AN ECONOMETRIC MODEL TO PREDICT THE LIVE CATTLE BASIS AT THREE DIFFERENT LOCATIONS IN THE UNITED STATES

by

DARRELL D. HOLADAY

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Approved by:

Orlen C. Grunewald
Major Professor

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CHAPTER I

INTRODUCTION

In 1964, trading of live beef cattle futures contracts was approved on the Chicago Mercantile Exchange. This allowed cattle producers and buyers to transfer some of their price risk to speculators by taking a position (short or long) on the Exchange opposite of their cash position. This transfer of risk is a process known as hedging.

The basis, commonly defined as the difference between a futures contract price and the cash price at a particular time and place, is fundamental to using, understanding, and studying the futures market. Hedgers, who either buy or sell commodities in the cash market and then take the opposite position in the futures market, are concerned with how the cash-futures price spread (basis) will behave. This simultaneous trading in the two markets, known as arbitrage, means that the basis is being bought or sold. Returns depend on how the basis changes.

For a storable commodity, the basis reflects the cost of carrying the commodity over time, a transportation charge from the holding location to the point of use, a possible quality differential, and any market imperfections. The basis for nonstorable commodities is less well understood. In the case of livestock, live animals cannot be held for long periods of time without changes in their fundamental characteristics (weight, quality grade, yield grade). This being the case, the theoretical relationship between cash prices (the price today) and futures prices (the expected price at some time in the future) is much less clear.

INTERPRETATION OF LIVESTOCK MARKETING AND BASIS

One of the principal differences between the behavior of futures prices for the different categories of commodities is the linkage or degree of association between the prices of near and distant delivery months. For storable commodities such as corn, changes in daily prices for both near and distant contracts tend to move together, but this is less true for commodities where nearby and distant futures are not closely linked by inventories. Potatoes provide a special case of a commodity without an inventory linkage between crop years, and, hence, changes in daily prices for contracts maturing in different crop years have little or no correlation.

Price linkages between futures prices of most nonstorables, such as live cattle, represent an intermediate position between the corn and potato examples. Daily prices for live cattle contracts with different delivery months tend to move in the same direction. However, price differences, even between nearby contracts are less stable for cattle than for corn, and the correlation between the near futures contract and the subsequent contracts decreases as the time interval between contracts lengthens.

Cattle feeders, almost by definition, have limited flexibility in their production and marketing decisions. In the very short run, cattle feeders may be able to defer marketings a few days or weeks; in the intermediate run, feeding programs can be altered, for example, by using more roughage and less grain; for the longer run, female animals may be withheld from feedlots for breeding purposes. It is for these reasons that the prices of live cattle futures (which require the delivery of grain-fed steers) are interrelated. All futures prices for cattle are influenced by factors such as changes in the prices of corn, soybean meal, and feeder calves, but prices for distant contracts respond more to anticipated changes in future supplies, while prices for near contracts reflect current economic conditions. Thus, there is more range for the independent movement of nearby and distant futures for nonstorables such as cattle than for storable commodities like corn.

Leuthold's empirical analysis of prices for live cattle futures contracts is consistent with the foregoing observations. His analysis indicates that, given the current cash price, the prices of forthcoming futures are a function mainly of the expected supply of fed cattle in the particular delivery month being analyzed. (Leuthold 1979)

Distant cattle futures prices also are related to the current cash price of feeder cattle placed in feedlots. The difference between these two prices is analogous to the price of storage, but in this case the difference is determined by the cost of feeding cattle. The relationship is somewhat more complex for cattle than for grain because steers are being transformed into finished full-fed steers. The cost involved is that of feeding cattle instead of carrying an inventory.

In a well-functioning market, cash prices and the price of the near futures contract will move in tandem and converge as the maturity date of the contract is approached. In theory, the cash and futures prices will be identical in the delivery month. However, even in a market that is functioning well, there will be some costs in making and taking delivery. Thus, in practice, the difference in futures and cash prices (basis has not been zero at contract maturity.

OBJECTIVES

This research developed and tested a theoretical model which identified fundamental characteristics causing the basis for live cattle to change. The live cattle basis was analyzed to provide a better understanding of the economic factors affecting live cattle futures, cash, and basis relationships. More specifically an econometric model was developed to predict cash prices, futures prices, and the basis for live cattle contracts up to seven months from delivery for selected cash markets.

After analyzing the data and the results of the different models, a final objective was to discuss the effects of the results on the cattle industry. Emphasis was placed on explaining the impact of the results on the structure of the industry and the effectiveness of the futures markets for live cattle hedging.

Hypothesis

The importance of explaining the basis has been summarized by Ward and Dasse when they stated "if the basis cannot be explained, then there is a reason to question both the market's performance and economic usefulness" (Ward and Dasse, page 71). Economists are constantly encouraging producers to become more efficient in marketing their product. This may include a hedging program which attempts to maximize profit with a minimal amount of risk. Therefore, using hedging as a marketing tool without sufficient understanding and economic explanation of the basis is precarious.

This research develops and tests a theoretical model to identify the variables which affect the cash-futures price spread (basis) for live cattle. It is hypothesized that the basis for live cattle is primarily a function of factors affecting the supply. Furthermore, the basis will reflect the marginal cost of converting live cattle into a consumable product.

Thesis Outline

The analysis is designed to provide a better understanding of the economic factors affecting the basis for live cattle. After reviewing the major literature on basis analysis, a simultaneous three-equation model is developed in two forms. Next, the models are empirically evaluated to determine the contribution of the economic variables to the basis for live cattle. A discussion of the implications of the results and conclusions with regards to basis estimation ends the paper.

CHAPTER II

Literature Review

The Relationship Between Cash and Futures Prices

The cash-futures price relationship is an important factor for livestock producers. In a traditional sense hedging is thought of as a risk-avoiding activity which depends on parallel movements in cash and futures prices. Working noted that futures and cash prices do not move in parallel and therefore hedging in the traditional sense is unattainable. Hedgers, however, can arbitrage the cash and futures markets if they are able to predict basis fluctuations. Thus, livestock producers can benefit from hedging to the extent that they can predict basis fluctuation.

The basis has three deminsions: time, grade and space. The time dimension is the depiction in the futures market of the intertemporal prices for identical goods. For storable commodities, these intertemporal prices relfect the cost-of-carry associated with storing the commodity from one time period to the next. For nonstorable commodities, the relationships present differ at various times of the year. For example, basis levels for livestock tend to be strongest (narrower) during the fall when large quantities of livestock are coming to market and weakest (wider) in the spring as supplies of marketable livestock decline. The grade dimension represents different qualities and weights of livestock. The spatial dimension represents different par delivery locations.

Intertemporal Basis for Nonstorable Commodities

The livestock markets exhibit no functional relationship between cash and futures prices except during the contract delivery month. The futures price is simply a market-expected cash price. However,to assume that cash and futures prices in livestock markets are independent would be a mistake. Leuthold and Peterson have found that cash and futures prices for hogs are not independent of each other. Some degree of positive correlation between cash and futures prices can be expected as expectations of market conditions affect both cash and futures prices-although not equally (Leuthold and Peterson).

When dealing with agricultural commodities there is almost no commodity which is completely nonstorable. Livestock, for example, can be held to heavier weights or fresh meat can be placed into cold storage. Therefore, it is expected that the analysis of the basis may differ among agricultural commodities and it is appropriate to look in greater detail at a few individual market studies.

Time Series Forecasting Models of Lumber Cash, Futures, and Basis Prices

Ronald A. Oliveira et.al

In 1976, Oliveira et.al analyzed the possibility of using autoregressive-intergrated-moving-average (ARIMA) models to forecast various lumber prices. The forecasting models were used for (i) various lumber cash prices, (ii) the lumber futures prices, and (iii) the basis series for the lumber cash prices.

The purpose of the study was to investigate the potential of a relatively new time series analysis technique, namely the Box-Jenkins autoregressive- integrated-moving-average model, in the development of weekly forecasting models for various lumber prices. More specifically, the objectives were to develop simple, naive forecasting models, based exclusively on the past behavior of a time series for lumber cash and futures prices and to test the accuracy of these models for shortrun forecast horizons.

The Box-Jenkins model fitting procedure was used by Oliveira (et.al) and often resulted in more than one acceptable model for the various lumber price series. Three basic criteria were used to select the final models: (i) low standard error of the estimates (thus, a good fit over the sample period), (ii) significance of most coefficients at the 95 percent confidence level, and (iii) as few coefficients as possible.

The data set for the study consisted of weekly observations for eight different lumber cash market price series, the lumber futures market price series, and the basis series for each of the eight cash prices. The sample period for the weekly price series was from January 1973 through December 1974 , resulting in 103 observations. The test period was January 1975 to July 1975.

The final models for each price series were employed as forecasting equations. For each forecast value, an upper and lower 95 percent confidence limit was estimated. The mean square and the mean percent error were calculated as measures of accuracy for each series at forecast periods of lengths 1,2,3,4,8,12,16, and 20 weeks.

The forecasting ability of the various cash series models resulted in 8-week mean percent errors ranging from 1.39 percent to 15.88 percent. In looking at the accuracy of the cash series models, the amount of error increased considerably in moving from 4-week forecasts to 8-week or longer forecasts.

The forecasting accuracy of the futures series was constant throughout the sample and predicted periods. In 1974, a mean percent error was maintained at less than 10 percent through the 20-week period. In 1975, the same accuracy was maintained through the 16-week period. Although the accuracy of the futures ARIMA forecasts was not as good as the best of the cash models, in general, the futures mean percent errors were smaller than most of those for the cash series.

The basis series ARIMA models were disappointing. The basis series forecast results had considerably higher mean percent errors relative to the cash models. A mean percent error of less than 10 percent occasionally occurred with the 1-week period, with an increase to 204.3 percent in 20-week period errors for one basis model.

The results of the cash series models revealed errors that steadily increased with the length of the forecast period, but this was not the case for the basis series. The basis models errors fluctuated widely from the 1-week sample period to the 20-week sample period. It was suggested by Oliveira et.al that the unexpected fluctuation in mean percent errors could be explained by the character of the futures price. Given that the basis is calculated using the futures price of the contract nearest to maturation, as one shifts from one contract to another, the magnitude of the basis series can change considerably. In other words, the basis series is at a low point at the close of a contract period since the futures price is then close to the cash price; however, when the next futures price is far from a new contract, there can be a noticeable change in the near futures price. Even though the relative change in the futures price may not be great, the relative change in the basis can be quite significant.

It was concluded that the ARIMA models for the cash and futures series produced better results than those for the basis series. The basis price could still be of assistance within the lumber market, but the sample period and prediction period must be limited in length to that of one futures contract period.

Empirical Contributions to Basis Theory: The Case of Citrus Futures

Ronald W. Ward and Frank A. Dasse

Ward and Dasse explored empirically those variables contributing to the basis in frozen concentrated orange juice (FCOJ). The efforts were intended to both illustrate basis theory as it applies to a given commodity and to provide empirical reference for judging the economic performance of the orange concentrate contract.

In developing the FCOJ basis model, it is necessary to understand the chronology of the industry. The orange season officially begins December 1, but the first crop estimate by the U.S. Department of Agriculture is released in October. The crop is susceptible to a freeze from December to mid-February, and the late crop is harvested by July.

During the latter months of the season, there is considerable speculation about the next year's crop, and this information may be reflected in the contracts extended over these months. Finally, there is a continual need for storage since much of the fruit is processed into bulk concentrate and later converted to consumable packs. Because of the orange crop season, the July contract was selected for studying the FCOJ basis model.

It was hypothesized that there were six variables that contribute to the FCOJ basis residual. Three are general variables (risk premium, convenience yield, and market liquidity) and three that are unique to the FCOJ market (freeze bias, bias adjustments, actual freeze effect).

The final basis residual model, after incorporating the variables, was: $BR_{t(i)} = \lambda_0 + \lambda_1 RP_{t(i)} + \lambda_2 CY_{t(i)} + \lambda_3 ML_{t(i)} + \beta_1 FB_{t(i)} + \beta_2 FBA_{t(i)}$

$$+ \beta_3 FZ_{t(i)} + U_{t(i)}$$

BR = Basis Residual

RP = Risk Premium

CY = Convenience Yield

ML = Market Liquidity

FB = Freeze Bias

FBA = Freeze Bias Adjustment

FZ = Actual Freeze

with the λj coefficients relating to the theoretical variables common to all commodities; the βj's are unique to the FCOJ model.

Of the three general variables used in the model, only convenience yield was found to significantly affect the basis residual. This suggests that there has been no significant widening of the basis serving as a risk rewarding inducement for holding inventories during high risk periods. The results also indicate that market liquidity (too few speculators in the market during the closing contract months) has not caused measurable distortions in the basis.

The three variables that were unique to the FCOJ basis model exhibited a pronounced effect on the basis residual. An omission of these variables leads to a clear misspecification of the basis model.

The model clearly supports both the theory of storage and the necessity for measuring market bias. Market bias can clearly cause deviations from the storage function.

The importance of these results is reflected in the fact that in explaining the basis for a particular commodity, one must consider the different biases within the market along with the general variables that make up the basis residual.

Factors Affecting Corn Basis in Southwestern Ontario

Larry Martin, John L. Groenewegen, and Edward Pidgeon

In 1977 Martin et.al. attempted to explain the southwestern Ontario corn basis with an econometric model. It is well understood that the local basis is affected by local market conditions, but for the few cases in which analyses of local basis have been undertaken, relatively naive models have been used to explain basis variations. The ability to explain nondelivery point basis using variables reflecting local market conditions is important for evaluating pricing performance and for providing local traders and hedgers an understanding of the factors which cause variations in the local basis.

Three factors seemed to theoretically affect the basis at Chatham (major pricing point for southwestern Ontario): the land-locked location of the Chatham market, variations in the local supply-demand balance, and competition with U.S. corn.

Given the above factors the basis model suggested was:

$$BR_t^i = F(S^i, IPOC_t, CCP_t, USCP_t, WFGA_t, D_i)$$

where

BR_t^i = basis residual in month i of crop year t.

S^i = seasonality.

$IPOC_t$ = ratio of eastern Canadian production to eastern Canadian consumption.

CCP_t = Canadian corn production in year t.

$USCP_t$ = U.S. corn production in year t.

$WFGA_t$ = availability of western feed grains to the domestic market in eastern Canada.

D_i = dummy variables which represent short-run pricing abberations.

Equations for average monthly basis residual were estimated with data from crop years 1962 through 1976, using ordinary least squares (OLS) (see Table 1).

The seasonality variable was included in the model to accomodate the seasonal changes that the Chatham basis undergoes during a year. These changes include the harvest glut which causes prices in Ontario to be bid down, and the strengthening of the basis during the late fall and winter after the harvest glut has been reduced. This strenthening of the basis in the winter becomes even more substantial as the Great Lakes- St. Lawrence Seaway shipping lane is closed. When the shipping is open during the spring the basis once again weakens. This seasonality led to a separate equation for each month of the crop year.

The ratio of eastern Canadian corn production to consumption was included to account for competition in the eastern Canadian market between domestic and U.S. corn.

Western feed grain availability was included as a proxy for Canadian Wheat Board and federal feed grain pricing policy. Actual movements of western feed grains to the domestic eastern market were used in the analysis as a measurement of the availability.

Canadian and U.S. corn production were used for obvious supply conditions. Dummy variables were used for certain months in 1972-74 to account for domestic or international conditions which disrupted normal marketing in these years.

The results of the analysis suggest that a substantial amount of the variation in the southwestern Ontario basis is explained by variables reflecting local market conditions. During the fall months, the size of the Canadian and U.S. crops is the most important factor. During the winter, when the eastern Canadian market is essentially closed, the only significant factor is the size of the Canadian crop relative to local demand. After navigation is reopened in the spring, both local production relative to demand and the availability of western feed grains have significant effects.

Table 1.

Monthly Equations for Ontario Basis Residual
(t-values in parentheses)

Month	Intercept	IPOC	CCP	USCP	WFGA	D72	D73	D74	R^2
October	.384	-.609 (-5.26)							.68
November	-.532		-.313 (-6.97)	.126 (4.67)			.139 (3.02)		.85
December	-.361		-.232 (-4.36)	.088 (2.77)			.201 (3.68)		.76
January	.334	-.458 (-3.59)				.075 (1.49)	.097 (1.89)		.66
February	.372	-.493 (-3.83)				.116 (2.27)	.079 (1.51)		.69
March	.313	-.440 (-3.51)				.238 (4.71)			.75
April	.284	-.402 (-3.41)				.206 (4.40)	.188 (3.94)		.82
May	.321	-.278 (-1.64)			-.157 (-2.26)	.146 (2.14)	.294 (4.41)		.73
June	.335	-.217 (-1.09)			-.187 (-2.31)	.346 (4.31)	.193 (2.48)		.71
July	.514	-.441 (-2.64)			-.142 (-2.22)	.292 (4.68)		.166 (2.49)	.76

Note: Units in which the explanatory variables are measured are: IPOC, ratio of Eastern Canadian production to Eastern Canadian consumption with 1 occurring when the two are equal; CCP; 1 = 100 million bu.; USCP, 1 = 1 billion bu.; WFGA, 1 = 1 million tonnes.

An Analysis of the Futures-Cash Price
Basis for Live Beef Cattle

Raymond M. Leuthold

Leuthold hypothesized that the basis for live cattle could be explained with an econometric model which contained variables that portrayed shifts in supply. The basis for livestock is not a market determined value in the same sense as in the case for grains but rather reflects the residual of futures and cash prices. This implies independence between the two prices. Of course, some of this independence can be lost through expectations, altering of feeding programs and market weights, and livestock being held off the market.

The meaning of the cash price is straightforward: a result of current demand and supply conditions. The futures price is interpreted as reflecting the consensus of what traders expect the cash price to be at a particular time in the future, given currently available information.

It was assumed that the markets (cash and futures) for the two sets of demand and supply functions were virtually independent. It was also pointed out that because of the maximum time span of only seven months, it would be assumed that current demand and expected demand functions were the same. In other words, changes in the demand variables would probably affect current and expected demand conditions similarly. Therefore, the resulting price spread comes mainly from the difference between current and expected supply conditions.

Price becomes an adjusting mechanism for shifting supply. Substituting both current and expected price-dependent supply equations into the basis equation results in the basis becoming a function of current supply, expected supply, and other variables. The basis, therefore, was considered a function primarily of the expected shifts in supply.

The hypothesized basis models used for estimation were:

BAS = f(SLBF , PC , CP , FDRP , COF5-7 , COF7-9 , COF9-11 , Q2, Q3, Q4)

where

BAS = FP -CP ; i = 0-1, 2-3, 4-5, 6-7 indicating the number of months until delivery or contract maturity. A zero represents the month of delivery. FP is the monthly average of daily closes for the respective futures contract.

SLBF = number of beef slaughtered commercially each month in the U.S.

PC = monthly price of corn in the U.S.

CP = monthly average price of choice slaughter steers, 900-1,100 pounds at Omaha

FDRP = monthly average price of choice feeder steers, 600 to 700 pounds at Kansas City.

COF 5-7
COF 7-9 = number of cattle on feed in each respective weight
COF 9-11 group.

Q2, Q3, Q4, = dummy variables for the last three quarters of each year.

The results of this analysis represents a model that effectively explained the basis if the delivery month was 2-7 months in the future. But the nearby basis model was disappointing with a very low coefficient of variation . Leuthold theorized that the nearby basis was more random and, therefore, more difficult to explain. Also the assumption of independence between cash and futures close to delivery seemed to be violated.

Basically the signs of the coefficients in the various models were as expected and, as noted earlier, the statistical fit became better as the delivery month became more distant. One can hypothesize that because all the variables contained in the model were supply oriented and that most of the price discovery in the future months was based on supply expectations, it would have been expected that this model would provide a better explanation of basis variation as the amount of time to delivery increases.

Leuthold felt that a high proportion of the variation in the live cattle basis could be explained by factors which determine and shift the supply curve. The results of this analysis confirmed this hypothesis when considering contracts two to seven months prior to delivery.

Table 2.

Results of Regressing Cattle Basis on Independent Variables, Monthly Data, 1965-1977*

Independent Variable	BAS 0-1	BAS 2-3	BAS4-5	BAS 6-7
Constant	1.75 (1.64)	3.52[b] (2.78)	4.79[b] (4.00)	5.20[b] (3.99)
SLBF	-.0001 (-.45)	.0006 (1.55)	.0002 (.57)	.0003 (.83)
PC	1.33[b] (5.78)	4.28[b] (14.74)	6.19[b] (22.58)	6.85[b] (21.10)
CP	-.17[b] (-5.24)	-.69[b] (-17.89)	-.98[b] (-26.92)	-1.07[b] (-27.53)
FDRP	.16[b] (5.50)	.51[b] (14.25)	.68[b] (19.85)	.73[b] (21.26)
COF5-7				-.0008[a] (-2.11)
COF7-9		-.001[b] (-3.69)	-.001[b] (-3.03)	
COF9-11	-.001[b] (-2.87)	-.0003 (-.56)	-.0002 (-.51)	-.001[a] (-2.32)
Q2	-.08 (-.36)	-.82[b] (-2.84)	-1.64[b] (-6.00)	-1.09[b] (-3.09)
Q3	-.30 (-1.34)	-.29 (-.94)	-.61[a] (-2.07)	-1.61[b] (-4.31)
Q4	.26 (1.16)	-.04 (-.14)	-.25 (-.95)	-.31 (-.73)
R^2.	.26	.78	.89	.90
Durbin-Watson	2.14	1.61	1.60	1.40

*The t-ratios are in parentheses below the regression coefficients.

[a]Significantly different from zero at the 95 percent confidence level.

[b]Significantly different from zero at the 99 percent confidence level.

source (Leuthold 1979)

An Analysis of the Futures-Cash Price Basis for Live Beef Cattle: Comment

William G. Tomek

Tomek reviewed Leuthold's analysis and reinterpreted the results to give more clarity to Leuthold's conclusions (cash and futures tend to move independent of each other). The basis model used by Leuthold was:

$$F_t^j - P_t = a_1^j + a_2^j D_2 + a_3^j D_3 + a_4^j D_4 + b^j P_t + c_j Q_t + \text{other}$$

variables

where F_t^j = current price of live cattle futures contract maturing j months in the future,

P_t = current cash price of slaughter steers,

Q_t = commercial beef slaughter in month t,

D = seasonal zero-one variables by quarter.

Tomek adjusted the basis model in two basic ways:

1) the coefficients of the dummy variables were combined with the base period intercept coefficients to give estimates of the intercepts by quarter, and
2) the cash price (P_t) on the left-hand side (dependent variable) of the equation was combined with the cash price on the right-hand side (independent variable) leaving the futures price (F) as a function of the cash price. The adjustments resulted in the following model:

$$F_t^j = b^j P_t + P_t + \ldots = (1 + b^j)\, P_t.$$

The results of this analysis confirm that futures prices of contracts five and seven months from delivery have a zero basis. The results were also consistent with theory in that as the maturity date of a futures contract approaches, the coefficient of P moved toward one. Of course, as maturity got closer futures prices were expected to move in a one-to-one relationship with a zero basis (therefore their relationship is no longer independent).

The Cash-Futures Price Spread for Live Hogs

Leuthold and Peterson

In the Leuthold study of the live cattle basis, an assumption of independence between cash and futures prices was made. This allowed them to combine the supply functions for each of these markets into a single equation model. A substantial amount of the variation in the basis could be explained by shifts in supply, but the statistical fit was very poor when analyzing contract months within 3 months of delivery. This signalled the fact that as the time horizon shortens, cash and futures prices become more interdependent and current supplies become an indicator of expected supplies in nearby months.

It was hypothesized by Leuthold and Peterson that the cash price, the futures price, and thereby the basis for hogs are determined simultaneously. The cash price is a function of current demand and supply conditions, while the futures price results from expected demand and supply conditions. As in the live cattle study, it was assumed that current demand and expected demand are the same, therefore, the difference between the cash and futures hog prices result primarily from current and expected supply conditions.

The futures price was expressed as a function of expected marketings during the maturity month. Proxies for these marketings were found in the USDA quarterly estimates of hog numbers for weight classes that would reach market weight when the contract expires. The current cash price was expressed as a function of current slaughter, given a constant demand. Also, because of the seasonality in hog marketings, dummy variables were included to represent the second, third, and fourth hog quarters.

Because it was hypothesized that cash and futures prices are determined simultaneously, the futures price equation contained the cash price and the cash price equation included the futures price as an independent variable. The linkage between cash and futures is the basis, which was hypothesized to be a function of the cash price and the amount of pork in cold storage. The cold storage variable signifies whether packers will bid up the cash price. The final variable, cash price, connects the basis function with the other two equations and acts as a shifter for various price levels.

The result is a three equation, three unknown model as follows (expected signs are in parenthesis):

Futures price = f(hog inventories (-), cash price (+))

Cash price = f(futures price (+), slaughter (-), quarterly dummy var.)

Basis = f(cash price (-), cold storage (+))

The results were basically what was hypothesized (see Table 3). The signs of the coefficients were generally as expected and usually highly significant. The weakest link was the relationship between futures price and hog inventory levels which reflected expected supply. Four of the seven coefficients were negative as expected, but only two of those were significant. The cash price was negatively related to current slaughter, as expected, and the cash and futures prices were highly positively related.

An interesting result was the significance and positive relationship between the basis and cold storage. This suggested that storage provides a link between the cash and futures prices and kept them from behaving strictly as would be expected for a nonstorable commodity.

The underlying hypothesis for this analysis was that cash and futures prices were not independent and that a three-equation model could be developed to explain the linkage between cash and futures prices (the basis). The results were impressive and, for the most part, supported the hypothesis.

Table 3.

Results of Hog Basis Model,
Monthly: 1970-1980*

Variables	Basis 01	23	45	67
EQ.1 Dependent Variable:	FUT01	FUT23	FUT45	FUT67
Constant	1.07 (.83)	2.94 (.62)	14.26 (3.15)	29.48 (4.27)
PRHOG	.94 (51.95)	.83 (16.54)	.66 (12.29)	.46 (6.12)
HOGG180	.0004 (2.01)			
HOG12-18		.001 (3.58)		
HOG6-12		-.0006 (-2.35)	.0009 (2.31)	
HOGL60			-.0006 (-3.36)	-.0002 (-1.00)
SOWFAR				-.002 (-1.89)
EQ.2 Dependent Variable:	PRHOG	PRHOG	PRHOG	PRHOG
FUT01	1.02 (77.06)			
FUT23		1.14 (40.64)		
FUT45			1.24 (30.38)	
FUT67				1.34 (22.90)
SLHOG	-.0003 (-4.10)	-.0008 (-4.83)	-.001 (-6.18)	-.002 (-6.04)
Q2	.29 (.63)	-2.70 (-3.25)	-.25 (-.23)	1.12 (.78)
Q3	.96 (2.12)	1.93 (2.42)	3.02 (2.88)	1.93 (1.39)
Q4	.66 (1.40)	-1.26 (-1.50)	.21 (.18)	.79 (.55)

Table 3 continued.

EQ.3 Dependent Variable	BAS01	BAS23	BAS45	BAS67
PRHOG	-.03	-.13	-.16	-.22
	(-3.38)	(-7.87)	(-8.20)	(-9.66)
COLDSTOR	.008	.02	.02	.03
	(6.32)	(8.68)	(8.46)	(9.61)

*In parentheses below the regression coefficients is the ratio of the estimated coefficient to the estimated standard error. Any ratio greater than 2.0 is considered significant.

DEFINITION OF VARIABLES:

BASXX = futures price (FUTXX) minus cash price (PRHOG) at month t with the futures prices being 0 to 7 months forward. Months are combined in pairs, o and 1,2 and 3,4 and 5, 6 and 7.

FUTXX = monthly average of daily closes for the respective futures contract, dollars per hundredweight, 0 to 7 months forward.

PRHOG = monthly average price of barrows and gilts, 7 markets, dollars per hundredweight, current month.

SLHOG = number of hogs slaughtered, U.S., 1,000 head, monthly.

COLDST = frozen and cured pork in storage, 1,000 pounds, U.S., monthly.

HOGG180 = number of hogs and pigs exceeding 180 pounds, quarterly, 1,000 head, 10 states.

HOG12-18 = number of hogs and pigs 120-179 pounds, quarterly, 1,000 head, 10 states.

HOG6-12 = number of hogs and pigs 60-119 pounds, quarterly, 1,000 head, 10 states.

HOGL60 = number of hogs and pigs under 60 pounds, quarterly, 1,000 head, 10 states.

SOWFAR = number of sows farrowing, quarterly, 1,000 head, 10 states.

Q2 = dummy variable for March, April, May.

Q3 = dummy variable for June, July, August.

Q4 = dummy variable for September, October, November.

Summary

The studies reviewed have illustrated some important factors influencing the futures-cash price differential. First, the best understood and most accurately predicted price differentials are those of storable commodities. Second, some cost of conversion can be found as reflected by the basis for livestock commodities. Paul and Wesson first identified the concept of marginal cost conversion in a study of cattle feeding as the market price from converting one form of commodity into another with the cost of physical storage as a special case of the cost of conversion. Ehrick tested this hypothesis for the case of live beef cattle and found that the emperical evidence was not sufficient to support or reject the hypothesis. Several years later, however, Leuthold and Peterson tested the hypothesis for cattle and hogs respectively and found empirical support.

The approach used by Leuthold and Peterson for investigating the basis was to assume that since livestock could not be carried from one period to the next, supplies at any two points in time were independent. Over a short time horizon of a few months, income should remain relatively constant. There is also not enough time for consumer tastes and preferences to change significantly. Therefore, if prices of substitutes could be assumed to remain relatively constant, demand would remain relatively constant and expected changes in supply alone should account for any differences between current (cash) and expected (futures) prices.

Combining separate, independent supply functions for cash futures prices into a single equation, they found that the basis could be explained by shifts in supply. The results of this study indicated that a problem existed in their assumption of independence between present and future prices. His basis models of futures contracts within three months of delivery lost explanatory power as compared to the more distant basis models.

In a comment to that paper, Tomek pointed out that as the delivery date for the futures contract becomes more distant (as the time horizon increases) the two price series become more independent. Conversely, as the time horizon shortens, cash and futures prices become more interdependent and current supplies become an indicator of expected supplies in nearby months. A major implication of Tomek's finding was that cash and futures prices for livestock may not be generated by completely independent processes, especially for the nearby months.

CHAPTER III

METHODOLOGY

The cash price data used in the study were obtained for three live cattle market locations in the U.S. over a period January 1973 through February 1982 from "Livestock Meat Wool" (Agricultural Marketing Service). The three locations were Omaha, Iowa and Texas Panhandle. The weekly average cash price was collected for each location for choice, yield grade 2-4, 900-1100 lbs. steers (which conforms to the live cattle futures contract traded on the Chicago Mercantile Exchange)(see Table 4).

For each week in the nine year period, the weekly average closing price was calculated for each live cattle futures contract up to eight months from delivery. For example, on the week ending January 20, 1973, a weekly average close was calculated for the February, April, June, and August live cattle contracts. The weekly average closes were calculated by using the daily closes given in the Chicago Mercantile Exchange Yearbook. Federally inspected cattle slaughter was collected for each week from "Livestock and Meat Situation" (USDA Crop and Livestock Reporting Service). The cold storage figures used were collected from the monthly USDA "Cold Storage" stocks report (USDA Crop and Livestock Reporting Service). The cattle-on-feed numbers were collected from the quarterly 13-state USDA reports.

For each report, a quantity of cattle was calculated that would affect each futures contract month up to the eight month delivery period. Normal rates of gain were used to determine when each weight group would be considered cattle ready to be marketed. The process that was decided upon was very simple and straightforward. For each given report the number of steers on feed were broken into these weight groups: (over 1100 lb., 900-1100 lb., 700-900 lb., 500-700 lb., under 500 lb.). The weight groups for heifers on feed included: (over 900 lb., 700-900 lb., 500-700 lb., under 500 lb.). The 1100 lb. or over weight group of steers and the weight group of heifers over 900 lbs. were not used because it was assumed that a large percentage of these weight groups were already marketed shortly after the inventory date. The steers in the 900-1100 lb. group were combined with one-half of the heifers in the 700-900 lb. group to make up the number of cattle on feed that should affect the futures contract two months from delivery. Steers in the 700-900 lb. weight group combined with the other half of the 700-900 lb. heifer group made up the cattle numbers that should affect the futures contract four months from delivery. The numbers for the futures contract six months from delivery consisted of the 500-700 lb. weight groups of steers and heifers. The steers and heifers under 500 lbs. were combined to make the group that should affect the futures contract eight months from delivery. An example of how each cattle on feed report was handled is in Table 5.

Table 4.

RULES AND SPECIFICATIONS FOR LIVE BEEF CATTLE FUTURES CONTRACTS

COMMODITY SPECIFICATIONS--Each futures contract shall be for Choice grade live steers, as defined by the United States Department of Agriculture (USDA) "Official United States Standards for Grades of Slaughter Cattle" as amended March 6, 1975, effective February 23, 1976.

FUTURES CALL

TRADING MONTHS AND HOURS--Futures contracts shall be scheduled for trading during such hours and delivery in such months as may be determined by the Board.

TRADING UNIT--The unit of trading shall be 40,000 pounds of Choice grade live steers.

DAILY PRICE RANGE--There shall be no trading at a price more than $.015 per pound above or below the previous day's setting price.

PAR DELIVERY AND SUBSTITUTIONS

PAR DELIVERY UNIT--A par delivery unit is 40,000 pounds of USDA yield grade 1,2,3, or 4 Choice quality grade live steers, averaging between 1050 pounds and 1200 pounds with no individual steer weighing more than 100 pounds above or below the average weight for the unit. Nor more than 8 head (Effective August 1981 Futures Contract: not more than 4 head) of estimated yield grade 4 Choice steers shall be permitted in a par delivery unit. No individual animal weighing less than 950 pounds or more than 1300 pounds shall be deliverable.

Par delivery units containing steers with an average weight between 1050 pounds and 1125.5 pounds shall have an estimated average hot yield of 62%. Par delivery units containing steers with an average weight between 1125.6 pounds and 1200 pounds shall have an estimated average hot yield of 63%.

All cattle contained in a delivery unit shall be healthy. Cattle which are unmerchantable, such as crippled, sick, obviously damaged or bruised, or which for any reason do not appear to be in satisfactory condition to withstand shipment by rail or truck shall be excluded. No cattle showing a predominance of dairy breeding or showing a prominent hump on the forepart of the body shall be deliverable. Such determination shall be made by the grader and shall be binding on all parties.

Interpretation--Hot yield is the hot carcass dressing percentage before shrouding.

Table 4 continued.

WEIGHT DEVIATIONS--Steers weighing from 100 to 200 pounds over or under the average weight of the steers in the delivery unit shall be deliverable at a discount of 3¢ per pound provided that no individual animal weighing less than 950 pounds or more than 1300 pounds shall be deliverable. For purposes of computing such discount, the weight of the over or under weight animals shall be considered the same as the average weight per head of the delivered unit.

Steers weighing more than 200 pounds over or under the average weight of the load are not acceptable. The judgment of the grader as to the number of such overweight or under weight cattle in the delivery unit shall be final and shall be so certified on the grading certificate.

YIELD DEVIATIONS--Delivery units with an estimated average hot yield under par shall be acceptable with a discount of one-half cent per pound for each one-half percent or less by which the estimated yield is under par. Units with an estimated average hot yield of less than 60 percent shall not be deliverable.

YIELD GRADE DEVIATIONS--Estimated yield grade 4 Choice quality steers, up to and including 8 head (Effective August 1981 Futures Contract: 4 head) are deliverable at par.

All Good quality grade, yield grade 4 steers are deliverable at 3¢ per pound discount for yeild grade plus the quality discount. (Effective August 1981 Futures Contract: Good, yield grade 4 steers are not deliverable.)

If 9 or more steers of yield grade 4 (Good and Choice quality grade) are contained in the delivery unit, all yield grade 4 cattle in excess of 8 up through a maximum of 18 head are deliverable at a 3¢ per pound discount. (Effective August 1981 Futures Contract: If five or more steers of yield grade 4 choice quality grade are contained in the delivery unit, all yield grade 4 cattle in excess of four up through a maximum of eight head are deliverable at a discount of 15 per cent of the settlement price.)

For purposes of computing such discount, the weight of such yield grade 4 steers shall be considered the same as the average weight per head of the delivered unit.

Any delivery unit containing more than 18 head (Effective August 1981 Contract: 8 head) of cattle with an estimated yield grade of 5 shall not be deliverable.

QUALITY GRADE DEVIATIONS--Delivery units containing not more than eight head of USDA Good grade steers may be substituted at a 3¢ per pound allowance for each Good grade steer. For the purpose of computing such allowances, the weight of such Good grade steers shall be considered the same as the average weight per head of the delivered unit.

QUANTITY DEVIATIONS--Variations in quantity of a delivery unit not in excess of 5% of 40,000 pounds shall be permitted at the of the delivery, with appropriate adjustment to reflect delivered weight but with no further penalty.

Table 5.

An Example of Calculations Using A

Cattle-on-Feed Report

(1,000 head)

Year	Quarter			Steers		
		< 500	500-700	700-900	900-1100	> 1100
1977	1	521	1311	2403	1948	406
			Heifers			
		< 500	500-700	700-900	> 900	
1977	1	569	1117	1347	605	

*COF01 = 1948 + 1/2(1347) = 2621

COF23 = 2403 + 1/2(1347) = 3076

COF45 = 1311 + 1117 = 2428

COF67 = 521 + 569 = 1090

*Denotes cattle on feed that should affect the futures contract two months from delivery.

An initial problem with the data was the fact that the cattle on feed numbers were available only on a quarterly basis, therefore, the cattle on feed figures changed only four times during a year (52-week period). The cold storage data were available only on a monthly basis which meant the cold storage figure was constant 4-5 weeks before changing.

For every weekly observation a basis (futures price minus cash price) was calculated for each location. The most nearby basis model, labeled BASTX01 ("TX" refers to the market location--Texas Panhandle; OM and IA refer to Omaha and Iowa respectively) refers to all those observations when futures contracts are in the delivery month or the month preceding delivery. During a delivery month, the next contract is two months away; all those basis observations involving futures contracts two and three months prior to delivery were combined. This model was labeled BASTX23. Similarly, the basis observations for contracts four and five months out in time were combined as were those for six and seven months out. These models were deisgnated as BASTX45 and BASTX67 respectively.

THE MODELS

FUTURES PRICE MODEL

Under the assumption of constant demand, the futures price is considered a function of expected supply conditions. Factors affecting long-run supply are costs of inputs such as the prices of corn, supplement, and feeder cattle. However, in shorter time periods of up to seven months, production decisions have been made and feed prices affect only short-run marketing decisions. Of course, producers of live cattle do have the option of increasing the proportion of non-fed slaughter that is marketed. Another adjustment that can be made is slaughter weight, which is influenced greatly by the cash price and feed costs (beef-corn price ratio).

Given the above considerations, the key factors affecting futures prices within the short run horizon are production decisions made some time previously. They are reflected in the number of cattle expected to be marketed at some given time in the future. Therefore, the futures price was expressed as a function of expected marketings during the maturity month, with the calculated cattle-on-feed numbers used as proxies for the number of cattle that would reach market when the contract expires. The futures price was expected to be negatively related to the quantity variables therefore increases in cattle-on-feed inventories would shift the expected supply function, causing the futures price to fall.

As stated earlier, the cash price and futures price for live cattle become more interdependent as the time horizon between cash and the delivery month shortens. This implies that cash and futures prices for live cattle could not be generated by completely independent processes, but should be determined in a simultaneous process which would use the interrelationships between cash and futures to explain the variation in the three dependent variables (cash, futures, and basis). Therefore, the futures price equation also contained the cash price as a variable. Because cash and futures should be affected similarly by most exogenous shocks to the system, the cash price coefficient was expected to have a positive relationship. Thus, the futures price model was:

Futures price = f(cattle inventories (-), cash price (+)).

CASH PRICE MODEL

The current cash price was determined to be function of current slaughter, given a constant demand. Increases (decreases) in slaughter should depress (raise) cash prices, resulting in a negative relationship. As determined earlier, the cash price equation should have the futures price included as a variable and the two should have a positive relationship. The cash price model was:

Cash price = f(futures price (+), slaughter (-)).

BASIS MODEL

The connecting link between the cash price and futures price was the basis, and it was hypothesized to be a function of the cash price and the amount of cold storage. Frozen beef can be stored for periods up to twelve months with no loss in quality. When cold storage is ample, there is no reason for packers to bid up the cash price, ceteris paribus. Low levels of cold storage may cause packers to compete more strongly for live cattle,thus increasing current cash prices relative to futures prices. From this argument, cold storage, which provides the connecting link between current and future prices, was expected to have a positive relationship with the live cattle basis. The basis model was:

Basis = f(cash price (-), cold storage (+)).

SIMULTANEOUS MODEL

The models were combined to develop a three-equation, three-unknown model as follows:

FUTXX = f(COFXX, cash price)
Cash Price = f(FUTXX, slaught)
BASZZXX = f(cash price, COLDSTOR)

where =

BASZZXX = futures price (FUTXX) minus cash price (name of location) at week t with the futures price being 0 to 7 months forward. Futures delivery months were combined in pairs, 0 and 1, 2 and 3, 4 and 5, 6 and 7. ZZ was the location variable as to where the basis was being computed (Omaha (OM), Iowa (IA), Texas Panhandle (TX).

FUTXX = weekly average of daily closes for the respective futures contract, dollars per hundredweight, 0 to 7 months forward.

OMAHA, IOWA, TEXAS Cash Price = weekly average cash price of choice YG, 2-3 steers at the different locations.

SLAUGHT = number of cattle slaughtered, U.S., 1,000 head, weekly.

COLDSTOR = total frozen beef, 48 states, 1,000 pounds, monthly.

COFXX = the number of cattle on feed that should affect the futures month (FUTXX) 0 to 7 months from delivery.

VARIATIONS FROM THE MODEL

Basis as a Percent

Variations from the basic model were also analyzed. The first change came in the manner in which the basis was presented. It was felt that maybe the basis should not be analyzed in absolute terms but in relative terms. Therefore, the change consisted of the basis being expressed as a percent of the cash price at the location being analyzed. This change was intended to eliminate the variation (if any) in the basis that was caused solely by the level of cash price being paid, i.e. basis will always be greater at higher absolute price levels than at lower levels. This basis model variation was:

BPCTZZX = f(cash price (-), cold storage (+))

BPCTZZX = the original basis for week t at the ZZ location divided by the cash price at the ZZ location for the given months 0 to 7 months from delivery(1,3,5,7).

Adding Basis Variables

Another variation to the original model was to add the cattle-on-feed variables and the slaughter variable to the basis model. These variables were analyzed using both the regular basis model (BASZZXX) and the basis as a percent model (BPCTZZX). Therefore the basis model as a result of this variation consisted of:

BASIS = f(cash price (-), cold storage (+), cattle inventories (-), slaught (+))

Method of Estimation

In the models discussed above the problem of estimating the parameters has special features that are not present when a model involves only a single relation. In this case the ordinary least squares estimators of the regression coefficients are inconsistent and other methods must be devised to provide consistent estimates. Therefore, the live cattle basis models were analyzed using two-stage least squares to estimate the coefficients.

The basic requirement of the economic model is that the number of the variables whose values are to be explained must be equal to the number of independent relationships in the model--i.e., to the number of different pieces of relevant information--otherwise the values of these variables would not be determinate. In addition to the variables whose values are to be explained, a model may, and usually does, contain variables whose values are not immediately affected by the mechanism described by the model. The relevance of these variables lies in their roles as explanatory factors. This leads to a distinction between those variables whose values are to be explained by the model and those that contribute to providing such an explanation; the former are called endogenous and the latter predetermined.

Predetermined variables can be subdivided into exogenous and lagged endogenous variables. The values of the exogenous variables are completely determined outside the system under consideration, whereas the values of the lagged endogenous variables are represented by the past values of the endogenous variables of the model. Models having no lagged endogenous variables are not uncommon.

CHAPTER IV

RESULTS

Data Analysis

Cash Price Level

Of the three locations that were analyzed Texas had the highest average price of $52.25 per cwt over the nine year period.(See Table 6) Texas also had the largest standard deviation of $12.24 per cwt. The upper quartile cash price at Texas over the period was $65.15 per cwt. This should indicate to cattle producers that a price above $65.00 was at least better than 75% of the prices received during the analysis period. The 90% quantile for the Texas cash price was $69.40 cwt with a maximum price of $78.30.

As indicated by Figure 1, 42% of the prices were within 18% ($39-$47) of the total range ($34.45-$78.31)(bar charts for Omaha and Iowa cash prices show similar patterns). This breakdown was not meant to indicate that cash prices were not volatile or that elevated cattle prices have not been (or will not be) attainable. The results did indicate that individual price objectives could have been beneficial to the producer. Because extremely high cattle prices were not sustained for long periods of time, it was important for producers to set reasonable objectives. Once these price objectives were met, producers had the opportunity to solidify these goals by hedging through the use of the futures markets or forward contracting. Of course when hedging by using the futures, adverse basis movement can lead to objectives that are not met.

Table 6.

Cash Price Statistics For Study Locations
1973-82

Location	Mean Price/cwt	Std. Dev.	Median	Range	75%0Q
Texas	52.25	12.24	48.50	43.86	65.15
Omaha	51.46	11.74	47.78	42.78	63.86
Iowa	51.29	12.04	47.65	42.48	64.39

Figure 1.

```
$/cwt   BAR CHART OF TEXAS CASH PRICE          #
   79+*                                        1
     .**                                       3
     .**                                       3
     .*****                                   10
     .**********                              20
     .******************                      35
     .********************                    40
     .***********                             21
     .***********                             22
     .******                                  11
     .*                                        2
   57+****                                     8
     .*******                                 13
     .**********                              19
     .*********                               18
     .********                                16
     .**************                          28
     .*****************                       34
     .********************                    39
     .***************************             54
     .***********************                 46
     .**********                              19
   35+********                                15
      ----+----+----+----+----+--
      *MAY REPRESENT UP TO 2 COUNTS
```

As can be seen in Figure 2 the basis values at Omaha (futures contract two months from delivery) approached a normal distribution. (This was also true of the other two locations.) The normality statistic (D:Normal) was .0438 which is significant at the 95% confidence level. The mean of the BASIS01 (futures-cash) in Omaha was $.79 cwt and the standard deviation was $1.70 cwt. Assuming a normal distribution, 66 percent of the basis figures fell into the range of $2.49 and $-.91 cwt.

Figure 2.

```
                 BAR CHART OF THE BASIS AT OMAHA
                   TWO MONTHS FROM DELIVERY     #

   8.25+*                                       1
       .
       .
   6.75+*                                       1
       .*                                       1
       .
   5.25+*                                       1
       .**                                      3
       .***                                     6
   3.75+*******                                13
       .********                               16
       .*************                          26
   2.25+****************                       32
       .****************************           56
       .***********************************    69
   0.75+**********************************     68
       .************************               47
       .*****************                      34
  -0.75+****************                       31
       .*************                          26
       .*********                              17
  -2.25+*******                                13
       .****                                    7
       .***                                     5
  -3.75+*                                       1
       .*                                       1
       .*                                       1
  -5.25+*                                       1
        ----+----+----+----+----+----+----+
        *MAY REPRESENT UP TO 2 COUNTS
```

The other two locations exhibited the same type of distribution when examining the basis of contracts two months from delivery. In Texas the BASIS01 mean was $.01 cwt and standard deviation $1.67 cwt.(See Table 7) The normality statistic was .0398 and with a normal distribution 66 percent of the basis figure fell into the range of $1.68 and -$1.66 cwt. The Iowa BASIS01 mean was $.97 cwt with a standard deviation of $1.76 cwt. This gave a 66 percent range of $2.72 to $-.78 cwt. At each location the mean basis increased as the number of months until delivery increased. This was also true of the standard deviation. For example the BASIS23 (futures contract two to three months from delivery) mean at Omaha was 1.21 and the standard deviation was 3.28 which compared to .79 and 1.70 respectively for BASIS01.

Table 7

Means, Standard Deviations, and Normal Statistics For Each Study Location

	MEAN	STD DEV	D:NORMAL
Omaha			
BASIS01	.79	1.70	.048
BASIS23	1.21	3.28	.052
BASIS45	1.41	4.11	.055
BASIS67	1.68	4.26	.066
Texas			
BASIS01	.01	1.67	.0398
BASIS23	.43	3.31	.05
BASIS45	.63	4.20	.068
BASIS67	.90	4.36	.056
Iowa			
BASIS01	.97	1.76	.056
BASIS23	1.38	3.34	.045
BASIS45	1.59	4.16	.053
BASIS67	1.85	4.32	.052

As would be expected (after examining the means and standard deviations) the basis range at each location became wider as the number of months until delivery increased (see Table 8). For example the range of the basis in Texas two months from delivery was $12.47. This basis range swelled to $20.41 as we moved out to four months from delivery and out to $24.34 eight months from delivery.

Table 8.

BASIS RANGES FOR EACH STUDY LOCATION[a]

	OMAHA	TEXAS	IOWA
BASIS01	13.01	12.47	17.41
BASIS23	18.76	20.41	18.89
BASIS45	22.47	23.43	22.34
BASIS67	24.65	24.34	23.82

[a]The range was defined as the difference between the strongest (postive) and weakest (negative) basis.

The increasing response of the basis means, standard deviations, and ranges as the time until delivery increases, led to the cash and futures relationship that was explored. In other words, the responses confirmed the idea that the live cattle cash and futures prices had a high correlation when the futures months were within two months of delivery, but the correlation weakened as the spot (cash) month and futures month became further apart.

This theory of cash and futures correlation was confirmed with a correlation analysis. As noted in Table 9 the correlation coefficients of futures and cash prices gradually decreased as the futures contract became further from delivery.

Table 9

CORRELATION COEFFICIENTS OF CASH AND FUTURES PRICES

	FUT01	FUT23	FUT45	FUT67
OMAHA	.989	.961	.941	.936
TEXAS	.991	.963	.940	.936
IOWA	.989	.961	.940	.936

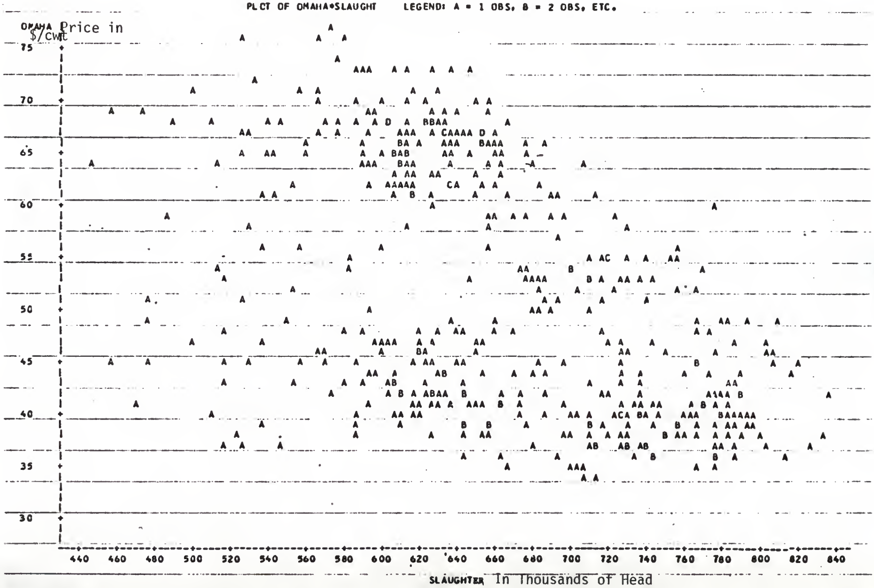
Examination of the different locational means allowed a conclusion as to which location seemed to have experienced the strongest (narrower) live cattle basis. The Texas Panhandle exhibited the strongest weekly average basis of the three locations. The Texas average basis was the strongest at each level of time (months) until delivery. Omaha recorded a stronger average basis than Iowa over the analysis period.

PLOT ANALYSIS

The last aspect of the data analysis was an examination of the different plots. One interesting set of plots was the graphs of weekly slaughter plotted in conjuntion with the weekly average cash prices at the three different locations. Each of the three plots exhibited the general trend that was expected. As the amount of slaughter increased, the price of fat cattle at the three different locations generally was lower. As can be seen in Figure 3, which represents the Omaha cash price vs. cattle slaughter, there were only six times in the examination period where the weekly cash price was over $60 cwt at the same time the weekly cattle slaughter was over 680,000 head. Therefore, this may well be an important hedging signal for cattle feeders to use. If cattle inventory levels indicate a weekly slaughter that will approach 680,000 head during the marketing period, then any opportunity to price cattle over $60 cwt would generally be better than expected, assuming the absence of any shifts in demand for beef or other meats. Only six times during the experiment period was the cash price at Omaha over $55 cwt and weekly cattle slaughter over 700,000 head during the same week. Once again this indicative relationship between price and slaughter could be used as a price objective tool.

Figure 3.

Cash Price vs Cattle Slaughter



ORIGINAL MODEL RESULTS

The results of the original models at each location are given in Tables 10-12. The coefficients in parentheses are the ratio of the estimated coefficient to the estimated asymptotic standard error which has an approximately normal distritubion. Since the bias of the standard error is unknown, any coefficient which is more than twice its standard error, indicating a ratio of 2 or greater, is considered significant.

The overall reaction to the results of the model is one that indicates a model with several problems in regard to trying to predict the live cattle basis. This can be demonstrated through examination of the results from the Texas model.

The results of the equation to predict the futures prices using the Texas Panhandle cash price and cattle inventory numbers were about as expected (Table 11). The coefficients for the cash variable were all positive and highly significant. The degree of significance decreased as the time until delivery increased. The cattle-on-feed coefficients were not as expected. Only four of the ten coefficients were of the expected negative sign. Of the four, three were significant at the 95 percent confidence level.

The results of the model used as a predictor of the Texas cash price through the use of two variables--futures price and slaughter--were mixed. The coefficients of the different futures price variables were positive as expected and significant. The results of the slaughter coefficients were disappointing. Only one of the four coefficients had the expected negative sign and was significant at the 95 percent confidence level.

The key to the whole model was in the results of the final part of the model which attempted to predict the basis. The major unexpected results were the outcomes of the Texas cash price coefficients. All four of the cash coefficients had positive signs rather than the negative relationship that was expected (as the cash price increases the basis becomes smaller). However, all of the cold storage coefficients were positive, as expected, and they were all significant. The percent of variance in the basis that was explained was low, with the coefficient of variation ranging from 4.9% to 2.4%.

The results of the original model at the other two locations, Omaha and Iowa, were basically the same. Both exhibited the same modeling problems as the Texas model. The models had similar problems with coefficients of the wrong sign and poor explanatory power in the basis models.

Table 10.

RESULTS OF ORIGINAL CATTLE BASIS MODEL,
AT OMAHA, WEEKLY, 1973-1982*

Variables	Basis 01	23	45	67
EQ1. Dependent Variable	FUT01	FUT23	FUT45	FUT67
Constant	-.963	1.543	-1.061	5.234
	(-1.03)	(.82)	(-.48)	(2.75)
OMAHA (cash)	.998	1.003	.991	.986
	(79.84)	(45.41)	(37.92)	(35.29)
COF01	.002			
	(4.40)			
COF23	-.001	.00006	.002	
	(-3.5)	(.12)	(3.5)	
COF45	.0002	-.001	-.003	-.003
	(1.38)	(-4.17)	(-6.97)	(-6.9)
COF67		.004	.0055	.006
		(6.24)	(7.42)	(8.3)
R-Square	.9541	.8363	.7902	.7678
EQ2. Dependent Variable	OMAHA	OMAHA	OMAHA	OMAHA
Constant	-2.46	-11.32	-.70	3.32
	(-1.47)	(-2.67)	(-.15)	(.71)
FUT01	.998			
	(64.04)			
FUT23		1.06		
		(26.89)		
FUT45			.954	
			(21.51)	
FUT67				.925
				(21.2)
SLAUGHT	.003	.01	.0026	-.002
	(1.81)	(2.88)	(.6391)	(-.405)
R-Square	.9506	.8033	.7412	.7322

Table 10 continued.

EQ3. Dependent Variable	BAS01	BAS23	BAS45	BAS67
Constant	-4.76	-9.17	-9.25	-8.17
	(-4.24)	(-3.93)	(-3.2)	(-2.7)
OMAHA (cash)	.059	.091	.093	.094
	(4.3176)	(3.25)	(2.61)	(2.4)
COLDSTOR	.00007	.00002	.00002	.000015
	(4.64)	(5.15)	(4.36)	(3.69)
R-Square	.0503	.0529	.0388	.0280

*In parentheses below the regression coefficients is the ratio of the estimated coefficient to the estimated standard error. Any ratio greater than 2.0 is considered significant.

Table 11.

RESULTS OF ORIGINAL CATTLE BASIS MODEL, AT TEXAS PANHANDLE, WEEKLY, 1973-1982*

Variables	Basis 01	23	45	67
EQ.1 Dependent Variables	FUT01	FUT23	FUT45	FUT67
Constant	-3.22 (-3.7)	-.46 (-.25)	-3.05 (-1.4)	5.49 (2.90)
Texas (cash)	.967 (87.35)	.972 (47.16)	.954 (39.01)	.956 (35.4)
COF01	.002 (5.57)			
COF03	-.0002 (-.67)	.0012 (2.57)	.0032 (5.64)	
COF05	.002 (1.35)	-.0015 (-4.4)	-.003 (-7.25)	-.003 (-6.71)
COF07		.003 (6.42)	.005 (7.57)	.0066 (9.04)
R-Square	.961	.854	.799	.768
EQ.2 Dependent Variable	TEXAS	TEXAS	TEXAS	TEXAS
Constant	-4.12 (-2.5)	-14.6 (-3.32)	-1.94 (-.38)	1.76 (.36)
FUT01	1.04 (67.5)			
FUT23		1.12 (27.17)		
FUT45			.99 (21.3)	
FUT67				.967 (21.1)
SLAUGHT	.003 (2.00)	.012 (3.17)	.0026 (.612)	-.0014 (-.34)
R-Square	.9552	.8041	.7386	.729

Table 11 continued.

EQ 3. Dependent Variable	BAS01	BAS23	BAS45	BAS67
Constant	-1.86	-5.02	-4.50	-4.91
	(-1.82)	(-2.3)	(-1.64)	(-1.67)
Texas (cash)	.002	.021	.011	.032
	(.15)	(.74)	(.33)	(.797)
COLDSTOR	.000005	.000013	.000013	.000013
	(3.51)	(4.29)	(3.47)	(3.12)
R-Square	.037	.0492	.0355	.024

*In parentheses below the regression coefficients is the ratio of the estimated coefficient to the estimated standard error. Any ratio greater than 2.0 is considered significant.

Table 12.

RESULTS OF ORIGINAL CATTLE BASIS MODEL, AT IOWA, WEEKLY, 1973-82*

	Basis			
Variables	01	23	45	67
EQ1. Dependent Variable	FUT01	FUT23	FUT45	FUT67
Constant	-.344 (-.3658)	2.31 (1.23)	-.30 (-.13)	6.31 (3.34)
Iowa (cash)	.973 (78.70)	.982 (45.11)	.967 (37.78)	.963 (35.04)
COF01	.002 (4.94)			
COF03	-.0012 (-3.42)	.002 (.49)	.002 (3.832)	
COF05	.0003 (1.80)	-.0014 (-3.91)	-.0029 (-6.7)	-.003 (8.25)
COF07		.0038 (6.06)	.005 (7.27)	.006 (8.25)
R-Square	.953	.835	.789	.765
EQ2. Dependent Variable	Iowa	Iowa	Iowa	Iowa
Constant	-4.48 (-2.56)	-14.5 (-3.3)	-3.42 (-.69)	.69 (.14)
FUT01	1.02 (62.93)			
FUT23		1.14 (26.75)		
FUT45			.99 (21.57)	
FUT67				.96 (21.78)
SLAUGHT	.003 (2.1)	.011 (3.16)	.003 (.88)	-.006 (-.1493)
R-Square	.9485	.7987	.7386	.7296

Table 12 continued.

EQ.3 Dependent Variable	BAS01	BAS23	BAS45	BAS67
Constant	-3.62	-7.75	-7.76	-6.94
	(-3.18)	(-3.36)	(-2.72)	(-2.31)
Iowa (cash)	.036	.067	.063	.066
	(2.65)	(2.37)	(1.87)	(1.81)
COLDSTOR	.000008	.0002	.000017	.000015
	(4.87)	(5.23)	(4.43)	(3.80)
R-Square	.0479	.0575	.0426	.0309

*In parentheses below the regression coefficients is the ratio of the estimated coefficient to the estimated standard error. Any ratio greater than 2.0 is considered significant.

Basis as a Percent

As was discussed in the methodology section, a model was also analyzed that presented the basis in terms of a percent of the cash price at the different locations. This was to test the hypothesis that the basis might be easier explained as a percent because of the idea that the basis is usually greater at higher levels of cattle prices than at lower levels.

The results of the basis as a percent models at the different locations are given in Tables 13-15. The deviation from the original models did not solve any of the problems associated with the original model. Again major problems existed in the basis prediction model. The cash price coefficients were of the wrong sign and were not significant. The cold storage coefficients became much smaller in the percent model as compared to the original model but the coefficients were positive, as expected, and significant. The coefficients of determination were again very low with the highest percentages in the Iowa basis model ranging from 7.2% to 4.8%.

Table 13.

RESULTS OF BASIS AS A PERCENT MODEL,
AT OMAHA, WEEKLY, 1973-1982*

Variables	Basis 01	23	45	67
EQ.1 Dependent Variable	FUT01	FUT23	FUT45	FUT67
Constant	-.96 (-1.032)	1.54 (.8249)	-1.06 (-.48)	5.23 (2.75)
Omaha (cash)	.998 (79.6)	1.003 (45.42)	.991 (37.92)	.986 (35.29)
COF01	.0017 (4.39)			
COF23	-.0012 (-3.49)	.00006 (.1205)	.002 (3.5)	
COF45	.0002 (1.38)	-.0015 (-4.17)	-.003 (-6.97)	-.003 (-6.9)
COF67		.004 (6.24)	.0055 (7.42)	.006 (8.3)
R-Square	.954	.836	.790	.768
EQ.2 Dependent Variable	OMAHA	OMAHA	OMAHA	OMAHA
Constant	-2.46 (-1.46)	-11.31 (-2.6)	-.70 (-.15)	3.3 (.71)
FUT01	.99 (64.04)			
FUT23		1.06 (26.89)		
FUT45			.95 (21.51)	
FUT67				.92 (21.2)
SLAUGHT	.0026 (1.81)	.01 (2.88)	.0026 (.639)	-.002 (-.405)
R-Square	.951	.8033	.741	.73

Table 13 continued.

EQ.3 Dependent Variable	BPCT01	BPCT23	BPCT45	BPCT67
CONSTANT	-.086 (-3.73)	-.17 (-3.6)	-.16 (-2.8)	-.14 (-2.3)
OMAHA (CASH)	.0009 (3.29)	.001 (2.49)	.0012 (1.77)	.001 (1.45)
COLDSTOR	3.25×10^{-7}	3.6×10^{-7} (5.57)	3.84×10^{-7}	3.52×10^{-7}
R-Square	.048	.065	.052	.042

*In parentheses below the regression coefficients is the ratio of the estimated coefficient to the estimated standard error. Any ratio greater than 2.0 is considered significant.

Table 14.

RESULTS OF BASIS AS A PERCENT MODEL,
AT TEXAS PANHANDLE, WEEKLY, 1973-1982*

Variables	Basis 01	23	45	67
EQ.1 Dependent Variable	FUT01	FUT23	FUT45	FUT67
Constant	-3.22	-.46	-3.05	5.49
	(-3.7)	(-.25)	(-1.4)	(2.90)
Texas (cash)	.96	.97	.95	.95
	(87.35)	(47.16)	(39.01)	(35.4)
COF01	.002			
	(5.57)			
COF23	-.0002	.0012	.0032	
	(-.67)	(2.57)	(5.64)	
COF45	.002	.0015	-.003	-.003
	(1.35)	(-4.4)	(-7.25)	(-6.71)
COF67		.003	.005	.006
		(6.42)	(7.57)	(9.04)
R-Square	.964	.857	.799	.769
EQ.2 Dependent Variable	TEXAS	TEXAS	TEXAS	TEXAS
Constant	-4.12	-14.6	-1.94	1.76
	(-2.5)	(-3.32)	(-.38)	(.36)
FUT01	1.04			
	(67.5)			
FUT23		1.12		
		(27.17)		
FUT45			.99	
			(21.3)	
FUT67				.967
				(21.1)
SLAUGHT	.003	.012	.0026	-.0014
	(2.00)	(3.17)	(.612)	(-.34)
R-Square	.955	.804	.738	.729

Table 14 continued.

EQ.3 Dependent Variable	BPCT01	BPCT23	BPCT45	BPCT67
CONSTANT	-.047	-.092	-.087	-.096
	(-2.22)	(-2.07)	(-1.55)	(-1.53)
TEXAS (CASH)	.0002	.0001	.00002	.002
	(.775)	(.336)	(.03)	(.32)
COLDSTOR	1.13×10^{-7}	2.73×10^{-7}	2.98×10^{-7}	2.95×10^{-7}
	(3.73)	(4.46)	(3.86)	(3.61)
R-Square	.035	.058	.048	.039

*In parentheses below the regression coefficients is the ratio of the estimated coefficient to the estimated standard error. Any ratio greater than 2.0 is considered significant.

Table 15.

RESULTS OF BASIS AS A PERCENT MODEL,
AT IOWA, WEEKLY, 1973-1982*

Variables	Basis 01	23	45	67
EQ.1 Dependent Variable	FUT01	FUT23	FUT45	FUT67
Constant	-.34 (-.3658)	2.31 (1.23)	-.30 (-.13)	6.31 (3.34)
Iowa (cash)	.973 (78.60)	.984 (45.11)	.967 (37.78)	.968 (35.04)
COF01	.002 (4.94)			
COF23	-.0012 (-3.42)	.002 (.49)	.002 (3.832)	
COF45	.0003 (1.80)	-.0014 (-3.91)	-.0029 (7.27)	-.003 (-6.62)
COF67		.0038 (6.06)	.005 (7.27)	.006 (8.25)
R-Square	.953	.834	.789	.765
EQ.2 Dependent Variable	IOWA	IOWA	IOWA	IOWA
Constant	-4.48 (-2.56)	-14.5 (-3.3)	-3.42 (-.69)	.69 (.14)
FUT01	1.02 (62.93)			
FUT23		1.1 (26.75)		
FUT45			.988 (21.57)	
FUT67				.96 (21.28)
SLAUGHT	.003 (2.1)	.011 (3.16)	.003 (.88)	-.006 (-.1493)
R-Square	.954	.799	.739	.729

Table 15 continued.

EQ.3 Dependent Variable	BPCT01	BPCT23	BPCT45	BPCT67
CONSTANT	-.06	-.14	-.12	-.11
	(-2.63)	(-2.96)	(-2.08)	(-1.86)
IOWA (CASH)	.0005	.0009	.0005	.0006
	(1.712)	(1.6)	(.76)	(.835)
COLDSTOR	1.69×10^{-7}	3.67×10^{-7}	3.74×10^{-7}	3.62×10^{-7}
	(4.99)	(5.51)	(4.66)	(4.26)
R-Square	.055	.072	.059	.048

*In parentheses below the regression coefficients is the ratio of the estimated coefficient to the estimated standard error. Any ratio greater than 2.0 is considered significant.

Other Deviations

Many other variations of the original model were experimented with, such as using all the variables in the basis model instead of only cash price and cold storage. Another slight deviation was a model that lagged slaughter one week in the original and basis as a percent models. A variation was attempted by using all of the variables in the basis equation of the percent model along with using lagged slaughter as variation from that model. None of the variations that were tried made any substantial improvements in expected sign or explanatory power. A variation in the model that could be investigated in the future would be to study the effects of change (Δ) in the variables within the model (i.e. slaughter, cattle-on-feed, cold storage).

CHAPTER V

Summary and Conclusions

Summary

A simultaneous three-equation model was developed to predict the weekly fluctuations of the Live Cattle Basis at three different locations in the United States. The three equations were known as the futures price model, cash price model, and basis model. Variables used within the models included: cash price, futures price, cattle-on-feed numbers, monthly cold storage, and weekly slaughter. The models were analyzed using two-stage least squares to estimate the coefficients.

The results of the simultaneous models were poor at each of the tested locations. The futures price models indicated cash price coefficients that were positive and significant, but the cattle-on-feed coefficients were positive which was not expected, and, as a whole, were not significant. The results of the models used to predict cash price at the different locations indicated the coefficients of the futures price variables were positive as expected and significant, but most of the slaughter coefficients were unexpectedly positive and not significant. The basis model results indicated coefficients with very little predictive power. All of the cash coefficients had positive signs rather than the negative relationship that was expected.

As to why the models within this thesis were not successful presents several possibilities. One possible data problem was that the variables were not consistent in terms of the time between their change. For example, cash, futures, basis, and slaughter variables were all collected on weekly intervals. The cattle-on-feed variables were constant for periods of 12 weeks before changing. The amount of beef in cold storage was reported monthly, therefore, it changed every fourth week.

Another possible data problem could have surfaced within the cash price information. "Livestock Meat Wool" (USDA) reported cash prices for Choice YG 2-4 cattle at the different locations. Since August of 1981, the live cattle futures contracts allow only four head of grade four cattle and allowed only eight head before 1981. The cash prices used were probably prices established for delivery type cattle, but it is important to point out that this could have been a problem.

A calculation problem could have also surfaced. There are several methods that could have been used to calculate the number of cattle-on-feed that would affect each futures month out to eight months from delivery. Obviously the method used (which was presented in the methodology chapter) could have deviated from the actual marketings that were affecting the futures price.

Conclusion

All of the situations discussed above could have contributed to the problems experienced with the thesis models. But to think that these possible deviations were a direct effect on the model results is unreasonable.

There is a lot of work to be done in the area of modeling the livestock basis (i.e. live hogs, live cattle, feeder cattle). Of course there are models that do a slightly adequate job of predicting the livestock basis on a quarterly interval and some even monthly. But models that predict the livestock basis on a weekly or daily interval into the future, with some degree of accuracy, are nonexistent. Models that predict only on a quarterly or monthly interval are not as useful to a producer as a weekly model. The most useful tools available to livestock producers today to predict the basis are seasonal trends at the different locations in the United States. This information coupled with fundamental market information can be extremely useful.

There has been some contention that if the livestock basis is not predictable, then the futures market must be an inefficient market. I contend that livestock futures were predictable in their early stages because of the lack of volume, but have become more efficient in reflecting the actual supply and demand, therefore, becoming more difficult to model. This reflects the randomness of these markets in representing the market price of these futures contracts and our inability in agriculture to thoroughly understand the modeling procedure.

Need for Further Research

The need for further research into predicting livestock basis is obvious. The direction that this research should take is not as obvious. A very close examination of the variables now used in attempts to predict livestock basis should be undertaken. Variations within the variables, such as lagged variations and change from one period of time to the next are all possible ideas that should be explored. Using time series forecasting models is also a direction that could possibly yield useful results.

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AN ECONOMETRIC MODEL TO PREDICT THE LIVE CATTLE BASIS AT THREE DIFFERENT LOCATIONS IN THE UNITED STATES

by

DARRELL D. HOLADAY

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A simultaneous three-equation model was developed to predict the weekly fluctuations of the Live Cattle Basis at three different locations in the United States. The three equations were known as the futures price model, cash price model, and basis model. Variables used within the models included: cash price, futures price, cattle-on-feed numbers, monthly cold storage, and weekly slaughter. The models were analyzed using two-stage least squares to estimate the coefficients.

Data collected for the period January 1973-February 1982 included: average weekly cash prices at the three different locations, average weekly live cattle futures closing prices from the Chicago Mercantile Exchange, weight breakdowns from the quarterly 13 State Cattle-on-Feed reports, weekly cattle slaughter, and the monthly reports on the amount of beef in cold storage.

The results of the simultaneous models were poor at each of the tested locations. The futures price models indicated cash price coefficients that were positive and significant, but the cattle-on-feed coefficients were positive which was not expected, and, as a whole, were not significant. The results of the models used to predict cash price at the different locations indicated the coefficients of the futures price variables were positive as expected and significant, but most of the slaughter coefficients were unexpectedly positive and not significant. The basis model results indicated coefficients with very little predictive power. All of the cash coefficients had positive signs rather than the negative relationship that was expected.

There is discussion of the problems and conclusions that result from the unsuccessful model. The thesis does point out that until a better modeling procedure is developed for the live cattle basis; statistical normalities, seasonal trends, and long term tendencies are the most accurate tools for predicting these basis figures.