Development and Testing of Models for Cash Price Relationships Between Lighter-Weight Stockers Through Heavier-Weight Feeders in a Selected Market

by

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Introduction

The broader issue for this paper is to test if price ratio approaches can be adapted to extend price forecasts for selected key price series to aid forecasting other related series. The USDA presently forecasts, within the cattle sector, the following key price series: feeder steers, Choice fed steers, Utility cows, and retail Choice beef as a part of the Situation and Outlook program. What types of modeling approaches can be used to relate the prices of these key series to prices for other weights, grades or locations for fed cattle, stocker/feeder cattle, wholesale meats, market spreads or futures markets basis relationships using ratio models?

We will limit this analysis to the stocker/feeder cattle market at Oklahoma City, but view that the methods evaluated could be generalized and applied to other related markets. We will describe stocker/feeder prices and the price ratios between different weights of feeder and stocker cattle at the Oklahoma City terminal market to the 700-800 pound Medium frame number 1 feeder steers to assess if trends, cycles or seasonal patterns are present. Next, we will evaluate different modeling approaches for forecasting price ratios, focusing on light [500-600 pound, Choice Medium frame No. 1] and heavy [700-800 pound, Choice Medium frame No. 1] weight feeder cattle.

This analysis draws upon the price series being utilized in the beef Situation and Outlook work at ERS: Stocker and feeder cattle at Oklahoma City, and Choice steer prices in the Nebraska direct market.[1] The application of this

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[1] Packers and Stockyards Statistical Report, 1988, indicated that in 1988 only 7.6 percent of the nation's slaughter steers and heifers were procured from public markets. Some of the major cattle feeding states-- Kansas (<.1%), Texas (.3%), Nebraska (6.0%), Oklahoma (1.9%), and Colorado (<.1%) --had well below the national average proportions procured from public markets. [P&SA] Most slaughter steers and heifers are now procured from non-public markets, direct markets or through marketing agreements and forward contracts. Therefore, ERS is shifting away from the terminal market at Omaha, Nebraska to the direct market at Nebraska for slaughter cattle price quotes. The Choice Steer price quote forecasts will switch from the 1000-1100 pound kinds to 1100-1300 pound kinds due to the increasing average fed cattle weights. The feeder/ stocker cattle quotes will be shifted from the terminal market at Kansas City, Missouri to the terminal market at Oklahoma City, Oklahoma as the volume traded at Kansas City had declined relative to Oklahoma City. Slaughter cow price series will be switched from Omaha, Nebraska terminal to the terminal market at Sioux Falls, South Dakota due to the greater volume of slaughter cows marketed in the latter.

research is to develop, test, and refine tools to support staff analyses and forecasting activities within USDA.

The cattle sector has had longer-term shifting relationships between feeder cattle weight groups due to market conditions and genetic changes that likely have impacts throughout the different production phases. Cattle production can be viewed as consisting of three distinct phases 1) Cow-calf production, 2) backgrounding or stocker, and 3) feedlot. A biological production cycle from conception for a cow or heifer to slaughter of the offspring usually spans two to three years. The majority of the cow-calf operations continue to sell their calves as stockers or feeders rather than retain ownership through backgrounding or feedlot phases. Indications are that more than half of the feeder calves are sold during the fall quarter. [Gilliam] There are readily available quoted cash markets for different weights of stocker and feeder steers and heifers throughout the nation. Structural analysis approaches to analyze feeder steer price differentials usually apply budgetary approaches which include the value of finished cattle, the cost of gain and other factors which treat stocker/feeder cattle as a derived demand from feedlots.[Buccola] Most cattle operations have a great deal of flexibility in how to buy, sell or pass price risk for stocker/feeder cattle ranging from the use of options or futures to hedge, retaining ownership though the feedlot, or of buying or selling calves as light as 300 pounds to upwards of 800-900 pounds.

Objective

The main objective of this paper is to test if price ratio modeling can be used to extend present forecasting procedures for a key weight feeder steer price to other weights and grades of stocker/feeder cattle.

- How stable are price ratios of different weights of stocker/feeder cattle over time and do longer-term trends or cycles exist?

- How regular and strong are shorter-term seasonal price patterns for stocker/feeder cattle price relationships?

- How do univariate models compare with more complex multivariate approaches to forecast price ratios for weekly and monthly periods?

Three modeling approaches were selected to evaluate tradeoffs between simple models which can be mechanically applied with limited judgement required and more complex models which require increasing levels of judgement to apply [Brandt]. The approaches selected are a partial set of the approaches that could be applied. Exponential smoothing was selected as the simplest to apply; it is widely used by many applied analysts. The univariate form of the Box-Jenkins approach is generally seen as more difficult and typically requires more analyst judgement to select the proper transformations and model structure. The third approach tested was a dynamic regression model that combines time-series-oriented features and the effects of explanatory variable(s); it is the most complex and difficult to apply among the three approaches. The choice of forecasting method should be determined after an examination of the data, the relative goodness of fit and the ability to forecast outside of sample. [Goodrich]

Exponential Smoothing

Exponential smoothing is a widely used forecasting approach that is both robust and adaptive to changes in the structure of the data. It is often a part of an automatic forecasting system and can be mechanically applied. [Goodrich, Hendry] The Winters three-parameter smoothing model was used. The additive form of this model is:

$$(1)\quad \overline{Y}_t(m) = L_t + mT_t + I_t(m)$$

$$(2)\quad L_t = \alpha(Y_t - I_{t-s}) + (1-\alpha)(L_{t-1} + T_{t-1})$$

$$(3)\quad T_t = \gamma(L_t - L_{t-1}) + (1-\gamma)T_{t-1}$$

$$(4)\quad I_t = \delta(Y_t - L_t) + (1-\delta)I_{t-s}.$$

L=level, T=trend, I=seasonal index.

Box-Jenkins

The Box-Jenkins approach is more complex than most exponential smoothing approaches. [Goodrich, Hendry] The general autoregressive integrated moving average (ARIMA) model uses a combination of autoregressive (AR), integration (I) and moving average (MA) operators. The time series must be stationary for this application. Since most time series involving prices are not stationary, preprocessing transformations are applied. When the data are not seasonal, Box-Jenkins models will often outperform exponential smoothing models. A log transformation was used to transform the series. Short horizon forecasts of nonstationary time series depend both upon the ARIMA model fitted to the transformed data, and upon the nature of the stationary transformations. Long horizon forecasts depend entirely upon the stationary transformations. [Goodrich]

Dynamic Regression

Dynamic regression is a multivariate approach which combines time-series oriented features with explanatory variable(s). [Goodrich] An exogenous factor was incorporated to represent the cost of gain for cattle in feedlot programs. The models were selected in an iterative fashion from a select group of exogenous data. The model used the price ratio for stocker/feeder steers as the endogenous factor with selected lags and autoregressive terms, and a cost of gain variable.

Forecast Master Plus was used to transform the time series, develop the models and calculate the forecasts.[2] [Goodrich] The approaches were compared by goodness of fit within sample comparisons among models using the Akaike

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[2] Forecast Master Plus, Version 1.01, Electric Power Institute, EPRI, 3412 Hillview Avenue, Palo Alto, CA 94403. The optimize option was used to select the "optimal" model where available and forecasts were developed using the forecast option.

Information Criterion (AIC) and the Bayesian Information Criterion (BIC)[3]. [Goodrich] We selected a linear loss function, in preference to a quadratic loss function, to evaluate out-of-sample forecasts; the Mean Absolute Percent Error [MAPE] was calculated and compared to rank the models tested. [Brandt]

Data and Data Transformations

Stocker/Feeder Cattle Prices: Weekly Feeder cattle prices were collected from 1973 through 1990 for selected weights of stocker steers and heifers at the Oklahoma City, terminal market, released by the USDA's Agricultural Marketing Service. [Livestock, Meat and Wool Market News] However, most of the analysis concentrated upon the 1980's, as the 1970's were influenced by a number of atypical shocks such as the sharp price advance for grains, drought, high interest rates, and cattle herd liquidation pressures.

Holidays and other factors resulted in some missing weekly prices which were filled by adjusting the price quoted for the next available weight of stocker by the average difference between the two price series for the week preceding and the week following the missing value. Thus, seasonal price variations would likely be less disturbed than applying some longer-term average price difference based upon one year or several years to derive the missing values. Less than 1 percent of the weekly values were missing.

The years with 53 weekly observations (1975, 1980, and 1986) had the week beginning December 27th removed, to standardize all years to 52 weekly observations. Standardization allows out-of-sample forecasts to be matched for different forecast spans. The 52nd and 1st week's prices were adjusted before deleting the 53rd week's price quote by weighting two-thirds of the 52nd week's price with one-third of the 53rd week's price and like adjustment for the first week's actual price. This approach was viewed as retaining more of the information contained within the overall time series than simply deleting the 53rd week's price information.

Other Series Collected

Monthly series were collected for selected weights of feeder steers and heifers at Oklahoma City, Nebraska direct Choice fed steers, 1100-1300 pounds, the feed cost per hundred pounds of gain from the USDA High Plains custom cattle feeding budgets, and the Omaha steer/corn price ratio. Two feedlot cost of gain price ratios series were derived by dividing the USDA budgeted feed costs per hundred pounds of gain by the Nebraska Direct Choice fed steers price and by the key grade feeder steer price at Oklahoma City. The USDA custom cattle feeding cost per hundred pounds of gain includes corn, milo, cotton seed meal, and alfalfa used to produce a total of 500 pounds of gain during the feeding period. In recent years, wheat feeding and changes in feedlot feeding technologies likely have resulted in lower costs of gains than these budgets indicate.

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[3]Goodrich views the AIC and the BIC as having limited statistical meaning by themselves; they are meaningful only for comparisons between different models applied to the same historical data set.

Some Properties of the Oklahoma City Prices

Statistical properties of the series are presented for the full span, 1973 - 1989, and for only the 1980's to illustrate the magnitude of some the forces at work within the cattle sector, Table 1. For the full series, weekly prices for 700-800 pound feeder steers had extreme values ranging from $24.75 per cwt to $87.94 with a weekly average of $59.99, a standard deviation of $15.97, and a coefficient of variation of 26.6 percent, Figure 1. Stocker steer prices, 500-600 pounds, during the 1980's were priced at premiums to 700-800 pound steers, Figure 2. The heifer price series had a wider price range than the steer series, Figure 3. Heifer prices have larger coefficients of variation than steers due to their potential dual use for either breeding or slaughter. Nominal cattle prices during the 1980's had higher averages and smaller standard deviations due to the narrower range between extremes than during the 1970's.

Table 1. Weekly Oklahoma City Feeder Steer and Heifer Prices Averages, Standard Deviation, High and Low, 1973-89 and 1980-89

Type\a	1973-89				1980-89			
	Avg.	S.Dv	High	Low	Avg.	S.Dv.	High	Low
	------------ $ per hundredweight ---------							
Steers 400-500#	70.22	21.40	117.6	23.70	80.55	12.96	109.2	61.80
Steers 500-600#	65.12	18.64	101.4	24.75	74.74	10.62	99.25	60.35
Steers 600-700#	61.88	19.93	92.30	24.75	70.97	9.25	89.96	54.67
Steers 700-800#	59.99	15.99	87.94	24.75	68.88	8.46	87.94	51.23
Heifers 400-500#	58.79	18.96	97.00	19.10	68.04	11.93	96.06	51.55
Heifers 500-600#	56.43	17.00	88.25	19.60	65.25	10.21	88.25	84.30
Heifers 600-700#	55.17	16.06	84.30	16.90	63.91	9.03	84.30	48.06

\a Other weights not included due to more frequent "unquoted" prices for some years.

The effects of the cattle cycle are evident in the nominal prices with the highest prices occurring in the 1978 and 1979 cyclical low in the cattle herd and again in recent years as the latest cattle cycle's expansion phase gets under way. The lowest prices occurred in the early 1970's when cattle numbers were at high levels and grain prices skyrocketed. Thus, the rise and fall of the local mean, i.e. the weekly average for a year, in nominal prices for stocker/feeder cattle prices exhibit a "stochastic trend-cycle" phenomenon. [Goodrich] Most business statistics have stochastic trends, which are not entirely predictable from their own past, and are often intertwined with stochastic cyclic effects. The cattle cycle, feed cost changes, business cycles and other factors likely are confounded.

Nominal price series appear to have a range-level effect where increasing variance is associated with increased price level. The average of the first differences is positive suggesting that a long term trend may be present.

One approach to remove some of the nominal price level effects is to develop relative price ratios between stocker/feeder series by dividing by a key feeder series; Oklahoma City 700-800 pound Medium frame feeder steer price is used as the key feeder price series, Table 2, Figure 4, Figure 5.

To focus upon longer term cyclic and trend patterns and remove the seasonal variation in the price ratio series, 52 week moving averages were calculated, Figure 6 and Figure 7. Trend and cyclic patterns are still present. The trend and cyclic components for heifers have greater ranges than steers.

Table 2. Weekly Price Ratios Oklahoma City Feeder Steer and Heifer Prices to Oklahoma City 700-800# Feeder Steers, Averages, Standard Deviation, High and Low, 1973-89 and 1980-89

Type \a	1973 - 89				1980 - 89			
	Avg.	S.Dv	High	Low	Avg.	S.Dv.	High	Low
	------------ $ per hundredweight ---------							
Steers 400-500#	1.159	.089	1.411	.918	1.167	.077	1.379	.969
Steers 500-600#	1.079	.053	1.262	.930	1.084	.048	1.262	1.003
Steers 600-700#	1.029	.022	1.161	.968	1.030	.019	1.123	1.022
Steers 700-800#	------------Divisor in the Ratio-----------							
Heifers 400-500#	.965	.091	1.194	.699	.984	.073	1.194	.839
Heifers 500-600#	.931	.057	1.106	.765	.945	.045	1.106	.846
Heifers 600-700#	.912	.042	1.002	.765	.927	.026	1.022	.853

\a Other weights not included due to frequent unquote prices for some years.

WEEKLY MODELS

Exponential smoothing and Box-Jenkins models were estimated and compared using the weekly price ratios of stocker/feeder steer prices --Oklahoma City, Medium Frame, number 1, steers, 500-600 pounds, divided by Oklahoma City, Medium Frame, number 1, steers, 700-800 pounds. Since cost of feedlot gains variables were not available weekly, dynamic regression models were not estimated for these weekly relationships. Each model estimation utilized 260 within sample observations and 26 periods out-of-sample forecasts were made developed for five year moving spans. The first model span began January 6, 1980 though 1984.

Exponential Smoothing Models

The smoothing models were well behaved with positive coefficients that were less than 1.0. The greatest weight was given to the level component and the least to the trend component. The large size of the level component may partly explain the poorer performance when used as a longer term forecasting tool. The model spanning the weekly observations from 1980 through 1984 behaved differently than the other exponential models most likely due to the sharp change in level that occurred during the sampled period, Table 3. The significant levels for the Ljung-Box test indicates the residuals are not a white noise series.

Exponential smoothing may be a useful tool for forecasting over a shorter time horizon, a few weeks forward perhaps, as part of a market tracking approach but is of limited value for longer forecast horizons. The seasonal pattern is apparently quite irregular and poorly fitted over the 26 weeks period forecast outside the sample period. The level coefficient was the largest in all the time spans modeled at .826 for all model spans except 1980-84 which was .493. The seasonal coefficient ranged between a low of .338 to .388 in all model spans except the 1980-84 model which was .009. The trend coefficient was very small relative to the level or seasonal coefficients, ranging between .00033 to .00437. Thus, the level component had the greatest influence when developing forecasts and may contribute to the poor forecasting performance over a longer horizon.

Table 3. Diagnostics for Weekly Exponential Smoothing Models- 500-600# Feeder Steer Price Ratio to 700-800# Feeder Steers

Model Span	Adjusted R. Sq.	Durbin Watson \a	Ljung-Box \b	AIC \c	BIC \d	RMSE \e
1980-84	.773	.912	119.8**	.01837	.01876	.01827
1981-85	.831	1.428	44.4**	.01462	.01492	.01453
1982-86	.881	1.440	54.6**	.01575	.01608	.01566
1983-87	.870	1.422	51.3**	.01696	.01732	.01659
1984-88	.865	1.669	33.7*	.01704	.01739	.01659
1985-89	.825	1.669	35.6**	.01873	.01912	.01862

* significant at the 5% level.
** significant at the 1% level.
\a Durbin Watson -Test for first lag error autocorrelation, no correlation in residual errors equal to 2.0, positive correlation less than 2.0, negative correlation greater than 2.0.
\b Ljung-Box -Test for overall departure of the error Autocorrelation Function from white noise, Tested against the Chi-square distribution.
\c AIC - Akaike Information Criterion, smaller is better.
\d BIC - Bayesian Information Criterion, smaller is better, penalizes more complex models more severely.
\e Root Mean Squared Error, RMSE, the square of the errors averaged, smaller values indicate a better fit.

Weekly Box-Jenkins Models

Weekly Box-Jenkins models for steers and heifers varied from time period to time period. The model diagnostics generally had slightly higher adjusted R-squared statistics, Durbin-Watson statistics closer to 2.0, with smaller AIC's and BIC's, but smaller Ljung-Box statistics than the exponential smoothing models. Box-Jenkins had smaller RMSE within the sample period but larger for the out-of-sample forecasts, Table 4. The Box-Jenkins approach applied to weekly observations has a "short term memory" as indicated by the limited variation in forecasts beyond a few weeks.

The weekly models using Box-Jenkins had slightly lower (better) values for the AIC's and BIC's than the smoothing models. But the amount of gain is seen as modest given the greater complexity of the Box-Jenkins models. The Ljung-Box statistics were not significant, indicating the error autocorrelation function (ACF) did not depart from a white noise series.

Table 4. Diagnostics Weekly Box-Jenkins Models- 500-600# Feeder Steer Price Ratio to 700-800# Feeder Steers

Model Span (260 obs.)	Adjusted R Sq.	Durbin Watson \a	Ljung-Box \b	AIC \c	BIC \d	RMSE \e
1980-84	.852	1.971	16.12	.01481	.01502	.01476
1981-85	.849	1.999	15.25	.01411	.01438	.01405
1982-86	.889	1.987	23.01	.01518	.01539	.01506
1983-87	.856	1.844	25.55	.01638	.01650	.01632
1984-88	.862	1.943	17.86	.01668	.01680	.01662
1985-89	.831	1.972	27.29	.01844	.01882	.01822

See footnotes Table 3.

MONTHLY MODELS

Monthly models were estimated and compared using the two univariate and the multivariate approaches for a stocker/feeder price ratios. Models were developed for five-year moving spans with 60 observations within sample and 6 monthly forecasts out-of-sample. A model spanning 10 years, 1980-89, with 9 months forecasts outside sample was also developed to compare stability of the model coefficients over different time spans and forecasting ability.

Feedlot Cost Data

Feeder and stocker steer demand is derived from feedlots. If the cost of gain is expected to decline for a given fed steer price, feedlots would bid more for placements and raise the price ratio of feeder cattle to fed steers. Conversely, an advancing cost of gain would narrow the feeder steer price ratio to fed steers.

Three different measurements for feed costs were tested: Omaha fed steer/corn price ratio, Nebraska direct fed steer/feedlot feed cost of gain per cwt price ratio, and feeder steer/feedlot feed cost of gain per cwt price ratio. The feeder steer price ratio to the feedlot cost of gain per cwt had the best fit. It had an inverse relation to the price ratio of stocker steers to feeder steers. This indicates that feedlot operators bid more aggressively for feeder weight steers than for lighter weight stocker steers when feedlot gain costs decline.

Exponential Smoothing Models

Diagnostics for exponential smoothing models had the highest RMSE (poorest fit), dynamic regression models had the lowest (best fit). The size of the AIC's among the models were similar. The BIC statistics were generally higher for the more complex dynamic regression models due to the penalty for complexity.

The coefficients for the Level and Seasonal components ranged between .4 to .6 in all six models with the Trend coefficient ranging between a low of .00096 to a high of .00836.

Table 5. Diagnostics for Monthly Exponential Smoothing Models, 500-600# Feeder Steers Price Ratios to 700-800# Feeder Steers

Model Span	Adjusted R Sq.	Durbin Watson \a	Ljung-Box \b	AIC \c	BIC \d	RMSE \e
1980-84	.600	1.760	8.61	.0237	.0245	.0225
1981-85	.559	1.648	19.36	.0230	.0242	.0338
1982-86	.692	1.293	29.58*	.0246	.0259	.0259
1983-87	.662	1.263	30.00*	.0244	.0257	.0232
1984-88	.750	1.383	26.01	.0227	.0239	.0216
1985-89	.654	1.381	17.49	.0257	.0270	.0244
1980-89	.735	1.721	15.59	.0239	.0248	.0234

See footnotes Table 3.

Box-Jenkins Models

The Box-Jenkins models were preprocessed by a log transformation using the Forecast Master Plus XFORM operation and the optimize feature to select the lag structure. The lag structure identified changed among the six time spans tested. A one-period autoregressive factor entered in all of the models. Later-modeled time spans had seasonal autoregressive terms, moving average variables, or seasonal moving average terms. The seasonal characteristics of the monthly stocker/feeder price ratios were stronger than for the weekly series modeled.

Table 6. Diagnostics for Monthly Box-Jenkins Models, 500-600# Feeder Steer Price Ratio to 700-800# Feeder Steers

Model Span	Adjusted R Sq.	Durbin Watson \a	Ljung-Box \b	AIC \c	BIC \d	RMSE \e
1980-84	.523	1.974	20.26	.0247	.0252	.0229
1981-85	.522	1.800	31.02*	.0234	.0238	.0217
1982-86	.700	1.760	22.21	.0242	.0255	.0216
1983-87	.709	1.774	15.69	.0228	.0241	.0201
1984-88	.753	1.985	14.74	.0228	.0241	.0199
1985-89	.649	1.856	10.66	.0263	.0263	.0250
1980-89	.705	2.040	15.61	.0250	.0259	.0225

See footnotes Table 3.

Dynamic Regression Models

Data used for the dynamic regression models was preprocessed by a log transformation to correct for nonstationarity present in the price ratio series. As a starting point to dynamic regression model development, Box-Jenkins models were fitted to get a starting lag structure. Later iterations tested different forms of the exogenous feed cost variables and the significance of the lag variables. The model's lag structure did not remain constant across the six different time spans modeled, but a 1-period and 12-period lag usually entered and a few model spans had a 24-period lag. High costs from 1980 through mid-1986 resulted in low feeder/feedlot gain cost of ratios. The models spanning these periods, 1980-84, 1981-85 and 1982-86, had the largest negative coefficients for this feeder/feed cost price of gain ratio, -.2748, -.2319, and -.2461, respectively, with highly significant t statistics (over .05 probabilities). The later model spans which had higher feeder/feed cost price ratios, due to both higher feeder steer prices and lower feed costs, and had smaller negative coefficients with less significant t statistics (less than .05 probabilities).

Table 7. Diagnostics for Monthly Dynamic Regression Models, 500-600# Feeder Steer Price Ratio to 700-800# Feeder Steers

Model Span	Adjusted R Sq.	Durbin Watson \a	Ljung-Box \b	AIC \c	BIC \d	RMS Error
1980-84	.564	1.991	7.69	.0257	.0284	.0206
1981-85	.650	2.339	20.38	.0241	.0269	.0196
1982-86	.816	1.685	34.21*	.0228	.0254	.0184
1983-87	.716	1.616	43.60**	.0218	.0243	.0173
1984-88	.703	2.159	9.46	.0187	.0201	.0148
1985-89	.534	2.003	9.86	.0325	.0359	.0246
1980-89	.786	2.210	13.13	.0233	.0256	.0196

See footnotes Table 3.

Comparisons of Monthly Models' Out-of-Sample Forecasts

Mean Absolute Percentage Errors (MAPE) were calculated for each of the three methodologies spanning 1980:1-1989:12 with a nine month out of sample forecast, 1990:1-1990:9, Table 8. The Dynamic Regression model had the smallest MAPE for both within sample and out-of-sample forecasts.

Table 8. Mean Absolute Percentage Errors (MAPE) for Monthly Price Ratio Model Forecasts, 500/600# Feeder to 700/800# Feeder, Oklahoma City

Model Type:	Within Sample \a (1984:1-89:12)	Out-of-sample (1990:1-9)
Exponential Smoothing	1.565%	3.532%
Box-Jenkins	1.552	4.441
Dynamic Regression	1.371	3.472

\a Due to the use of lags in the Dynamic Regression Model, the within sample MAPE calculations spanned only 1984-89 for all models even though Exponential smoothing and Box-Jenkins models had within sample forecasts available prior to 1984.

Areas for Further Development

Further development of multivariate approaches appears to hold the most promise. This paper tested only dynamic regression but other multivariate approaches may be superior.

Additional exogenous factors to more adequately reflect the forage supply and cost to background stocker cattle may be beneficial. Also the role of producer price expectations for fed cattle should be included. Price ratio models for heifers to feeder steers are more complex and was not addressed in the models tested. Price ratios for heifers to feeder steers likely would be influenced by additional factors due to their potential dual use as feedlot placements or breeding herd replacements.

SUMMARY AND CONCLUSIONS

Price ratios between different weights of stocker and feeder cattle during the 1970's and 1980's were not stable but exhibited a longer term trend/cycle phenomena. Weekly models exhibited very weak seasonal patterns that were irregular and poorly fitted by the univariate approaches tested. Monthly price ratio models were better able to identify seasonal patterns. The multivariate models, using dynamic regression, generally were superior to the univariate models tested but are more complex and difficult to develop.

As an approach to forecasting the price ratio of stocker steers to feeder steers, [Oklahoma stocker steers, Medium Frame, Number 1, 500-600 pound divided by Oklahoma City feeder steers, Medium Frame, Number 1, 700-800 pounds] can provide forecasts for a short-term horizon of a period or two. But univariate approaches provide a relative weak forecasting tool for longer forecasting horizons, beyond a few weeks. Weekly price ratios between stocker/feeder steers displayed a longer term trend/cycle phenomena and an irregular seasonal pattern that are poorly fitted by univariate approaches. Winters exponential smoothing models, which use three components, have significant Ljung-Box statistics indicating the residuals were significantly different than white noise series. These models had most of the influence from the level component. Box-Jenkins models were more difficult to develop, since the time series needed to be transformed and model specifications are more time-consuming to develop. Box-Jenkins models had smaller Root Mean Squared Errors, RMSE, but still did not capture adequately the seasonal patterns within the weekly series.

Models using monthly averages were better able to incorporate seasonal characteristics. Univariate models using Exponential Smoothing and Box-Jenkins approaches generally had larger RMSE than the multivariate models developed using dynamic regression. Feedlot feed cost of gain as an explanatory variable, expressed as a price ratio to feeder steers, was a significant explanatory variable in the price ratio for stocker steers to feeder steers. Multivariate approaches appear to hold more promise to forecast price ratios than univariate approaches particularly for forecasting horizons more than a few periods.

Ranking monthly models forecasts out-of-sample, by the size of the Mean Absolute Percent Errors [MAPE], the Dynamic regression models had smallest MAPE's and ranked ahead of Box-Jenkins or the exponential smoothing models. The exponential smoothing models had the largest MAPE.

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Figure 1

Weekly Feeder Steer Price

Oklahoma City 700-800 Pounds, Med. Frame No. 1

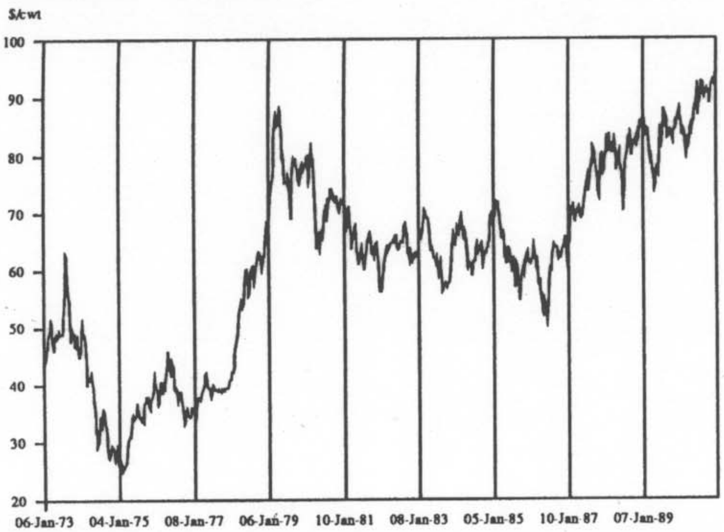


Figure 2

Weekly Feeder Steer Price

Oklahoma City 500-600 Pounds, Med Frame No. 1

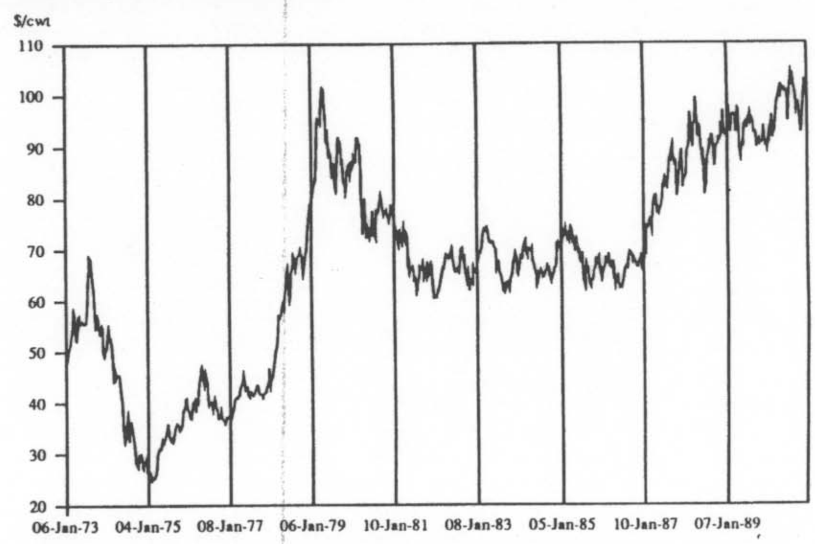


Figure 3

Weekly Feeder Heifer Price

Oklahoma City 600-700 Pounds, Med. Frame No. 1

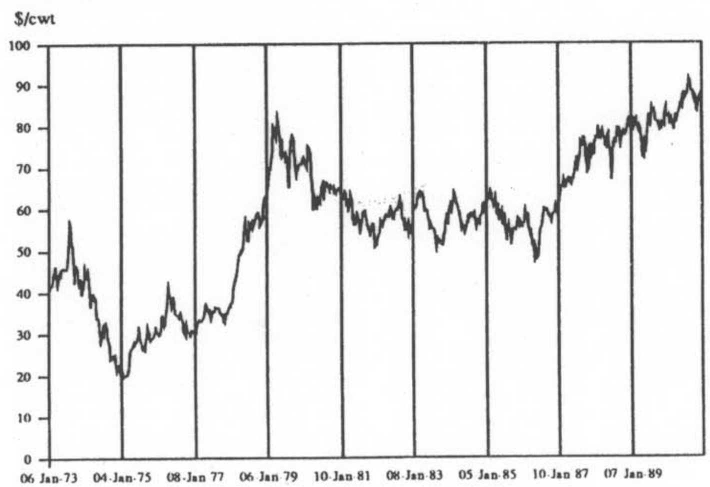


Figure 4

Weekly Feeder Steer Price Ratio

Oklahoma City 500-600 Steers / 700-800 Steers, Med. Frame No. 1

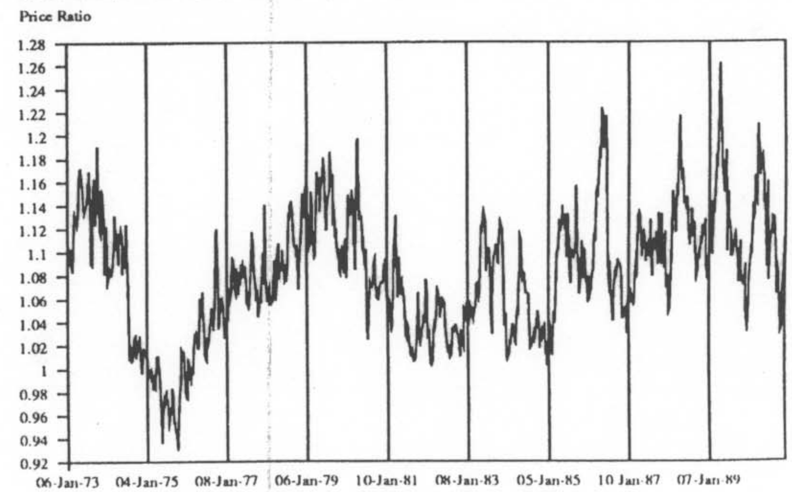


Figure 5

Weekly Feeder Heifer Price Ratio

Oklahoma City 600-700 Heifers / 700-800 Steers, Med. Frame No. 1

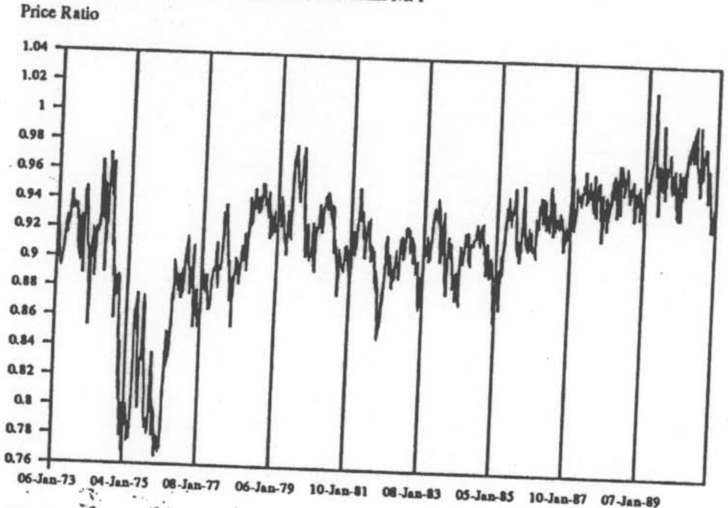


Figure 7

Deseasonalized Annual Price Ratio

Oklahoma City Feeder Heifers / 7-8 Feeder Steers, Med. Frame No. 1

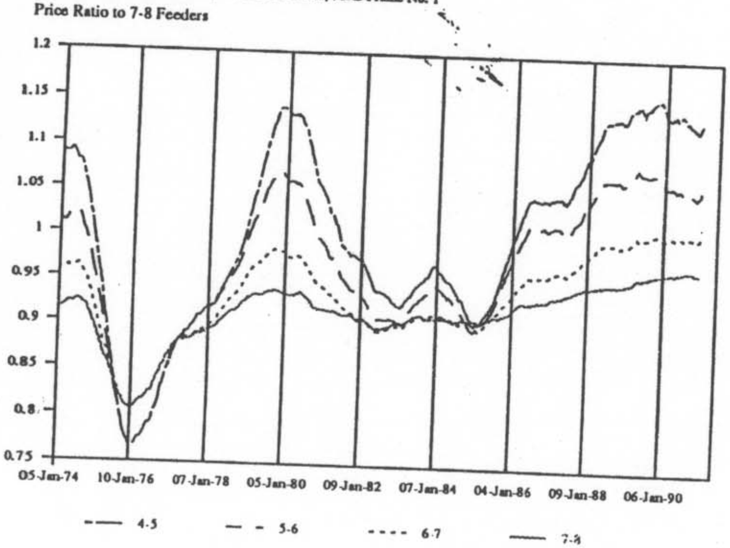
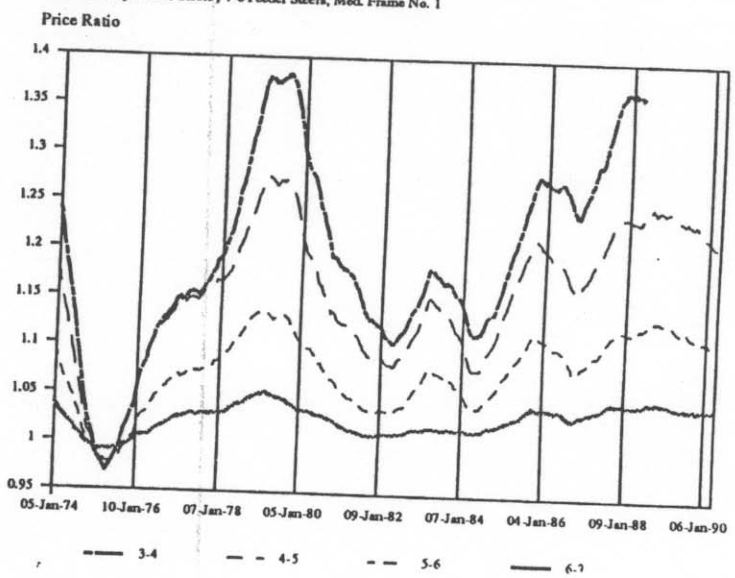


Figure 6

Deseasonalized Annual Price Ratio*

Oklahoma City Feeder Steers / 7-8 Feeder Steers, Med. Frame No. 1



*52 Week Moving Average