Journal of Agricultural and Resource Economics 30(3):580–596

Price Discovery and Pricing Choice Under Divergent Supply Scenarios in an Experimental Market for Fed Cattle

Clement E. Ward

Previous research has not addressed the impacts of alternative supply conditions on price discovery and pricing choice. This study estimated models with data from an experimental market, the *Fed Cattle Market Simulator*, encompassing live weight, dressed weight, and grid pricing under two alternative supply scenarios. Significance of variables explaining transaction price variation and pricing choice differed between the two supply periods. Overall results were close to expectations. Higher quality cattle marketed with a grid brought higher prices in both supply periods. Having lower quality cattle in either supply period increased the probability of cattle being marketed (purchased) on a live weight basis.

Key words: experimental market, fed cattle, market simulator, price discovery, pricing choice, pricing methods

Introduction

Thomsen and Foote (1952) defined price discovery over a half century ago as the process of arriving at transaction prices for a given quality and quantity of a commodity at a given time and place. Relatively little earlier research has focused on estimating price discovery models for fed cattle using industry transaction data (in chronological order: Ward, 1981, 1992; Jones et al., 1992; Schroeder et al., 1993; Ward, Koontz, and Schroeder, 1998; Schroeter and Azzam, 2003). Typically, transaction data are difficult to obtain, especially given the market structure trend toward increased consolidation, and data collection often requires regulatory agency intervention. For example, the USDA's Grain Inspection, Packers and Stockyards Administration (GIPSA) was responsible for acquiring data in the two most recent studies mentioned above.

Only a single pricing choice model has been estimated for fed cattle (Capps et al., 1999), also with data collected by GIPSA from packers. Their 1992–93 data period preceded the rapid shift to value-based pricing or grid pricing which occurred between 1996 and 2001 (Schroeder et al., 2002). During that five-year study period, cattle feeders indicated increasing the proportion of fed cattle marketed with a grid from 16% to 45%, and anticipated grid pricing to reach 62% by 2006.

Considerable research has been conducted on grid pricing of fed cattle (in chronological order: Feuz, Fausti, and Wagner, 1993, 1995; Fausti and Feuz, 1995; Feuz, 1999; Schroeder and Graff, 2000; Anderson and Zeuli, 2001; Fausti and Qasmi, 2002; Whitley,

---

Clement E. Ward is professor and extension economist, Department of Agricultural Economics, Oklahoma State University.
Review coordinated by DeeVon Bailey.

2003; McDonald and Schroeder, 2003). Most studies focus on price, revenue, and profit variability; risk and risk transfer from buyers to sellers; market signals associated with grid pricing; and comparisons between grid prices and alternative pricing methods. No research has yet addressed factors affecting the choice of pricing methods and how these dynamics change under alternative market supply conditions.

Price discovery models estimated with data from the *Fed Cattle Market Simulator* (*FCMS*) (Ward et al., 1996) were patterned after prior research with industry data, and results paralleled findings reported in those studies (Ward, 1981, 1992; Schroeder et al., 1993). As pricing methods in the industry changed, substantive changes were required of the *FCMS*. Three genetic types of fed cattle with differing carcass characteristics were incorporated into the market simulator (instead of one genetic type) to more closely mimic cattle variability evident in the industry (Hogan et al., 2003). Dressed weight and grid pricing alternatives were included in addition to live weight and forward contract pricing. The combined result significantly expanded decision making for simulator participants, who now had to market three genetic types of cattle at up to five weights and by up to four cash-market pricing methods. These changes substantially influenced price discovery and pricing choice by market simulator participants.

No price discovery models have explicitly incorporated grid pricing, nor have any models explicitly considered how factors affecting price discovery change during periods of higher or lower supplies of cattle, as in a cattle cycle. Neither have pricing choice models been estimated to determine how pricing choice among several alternatives may change under divergent supply conditions. Consequently, two objectives were established for this research: (*a*) to determine factors affecting price discovery in an experimental market for fed cattle under varying supply conditions, specifically incorporating alternative pricing methods and qualities of fed cattle; and (*b*) to determine the choice of pricing method by market simulator participants under varying supply conditions.

Price Discovery, Pricing Choice, Grid Pricing, and Related Literature

Two approaches to price discovery were developed by Carlberg and Ward (2003)—derived demand and partial adjustment. Essentially all price discovery research for fed cattle follows the derived demand approach. Table 1 provides a general summary and comparison of published research cited above related to identification of factors affecting transaction prices for fed cattle.[1]

As detailed in table 1, the comparison shows considerable similarity across studies with some differences being dependent on model objectives. Nearly all variables listed in each study were statistically significant in one or more models estimated. Therefore, variables included to explain variation in fed cattle transaction prices were similar, and significance of those variables was relatively consistent. However, coefficients and elasticities varied because data periods and other characteristics of the studies differed. Carlberg and Ward (2003) report that derived demand models should include variables capturing general demand and supply conditions plus quantity, quality, time, and space variables specific to each discovered price.

[1] Note that in preparing table 1, the author has claimed the prerogative to simplify categorization of variables in the cited studies. Thus, readers are cautioned to consult the original articles for exact variable definitions.

Table 1. Summary and Comparison of Relevant Fed Cattle Price Discovery Research

	Author(s) of Fed Cattle Price Discovery Research			
Study Attribute	**Ward (1981)**	**Ward (1992)**	**Jones et al. (1992)**	**Schroeder et al. (1993)**
Observation Unit	Transaction Price	Transaction Price	Transaction Price Differences	Transaction Price
No. Observations	344	656	1,376	1,407
Market Area	Local	Local	Regional	Regional
Data Period	July 1979	June 1989	May–Nov. 1980	May–Nov. 1980
Independent Variables [a]	▸ Wholesale Value ▸ Futures Market Price ▸ Quality Grade ▸ Weight ▸ Yield ▸ Sale Lot Size ▸ Distance ▸ Forward Purchase ▸ Bargaining Range ▸ Number of Bids ▸ Number of Bidders ▸ Sub-markets [b]	▸ Wholesale Value ▸ Futures Market Price ▸ Quality Grade ▸ Sex [b] ▸ Sale Lot Size ▸ Forward Purchase ▸ Day of Week [b] ▸ Number of Bidders ▸ Buyer [b]	▸ Quality Grade ▸ Yield Grade ▸ Weight ▸ Yield ▸ Sex [b] ▸ Uniformity [b] ▸ Sale Lot Size ▸ Days on Feed ▸ Brands ▸ Breed [b] ▸ Day of Week [b] ▸ Distance ▸ Forward Purchase ▸ Feedlot [b] ▸ Buyer [b] ▸ Number of Bids	▸ Wholesale Value ▸ Futures Market Price ▸ Total Marketings ▸ Quality Grade ▸ Yield Grade ▸ Weight ▸ Yield ▸ Sex [b] ▸ Uniformity [b] ▸ Sale Lot Size ▸ Brands ▸ Breed [b] ▸ Day of Week [b] ▸ Distance ▸ Forward Purchase ▸ Buyer [b] ▸ Forward Contracted

[a] Readers are cautioned that variables may be defined differently across studies. Thus, readers are strongly encouraged to refer to each article for exact variable definitions.
[b] Designates a discrete variable.
[c] Average of observations over three semesters of 60 trading weeks each.

The sole pricing choice study for fed cattle (Capps et al., 1999) had two components. One model considered the choice of procurement method: cash market, marketing agreement, forward contract, and packer-owned cattle. The second model, of most importance here, considered the choice of pricing method: live weight, carcass (or dressed) weight, and formula. Independent variables were similar to the lists shown in table 1. One variable not included in the models compared in table 1 was the Herfindahl index. All other variables were present in one or more of the studies summarized in table 1.

Early research on alternative pricing methods for fed cattle documented the shift in risk when moving from live weight pricing to carcass weight pricing to grid pricing (Ward, 1987; Feuz, Fausti, and Wagner, 1993, 1995; Fausti and Feuz, 1995). Commensurate with the shifting of risk to cattle feeders from packers, there exists the opportunity for larger returns. Research has documented and verified this risk-return tradeoff. In addition, however, research confirms that grid pricing increases the variability of prices, revenue, and profits (Anderson and Zeuli, 2001; McDonald and Schroeder, 2003). Variability is introduced in many ways, including the base price, premiums-discounts for carcass traits, and carcass attributes of cattle sold.

The price-signaling function of grids, or pricing accuracy, has been addressed in several studies and is of particular interest to economists in assessing the effectiveness

Table 1. Extended

	Author(s) of Fed Cattle Price Discovery Research			
Study Attribute	**Ward et al. (1996)**	**Ward, Koontz, and Schroeder (1998)**	**Schroeter and Azzam (2003)**	**Carlberg and Ward (2003)**
Observation Unit	Transaction Price	Transaction Price	Transaction Price Differences	Transaction Price
No. Observations	2,682	139,189	17,846	2,202 [c]
Market Area	Experimental Market	National	Regional	Experimental Market
Data Period	72 weeks	Apr. 1992–Apr. 1993	Feb. 1995–May 1996	60 weeks [c]
Independent Variables [a]	▸ Wholesale Value ▸ Futures Market Price ▸ Show List Inventory ▸ Total Marketings ▸ Estimated Profit Margin ▸ Weight [b] ▸ Cash/Contract [b] ▸ Feedlot [b] ▸ Buyer [b] ▸ Forward Contracted [b]	▸ Wholesale Value ▸ Futures Market Price ▸ Quality Grade ▸ Yield Grade ▸ Sex [b] ▸ Weight ▸ Sale Lot Size ▸ Forward Purchase ▸ Day of Week [b] ▸ Plant Utilization ▸ Plant [b] ▸ Pricing Method [b] ▸ Time [b]	▸ Quality Grade ▸ Yield Grade ▸ Yield ▸ Weight ▸ Sex [b] ▸ Number of Head ▸ Distance ▸ Day of Week [b] ▸ Captive Supplies	▸ Wholesale Value ▸ Futures Market Price ▸ Show List Inventory ▸ Total Marketings ▸ Weight [b] ▸ Cash/Contract [b] ▸ Feedlot [b] ▸ Buyer [b]

of grid pricing in achieving pricing-to-value objectives. A central question is whether or not grids send signals clearly and efficiently, and thereby provide the incentives which many ascribe to grid pricing (Feuz, 1999; Fausti and Qasmi, 2002). Nearly all grid pricing research identifies the importance of carcass weight, the Choice-Select price difference, and yield grade 3-4 price difference.

Considerable additional research is directly or tangentially relevant to the focus of this analysis on price discovery and pricing choice. Examples include price discovery in a more aggregated context than transaction prices (Hudson and Purcell, 1985); valuation inaccuracies in purchasing fed cattle (Faminow, de Matos, and Richmond, 1996); buyer-seller relationships and implications for competition (Hunnicutt, Bailey, and Crook, 2004; Crespi and Sexton, 2004); and formula pricing of the base price in grids and implications for transaction prices from delivery of captive supply cattle (Xia and Sexton, 2004; Schroeter and Azzam, 2004). However, the core literature of importance remains the studies identified in table 1.

Data and Procedures

Data for the models estimated were generated in a day-and-a-half-long workshop with employees of Cargill Meat Solutions in January 2004. Employee-participants consisted of feedlot managers from Caprock Industries (Cargill's cattle-feeding entity), and cattle buyers, meat and byproducts salespersons, and plant and corporate personnel (including

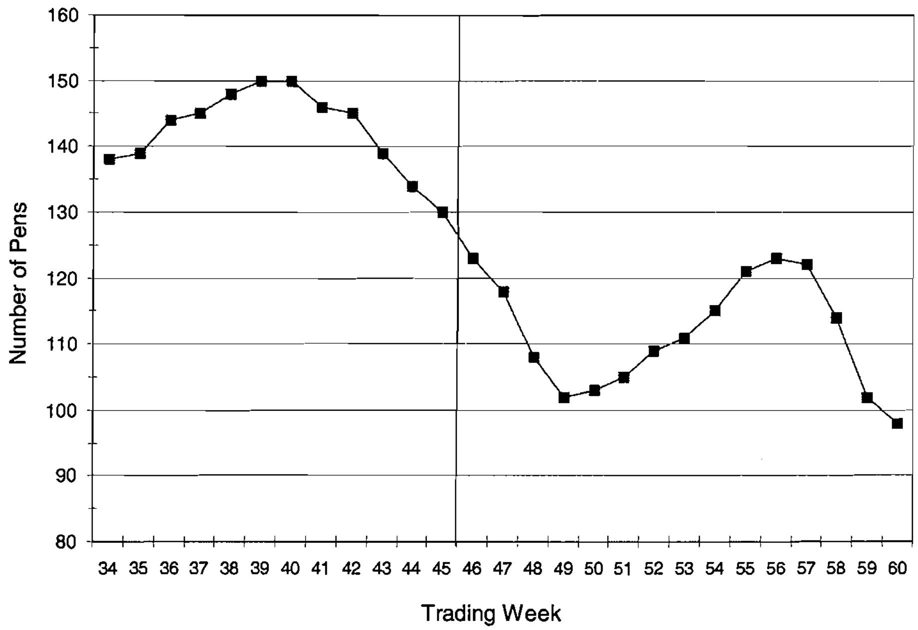

Figure 1. Show list inventory periods, by trading week

information technology, quality control, transportation, and human resources) from Excel Corporation (Cargill's meatpacking entity). As is customary for *FCMS* workshops, the workshop was conducted with a typical starting point (week 21 of the simulator), a learning period beginning with live weight pricing only, then progressing to dressed weight pricing only, and subsequently to grid pricing only, before allowing participants to choose any pricing method. Data collection began in week 34 after the learning period ended, and extended through week 60. The unit of observation is a transaction for one pen of fed steers. Total transactions numbered 1,066.

A derived demand model was specified and estimated with individual transaction prices as the dependent variable. Independent variables were similar to previous price discovery research, but included variables unique to this study—e.g., cattle genetic type and pricing method. Workshop data were divided into two groups of nearly equal trading duration, i.e., a high-supply period (weeks 34 to 45) and a low-supply period (weeks 46 to 60) (figure 1). The show list inventory each week of the high-supply period exceeded that for each week of the low-supply period. The same model specification was estimated separately for each supply period and the two combined periods.

A multinomial logit model was specified and estimated, with the dependent variable being the choice of pricing fed cattle by live weight, dressed weight, or grid. The objective was to determine factors affecting choice of alternative pricing methods. Independent variables were similar to those reported in Capps et al. (1999) but without their focus on buyer competition and excluding variables unique to their study (such as seasonality and distance to buyer). The model specified here was also estimated separately for high-supply and low-supply periods and for the entire data period.

Table 2 provides a summary of the data for the two supply periods. During the high-supply period, live weight and dressed weight prices for fed cattle and boxed beef prices were significantly lower than under the low-supply period based on a t-test of sample

Table 2. Mean Values for Selected Variables, by Supply Period: Cargill Meat Solutions Workshop, January 2004

Variable	High-Supply Period	Low-Supply Period
Live-weight fed cattle price ($/cwt)*	72.25	79.82
Dressed-weight fed cattle price ($/cwt)*	114.55	126.47
Weekly marketings/slaughter (number of pens)*	42.80	37.30
Boxed beef price ($/cwt)*	116.28	122.30
Show list inventory (number of pens)*	142.50	111.50
Choice-Select price difference ($/cwt)*	-4.97	-5.18
Yield grade 3-4/5 price difference ($/cwt)**	-10.02	-9.94

* Denotes significant mean difference based on t-test at the 0.01 level with *unequal* variances.
** Denotes significant mean difference based on t-test at the 0.01 level with *equal* variances.

means. Conversely, but as expected, weekly marketings (or slaughter) and the show list inventory of cattle available for sale were significantly higher during the high-supply period than during the low-supply period. The Choice-Select price difference was significantly lower during the high-supply period, while the yield grade 3-4/5 price difference was higher. Both price differences are dependent on the show list inventory and marketing/slaughter weight (Hogan et al., 2003).

Table 3 shows the distribution of transactions by pricing method for the two data periods. Chi-square tests indicated significant differences in how simulator participants priced fed cattle during the high-supply and low-supply periods. Grid pricing was more prevalent during both periods, both absolutely and relatively, followed by live weight pricing in the high-supply period and dressed weight pricing in the low-supply period. Forward contracting increased absolutely and relatively during the low-supply period compared with the high-supply period.

Models Estimated

Price Discovery Model

Carlberg and Ward (2003) offer a theoretical foundation for the price discovery model specified here. They draw from Tomek and Robinson's (1990) discussion of derived demand and Ladd and Martin's (1976) discussion of the value of an input, and apply it to the price of fed cattle. From a production function for boxed beef and the profit function for a beef packing firm, Carlberg and Ward derive the first-order condition for the profit-maximizing use of the fed cattle input into boxed beef production. Thus,

$$p_i = \sum_{j=1}^{n} T_{jB}\left(\partial \varphi_{jB} / \partial x_{iB}\right), \tag{1}$$

where the price (p) of input i is the sum of the imputed price (T) for each input times the marginal yield for the jth input characteristic ($\partial \varphi_{jB} / \partial x_{iB}$) of input x used in the production of boxed beef (B). The empirical derived demand model includes the value of input characteristics to the buyer and input demand factors, including supply conditions.

Table 3. Cash and Contract Pricing, by Supply Period: Cargill Meat Solutions Workshop, January 2004

Variable		High-Supply Period	Low-Supply Period
		— Number of Transactions —	
Cash Pricing Method:*	Live Weight	133	52
	Dressed Weight	125	184
	Grid	259	313
Cash vs. Contract Pricing:*	Cash	453	376
	Forward Contract	64	173

* Denotes significant mean difference in χ^2 at the 0.01 significance level.

Variables chosen were similar to models estimated in studies compared in table 1. The objective was to determine factors affecting the variation in live weight, cash market prices for fed cattle in the market simulator with specific interest in interdependent effects related to pricing methods and genetic types. The model estimated is given by:

$$(2)\qquad Price_i = \alpha + B_1 BoxedBeef_{t-1} + B_2 ShowList_t + \sum_{j=1}^{4} B_{3j} LiveWt_j + \sum_{j=1}^{3}\sum_{k=1}^{3} B_{4jk} MethodGenetics_{jk} + \sum_{j=1}^{2} B_{5j} TransactionType_j + \sum_{j=1}^{8} B_{6j} Feedlot_j + \sum_{j=1}^{4} B_{7j} Packer_j,$$

where variables are defined in table 4. The coefficient sign on *BoxedBeef* was expected to be positive (table 4) based on derived demand theory, while the expected sign for the *ShowList* or supply variable was negative. Previous research with experimental market data (Ward et al., 1996) found a negative relationship for lighter and heavier weights of fed cattle (*LiveWt*) relative to the base weight of 1,150 pounds. Live weight transactions and lower genetic type cattle (*MethodGenetics*) were expected to result in lower prices compared with the base category, i.e., dressed weight transactions and medium genetic type cattle. Higher prices were expected for transactions priced by a grid and for higher genetic type cattle. Carlton (1979) showed that uncertainty and transaction costs are incentives to use contracts. Previous research with experimental market data found contract prices may be higher or lower than cash prices (*TransactionType*), depending in large part on participant behavior (Carlberg and Ward, 2003; Ward et al., 1996). Mixed positive and negative signs were expected for *Feedlot* and *Packer* participants, as in previous research (Carlberg and Ward, 2003; Ward et al., 1996). Simply stated, some teams managed their marketing or procurement business more effectively than others.

Equation (2) was estimated by feasible generalized least squares (FGLS) in SAS (SAS Institute, Inc., 2002–03) to account for heteroskedasticity inherent in cross-section, time-series data. Live weight prices were converted to dressed weight prices based on the known dressing percentage for each genetic type and each weight of fed cattle in the market simulator. Net grid prices were the negotiated dressed weight base prices plus premiums and discounts for known carcass characteristics in the simulator. A fixed

Table 4. Definition of FGLS and MNL Variables and Their Expected Signs

Variable	Variable Definition	Expected Sign
Dependent Variables:		
$Price_i$	Transaction price ($/cwt) for the ith pen of fed cattle	N/A
$PricingMethod_{ij}$	Pricing method choice j for the ith pen of fed cattle; j = 1–3, where 1 = live weight, 2 = dressed weight, and 3 = grid	N/A
Independent Variables:		
$BoxedBeef_{t-1}$	Boxed beef price in period $t-1$ ($/cwt)	+
$ShowList_t$	Inventory of pens available for sale (1,100 to 1,200 lbs.) in week t	–
$LiveWt_{ij}$	Zero-one dummy variable for weight of fed cattle sold for the ith pen of fed cattle; j = 1–4, where 1 = 1,125 lbs., 2 = 1,150 lbs., 3 = 1,175 lbs., and 4 = 1,200 lbs.; base = 1,150 lbs.	–
$MethodGenetics_{ijk}$	Zero-one dummy variable for pricing method j and genetic type k interaction for the ith pen of fed cattle; j = 1–3, where 1 = live weight, 2 = dressed weight, and 3 = grid; k = 1–3, where 1 = low genetic type, 2 = medium genetic type, and 3 = high genetic type; base = dressed weight, medium genetic type	+/–
$GeneticType_{ij}$	Zero-one dummy variable for genetic type j for the ith pen of fed cattle; j = 1–3, where 1 = low genetic type, 2 = medium genetic type, and 3 = high genetic type; base = medium genetic type	+/–
$TransactionType_j$	Zero-one dummy variable for type of transaction; j = 1–2, where 1 = cash and 2 = forward contract; base = cash	–
$Feedlot_j$	Zero-one dummy variable for feedlot team; j = 1–8, where 1 = team #1, 2 = team #2, ..., 8 = team #8; base = 8	+/–
$Packer_j$	Zero-one dummy variable for packer team; j = 1–4, where 1 = team #1, 2 = team #2, ..., 4 = team #4; base = 4	+/–
$ChoiceSelect_t$	Price difference ($/cwt) between Choice and Select carcasses in week t	–
$YG3YG4/5_t$	Price difference ($/cwt) between yield grade 3 and yield grade 4/5 carcasses in week t	–

premium of $8/cwt was assumed for prime carcasses, a fixed premium of $4/cwt for yield grade 1-2 carcasses, and a fixed $10/cwt discount for light and heavy carcasses. Discounts for Select and yield grade 4/5 carcasses were dependent on market conditions (Hogan et al., 2003).

Pricing Choice Model

Capps et al. (1999) present the theoretical rationale for a multinominal logit (MNL) model applied to choice of pricing methods for fed cattle. They estimate a model specified after Ward (1981) and related work in which procurement and pricing methods were dependent on factors affecting fed cattle prices. Vergara et al. (2004) address pricing choice for cotton and cite related research for other commodities. The objective here was to determine the probability of pricing fed cattle by alternative methods.[2]

[2] An ordered logit (OL) model was estimated, but results are not reported here. Rationale for the OL model was that moving from live weight to dressed weight to grid pricing represents a shift in risk acceptance from the packer to the feeder (Ward, 1987; Feuz, Fausti, and Wagner, 1995), thus also representing an ordering in terms of risk tolerance or acceptance by cattle feeders. The MNL model was deemed preferable versus an OL model to directly compare the probability of pricing fed cattle by live weight or dressed weight versus a grid.

The pricing choice model estimated is written as:

$$(3)\qquad PricingMethod_{ij} = \alpha + B_1 BoxedBeef_{t-1} + B_2 ShowList_t + \sum_{j=1}^{4} B_{3j} LiveWt_j + \sum_{j=1}^{3} B_{4j} GeneticType_j + \sum_{j=1}^{2} B_{5j} TransactionType_j + B_6 ChoiceSelect_t + B_7 YG3YG4/5_t + \sum_{j=1}^{8} B_{8j} Feedlot_j + \sum_{j=1}^{4} B_{9j} Packer_j,$$

where variables are defined in table 4. Expected signs were discussed for most variables in equation (2). The *ChoiceSelect* variable is expected to be inversely related to price, thus to choice of pricing method. As the discount for Select grade carcasses increases, the net grid price is expected to decline, suggesting a preference for dressed weight or live weight pricing. Similarly, though the net effect is frequently smaller for a given mix of carcasses, as the discount for yield grade 4/5 carcasses increases (*YG3YG4/5*), the net grid price declines and feeders could be expected to choose dressed weight or live weight pricing. Estimation of equation (3) was by maximum likelihood in SAS (SAS Institute, Inc., 2002–03).

Results

Price Discovery Model

The explanatory power of the price discovery model differed among the three estimation periods, i.e., two supply periods and the combined period. The model explained variation in transaction prices better in the low-supply period (adjusted $R^2 = 0.953$) than in the high-supply period (adjusted $R^2 = 0.776$) or the combined period (adjusted $R^2 = 0.902$). The ability to explain variation in transaction prices was robust across periods for some variables, while not for others. Results are presented in table 5.

Boxed beef (*BoxedBeef*) behaved in the model as expected. It was positively and significantly related to transaction prices in all three periods, as found typically in previous research.

The inventory of market-ready cattle (*ShowList*) behaved as expected for the combined period but not in each period. The show list coefficient carried the correct sign in the high-supply period but was not significant. In the low-supply period, however, it was positive and significant, which was unexpected for a supply variable in a price-dependent model. Yet, casual observation of workshop participants' behavior during many *FCMS* workshops suggests an explanation. During low supplies, insufficient market-ready cattle are available for all packers to operate each plant at its unique minimum-cost volume. Therefore, any increase in available supplies during a generally low-supply period, rather than depressing prices, stimulates buyer competition to more closely reach the minimum-cost volume, and thus positively affecting transaction prices.

Related to the explanation just proffered is the finding for weights of fed cattle (*LiveWt*). In the high-supply period, ample pens of cattle are available for all packers to

Table 5. Price Discovery Estimation Results

Independent Variable		Coefficient: High-Supply Period	Coefficient: Low-Supply Period	Coefficient: Combined Period
Intercept		6.632*	-90.259***	-46.928***
		(1.85)	(30.47)	(15.86)
$BoxedBeef_{t-1}$		0.949***	1.660***	1.453***
		(33.08)	(78.94)	(66.40)
$ShowList_t$		-0.016	0.108***	-0.052***
		(1.07)	(7.59)	(8.02)
$LiveWt_j$:	1,125 lbs.	N/A	3.210***	3.981***
			(7.13)	(12.75)
	1,150 lbs.	Base	Base	Base
	1,175 lbs.	-1.425***	-0.585*	-0.295
		(5.48)	(1.87)	(1.21)
	1,200 lbs.	-3.806***	-5.557***	-1.197**
		(7.66)	(4.40)	(2.15)
$MethodGenetics_{jk}$:	Live, Low	-0.481	2.441***	0.133
		(1.10)	(3.26)	(0.27)
	Live, Medium	-0.774*	0.397	0.065
		(1.86)	(0.73)	(0.14)
	Live, High	-2.961***	-1.093*	-2.046***
		(5.22)	(1.74)	(3.36)
	Dressed, Low	-0.110	-0.378	-0.284
		(0.32)	(1.00)	(0.68)
	Dressed, Medium	Base	Base	Base
	Dressed, High	0.025	-1.134**	-1.132***
		(0.06)	(2.56)	(2.76)
	Grid, Low	-0.394	-0.047	0.038
		(0.81)	(0.11)	(0.10)
	Grid, Medium	0.123	0.152	0.676**
		(0.36)	(0.41)	(2.14)
	Grid, High	0.851**	0.810*	1.210***
		(2.52)	(1.96)	(3.60)
$TransactionType_j$:	Cash	Base	Base	Base
	Forward Contract	2.90***	0.133	1.687***
		(7.01)	(0.39)	(5.56)
$Feedlot_j$:	#1	-0.961*	1.893***	-0.149
		(1.88)	(4.20)	(0.35)
	#2	-0.157	3.369***	1.055***
		(0.33)	(6.93)	(2.60)
	#3	-0.080	2.935***	0.571
		(0.17)	(7.15)	(1.35)
	#4	-0.063	2.241***	0.390
		(0.12)	(4.22)	(0.87)
	#5	0.630	1.364***	0.450
		(1.16)	(3.45)	(1.01)

(continued . . .)

Table 5. Continued

Independent Variable		Coefficient		
		High-Supply Period	Low-Supply Period	Combined Period
Feedlot$_j$:	#6	0.294	1.322***	0.079
		(0.66)	(2.97)	(0.21)
	#7	1.156**	1.694***	1.535***
		(2.40)	(3.68)	(3.73)
	#8	Base	Base	Base
Packer$_j$:	#1	0.046	-1.082***	-0.728***
		(0.15)	(3.34)	(2.66)
	#2	0.092	0.558	-0.338
		(0.31)	(1.56)	(1.15)
	#3	0.006	-0.349	-0.835***
		(0.02)	(1.10)	(3.05)
	#4	Base	Base	Base
No. of transactions		516	549	1,065
Adjusted R^2		0.776	0.953	0.902

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Numbers in parentheses are absolute values of calculated t-statistics.

meet or exceed their minimum-cost volume; thus, no lighter weight cattle (1,100 and 1,125 pounds) were traded. In the low-supply period, lighter and less finished cattle (1,125 pounds) were marketed or "pulled forward" and were paid a premium consistent with each packer's desire to fill its plant capacity needs. Previous research with market simulator data has consistently found that packers discount heavier cattle, typically less for 1,175-pound cattle than for 1,200-pound cattle. This occurs for two reasons. First, feeders are severely discounted for fed cattle not sold at 1,200 pounds, in part representing the penalty for over-finishing cattle. Second, negotiating strength shifts to packers as fed cattle move into the heavier weight classes, thereby increasing the observed discount for heavier fed cattle, despite the fact that heavier cattle are more economical for packers than lighter cattle. Results here reveal packers significantly discounted 1,175-pound cattle, moreso in the high-supply period than low-supply period ($1.43/cwt versus $0.59/cwt), while the reverse was found for 1,200-pound cattle ($3.81/cwt versus $5.56/cwt).

Of particular interest was the effect on transaction prices from the interaction of pricing method and genetic type (*MethodGenetics*). Many economists familiar with grid pricing recommend marketing higher quality cattle with a grid and lower quality cattle on a live weight basis (ceteris paribus). This relates to the risk acceptance for each pricing method and unknown carcass characteristics of cattle marketed. In the simulated fed cattle market, carcass characteristics are known by feeders and packers, unlike in the real fed cattle market. The general recommendation by economists was borne out in the estimated models to a limited extent. Packers paid a consistently lower price (from $1.09 to $2.96/cwt) for high quality cattle marketed on a live weight basis, regardless of the supply period, compared with the base variable (medium quality cattle priced on a dressed weight basis). Similarly, there was a consistently higher price paid by packers (from \$0.81 to \$1.21/cwt) for higher quality cattle marketed on a grid, regardless of supply period.

During the low-supply period, low quality cattle received a price premium when purchased on a live weight basis (\$2.44/cwt). This may be explained in part by the packers' need for fed cattle, regardless of quality, to meet their plant capacity needs. Thus, packers may have been more attentive to prices paid for other qualities of cattle marketed by alternative methods while paying whatever market conditions dictated to purchase the lower quality cattle, and thereby keep their plant operating as efficiently as possible. This strategy is consistent with a quantity-driven industry characterized by economies of size.

Another variable of interest was the relationship between cash and forward contract prices (*TransactionType*). It could be argued that how buyers and sellers priced forward contracts affected the cash versus contract price relationship. During the high-supply period, the price level trended generally downward. Participants in the *FCMS* typically negotiate forward contract prices in week t (while cattle weigh 1,100 pounds) for delivery in week $t+2$ (when cattle weigh 1,150 pounds). Therefore, as results indicated, forward contracted prices were higher than cash market prices in the high-supply period (\$2.90/cwt). Packers failed to correctly account for the expected market decline, thus paying more for contract prices than negotiated prices in the cash market. The same was not found for the low-supply period, with prices generally trending upward. Cash and forward contract prices were not significantly different, and forward contracting represented a higher percentage of total transactions, again reflecting packers' need to purchase cattle in advance so as to have a number close to their minimum-cost volume.

Previous FCMS research consistently found significant differences among some feedlot (*Feedlot*) and packer (*Packer*) teams. Larger price differences were found during the low-supply period than the high-supply period. One explanation may be that when cattle numbers are smaller, feedlots especially, but packers to a limited extent, have more opportunity to differentiate themselves from their rivals. For feedlots, the base or comparison feedlot (#8) was not significantly larger than other feedlots. However, the comparison packer (#4) was the largest and lowest-cost packer. For the two supply periods combined, the most efficient packer was able to capitalize on its lower cost structure and pay higher prices than two of its rivals.

Pricing Choice Model

Like the price discovery model, the pricing choice model results differed somewhat between supply periods, but findings were generally consistent with the price discovery model. The multinomial logit (MNL) model was estimated to determine factors affecting the probability of using alternative pricing methods. Results in table 6 are presented in terms of the likelihood of using either live weight or dressed weight pricing compared with grid pricing.

The wholesale price level for boxed beef (*BoxedBeef*) affected the likelihood of using grid pricing. As prices increased from their mean level, the probability of using live weight or dressed weight pricing declined compared with grid pricing. This may be related to the fact that as the general price level increases, each pen of cattle becomes more valuable and the marginal or relative importance of how each of the cattle in a pen are priced increases.

Table 6. Pricing Choice Estimation Results

	Coefficient[a]					
	High-Supply Period		Low-Supply Period		Combined Period	
Independent Variable	Live	Dressed	Live	Dressed	Live	Dressed
Intercept	-11.275 (0.54)	24.881 (2.08)	-49.958** (4.45)	12.891 (0.91)	-15.012** (4.23)	11.625** (4.10)
$BoxedBeef_{t-1}$	-0.056 (0.79)	-0.152** (4.57)	-0.127*** (8.79)	-0.162*** (35.32)	-0.067*** (7.69)	-0.082*** (20.23)
$ShowList_t$	0.086*** (8.17)	0.156*** (24.73)	0.029 (0.080)	0.023 (1.34)	0.035*** (24.01)	-0.014** (6.02)
$LiveWt_j$:						
1,150 lbs.	Base	Base	Base	Base	Base	Base
1,175 lbs.	0.211 (0.85)	-0.440* (2.96)	1.973*** (9.91)	-0.267 (1.84)	0.682*** (15.99)	-0.037 (0.09)
1,200 lbs.	-0.385 (1.00)	-1.094*** (6.73)	0.673 (1.08)	-0.830* (2.81)	0.042 (0.02)	-0.432* (3.26)
$GeneticType_j$:						
Low	-1.115*** (34.24)	0.015 (0.01)	-0.772*** (12.98)	-0.122 (0.65)	-0.741*** (38.03)	0.234 (0.35)
Medium	Base	Base	Base	Base	Base	Base
High	0.330* (2.93)	0.638*** (10.77)	-0.051 (0.04)	0.060 (0.15)	0.167 (1.53)	0.234** (5.28)
$TransactionType_j$:						
Cash	Base	Base	Base	Base	Base	Base
Forward Contract	0.536** (4.74)	0.256 (0.55)	-0.529** (4.24)	0.176 (1.00)	-0.071 (0.25)	-0.085 (0.45)
$ChoiceSelect_t$	-0.684 (2.42)	1.641*** (11.39)	-3.058** (4.74)	-0.006 (0.00)	-0.982*** (9.44)	0.124 (0.20)
$YG3YG4/5_t$	-0.526 (0.62)	2.227*** (8.36)	-4.171** (6.52)	-0.174 (0.04)	-1.322*** (10.57)	0.130 (0.15)
$Feedlot_j$:[b]						
#1	-1.636*** (31.94)	-0.374 (0.92)	0.539 (1.50)	0.642** (5.88)	-0.658*** (12.39)	0.146 (0.65)
#2	0.296 (0.62)	-0.735** (6.07)	N/A	N/A	0.510** (3.88)	0.070 (0.18)
#3	-1.577*** (22.60)	-1.283*** (12.19)	-0.507 (3.35)	1.669*** (11.52)	-0.846*** (19.91)	-0.076 (0.18)
#4	0.616 (2.28)	0.419 (1.19)	0.693 (2.12)	0.458* (3.41)	0.794** (5.16)	0.459** (6.33)
#5	N/A	N/A	-0.384 (1.75)	-0.102 (0.16)	0.023 (0.01)	0.515*** (6.94)
#6	0.362 (1.81)	0.260 (0.73)	N/A	N/A	0.125 (0.30)	-0.670*** (15.75)
#7	-0.796*** (7.11)	-1.561*** (20.85)	0.888 (2.39)	-1.376*** (32.89)	-0.392* (3.24)	-0.927*** (28.77)
#8	Base	Base	Base	Base	Base	Base

(continued . . .)

Table 6. Continued

	Coefficient[a]					
	High-Supply Period		Low-Supply Period		Combined Period	
Independent Variable	Live	Dressed	Live	Dressed	Live	Dressed
Packer$_j$:						
#1	-2.186*** (26.52)	1.708*** (28.94)	-0.376 (1.12)	1.198*** (28.46)	-1.346*** (37.31)	1.198*** (63.89)
#2	-0.972** (5.34)	1.370*** (40.81)	-0.128 (0.15)	-0.317* (3.08)	-0.693*** (9.52)	0.430*** (16.60)
#3	-1.610*** (15.85)	2.261*** (41.59)	-0.143 (0.25)	1.338*** (40.90)	-0.975*** (21.36)	1.336*** (99.57)
#4	Base	Base	Base	Base	Base	Base
No. of transactions	516	516	549	549	1,065	1,065

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Numbers in parentheses are absolute values of calculated χ^2 statistics.

[a] Coefficients for live weight and dressed weight pricing are compared with grid pricing.

[b] Due to estimation problems, feedlots were combined as follows: feedlots #5 and #6 for the high-supply period; feedlots #2 and #4, and feedlots #6 and #7 for the low-supply period.

For the high-supply period and both periods combined, the size of the show list (*Show List*) of available cattle affected the pricing method chosen. As show list size increased, feeders and packers were more likely to use live weight or dressed weight pricing. Packers may be less apt to purchase cattle on a grid during periods when they have the negotiating strength, as would likely be the case during high-supply periods. For both periods combined, an increasing show list inventory was associated with using live weight pricing more than grid pricing, but dressed weight pricing less than grid pricing.

Weight of fed cattle marketed (*LiveWt*) had a limited effect on pricing choice. Generally, but especially in the high-supply period, trades involving heavier cattle (1,175 and 1,200 pounds) decreased the likelihood of using live weight or dressed weight pricing compared with grid pricing. Heavier cattle tended to be over-finished, with a higher percentage of more heavily discounted carcasses; thus packers may have insisted on using, or pressured feeders to use, grid pricing for those cattle.

Of particular interest in this model was whether or not feeders and packers chose a specific pricing method for fed cattle of a given genetic type or set of carcass attributes (*GeneticType*). Results provide evidence that cattle quality characteristics matter, but results differed from the price discovery model. For both supply periods and the two periods combined, having low quality cattle decreased the probability of using live weight pricing compared with grid pricing. This finding was unexpected. High quality cattle were more likely to be priced on a live weight or dressed weight basis than priced with a grid in the high-supply period (also unexpected), but not in the low-supply period.

Results for the transaction type (*TransactionType*) again reflected buyer-seller behavior under different supply conditions. In the high-supply case, forward contracts were more likely to be used in live weight trading than grid priced trades. However, the reverse was true in the low-supply period. There, forward contracted trades were more likely to be priced via grid than on a live weight basis. For the two periods combined, transaction type did not increase the likelihood of using a specific pricing method.

Grid pricing research consistently emphasizes the importance of the Choice-Select price difference (*ChoiceSelect*) and to a lesser extent the yield grade 3-4/5 price difference (*YG3YG4/5*), as was noted in the literature review section. Both price differences were found important in the MNL model, reflecting similar pricing behavior by buyers and sellers across supply periods. As the Choice-Select price difference increased, meaning larger discounts for lower quality carcasses, the likelihood of using dressed weight pricing increased in the high-supply period while the likelihood of live weight pricing decreased in the low-supply period. The same was found for the yield grade discount. As the yield grade 3-yield grade 4/5 price difference increased, meaning larger discounts for lower-yielding or over-finished carcasses, the likelihood of using dressed weight pricing increased in the high-supply period while the likelihood of live weight pricing decreased in the low-supply period. Results for the two discount series were not expected since increasing the discount for a given quality grade or yield grade of cattle reduces the net grid price (ceteris paribus).

Not surprisingly, feedlot teams (*Feedlot*) and packer teams (*Packer*) had different propensities to use specific pricing methods relative to their rivals. However, no consistency was noted for the behavior among feedlot and packer teams across supply periods.

Summary and Conclusions

Experimental market data from a *Fed Cattle Market Simulator* workshop with a large meatpacking firm were used to estimate price discovery and pricing choice models under two divergent supply scenarios. No previous price discovery and pricing choice models have explicitly considered market behavioral differences stemming from widely varying supply conditions, as in opposite periods of the cattle cycle. Neither have previous price discovery or pricing choice models specifically incorporated grid pricing, despite an increase in the relative importance of grid pricing as a pricing mechanism for fed cattle.

Many relationships between dependent variables in the price discovery model were similar to those found in previous price discovery research on fed cattle, especially for the two supply periods combined. However, differences *between supply periods* were also found. Responsiveness of transaction prices to boxed beef price changes differed between the two supply periods. Differences can be explained in some cases by behavioral differences among workshop participants operating under diverse supply conditions. Such was the case for effects related to the show list inventory, weights of cattle marketed, and contracting versus cash market pricing. Thus, price discovery is influenced by supply conditions, such as different stages of the cattle cycle.

The interaction of pricing method and genetic type of cattle also led to differences in findings during the two supply periods. Consistently, pricing high quality cattle on a live weight basis brought lower prices, and pricing high quality cattle on a grid brought higher prices, both compared with marketing medium quality cattle on a dressed weight basis.

In the pricing choice model, some relationships differed between supply periods, but some did not. Higher wholesale prices led to an increased probability of using grid pricing, with a single exception across the three supply periods (i.e., low, high, and combined). A higher inventory of market-ready cattle in the high-supply period led to an increased probability of using live weight or dressed weight pricing. Pricing cattle of different weights varied somewhat across supply conditions.

In both supply periods individually and combined, having lower quality cattle decreased the probability of pricing them on a live weight basis. Having higher quality cattle in the high-supply period and the two periods combined tended to increase the probability of marketing them on a dressed weight basis. Supply conditions also affected the probability of pricing forward contracts by live weight or grid.

As hypothesized a priori, and consistent with observed behavior of market simulator participants, pricing and competitive behavior change as supply conditions change, much as would be the case for cattlemen experiencing a cattle cycle. Inventory or supply conditions affected both price discovery and pricing choice. The effects are partly due to changes in the buyer-seller interaction or competitive process under alternative supply environments. Economists need to be aware of these supply effects when observing pricing behavior in the real-world marketplace, and when analyzing or evaluating price discovery for any given period, to correctly understand factors affecting price discovery and pricing behavior in the marketplace.

Price discovery needs to be assessed in the context of existing supply conditions. Supply conditions translate into behavioral changes on the part of cattle feeders and packers, thereby influencing the use of marketing methods and pricing outcomes. While these differences may be viewed as subtle rather than profound, their existence was significant, and thus should be recognized as important by economists, market participants, and others.

[*Received August 2005; final revision received October 2005.*]

References

Anderson, J. D., and K. A. Zeuli. "The Revenue Risk of Value-Based Pricing for Fed Cattle: A Simulation of Grid vs. Average Pricing." *Internat. Food and Agribus. Mgmt. Rev.* 4(2001):275–286.

Capps, O., Jr., H. A. Love, G. W. Williams, and W. L. Adams. "Examining Packer Choice of Slaughter Cattle Procurement and Pricing Methods." *Agr. and Resour. Econ. Rev.* 28(1999):11–25.

Carlberg, J. G., and C. E. Ward. "Alternative Theories and Empirical Approaches to Price Discovery: An Application to Fed Cattle." *J. Agr. and Appl. Econ.* 35,3(2003):649–661.

Carlton, D. W. "Contracts, Price Rigidity, and Market Equilibrium." *J. Polit. Econ.* 87(1979):1034–1062.

Crespi, J. M., and R. J. Sexton. "Bidding for Cattle in the Texas Panhandle." *Amer. J. Agr. Econ.* 86,3 (2004):660–674.

Faminow, M. D., M. de Matos, and R. J. Richmond. "Errors in Slaughter Steer and Heifer Prices." *Agribus.: An Internat. J.* 12,1(1996):79–87.

Fausti, S. W., and D. M. Feuz. "Production Uncertainty and Factor Price Disparity in the Slaughter Cattle Market: Theory and Evidence." *Amer. J. Agr. Econ.* 77,3(1995):533–540.

Fausti, S. W., and B. A. Qasmi. "Does the Producer Have an Incentive to Sell Fed Cattle on a Grid?" *Internat. Food and Agribus. Mgmt. Rev.* 5(2002):23–39.

Feuz, D. M. "Market Signals in Value-Based Pricing Premiums and Discounts." *J. Agr. and Resour. Econ.* 24,2(1999):327–341.

Feuz, D. M., S. W. Fausti, and J. J. Wagner. "Analysis of the Efficiency of Four Marketing Methods for Slaughter Cattle." *Agribus.: An Internat. J.* 9,5(1993):453–463.

———. "Risk and Market Participant Behavior in the U.S. Slaughter-Cattle Market." *J. Agr. and Resour. Econ.* 20,1(1995):22–31.

Hogan, R. J., Jr., C. E. Ward, J. N. Trapp, D. S. Peel, and S. R. Koontz. "Economic Components of the *Fed Cattle Market Simulator*." Res. Bull. No. B-817, Agr. Exp. Sta., Oklahoma State University, Stillwater, OK, September 2003.

Hudson, M. A., and W. D. Purcell. "Price Discovery Processes in the Cattle Complex: An Investigation of Cash-Futures Price Interaction." Bull. No. 85-12, Agr. Exp. Sta., Virginia Polytechnic and State University, Blacksburg, VA, Fall 1985.

Hunnicutt, L., D. Bailey, and M. Crook. "Rigidity in Packer-Feeder Relationships." *J. Agr. and Appl. Econ.* 36,3(2004):627–638.

Jones, R., T. C. Schroeder, J. Mintert, and F. Brazle. "The Impacts of Quality on Cash Cattle Prices." *S. J. Agr. Econ.* 24,2(1992):149–162.

Ladd, G. W., and M. B. Martin. "Prices and Demands for Input Characteristics." *Amer. J. Agr. Econ.* 58(1976):21–30.

McDonald, R. A., and T. C. Schroeder. "Fed Cattle Profit Determinants Under Grid Pricing." *J. Agr. and Appl. Econ.* 35,1(2003):97–106.

SAS Institute, Inc. *SAS™ System Under Microsoft Windows*, Release 9.1. Cary, NC: SAS Institute, Inc., 2002–03.

Schroeder, T. C., and J. L. Graff. "Estimated Value of Increased Pricing Accuracy for Fed Cattle." *Rev. Agr. Econ.* 22,1(2000):89–101.

Schroeder, T. C., R. Jones, J. Mintert, and A. P. Barkley. "The Impact of Forward Contracting on Fed Cattle Prices." *Rev. Agr. Econ.* 15(1993):325–337.

Schroeder, T. C., C. E. Ward, J. Lawrence, and D. M. Feuz. "Fed Cattle Marketing Trends and Concerns: Cattle Feeder Survey Results." Rep. No. MF-2561, Dept. of Agr. Econ., Kansas State University, Manhattan, KS, June 2002.

Schroeter, J. R., and A. Azzam. "Captive Supplies and the Spot Market Price of Fed Cattle: The Plant-Level Relationship." *Agribus.: An Internat. J.* 19,4(2003):489–504.

———. "Captive Supplies and Cash Market Prices for Fed Cattle: The Role of Delivery Timing Incentives." *Agribus.: An Internat. J.* 20,3(2004):347–362.

Thomsen, F. L., and R. J. Foote. *Agricultural Prices*, 2nd ed. New York: McGraw-Hill, 1952.

Tomek, W. G., and K. L. Robinson. *Agricultural Product Prices*, 3rd ed. Ithaca, NY: Cornell University Press, 1990.

Vergara, O., K. H. Coble, T. O. Knight, G. F. Patrick, and A. E. Baquet. "Cotton Producers' Choice of Marketing Techniques." *Agribus.: An Internat. J.* 20,4(2004):465–479.

Ward, C. E. "Short-Period Pricing Models for Fed Cattle and Impacts of Wholesale Carcass Beef and Live Cattle Futures Market Prices." *S. J. Agr. Econ.* 13(1981):125–132.

———. "Market Structure Dynamics in the Livestock-Meat Subsector: Implications for Pricing and Price Reporting." In *Key Issues in Livestock Pricing: A Perspective for the 1990s*, eds., W. Purcell and J. Rowsell. Blacksburg, VA: Research Institute on Livestock Pricing, Virginia Polytechnic and State University, 1987.

———. "Inter-Firm Differences Between Fed Cattle Prices in the Southern Plains." *Amer. J. Agr. Econ.* 74(1992):480–485.

Ward, C. E., S. R. Koontz, D. S. Peel, and J. N. Trapp. "Price Discovery in an Experimental Market for Fed Cattle." *Rev. Agr. Econ.* 18(1996):449–466.

Ward, C. E., S. R. Koontz, and T. C. Schroeder. "Impacts from Captive Supplies on Fed Cattle Transaction Prices." *J. Agr. and Resour. Econ.* 23,2(1998):494–514.

Whitley, J. E. "The Political Economy of Quality Measurement: A Case Study of the USA Slaughter Cattle Market." *Austral. J. Agr. and Resour. Econ.* 46,3(2003):515–538.

Xia, T., and R. J. Sexton. "The Competitive Implications of Top-of-the-Market and Related Contract-Pricing Clauses." *Amer. J. Agr. Econ.* 86,1(2004):124–138.