Average	-0.3573	-3.38	0.001
Two Year Hist Average	-0.3242	-3.07	0.002
Four Year Hist Average W/Optimal Deviation (One Month Ahead)	-0.6739	-6.38	0.000
Seven Year Olympic Average	-0.4175	-3.95	0.000
SixYear Olympic Average	-0.3827	-3.62	0.000
Five Year Olympic Average	-0.4114	-3.90	0.000
Four Year Olympic Average	-0.4122	-3.90	0.000
Three Year Olympic Average	-0.3902	-3.70	0.000
Constant	135.3029	8.24	0.000
RMSE			1.3808
R^2			0.0373
No. Observations			3762

The absolute errors for all simple and Olympic average based models as well as optimal deviation models with a horizon of one month ahead. For this comparison of models Kansas was used as the default region and the one-year simple average was used as the default model. In keeping with the tests previously done in this chapter models for the region of Nebraska have statistically significant higher absolute errors than the regions of Kansas and Texas. The negative coefficients for all models assessed confirms the expectation all of the models having lower absolute errors than the one-year simple average. It is clear that optimal deviation models are the best performers amongst historic average approaches. What is more interesting is the next three best performing approaches are all Olympic averages. Perhaps future works using historic averages to forecast basis should explore the use of Olympic averages.

Next the squared errors of only historic average based approaches were considered. The results of this testing as shown in table 6-5 highlight the variability of forecast error. The results of this test mirror those in seen in previous test in this chapter. Again Nebraska regional models have higher variability of forecast error than Kansas or Texas regional models and this difference is highly statistically significant. Again the negative coefficients on all models considered versus the one-year simple historic average indicate that it is the least preferred approach to forecasting fed cattle basis. The historic average with optimal deviation across a one month horizon was again clearly the preferred model for those wishing to minimize forecast error variability. This approach was then distantly followed by Olympic averaging methods.

Table 6-5, Comparison of Squared Errors for Only Historic Average Models (Monthly)

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	1.7983	5.35	0.000
Texas	-0.1082	-0.32	0.747
Year	-0.4258	-8.54	0.000
Five Year Hist. Average	-2.1338	-3.32	0.001
Four Year Hist. Average	-2.1458	-3.34	0.001
Three Year Hist Average	-2.0532	-3.19	0.001
Two Year Hist Average	-1.8036	-2.80	0.005
Four Year Hist Average W/Optimal Deviation (One Month Ahead)	-3.7629	-5.85	0.000
Five Year Olympic Average	-2.4415	-3.80	0.000
Four Year Olympic Average	-2.3037	-3.58	0.000
Five Year Olympic Average	-2.3455	-3.65	0.000
Four Year Olympic Average	-2.3742	-3.69	0.000
Three Year Olympic Average	-2.0909	-3.25	0.001
Constant	859.7990	8.59	0.000
RMSE			8.4125
R^2			0.0385
No. Observations			3762

Weekly Models:

Table 6-6 gives the results for a test of absolute errors of the 12 competing weekly basis forecasting models. Absolute errors for the weekly models were tested in the same manner as they were for monthly models following the model outlined in equation 12. Once again Kansas was used as the default region and the weekly base econometric model was used as the default model.

Results from testing are similar to those seen with the use of monthly models. Nebraska is significantly different from Kansas while Texas is not. The historic averages all have larger absolute error relative to the base econometric model. The historic average with optimal deviation on a one-week-ahead horizon was the best performing historic average based model.

There is very little difference between the three econometric models in terms of absolute error as the coefficients are very small and not statistically significant.

Table 6-6. In-Sample Comparison of Absolute Errors Across All Weekly Models

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	0.0578	2.15	0.032
Texas	0.0018	0.07	0.946
Year	-0.0614	-7.45	0.000
Five Year Hist. Average	0.7092	13.17	0.000
Four Year Hist. Average	0.7805	14.50	0.000
Three Year Hist Average	0.7455	13.85	0.000
Two Year Hist Average	0.6708	12.46	0.000
One Year Hist. Average	0.8453	15.70	0.000
Four Year Hist Average W/Optimal Deviation (One Month Ahead)	0.2218	4.12	0.000
Five Year Olympic Average	0.6229	11.57	0.000
Four Year Olympic Average	0.6905	12.83	0.000
Three Year Olympic Average	0.6812	12.66	0.000
Stripped Spread Model	0.0032	0.06	0.953
Full Model With Spread	0.0001	0.00	0.999
Constant	123.9977	7.50	0.000
RMSE			1.0170
R^2			0.0968
No. Observations			8568

The weekly models were also evaluated in terms of squared error following the same model used to test monthly squared errors as shown in equation 13 to assess the variability of forecast error amongst competing models. The results are provided in table 6-7.

Again there was higher squared error for Nebraska than the default of Kansas. In the weekly case this coefficient was not statistically significant. The historic average with optimal deviation incorporated had the lowest squared error of the historic average approaches. The weekly Olympic historic average models had higher squared error than the simple historic average models in the one and three year cases. This is surprising beings the Olympic averages do not incorporate data points which appear to be outliers. The econometric models had the lowest squared errors. Both econometric models which incorporated spread variables had lower squared error than the base econometric model but the coefficients are not statistically significant.

Table 6-7. In-Sample Comparison of Squared Error Across All Weekly Models

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	0.1499	1.37	0.171
Texas	-0.0196	-0.18	0.858
Year	-0.2949	-8.80	0.000
Five Year Hist. Average	2.5754	11.76	0.000
Four Year Hist. Average	2.9206	13.34	0.000
Three Year Hist Average	2.8222	12.89	0.000
Two Year Hist Average	2.3847	10.89	0.000
One Year Hist. Average	3.0780	14.05	0.000
Four Year Hist Average W/Optimal Deviation (One Month Ahead)	0.6251	2.85	0.004
Five Year Olympic Average	2.8222	12.89	0.000
Four Year Olympic Average	2.3847	10.89	0.000
Three Year Olympic Average	3.0780	14.05	0.000
Stripped Spread Model	-0.0228	-0.10	0.917
Full Model With Spread	-0.0158	-0.07	0.942
Constant	593.2063	8.82	0.000
RMSE			4.1380
R^2			0.0858
No. Observations			8568

The final in-sample look at weekly forecast errors is a look at the bias of the forecasts. The bias defined as the average of the basis less the forecast is provided in the table 6-8.The bias observed in the weekly models differs from what was observed in monthly models in a sense that in most cases it is negative. Once again, the bias of the econometric models is very close to zero as is to be expected. The bias in the longer term historic averages is also larger as is to be expected as they adjust to change at a slower rate than their shorter term counterparts. The models with negative bias may present short hedgers with a bit of a pleasant surprise. When the time comes to lift the short hedges one would expect to see a stronger basis than what was expected at the time of the forecast.

Table 6-8. Bias of Weekly Fed Cattle Basis Forecasting Models Evaluated in Chapter 6

Period from June 2006 to December 2010 Bias (Basis - Forecast) Historical Average			
	Nebraska	**Kansas**	**Texas**
5 Year	-0.8044	-0.5272	-0.2905
4 Year	-0.6711	-0.4841	-0.2637
3 Year	-0.4376	-0.3384	-0.1377
2 Year	-0.0555	-0.0911	0.0633
Previous Year	0.0360	-0.0178	0.2683
Optimal Deviation	-0.0137	-0.0358	0.0142
Bias (Basis - Forecast) Olympic Average			
5 Year	-0.5136	-0.4647	-0.2045
4 Year	-0.4300	-0.4455	-0.2015
3 Year	-0.2711	-0.3355	-0.1171
Bias (Basis - Forecast) Econometric Models			
Base	0.0000	0.0000	0.0000
Spread	0.0000	0.0000	0.0000
Stripped	-0.0039	-0.0032	0.0012

Weekly Historic Average Based Models Only:

Similar to work done with monthly historic average models it seems appropriate to assess the differences in errors between weekly historic average based models given no formal comparison of all methods of historical averaging employed in chapter 4. Results from this comparison are given in table 6-9. Similar to the comparison amongst monthly historic average models, Kansas was used as the default region and the one-year simple historic average was used as the default model.

Table 6-9, Comparison of Absolute Errors for Only Historic Average Models (Weekly)

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	0.0840	2.46	0.014
Texas	-0.0025	-0.07	0.943
Year	-0.0791	-7.57	0.000
Five Year Hist. Average	-0.1361	-2.30	0.021
Four Year Hist. Average	-0.0648	-1.09	0.274
Three Year Hist Average	-0.0998	-1.69	0.092
Two Year Hist Average	-0.1745	-2.95	0.003
Four Year Hist Average W/Optimal Deviation (One Month Ahead)	-0.6235	-10.53	0.000
Five Year Olympic Average	-0.2224	-3.76	0.000
Four Year Olympic Average	-0.1548	-2.62	0.009
Three Year Olympic Average	-0.1641	-2.77	0.006
Constant	160.5466	7.65	0.000
RMSE			1.1183
R^2			0.0317
No. Observations			6426

The positive coefficient for the region of Nebraska indicated higher absolute forecast error for all models in this region relative to Kansas and Texas. The negative coefficients for all models compared to the one-year simple historic average indicate lower absolute forecast error for these models versus the default. Similar to testing on the monthly historic average approaches the preferred model to minimize absolute forecast error is the optimal deviation model distantly followed by Olympic average models.

Table 6-10 gives a comparison of all weekly historic average models based on squared error. These results fall in line with expectations of higher squared error for regional models of Nebraska versus the regions of Kansas and Texas, and lower squared errors for all models versus the one-year simple historic average. Again the optimal deviation model was the ideal model for minimizing squared forecast error.

Table 6-10, Comparison of Squared Errors for Only Historic Average Models (Weekly)

	Dependent Variable (Absolute Error, $/cwt)		
Variable	Coefficient	T-Statistic	P-Value
Nebraska	0.2159	1.50	0.132
Texas	-0.0349	-0.24	0.808
Year	-0.3834	-8.73	0.000
Five Year Hist. Average	-0.5026	-2.02	0.043
Four Year Hist. Average	-0.1574	-0.63	0.526
Three Year Hist Average	-0.2558	-2.79	0.005
Two Year Hist Average	-0.6933	-2.79	0.005
Four Year Hist Average W/Optimal Deviation (One Month Ahead)	-2.4529	-9.87	0.000
Five Year Olympic Average	-0.8274	-3.33	0.001
Four Year Olympic Average	-0.5920	-2.38	0.017
Three Year Olympic Average	-0.5458	-2.20	0.028
Constant	773.9821	8.78	0.000
RMSE			4.6960
R^2			0.0323
No. Observations			6426

Chapter 7 - Out-of-Sample Testing

The final test of all forecasting methods explored in this work is "out-of-sample" testing. Since the sample over which the models were developed stopped the last week of December 2010 there were approximately 12 months of untouched basis observations. Due to the small number of observations no formal comparison of models via OLS will be made in this chapter. It is important when considering the out-of-sample test to remember that these tests were only carried out across one year, and the year of 2011 may or may not be representative of model performance over longer time spans. With this in mind tables in this chapter will present, bias, mean absolute error (MAE), and mean squared error (MSE) of forecast from historical average and econometric approaches in hopes of gaining some perspective on model performance on a level, out-of-sample, playing field.

Due to out-of-sample testing being a bit of a tedious task, and the fact that weekly models are considered to be the most useful models in terms of decision making, out-of-sample testing was conducted only on weekly models. The historic average methods were first updated to include the observations from 2010 and then the averages were used to forecast basis across the three regions from the weeks of January 2, 2011 through December 4, 2011. The out-of-sample testing on the two-year historic averages with optimal deviation included as well as out-of-sample testing on the three econometric models was conducted on horizons of 1, 4, 8, and 12 weeks. To forecast 2011 fed cattle basis with the two-year optimal deviation models the forecast errors from the two-year simple average model were lagged *"h"* steps, the length of the forecast horizon, prior to 2011 and were used along with the optimal weights previously calculated in-sample in chapter 4. Forecasts were carried out for all three regions in this manner.

To prepare for out-of-sample forecasting with the econometric models the method which was used in this work is to go back in-sample and then re-estimate the basis models by lagging the exogenous variables by *"h"* steps, the length of the forecast horizon. Lagging the independent variables is an intermediate step which gives the relationship between the variables and basis "*h"* steps into the future. The results from these estimations are available in the tables in Appendix A. Once the coefficients were estimated it was then possible to transform the observations for the independent variables from the desired start date, *"h"* weeks ahead of the first forecasted week, January 2, 2011, to *"h"* weeks ahead of the desired stop date, December 4, 2011, using the appropriate value of rho and the Cochrane-Orcutt method. Once the variables were transformed it was then possible to sum the product of all variables and the appropriate coefficients at each observation to obtain a forecast of basis *"h"* weeks ahead of that observation.

Table 7-1 gives a comparison of how historic averages performed in the period in 2011 selected for out-of-sample testing. This will give a base of comparison to benchmark the out-of-sample results from econometric and optimal deviation models against. Notably there seems to be a large positive bias for all historic averages, with one-year simple averages having the lowest bias at $0.56/cwt. If producers had used these forecasts in 2011 for Nebraska they would have seen basis at stronger levels than what forecasts had lead them to expect. It is also notable that simple historic averages out performed Olympic averages in terms of minimizing MAE and the shorter simple averages outperformed those of greater lengths. The performance of historic average models in Nebraska for 2011 as shown by table 7-1 seems to fall in line with the performance of the historic averages for Nebraska as shown in chapter 4.

Table 7-1. Weekly Historic Average Forecast Error For Nebraska January to December 4 , 2011

Hist. Average	BIAS ($/CWT)	MAE ($/CWT)	MSE
Five-Year	1.57	1.74	5.12
Four-Year	1.66	1.85	5.52
Three-Year	1.42	1.69	4.80
Two-Year	1.15	1.65	5.00
One-Year	0.56	1.65	5.17
Five-Year Olympic	1.62	1.77	5.45
Four-Year Olympic	1.70	1.83	5.85
Three-Year Olympic	1.55	1.79	5.62

Table 7-2 gives a comparison of, bias, MAE, and MSE, for the out-of-sample testing of optimal deviation and econometric models for Nebraska. Across the four horizons tested optimal deviation models seem to be the best performers in terms of minimizing MAE. Econometric models only outperform the historic average models in table 7-1, in terms of minimizing MAE, on one week horizons.

Table 7-2. Summary of Out-of-Sample Error for Nebraska Weekly Econometric and Optimal Deviation Models

Nebraska Bias ($/CWT)

	Base	Full	Stripped	Optimal Deviation
One Week	0.77	0.87	0.75	0.39
Four Week	1.04	1.11	0.11	0.96
Eight Week	1.04	1.32	1.15	1.06
Twelve Week	1.03	1.26	1.45	1.10

Nebraska MAE ($/CWT)

	Base	Full	Stripped	Optimal Deviation
One Week	1.39	1.44	1.37	1.22
Four Week	1.83	1.84	1.71	1.59
Eight Week	1.83	1.94	1.85	1.57
Twelve Week	1.91	1.94	2.03	1.62

Nebraska MSE

	Base	Full	Stripped	Optimal Deviation
One Week	3.27	3.40	3.22	2.50
Four Week	5.48	5.48	4.31	4.78
Eight Week	5.45	5.88	5.50	4.81
Twelve Week	5.75	5.85	6.37	4.88

Table 7-3 gives a comparison of competing historic average models for Kansas for the year 2011. These models have notably less bias when used to forecast basis in Kansas than in Nebraska. In terms of minimizing mean absolute error simple historic averages of greater length outperformed shorter averages. Olympic averages had forecast accuracy that fell in the middle of the pack in terms of minimizing, bias, MAE, and MSE.

Table 7-3. Weekly Historic Average Forecast Error For Kansas January to December 4 , 2011

Hist. Average	BIAS ($/cwt)	MAE ($/cwt)	MSE
Five-Year	0.24	1.19	2.10
Four-Year	0.35	1.28	2.43
Three-Year	0.19	1.26	2.47
Two-Year	-0.07	1.41	3.05
One-Year	-0.53	1.62	4.06
Five-Year Olympic	0.25	1.25	2.37
Four-Year Olympic	0.29	1.30	2.64
Three-Year Olympic	0.20	1.31	2.72

Table 7-4 gives a comparison of errors for out-of-sample forecasting across horizons from one to twelve weeks for Kansas. In terms of minimizing mean absolute error the econometric and optimal deviation models for Kansas tend to have very similar out-of-sample performance. However the five-year simple average outperforms all these methods for the year of 2011. The optimal deviation model does the best job of minimizing bias across all horizons tested. These tests seem to favor the use of either five-year simple averages or a two-year historic average with optimal deviation included for Kansas. On short horizons, one to four weeks, the econometric models had slightly lower MAE than the optimal deviation model. However it may not be possible to estimate the econometric models on such short horizons as the necessary data may not be available until a few weeks after the week in question.

Table 7-4. Summary of Out-of-Sample Error for Kansas Weekly Econometric and Optimal Deviation Models

Kansas Bias ($/CWT)

	Base	Full	Stripped	Optimal Deviation
One Week	0.27	0.36	-0.72	0.03
Four Week	0.16	0.20	-0.09	0.01
Eight Week	0.12	1.32	0.41	-0.04
Twelve Week	0.10	0.37	0.47	-0.05

Kansas MAE ($/CWT)

	Base	Full	Stripped	Optimal Deviation
One Week	1.23	1.24	1.38	1.33
Four Week	1.31	1.40	1.34	1.46
Eight Week	1.38	1.94	1.40	1.38
Twelve Week	1.39	1.38	1.38	1.42

Kansas MSE

	Base	Full	Stripped	Optimal Deviation
One Week	2.33	2.37	2.76	2.83
Four Week	2.68	2.87	2.70	3.33
Eight Week	2.75	5.88	2.92	3.00
Twelve Week	2.95	2.76	2.86	3.12

Table 7-5 compares weekly historic averages for Texas for the year 2011. The results for Texas are similar to the results for Kansas. Longer simple averages are preferred to shorter simple averages and Olympic average models fall in the middle of the pack in terms of minimizing, bias, MAE, and MSE.

Table 7-5. Weekly Historic Average Forecast Error For Texas January to December 4 , 2011

Hist. Average	BIAS ($/cwt)	MAE ($/cwt)	MSE
Five-Year	0.12	1.18	1.91
Four-Year	0.17	1.22	2.02
Three-Year	-0.10	1.24	2.13
Two-Year	-0.36	1.38	2.73
One-Year	-0.41	1.55	3.88
Five-Year Olympic	0.14	1.24	2.14
Four-Year Olympic	0.13	1.24	2.18
Three-Year Olympic	-0.02	1.27	2.30

Table 7-6 gives a summary of forecast errors from the two-year optimal deviation and the econometric models for Texas. The base and full econometric models have very similar characteristics in terms of out-of-sample bias and MAE. These models perform better than the two-year optimal deviation model across all horizons tested. Again it is important to remember that it may not be practical in real time to perform econometric forecast on shorter horizons due to lags in data reporting. In any case five-, four-, and three-year simple historic averages outperform these models in terms of reducing MAE, and MSE. There are some small gains, less than $0.10/cwt in absolute value for the econometric models in terms of reducing bias. With only one year’s out-of-sample testing it can cautiously be said that historic average approaches may be the most accurate and practical method to forecast fed cattle basis in Texas.

Table 7-6. Summary of Out-of-Sample Error for Texas Weekly Econometric and Optimal Deviation Models

Texas Bias ($/CWT)

	Base	Full	Stripped	Optimal Deviation
One Week	0.04	0.13	-0.65	-0.10
Four Week	0.11	0.18	0.09	-0.19
Eight Week	0.09	0.32	0.56	-0.32
Twelve Week	0.07	0.24	0.40	-0.32

Texas MAE ($/CWT)

	Base	Full	Stripped	Optimal Deviation
One Week	1.14	1.15	1.28	1.22
Four Week	1.17	1.20	1.25	1.42
Eight Week	1.27	1.29	1.38	1.34
Twelve Week	1.23	1.16	1.28	1.39

Texas MSE

	Base	Full	Stripped	Optimal Deviation
One Week	2.14	2.15	2.57	2.48
Four Week	2.17	2.17	2.34	3.01
Eight Week	2.33	2.37	2.66	2.62
Twelve Week	2.50	2.09	2.44	2.78

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Chapter 8 - Conclusions

Futures markets provide invaluable information to parties forming price expectations for commodities since they are a source of low cost readily available information, which in an efficiently functioning market should reflect all private and public knowledge. While futures may not be extremely accurate they are often the best forecast available. For producers and end users wishing to make a localized forecast of price the best method is then to add some expectation of basis to the appropriate futures contract.

As the beef industry consolidates, controlling input and output prices will become ever more important. Hedging and contracting of both outputs and inputs are already commonplace considerations in the beef feeding industry. Therefore, having a strong understanding of factors which affect basis and forming solid expectations of future basis will become ever more imperative for those involved.

Historical averages have been the subject of multiple academic journal articles which have attempted to forecast basis for crops and livestock commodities. While historical averages are easy to use and require minimal data there are advantages to analyzing the relationships between basis and relevant variables relating to localized supply and demand conditions for these commodities.

Simple historical averages have seen much use, and make sense to use as a jumping off point as they are the most straightforward of the forecasting approaches available. More recently there have been many studies which successfully improved upon simple historical averages by incorporating a percentage of the current deviation between forecasts and the market.

Olympic historical averages are possibly a viable alternative to simple historical averages. In this study Olympic averages performance was comparable to historical averages with optimal deviation incorporated in terms of minimizing absolute error and squared error. The use of Olympic historical averages may be worthy of further attention from researchers wishing to explore the use of historical averages in forecasting commodity basis.

Weighted historical averages were briefly explored in this research however they were not given much attention due to the arbitrary nature of the weights chosen and the relatively lackluster performance when compared to some of the competing models. The focus of this work was mainly the development of viable econometric based models for forecasting so the author may have unfairly dismissed the weighted historical average approach. Much work could be done with weighted averages as far as taking sophisticated approaches to optimizing the weights used in various forecasting lengths. Weighted averages may very well, when constructed in a more sophisticated manner or when applied to various other commodities, be a very useful approach. The exploration of this approach may be a worthwhile exercise for researchers interesting in using historical averages to forecast basis.

Econometric models have the potential to make better forecasts of basis by using available data regarding local supply and demand and exploiting relationships with basis. In-sample modeling revealed several important relationships between supply and demand factors and basis. Out-of-sample testing showed that the weekly econometric models this work explored could not provide forecasts superior to historical averages in terms of minimizing absolute error, squared error, and bias.

Across all econometric models estimated in this work, both monthly and weekly lags of basis, futures spreads, and seasonality tended to explain variability in fed cattle basis well in-sample. Of the other factors considered, carcass weights, captive supply, and cold storage also proved to be statistically significant factors explaining variability in basis in some of the models. Open interest in the live cattle futures contract was suggested by some of the previous literature as a potential factor which influences basis. Open interest may warrant some exploration in future econometric analyses of fed cattle basis.

This work favors historic averaging models as a means of forecasting basis, although the use of one-year historic averages is ill-advised and forecasters should use multiple year averages. In markets not undergoing significant structural change such as Kansas and Texas this work showed historic averages of lengths of four to five years to have roughly a $0.40/CWT advantage in absolute error over just using the basis from the preceding year as a forecaster. On a 1,250 lb. animal this translates to a gain of $5/head in accuracy. Langemeier (2011) in the most recent report on cattle feeding returns available at agmanager.info forecasted margins for fed cattle in November to range from a loss of $20/head to a gain of $5/head, with this in mind it can be said the gain from using longer averages could very well constitute the difference between profit and loss and proportional to fed cattle margins is very significant. Feeders and packers be well served by weekly historic averaging approaches with lengths of greater than one year. It is important to note that historic averages including fewer years may perform better in markets undergoing structural change, such as, Nebraska. The performance of historic average models versus econometric models as highlighted by out-of-sample testing in chapter 7 suggest university extension personnel might serve fed cattle market participants well by employing historic average based forecasting techniques. However these conclusions should be taken with a grain of salt as only one year was analyzed in the out-of-sample tests and 2011 may or may not prove to be an accurate representation of fed cattle markets for years to come.

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Appendix A - Out of Sample Econometric Model Estimates

Base Model Results

Table A-1, Out of Sample Base Model Results, 1 Week Horizon

Out of Sample Testing Weekly Base Model, One Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5582	0.5396	0.5464
	(0.000)	(0.000)	(0.000)
First Difference Local Corn Price	0.4505	0.2097	0.2050
	(0.020)	(0.076)	(0.189)
Percentage Select	0.1333	1.5011	-2.0674
	(0.903)	(0.011)	(0.261)
Captive Supply	-1.2331	-0.5676	-.8269
	(0.396)	(0.700)	(0.580)
First Difference Weights	0.0099	-0.0014	0.0101
	(0.626)	(0.946)	(0.580)
Monthly Dummy (default = January)			
February	0.5576	0.4047	0.1613
	(0.116)	(0.264)	(0.647)
March	1.1906	0.2991	0.0952
	(0.001)	(0.398)	(0.780)
April	1.8519	0.9725	0.6799
	(0.001)	(0.007)	(0.051)
May	2.4661	1.8685	1.8232
	(0.000)	(0.000)	(0.000)
June	0.8033	0.4577	0.4303
	(0.030)	(0.207)	(0.223)
July	0.7359	-0.1746	-0.3044
	(0.031)	(0.611)	(0.360)
August	0.7525	0.3846	0.1333
	(0.025)	(0.255)	(0.684)
September	0.2171	-0.0724	-0.2252
	(0.522)	(0.834)	(0.504)
October	1.0718	0.6700	0.6783
	(0.001)	(0.047)	(0.040)
November	1.1871	0.6916	0.7689
	(0.001)	(0.045)	(0.022)
December	0.3617	0.0725	0.3106
	(0.283)	(0.831)	(0.354)

Table A-1, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Constant	-1.4696	-1.3052	0.4102
	(0.000)	(0.000)	(0.624)
RMSE	1.0190	1.0370	1.0425
MAE	0.7876	0.8022	0.8133
R^2	0.7847	0.6438	0.6527
Adj. R^2	0.7722	0.6179	0.6274
Rho	0.0160	0.0229	-0.0208
No. Observations	237	237	237

Table A-2, Out of Sample Base Model Results, 4 Week Horizon

Out of Sample Testing Weekly Base Model, Four Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Value in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.0923	0.1382	0.1882
	(0.050)	(0.001)	(0.000)
First Difference Local Corn Price	-0.2055	-0.1430	-0.1601
	(0.241)	(0.153)	(0.294)
Percentage Select	-1.4981	2.1624	0.1144
	(0.436)	(0.034)	(0.958)
Captive Supply	-0.8061	-0.0047	-0.1511
	(0.525)	(0.997)	(0.912)
First Difference Weights	-0.0230	-0.0304	-0.0384
	(0.224)	(0.113)	(0.059)
Monthly Dummy (default = January)			
February	1.1957	0.2617	0.1089
	(0.017)	(0.596)	(0.827)
March	2.3416	0.6595	0.3067
	(0.000)	(0.228)	(0.570)
April	3.3114	1.8705	1.6225
	(0.000)	(0.001)	(0.003)
May	2.1013	0.5620	0.5409
	(0.001)	(0.330)	(0.340)
June	1.004	-0.3015	-0.4081
	(0.095)	(0.595)	(0.462)
July	0.8056	-0.4411	-0.6680
	(0.161)	(0.420)	(0.211)
August	0.2113	-0.4616	-0.6849
	(0.710)	(0.393)	(0.195)

Table A-2, Continued….

Variable (P-Values in Parenthesis)	Dependent Variable (basis, $/cwt) Nebraska	 Kansas	 Texas
September	0.7829	0.1789	0.1352
	(0.169)	(0.743)	(0.801)
October	1.0457	0.3445	0.1847
	(0.060)	(0.521)	(0.726)
November	0.9714	0.2579	0.6126
	(0.081)	(0.630)	(0.247)
December	0.2518	-0.3253	-0.2281
	(0.613)	(0.504)	(0.645)
Constant	-1.7711	-1.5368	-0.4120
	(0.006)	(0.006)	(0.688)
RMSE	1.1079	1.1142	1.1398
MAE	0.8665	0.8671	0.8920
R^2	0.3185	0.1658	0.1796
Adj. R^2	0.2683	0.1043	0.1191
Rho	0.5340	0.4989	0.4402
No. Observations	234	234	234

Table A-3, Out of Sample Base Model Results, 8 Week Horizon

Out of Sample Testing Weekly Base Model, Eight Week Horizon

Variable (P-Value in Parenthesis)	Dependent Variable (basis, $/cwt) Nebraska	 Kansas	 Texas
Lagged live cattle basis	0.0663	0.0589	0.0720
	(0.164)	(0.167)	(0.099)
First Difference Local Corn Price	0.0722	-0.0358	-0.0900
	(0.680)	(0.700)	(0.512)
Percentage Select	1.3517	2.7593	1.4952
	(0.521)	(0.009)	(0.450)
Captive Supply	-1.5284	-0.9182	-1.3067
	(0.210)	(0.449)	(0.302)
First Difference Weights	0.0209	0.0242	0.0161
	(0.256)	(0.187)	(0.398)
Monthly Dummy (default = January)			
February	0.9477	0.1887	-0.0967
	(0.061)	(0.702)	(0.847)
March	1.9888	1.5495	1.3800
	(0.001)	(0.006)	(0.014)
April	0.8928	0.2944	0.5059
	(0.148)	(0.616)	(0.384)

Table A-3, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Value in Parenthesis)	Nebraska	Kansas	Texas
May	-0.1767	-0.2555	-0.1424
	(0.782)	(0.670)	(0.810)
June	-1.1948	-1.4393	-1.4827
	(0.056)	(0.015)	(0.011)
July	-1.4285	-1.0931	-1.2992
	(0.017)	(0.057)	(0.022)
August	-0.9228	-0.5122	-0.4624
	(0.120)	(0.367)	(0.409)
September	-0.7930	-0.5191	-0.4302
	(0.181)	(0.364)	(0.447)
October	-0.5527	-0.2433	0.1636
	(0.341)	(0.665)	(0.769)
November	-1.0316	-0.6913	-0.4900
	(0.081)	(0.227)	(0.391)
December	-1.2558	-0.5824	-0.3825
	(0.012)	(0.234)	(0.442)
Constant	-1.0121	-1.2537	-0.6412
	(0.144)	(0.031)	(0.505)
RMSE	1.0880	1.0699	1.0869
MAE	0.8430	0.8440	0.8701
R^2	0.2714	0.1409	0.1352
Adj. R^2	0.2167	0.0764	0.0702
Rho	0.5876	0.5688	0.5339
No. Observations	230	230	230

Table A-4, Out of Sample Base Model Results, 12 Week Horizon

Out of Sample Testing Weekly Base Model, Twelve Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0081	0.0029	0.0041
	(0.870)	(0.946)	(0.928)
First Difference Local Corn Price	-0.4978	-0.0728	-0.0689
	(0.007)	(0.444)	(0.644)
Percentage Select	-3.4770	2.3488	0.2609
	(0.107)	(0.037)	(0.905)
Captive Supply	1.4273	1.7883	1.8825
	(0.248)	(0.133)	(0.136)

Table A-4, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
First Difference Weights	0.0233	0.0156	0.0202
	(0.212)	(0.387)	(0.291)
Monthly Dummy (default = January)			
February	0.6545	0.9577	0.7687
	(0.152)	(0.023)	(0.063)
March	-0.1657	-0.2427	-0.3081
	(0.662)	(0.346)	(0.110)
April	-1.1553	-1.1237	-0.8305
	(0.033)	(0.019)	(0.066)
May	-1.7967	-1.8545	-1.8669
	(0.002)	(0.000)	(0.000)
June	-2.3825	-1.9490	-2.0637
	(0.000)	(0.000)	(0.000)
July	-1.8634	-1.1516	-1.2395
	(0.001)	(0.023)	(0.010)
August	-1.7273	-1.2574	-1.0230
	(0.001)	(0.012)	(0.032)
September	-1.5396	-0.7984	-0.3586
	(0.005)	(0.116)	(0.461)
October	-1.8996	-1.3093	-0.8294
	(0.000)	(0.011)	(0.094)
November	-2.3537	-1.4665	-1.1935
	(0.000)	(0.004)	(0.017)
December	-1.2126	-0.8743	-0.6813
	(0.011)	(0.052)	(0.130)
Constant	1.1128	-0.4947	0.4719
	(0.091)	(0.355)	(0.637)
RMSE	1.0948	1.0643	1.0918
MAE	0.8635	0.8229	0.8551
R^2	0.2897	0.1430	0.1384
Adj. R^2	0.2353	0.0774	0.0724
Rho	0.5740	0.5760	0.5229
No. Observations	226	226	226

Table A-5, Out of Sample Base Model Results, 16 Week Horizon

Out of Sample Testing Weekly Base Model, Sixteen Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0571	-0.0523	-0.0494
	(0.257)	(0.226)	(0.286)
First Difference Local Corn Price	0.1622	0.1264	0.2482
	(0.391)	(0.183)	(0.099)
Percentage Select	-1.3252	2.5464	-3.0325
	(0.543)	(0.027)	(0.166)
Captive Supply	-0.5512	-0.2459	0.6638
	(0.656)	(0.832)	(0.598)
First Difference Weights	0.0189	0.0118	0.0247
	(0.314)	(0.500)	(0.196)
Monthly Dummy (default = January)			
February	0.0953	-0.1592	0.3261
	(0.834)	(0.699)	(0.427)
March	-0.7226	-0.5649	0.0320
	(0.054)	(0.026)	(0.868)
April	-1.7169	-1.8259	-1.5815
	(0.001)	(0.000)	(0.000)
May	-2.0915	-1.5523	-1.4295
	(0.000)	(0.003)	(0.004)
June	-2.0375	-1.2917	-1.1111
	(0.000)	(0.012)	(0.026)
July	-1.7564	-0.9981	-0.5199
	(0.001)	(0.046)	(0.281)
August	-1.5423	-1.0086	-0.4363
	(0.004)	(0.042)	(0.361)
September	-2.2710	-1.6444	-0.9003
	(0.000)	(0.001)	(0.072)
October	-2.7962	-2.0121	-1.3700
	(0.000)	(0.000)	(0.007)
November	-1.8431	-1.2701	-0.9363
	(0.001)	(0.012)	(0.062)
December	-0.5323	-0.5565	-0.4829
	(0.261)	(0.205)	(0.281)

Table A-5, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Constant	0.6430	-0.4710	1.8209
	(0.331)	(0.383)	(0.068)
RMSE	1.0998	1.0442	1.0848
MAE	0.8522	0.8079	0.8403
R^2	0.2813	0.1381	0.1227
Adj. R^2	0.2252	0.0708	0.0542
Rho	0.5683	0.5875	0.5274
No. Observations	222	222	222

Table A-6, Out of Sample Base Model Results, 20 Week Horizon

Out of Sample Testing Weekly Base Model, Twenty Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0029	-0.0415	-0.0165
	(0.953)	(0.348)	(0.727)
First Difference Local Corn Price	-0.0635	-0.1056	-0.1475
	(0.735)	(0.294)	(0.355)
Percentage Select	-2.6306	2.3697	0.9376
	(0.207)	(0.050)	(0.678)
Captive Supply	-0.1883	0.0355	0.4443
	(0.879)	(0.976)	(0.730)
First Difference Weights	0.0347	0.0371	0.0258
	(0.065)	(0.038)	(0.187)
Monthly Dummy (default = January)			
February	-1.8603	-1.4814	-1.3563
	(0.000)	(0.002)	(0.006)
March	-2.2326	-1.9219	-2.0656
	(0.000)	(0.000)	(0.000)
April	-2.3936	-1.6090	-1.8416
	(0.000)	(0.005)	(0.001)
May	-2.4285	-1.5195	-1.8573
	(0.000)	(0.009)	(0.002)
June	-2.0913	-1.1899	-1.1916
	(0.001)	(0.038)	(0.039)
July	-1.7852	-1.3498	-1.2444
	(0.002)	(0.016)	(0.026)
August	-3.1584	-2.3839	-1.8094
	(0.000)	(0.000)	(0.001)

Table A-6, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
September	-3.2742	-2.2380	-1.9862
	(0.000)	(0.000)	(0.001)
October	-2.7037	-1.8691	-1.9157
	(0.000)	(0.001)	(0.001)
November	-1.0648	-1.0246	-1.3180
	(0.066)	(0.065)	(0.020)
December	0.0652	0.0012	-0.1976
	(0.895)	(0.998)	(0.690)
Constant	1.5055	-0.0992	0.7520
	(0.027)	(0.871)	(0.481)
RMSE	1.0744	1.0418	1.0987
MAE	0.8455	0.8142	0.8812
R^2	0.3266	0.1556	0.1165
Adj. R^2	0.2730	0.0884	0.0462
Rho	0.5657	0.5778	0.5219
No. Observations	218	218	218

Table A-7, Out of Sample Base Model Results, 24 Week Horizon

Out of Sample Testing Base Model, Twenty Four Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.0352	-0.0195	-0.0092
	(0.470)	(0.650)	(0.841)
First Difference Local Corn Price	0.5123	0.2879	0.4360
	(0.004)	(0.001)	(0.002)
Percentage Select	-2.8850	2.5351	-0.2611
	(0.169)	(0.027)	(0.902)
Captive Supply	-1.0819	-0.5262	-0.1186
	(0.376)	(0.653)	(0.925)
First Difference Weights	-0.0086	0.0073	0.0107
	(0.651)	(0.690)	(0.583)
Monthly Dummy (default = January)			
February	-0.3081	-0.3216	-0.5525
	(0.534)	(0.505)	(0.268)
March	-0.8963	-0.3815	-0.7717
	(0.117)	(0.497)	(0.174)
April	-1.0106	-0.4960	-0.8393
	(0.095)	(0.399)	(0.155)

Table A-7, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
May	-0.5693	0.1869	-0.0399
	(0.364)	(0.757)	(0.947)
June	0.1712	0.3426	0.2671
	(0.780)	(0.568)	(0.655)
July	-1.2579	-0.8514	-0.5228
	(0.035)	(0.149)	(0.373)
August	-1.1104	-0.4641	-0.3959
	(0.068)	(0.442)	(0.510)
September	-0.8503	-0.4564	-0.6188
	(0.163)	(0.453)	(0.308)
October	0.6711	0.0627	-0.1560
	(0.259)	(0.916)	(0.793)
November	1.9598	1.4168	0.9495
	(0.001)	(0.013)	(0.101)
December	1.7789	1.4225	1.3967
	(0.000)	(0.003)	(0.005)
Constant	-0.1843	-1.5947	-0.0208
	(0.787)	(0.008)	(0.984)
RMSE	1.0632	1.0296	1.0876
MAE	0.8337	0.8113	0.8273
R^2	0.3321	0.1675	0.1168
Adj. R^2	0.2779	0.0999	0.0451
Rho	0.5791	0.6063	0.5612
No. Observations	214	214	214

Base Model + Futures Spread Results

Table A-8, Out of Sample Base Model + Spread Results, 1 Week Horizon

Out of Sample Testing Weekly Base Model + Spread, One Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5542	0.5378	0.5497
	(0.000)	(0.000)	(0.000)
Spread	-0.0928	-0.0927	-0.0890
	(0.015)	(0.017)	(0.016)
First Difference Local Corn Price	0.4617	0.2122	0.2025
	(0.018)	(0.077)	(0.203)
Percentage Select	0.0913	1.4255	-2.3859
	(0.934)	(0.019)	(0.205)

Table A-3, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Captive Supply	-1.2057	-0.5395	-0.7923
	(0.402)	(0.710)	(0.591)
First Difference Weights	0.0117	-0.0004	0.0118
	(0.560)	(0.986)	(0.561)
Monthly Dummy (default = January)			
February	0.1276	-0.0225	-0.2488
	(0.744)	(0.955)	(0.516)
March	0.7884	-0.1076	-0.2983
	(0.038)	(0.780)	(0.420)
April	1.6442	0.7555	0.4642
	(0.000)	(0.039)	(0.185)
May	2.2899	1.6770	1.6261
	(0.000)	(0.000)	(0.000)
June	0.9327	0.5795	0.5418
	(0.012)	(0.109)	(0.121)
July	0.8746	-0.0413	-0.1743
	(0.011)	(0.904)	(0.596)
August	0.5835	0.2111	-0.0282
	(0.085)	(0.533)	(0.931)
September	0.0782	-0.2118	-0.3539
	(0.818)	(0.539)	(0.288)
October	0.9263	0.5243	0.5411
	(0.005)	(0.119)	(0.097)
November	1.1217	0.6203	0.7014
	(0.001)	(0.067)	(0.032)
December	0.2747	-0.0170	0.2278
	(0.411)	(0.960)	(0.488)
Constant	-1.1896	-0.9997	0.8215
	(0.002)	(0.006)	(0.343)
RMSE	1.0070	1.0246	1.0298
MAE	0.7865	0.7994	0.8067
R^2	0.7912	0.6550	0.6682
Adj. R^2	0.7750	0.6282	0.6424
Rho	0.0119	0.0179	-0.0348
No. Observations	237	237	237

Table A-9, Out of Sample Base Model + Spread Results, 4 Week Horizon

Out of Sample Testing Weekly Base Model + Spread, Four Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.1012	0.1449	0.1996
	(0.033)	(0.001)	(0.000)
Spread	-0.0680	-0.1228	-0.1158
	(0.293)	(0.042)	(0.050)
First Difference Local Corn Price	-.1822	-0.1265	-0.1339
	(0.314)	(0.234)	(0.414)
Percentage Select	-1.3243	1.7920	-1.1994
	(0.471)	(0.066)	(0.601)
Captive Supply	-0.8576	-0.0199	-0.1525
	(0.510)	(0.988)	(0.916)
First Difference Weights	-.0246	-0.0315	0.0407
	(0.205)	(0.109)	(0.055)
Monthly Dummy (default = January)			
February	0.8543	-0.3569	-0.4821
	(0.132)	(0.510)	(0.378)
March	2.0858	0.1329	-0.2069
	(0.001)	(0.816)	(0.714)
April	3.3704	1.8249	1.5842
	(0.000)	(0.001)	(0.003)
May	2.1095	0.5251	0.5150
	(0.000)	(0.337)	(0.341)
June	1.0807	-0.1752	-0.2718
	(0.065)	(0.743)	(0.606)
July	0.9818	-0.2235	-0.4578
	(0.078)	(0.663)	(0.365)
August	0.0950	-0.6372	-0.8343
	(0.863)	(0.209)	(0.095)
September	0.7645	0.0992	0.0983
	(0.164)	(0.846)	(0.846)
October	1.0057	0.1935	0.0939
	(0.063)	(0.701)	(0.851)
November	0.9965	0.2312	0.6434
	(0.064)	(0.645)	(0.197)
December	0.1546	-0.4521	-0.3257
	(0.752)	(0.334)	(0.496)

Table A-9, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Constant	-1.6565	-1.0794	0.4568
	(0.009)	(0.051)	(0.673)
RMSE	1.1187	1.1204	1.1542
MAE	0.8778	0.8789	0.8979
R^2	0.3636	0.2316	0.2484
Adj. R^2	0.3135	0.1711	0.1892
Rho	0.4873	0.4262	0.3553
No. Observations	234	234	234

Table A-10, Out of Sample Base Model + Spread Results, 8 Week Horizon

Out of Sample Testing Weekly Base Model + Spread, Eight Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.0726	0.0579	0.0726
	(0.132)	(0.183)	(0.104)
Spread	-0.3060	-0.2913	-0.2922
	(0.000)	(0.000)	(0.000)
First Difference Local Corn Price	0.1029	-0.0544	-0.1148
	(0.586)	(0.616)	(0.475)
Percentage Select	1.5646	2.7449	0.5518
	(0.410)	(0.003)	(0.806)
Captive Supply	-1.7153	-1.0946	-1.4918
	(0.175)	(0.400)	(0.275)
First Difference Weights	0.0226	0.0271	0.0169
	(0.233)	(0.161)	(0.405)
Monthly Dummy (default = January)			
February	-0.1852	-0.9742	-1.2679
	(0.734)	(0.057)	(0.015)
March	1.2861	0.8792	0.6981
	(0.027)	(0.099)	(0.197)
April	0.8268	0.4392	0.6145
	(0.142)	(0.381)	(0.227)
May	-0.5681	-0.6008	-0.4929
	(0.328)	(0.239)	(0.340)
June	-0.4336	-0.7630	-0.8066
	(0.440)	(0.124)	(0.109)
July	-0.7099	-0.3664	-0.5802
	(0.183)	(0.441)	(0.229)

Table A-10, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
August	-1.1070	-0.6706	-0.6020
	(0.035)	(0.154)	(0.207)
September	-0.7638	-0.4821	-0.3685
	(0.145)	(0.309)	(0.445)
October	-0.6727	-0.3791	0.1043
	(0.193)	(0.418)	(0.827)
November	-1.2935	-0.8900	-0.5689
	(0.016)	(0.068)	(0.252)
December	-1.4214	-0.6513	-0.4307
	(0.003)	(0.142)	(0.346)
Constant	-0.4691	-0.7119	0.3007
	(0.459)	(0.170)	(0.777)
RMSE	1.0792	1.0709	1.0861
MAE	0.8343	0.8483	0.8600
R^2	0.4135	0.3020	0.2919
Adj. R^2	0.3665	0.2460	0.2351
Rho	0.4765	0.3880	0.3609
No. Observations	230	230	230

Table A-11, Out of Sample Base Model + Spread Results, 12 Week Horizon

Out of Sample Testing Weekly Base Model + Spread, Twelve Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0135	-0.0218	-0.0236
	(0.789)	(0.622)	(0.611)
Spread	-0.2295	-0.2427	-0.2281
	(0.000)	(0.000)	(0.000)
First Difference Local Corn Price	-0.4578	-0.0746	-0.1028
	(0.020)	(0.491)	(0.522)
Percentage Select	-2.4163	2.3468	-1.9536
	(0.238)	(0.019)	(0.432)
Captive Supply	1.3243	1.6528	1.8732
	(0.301)	(0.193)	(0.173)
First Difference Weights	0.0223	0.0137	0.0145
	(0.247)	(0.471)	(0.477)

Table A-11, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Monthly Dummy (default = January)			
February	0.4416	0.7778	0.8961
	(0.415)	(0.110)	(0.062)
March	-0.0874	0.1122	0.6301
	(0.879)	(0.823)	(0.196)
April	-0.9881	-0.7268	-0.2433
	(0.073)	(0.120)	(0.589)
May	-1.5177	-1.3189	-1.0628
	(0.008)	(0.005)	(0.019)
June	-1.5507	-0.7717	-0.6480
	(0.005)	(0.097)	(0.144)
July	-1.0100	-0.0557	0.1077
	(0.054)	(0.901)	(0.800)
August	-1.4428	-0.7155	-0.2056
	(0.005)	(0.100)	(0.619)
September	-1.2638	-0.3327	0.3857
	(0.014)	(0.450)	(0.361)
October	-1.8688	-1.0988	-0.7267
	(0.000)	(0.014)	(0.252)
November	-2.0448	-0.8419	-0.2916
	(0.000)	(0.054)	(0.480)
December	-0.9675	-0.4384	0.4411
	(0.003)	(0.036)	(0.357)
Constant	0.9229	-0.6088	1.0524
	(0.151)	(0.228)	(0.367)
RMSE	1.0971	1.0698	1.1051
MAE	0.8713	0.8333	0.8717
R^2	0.3833	0.2708	0.2667
Adj. R^2	0.3329	0.2112	0.2068
Rho	0.4934	0.4215	0.3598
No. Observations	226	226	226

Table A-12, Out of Sample Base Model + Spread Results, 16 Week Horizon

Out of Sample Testing Weekly Base Model + Spread, Sixteen Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0674	-0.0625	-0.0657
	(0.188)	(0.160)	(0.161)
Spread	-0.1141	-0.0869	-0.1030
	(0.091)	(0.167)	(0.099)
First Difference Local Corn Price	0.1738	0.1241	0.2212
	(0.371)	(0.224)	(0.171)
Percentage Select	-0.8394	2.5296	-4.6532
	(0.699)	(0.024)	(0.047)
Captive Supply	-0.3593	-0.0394	0.9345
	(0.774)	(0.974)	(0.472)
First Difference Weights	0.0231	0.0153	0.0283
	(0.222)	(0.398)	(0.148)
Monthly Dummy (default = January)			
February	-0.6004	-0.6455	-0.2698
	(0.280)	(0.207)	(0.597)
March	-1.9300	-1.6782	-1.2953
	(0.001)	(0.002)	(0.015)
April	-2.2343	-2.3115	-2.1223
	(0.000)	(0.000)	(0.000)
May	-2.5025	-1.9001	-1.7868
	(0.000)	(0.000)	(0.000)
June	-2.0951	-1.4036	-1.1690
	(0.000)	(0.006)	(0.017)
July	-1.8184	-1.0936	-0.5817
	(0.001)	(0.027)	(0.218)
August	-1.8904	-1.3009	-0.7100
	(0.000)	(0.007)	(0.121)
September	-2.6013	-1.9242	-1.1807
	(0.000)	(0.000)	(0.014)
October	-3.0760	-2.2194	-1.7401
	(0.000)	(0.000)	(0.007)
November	-2.0134	-1.4099	-1.0439
	(0.000)	(0.002)	(0.018)
December	-0.1871	-0.2000	0.1664
	(0.557)	(0.333)	(0.704)

Table A-12, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Constant	0.9901	-0.0701	2.9722
	(0.146)	(0.900)	(0.008)
RMSE	1.0975	1.0536	1.0927
MAE	0.8506	0.8158	0.8455
R^2	0.3118	0.1776	0.1662
Adj. R^2	0.2545	0.1091	0.0967
Rho	0.5464	0.5240	0.4648
No. Observations	222	222	222

Table A-13, Out of Sample Base + Spread Model Results, 20 Week Horizon

Out of Sample Testing Weekly Base Model + Spread, Twenty Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0046	-0.0425	-0.0155
	(0.926)	(0.340)	(0.743)
Spread	0.0337	0.0533	0.0655
	(0.622)	(0.416)	(0.328)
First Difference Local Corn Price	-0.0590	-0.1056	-0.1449
	(0.753)	(0.294)	(0.360)
Percentage Select	-2.5030	2.3075	1.1463
	(0.230)	(0.052)	(0.609)
Captive Supply	-0.2079	0.0282	0.4237
	(0.867)	(0.981)	(0.742)
First Difference Weights	0.0344	0.0365	0.0252
	(0.067)	(0.042)	(0.197)
Monthly Dummy (default = January)			
February	-1.7091	-1.2607	-1.0695
	(0.003)	(0.022)	(0.062)
March	-2.0884	-1.7235	-1.7920
	(0.001)	(0.004)	(0.004)
April	-2.3266	-1.5310	-1.7143
	(0.000)	(0.008)	(0.004)
May	-2.3768	-1.4672	-1.7542
	(0.000)	(0.012)	(0.003)
June	-2.1444	-1.2863	-1.2901
	(0.001)	(0.026)	(0.028)
July	-1.8430	-1.4482	-1.3468
	(0.002)	(0.010)	(0.018)

Table A-13, Continued….

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
August	-3.1085	-2.3190	-1.7123
	(0.000)	(0.000)	(0.003)
September	-3.2244	-2.1797	-1.8906
	(0.000)	(0.000)	(0.001)
October	-2.6562	-1.8083	-1.8174
	(0.000)	(0.002)	(0.002)
November	-1.0339	-1.0010	-1.2647
	(0.076)	(0.071)	(0.027)
December	0.0942	0.0258	-0.1537
	(0.849)	(0.957)	(0.757)
Constant	1.3779	-0.2046	0.4798
	(0.048)	(0.746)	(0.659)
RMSE	1.0745	1.0423	1.0970
MAE	0.8463	0.8144	0.8808
R^2	0.3273	0.1633	0.1189
Adj. R^2	0.2701	0.0922	0.0440
Rho	0.5650	0.5675	0.5223
No. Observations	218	218	218

Table A-14, Out of Sample Base + Spread Model Results, 24 Week Horizon

Out of Sample Testing Weekly Base + Spread Model, Twenty Four Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.0393	-0.0156	-0.0057
	(0.422)	(0.719)	(0.902)
Spread	0.0393	0.0424	0.0307
	(0.570)	(0.537)	(0.657)
First Difference Local Corn Price	0.5124	0.2879	0.4387
	(0.004)	(0.001)	(0.002)
Percentage Select	-2.9180	2.6015	-0.2734
	(0.163)	(0.024)	(0.898)
Captive Supply	-1.0699	-0.5180	-0.1128
	(0.382)	(0.658)	(0.928)
First Difference Weights	-0.0089	0.0070	0.0104
	(0.640)	(0.702)	(0.594)
Monthly Dummy (default = January)			
February	-0.1483	-0.1469	-0.4289
	(0.796)	(0.794)	(0.458)

Table A-14, Continued….

Variable (P-Values in Parenthesis)	Dependent Variable (basis, $/cwt) Nebraska	Kansas	Texas
March	-0.7591	-0.2244	-0.6622
	(0.230)	(0.719)	(0.295)
April	-0.9654	-0.4322	-0.7945
	(0.116)	(0.470)	(0.187)
May	-0.5262	0.2403	-0.0015
	(0.406)	(0.694)	(0.998)
June	0.1057	0.2744	0.2193
	(0.865)	(0.652)	(0.717)
July	-1.3281	-0.9245	-0.5733
	(0.028)	(0.124)	(0.337)
August	-1.0748	-0.4149	-0.3614
	(0.080)	(0.497)	(0.553)
September	-0.8132	-0.4127	-0.5855
	(0.184)	(0.500)	(0.339)
October	0.7257	0.1232	-0.1099
	(0.227)	(0.838)	(0.855)
November	1.9811	1.4435	0.9693
	(0.001)	(0.012)	(0.095)
December	1.8007	1.4406	1.4118
	(0.000)	(0.003)	(0.005)
Constant	-0.2646	-1.7229	-0.0906
	(0.705)	(0.007)	(0.931)
RMSE	1.0636	1.0293	1.0874
MAE	0.8356	0.8122	0.8721
R^2	0.3364	0.1686	0.1183
Adj. R^2	0.2788	0.0965	0.0418
Rho	0.5749	0.6056	0.5596
No. Observations	214	214	214

Stripped Model (Lagged Basis + Futures Spread+ Seasonal Dummies) Results

Table A-15, Out of Sample Stripped Model Results, 1 Week Horizon

Out of Sample Testing Weekly Stripped Model, One Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.5793	0.5544	0.5766
	(0.000)	(0.000)	(0.000)
Spread	-0.0843	-0.0929	-0.0794
	(0.027)	(0.017)	(0.036)
Monthly Dummy (default = January)			
February	0.2164	-0.0311	-0.1675
	(0.580)	(0.937)	(0.669)
March	0.7846	-0.1535	-0.2294
	(0.039)	(0.689)	(0.543)
April	1.5578	0.7379	0.4504
	(0.000)	(0.043)	(0.207)
May	2.2180	1.6295	1.5783
	(0.000)	(0.000)	(0.000)
June	0.9234	0.5821	0.4826
	(0.009)	(0.094)	(0.156)
July	0.8170	-0.0283	-0.2057
	(0.015)	(0.933)	(0.532)
August	0.6283	0.2553	0.0061
	(0.060)	(0.445)	(0.985)
September	0.1283	-0.1701	-0.3194
	(0.701)	(0.615)	(0.337)
October	0.9351	0.5372	0.4855
	(0.005)	(0.111)	(0.141)
November	1.0908	0.5937	0.6277
	(0.001)	(0.077)	(0.056)
December	0.2887	0.0282	0.1785
	(0.388)	(0.933)	(0.591)
Constant	-1.1405	-0.4499	-0.2422
	(0.000)	(0.104)	(0.369)
RMSE	1.0057	1.0110	1.0324
MAE	0.7792	0.7855	0.8068
R^2	0.7911	0.6654	0.6666
Adj. R^2	0.7790	0.6461	0.6473
Rho	0.0108	0.0192	-0.0302
No. Observations	239	239	239

Table A-16, Out of Sample Stripped Model Results, 4 Week Horizon

Out of Sample Testing Weekly Stripped Model, Four Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.1178	0.1503	0.1992
	(0.009)	(0.000)	(0.000)
Spread	-0.0595	-0.1218	-0.1049
	(0.376)	(0.056)	(0.100)
Monthly Dummy (default = January)			
February	0.9036	-0.3989	-0.4676
	(0.120)	(0.478)	(0.413)
March	2.0277	0.0449	-0.2407
	(0.001)	(0.940)	(0.689)
April	3.1915	1.7062	1.4482
	(0.000)	(0.003)	(0.011)
May	1.8280	0.3688	0.2509
	(0.002)	(0.508)	(0.654)
June	0.7689	-0.3671	-0.6050
	(0.188)	(0.498)	(0.265)
July	0.7633	-0.3386	-0.6633
	(0.179)	(0.525)	(0.214)
August	-0.0717	-0.7325	-1.0277
	(0.899)	(0.165)	(0.053)
September	0.5383	-0.0703	-0.1925
	(0.339)	(0.895)	(0.719)
October	0.8951	0.1420	-0.0746
	(0.109)	(0.788)	(0.888)
November	0.7360	0.0290	0.3128
	(0.178)	(0.955)	(0.547)
December	0.1021	-0.4199	-0.3671
	(0.839)	(0.387)	(0.458)
Constant	-1.8442	-0.3023	0.0649
	(0.000)	(0.483)	(0.881)
RMSE	1.1148	1.1064	1.1372
MAE	0.8655	0.8725	0.8856
R^2	0.3345	0.2150	0.1860
Adj. R^2	0.2955	0.1690	0.1383
Rho	0.5132	0.4610	0.4370
No. Observations	236	236	236

Table A-17, Out of Sample Stripped Model Results, 8 Week Horizon

Out of Sample Testing Weekly Stripped Model, Eight Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.0729	0.0486	0.0725
	(0.114)	(0.236)	(0.080)
Spread	-0.2915	-0.2839	-0.2765
	(0.000)	(0.000)	(0.000)
Monthly Dummy (default = January)			
February	-0.1374	-0.9380	-1.1852
	(0.807)	(0.081)	(0.031)
March	1.1308	0.7339	0.5680
	(0.061)	(0.194)	(0.327)
April	0.6633	0.2412	0.3484
	(0.258)	(0.653)	(0.526)
May	-0.6196	-0.7536	-0.7488
	(0.288)	(0.155)	(0.166)
June	-0.4502	-0.7708	-0.9793
	(0.425)	(0.133)	(0.062)
July	-0.6286	-0.2495	-0.5953
	(0.251)	(0.620)	(0.248)
August	-1.0103	-0.5619	-0.5923
	(0.063)	(0.260)	(0.247)
September	-0.7145	-0.4006	-0.4226
	(0.187)	(0.425)	(0.412)
October	-0.7198	-0.3696	0.0082
	(0.183)	(0.461)	(0.987)
November	-1.1893	-0.7493	-0.5431
	(0.030)	(0.143)	(0.300)
December	-1.3644	-0.5485	-0.4026
	(0.005)	(0.238)	(0.399)
Constant	-0.1097	0.2635	0.5506
	(0.808)	(0.519)	(0.187)
RMSE	1.0755	1.0653	1.0907
MAE	0.8427	0.8424	0.8635
R^2	0.3839	0.2828	0.2383
Adj. R^2	0.3472	0.2400	0.1929
Rho	0.5102	0.4392	0.4398
No. Observations	232	232	232

Table A-18, Out of Sample Stripped Model Results, 12 Week Horizon

Out of Sample Testing Weekly Stripped Model, Twelve Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	0.0155	-0.0027	0.0068
	(0.747)	(0.947)	(0.871)
Spread	-0.2239	-0.2378	-0.2057
	(0.001)	(0.000)	(0.001)
Monthly Dummy (default = January)			
February	0.3054	0.5073	0.6910
	(0.602)	(0.347)	(0.214)
March	-0.1167	-0.0847	0.4524
	(0.853)	(0.882)	(0.443)
April	-1.1473	-0.9225	-0.4141
	(0.061)	(0.089)	(0.459)
May	-1.8257	-1.6264	-1.4185
	(0.003)	(0.002)	(0.010)
June	-1.5553	-0.6909	-0.7908
	(0.008)	(0.183)	(0.139)
July	-1.1196	-0.1362	-0.1006
	(0.050)	(0.789)	(0.848)
August	-1.6488	-0.8287	-0.4384
	(0.004)	(0.101)	(0.401)
September	-1.4853	-0.4871	0.1365
	(0.009)	(0.338)	(0.795)
October	-1.9096	-1.1502	-0.4105
	(0.001)	(0.028)	(0.447)
November	-2.1137	-0.9691	-0.4651
	(0.000)	(0.061)	(0.383)
December	-1.2575	-0.6661	-0.3557
	(0.013)	(0.153)	(0.460)
Constant	0.4810	0.4332	0.3636
	(0.307)	(0.294)	(0.394)
RMSE	1.1140	1.0597	1.0866
MAE	0.8810	0.8312	0.8553
R^2	0.3346	0.2536	0.1945
Adj. R^2	0.2942	0.2083	0.1456
Rho	0.5140	0.4576	0.4653
No. Observations	228	228	228

Table A-19, Out of Sample Stripped Model Results, 16 Week Horizon

Out of Sample Testing Weekly Stripped Model, Sixteen Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0554	-0.0413	-0.0485
	(0.250)	(0.313)	(0.253)
Spread	-0.1144	-0.0885	-0.0820
	(0.108)	(0.183)	(0.233)
Monthly Dummy (default = January)			
February	-0.7799	-1.0321	-0.6805
	(0.186)	(0.062)	(0.236)
March	-2.1372	-2.0918	-1.5482
	(0.001)	(0.001)	(0.014)
April	-2.5728	-2.7603	-2.5571
	(0.000)	(0.000)	(0.000)
May	-2.6840	-2.2275	-2.1134
	(0.000)	(0.000)	(0.000)
June	-2.2862	-1.6311	-1.5130
	(0.000)	(0.004)	(0.010)
July	-2.0160	-1.3104	-0.9779
	(0.001)	(0.019)	(0.093)
August	-2.2550	-1.7198	-1.3001
	(0.000)	(0.002)	(0.024)
September	-2.7163	-2.1486	-1.4890
	(0.000)	(0.000)	(0.012)
October	-3.2747	-2.5802	-2.0675
	(0.000)	(0.000)	(0.001)
November	-2.2589	-1.8455	-1.5028
	(0.000)	(0.001)	(0.008)
December	-0.9837	-0.9730	-1.0214
	(0.053)	(0.041)	(0.039)
Constant	1.0638	1.2771	1.3036
	(0.032)	(0.005)	(0.005)
RMSE	1.0801	1.0231	1.0574
MAE	0.8412	0.8004	0.8362
R^2	0.2669	0.1725	0.1186
Adj. R^2	0.2215	0.1213	0.0640
Rho	0.5970	0.5787	0.5828
No. Observations	224	224	224

Table A-20, Out of Sample Stripped Model Results, 20 Week Horizon

Out of Sample Testing Weekly Stripped Model, Twenty Week Horizon

Variable	Dependent Variable (basis, $/cwt)		
(P-Values in Parenthesis)	Nebraska	Kansas	Texas
Lagged live cattle basis	-0.0022	-0.0435	-0.0119
	(0.964)	(0.297)	(0.786)
Spread	0.0406	0.0545	0.0760
	(0.578)	(0.430)	(0.291)
Monthly Dummy (default = January)			
February	-1.3634	-1.1032	-0.8118
	(0.022)	(0.052)	(0.170)
March	-1.6401	-1.4242	-1.3241
	(0.014)	(0.024)	(0.044)
April	-1.9208	-1.2277	-1.2671
	(0.003)	(0.044)	(0.047)
May	-1.9411	-1.0950	-1.2439
	(0.003)	(0.070)	(0.049)
June	-1.7808	-0.8172	-0.9011
	(0.006)	(0.172)	(0.149)
July	-1.5720	-1.0669	-1.0617
	(0.014)	(0.072)	(0.086)
August	-2.7210	-1.8956	-1.3269
	(0.000)	(0.001)	(0.033)
September	-2.6917	-1.7089	-1.4134
	(0.000)	(0.005)	(0.027)
October	-2.2477	-1.4236	-1.3820
	(0.001)	(0.019)	(0.030)
November	-0.6102	-0.5384	-0.7526
	(0.315)	(0.346)	(0.207)
December	0.1312	0.1404	0.0259
	(0.797)	(0.773)	(0.959)
Constant	0.4026	0.3598	0.6311
	(0.435)	(0.448)	(0.202)
RMSE	1.0699	1.0299	1.0777
MAE	0.8309	0.8070	0.8625
R^2	0.2369	0.1378	0.0732
Adj. R^2	0.1887	0.0834	0.0147
Rho	0.6427	0.6182	0.6176
No. Observations	220	220	220

Table A-21, Out of Sample Stripped Model Results, 24 Week Horizon

Out of Sample Testing Weekly Stripped Model, Twenty Four Week Horizon

	Dependent Variable (basis, $/cwt)		
Variable	Nebraska	Kansas	Texas
Lagged live cattle basis	0.0321	-0.0112	-0.0069
	(0.502)	(0.790)	(0.876)
Spread	0.0360	0.0343	0.0302
	(0.620)	(0.624)	(0.671)
Monthly Dummy (default = January)			
February	-0.0132	-0.1527	-0.3387
	(0.982)	(0.788)	(0.563)
March	-0.5894	-0.1703	-0.4945
	(0.369)	(0.787)	(0.443)
April	-0.7399	-0.3667	-0.7146
	(0.252)	(0.549)	(0.249)
May	-0.4052	0.3507	0.0980
	(0.531)	(0.564)	(0.873)
June	-0.1333	0.3278	0.2167
	(0.835)	(0.587)	(0.721)
July	-1.4678	-0.8066	-0.5455
	(0.021)	(0.183)	(0.371)
August	-0.8736	-0.1442	-0.1346
	(0.178)	(0.816)	(0.829)
September	-0.7191	-0.2252	-0.4293
	(0.265)	(0.716)	(0.492)
October	0.6906	0.1475	-0.1395
	(0.278)	(0.809)	(0.822)
November	1.8739	1.3725	0.9573
	(0.002)	(0.016)	(0.101)
December	1.6741	1.5128	1.3955
	(0.001)	(0.002)	(0.005)
Constant	-1.0325	-0.7763	-0.2722
	(0.042)	(0.104)	(0.571)
RMSE	1.0604	1.0303	1.0786
MAE	0.8253	0.8030	0.8508
R^2	0.2628	0.1446	0.1006
Adj. R^2	0.2154	0.0895	0.0427
Rho	0.6398	0.6274	0.5340
No. Observations	216	216	216

Appendix B - Formulas

Formulas for R-squared and Adjusted R-squared

R-squared = ESS/TSS=1-(RSS/TSS)

Where;

ESS = Explained Sum of Squares

TSS = Total Sum of Squares

RSS = Residual Sum of Squares

Adjusted R-squared= 1-((RSS/(T-K))/TSS/(T-1))

Where;

T=number of observations

K = number of right hand side variables