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Impacts from Captive Supplies on Fed Cattle Transaction Prices

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Increased use of noncash-price procurement methods has concerned cattlemen for the past several years. This research estimated impacts of captive supplies on transaction prices for fed cattle. Negative relationships were found between transaction prices and percentage deliveries from the inventory of forward contracted and marketing agreement cattle. However, impacts from the absolute size of the total captive supply inventory were not significant. Price differences were found among procurement methods with forward contract prices being much lower. On balance, captive supplies had small but often negative effects on fed cattle transaction prices.

Key words: captive supplies, fed cattle, forward contracts, marketing agreements, packer feeding, price analysis, price discovery, procurement methods

Introduction

Increased meatpacking concentration and increased use of noncash-price procurement methods for fed cattle by meatpackers recently led to a congressionally mandated study of multiple issues related to meatpacking concentration (Packers and Stockyards Program).[1] In this article, we report results from one component of the larger study.

The general objective of this research was to determine impacts of captive supplies (i.e., cattle owned or committed to a specific packer two weeks or more prior to slaughter) on cash or spot market transaction prices for fed cattle. Specific objectives were to: (*a*) estimate the extent to which cash market fed cattle transaction prices are impacted by delivering cattle from an inventory of captive supplies, (*b*) estimate the extent to which transaction prices are impacted by buyers having an inventory of captive supplies from which delivery could be made, and (*c*) estimate price differences between cash market transaction prices and prices for cattle purchased under different captive supply methods.[2]

Captive supplies take three forms: (*a*) packer-owned cattle fed in packer-owned and commercial feedlots, (*b*) fed cattle purchased by fixed price and basis forward contracts, and (*c*) exclusive marketing and purchasing agreements for procuring fed cattle. Packer-

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[1] Noncash-price procurement methods also can be called packer-controlled supplies, but are popularly referred to as captive supplies. For brevity, the commonly accepted term "captive supplies" is used in this article.

[2] While understanding and modeling decision making during the contracting process is interesting and important (e.g., Hennessy), it was not part of the congressional mandate, and thus is not addressed here.

fed cattle are transferred from a feedlot to the slaughter plant when cattle reach slaughter weight, and a transfer price is assigned to the cattle on the day they are slaughtered. Basis contracting involves a packer bidding a basis (i.e., cash minus futures market price) for the month fed cattle are expected to reach slaughter weight. The cattle feeder reserves the right to decide when to price the cattle (i.e., select a futures market price) prior to delivery of cattle to the packer. Once the cattle are priced, the basis contract essentially becomes a fixed price forward contract. Exclusive feedlot marketing or packer purchasing agreements are, in essence, supply contracts in which the cattle feeder agrees to market a specified number of cattle for some specified time period (e.g., week, month, or year) to a given buyer. Price is based on a prearranged formula, typically consisting of a base price with premiums and discounts associated with variation in cattle quality.

One element common to each form of captive supply is that packers have some portion of their desired slaughter volume purchased two weeks or more prior to the livestock being slaughtered.[3] These forward purchases enable packers to coordinate captive supply deliveries with cash market purchases and deliveries. A major question, then, is whether the use of captive supplies affects slaughter cattle prices. Only a few previous studies have examined this issue, and all suffer from limitations involving data breadth and detail, time period, or modeling approach.

Elam compared forward contracting in six Texas feedlots with hedging fed cattle over the period May 1987 through September 1989. He reported contract prices were \$0.28–\$0.59/cwt lower than hedged prices for steers, and \$0.86–\$1.64/cwt lower for heifers. Cattle feeders were giving up a portion of the basis to packers when they forward contracted cattle. This could be considered a risk transfer premium from cattle feeders to packers. Elam also estimated the effect captive supply deliveries had on monthly average fed cattle prices in the U.S. and in Texas, Kansas, Colorado, and Nebraska. Captive supply deliveries were inversely related to fed cattle prices over the period October 1988 through May 1991. For each 10,000 cattle delivered under captive supply arrangements, U.S. fed cattle prices declined by \$0.03–\$0.09/cwt, while for individual states, results ranged from not significant to −\$0.37/cwt.

Eilrich et al. compared forward contracting with hedging fed cattle using data from five feedlots covering the period 1988–90. Their findings showed that both net basis contract prices and hedged prices were lower than estimated cash prices. Price differences ranged from \$1.57–\$1.77/cwt assuming either \$0.20/cwt or \$0.40/cwt transportation costs, respectively. This price difference is the risk transfer premium for forward contracting at a fixed price or basis.

Hayenga and O'Brien examined the effect of captive supplies on weekly average fed cattle prices and price variability in Kansas, Colorado, Nebraska, and Texas over the 15-month period from October 1988 through December 1989. They found effects that were usually not significant or that had mixed positive and negative signs relative to other market prices.

The sole previous study which examined the relationship between forward contracting (including marketing agreements) and transaction prices for fed cattle was conducted by Schroeder et al. (1993). They collected data from feedlots in southwestern Kansas

[3] Both the Grain Inspection, Packers and Stockyards Administration (GIPSA) and the U.S. Department of Agriculture/Agricultural Marketing Service (USDA/AMS) use the two-week-ahead period to differentiate captive supply purchases from spot market purchases.

from May–November 1990. Results indicated a negative relationship between forward contracting and fed cattle prices, ranging from \$0.15 to \$0.31/cwt. Price impacts differed among packers and subperiods within the six-month period and were not significant for some packers and time periods.

In this study we attempt: (*a*) to model the interdependent nature of delivering cattle from captive supply inventories (i.e., for all three types of captive supplies) and purchasing fed cattle in the cash market; (*b*) to model the impact on transaction prices caused by the size of the captive supply inventory from which future deliveries can be made; and (*c*) to estimate price differences between cash market fed cattle prices and prices for cattle purchased by all three captive supply methods. Because of the congressional mandate for this work, access to data was unique and better than all previous studies dealing with captive supply impacts. Relative to other studies, data for this study: (*a*) came directly from transaction records of the largest meatpacking plants and firms, rather than a few feedlots; (*b*) covered a broader geographic area, i.e., cattle procurement from nearly the entire United States; (*c*) encompassed transactions from a longer time period, i.e., twice as long as that used by Schroeder et al. (1993); (*d*) contained transaction details on all types of captive supplies, rather than just forward contracts and marketing agreements; and (*e*) utilized several times more observations than any previous study. Unique access to data enabled modeling captive supply impacts not heretofore possible due to significant data limitations.

Data

Transaction records were collected by the Packers and Stockyards Program from the 43 largest steer and heifer slaughtering plants owned by 25 firms. Data consisted of each sale lot of 35 head or more during slaughter days from April 5, 1992 through April 3, 1993. Each sale lot record included the following: (*a*) packing plant and firm identification; (*b*) cattle slaughter date; (*c*) cattle purchase date; (*d*) number of head; (*e*) cattle sex or type (steers, heifers, dairy, Holstein, or mixed lots of cattle); (*f*) pricing or purchasing method (live weight cash-price purchase, dressed weight cash-price purchase, forward contract purchase, packer-fed transfer, or marketing agreement purchase); (*g*) total purchase weight (live weight and dressed weight); (*h*) average dressing percentage; (*i*) total delivered cost; (*j*) average cost/cwt (dressed weight \$/cwt); (*k*) distribution of carcasses among quality grades; (*l*) distribution of carcasses among yield grades; and (*m*) transportation and commission costs.

Records kept by individual firms or plants differed. As a result of missing data, irreconcilable differences in data, incompatible data among plants, and data errors, the usable data set consisted of 139,189 sale lot observations from 28 plants owned by nine firms, including all "big three" packers (Ward, Koontz, and Schroeder).[4] Transactions used accounted for 16.5 million fed cattle, representing 63.2% of total steer and heifer purchases in 1993. Secondary data supplemented primary data and included: daily boxed beef cutout values from the USDA/AMS, and daily live cattle futures market prices from the Chicago Mercantile Exchange (CME). Variables used are defined in table 1, and summary statistics for selected variables are presented in table 2.

[4] Usable data consisted of 69.4% of all transaction records collected by the Packers and Stockyards Program.

Conceptual Framework and Model Development

In a general supply-demand framework, procurement of fed cattle by each captive supply method reduces the supply of market-ready fed cattle that can be purchased in the cash market during the normal one to two weeks prior to slaughter. Effectively, the short-run supply curve for market-ready fed cattle shifts to the left. Packers using captive supply procurement methods purchase fewer fed cattle from the spot market because a percentage of their slaughter needs will be met from captive supply cattle deliveries. Thus, the short-run demand curve for fed cattle also shifts to the left. The net price effect is unknown with certainty and requires empirical estimation. Conceptually, the "new" demand curve could intersect the "new" supply curve at a price above, equal to, or below the initial price. The "new" short-run equilibrium price depends on the exact shape and position of the two curves. This supply-demand framework leads to a simple model for analyzing captive supplies.

Both cattle feeders and meatpackers have economic incentives to enter into captive supply arrangements. Schroeder et al. (1997) identify several. Incentives for using forward contracts include: for cattle feeders—reduce price risk, obtain favorable financing, ensure buyer access for cattle, and reduce transactions costs; and for packers—secure slaughter needs, secure desired quality of fed cattle, reduce transactions costs, and reduce price risk. Incentives for using marketing agreements include: for cattle feeders—receive premiums for some cattle quality characteristics, obtain carcass information, ensure buyer access for cattle, and reduce transactions costs; and for packers—increase cattle quality control, secure slaughter needs, and reduce transactions costs. Incentives for packer feeding include: for cattle feeders—increase feedlot utilization and improve packer-feedlot relationship; and for packers—secure slaughter needs, earn profits from cattle feeding, and increase cattle quality control. The problem is not simple, and this literature is developing (Hennessy).

Our approach follows that of previous research and uses a simple model which addresses the specific objectives. The reduced-form transaction price models estimated here are those derived by Schroeder et al. (1993). In the Schroeder et al. study, supply and demand equations for contract and spot market purchases are used to derive a reduced-form model where fed cattle transaction prices are a function of beef prices, animal characteristics, the amount of contracting, and other factors. The model allows for straightforward measurement of the impact of captive supplies on transaction prices.

Three issues are addressed in this study. First, packers' decisions to deliver captive supply cattle and to purchase cash market cattle are likely determined simultaneously. Conceivably, packers could purchase cattle in the cash market and then determine how many and when to deliver captive supply cattle. Alternatively, packers could decide how many and when to deliver captive supply cattle, and then determine how many cattle to purchase in the cash market. The order of causality determines whether packers can use captive supplies as a strategic decision variable, i.e., whether they exercise market power by delivering forward purchased cattle to reduce their need for cash market purchases, and thereby reduce cash market transaction prices. These issues are treated in Model 1, below.

Table 1. Definitions of Variables

Variable	Definition
Model 1, Equation (1):	
PCP_t	Each plant's captive supply and cash (spot) market purchases of cattle on the day cash market cattle were purchased, as a percentage of the plant's maximum capacity.
NFC_t	Number of head of forward contracted cattle purchased by each plant on day t.
NPF_t	Number of head of packer-fed cattle purchased by each plant on day t.
NMA_t	Number of head of marketing agreement cattle purchased by each plant on day t.
NSP_t	Number of head of cash market cattle purchased by each plant on day t.
CAP	Maximum daily plant capacity for each plant during the data period.
Model 1, Equations (2)–(4):	
$PQFC_t$	Percentage of forward contracted cattle during the market window period (t plus 28 days) which were delivered to each plant on the day cash market cattle were purchased.
$PQPF_t$	Percentage of packer-fed cattle during the market window period (t plus 28 days) which were delivered to each plant on the day cash market cattle were purchased.
$PQMA_t$	Percentage of marketing agreement cattle during the market window period (t plus 28 days) which were delivered to each plant on the day cash market cattle were purchased.
BSS_t	Basis on the day cash market cattle were purchased (dressed weight cash market price converted to a live weight price minus the preceding day's closing live cattle futures market price for the nearby contract).
$TRPRC_t$	Cash market transaction price on the day cash market cattle were purchased.
$LCFMP_{t-1}$	Preceding day's closing live cattle futures market price for the nearby contract.
$DDOW_{i,t}$	Zero-one dummy variable for day of the week cash market cattle were purchased (Monday, Tuesday, . . . , Saturday/Sunday).
$DMON_{i,t}$	Zero-one dummy variable for month of the year cash market cattle were purchased (January, February, . . . , December).
Model 1, Equation (5):[a]	
$ABBCV_{t-1}$	Preceding day's boxed beef cutout value on the day cash market cattle were purchased, adjusted for the percentage of the sale lot grading USDA Choice grade and above, or Select grade and below.
$DTYP_{i,t}$	Zero-one dummy variable for the type of cattle purchased (steers, heifers, mixed sex, Holstein, and dairy cattle).
$AHotWt_t$	Average dressed weight of the sale lot.
$NoHd_t$	Number of head in the sale lot.
$PYG1\text{–}3_t$	Percentage of USDA Yield Grade 1–3 cattle in the sale lot.
FWD_t	Number of days between purchase and delivery for cash market cattle on the day cash market cattle were purchased.
$TRND_t$	Month cattle were purchased.
$DPLT_{i,t}$	Zero-one dummy variable for the packing plant that purchased cash market cattle (plant 1, plant 2, . . . , plant 28).

Table 1. Continued

Variable	Definition
Model 2, Equation (6):[a]	
QFC_t	Number of forward contracted cattle available for delivery over the next 28 days, on the day cash market cattle were purchased.
QPF_t	Number of packer-fed cattle available for delivery over the next 28 days, on the day cash market cattle were purchased.
QMA_t	Number of marketing agreement cattle available for delivery over the next 28 days, on the day cash market cattle were purchased.
$QTOT_t$	Number of forward contracted, packer-fed, and marketing agreement cattle available for delivery over the next 28 days, on the day cash market cattle were purchased.
Model 3, Equation (7):[a]	
$PPRC_t$	Purchase price (purchase price or transfer price) on the day cattle were purchased.
$FWDALL_t$	Number of days between purchase and delivery for cash market and captive supply cattle on the day cash market cattle were purchased.
$DMETH_{i,t}$	Zero-one dummy variable for procurement methods ($DFWDCON_t$ = forward contract, $DPKRFED_t$ = packer-fed, $DMKTAGREE_t$ = marketing agreement, and $DCASH_t$ = cash market).

[a] Variables not previously defined.

Table 2. Selected Summary Statistics

Variable	Unit	Mean	Std. Dev.	Min.	Max.
Noncaptive Supply Variables:					
$TRPRC_t$	$/cwt	121.10	5.98	105.00	142.00
$ABBCV_{t-1}$	$/cwt	115.60	4.53	107.07	128.93
$LCFMP_{t-1}$	$/cwt	75.55	3.08	70.10	83.72
BSS_t	$/cwt	0.74	2.34	-15.89	15.29
PCP_t	%	155.9	123.8	1.00	1,501
$AHotWt_t$	lbs.	731.8	60.4	442	1,028
$NoHd_t$	head	118.3	94.0	35	1,116
$PYG1\text{–}3_t$	%	95.9	5.7	0.00	100
FWD_t	days	5.8	3.0	0.00	14
$FWDALL_t$	days	13.3	31.0	0.00	390
Captive Supply Variables:					
$PQFC_t$	%	5.8	11.0	0.00	100
$PQPF_t$	%	5.7	11.1	0.00	100
$PQMA_t$	%	5.2	5.4	0.00	100
QFC_t	head	7,201	12,149	0.00	67,398
QPF_t	head	640	1,748	0.00	10,877
QMA_t	head	11,929	14,785	0.00	66,985

Second, packers who have an inventory of captive supply cattle are alleged to use the size of their inventory to bid lower for cash market cattle, and thus reduce transaction prices for cash market purchases. This second issue differs from the first. The first focuses on simultaneously delivering from the captive supply inventory and purchasing cash market cattle, whereas the second measures transaction price impacts from having a given size inventory of captive supply cattle from which to deliver for slaughter at some future time. This issue is empirically tested using Model 2, as discussed below.

Third, forward contract prices are expected to be lower than cash prices based on both theoretical (Carlton) and empirical work (Elam; Eilrich et al.). The degree to which packer-fed cattle prices and marketing agreement fed cattle prices differ from spot-market cattle prices is unknown. Model 3, presented later, addresses this concern.

Model 1: Captive Supply Shipments-Price Relationships Model

The following simultaneous system of equations models how cash market transaction prices are affected by delivering fed cattle from a captive supply inventory. This model provides a test of whether packers use captive supplies as a strategic decision variable, as discussed previously. The system includes four equations which capture the variation in the three captive supply variables and the transaction price. All equations are basically reduced-form models of each quantity and price. Variations in the quantities are explained as a function of a relevant price and other supply and demand factors. Variations in transaction prices are explained as a function of quantities and other supply and demand factors. The unit of observation is a transaction record for a sale lot of fed cattle purchased on day t, i.e., the purchase date for cash market cattle. Define each plant's captive supplies plus cash purchases as a percentage of its capacity as follows:

$$PCP_t = [(NFC_t + NPF_t + NMA_t + NSP_t)/CAP] \times 100, \quad (1)$$

where PCP_t is each plant's captive supply and cash (spot) market purchases of cattle on the day cash market cattle were purchased, as a percentage of the plant's maximum capacity; NFC_t is the number of head of forward contracted cattle purchased by each plant on day t; NPF_t is the number of head of packer-fed cattle purchased by each plant on day t; NMA_t is the number of head of marketing agreement cattle purchased by each plant on day t; NSP_t is the number of head of cash market cattle purchased by each plant on day t; and CAP is the maximum daily plant capacity for each plant during the data period (table 1).

Maximum daily slaughter (CAP) was based on the largest number of fed cattle slaughtered by each plant on any one day during the data period. Purchases as a percentage of plant capacity (PCP_t) were computed for each day and assigned to all transaction records for cash market purchases of fed cattle on that same day. On any given day, significantly more cattle may be purchased by a packer than are slaughtered. For example, two previous studies found significantly more cattle were purchased earlier in the week (Monday through Wednesday) than later in the week (Ward 1992;

Schroeder et al. 1993). Plant sizes varied widely. Daily purchases of fed cattle, both in total and by each procurement method, also varied widely. Therefore, daily purchases were converted to percentages of plant capacity to reduce the absolute disparity among plants and days.

Captive Supply Deliveries. The three forms of captive supply deliveries (i.e., forward contracted, packer-fed, and marketing agreement) are related to economic conditions present at the time these deliveries can be made. The models listed below were specified to explain the three forms of captive supply deliveries.

- Forward Contract Deliveries:

(2) $$PQFC_t = f(BSS_t, TRPRC_t, PCP_t, DDOW_{i,t}, DMON_{i,t}),$$

where $PQFC_t$ is the percentage of forward contracted cattle during the market window period (t plus 28 days) delivered to each plant on the day cash market cattle were purchased; BSS_t is the basis on the day cash market cattle were purchased; $TRPRC_t$ is the cash market transaction price on the day cash market cattle were purchased; $DDOW_{i,t}$ is a zero-one dummy variable for day of the week cash market cattle were purchased (Monday, Tuesday, ..., Saturday/Sunday); and $DMON_{i,t}$ is a zero-one dummy variable for month of the year cash market cattle were purchased (January, February, ..., December) (table 1).

- Packer-Fed Deliveries:

(3) $$PQPF_t = f(LCFMP_{t-1}, TRPRC_t, PCP_t, DDOW_{i,t}, DMON_{i,t}),$$

where $PQPF_t$ is the percentage of packer-fed cattle during the market window period (t plus 28 days) delivered to each plant on the day cash market cattle were purchased, $LCFMP_{t-1}$ is the preceding day's closing live cattle futures market price for the nearby contract, and other variables are as defined previously (table 1).

- Marketing Agreement Deliveries:

(4) $$PQMA_t = f(LCFMP_{t-1}, TRPRC_t, PCP_t, DDOW_{i,t}, DMON_{i,t}),$$

where $PQMA_t$ is the percentage of marketing agreement cattle during the market window period (t plus 28 days) delivered to each plant on the day cash market cattle were purchased, and other variables are as defined previously (table 1).

The percentage of available captive supply cattle delivered by individual plants on specific dates ($PQFC_t$, $PQPF_t$, $PQMA_t$) varied by day and month. Therefore, dummy variables were included in equations (2)–(4) for day of the week ($DDOW_{i,t}$) and month of the year ($DMON_{i,t}$). Basis (BSS_t) was calculated by subtracting the preceding day's closing live cattle futures market price for the nearby contract ($LCFMP_{t-1}$) from the dressed weight price times 63% (i.e., an estimated average dressing percentage to convert the dressed weight price to a live weight price).[5]

Data did not allow computing the total inventory of forward contracted, packer-fed, and marketing agreement cattle. Therefore, captive supply inventory variables ($PQFC_t$, $PQPF_t$, $PQMA_t$) were estimated by summing the number of cattle actually delivered for each respective type of captive supply during the following 28 days. The percentage of forward contracted, packer-fed, and marketing agreement cattle delivered from the moving 28-day inventory was computed and assigned to all transaction records for each cash market purchase day.

Transaction Price. The cash market transaction price for each pen of cattle was modeled as:

$$(5) \quad TRPRC_t = f(ABBCV_{t-1}, LCFMP_{t-1}, DTYP_{i,t}, AHotWt_t, AHotWt_t^2, NoHd_t, NoHd_t^2, PYG1\text{–}3_t, FWD_t, DDOW_{i,t}, PCP_t, TRND_t, TRND_t^2, TRND_t^3, DPLT_{i,t}, PQFC_t, PQPF_t, PQMA_t),$$

where $ABBCV_{t-1}$ is the preceding day's boxed beef cutout value on the day cash market cattle were purchased, adjusted for the percentage of the sale lot grading USDA Choice grade and above, or Select grade and below; $DTYP_{i,t}$ is a zero-one dummy variable for the type of cattle purchased (steers, heifers, mixed sex, Holstein, and dairy cattle); $AHotWt_t$ is the average dressed weight of the sale lot; $NoHd_t$ is the number of head in the sale lot; $PYG1\text{–}3_t$ is the percentage of USDA Yield Grade 1–3 cattle in the sale lot; FWD_t is the number of days between purchase and delivery for cash market cattle on the day cash market cattle were purchased; $TRND_t$ is the month cattle were purchased; $DPLT_{i,t}$ is a zero-one dummy variable for the packing plant that purchased cash market cattle (plants 1–28); and other variables are as defined previously (table 1).

Several variables included in equation (5) are based on previous studies explaining the variation in fed cattle transaction prices (Jones et al.; Schroeder et al. 1993; Ward 1981, 1992), including: boxed beef cutout value adjusted for the percentage of the sale lot grading USDA Choice grade and above, or Select grade and below ($ABBCV_{t-1}$);[6] live cattle futures market price ($LCFMP_{t-1}$); type of cattle ($DTYP_{i,t}$); weight of the cattle ($AHotWt_t$, $AHotWt_t^2$); number of head in the sale lot ($NoHd_t$, $NoHd_t^2$); percentage of cattle which yield grade 1–3 ($PYG1\text{–}3_t$); number of days between purchase and delivery (FWD_t); day of the week ($DDOW_{i,t}$); and the plant which purchased the cattle ($DPLT_{i,t}$). Cash market prices also were expected to depend on plant utilization, here proxied by purchases as a percentage of plant capacity (PCP_t), to account for the functional relationship between plant utilization and slaughter processing costs (Ward 1993).

[5] The nearby contract was moved to the next contract at the beginning of the contract maturity month.

[6] $ABBCV_{t-1} = (BBCV_{Choice} \times \%Choice) + (BBCV_{Select} \times \%Select)$, where $BBCV$ is boxed beef cutout value. Four boxed beef cutout value data series were used (Choice, YG1–3, 550–700 lbs.; Choice, YG1–3, 700–850 lbs.; Select, YG1–3, 550–700 lbs.; and Select, YG1–3, 700–850 lbs.). Each transaction was matched with the appropriate boxed beef cutout value based on the average dressed weight of the sale lot.

During the study period, prices trended downward, then reversed and trended upward for the remainder of the period. Therefore, cubic time-trend variables ($TRND_t$, $TRND_t^2$, $TRND_t^3$) were included to remove trend in cash fed cattle prices not fully captured by trends in boxed beef cutout values or live cattle futures market prices. Time-trend variables are discussed more fully in the results section; however, they capture in part the time between purchase or contract date and the delivery date. Variables for the extent of captive supply deliveries ($PQFC_t$, $PQPF_t$, $PQMA_t$) were included to measure the transaction price impacts from captive supply deliveries.

Model 2: Captive Supply Inventory-Price Relationships Model

Model 1, described above, estimates how *deliveries* of captive supply cattle affect cash market cattle prices. A second model was estimated to determine whether buyers having an *inventory* of fed cattle procured by captive supply methods impact fed cattle transaction prices. No simultaneity is implied in estimating the relationship between size of the captive supply inventory at the time cash market cattle are purchased and cash market transaction prices. Therefore, the cash market transaction price was modeled as:

$$(6) \qquad TRPRC_t = f(ABBCV_{t-1}, LCFMP_{t-1}, DTYP_{i,t}, AHotWt_t, AHotWt_t^2, NoHd_t, NoHd_t^2, PYG1\text{–}3_t, FWD_t, DDOW_{i,t}, PCP_t, TRND_t, TRND_t^2, TRND_t^3, DPLT_{i,t}, QFC_t, QPF_t, QMA_t),$$

where QFC_t is the number of forward contracted cattle available for delivery over the next 28 days, on the day cash market cattle were purchased; QPF_t is the number of packer-fed cattle available for delivery over the next 28 days, on the day cash market cattle were purchased; QMA_t is the number of marketing agreement cattle available for delivery over the next 28 days, on the day cash market cattle were purchased; and other variables are as defined previously (table 1).

Model 2 is similar to equation (5) of Model 1 in that several variables are included to explain variation in fed cattle transaction prices, but Model 2 differs in two ways. First, variables for percentage *deliveries* from the captive supply inventory are replaced by variables for the size of the captive supply *inventory* (QFC_t, QPF_t, QMA_t). Variables for captive supply inventory were included to measure the effect on cash market transaction prices from changes in the size of the captive supply inventory. As before, captive supply inventory variables are based on the number of captive supply cattle actually delivered during the following 28 days. Second, Model 2 is a single-equation model with no assumptions of simultaneity, rather than a system of equations as in Model 1 which assumed simultaneity of decisions to deliver cattle from the inventory of captive supplies and to purchase cattle in the cash market. The interaction between quantities and price from Model 1 are of paramount interest, but the results from Model 2 are directly comparable to previous research. Also, the results from Models 1 and 2 will be compared to assess the robustness of alternative specifications.

Model 3: Captive Supply-Cash Price Differences Model

Previous research found price differences between forward contracted prices or hedged prices and estimated cash transaction prices (Eilrich et al.). To date, data have not been available to estimate price differences for fed cattle procured by different methods. Thus, Model 3 is specified to estimate the price difference between cash transaction prices for fed cattle and prices for fed cattle purchased under three captive supply methods. The cash market transaction price was modeled as:

$$(7) \qquad PPRC_t = f(ABBCV_{t-1}, LCFMP_{t-1}, DTYP_{i,t}, AHotWt_t, AHotWt_t^2, NoHd_t, NoHd_t^2, PYG1\text{–}3_t, FWDALL_t, DDOW_{i,t}, PCP_t, TRND_t, TRND_t^2, TRND_t^3, DPLT_{i,t}, DMETH_{i,t}),$$

where $PPRC_t$ is the purchase price (purchase price or transfer price) on the day cattle were purchased; $FWDALL_t$ is the number of days between purchase and delivery for cash market and captive supply cattle on the day cash market cattle were purchased; $DMETH_{i,t}$ is a zero-one dummy variable for procurement methods (forward contract, packer-fed, marketing agreement, or cash market); and other variables are as defined previously (table 1).

Model 3, like equation (5) of Model 1 and equation (6) of Model 2, includes several variables to explain variation in fed cattle transaction prices. In this model, the dependent variable is the purchase price ($PPRC_t$) for cash market *and* captive supply cattle, rather than just cash market cattle as in Models 1 and 2. Two independent variables in Model 3 also differ from previous models. Previous research found that the time between purchase date and slaughter date affected transaction prices (Ward 1981, 1992; Schroeder et al. 1993). In this model, a similar variable was added to measure the difference between purchase and slaughter date for all purchases ($FWDALL_t$), rather than just for cash market purchases as in previous studies and in the preceding two models. Second, a variable was added to measure the difference between cash market transaction prices and prices for fed cattle purchased by other methods ($DMETH_{i,t}$).

Empirical Results

Two-stage least squares regression [Model 1, equations (2)–(5)] and ordinary least squares regression [Models 2 and 3, equations (6) and (7)] were used. Reported significance of coefficients refers to the 0.01 level. Several versions of each model were estimated, some using plant dummy variables, firm dummy variables, some using 28-day captive supply inventories, and 14-day inventories. Models were estimated for the entire one-year data period, while others also were estimated for quarterly subperiods. Only the 28-day/plant versions (i.e., models including plant dummy variables) of Models 1 and 2 estimated for the entire one-year period are reported here. For Model 2, two types of captive supply inventory variables were included—individual variables

Table 3. Noncaptive Supply Variables: Selected Results from Transaction Price Equations, Models 1–3 ($/cwt)

Variable	Model 1 Equation (5)	Model 2 Equation (6)	Model 3 Equation (7)
$ABBCV_{t-1}$	0.51*	0.48*	0.59*
	(105.77)	(99.49)	(196.58)
$LCFMP_{t-1}$	0.28*	0.36*	0.27*
	(32.36)	(49.35)	(53.85)
$AHotWt_t$	0.01*	0.022*	0.007*
	(4.39)	(7.54)	(3.27)
$AHotWt_t^2$	-0.00001*	-0.000018*	-0.00001*
	(7.07)	(9.45)	(6.61)
$NoHd_t$	0.004*	0.004*	0.005*
	(19.89)	(16.90)	(24.60)
$NoHd_t^2$	-0.000006*	-0.000005*	-0.000008*
	(13.83)	(10.63)	(19.19)
$PYG1\text{–}3_t$	0.05*	0.06*	0.04*
	(35.06)	(30.18)	(31.01)
FWD_t	0.08*	0.11*	—
	(28.81)	(32.79)	
$FWDALL_t$	—	—	-0.008*
			(16.69)
PCP_t	0.003*	0.002*	0.001*
	(28.02)	(16.86)	(19.18)

Notes: An asterisk (*) denotes significance at the 0.01 level. Numbers in parentheses are absolute values of calculated t-statistics.

described previously for each type of captive supply inventory (i.e., QFC_t, QPF_t, QMA_t), and a single captive supply inventory variable ($QTOT_t$) which is the sum of the three individual captive supply inventories. Only the plant version of Model 3 estimated for the entire one-year period is reported here. Results are robust for the alternative specifications. (Complete results are provided in Ward, Koontz, and Schroeder.) Selected results for noncaptive supply variables are discussed below, followed by a discussion of the captive supply variables.

Noncaptive Supply Variables

Table 3 provides a comparison of selected results from the transaction price equations for Models 1, 2, and 3. Numerous noncaptive supply factors explained the variation in fed cattle transaction prices, many of which were significant in previous research. Results were generally robust across the three models. Exceptions and similarities or differences with prior work are noted briefly here.

Boxed beef cutout values, adjusted by quality grade of cattle in the sale lot ($ABBCV_{t-1}$), and closing prices for the nearby live cattle futures market contract ($LCFMP_{t-1}$) directly affected fed cattle prices, consistent with Schroeder et al. (1993) and

Ward (1992). Several variables representing cattle quality significantly affected fed cattle prices. Type of cattle (i.e., steers, heifers, Holsteins) affected prices as expected, as did average dressed weight of carcasses in the sale lot. Unlike previous research (Jones et al.; Ward 1992), a quadratic rather than linear relationship was found between number of head in the sale lot and prices paid ($NoHd_t$ and $NoHd_t^2$). Higher transaction prices were associated with an increased percentage of cattle in the sale lot which yield graded 1–3 ($PYG1\text{–}3_t$), similar to previous findings (Schroeder et al. 1993).

Fed cattle prices differed by day of the week when cattle were purchased ($DDOW_{i,t}$). While not reported in tables here, highest transaction prices were found on Monday, the same day as in previous studies (Schroeder et al. 1993; Ward 1992). However, the remaining within-week pattern differed among the three studies. Coefficients on day-of-week variables were less robust among versions of the models than other variables. Results confirm significant within-week price differences, but suggest the within-week pattern may vary due to differences in model specification, data, or study period.

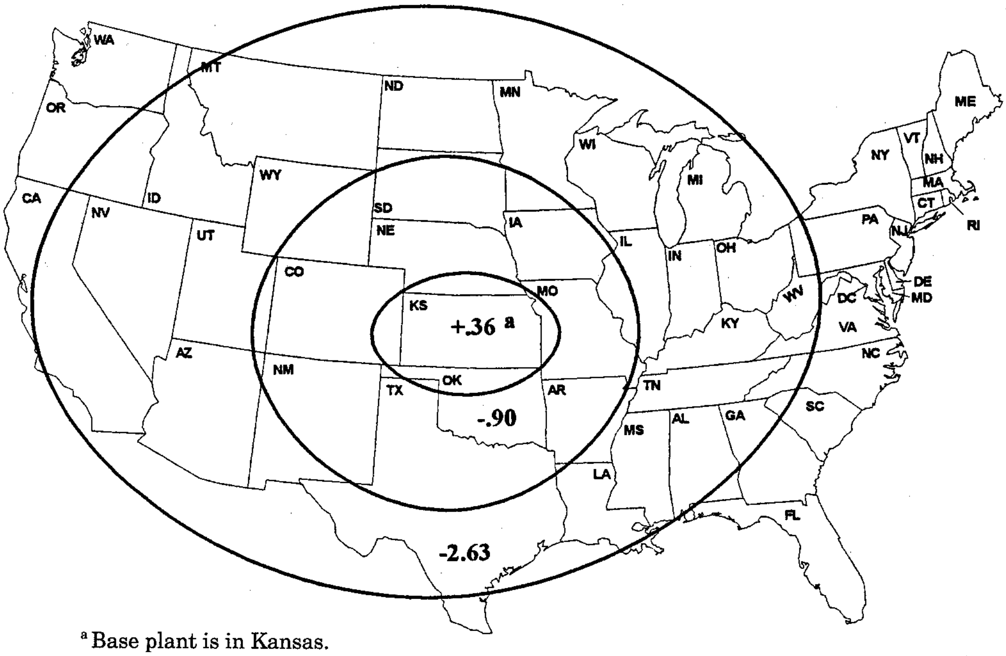
Fed cattle prices during the study period exhibited a seasonal pattern. Initially, time-trend variables were excluded from the models, but later were added to Model 3, as discussed subsequently, then added to the transaction price equation of Model 1 and to Model 2. Inclusion of the cubic time-trend variables ($TRND_t$, $TRND_t^2$, $TRND_t^3$) resulted in capturing the within-year pattern of cash market fed cattle prices during the year studied which were not represented fully by movements in boxed beef cutout values and live cattle futures market prices. Inclusion of these variables does not qualitatively alter noncaptive supply or the captive supply results from the models.

Number of days between purchase and delivery of cattle purchased in the cash market (FWD_t) was related to fed cattle prices. A similar variable had a negative relationship with fed cattle prices in 1979 (Ward 1981), but a positive effect in 1989 (Ward 1992) and 1990 (Schroeder et al. 1993). As number of days between purchase and delivery of only cash market cattle increased, so did fed cattle prices (Models 1 and 2). However, for Model 3, as number of days between purchase and delivery of cattle purchased by all procurement methods increased, the effect on cash market fed cattle prices was negative. This difference probably relates to the time lag between purchase and slaughter date for forward contracted cattle compared with the shorter purchase and slaughter date difference for cash market cattle.

Purchases as a percentage of plant capacity (PCP_t) were expected to affect transaction prices for fed cattle, but no comparable variable had been used in previous transaction price models. Coefficients on the percentage purchases variable were consistently positive. Economies of size and differences in plant utilization exist among cattle slaughtering and carcass fabricating plants (Ward 1993). Larger, more efficient plants can pay more for fed cattle than smaller, less efficient plants, but may do so only if sufficient competition exists among firms. Although packers paid significantly higher prices when purchases as a percentage of capacity increased (which was a proxy for increased plant utilization), the magnitude of the price increase was small.

Previous research found differences in prices paid for fed cattle among packers (Ward 1992; Schroeder et al. 1993). The comparison of plant results ($DPLT_{i,t}$) in table 4 indicates price differences among plants varied widely within and between models.[7] Thus,

[7] Plants are not identified by name or location to preserve confidentiality.



[a] Base plant is in Kansas.

Figure 1. Average price differences ($/cwt) across three groups of plants

coefficients on the price differences paid by plants were less robust than for most other variables. The base plant in all models was a large plant located in Kansas. There was a tendency for plants paying lower prices to be smaller or located farther from the primary cattle feeding area (i.e., the plains region of Texas, Oklahoma, Kansas, Colorado, and Nebraska). A map showing average price differences across three groups of plants is presented in figure 1. Highest prices were paid by plants located in and near Kansas, and lowest prices were paid by plants located farthest from the Kansas area. It should be noted, however, that there were exceptions within each of the three areas in figure 1. Results from this model were consistent with findings from the fed cattle regional market definition component of the larger Packers and Stockyards Program study (Hayenga, Koontz, and Schroeder). Packers tend to operate in a more national than regional market for fed cattle procurement. Spatial arbitrage across regional markets keeps prices well integrated.

Captive Supply Variables

Model 1: Captive Supply Deliveries, Equations (2)–(4). Factors expected to explain the variation in deliveries from the captive supply inventory for each plant, besides day of the week and month of the year, included: basis, current cash prices, and percentage purchases of plant capacity for forward contracted cattle; expected prices, current cash prices, and percentage purchases of plant capacity for packer-fed and marketing agreement cattle. Barkley and Schroeder found that packers use captive supplies to keep plant utilization high. Therefore, an inverse relationship was expected between

Table 4. Plant Dummy Variables: Selected Results, Models 1–3 ($/cwt)

Variable	Model 1 Equation (5)	Model 2 Equation (6)	Model 3 Equation (7)
$DPLT1_{i,t}$	Base	Base	Base
$DPLT2_{i,t}$	-5.06*	-3.66*	-4.19*
	(28.59)	(27.42)	(58.17)
$DPLT3_{i,t}$	0.20*	-0.28*	-0.26*
	(4.38)	(3.67)	(6.54)
$DPLT4_{i,t}$	-2.01*	-0.79*	-0.85*
	(15.38)	(7.60)	(18.93)
$DPLT5_{i,t}$	0.53*	1.29	1.11*
	(4.10)	(10.52)	(13.80)
$DPLT6_{i,t}$	-0.96*	-0.24*	0.64*
	(8.30)	(2.72)	(15.44)
$DPLT7_{i,t}$	-0.47*	0.02	-0.33*
	(4.20)	(0.15)	(7.07)
$DPLT8_{i,t}$	-3.41*	-0.78*	-2.44*
	(13.61)	(3.72)	(24.16)
$DPLT9_{i,t}$	-0.64*	0.32*	0.59*
	(6.48)	(3.23)	(12.31)
$DPLT10_{i,t}$	-0.71*	-0.10	-0.28*
	(13.15)	(1.68)	(6.93)
$DPLT11_{i,t}$	0.49*	-0.03	0.09
	(10.91)	(0.57)	(2.35)
$DPLT12_{i,t}$	-0.44*	-0.03	0.31*
	(3.90)	(0.37)	(6.25)
$DPLT13_{i,t}$	1.04*	-0.52*	0.35*
	(5.45)	(5.04)	(8.10)
$DPLT14_{i,t}$	0.14*	-0.34*	0.08
	(2.95)	(4.80)	(1.79)
$DPLT15_{i,t}$	-0.83*	—[a]	0.60*
	(6.64)		(13.78)
$DPLT16_{i,t}$	1.57*	—[a]	-0.06
	(12.34)		(1.16)
$DPLT17_{i,t}$	-2.44*	-2.15*	-1.35*
	(26.43)	(21.90)	(24.75)
$DPLT18_{i,t}$	0.71*	0.50*	0.35*
	(14.28)	(8.67)	(8.73)
$DPLT19_{i,t}$	-0.94*	0.30	0.43*
	(5.24)	(2.09)	(6.78)
$DPLT20_{i,t}$	-1.66*	-0.32*	-0.34*
	(13.79)	(2.94)	(7.07)
$DPLT21_{i,t}$	-1.35*	-0.49*	0.11
	(10.59)	(3.73)	(1.91)
$DPLT22_{i,t}$	-1.27*	-0.27	0.15*
	(10.28)	(1.69)	(3.08)

Table 4. Continued

Variable	Model 1 Equation (5)	Model 2 Equation (6)	Model 3 Equation (7)
$DPLT23_{i,t}$	-1.26*	—[a]	0.33*
	(9.91)		(7.09)
$DPLT24_{i,t}$	-1.95*	-1.37*	-0.88*
	(19.84)	(16.32)	(15.78)
$DPLT25_{i,t}$	-2.48*	—[a]	-1.11*
	(18.06)		(15.66)
$DPLT26_{i,t}$	-3.12*	—[a]	-2.35*
	(22.66)		(33.88)
$DPLT27_{i,t}$	-1.96*	—[a]	-0.49*
	(14.58)		(7.53)
$DPLT28_{i,t}$	-1.38*	0.33	0.09
	(10.49)	(1.60)	(1.46)

Notes: An asterisk (*) denotes significance at the 0.01 level. Numbers in parentheses are absolute values of calculated t-statistics.
[a] Plant did not have captive supplies.

purchases as a percentage of plant capacity (PCP_t) and captive supply deliveries. Results were mixed. Percentage purchases were inversely related to increased deliveries of packer-fed and marketing agreement cattle as expected, but positively associated with increased deliveries from the inventory of forward contracted cattle. The reason for the difference is not known.

It was expected that deliveries from captive supplies would increase as cash market prices increase, thus decreasing buying pressure on cash market prices. Higher cash market prices ($TRPRC_t$) were positively associated with increased percentage deliveries of captive supply cattle.

Basis (BSS_t) was expected to affect deliveries of forward contracted cattle through its relationship with current market prices. When combined with the transaction price variable, basis represents the movement of the futures market relative to the cash market. One argument is that as the basis strengthens, indicating that cash prices are increasing relative to futures market prices, packers may deliver cattle from their forward contracted inventory to reduce cash market buying pressure, thus allowing cash market prices to decline temporarily. However, an unexpected inverse relationship was found between basis and forward contract deliveries.

Lagged futures market prices ($LCFMP_{t-1}$) were included in the equations for percentage of packer-fed and marketing agreement cattle. As futures market prices increase for the nearby contract, packers may increase deliveries from captive supply inventories to reduce buying pressure in the cash market. Again, an unexpected inverse relationship was found between the futures market price and deliveries of both marketing agreement and packer-fed cattle.

Generally, results for the three equations explaining deliveries of cattle from the three types of captive supply inventories were weak. This was the first attempt to model captive supply deliveries, and more research is needed.

Table 5. Results for Captive Supply Variables: Model 1, Equation (5)

Variable	Coefficient ($/cwt)	Flexibility[a]	Variable	Coefficient ($/cwt)	Flexibility[a]
$PQFC_t$	-0.05* (7.40)	-0.0004	$PQMA_t$	-0.36* (13.87)	-0.0030
$PQPF_t$	-0.06 (1.74)	0.0005			

Notes: An asterisk (*) denotes significance at the 0.01 level. Numbers in parentheses are absolute values of calculated t-statistics.
[a] Flexibilities are the regression coefficient times the inverse of the mean transaction price.

Model 1: Captive Supply Deliveries-Price Relationships, Equation (5). Table 5 shows results for captive supply variables in the transaction price equation of Model 1. Increasing deliveries of cattle from two of the three types of captive supply inventories were associated with lower transaction prices for fed cattle. A 1% increase in captive supply deliveries, which are measured in percentages, was associated with: a $0.05/cwt[8] decline in fed cattle transaction prices for forward contracted cattle ($PQFC_t$), a $0.36/cwt decline for marketing agreement cattle ($PQMA_t$), and no significant impact for packer-fed cattle ($PQPF_t$). For all three types of captive supplies, a one percentage point increase in deliveries from each respective inventory of captive supply cattle represents a significant increase in use of captive supplies based on mean values for each type (table 2). Flexibilities also are presented in table 5. Percentage changes in transaction prices from a 1% increase in each captive supply procurement method are small—less than 1% in all cases.

A modified-Hausman test (Godfrey) was used to test for simultaneity between the percentage delivery of cattle from captive supply inventory and transaction prices for fed cattle. Test results indicated there was simultaneity between cash market transaction prices and percentage deliveries of forward contracted and marketing agreement cattle, but not packer-fed cattle. Thus, decisions by packers to deliver forward contracted and marketing agreement cattle are made simultaneously with decisions to purchase cash market cattle. However, the decision to deliver packer-fed cattle ($PQPF_t$) is made independently of the decision to purchase cash market cattle. Results suggest price is not a decision variable for packers when timing packer-fed cattle deliveries.

No previous research has considered the simultaneity question, and no previous studies have specifically examined impacts from packer-fed and marketing agreement deliveries, so no direct comparison can be made between our model results and previous work. However, previous studies which examined impacts from deliveries of forward contracted cattle (Elam; Hayenga and O'Brien; Schroeder et al. 1993) found negative or mixed impacts on fed cattle prices from increased deliveries. A negative relationship was found here.

Model 2: Captive Supply Inventory-Price Relationships, Equation (6). Coefficients on individual captive supply inventory variables had mixed signs, while the coefficient on

[8] All prices are stated in dollars per hundredweight ($/cwt) of dressed weight.

Table 6. Results for Captive Supply Variables: Model 2, Equation (6)

Variable	Coefficient[a] ($/cwt)	Flexibility[b]	Variable	Coefficient[a] ($/cwt)	Flexibility[b]
QFC_t	0.013*	0.000773	QMA_t	-0.017*	-0.001675
	(7.25)			(7.63)	
QPF_t	-0.179*	-0.000945	$QTOT_t$	-0.002	-0.000326
	(11.60)			(1.06)	

Notes: An asterisk (*) denotes significance at the 0.01 level. Numbers in parentheses are absolute values of calculated t-statistics.
[a] Coefficients were converted to represent price ($/cwt) changes for a 1,000-head change in the captive supply vehicle.
[b] Flexibilities are the regression coefficient times the mean of the captive supply inventory variable divided by the mean transaction price.

Table 7. Results for Procurement Method Variables: Model 3, Equation (7)

Variable	Coefficient ($/cwt)	Variable	Coefficient ($/cwt)
$DCASH_t$	Base	$DPKRFED_t$	0.01
			(0.16)
$DFWDCON_t$	-3.16*	$DMKTAGREE_t$	0.10*
	(67.99)		(3.82)

Notes: An asterisk (*) denotes significance at the 0.01 level. Numbers in parentheses are absolute values of calculated t-statistics.

the total captive supplies variable was not significant (table 6). A 1,000-head increase in the size of captive supply inventory was associated with: a $0.01/cwt increase in transaction prices for the forward contract inventory (QFC_t), a $0.18/cwt decline for the packer-fed inventory (QPF_t), and a $0.02/cwt decline for the marketing agreement inventory (QMA_t). In each case, a 1,000-head increase in the inventory of captive supplies represents a substantial increase based on mean values in table 2 for the study period. Results suggest different types of captive supplies have differential impacts on fed cattle prices. Thus, a total captive supply inventory variable ($QTOT_t$) was substituted for the individual captive supply inventory variables to assess the overall impact from the three types of captive supplies. Its coefficient was not statistically significant.

Flexibilities also are presented in table 6, and are small. A 1% increase in cattle purchases by any captive supply method or all three methods combined had less than a 1% impact on fed cattle transaction prices.

Model 3: Captive Supply-Cash Price Differences, Equation (7). Average price differences between cash market transaction prices and prices for captive supply variables also were mixed (table 7). A large average price difference was found between forward contract prices and cash market prices ($DFWDCON_t$) over the study period. Forward contract prices averaged $3.16/cwt below cash market transaction prices, which translates to $1.99/cwt on a live weight basis using a 63% dressing percentage. Large initial price differences between forward contract prices and cash market problems raised questions about correct model specification. It was argued that the time lag between purchase date and slaughter date for forward contracts in a downward-trending market contributed to the large negative differential. As a result, cubic time-trend variables were included in Model 3 to remove the within-year price trend. However, results for average price differences were robust. Results here paralleled but were somewhat higher than findings by Eilrich et al., where net basis contracts and simulated hedged prices were $1.77/cwt less than cash market prices on a live weight basis, assuming an average transportation cost of $0.40/cwt for cattle feeders. Results support the theoretical conclusion by Carlton that forward contract prices are expected to be lower than the expected value of cash market prices. These findings suggest packers have a significant economic incentive to use forward contracts in purchasing fed cattle.

Cattle feeders also have an incentive to use basis contracts. Koontz and Trapp studied cattle feeding profits for 33,250 pens of cattle fed in 64 southern plains feedlots from May 1986 through March 1993. They found that the contribution of basis risk to pen profit variability was four times greater than the contribution from price-level risk. Reducing basis risk, such as by basis contracts, could reduce pen profit variability by 40%. Their results, combined with results here, suggest that basis contracting may reduce profit variability for cattle feeders, but only at some lower price and profit level.

Average price differences between packer-fed cattle ($DPKRFED_t$) and cash market cattle ($DCASH_t$) were not significant. The price recorded for packer-fed cattle is in essence a transfer price between the cattle feeding and cattle slaughtering divisions of the company, not a market-discovered transactions price. This price might be expected to track cattle feeding costs or track the cash market price, so that transfer prices represent current market conditions.

Average prices for marketing agreement cattle ($DMKTAGREE_t$) were significantly higher ($0.10/cwt) than for cash market cattle. Assuming marketing agreements result in increased exchange of information between feeders and packer regarding carcass performance, then one could expect a positive price difference between fed cattle purchased by marketing agreement compared with those purchased in the cash market. Over time, cattle feeders should use the additional information and improved communications to better feed and market fed cattle, which should be reflected in higher prices. Additionally, the incremental information may allow feeders to alter the type of feeder cattle purchased so as to better match packers' demands when cattle reach market weight. The higher price may also represent lower transactions costs associated with procuring cattle via marketing agreement.

Summary and Conclusions

The overall objective of this study was to measure the impacts of captive supplies on cash market transaction prices for fed cattle, and three alternative models were estimated. Simultaneity was found between the decisions to deliver forward contracted and marketing agreement cattle and the decision to purchase cash market cattle.

Negative relationships were found between transaction prices and the percentage deliveries from the inventory of forward contracted and marketing agreement cattle.

Results measuring transaction price impacts from the absolute size of the captive supply inventory were mixed. The total inventory of captive supply cattle had no significant effect on cash market transaction prices. The price impact was negative for packer-fed and marketing agreement cattle, but positive for forward contracted cattle.

Significant average price differences were found to depend on procurement methods during the study period. Forward contract prices averaged much lower than cash market transaction prices. Prices for packer-fed cattle were not significantly different than those for cattle purchased in the cash market, while prices paid for cattle purchased via marketing agreement were higher.

On balance, captive supplies during the study period did not have large adverse effects on fed cattle transaction prices. Impacts were somewhat mixed, but results, when negative, generally were small. The expected large negative impacts that contributed to Congress mandating the study (Packers and Stockyards Program) and large negative impacts subsequently claimed by cattle producers (USDA, Advisory Committee on Agricultural Concentration) were not found. Cattle feedlot and packing plant locations had a greater impact on transaction prices than did captive supplies.

While this study was the first in several respects to estimate transaction price impacts and had access to the most comprehensive data available for any captive supply study, results raise several unanswered questions, pointing to the need for further research. Model results for the percentage deliveries from each type of captive supply inventory were informative but weak in terms of explanatory power, and produced some conceptually unexpected results. A complete theory of use and impacts of captive supplies is needed. The complete theory needs to account for incentives to use captive supply marketing/procurement methods, both for cattle feeders and packers, as well as timing of expected market impacts. The attempt to account for time lags between purchase and slaughter dates was limited, and may have contributed to the finding of the large average price difference between forward contract prices and cash market prices. However, these results did not differ greatly from previous research. All results may be sensitive to the study period, geographic coverage of the data, and model specification. Further research is needed with data for other time periods, as well as for smaller geographic areas, since captive supply impacts may be more relevant when estimated for localized market areas. While this study focused on transaction price impacts, we recommend also estimating captive supply impacts on daily or weekly average fed cattle prices in future research.

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