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**THE EFFECT OF CONTRACTING ON PRICING DYNAMICS IN THE
FED CATTLE MARKET: AN EXPERIMENTAL SIMULATION APPROACH**

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THE EFFECT OF CONTRACTING ON PRICING DYNAMICS IN THE FED CATTLE MARKET: AN EXPERIMENTAL SIMULATION APPROACH

ABSTRACT

The increased amount of contracting in many agricultural markets continues to be a source of considerable controversy. Some research indicates that increased levels of contracting lead to better prices for processors/users while other research is inconclusive. This article uses an experimental economics approach to study the effects on prices of systematic variations in contracting levels using an experimental model of the fed cattle market. Using experimental economics allowed the control of contracting levels and other variables (e.g. supply levels) that are not possible using industry data. Pricing dynamics changed considerably with increased levels of contracting, but the mean price level was found to be not related to contracting levels. The response of price to a given supply was found to increase as contracting levels increase. In addition, price variability with high levels of contracting showed long periods with relatively little adjustments followed by short periods of abrupt changes.

Key words: Thin market, experimental simulation, fed cattle marketing

THE EFFECT OF CONTRACTING ON PRICING DYNAMICS IN THE FED CATTLE MARKET: AN EXPERIMENTAL SIMULATION APPROACH

Various forms of contracting are increasingly the means by which agricultural products are produced and accounts for over one-third of total U.S. agricultural production (USDA 1996). However, the use of contracting varies by industry with some (e.g. poultry, eggs) having almost all production in contracts and others (e.g. wheat, soybeans) with a fairly small amount of contracting (Barkema, Drabenscott and Welch). Contracting is especially controversial in industries where contracting has not traditionally been extensive and there is a growing trend towards increased levels. Concerns often focus on potentially decreasing prices paid to producers as processors and other potential customers may be able to exert market power due to contracting (e.g. USDA, Advisory Committee on Agricultural Concentration).

In recent years, fed cattle marketing has experienced increased levels of contracting, vertical integration, and strategic alliances. Currently, there is a trend in the cattle industry towards contracting and increased levels of contracting. Within this industry, there have been strong ongoing concerns about the impact of this change on pricing dynamics (Hayenga 1979). Some research has shown that these changes result in lower prices and returns to farmers (Elam 1992; Ward, Koontz and Schroeder 1998). These changes and potential effects are a source of substantial controversy.

Most of the literature has focused upon the degree of non-competitive behavior that is caused by contracting. For example, one measure has been to compare prices paid for contracting with prices paid on the open market (e.g. Ward, Koontz and Schroeder). While their approach certainly has merit, one somewhat neglected aspect of contracting is their overall impact on price discovery and market pricing dynamics as markets as the level of contracting increases. This issue is similar to thin market issues explored by Tomek. A key issue is how contracting changes or can be expected to change the underlying pricing dynamics in the

marketplace. At what point can we expect substantial effects of contracting on price levels? What is the nature of this impact? To study these questions requires more information than is available from cattle markets because it requires varying contracting levels in the market and then analyzing performance.

To overcome these data limitations, this study collects and uses data from an experimental economic simulation of the fed cattle market, the *Fed Cattle Market Simulator* (FCMS). In past studies using the FCMS, researchers have analyzed the effects of public information (Anderson, et al, 1998), price discovery (Ward, et al, 1996), the value of non-price vertical coordination in the fed cattle market (Anderson and Trapp, 1999) and marketing agreements (Ward et al, 1999). This study will focus on the effects contracting has on the cash market price received for beef cattle. Controlled changes in contracting levels will be used to examine their effect on cash price levels and pricing dynamics.

STUDIES OF THE EFFECTS OF CONTRACTING AND THIN MARKETS

In contracting arrangements, processors (e.g. packers) arrange with producers (e.g. feedlots) to buy their product at least two weeks prior to actual delivery. The amount in the contracting arrangement has been removed from the open market. While much of the research on contracting has focused on relative returns to producers and process (i.e. market power effects), contracting also has an effect of thinning the market, i.e. there are fewer transactions in the market for price discovery. In terms of understanding the effects of contracting on the market, these two effects are linked.

Research measuring the effects of contracting has studied the effects of price in relation to different levels of contracting. Elam found that increasing levels of captive supply (which contracting is one form) were associated with lower prices in the U.S. and had price effects from negative to insignificant in Kansas, Nebraska, Colorado, and Texas over the period of October 1988 to May 1991. A second study also found a negative relationship between fed cattle captive supply shipments and cash market transaction prices between May and November 1990 in

Kansas (Schroeder 1993). In contrast, Hayenga and O'Brien compared weekly average feeder prices for the same states with other reported market prices from October 1988 to December 1989 and found that the impact of captive supply on price was insignificant or mixed. Overall, empirical research using market data generally has found captive supplies have a negative or mixed impact on cash prices.

A related vein of research has focused upon differences paid for transactions prices (i.e. individual sales) between cash sales and cattle sold in captive supply arrangements. Ward, Koontz, and Schroeder (1998), using a unique national data set from April 1992 to April 1993, estimated impacts from captive supply on cash transaction prices across the United States and generally found increased levels of captive supply yielded modestly lower cash transaction prices in comparison to prices for contracting. This effect varied substantially with type of captive supply arrangement. Ward et al (1999) used the FCMS to develop data to compare prices paid for cattle sold in imposed exclusive contract agreements with cash prices. They found that transactions prices were higher during agreement periods but more varied than during non-agreement periods. Transactions prices also showed greater variability during agreement periods than during non-agreement periods.

The common method utilized in these studies has been to develop a reduced form model which contains relevant variables for prices, supply and demand for the fed cattle markets in question. Typically the studies have been over relatively short time periods where contract levels are relatively static or growing slowly. Differing results may be a result of different market conditions or other reasons.

In general, these studies do not provide much information about the dynamics of price discovery in markets with large amounts of contracting as they have tended to focus on the issue of processor exerting market power to receive better prices. That is, it is generally assumed that cash markets function more or less the same despite growing levels of contracting. Of course, *at some point* pricing dynamics are affected by thinning markets. Currently, estimates range from 20-50 percent of the fed cattle market being traded through contracting arrangements.

From theory, as markets become thin we would expect that average prices would not change, but the volatility of prices would increase and pricing efficiency would decline (Hayenga). Tomek studied the efficiency of cattle prices through comparing prices of strong terminal market with a declining terminal market. He found that as the terminal market declined, imprecise pricing resulted. Since that time, there has been surprisingly little literature on thin markets, except for futures markets (e.g. Carter, 1989; Gordon 1984).

Given the importance of markets for resource allocation between producers and processors, an important issue is to what extent pricing dynamics are effected by thin markets as a result of contracting arrangements. Essentially there has been little study of the effect of contracting on pricing dynamics. In this article, contracting levels are controlled systematically. This will enable the research to address two important issues: (1) identify whether pricing dynamics and price formation processes change as contracting level increases (2) provide another analysis of how cash prices are effected by increasing levels of contracting albeit controlling for many factors as is possible using experimental economics.

EXPERIMENTAL DESIGN AND DATA COLLECTION

Experimental economics is an approach often used to study various economic activities that are difficult or impossible to study using market data. For example, it is difficult to assess the effects on the market of contracting levels beyond what the market has experienced, yet this information has value. Using experimental economics it is possible to isolate effects of contracting from other effects.

THE FCMS

The experimental simulation of the FCMS integrates business simulation and experimental economics. As such, it contains components of microeconomic systems that have been identified for use for laboratory experiments (Friedman and Sunder). Within a specified market and institutional structure, subjects/participants of experimental simulation studies make

decisions that affect performance of their particular market and the entire market (Ward et al, 1999).

The Fed Cattle Market Simulator was developed to simulate marketing activities analogous to that which exists between feedlots and packing companies. The FCMS allows participants to be both packers and feeders through trading pens of cattle. The cattle are produced by feedlots and then sold to packers. It is the job of both the feedlots and the packers to mathematically calculate the breakeven prices that must be received in order to achieve profits or avoid losses that could occur through trading. Each side seeks to earn the most profit they are capable of receiving from cattle sales.

The FCMS is played in specific trading periods that last between seven and eight minutes. Each trading period is designed to be analogous to a week of real world cattle marketing. At the end of each trading week, there is a five to ten minute information session in which participants monitor prices and analyze supply and demand information that are analogous to that available from the USDA/AMS (Anderson et al. 1999).

Once the simulation begins, feedlots are given a certain amount of cattle which they have to market to the packers. Cattle within the simulation may be sold through the use of an open cash market, marketing agreement, or forward contract. It is the responsibility of the feedlots and processors to bargain with one another in such a way as to arrive at a reasonable sales price for both parties.

A key feature of decisionmaking in the FCMS is that it focuses upon the negotiations in the fed cattle market and the effects of the market on cattle prices. Key features include:
Supply control: The supply that individual feedlots get is set over time and varies according to a fixed pattern. This essentially means that there can be little change in the overall production levels of cattle between years and that production/supply decisions is essentially fixed at a given time.

Fixed processing capacity: Processors over the period of the simulation cannot expand capacity and the industry as a whole has a fixed processing capability. In the time period of the

simulation, it would typically not be possible to expand capacity in the industry.

Boxed beef prices: Boxed beef prices are a critical decision variable for processors as they select appropriate levels of cattle for processing. The amount of beef supplied by cattle processors directly effects the overall market price for boxed beef which is consistent with the marketplace dynamics.

The mechanics of the simulation are explained in more detail in Trapp et al (1995) and were designed to simulate the dynamics experienced within the industry as discussed earlier. This simulation has been used in training for several companies involved in the cattle merchandising and processing business, and industry participants have indicated that it does have the same overall dynamics as the fed cattle market.

EXPERIMENTAL DESIGN

Data for this research, as stated, were generated from the FCMS, a university one-hour special problems class. The class generally consists of junior and seniors in agricultural majors. The data set was generated from a one semester controlled study of contracting levels in the spring of 1999 and then compared with pricing results of three previous years where no forced contracting was done (1994, 1995, and 1996).

Students were allowed to freely trade animals for the first simulated thirteen weeks of the study in order to become familiar with the interaction process required to be successful. At the end of this introduction session, students were informed by the administrators of the study that selected levels of contracting (a form of contracting) were going to gradually be implemented into the simulation. Before each trading period, feedlots were instructed how many cattle were to be contracted to predetermined processors.

The research plan consisted of six discrete contracting levels: 1) 0%, 2) 25%, 3) 50%, 4) 62%, 5) 75%, and 6) 87% of the entire amount of cattle supplied to the market. Each level of contracting was used once for eight weeks before going to the next consecutive level. Table 1 contains a summary of statistics of the data generated in the simulation.

Contract prices were formula priced from the previous week's cash price. Modifications

were made to the contract price if either the packer or feeder involved in a contractual agreement lost money the week before. In order to make appropriate adjustments, both packers and feeders were required to indicate if they lost or made money. If both entities were making or losing money, then no adjustment was made. However, if one entity was making money and the other losing money, then a \$0.50/cwt price adjustment was made for the packer or feeder that was losing money. Further, in all cases, packers and feeders were not allowed to share profit and loss statements. Finally, in the event of disputes over the truthfulness of prices from previous weeks, the administrators of the experiment had the right to penalize the offending party up to \$2.00/cwt at their discretion.¹

The testing period consisted of 58 simulated weeks in which contracting was monitored. All contracts were selected at random, and students involved were rotated so that all players had the opportunity to experience trade as both feedlot and processing managers.

EMPIRICAL MODEL AND RESULTS

Contracting may have notable effects on general supply and demand conditions because it causes a thin cash market. In this situation contracting reduces the number of available (non-purchased or non-committed) fed cattle in short-term supply. This occurs because animals are already contracted to specific individuals, therefore reducing the number of animals available for sale in the cash market. Additionally, packers will purchase fewer animals from the open market because their demands have been partially met through contracting cattle deliveries. As a result, the short-term demand curve shifts to the left and a new supply/demand equilibrium is established.

In the beef industry, feedlots and processors bargain and negotiate in order to establish transaction prices. Previous transaction specific research dealing with the impacts of contracting on fed cattle prices have established both supply and demand variables as well as transaction

¹ This penalty was not applied in the simulation as there were no disputes.

specific information (Ward et al. 1998). Previous research can be conceptualized by the following general model:

(1) Price = f(Supply/Demand, Transaction Specific Characteristics).

However, this study focuses on week-to-week market changes so the use of transaction specific information is not applicable.

Supply and demand in this case can be represented by show list size (the number of animals available for sale) and boxed beef price (the price in which wholesale cuts of meat are sold), respectively. These characteristics parallel those used by Anderson et al. (1999) and Ward et al. (1998, 1999).

The effects of contracting can be captured through adding an additional variable that is representative of the contracting level utilized during the applicable week of study. The use of contracting causes a form of captive supply as well as leads to a thin cash market. The contracting variable is important because it indicates the amount of the market which is contracted and hence is not negotiated.

Figure 1 shows price data for the years 1994, 1995, 1996 and 1999 along with contracting percent for 1999. At the 0% contracting level, prices are very similar indicating that similar underlying pricing dynamics exist for all four years. However, at the 25% contracting level, 1999 cash prices begin to consistently deviate from the other years, sometimes dramatically. It is apparent that different pricing dynamics are present with even modest levels of contracting.

The fact that pricing dynamics change is not surprising. However, it is surprising to see that cash prices associated with contracts (1999) rose above previous years' prices (1994, 1995, and 1996) in certain situations even with high levels of contracting. This suggests that increasing levels of contracting may not lead to lower cash market prices as some empirical evidence has indicated.

The effects of contracting will be evaluated by testing three hypotheses. Each hypothesis will utilize different approaches to study thin market effects. The hypotheses are: 1) Increased levels of contracting cause lower average cash prices, 2) Increased levels of contracting cause an

“enhanced supply effect”, and 3) Increased levels of contracting cause cash prices to become increasingly volatile.

EFFECTS OF CONTRACTING ON AVERAGE CASH PRICE

In order to evaluate the effects of contracting on cash market price it is necessary to include the factors that have an affect on overall price formation as well as contracting levels. As discussed earlier, the variables that are effective at describing supply and demand conditions are show list size and boxed beef price. With the addition of a contracting variable this results in the following regression model:

$$(2) \quad P_t = \beta_0 + \beta_1 \text{BBP}_{t-1} + \beta_2 \text{SHWL}_t + \beta_3 \text{PerCont}_t + \epsilon_t$$

where P_t is the cash price, BBP_{t-1} is the lagged boxed beef price, SHWL_t is the total number of pens on the show list, PerCont_t is the percent contracting, and the subscript t refers to the trading week. The contracting percentage is used as a test variable in order to analyze whether it has a significant affect on price determination as contracting levels increase.

The results of the model are presented in Table 2. First order auto-correlation was discovered and corrected for using the Cochrane-Orcutt procedure for correction of auto-correlation as employed by the Statistical Analysis System (SAS). Additionally, multiplicative heteroskedasticity was found using the Breusch-Pagan, Glejser, and Harvey tests for heteroskedasticity. The model proved to have strong explanatory power and revealed an R^2 of 0.90. Each of the parameter estimates is highly significant. Most interestingly, the contracting coefficient is negative which is consistent with the common argument that high levels of contracting lead to low cash prices. This result may be consistent with earlier research, but the graphical illustration of cash market prices (Figure 1) suggests that the previous regression results may not fully reflect the underlying price dynamics. As shown from the graph, cash price exceeds normal levels in many situations. This certainly seems to contradict the evidence above.

Table 3 presents a comparison of mean prices at different contract levels indicating if any of the pricing data deviated significantly between the years. The results indicate that mean prices for data comprising 1994, 1995, and 1996 were not statistically significantly different,

whereas the mean prices for 1999 were statistically different in four of the six periods during which contracting levels were specified. Further, three of the four significant differences occurred during periods with the highest levels of contracting.

Prices representing 1999 became significantly different once contracting was implemented. The only deviation from this pattern occurred at the 50% contracting level where the price crossed the prices associated with the other years. Most importantly, price was *not only significantly lower than previous cash prices, but also significantly higher than the norm.*

An interesting aspect of when cash price exceeded typical prices is that supply levels were relatively low. In Table 3 supply for the 1999 year were characterized as high, average and low compared to a balanced market (i.e. 115-122 pens). These result seems to suggest that high prices are higher than the norm with small supply levels and low prices are lower than the norm with large supply levels due to contacting. Under increased contracting levels this would indicate that supply has a more dramatic affect on cash market prices. This may indicate that the cash market overreacts when the market as a whole experiences extreme supplies (either high or low) along with even modest levels of contracting.

The results from the regression analysis supported some empirical evidence that increasing levels of contracting lead to lower cash prices. However, the qualitative results yielded from the graphical depiction of cash prices as well as the statistical test results suggest that contracting has mixed effects on cash price that seem to have a relationship with overall supply levels.

CONTRACTING AND DEMAND STRUCTURE

The previous results showed that contracting seemed to have varied or inconsistent effects on the cash price. This suggests that under certain conditions, contracting can cause cash prices to rise above normal, while at other times it can cause cash prices to dip below normal. As contracting increases, the number of buyers and sellers bargaining in the cash market declines. Therefore, the competition for available supply is decreased in the cash market and cash price declines. Therefore, it is possible that as contracting levels increase, the impact of

supply on the cash price increases. This suggests that there may be different relationships between supply and price than when contracting is not present.

This hypothesis can be tested through modifying Equation 3 to include a variable that represents the interaction of contracting and show list. This theory can be tested through the empirical equation:

$$(3) \quad P_t = \beta_0 + \beta_1 \text{BBP}_{t-1} + \beta_2 \text{SHWL}_t + \beta_3 \text{PerCont}_t + \beta_4 \text{ShwlCon}_t + \epsilon_t,$$

where P_t , BBP_{t-1} , SHWL_t , and PerCont_t are unchanged, and ShwlCon_t is the interaction of SHWL_t and PerCon_t .

The statistical results of this regression are shown in Table 4. The parameter sign of boxed beef remains unchanged, however the parameter sign for contracting became positive but was not significantly different from zero, indicating that it did not have either a positive or negative affect on cash price. Further, the show list variable became insignificant while the show list-contracting interaction variable is significant, indicating that it has an affect on cash price.

The R^2 of this regression analysis is 0.91, which indicates slightly broader explanatory power than Equation 3. First order auto-correlation was detected and corrected for using the Cochrane-Orcutt procedure in SAS. Multiplicative heteroskedasticity was also found using the Breusch-Pagan, Glejser, and Harvey tests for heteroskedasticity.

The results of this experimental model suggest that the show list-contracting interaction variable yields results that have previously not been found. This variable indicates that contracting is capable of enhancing the effect of supply on cash price and further shows that cash price can be both negatively and positively affected depending on the supply situation.

Contracting and Price Volatility

One of the expectations from theory is that as contracting increases then prices will become more volatile (Raikes 1978). Volatility issues studied in this context refer to abrupt and sudden changes in cash prices due to extensive contracting which leads to an increasingly thin market. Through observing the effects of the controlled levels of contracting used in this

research, it is possible to study price volatility on a week to week basis as well as to see whether the cash market is subject to large overall price adjustments. The goal of this study is to make an initial observation about the mechanics of price volatility, rather than create in depth research. The information gained from this study should be used to identify the initial effects of contracting on volatility and create a basis in which further research can be accomplished.

These patterns can be studied through the examining week-to-week price variation as shown in Table 5. Between weeks 35 and 42, the changes in 1999 cash price are not significantly different than those for 1994, 1995, and 1996. However, between weeks 43 and 75 the price change is significantly different than the previous years. Even more interesting is the fact that between the weeks of 43-50 and 59-66 the cash price for 1999 had less price change than the other years.

It can be noted that cash price volatility is affected by increasing contract levels. Cash price changes for 1999 were found to be significantly different from the changes for 1994, 1995, and 1996. Interestingly, the changes for 1999 were not only different in higher volatility, but also resulted in lower volatility.

CONCLUSION

This study has provided important insights into the effects of increasing levels of contracting on cash pricing dynamics. Results obtained indicate that contracting substantially changes pricing dynamics and price formation related to supply conditions even at a modest contracting level of 25%. These results were different from earlier research and were accomplished using of experimental economics.

Contracting seemed to have a substantial impact on cash price variability. Research in the experimental market suggests that, in the presence of contracting, cash prices experiences lower week-to-week price volatility followed by significantly large price changes in the presence of contracting. This was especially true as contracting levels increased. This information could

potentially be beneficial for new, effective risk management approaches when contracting is thought to have a major influence on market dynamics.

The results of this study suggest price responds differently to changes in supply with contracting. Results indicate that the slope of the demand curve becomes steeper as cattle contracting increased. This effect could be termed an “enhanced supply effect” of contracting and causes cash prices to experience “higher highs” and “lower lows” depending on supply levels. This suggests that earlier empirical research that showed negative or mixed effects of contracting on market cash prices may be the result of the supply conditions that existed at that time in the market.

These results of this study were based on a particular method of contracting. It is possible that other forms of contracting could have different effects upon market price. This suggests that a fruitful potential research approach would be to study the effects of contracting on the market with differing data sets or approaches to verify the approach. One useful bit of information for studies using market data would be to recognize the effect of contracting on the slope of the demand curve for fed cattle.

This research has analyzed the effects of contracting on cash prices. The use of experimental simulation allowed for the creation of data that were used to estimate characteristics of contracting that were previously unknown. The results obtained suggest that future research into contracting should usefully consider that contracting can change pricing dynamics and demand structure in important ways.

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Table 1. Summary Statistics of Weekly Data

VARIABLE	N	Mean	Standard Deviation	Minimum	Maximum
Average Price (\$/cwt)	58	77.25	6.43	67.77	88.75
Boxed Beef Price (\$/cwt)	58	124.19	6.77	113.07	137.21
Showlist (pens)	58	113.43	20.07	89.0	154.0
Contracting %	58	41.24	33.15	0.0	87.0

Table 2. Cash Price Regression Analysis with Contracting Percentage

VARIABLE	COEFFICIENT
Constant	-15.98* (-1.52) ^a
Boxed Beef Price (BBP)	0.84* (10.65)
Showlist (SHWL)	-0.08* (-3.21)
Contracting Percent (PerCont)	-0.06* (-3.46)
R ²	0.90
No. of Observations	58

^a Represents t-statistics, * denotes significance at the 10% level.

Table 3. Mean Price (\$/cwt) and Test for Significant Differences for 1994, 1995, 1996, and 1999 with 1999 Contract Level

YEAR	CONTRACTING WEEK					
	35-42	43-50	51-58	59-66	67-74	75-82
1994	73.0	75.2	79.6	82.1	78.6	78.0
1995	72.8	74.7	79.6	81.8	81.3	77.9
1996	73.6	74.0	78.5	81.1	81.1	78.5
Contracting Percent	0%	25%	50%	62%	75%	87%
1999	74.3	70.3*	78.4	85.0*	86.1*	69.4*
Showlist ¹		High	Low	Low	Average	Average
Showlist ²	138	128	100	91	116	116

* Denotes a significant difference from all others at the 10% level.

¹ Showlist size as compared to average showlist of 115-122.

² Average showlist size for each contracting percentage.

Table 4. Cash Price Regression Analysis with Contracting Interaction

VARIABLE	COEFFICIENT
Constant	-25.38* (-2.40) ^a
Boxed Beef Price (BBP)	0.87* (11.94)
Showlist (SHWL)	-0.03 (-0.72)
Contracting Percent (PerCont)	0.08 (0.97)
Showlist*Contracting Percentage (ShwlCon)	-1.18 X 10 ⁻³ * (-1.69)
R ²	0.91
No. of Observations	58

^a Represents t-statistics, * denotes significance at the 10% level.

Table 5. Mean Week-to-Week Price Change (\$/cwt) and Test for Significant Differences for 1994, 1995, 1996, and 1999 with 1999 Contract Level

YEAR	CONTRACTING WEEK					
	35-42	43-50	51-58	59-66	67-74	75-82
1994	0.27	0.96	0.61	0.90	0.88	0.73
1995	0.50	1.70	0.81	0.77	1.07	0.99
1996	0.57	1.35	0.79	0.83	0.59	0.95
Contracting Percent	0%	25%	50%	62%	75%	87%
1999	0.59	0.40*	1.58*	0.49*	3.19*	1.74

* Denotes a significant difference from all others at the 10% level.

Figure 1. Prices for Years Studied and 1999 Contracting Percent



