[redacted]

Working Papers

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
SYMONS HALL
UNIVERSITY OF MARYLAND
COLLEGE PARK 20742

[redacted]

Expectations, Futures Prices, and Feedlot Operator Behavior

by

Rodney Smith and Bruce L. Gardner

Department of Agricultural and Resource Economics
University of Maryland
College Park, Maryland 20742

Working Paper No. 92-16

September 1992

The authors are graduate student and professor, respectively, in the Department of Agricultural and Resource Economics, University of Maryland, College Park, MD 20742.

EXPECTATIONS, FUTURES PRICES, AND FEEDLOT OPERATOR BEHAVIOR

Introduction

This paper attempts to improve our understanding of the effects of market prices on cattle marketing decisions. Following Shonkwiler and Hinkley (1985) and Tronstad and McNeil (1989), we use future prices as measures of unobserved price expectations. This approach enables us to distinguish between the effects of current cash price and nearby expected future prices. 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 considering cash and futures prices simultaneously we hope to separate these two effects.

Previous Research

Myers, Havlicek and Henderson (1970) and Brester and Marsh (1970) 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 Marketing Decision

Cattle feeders are assumed to make marketing decisions with an objective of maximizing expected profits. Risk preferences are not incorporated because the main market risks are short-term price fluctuations that can be hedged against using the same futures prices that we use as an indicator of price expectations. As Feder, Just and Schmitz (1980) show, a risk-averse, utility maximizing firm will equate marginal cost to the futures price, not the firm's own expectation of cash prices, in making production decisions.

At time t a feedlot's cattle are assumed to be physically ready for market as fed steers (over 900 pounds in weight). The market value of the cattle at time t is

$$V_t = P_t\, Q_t\, H_t, \qquad (1)$$

where V_t is the market value of the feedlot's marketable fed cattle at time t, P_t is the market price of fed beef per hundredweight at time t, and Q_t and H_t are, respectively, the number of and average weight of marketable fed cattle on the feedlot at time t. The expected market value of the cattle at time t from holding the cattle on feed for another period — assumed to be one month — is

(2) $${}_tV^*_{t+1} = {}_tP^*_{t+1}\ Q^*_{t+1}\ H^*_{t+1} - C(Q_t;\ W_t,\ Z_t),$$

where ${}_tV^*_{t+1}$ is the expected value at time t from holding the cattle until t + 1; ${}_tP^*_{t+1}$ is the expected price per hundredweight of fed beef at time t + 1; Q^*_{t+1} is the expected number of cattle marketed at t + 1; and H^*_{t+1} is the expected average weight per animal at t + 1. $C(Q_t;\ W_t,\ Z_t)$ is the cost function for feeding the Q_t cattle an additional month. The costs are divided into variable and fixed costs, with factor prices of variable and quantities of fixed factors represented by the vectors W_t and Z_t, respectively. The main variable cost is feed, which changes with the number of cattle held. The main fixed costs are feedlot space and marketing capacity. (If the sale date were fixed in advance, then new calves could be placed in feedlots just after the fed cattle were marketed, so there would be no idle feedlot capacity. But the decision here is at time t — the decision whether to market at the current date, given conditions observed at that date.)

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

$$Q^*_{t+1} = Q_t(1 - \delta)$$

$$H^*_{t+1} = H_t(1 + \rho).$$

The expected profit from selling at t rather than t + 1 is given by subtracting equation (2) from equation (1):

(3) $$\Pi_t^* = P_t Q_t H_t - {}_tP^*_{t+1} Q_t (1 - \delta) H_t(1 + \rho) + C(Q_t; W_t, Z_t).$$

To obtain the supply of marketed cattle to maximize expected profits at time t, differentiate (3) with respect to Q_t (by Hotelling's lemma):

(4) $$Q_t = P_tH_t - {}_tP^*_{t+1} (1 - \delta) H_t (1 + \rho) + \partial C/\partial Q_t + (\partial C/\partial Z_t)*(\partial Z_t/\partial Q_t).$$

where $\partial C/\partial Q_t$ is marginal variable cost, measured by feed prices, and $(\partial C/\partial Z_t)*(\partial Z_t/\partial Q_t)$ measures the effective constraint imposed by feedlot or marketing capacity.

We obtain an econometric specification of the cost function by postulating that when a change in the marketing pattern is indicated by current as compared to expected revenue, capacity constraints may prevent a full adjustment at time t. This situation is modelled as:

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

i.e., the observed change in marketings is a fraction, γ, of the difference between desired marketings and last month's marketings, where $\hat{Q}_t$ is desired marketings at time t (if there were no capacity constraint). Adding Q_{t-1} to both sides,

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

Since $\hat{Q}_t$ is just the expected profit-maximizing Q_t from equation (4), the lagged dependent variable replaces Z_t in (4) to estimate the effect of capacity constraints.

With the substitution of the lagged dependent variable for Z_t in equation (4), we have the linear regression equation

(7) $$Q_t = \beta_0 + \beta_1 R_t + \beta_{2t} R^*_{t+1} + \beta_3 W_c + \beta_4 Q_{t-1} + \sum_{i=5}^{15} \beta_j D_j$$

Equation (7) is expressed in terms of head of cattle as units of Q_t. The corresponding price is R_t, revenue per head, $= P_tH_t$. From January 1973 through October 1987 the average weight of cattle slaughtered in the U.S. (48 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. ${}_tR^*_{t+1}$ is measured as the nearest futures price times H_t times 2.8 pounds per day (average weight gain) times the number of days to delivery on the futures contract. W_c is the price of corn, the D_j are monthly dummies, and the β's are parameters to be estimated.

Data

The data used to estimate equation (7) 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 (7). 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.

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 is expected, since once cattle reach market weight, they will be sold in a relatively short period of time 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 (5) is equal to 0.31. Shonkwhiler and Hinkley estimated that the coefficient of adjustment associated with cattle placements was 0.63. 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.

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	

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		"

References

Brester, G.W. and J.M. Marsh (1970)

Feder, G., R. Just and A. Schmitz. "Futures Markets and the Theory of the Firm Under Price Uncertainty," *Quarterly Journal of Economics* 94(1980):317-328.

Gardner, B.L. "Futures Prices in Supply Analysis," *American Journal of Agricultural Economics* 58(1976):81-84.

Hayenga, M.L. and D. Hacklander. "Monthly Supply-Demand Relationships for Fed Cattle and Hogs," *American Journal of Agricultural Economics* 52(1970):535-544.

Hurt, C.A. and P. Garcia. "The Impact of Price Risk on Sow Farrowings," *American Journal of Agricultural Economics* 64(1982):565-568.

Jarvis, Lovell S. "Cattle as Capital Goods and Ranchers as Portfolio Managers," *Journal of Political Economy* 82(1974):489-520.

Kolb, R.W. and G.D. Gay. "The Performance of Live Cattle Futures as Predictors of Subsequent Spot Prices," *The Journal of Futures Markets* 3(1983):55-63.

Myers, L.H., J. Havlicek Jr. and P.L. Henderson. "Short-term Price Structure of the Hog-pork Sector of the United States," Purdue University Research Bulletin 855, February 1970.

Nelson, G. and T. Spreen. "Monthly Steer and Heifer Supply," *American Journal of Agricultural Economics* 60(1978):117-125.

Ospina, E. and C.R. Shumway. "Disaggregated Analysis of Short-run Beef Supply Response," *Western Journal of Agricultural Economics* 4(1979):43-59.

Shonkwiler, J.S. and S. Hinkley. "A Generalized Supply Reponse/Factor Demand Model and Its Application to the Feeder Cattle Industry," *Western Journal of Agricultural Economics* 10(1985):245-253.

Tronstad and McNeil. "Asymmetric Price Risk: An Econometric Analysis of Aggregate Sow Farrowings," *American Journal of Agricultural Economics* 71(1989):630-637.

Tryflos, P. "Canadian Supply Functions for Livestock and Meat," *American Journal of Agricultural Economics* 56(1974):107-113.

futures1.wp/lt/9-18-92