The Importance of Inventory in Short-Run Beef Market Analysis

by

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ABSTRACT

This study of presents evidence that inventories of market ready fed cattle (showlists) have a stronger influence on weekly slaughter cattle prices than do slaughter levels. Three data sources were used to test the relative correlation strength between showlist and price versus slaughter and price. These sources were: a) output from a fed beef market experiential learning simulator; b) publicly reported data; and c) private data from feedlot closeout records.

INTRODUCTION

Supply and demand research in grain markets defines supply as the sum of production plus inventories. Likewise the basic market clearing assumption for grain markets does not force production to equal consumption; rather it forces beginning inventories plus production to equal consumption plus ending inventories. Economists have long recognized the price stabilizing effect of inventories. In practice, inventories operate both as a buffer stock and as a mechanism for rationing supply between harvests. Supply and demand model specifications for livestock markets depart from those for grain markets because livestock products are generally viewed as being non-storable. Hence the basic market clearing assumption generally made for livestock is that production must equal consumption.

The thesis of this study is that fed cattle are storable in the short-run. More specifically the research will consider the weekly market for slaughter cattle and attempt to determine if weekly slaughter is the best proxy of supply, or whether "showlist size" (i.e. market ready inventories of cattle) is a better proxy of supply. The industry defines showlist as the volume of cattle that are ready for sale but have not been sold. This "list" is revealed through individual negotiations between packer buyers and feedlot managers. From a time dynamics point of view, cattle on the showlist are cattle within a "marketing window". It is of interest to note that buyers and sellers in the industry monitor showlist numbers quite closely, thus indicating that they believe it is a factor affecting short-run cattle price movements. A contention of this study is that previous studies of short run price variation (intra-month) in general have been unsuccessful because they fail to consider inventory as a factor influencing short-run price variation. This failure is believed to be due primarily to a lack of data reporting showlist inventories.

Feedlot managers have significant flexibility in determining the exact marketing date for a given pen of cattle. Implicitly the feedlot manager attempts to determine the point at which the value of the marginal product produced from continued feeding is equal to the marginal cost of continued feeding. This is the economically optimal point at which to sell, ceteris paribus.

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However, because of uncertainty regarding physical production, this point can not be precisely determined. Additionally, feeding trials and industry experience have established that this point is "nearly" satisfied over a rather wide weight range (i.e. one to two hundred pounds). Thus with regard to optimal physical marketing conditions, feedlot managers tend to "satisfice" rather than optimize. This results in a marketing window being established for feedlot cattle rather than an optimal marketing date. The endpoints of this window are practically defined as the earliest and latest possible marketing dates for a pen of cattle that will not result in a price penalty for over or under finished cattle. Within this window, it is contended that cattle are essentially "storable". Cattle within this window continue to grow, but this growth is very predictable and, as defined, does not significantly affect quality or price.

Within the marketing window, market conditions rather than physical attributes of the animal become the primary marketing consideration. Stated alternatively, the marketing decision becomes one of short-run inventory management rather than production control. Key market conditions are hypothesized to include price expectations, perceived industry wide showlist sizes, and the current psychological relations between buyers and sellers in the transactions negotiations process, i.e. the "tone of the market".

The existence of a marketing window allows both the feedlot manager and the packing plant manager to accomplish several objectives. Transactions costs can be lowered since it is possible to sell several pens from different points within the marketing window on the same date. Additionally, feedlot managers may either sell cattle early or hold them late in the marketing window depending upon short-run price expectations. On the other side of the market, packing plant managers have a strong incentive to maintain a uniform flow of quality cattle through the packing plant in an effort to operate at the lowest point on their average cost curve. Thus, showlist provides a buffering mechanism that is expected to increase the operational efficiency of the industry.

During normal marketing patterns, cattle are sold near the center of their marketing window (close to the expected marketing date). Bacon has shown that an expected marketing date can be determined relatively accurately for a given pen of animals when their placement date, weight, and sex are known (Bacon). However, during abnormal marketing situations (which may develop for numerous reasons including weather, market psychology, exogenous shocks, etc), cattle may not be sold close to their expected marketing date and may even be sold outside of the marketing window. When this happens, cattle are said to be "green" (early) or "backed up" (held past the end of the marketing window) and, the showlist will become abnormally large or small. Such periods often result in considerable price volatility. Thus, it is important to both buyers and sellers to anticipate when such abnormalities will occur and take defensive strategies to avoid the potential consequences.

OBJECTIVES

The general objective of this study is to determine the ability to predict intra-month (weekly) prices as a function of short-run supply. To accomplish this objective, it is first necessary to determine what constitutes the best measure of short-run supply. This study examines whether fed cattle slaughter or showlist size is the best measure. The primary hypothesis to be tested in making this determination is whether show list size or weekly slaughter is more strongly correlated with price. Past studies of short-run beef market behavior have been unable to test this hypothesis because no data series for market ready cattle inventories (showlist) existed.

DATA SOURCES

Several data sources are utilized in this study. These included the USDA seven states Cattle on Feed report, the USDA federally inspected slaughter reported in the Livestock, Meat and Wool Market News. , Omaha cash market prices, simulation data from the Packer-Feeder Simulation Game developed at Oklahoma State University (Trapp et al.) and, primary feedlot data collected by professional Cattle Consultants Incorporated (PCC).

The USDA seven states Cattle on Feed report, released monthly, contains an estimate of the previous month's placements and marketings and the current month's beginning inventory of cattle on feed. Following the lead of Meyer, this data set was differentiated from a monthly data set to a weekly data set assuming a uniform distribution of marketings and placement throughout the month (Meyer).

The USDA Livestock, Meat and Wool Market News. report contains an estimate of the number of steers, heifers, dairy and non-dairy cows and bulls slaughtered under federal inspection during the previous week. Steers and heifers were separated out to provide a comparable data series to the USDA seven states Cattle on Feed report.

Price information was collected from the Omaha cash market for 1100-1300 pound steers. A weekly average for steers grading either select or choice was used.

A semester's output from the Packer-Feeder game was used for the experiential data section. The Packer-Feeder simulator is an experiential learning model developed at Oklahoma State University (Trapp et al.). The objective of the Packer-Feeder Simulator is to provide instruction on the structure, conduct, and performance of the fed cattle market; specifically in the timing of transactions and the role of market information. Participants learn in an experiential or "hands on" environment by performing either the role of a feedlot manager or a packing plant manager. The participants' objective is assumed to be profit maximization through the selling (buying) of cattle. Placements and boxed beef demand are exogenous. Through negotiations, the players endogenously determine the timing of cattle sales and slaughter cattle prices. Feedlots have a five week window in which to market their cattle; failure to market the cattle within this time frame results in severe price penalties. Both feedlots and packers are supplied with respective cost information. It is up to the individual feedlot and packing plant to determine their exact costs and negotiate cattle transfers accordingly. In addition, the game includes a futures market and forward contracting is allowed. The simulation time is six to eight weeks per one hour class session.

The private data set was collected by Professional Cattle Consultant (PCC) as a normal part of their business operations. This data set contains pen level "closeout" data for approximately eighty-five feedlots feeding between 22 and 25 percent of the cattle reported in the seven state

Cattle on Feed Report. Included in the data set are the following variable for each pen of cattle: average placement weight and purchase price as well as the placement date and sex of the animals; the slaughter weight, date and sales price; death losses, days-on-feed, average daily rate of gain, feed fed per pound of gain, feed price, and total feed cost.

PROCEDURES

The origination of the focus of this study was highly influenced by the work of Trapp et al. on the Packer-Feeder game developed at Oklahoma State University. Over the course of development and implementation of the Packer-Feeder game, it became apparent that certain hypothesis once considered untenable could now be empirically tested. The most significant among these were the correlation between showlist and price versus the correlation between slaughter and price. However, to validate the hypothesis testing done with the Packer-Feeder game, it was deemed necessary to determine if the results could be duplicated using "real world" data. Two types of "real world" data were used to validate the hypothesis originally tested with the experiential model. The first of these consisted of publicly reported data and the second consisted of private data collected by PCC.

Experiential Data Model. The showlist, slaughter price, and marketings data generated by the experiential learning model were used to test the basic hypothesis of whether showlist and price, or slaughter and price, are more strongly correlated. Within the experiential simulation model it is possible to know at all times the cattle which, according to the game's rules, are available for sale, i.e. are on the showlist. The timing of the sale of showlist cattle as well as the slaughter price received for the cattle sold is endogenously determined by the players in the simulation through negotiations occurring between players playing roles as packers and feeders. Feeder cattle supplies, feeder cattle prices, cost of gain, and boxed beef demand are exogenous to the game.

From Table 1, it is evident that the experiential learning simulator generates price and showlist data series which have strong negative correlation. A significantly weaker negative correlation is exhibited between the slaughter quantity and price series generated by the simulator.

Linear regression models were estimated using data generated by the experiential simulator which predicted slaughter price as a function of the following variables: showlist only; slaughter only; and both showlist and slaughter. The results or these regressions are reported in Table 2.

A question of causality arises with regard to whether showlist creates a price response or whether price response creates a change in the showlist. Granger causality testing of the time series data for showlist and slaughter price was unable to confirm the direction of the causality. Also it should be noted that the time series data for price, showlist and slaughter are not stationary and significant autocorrelation exists for the regressions between price and showlist, and between price and slaughter. In response to these problems a first difference model was developed and changes in prices were predicted as a linear function of changes in showlist only, changes in slaughter only, and changes in both showlist and slaughter. The model is stationary after first differencing and it was found that changes in showlist do Granger cause changes in price.

Public Model. To employ the same framework utilized with data from the experiential learning model, but using publicly available data, it is necessary to develop weekly showlist and weekly fed cattle marketings data series. This was accomplished in two steps. First a weekly marketings and placements series was developed from the seven state Cattle on Feed report. This approach is obviously limited in that nothing is known about the distribution of placements of the cattle on feed. One might assume that marketings are strongly correlated with federally inspected slaughter and thus impose an empirical distribution on marketings. However, there is significant debate about the level of correlation between the two (Peel). Thus, a uniform distribution is assumed for placements and marketings. The weekly designations were from Friday through Thursday. This is because of the low concentration of marketings reported in cash markets on Fridays and Saturdays. Therefore, some months have four marketing weeks and some have five. To avoid sharp shifts in the weekly transformed data set, a five week centered moving average was used (Meyer).

Given the availability of estimated weekly marketings and placements, a showlist proxy variable was developed. Previous research by Bacon estimated the marketing window to be twenty-two to twenty-eight days in length and the average days on feed to be 147 days (twenty-one weeks). A marketing window length of twenty-eight days (four weeks) was selected for this study. Thus it was assumed that cattle enter the marketing window, i.e. go on the showlist, four weeks in advance of their expected slaughter date. Therefore, cattle going onto the showlist consist, on average, of cattle placed on feed seventeen weeks ago (i.e. twenty-one minus four). Given these assumptions a public data showlist proxy variable was specified as follows:

$$SHOWLIST_t = \Sigma M_i \quad i = t\text{-}4 \text{ to } t \tag{1a}$$

$$SHOWLIST_{t+1} = SHOWLIST_t + P_{t-17} + M_t \tag{1b}$$

$$\vdots$$

$$SHOWLIST_n = SHOWLIST_{n-1} + P_{n-17} + M_n \tag{1n}$$

Where: P_{t-17} ------- is placements lagged seventeen weeks
M_t ---------- is marketings during the current week
$SHOWLIST_t$ --- is the showlist proxy variable

Marketings now refer to the marketing series generated from the Cattle on Feed report. Slaughter refers to the steer and heifer volume as reported in the USDA Livestock, Meat and Wool Market News. The simple correlation coefficients found between the above defined data series for showlist and slaughter, and the report weekly average Omaha slaughter steer price are reported in Table 1. Showlist and slaughter are both, individually and then jointly, regressed on Omaha slaughter steer price. Seasonality is corrected for by the inclusion of a dummy variable for month. The results are reported in Table 3. First difference models of these same equations were also run. The results are also reported in Table 3.

Private Data Model. Concurrent to the development of the Packer-Feeder experiential learning simulator, Trapp and Bacon developed a biologically based fed cattle marketings forecasting model. This model utilizes the private data set previously described. Data are available from January of 1986 through April of 1992. The core or the model consists of an equation to predicted the expected days on feed (DOF) of each incoming pen of cattle. The equation predicts days on feed as a function of placement weight, sex of the animals, location of the feedlot, and month of the year. Given a predicted number of days on feed each pen of cattle is placed into a queuing model to simulate its movement through time (growth) to its eventual slaughter date. Different weights, sexes, etc. of cattle enter the que with different expected days on feed. Thus cattle projected to be slaughtered on a given day will likely have been placed on many different days. However, the queuing model is capable of discerning this fact and generating one aggregate daily marketings figure with the proper delay imposed for each pen of cattle. Each simulated day's volume of cattle exiting the feedlot que is summed to determine a weekly marketings series.

For the purposes of this study the fed cattle marketings simulation model described above was used to simulate the expected date cattle would go on the showlist. As previously described for the "Public Data Model" cattle were assumed to be placed on the showlist four weeks prior to their expected slaughter date.

Actual marketings were determined from the private data set itself according to the reported marketings date. In reality the easiest method found to aggregate the private data set into a set of daily marketing figures was to run the queuing simulation model and replace the forecasted DOF value with the true DOF value.

Given the showlist entry (placement) and exit data (marketings) series described above, the showlist proxy model reported in Equation #1 was used to develop a showlist proxy variable for the private data set. The Omaha weekly average slaughter price was then regressed against this showlist proxy variable as well as the reported marketings for the eighty-five feedlots contributing to the private data set, and against both the showlist proxy variable and reported marketings in the same equation. Seasonality is corrected for by the inclusion of a dummy variable for month. First difference models of the same equations were also estimated. The simple correlation results are reported in Table 1. The regression model results are reported in Table 4.

RESULTS

Table 1 reports the simple correlations results. In the Experiential model, price and showlist exhibits a strong negative correlation (-.90). The sign is as expected in that price is expected to move in the opposite direction of showlist. While the sign on slaughter in the experiential model is correct, it is not as strongly correlated with price (-.62). This is as expected in that the feedlot managers and packing plant managers are making their short range marketings decisions based on cattle ready for sale.

In the Public data model, the correlation coefficient between price and showlist has the correct sign but is rather weak. This was expected due to the approximation of a weekly data series from the seven states Cattle on Feed report. The correlation coefficient between price and

USDA federally inspected slaughter is of the correct sign but is not as strong as desired.

In the private data model, the correlation between price and showlist is of the correct sign but, again it is not as strong as desired (-.40). Part of the problem may be in refining the definition of showlist to better capture the exact timing of the negotiation process. However, the correlation is nearly two and a half times as strong as in the public data model and is stronger than the correlation between price and slaughter.

The regression model results indicate that showlist is globally superior to slaughter in predicting price (See Tables 2 and 3). In the Experiential Model (Table 2) both showlist and slaughter have the correct sign but the slaughter variable is not significant. In addition, in the slaughter equation, slaughter (slgtr) is not significant even at the 10 percent level. Also, the slaughter equation has strong positive autocorrelation while the showlist model is free of autocorrelation. Another advantage of the showlist model is that there is no concern about the residuals being distributed normally while the slaughter model has non-normal residuals. When moving to a first difference model, the showlist model remains robust, but the slaughter model does not; specifically the sign on slaughter changes from negative to positive. A third specification was attempted in which both showlist and slaughter were included. However, in all cases slaughter was insignificant. Therefore, those results were not included.

The Public Data model results reported in Table 3 are not as clear. Even after correcting for first order autocorrleation, significant positive autocorrelation remains suggesting non stationarity. However, it is worth noting that the T-values (reported in parentheses) are twice as strong for showlist as they are for slaughter. After first differencing to correct for non stationarity, the results are less clear except to note that the residuals of the showlist model are distributed normally at the 5 percent level but the residuals of the slaughter model are not.

The results of the PCC Private Data Model, reported in Table 4, indicate that the showlist variable is significant at the 10 percent level, but slaughter is not. Both variables do have the correct sign. The results reported are after correcting for first order autocorrelation. Since significant positive autocrrelation remained, the models were re-estimated as first difference models. The T-value on showlist (-1.47) in the first difference model actually improved, but the coefficient for the slaughter variable is of the wrong sign.

The change in sign observed for the slaughter variable in two of the three first difference models warrants further comment. A positive sign on the first difference value of slaughter can be interpreted as consistent with the hypothesis that inventory is the dominant factor influencing short-run price variation. An increase in the slaughter is consistent with a decline in the showlist inventory which in turn causes a rise in price. Thus, viewed from an inventory model perspective, rising slaughter rates are, ceteris paribus, consistent with falling inventories and rising prices.

FURTHER RESEARCH

This study represents an initial effort to better understand the structure of short-run price forecasting in the fed cattle market. As such, the study is meant to serve as a foundation for a more inclusive approach towards price forecasting. It remains unclear as to whether this approach will yield superior price forecasts over an ARIMA approach or whether a combined model will prove superior. What is clear however, is that the procedures followed in this study provides an avenue for directly testing hypotheses of market conduct considered to be relevant to the industry that can not be specified using ARIMA models.

An out growth of this study is the validation of Packer-Feeder Game as a hypothesis generating and testing tool. Conceptual and empirical validation of the Packer-Feeder game allows the applied economist to tackle a host of issues relating to market structure, conduct, and performance that can not be addressed readily using existing data series due to either the lack of public data or the unwillingness of private firms to provide access to their data bases.

SUMMARY AND CONCLUSIONS

The result of this study confirm the stated hypotheses that showlist is more strongly correlated with price than federally inspected slaughter. In the experiential model and the private data model, showlist proved to more highly correlated with price than slaughter. It was less highly correlated in the public data model, but that is believed to be due to the difficulty of adequately specifying the weekly showlist proxy variable. The hypothesized reason that showlist is more strongly correlated with price is that during price negotiation between feedlots and packers, more emphasis is given to the potential number of cattle that could be sold than to the actual number sold.

A significant implication evolving from this study is that in order to do useful short-run beef market price forecasting, timely, accurate, and publicly available data showlist size is a necessity. It is the authors' contention that to date very little if any useful short-run price analysis has been done in the beef market. While other forecasting approaches, namely ARIMA models, may be more applicable to developing short-run price forecasts, these approaches face the limitation in that they fail to provide useful information about the underlying structure. It is our perception that a better understanding of the underlying structure will provide a clearer understanding of the role and usage of information in the fed cattle market.

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TABLE 1. CORRELATIONS FOR EXPERIENTIAL, PUBLIC, AND PCC MODELS

MODEL		SHOWLIST	SLGTR	PRICE
EXPERIENTIAL	SHOWLIST	1.000		
	SLGTR	.570	1.000	
	PRICE	-.901	-.616	1.00
PUBLIC	SHOWLIST	1.000		
	SLGTR	.046	1.000	
	PRICE	-.169	-.301	1.000
PCC	SHOWLIST	1.000		
	SLGTR	.298	1.000	
	PRICE	-.397	-.237	1.000

TABLE 2. RESULTS OF EXPERIENTIAL MODEL (T-Values in Parentheses)

Variables	MODEL 1 (Showlist)	MODEL 2 (Slgtr)	1ST. Diff. (Showlist)	1ST. Diff. (Slgtr)
Intercept	88.654 (15.916)	81.498 (13.227)	.0179 (.139)	1.347 (1.105)
Showlist	-.672E-03 (-.236)	------	-.633E-03 (-2.106)	-----
Slgtr	------	-.186E-03 (.-581)	------	.337 (1.070)
R-square	.949	.943	.092	.025
Durbin-Watson	1.898	1.568	1.835	1.670
Normality	-1.150	-2.863	-1.150	-1.751

TABLE 3. RESULTS OF PUBLIC DATA MODEL*
(T-Values in Parentheses)

Variables	MODEL 1 (Showlist)	MODEL 2 (Slgtr)	1ST. Diff. (Showlist)	1ST. Diff. (Slgtr)
Intercept	61.242 (19.895)	60.787 (19.756)	.0459 (.813)	-.055 (.347)
Showlist	-.465E-03 (-1.080)	-----	-.231E-03 (-.619)	------
Slgtr	------	-0.82E-09 (-0.445)	------	-.124E-08 (-.692)
R-square	.978	.972	.030	.038
Durbin-Watson	1.583	1.575	1.806	1.800
Normality	-1.442	-1.442	-.879	-1.793

TABLE 4. RESULTS OF PRIVATE DATA MODEL*
(T-Values in Parentheses)

Variables	MODEL 1 (Showlist)	MODEL 2 (Slgtr)	1ST. Diff. (Showlist)	1ST. Diff. (Slgtr)
Intercept	59.649 (37.443)	58.819 (42.069)	.159 (1.722)	.178 (1.873)
Showlist	-.075E-05 (-1.338)	-----	-.104E-04 (-1.468)	-----
Slgtr	-----	-.189E-08 (-.523)	----	.289E-08 (.871)
R-square	.869	.866	.131	.122
Durbin-Watson	1.685	1.690	1.888	1.905
Normality	-1.572	-1.241	.580	.580

* Parameter values for seasonality not included.