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EXPECTATIONS, FUTURES PRICES, AND FEEDLOT OPERATOR BEHAVIOR

by

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Introduction

This paper attempts to improve our understanding of the effects of market prices on cattle marketing decisions, using futures prices as measures of unobserved price expectations. This approach has been used successfully in explaining feeder cattle placements, but not in marketings. Our aim is to provide empirical evidence on an unresolved issue in cattle marketing, the differential effects of the current price and near-term price expectations. When the cash price of fed cattle rises, the higher returns from current sales encourage increased marketings; yet, if the price is expected to remain high it may pay to feed cattle longer, holding them back from current marketing. By estimating marketings as a function of cash and futures prices simultaneously we hope to separate these two effects.

Previous Research

Myers, Havlicek and Henderson (1970) and Brester and Marsh (1983) exemplify the typical finding that when the price of fed cattle rises, fewer are marketed. Taking this finding as measuring a negative elasticity of supply of marketed cattle, issues can be raised about the stability of market equilibria and the effects of exogenous shocks on the fed cattle market. However, as many economists have recognized, this "supply response" to a rise or fall in the cattle price may reflect expectations of future prices as well as the observed cash price.

Hayenga and Hacklander (1970), Tryflos (1974), Nelson and Spreen (1978), and Ospina and Shumway (1979) made notable attempts to disentangle the effects of current and expected cattle prices on marketings. Hayenga and Hacklander estimated supply and demand functions for cattle and hogs using the change in cattle prices as a proxy for price expectations along with feed prices as regressors in their model estimates. A positive price change coefficient was estimated for the beef cattle regression. These results would lead one to conclude that when the change in the beef price is positive, e.g., when the June live beef spot price is higher than the May live beef spot price, cattle producers will increase marketings in June. When the change is negative, marketings decrease.

Nelson and Spreen developed a model of marketed cattle supply using the conceptual framework pioneered by Jarvis (1974) in which cattle are viewed as capital goods. In their model the capital asset value and current market value of fed cattle are compared to determine the marketing decision. The capital value of fed cattle is the expected price multiplied by the expected selling weight less the expected cost of feeding the cattle longer. The market value is the current price multiplied by the current weight of cattle. The model itself was not estimated due to the lack of a suitable measure of price expectations. Instead, Nelson and Spreen focused on the price formation mechanism. They developed a proxy for the expected price that was based on a function of the current month's price and the price movements for the previous three months. One of their conclusions was that there was "strong evidence for the existence of accelerated or delayed marketing in response to the pattern of recent prices," (Nelson and Spreen, p. 124).

Futures prices were used as a measure of expectations by Hurt and Garcia (1982) and by Tronstad and McNeil (1989) in their models of sow farrowings, with results indicating promise for this approach in livestock-sector modeling. Ospina and Shumway (1979) considered the use of futures prices to measure expectations but did not do so because the futures markets did not provide a time series of price data long enough and because futures prices were not quoted far enough into the future to be useful for their breeding herd inventory equation (Ospina and Shumway, p. 50). However, Shonkwiler and Hinkley (1985) were able to use futures prices successfully in modeling feeder cattle placements.

Two potential problems limit the prospects for the use of futures prices as price expectations. The first is the issue of whether futures prices are in fact unbiased estimates of subsequent cash prices. Kolb and Gay (1983) provide the most systematic evidence available to date for livestock futures, finding no systematic downward bias. But even if there is bias, changes over time in future prices will measure the change in expected price if the bias is constant. The second potential problem is variability in the basis between the price of a cash contract and the futures contract at time of delivery. It creates an errors-in-variables problem that could bias the estimated price coefficient downward. Empirical work by Gardner (1976) on crops and Hurt and Garcia (1982) on hogs suggests that future prices appear to yield slightly better fits and larger coefficients than lagged-price specifications in supply relationships, suggesting that the potential problems may not be damaging in practice.

A Model of the Cattle Placement Decision

As Krause (1991) indicates, one of the biggest challenges that cattle feeders face is determining the likely prices of fed cattle in the near future, and comparing the expected gains from feeding market-ready cattle a little longer with the expected costs of doing so, keeping in mind that there may be "pressure to empty pens for the next group of cattle" (p. 34). Thus, changing market conditions cause cattle feeders to adjust their marketing and placement decisions continuously. However, there may be constraints to a cattle feeder's responses to changing market conditions. If current fed cattle market prices are very favorable, and feedlot managers expect prices to fall soon, they could collectively run up against the industry's transportation or other marketing service constraints; and although the necessary services may be recruited, the cost of obtaining them may become prohibitive.

This situation lends to the standard partial adjustment framework where:

$$Q_t - Q_{t-1} = ((\hat{Q}_t - Q_{t-1})$$

i.e., the observed change in marketings between last month and the month is a fraction, γ, of the difference between desired marketings and last month's marketings, where Q_t is the number of cattle actually marketed at time t and $\hat{Q}$ is desired marketings at time t (if there were no adjustment constraints). Adding Q_{t-1} to both sides gives:

(1) $$Q_t = (\hat{Q}_t + (1 - ()Q_{t-1}$$

A profit maximizing cattle feeder's marketing decision is modeled as follows: We assume that at time t a cattle feeder has $\bar{Q}_t$ fed cattle ready for slaughter and is deciding on how many of the $\bar{Q}_t$ cattle to market at that time. Cattle that are not marketed at t must be fed until the next time period — assumed to be one month later — and then marketed at time t + 1; incurring additional costs by delaying the marketings. In the absence of binding constraints, the discounted expected profit of the cattle marketed at times t and t + 1, denoted π^*_t, is represented by

(2) $$\pi^*_t = R_tQ_t + R^*_{t+1} Q^*_{t+1} - c(W_t, Q^*_t)$$

where

$$0 \leq Q_t \leq \bar{Q}_t; \quad R_t = P_tH_t; \quad Q^*_{t+1} = \bar{Q}_t - Q_t; \quad R^*_{t+1} = {}_tP^*_{t+1}H^*_{t+1}.$$

The variable R_t represents the revenue per head, that the feedlot operator realizes if she markets fed cattle at t; P_t is the market price per hundred weight of fed cattle at time t, and H_t is the average weight of the cattle marketed at time t. R^*_{t+1} represents (at time t) the expected discounted revenue per head, of the remaining $\bar{Q}_t$ - Q_t cattle marketed at time t + 1; where ${}_tP^*_{t+1}$ is the time t discounted expected price per hundred-weight of fed beef sold at time t + 1 and H^*_{t+1} is the expected weight of the cattle marketed at t + 1. Q^*_{t+1} is the number of the $\bar{Q}_t$ - Q_t cattle that are expected to survive an additional month, the function $c(W_t, Q^*_{t+1})$ represents the cost of feeding cattle an additional month; the factor prices (feedstuffs) are represented by the vector W_t.

We assume that Q^*_{t+1} differs from $\bar{Q}_t$ - Q_t only by the expected monthly rate of death loss, δ, a constant, and that expected weight differs from current weight only by a constant monthly growth rate, ρ. Therefore:

(3)
$$Q^*_{t+1} = (\bar{Q}_t - Q_t)(1 - \delta),$$
$$H^*_{t+1} = H_t(1 + \rho).$$

Using (2) and (3), the desired number of cattle to market at time t solves:

(4)
$$\hat{Q}_t \in \underset{Q_t}{\operatorname{argmax}} \{R_t Q_t + R^*_{t+1}(\bar{Q}_t - Q_t)\phi - C(W_t, \bar{Q}_t - Q_t);\ \ 0 \le Q_t \le \bar{Q}_t\}$$

where $\phi = (1 - \delta)(1 + \rho)$ and $C(W_t, \cdot) = c(W_t, \cdot)$.

To obtain an econometric specification to explain Q_t we follow the standard procedure used in estimating adjustment cost models and postulate the following linear approximation of the cattle feeder's desired marketings:

(5)
$$\hat{Q}_t = \alpha_0 + \alpha_1 R_t + \alpha_2 R^*_{t+1} + \alpha_3 W_{c,t} + \sum_{j=5}^{15} \alpha_j D_j,$$

where $W_{c,t}$ is the price of corn at time t — used as a proxy for the price of feed, the D_j's are monthly dummy variables, and the α's are estimable parameters. Using (1) and (5), the econometric specification of the industry's marketings is:

$$Q_t = \gamma\alpha_0 + \gamma\alpha_1 R_t + \gamma\alpha_2 R^*_{t+1} + \gamma\alpha_3 W_{c,t} + (1 - \gamma)Q_{t-1} + \sum_{i=5}^{15} \gamma\alpha_j D_j + u_t,$$

or

(6)
$$Q_t = \beta_0 + \beta_1 R_t + \beta_2 R^*_{t+1} + \beta_3 W_{c,t} + \beta_4 Q_{t-1} + \sum_{i=5}^{15} \beta_j D_j + u_t,$$

where u_t is the error term and the β's are the parameters to be estimated; with $\beta_4 = (1 - \gamma)$, and $\beta_j = \gamma\,\alpha_j$, $j \ne 4$.

Data

From January 1973 through October 1987 the average weight of cattle slaughtered in the United States ranged between 972 and 1121 pounds, with a mean value of 1058 pounds. R_t is measured as average weight of cattle marketed each month (H_t) times the mid-month cash price of cattle. R^*_{t+1} is measures as the nearest futures price (appropriately discounted by the returns to treasury bills) times H_t times ρ = 2.8 pounds per day (average weight gain) times the number of days to delivery on the futures contract.

The data used for the variable of equation (6) are described in Table 1. The observations are monthly, from January 1973 through October 1987. It is assumed that R^*_{t+1} is endogenous. The truncated two stage least squares estimation procedure is employed to estimate equation (6). To identify the equation we use the fact that the demand for fed cattle is a derived demand from the wholesale demand of beef, and supply depends on earlier placements of feeder cattle. We do not attempt to identify the entire structural system, but simply use determinants of demand and supply as instruments. The exogenous variables in reduced-form regression are the spot price of corn, the returns on 6 month treasury bills, the beginning month's inventory of total cattle on feed, the beginning month's inventory of beef in cold storage, feeder cattle placements lagged 1 to 6 months, fed cattle marketings lagged 1 to 3 months, the wholesale price of beef, the wholesale price of pork, an index of beef byproduct values, and the monthly dummy variables.

Table 1. Data for regression analysis

Variable	Definition	Source
Q_t	total head of cattle marketed in thousands	USDA (1983, 1988)
H_t	average weight of cattle marketed	USDA (1983, 1988)
R_t	market value of fed cattle, dollars/head	calculated using W_t and Wall Street Journal mid-month Omaha steer price
R_t^*	capital or investment value of fed cattle, dollars/head	calculated using Wall Street Journal futures price at mid-month
W_c	spot price of corn, cents/bushel	Wall Street Journal (1978-1987), Chicago Mercantile Exchange Yearbook (1973-1977)
Instrumental variables:		
Interest rate on short term (6 month) treasury notes		Wall Street Journal
Previous month's inventory (end of month) of total cattle on feed in thousands		USDA (1983, 1988)
Lagged cattle placed on feed		"
Inventory of beef in cold storage		"
Wholesale price of beef		"
Wholesale price of pork		"
Beef byproduct value index		"

Results of Estimation

Table 2 shows the T2SLS results. All coefficients are of the expected signs. The coefficients on current and expected revenues, and lagged marketings are significant. Total marketings are increasing in current revenues and decreasing in expected revenues. The elasticities of marketings with respect to expected revenues and current revenues are -1.67 and 1.63 respectively. The signs are consistent with what we expect to see in the separate effects of actual and expected market forces. When making marketing decisions, cattle feeders are reacting to both actual market conditions and to their expectations on the market conditions to obtain in the near future. The respective elasticities measure responses to actual guaranteed revenues if selling today and to expected revenues if holding the cattle longer.

These results lend some insight into the causes underlying the negative elasticities estimated in studies mentioned earlier. Both spot and expected prices move very closely together (correlation coefficient = 0.91). Apparently using only one price to capture the effects of prices (revenues) on marketings confounds the effects and measures only the dominant effect, in this case the response to expected revenues. Note that if both the spot and expected future prices change by the same amount, the effect on marketings is small (-0.04) and not significantly different from zero. This implies that once cattle reach market weight, they will be sold either in the current month or by the delivery date of the next earliest futures contract (1 or 2 months) regardless of price. Corn prices are insignificant. The seasonal dummy variables' coefficients do not exhibit a strong seasonal pattern.

The coefficient on the lagged cattle marketings is significant, with a value of 0.69 implying the coefficient of adjustment γ in equation (1) is equal to 0.31. Shonkwiler and Hinkley estimated that the coefficient of adjustment associated with cattle placements was 0.63.

Table 2. Results of T2SLS Estimation of Cattle Marketings

Variable	Regression Coefficient	t-ratio
β_0 Constant	449	3.96
β_1 Expected revenue	-9.23	-2.96
β_2 Current revenue	9.89	2.95
β_3 Corn price	-12.1	-0.48
β_4 Lagged cattle marketings	.643	10.1
β_5 January dummy	302	5.59
β_6 February dummy	-96	-2.25
β_7 March dummy	264	4.03
β_8 April dummy	-25	-.63
β_9 May dummy	210	2.92
β_{10} June dummy	28	.71
β_{11} July dummy	155	2.26
β_{12} August dummy	122	3.09
β_{13} September dummy	146	2.27
β_{14} October dummy	110	2.80
β_{15} November dummy	-66	.97
$\bar{R}^2$	.42	
Durbin-Watson Statistic	2.28	
Degrees of Freedom	169	

Capacity and/or marketing constraint may be binding constraints for cattle feeders as for cattle placements. In our case the marketing constraint is likely to play a more important role, but our data do not permit the separation of these two sources of lagged adjustment. Under the assumption that the futures prices measure expected prices we can, however, rule out the adaptive expectations interpretation of the lagged dependent variable.

Conclusions

While cash and nearby futures prices of cattle are correlated, we are able use futures prices to estimate separate effects of current and expected future revenues resources from fed cattle. We find a positive own-price supply elasticity of current marketings in response to current price. We further find empirical support for the conjecture often given for observed negative supply elasticities in simple regressions of cattle marketings on cattle price; namely, the current price is also incorporating the effect of near-term expected future prices. When we introduce a separate variable to measure expectation of price, a positive effect of current price on current marketing emerges.

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