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John E. Ikerd

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FORECASTING SPREADS BETWEEN RETAIL BEEF AND LIVE CATTLE PRICES: A MODEL FOR ROUTINE USE BY MARKET ANALYSTS

John E. Ikerd *

The ultimate value of beef and consequently the value of beef cattle is determined at the retail beef market. Retail beef prices, not live cattle prices, ration scarce supplies and clear markets of increased production. Thus, retail beef prices rather than live cattle prices reflect overall supply and demand conditions for beef. Live cattle values and prices are derived from values and prices of beef at retail. However, accurate forecasts of retail beef prices will not insure accurate forecasts of live cattle prices. Spreads between retail beef and live cattle prices must be forecasted as well. Spreads between retail beef and live cattle prices are neither constant nor proportional to either retail beef or live cattle prices. And, forecasting these spreads can be as challenging as forecasting retail beef prices. The objective of the study reported in this paper was to develop a practical, usable model for forecasting spreads between retail beef and live cattle prices.

Price Spreads: Critical in Live Price Forecasting

Over the long run, general levels and trends in live cattle prices reflect general levels and trends in retail beef prices and marketing costs. In the long run, packers and retailers must cover their costs plus a

* John E. Ikerd is Professor of Agricultural Economics and Extension Economist at Oklahoma State University, Stillwater Oklahoma.

reasonable return on their investment. Thus, cattle prices cannot persist at levels above those allowing a competitive, positive margin between retail beef and live cattle prices. Likewise, there is no compelling evidence that packers and retailers earn more than competitive returns in the long run. About 95 percent of the monthly variation in spreads between retail beef and live cattle prices between 1964 and 1983 can be explained by changes in estimated costs of processing and retailing (Ikerd). But, the remaining 5 percent of unexplained variability can be critical in forecasting cattle prices.

This unexplained variability tends to be short run changes in spreads that are unrelated to longer term trends in overall marketing costs. Spreads between retail beef and live cattle have varied by 10 to 15 percent, both up and down, between high and low monthly average spead values "within" each year since 1979. Marketing costs have increased at a slow gradual rate during this period of highly volatile price spreads. Thus, these within year, short run changes in spreads cannot be explained by changes in overall costs of transforming live cattle into retail beef.

Accurate price spread forecasts are critical in deriving accurate live cattle price forecasts. Within-year swings in spreads during the 1980s have been equivalent of $8 to $10 per hundredweight in terms of live cattle prices. Thus, an analyst might have forecasted retail beef prices with perfect accuracy and still have realized errors of $8 to $10 in live cattle prices by assuming a constant retail beef to live cattle price spread. Less than 24 percent of the variation in live cattle prices can be explained by changes in retail beef prices during the period of June 1980 to December 1983. Over 64 percent of live price variation on the other hand was related to changes in spreads between retail beef and live cattle prices. Changes in spreads were not determined by the same fundamental factors affecting retail beef prices. Only about 1 percent of the variability in spreads

could be explained by changes in retail beef prices. Thus, accurate spread forecasts have been at least as important as accurate forecasts of fundamental beef supply and demand factors in recent years. And, accurate forecasts of retail beef prices are not easily translated into forecasts of either beef price spreads or forecasts of live cattle prices.

Objectives

The objective of the study reported in this paper was to develop a practical model for forecasting spreads between retail beef and live cattle prices on a short term, monthly basis. It was assumed that market analysts using such a model would have estimates of cattle slaughter variables, general economic variables and retail beef prices derived from various other models. Actual values of these variables were used as independent variables in alternative spread forecast models. Thus, ultimate accuracy of spread forecasts will depend on accuracy of estimates of "independent" variables as well as accuracy of estimates of the spread model coefficients. Such limitations are not untypical of most practical applications of statistically derived forecast models.

The ultimate objective of the work reported here is to improve the accuracy of live cattle price forecasts. Monthly live cattle price forecasts for 1984 are derived using the recommended model as an illustration of its practical application. No claim is made that the model presented is the ultimate in either model specification or methodology. But, it does represent a significant start in a direction of analysis critical to improving price forecasting methodology for beef cattle.

Hypothesis

The basic hypothesis underlying this study was that price spreads are determined in a market separate from, but related to, markets for retail beef and live cattle. An earlier study in this same project has supported an hypothesis of simultaneous determination of retail beef prices, beef

price spreads and live cattle prices in an intermarket approach to price spread determination (Ikerd). The objective of this later study was to build a practical, usable price spreads forecast model on the conceptual foundation of intermarket price spread determination.

The Question of Price Determination

Heien, Miller, Lamm, Lamm and Westcott, Hall, et. al. and others have analyzed lead-lag relationships between retail beef and live cattle prices. Most investigators have concluded that changes in retail beef prices generally lag changes in live cattle prices by up to 3 months. Such lag models treat changes in spreads between retail, wholesale and live market levels as residules of lead-lag relationships. For example, spreads will widen if live cattle prices fall but retail prices remain high. Likewise, spreads will narrow whenever live prices move higher and retail prices remain low. These studies seem to imply that cattle prices are determined first in live markets and later passed on to the retail level.

Any implication of ultimate value determination at the live market level is conceptually indefensible. Higher live cattle prices can be passed on to retail consumers only if available beef supplies will clear retail markets at those implied price levels. Lower live cattle prices will result in lower retail beef prices only if lower prices are necessary to move available beef supplies. Changes in supply and demand conditions for beef may be reflected more quickly or more clearly in live cattle prices than in retail beef prices in the short run. But, this does not imply that prices are first determined at the live market level.

The fact that live price changes typically lead retail price chances may reflect fundamentally induced changes in price spreads rather than live market price determination. Larger supplies and/or weaker beef demand could cause spreads between retail beef and live cattle prices to widen "before" those same factors resulted in lower retail beef prices. Smaller supplies

and/or stronger demand could cause spreads to narrow before retail prices rise. Live cattle prices are derived from retail beef prices by subtracting price spreads. Thus, wider spreads might well "cause" live cattle prices to drop before retail beef prices decline and narrow spreads might "cause" live cattle prices to rise before retail prices rise. The more defensible hypothesis still seems to be that retail prices, spreads, and live prices are determined simulataeously. But, fundamentally induced changes in spreads may cause live cattle prices to lead retail beef price changes in most cases. Questions of causality cannot be resolved by statistical analysis of leads and lags. Untimate conclusions regrading economic causality must rest with the logic of economic theory.

The nature of price determination has direct implications for development of forecast models. The basic hypothesis underlying the model outlined in this paper is that price spreads for beef are determined by supply of and demand for marketing services; including slaughter, processing and retailing of beef. Price spreads are not a residule value resulting from leads and lags between retail beef and live cattle prices. Price spreads reflect supply of and demand for marketing services in the same sense that retail prices reflect supply of and demand for beef.

Basic Supply-Demand and Price Spread Relationships

Earlier studies have indicated possible structural changes in beef price spreads over time. The intermarket model mentioned previously left wide cyclical swings in price spreads unexplained during the late 1970s and early 1980s. The same model explained 95 percent of total variation during the 20 year data period from 1964 to 1983. Parham and Duewer indicate several major shifts in price spread patterns during the decade of the 1970s following a relatively stable spread pattern of the 1960s. There have been major changes in the structure of the meat packing and retailing industries over the past two decades (Duewer). Thus, it seems unlikely that any model

with a single set of coefficients will adequately explain changes in beef price spreads over the past 20 years.

The data period chosen for analysis in this study was 1975 through 1983. A major aberration in beef price spreads occurred when a retail beef price ceiling was inposed in 1973. A major cyclical downturn in beef prices followed in 1974. The mid 1970s was a period of relative stability in cattle prices preceding a sharp upswing in prices in 1978 and 1979. The upturn of the late 1970s was followed by another period of relative price stability in during the early 1980s. The most volatile swings in spreads between retail beef and live cattle prices have occurred since beef prices moved to higher levels in the late 1970s. So, the data period of 1975 to 1983 avoids the aberrations of the early 1970s, includes periods of major shifts in overall beef prices and includes periods of major variability in beef price spreads.

The intermarket analysis of price spreads indicated that operating costs of packers and retailers, levels of commercial beef production and seasonal factors were primary determinants of spreads between retail beef and live cattle prices (Ikerd). Operating costs changes represent shifts in the overall supply of marketing services over extended periods of time. Changes in commercial beef production represent varying levels of utilization of industry facilities or movements along short run supply schedules over short periods of time. The seasonal factors likely represent seasonal characteristics of supply or demand that are not readily discernible in available market statistics. The intermarket model indicated also that price spreads are affected by some of the same basic market factors that affect retail prices of beef and live markets for cattle.

A single equation monthly model for spreads between retail beef and live cattle prices yielded the following parameter estimates and test statistics:

BPS= -222.337 +0.476 IPPC +0.284 DFIS +0.176 LVSW +0.425 DRPB -5.003 MAMJ

(16.81) (3.02) (4.59) (5.03) (4.61)

R-SQ=0.93 SE= 4.87 F(5,101)=283.49

Where: BPS= Beef Price Spread (Choice steer beef, composite retail minus live price in retail wt. equivalent)

IPPC= Index of prices of intermediate goods for manufacturing and hourly wages of production workers adjusted to give equal weights to goods and wages, converted to 1972 base.

DFIS= Daily federally inspected cattle slaughter. Monthly data divided by slaughter days, adjustments for Saturdays and Holidays.

LVSW= Average live weight of cattle slaughtered under federal inspection.

DRPB= Retail beef prices deflated by a 1972 based index of percapita personal income.

MAMJ= Single seasonal dummy variable- value of 1 for March April, May and June- value of 0 otherwise.

All data are monthly values

"t" values are values in parentheses.

Statistical results in general confirm hypothesized relationships. Beef spreads were found to be significantly related to changes in overall costs as represented by the variable IPPC. This index likely overstates recent changes in marketing costs, for meat packers in particular. Duewer indicated that packers' wage rates were stable in 1982 and actually declined during 1983. But, retail wages and costs of transportation and processing supplies have continued to increase.

Beef production was represented by two variables, daily federally inspected slaughter and live weights of cattle slaughtered. The analysis indicated that price spreads may be more sensative to changes in slaughter weights than to changes in slaughter numbers, although both are significant. For example, it would take a 5,682 head change in slaughter levels (roughly 5 percent of recent slaughter levels) to cause a $1 change in projected spreads. The same $1 change might be expected from a 2.4 lb. change in slaughter weights (roughly .2 to .3 percent recent average weights). Reactions to changing slaughter weights may reflect changes in relative bargaining strength of packers and cattle feeders during periods of changing supplies. Whether or not the feed lots are current, ie. moving cattle as they reach minimum market weight, is one of the most commonly discussed factors among industry analysts forecasting short run price movements.

Retail beef prices were included in the model to pick up effects of fundamental beef market factors on price spreads. Retail prices were deflated to avoid problems of high correlation between nominal beef prices and costs of intermediate goods and labor. The general trend in deflated beef prices has been down during the data period and the trend in beef price spreads has been up. But, there was a significant positive relationship between deflated prices and price spreads during the data period. This indicates that spreads tend to widen during short run periods of rising beef prices and tend to narrow during periods of falling beef prices. Other market factors account for longer term upward trend in spreads. The hypothesis that retail prices lag live price changes would imply widening spreads on falling markets and narrowing spreads on rising markets. The positive coefficient for deflated retail prices implies the opposite effect. The positive relationship between retail beef prices and spreads seems to indicate that a stronger retail beef market also represents a stronger

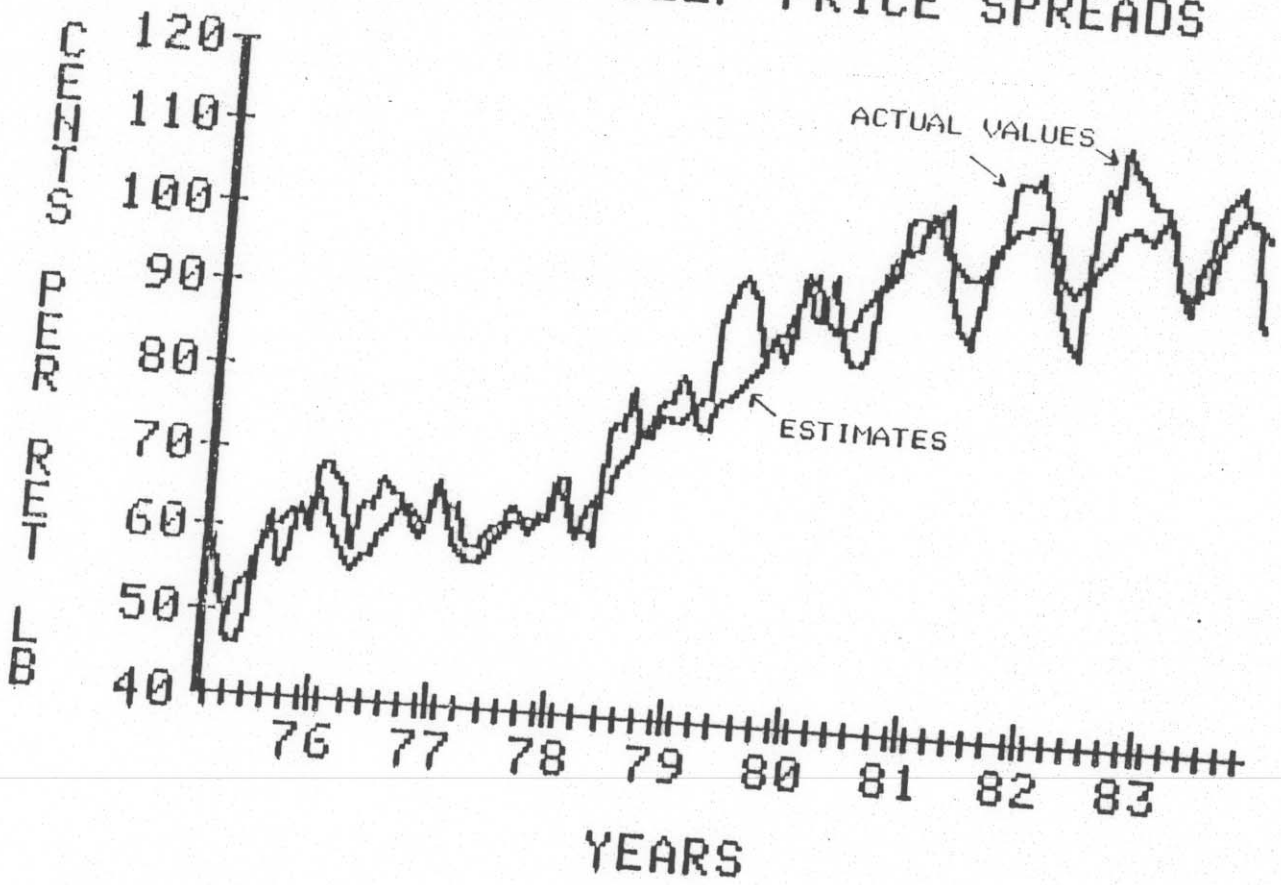
market for marketing services and a weaker retail market means a weaker market for services as well.

The significant negative coefficient on the March-June seasonal dummy variabile indicates more narrow spreads during spring months. Unfortunately, this seasonal pattern could not be captured with other seasonally related variables such as composition of the slaughter mix and changes in cold storage stocks. Thus, uncertainly remains regarding whether these undefined seasonal factors are destined to occur each spring or simply have tended to occur more frequently during the spring months in past years.

The R squared value of .93 indicated that a large proportion of total spread variability was explained by the model. But, the fact that "t" values for all coefficients were highly significant and similar in size was more meaningful. This indicates that no single variable is accounting for a major portion of the overall statistical signifiance of the model. The standard error value of just under 5 cents translates into a live cattle price of about $2 per hundredweight.

Figures 1 shows patterns in actual price spreads versus model estimates of spreads. Note that differences between actual and estimated spreads were relatively small during the 1975 to 1978 period. But, the model failed to capture a $10 plus upmove and retrenchment in spreads during 1979. Beyond 1979, the basic patterns were the same for actual and estimated spreads. But, changes in actual spreads were more volatile than changes in estimated spreads during the 1980s. Note also that periods of narrow spreads tended to last no more than one to two months and occurred in months from March to June. This indicates that the seasonal dummy variable respresents an average of one-to-two month periods of smaller spreads rather than a consistent pattern of narrow spreads throughout the spring months. The 1975-83 based model was able to capture the basic trends in patterns of spreads over time. But, the model was not deemed adequate for practical

FIGURE 1. BEEF PRICE SPREADS



forecasting purposes during the 1980s. It was apparent from figure 1 that the structural coefficients relating beef price spreads to the other variables for the 1980s were different from those of the 1970s.

Spread Forecast Model For The 1980s

Spreads between retail beef and live cattle prices have exhibited a consistent cyclical pattern since mid 1980, as shown in figure 2. The cycles appear to be seasonally related but are variable in length. For example, cyclical lows occurred in July 1980, June 1981, May 1982 and April 1983. But, a sharp downturn occurred also in December 1983. Cyclical highs were less well defined with spreads remaining wide anywhere from 4 to 7 months during the various cyclical highs.

Parameters of the 1975-83 beef price spread model were reestimated using data for the June 1980- December 1983 period only. The model with resulting parameter estimates and test statistics is shown below:

BPS=	-566.788	+1.304 IPPC	+0.581 DFIS	+0.280 LVSW	+1.432 DRPB	-7.971 MAMJ
		(5.09)	(3.78)	(4.30)	(4.29)	(4.84)

R-SQ=0.73 SE=4.38 F(5,37)=19.99 DW=1.360

All variables were unchanged from the previous model:

BPS= Beef price spreads.

IPPC= Index of intermediate goods and production wages.

DFIS= Daily federally inspected cattle slaughter.

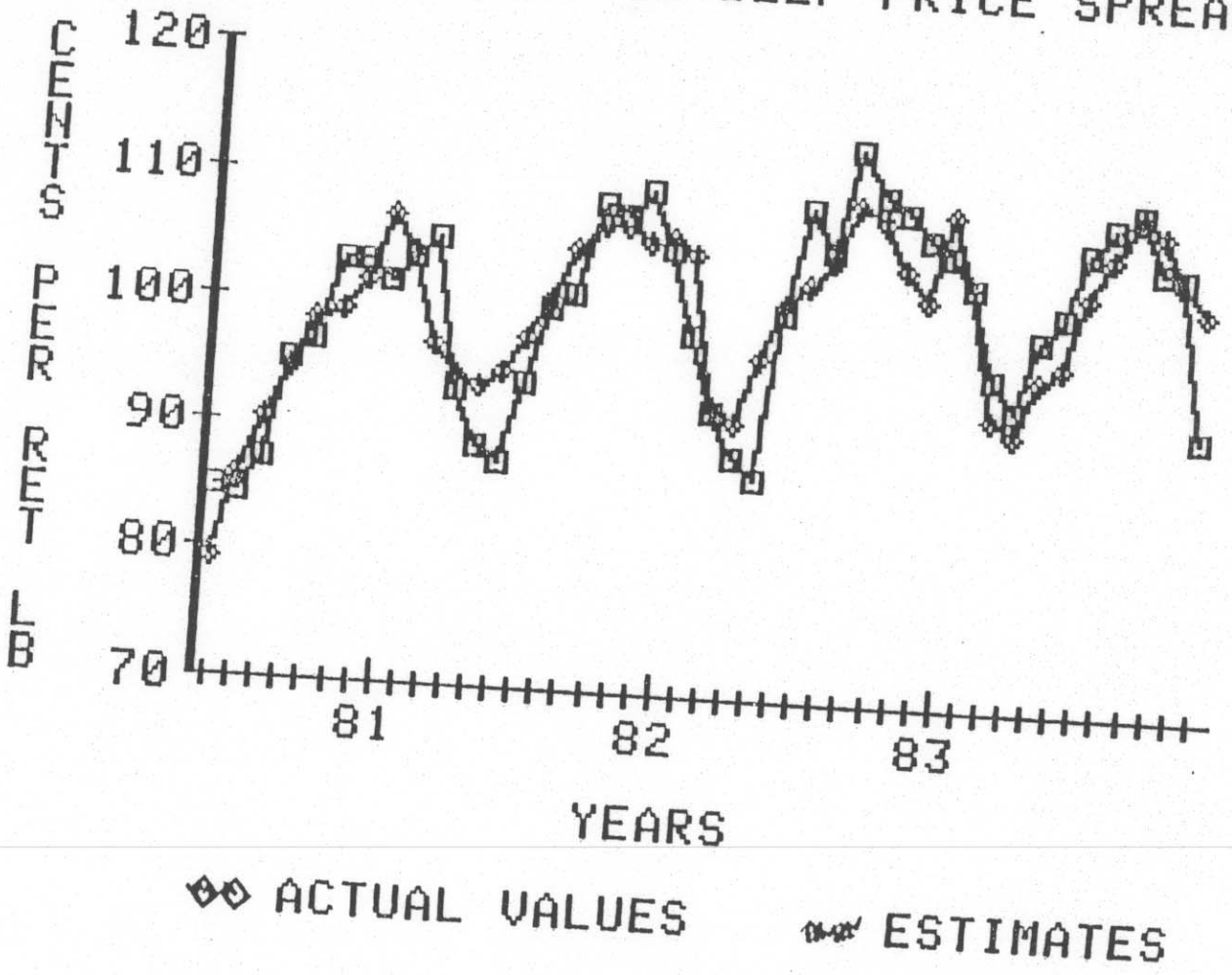
LVWT= Live weight of federally inspected cattle slaughter.

DRPB= Deflated retail beef price.

MAMJ= March, April, May, June seasonal dummy variable.

"t" values are values in parenthesis.

FIGURE 2. 1980-83 BEEF PRICE SPREADS



All parameter estimates were statistically signficant and had the same signs as previous longer term parameter estimates. Estimated coefficients were larger in absolute value for all independent variables. This indicated more sensative reactions of spreads to changes in the independent variables during the 1980s than for the total data period. Statistical t values were very similar, in spite of larger coefficients, indicating again the more volatile nature of relationships during the 1980s. The R squared value was .20 less for the 1980s analysis but the standard error value was less for the later period. The t values were even more equally balanced among variables for the latter period analysis. In general, the results seemed to confirm that the basic model for the total 1975-80 period was adequate for the later period as well. But, structural coefficients for the total period were not adequate to explain the more volatile price spread pattern of the 1980s.

Relationships between actual and estimated price spreads are shown in figure 2. In general, the model seemed to track spread patterns quite accurately. However, model forecasts overestimated the lowest spread values during 1981 and 1982. The model seemed to be fairly accurate in projecting the higher spread values with some apparent random misses during each spread peak. Another major error occurred on the sharp break in spreads in December 1983. This break was more typical of breaks seen in spring months of previous years. More research is needed to define the seasonal component of the model, particularly if history shows that the "seasonal break of 1984" actually occurred in December 1983. The model did indicate a break to lower spread values in December 1983 even though it did not accurately forecast its magnitude.

Monthly Spread Forecasts For 1984

True verification of any forecast model comes only from analysis of actual forecasts over an extended period of time. A model may track actual

values with estimated values quite accurately over some historic period and yet be inadequate for forecasting into the future. Thus, a model can be verified only if it is used to forecast "beyond" the current data period. Table 1 shows forecasts of spreads and resulting live cattle prices based on the 1980s forecast model. All other values shown have been forecasted using various other models and methods. Of course, the accuracy of forecasted spreads is dependent on the accuracy of estimates of these other values as well as adequacy of the spreads model.

Actual data are available for all variables for January and February of 1984. The actual spreads for January and February were 93.2 and 99.4 respectively. Thus, the model overestimated those spreads by roughly 8 and 5 cents respectively. Consequently, live cattle prices were underestimated by $2-$3 for those two months. This casts further doubts about whether the seasonal dummy variable truly represents a seasonal factor. More meaningful conclusions will be possible by mid 1984. By then it will be possible to determining whether or not the tendancy of spreads to narrow during the March-June period continued through 1984.

Those values shown in table 1 may or may not be accurate 1984 projections. But, it is apparent from table 1 that reasonable estimates of key values such as processing costs, cattle slaughter, slaughter weights, beef prices, etc. result in reasonable estimates of price spreads and live cattle prices. Based on these estimates, beef spreads would be expected remain relatively narrow through spring keeping live cattle prices in the high $60s through June. Wider spreads are expected to force cattle prices lower by late summer, in spite of higher retail beef prices, with lows of $63 in August and September. Some narrowing of spreads would allow prices to recover to the high $60s in late 1984 as smaller total meat supplies support higher beef prices as well.

All values shown in table 1 are typical of values forecasted by most

TABLE 1. MONTHLY SPREAD AND LIVE CATTLE PRICE FORECASTS FOR 1984

	JAN	FEB	MAR	APR	MAY	JUN
PROCESSING COST	137.1	137.5	139	141	142	142
LIVE WEIGHT	1072	1079	1085	1085	1078	1075
DAILY FI SLAU.	129.4	127.2	122.5	120.5	128.6	133
DEF. RET. BEEF	80	81	81.5	80.5	80	79.5
PERSONAL INCOME	300	301	303	304	306	308
RETAIL PRICE	240.00	243.81	246.95	244.72	244.80	244.86
BY-PROD VALUE	18	18.3	18.2	18.7	18.2	18.5
RET-LV SPREAD	101.89	104.53	98.18	98.19	101.53	102.53
CHOICE STEER PR.	65.05	65.66	69.57	68.85	67.28	67.01

	JUL	AUG	SEP	OCT	NOV	DEC
PROCESSING COST	143	143	143	144	144	144
LIVE WEIGHT	1070	1075	1080	1080	1075	1075
DAILY FI SLAU.	124.5	133.7	138.4	135.9	127.5	127.5
RETAIL BEEF	77.5	77.5	78.5	78.5	78	78.5
PERSONAL INCOME	311	314	316	318	320	321
RETAIL BEEF	241.03	243.35	248.06	249.63	249.60	251.99
BY-PROD VALUE	17.5	18	18.5	19.2	19.5	20
RET-LV SPREAD	102.60	109.34	114.91	114.76	107.76	108.48
CHOICE STEER PR.	64.97	63.34	63.19	64.20	67.22	68.13

market analysts. However, other estimates of processing or marketing costs could be substituted with little likely change in results. Carcass weights likely could be substituted for live weights resulting in a larger coefficient but little change in accuracy. Retail beef prices could be deflated by some other index of income or possibly by the CPI yielding similar results. The important conclusion is that critical short run variability of price spreads can be forecasted using these general types of variables. The primary value of the model presented here likely will be its usefulness in formulation of better price spread forecast models in the future.

Conclusions

Changes in spreads between retail beef and live cattle prices can be related statistically to changes in other fundamental market factors. This result supports the basic hypothesis that price spreads reflect the supply of and demand for marketing services which transform live cattle into retail beef. Thus, spreads are not simply a residule value resulting from lags between fundamentally induced changes at one level in the marketing system and later reflection of those changes at another level. In fact, the apparent lagged relationships may reflect fundamentally induced changes in price spreads instead. Widening spreads may "cause" live cattle prices to fall while retail prices are still moving higher. Narrowing spreads may "cause" live cattle prices to rise more quickly that retail prices during stronger market trends. Treating spreads as a "cause" of changes in live cattle markets rather than a "result" is an approach fundamentally different from approached taken in most past analyses. The basis hypothesis of the study reported here is that changing spreads cause changes in live cattle prices. Thus, forecasting spreads is a necessary step in forecasting live cattle prices.

An earlier intermarket model utilized data from 1964 to 1982 to identify

structural variables which simultaneously determine retail beef prices, retail beef to live cattle price spreads and live cattle prices (Ikerd, 1983). A single equation model showed the same general variables defined in the simultaneous system to be highly significant in explaining changes in beef price spreads during the 1975-83 period. Those same variables, with updated coefficient estimates, were found to be capable of explaining highly variable price spread patterns of the early 1980s. The structural parameters, or coefficients, seem to change or shift over time. And, an undefined, possibly seasonal, spread pattern leaves cause for lack of confidence in complete adequacy of forecasts resulting from the model. But, the basic nature of price spread determination and the potential for accurate spread forecasting seem clear. Perfection of results, as always, remains an elusive objective for further research.

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