Auctioneer Versus a Dominant Bidder: Evidence from a Cattle Auction

Kalyn T. Coatney
Dept. of Agricultural Economics
Mississippi State University
P.O. Box 5187, 365 Lloyd-Ricks-Watson Bldg.
Mississippi State, MS 39762
662-325-7983
k.coatney@msstate.edu

Ardian Harri
Dept. of Agricultural Economics
Mississippi State University
P.O. Box 5187, 318 Lloyd-Ricks-Watson Bldg.
Mississippi State, MS 39762
662-325-5179
harri@agecon.msstate.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2015 AAEA & WAEA Joint Annual Meeting, San Francisco, California, July 26-29.

Auctioneer Versus a Dominant Bidder: Evidence from a Cattle Auction

1.0 Introduction

Competition at livestock auction markets is an important issue for sellers. The United States Department of Agriculture, Grain Inspection Packers and Stockyards Administration (GIPSA),[1] in charge of enforcing the Packers and Stockyards Act of 1921,[2] has a longstanding history of investigating allegations and prosecution of anticompetitive behavior in livestock auctions. Since the late 1990's, however, GIPSA has been subjected to criticism and public allegations of ineffective regulatory efforts (USDA, OIG 1997; USDA, GAO 2000; Harkin 2005; USDA, OIG 2006; US, GAO 2006; Grassley 2009). From a normative standpoint, perfect monitoring and prosecution of anticompetitive behavior by antitrust authorities with limited resources is not efficient, especially in the case of asymmetric information (e.g. Besanko and Spulber, 1989; Penard and Souam, 1996; Souam, 2001). Therefore, auctioneers must continually utilize strategies to thwart anticompetitive behavior on their own as per their fiduciary responsibility to their sellers. If auctioneers are able to independently thwart anticompetitive behavior, then the need for costly regulatory surveillance and prosecution is in turn diminished.

Two studies analyzed auction data gathered as a part of a GIPSA investigation into the competitive effects of a dominant common bidding agent (Coatney et al., 2012; Coatney and Tack, 2014). A common bidding agent is defined as someone who represents and bids on behalf of multiple principal buyers in the auction. The common agent in the studies maintained purchase orders from three of the top five cull cow processors in the region and purchased

---

[1] http://www.gipsa.usda.gov/psp/psp.aspx

[2] http://www.gipsa.usda.gov/laws/law/PS_act.pdf

roughly 74 percent of the cattle at a Wisconsin auction market. Both studies found compelling evidence that the formation and presence of a dominant common bidding agent reduced competition.[3] The authors assert that competition was most likely reduced because the common bidding agent maintained a competitive advantage. In a common value auction setting, such as for the purchase of slaughter cattle, the presence of an advantaged bidder results in the disadvantaged rivals bidding passively (Bikhchandani, 1988; Klemperer, 1998; Rose and Kagel, 2008).

Though Coatney et al. (2012) and Coatney and Tack (2014) acknowledged the results may have also been partially driven by collusion among a subset of bidders and/or the principals the agent represented (as alleged by the auctioneer), neither study was able to separately identify collusion from the predictions of advantaged bidder theory. Regardless of the source of reduced competition, the auctioneer was most certainly faced with some form and degree of anticompetitive behavior. The question addressed in this analysis is the degree to which the auctioneer at the cattle auction was able to combat the apparently anticompetitive behavior.

This study extends the work Coatney et al. (2012) in two significant ways. The first is to better identifying whether the dominant common bidding agent actually faced less competition from the fringe bidders. The previous study found the dominant common bidding agent purchased cattle for $2.64 per hundred weight less than the fringe bidders. Though consistent with advantage bidder theory, the result cannot rule out some unknown superior bidding strategy by the common agent, such as simply being patient. The second is to evaluate the effectiveness of the auctioneer's attempts to thwart the weakened competition. In any weakened competitive state, the item will not 'sell itself' and an auctioneer, as a condition of his fiduciary responsibility

[3] The GIPSA investigation was ultimately closed without seeking prosecution.

to the seller, must attempt to secure the highest possible bid. The auctioneer strategy identified in this study is ‘leading the bid’ by asking for relatively higher opening bids in relation to the winning bids. Though the auction market affiliated itself with a bidding ally to challenge the common bidding agent, the data are not sufficient to identify the value of the allegiance.

The results indicate that the fringe rivals clearly bid more passively on the units purchased by the common bidding agent, hence supporting earlier findings. Facing a passive group of passive fringe rivals, the auctioneer led the bidding in relation to the common agent and received on average $0.80 per hundred weight less than his initial asking bid. Furthermore, the auctioneer’s asking bid was found to be negatively influenced by the degree of competition, which in turn reduces winning bids. Therefore, the auctioneer was unable to effectively challenge the dominant common bidding agent on his own, given the ‘open outcry’ English auction method. These results in conjunction with the inability of regulators to perfectly enforce competition suggest that maintaining competitive livestock auction markets must come from a combination of strategic efforts by the auctioneer, alternative auctioning methods, and enforcement of competition laws.

The structure of the manuscript is as follows. First, several auctioneer strategies are discussed. Next, the data is then briefly described followed by the development of the econometric models to identify the impacts of the dominant common agent’s impacts on competition and the auctioneer’s strategies. The results are discussed followed by the conclusions and implications drawn from the results.

2.0 Auctioneer Strategies

The authors have found little formal theory pertaining to the optimal strategies of the auctioneer (seller) in common value auctions, other than that of setting reservation prices (announced or secret) when facing a stochastic endogenously determined number of bidders (e.g. Levin and Smith, 1994; Bajari and Hortaçsu,2003). Unlike the implicit assumption of credibility reservation prices in the literature, the credibility of a reservation price for cull cows, and refusing to sell unless met, is extremely weak. The reason being is that cull cows are salvage capital goods with little value other than for slaughter. Additionally, the outside option for the seller is costly in that cull cows are typically highly perishable due to health conditions (Bascum and Young, 1998), costly to return to the owner's business, and if the animal perishes before sold the owner must pay to have a rendering plant pick up the animal.

Current common value English auction theory presumes the auctioneer's asking bid is less than or equal to the lowest private signal holder and thus provides no additional information to bidders (Milgrom and Weber, 1982, pg 1096). However, the auctioning procedures observed in real world livestock auctions do not follow the explicit assumptions of theory as the auctioneer does not know the value of the lowest private signal holder. Furthermore, as the cattle auctioneer is typically selling a large number of lots/animals in a reasonable time frame, the auctioneer cannot start each unit at sufficiently low prices. As such, because the auctioneer's fiduciary responsibility to the seller is to solicit the highest price, other common strategies or 'tricks of the trade' believed to simulate bidding competition are discussed.

Sellers often complain that their item would have sold for more, if only, the auctioneer had 'pushed' the bidders harder or 'led the bidding' by initially asked for a higher price. In regards to pushing the bidders, livestock auctioneers must weigh the time spent on 'crying' for a higher bid and moving the auction along at an adequate pace to sell numerous lots/individuals of cattle in a timely manner. The auctioneer claims to lead the bidding. Leading the bidding is intendent to serve three purposes, i) demonstrate to sellers the auctioneer is attempting to solicit the highest and best price, ii) potentially catch buyers unaware, and iii) signal the auctioneer's beliefs of the animal's true value.

The credibility of the auctioneer's initial asking bid, however, depends on the auctioneer's (and his seller's) outside option of not receiving a bid equal to the asking bid. As discussed earlier, the seller essentially has no credibility in setting a reservation price. In an attempt to help the auctioneer gain credibility, livestock auction market owners routinely engage in what are called 'market support' strategy. One of these entails the auction market buying the animal at a higher price than that which was last bid, then resell the animal later in the auction.[4] This strategy necessarily raises revenue to the seller. However, this strategy results in average losses to the auctioning house as the bidders rarely bid higher the second time around. Therefore, the credibility of this strategy in thwarting reduced competition is extremely weak.

Another market support strategy is for the auction market to ally itself with an independent 'market support' bidder. This ally bidder's sole job is to strategically bid when competition wanes. As was the case at the auction market analyzed herein, the market-support bidder's main duty was to bid against the dominant common agent when the main rivals refused to bid. However, whether or not the ally follows the directive to the benefit of the seller may not be a credible commitment.

Finally, other strategies exist that may or may not be expressly illegal such as 'phantom bidding' (Graham et al., 1990, Bag et al., 2000), and 'shill bidding' (Kosmopoulou et al. 2007). When the bidding stops, the auctioneer may elect to take a phantom higher bid if he believes that

[4] Auctioneers are expressly prohibited from buying on their own behalf. However, auction market owners or their representatives not engaged in the auctioning process are allowed to purchase a 'small' number of cattle at strictly a loss under the Packers and Stockyards Act, 1921.

the current bidder is 'good for another bump'. Shill bidding is when the seller poses as a bidder in the hopes of raising the final bid. To the knowledge of the authors, neither of these strategies was employed by the auctioneer or the sellers.[5]

3.0 Data

The unique data from the previous study conducted by Coatney et al. (2012) is analyzed in this study. The data represents a Wisconsin cull cow English auction and was collected by the auction market under the directive of GIPSA investigators. At the auction, a common bidding agent represented four of the six major principal purchasers. The data is derived from selling animals one at a time in a local auction in which the auctioneer uses an open-outcry English auctioning method. Nearly all of the cows were either directly or indirectly purchased for beef processors. The data spans over 34 separate sales from the dates October 4, 1999 to January 26th, 2000. There were 7,722 individual sales in the data.

The data includes three unique measures of the progression of the auctioning process not analyzed in Coatney et al. (2012). As far as the authors are aware, no data series from an 'open outcry' livestock auction has ever collected the following two data series. First, the auctioneer's initial asking bids (*AB*) were recorded by the auctioneer. Because it is not necessarily the case that the auctioneer will receive an opening bid equal to the *AB*, the first bid offered (*OB*) from the bidders is also captured in the data. It is often observed in general that auctioneers must

[5] Another strategy auctioneers believe temporarily enhance competition is 'short selling' the previous animal by knocking the animal off quickly at a "cheap" price to liven up the bidding. These are opinions derived from conversations with several auctioneers and the auctioneer that took the bids in the current data base.

lower their *AB* to begin the bidding process. The *AB* and *OB* was collected to get a sense of the degree of bidding competition for each animal. Finally, as in all real world data series, the sales price or winning bid (*WB*) was collected.

The data includes a control for intertemporal competition by measuring the bidder concentration. Specifically, the measure is a Cumulative Herfindahl-Hirschman Index (*CHHIA*), and is calculated at the agent bidder (*A*) level given not all principal purchasers are present at the auction. Essentially the concentration metric continually updates the bidders' market share changes as their proportion of winning bids change during the auction session and carries information across auction sessions by a weighted transition period (see Coatney et al., (2012), pages 65 - 67 for details).

To calculate the *CHHIA*, all bidding principal/agent relationships are known, along with the types of bidding agents. For instance, the common bidding agent (*CBA*) is a commission order buyer purchasing on behalf the two largest beef packers in the region by capacity, and a dealer firm who has a standing order with another large beef packer. The *CBA* purchased roughly 74 percent of the market, clearly maintaining a dominant position in the market. The salaried employees of two large beef packers by capacity (*PPacker*, *GPacker*) are present at the auction. The *PPacker* and *GPacker* only purchased roughly 8 and 2 percent of the market. The market support bidder (*L*) is a dealer who bids on behalf of himself and has standing orders with two small packers, purchasing roughly 8 percent of the market. Two other dealer buyers are present (*F*, *T*) bidding on their own behalf primarily for speculative reasons, each purchasing roughly 2 percent of the market. Finally, small dairy farmer bidders (*SFB*) are present bidding on their own behalf in search of cows that may still have value in breeding for beef or milk. These *SFB*'s collectively purchased roughly 4 percent of the market.

The physiological characteristics of each animal was collected to control for correlated output value adjustments, primarily red meat yield. Any physiological attribute that provides a positive signal to the bidder of red meat yield increases the value to the bidder. First, to control for the value of the red meat yield, breed data such as Holstein (*HC*) is collected. On an equal weight basis, Holsteins yield less red meat than beef breeds. Second, the auctioneer determined whether each animal has a negative attribute (*Neg*) such as lameness, dullness of character, lump jaw, Cesarean and cancer eye, all of which reduce the red meat yield. These negative attributes result in lost carcass yield due to trimming. Finally, the live weight (*LW*) was collected and, all else equal, is positively correlated with red meat yield.

Finally, the data include the cull cow carcass cut out value (*CV*) collected from the U.S.D.A. Agricultural Marketing Service to control for outside market conditions. A sale trend (*ST*) variable is developed to control for any unexplained trends due to the order an animal is sold within the auction day. Finally, an overall trend (*T)* variable is developed to account for any unexplained trends within the data series.[6]

4.0 Modeling Bidder Passivity and Results

The first model developed identifies whether the fringe bidders refrained from bidding against the dominant common bidding agent, indicative of a passive bidding fringe.

4.1 Modeling Fringe Bidder Passivity

There are five general bidding patterns observed in the data related to the *AB*, *OB* and the *WB*. The respective observed bidding patterns (*BP*) are depicted in figure 1 and the distribution of

[6] The descriptive statistics for these variables is provided in Coatney et al., (2012), table 2, page 67.

bidding patterns is provided in table 1. The only bidding pattern indicative of the typically assumed English auction format in the literature is *BP*2, where the auctioneer receives an opening bid at his initial asking price and subsequent bidding increases until there is a winner (Milgrom and Weber, 1982; Levin et al., 1996). This bidding pattern constitutes only around 29 percent of the data. Therefore, nearly 71 percent of the animals are sold by means of the auctioneer 'finding the market' and the bidders updating, or not, their information in means other than those described for English auctions. As such, the optimal bidding strategies in *BP*s 1, 3, 4, and 5 would require an alternative initial reservation price for each bidder, potentially similar to that of a first price auction. The effects on the *WB* of which are unknown.

In relation to the auctioneer being able to let an animal 'sell itself', the observed *BP*s 1, 2 and 5 demonstrate that roughly 58 percent of the *WB*s are at least as great at the *AB*s. This result indicates the auctioneer tended to lead the bidding as asserted by the auctioneer. The balance of *BP*s 3 and 4 demonstrate the auctioneer did not receive his *AB* for roughly 42 percent of the animals. In relation to the bidders, as a group, forcing the auctioneer to reduce his initial *AB*, *BP*s 3, 4, and 5 demonstrate that roughly 65 percent of the *OB*s were less than the *AB*s. This result indicates that periodically bidders may be attempting to find the lowest valued bidder to update their own reservation price as theorized in the common value auction literature (Milgrom and Weber, 1982; Levin et al., 1996). In relation to the ensuing bidding competition after the *OB*, *BP*s 2, 4 and 5 demonstrate that roughly 79 percent of the animals received multiple bids. The minimum bidding increments in cattle auctions is $0.25 per hundred weight. The balance are instances when bidders did not face bidding competition after the *OB*, where *BP*s 1 and 3 constitute roughly 21 percent of the animals sold. Interestingly, *BP*3 (roughly 15 percent) is more akin to a negotiated rather than auctioned outcome.

As can be seen in figure 1, *BP*s 2 and 3 are the best and worst case scenarios for the hopes of the auctioneer in receiving the highest and best price. If the fringe bidders refrain from competing against the common bidding agent, then it would be expected that the probability of observing *BP*s 1, 2, 4, and 5 would be greater than that for the *CBA*. To identify the associated *BP*s with the independent fringe bidders (*L*, *F*, *T*, *P*, *G*, and *SFB*) in relation to the *CBA* (where the *CBA* is the basis of comparison), the following multinomial model is estimated. The dependent variable is the respective *BP*, where *BP1* = 0, *BP2 = 2, ..., BP5 = 4*. Following Greene (2003, p. 720-722), the multinomial logit model of bidding patterns is represented as

$$\text{Prob}(Y_i = j) = \frac{e^{\boldsymbol{\beta}'_j \boldsymbol{x}_i}}{\sum_{k=0}^{3} e^{\boldsymbol{\beta}'_k \boldsymbol{x}_i}}, \quad j = 0,1,2 \quad \text{and} \quad i = 1,\dots,n. \tag{1}$$

The maximum likelihood estimates of the $\boldsymbol{\beta}$'s in equation 1 provide a set of probabilities that J + 1 bidding patterns are observed *n* covariates $\boldsymbol{x}_i$. To control for the other attributing factors other than fringe bidders, the additional covariates are the bidder concentration measure (*CHHIA*), carcass value (*CV*), cattle characteristics (*HC*, *Neg*, and *LW*) and two trend variables (*ST* and *T*) are used to predict the probability of observing a specific bidding pattern. The model implies that there are J computable log-odds ratios of the form

$$\ln\left[\frac{P_{ij}}{P_{ik}}\right] = \boldsymbol{x}'_i\left(\boldsymbol{\beta}_j - \boldsymbol{\beta}_k\right). \tag{2}$$

Assuming that the log-odds ratio does not depend upon the other bidding patterns, the $\boldsymbol{\beta}$'s in equation 2 can be interpreted as the increase in the log-odds of falling into bidding pattern *j* versus *k* for the i^{th} covariate, holding the other covariates constant. However, the coefficients in the model are difficult to interpret as they are the impacts of the exogenous variables on the latent variables. Therefore, the true marginal impacts on the endogenous variables must be calculated. The marginal effects of the covariates on the probabilities are

$$\delta_j = \frac{\partial P_j}{\partial x_i} = P_j \left[\boldsymbol{\beta}_j - \sum_{k=0}^{j} P_k \boldsymbol{\beta}_k \right] = P_j \left[\boldsymbol{\beta}_j - \overline{\boldsymbol{\beta}} \right]. \tag{3}$$

Therefore, every subvector of $\boldsymbol{\beta}$ enters every marginal effect, both through the probabilities and through the weighted average $\overline{\boldsymbol{\beta}}$ that appears in equation 3.

4.2 Results

The resulting multinomial marginal effects of equation (3) is provided in table 2. Bidding pattern 1 was combined with 2 (*BP*1&2) due to the relatively small percentage of observations. This observation represents the case where the auctioneer was not required to reduce his asking bid.

The results indicate that for *BP*1&2, all fringe bidders were significantly more likely to have been associated with this bidding pattern than the commission agent. In regards to *BP*3, the results indicate that all but dealer bidder *F* was significantly less likely to have been associated with this bidding pattern than the commission agent; the bidding pattern with both the smallest degree of bidding competition and the lowest *WB*. In regards to *BP*4, the results indicate that all but the salaried packer buyer *G* and the small farmer buyers (*SF*) were significantly less likely to have been associated with this bidding pattern than the commission agent; the bidding pattern with the third ranked degree of bidding competition and the second lowest *WB*. Finally in regards to *BP*5, the results indicate that all but

5.0 Modeling the Auctioning and Bidding Process and Results

The second model developed is designed to identify the progression of the auctioning process and identify the responses to competition and the impacts of the auctioneer on the winning bid in a dynamic recursive systems of equations. This modeling approach controls for the information updating of both auctioneer and bidders as they move through the bidding process for each animal, as well as across animals sold during the auctioning process.

5.1 Auctioning and Bidding Process Model

In regards to the auctioneer's impact on the bidding process, the dependent variables in time order of occurrence are $AB_t, OB_{t+\alpha}, WB_{t+\beta}$, for simplification of notation set the time delays $\alpha = 1$ and $\beta = 2$. These equations are estimated to identify the ultimate impact of auctioneer's opening ask price on winning bids; the strategy of leading the bidders. The following system of equations control for exogenous factors that may impact either the auctioneer and/or bidders strategies, such as bidder concentration, carcass cutout values, the dominant common bidding agent's purchases, cattle characteristics, or various important unobservable trends.

5.1.1 Auctioneer Asking Bid Equation

The auctioneer observes the animal as it walks in the ring. He first estimates the value of the animal given the cow's physiological characteristics and the history of competition among the buyers. The auctioneer derives his estimate of the animal's value and beliefs about the competition of the market from the same information set as the buyers.[7]

After forming an estimate of the cow's value, competition for the animal and auctioning strategy, the auctioneer announces his asking bid (*AB*). The auctioneer has two pieces of information available about overall competition at any point in the auction; the previous winning

---

[7] We ignore the auctioneer updating his beliefs about the current cow's value given previous sales of similar types of cows.

bids and bidder concentration. Being able to 'find the market' quickly is also an important issue because auctioneers are required to sell numerous cull cows one at a time in a timely fashion.[8] This results in the auctioneer balancing the tradeoff between selling the animal quickly and leading or pushing the bidders. Therefore, the asking opening bid for the i^{th} cow at time *t* and is specified as

$$AB_{i,t} = \beta_0 + B_1 WB_{i-1,t-1} + B_2 CHHIA_{i-1} + \beta_3 CV_a + \beta_4 HC_i + \beta_5 Neg_i + \beta_6 LW_i + \beta_7 LW_i^{\,2} + \beta_8 LW_i^{\,3} + B_9 ST_{ia} + B_{10} T_i + \omega_{i,t} \ , \tag{1}$$

where $AB_{i,t}$ **is** the auctioneer's asking bid for i^{th} cow at time t, $WB_{i-1,t-1}$ is the winning bid of the previous animal to account for the beliefs of price momentum, $CHHIA_{i-1}$ is the lagged Cumulative Herfindahl-Hirschman Index of winning bidders at the auction ranging from 0 to 10,000 and is included to account for the beliefs regarding the current state of competition at the auction, CV_a is the a^{th} auction day carcass cutout value index for cutter cows ($/hundred weight)and remains constant throughout the auction day, HC_i is a breed dummy variable that takes on a value of 1 if the i^{th} cow is Holstein, and zero otherwise, Neg_i is whether the cow has an observable negative attribute that takes on the value of 1 when the i^{th} cow displays a negative attribute, and zero otherwise, LW_i is the live weight of the animal, ST_{ia} is the order the cow is sold within an auction day, T_i is an overall trend observation ranging from 1 to 7722, and $\omega_{i,t}$ is the error term associated with the i^{th} cow at time *t*.

The a priori expectations of the asking bid coefficients are

[8] The typical time the auctioneer took to sell each animal in the data set was less than 1 minute.

$\beta_1 > 0,\ \beta_2 > 0,\ \beta_3 > 0,\ \beta_4 < 0,\ \beta_5 < 0,\ \beta_6 > 0,\ \beta_7 < 0,\ \beta_8 > 0,\ \beta_9 \neq 0,$ and $\beta_{10} \neq 0$. If the auctioneer is attempting to lead-the-bidders, then the previous winning bid and bidder concentration coefficients β_1 and β_2 will be positive. The reason being is that as winning bids increase, the auctioneer will attempt to keep the momentum going by increasing the asking price for the next animal. If bidder concentration is increasing, less bidders are sufficiently entering the competition and the auctioneer increases the asking price for the next animal to thwart the reduced competition.

5.1.2 Buyer Opening Bid Equation

If the auctioneer does not receive an opening bid (*OB*) equal to the *AB*, he must reduce the *AB* until he receives an *OB*. This will occur more frequently if the auctioneer is leading the bid. Interestingly, we have found no common (or private) value auction theory which identifies the optimal bidding strategy of an *OB* with this type of English auctioning procedure. Following the logic of existing theory, a rational assumption is that the *OB* must be less than or equal to at least the highest signal holder's reservation bid (r_H). If the $AB \geq r_H$, then before the *OB* is observed in the auctioning process, the initial optimal reservation bids can only be derived from a first price sealed bid approach. It is only when the *AB* is sufficiently less than the lowest private signal holder (s_L) will the reservation bidding depicted in Levin et al., (1996) for an English auctions be the appropriate theory. Therefore, it could be assumed that in a common value English auction, the winner's curse incentivizes bidders to seek the lowest private signal holder in order to optimally formulate updated reservation bids (Milgrom and Weber, 1982; Levin et al., 1996). Bidders in the current setting are better able to follow traditional common value English auction theory when $AB \leq s_L$.

Finally, the *AB* may convey some information to the bidders. Notwithstanding the auctioneer's desire to solicit the highest and best price for the seller, we assume bidders incorporate the *AB* into their information set while determining their optimal reservation bid and in return their *OB*s. If the auctioneer starts out too high, the buyers will wait for the auctioneer to back down. Therefore, after forming an estimate of the cow's value and competitiveness of the market at time t+1, bidders strategically determine an opening bid, one of which is realized. The observed opening bid for the i^{th} cow at time t+1 and is specified as

$$\begin{aligned} OB_{i,t+1} = {} & \alpha_0 + \alpha_1 \widehat{AB}_{i,t} + \alpha_2 CV_a + \alpha_3 HC_i + \alpha_4 Neg_i + \alpha_5 LW_i + \alpha_6 LW_i^2 + \alpha_7 LW_i^3 \\ & + \alpha_8 ST_{ia} + \alpha_9 T_i + \mu_{i,t+1} \ , \end{aligned} \tag{2}$$

where $\widehat{AB}_{i,t}$ is the predicted auctioneer starting bid from equation (1),and $\mu_{i,t+1}$ is the error term associated with the i^{th} cow at time t+1. The a priori expectations of the opening bid coefficients are

$\alpha_1 > 0, \alpha_2 > 0, \alpha_3 < 0, \alpha_4 < 0, \alpha_5 > 0, \alpha_6 < 0, \alpha_7 > 0, \alpha_8 \neq 0$ and $\alpha_9 \neq 0$.

5.1.3 Winning Bid Equation

After observing the *OB*, buyers are assumed to update their reservation bids. Once the auctioneer receives an *OB*, following industry practice he typically increases the asking bid in increments of no less than \$0.25/cwt for cull cows. Bidding continues until the auctioneer is unable to solicit a bid higher than the current bid. Because the information and process used by the bidders to update their optimal reservation bids is unknown, we extend Coatney et al. (2012) modeling to allow for the various strategic interactions depicted in the bidding patterns in table 1. However, for simplicity, we ignore buyer entry and learning processes considered in their analysis. We note that entry could also be related to the observed bidding patterns. The winning bid for the i^{th} cow at time t+2 is specified as

$$WB_{i,t+2} = \delta_0 + \delta_1 \widehat{OB}_{i,t+1} + \delta_2 CHHIA_i + \delta_3 CBA_i + \delta_4 CV_a + \delta_5 HC_i + \delta_6 Neg_i + \delta_7 LW_i + \delta_8 LW_i^2 + \delta_9 LW_i^3 + \delta_{10} ST_{ia} + \delta_{11} T_i + \psi_{i,t+2} \; , \quad (3)$$

where $\widehat{OB}_{i,t+1}$ is the predicted opening bid from equation (2), and $\psi_{i,t+2}$ the error term associated with the ith cow at time t+2. The a priori expectations of the winning bid coefficients are $\delta_1 > 0,\ \delta_2 < 0,\ \delta_3 < 0,\ \delta_4 > 0,\ \delta_5 < 0,\ \delta_6 < 0,\ \delta_7 > 0,\ \delta_8 < 0,\ \delta_9 > 0,\ \delta_{10} \neq 0,$ and $\delta_{11} \neq 0$.

5.1.4 Bidding Differential Equation

Finally, to address whether the potentially disadvantaged rivals identified in Coatney et al. (2012) where passive as predicted by theory (Bikhchandani 1988; Klemperer 1998: Rose and Kagel 2008), we construct a bidding differential (*BD*) model of passivity. Presumably, in the presence of an advantaged bidder, disadvantaged bidders exit the bidding. This would result in few or no bids being taken by the auctioneer, leaving the advantaged bidder free to win the item for the lowest possible winning bid.

The *BD* is the difference between the winning and opening bid, or $BD_{i,t+2} = WB_{i,t+2} - OB_{i,t+1}$. By substituting equation (1) into (2) and subtracting from (3), the bidding differential for the *i*th cow at time *t*+2 is specified as

$$BD_{i,t+2} = \lambda_0 + \lambda_1 \widehat{AB}_{i,t} + \lambda_2 \widehat{OB}_{i,t+1} + \lambda_3 CHHIA_i + \lambda_4 CBA_i + \lambda_5 CV_a + \lambda_6 HC_i + \lambda_7 Neg_i + \lambda_8 LW_i + \lambda_9 LW_i^2 + \lambda_{10} LW_i^3 + \lambda_{11} ST_{ia} + \lambda_{12} T_i + \varepsilon_{i,t+2} \; , \quad (4)$$

where $\varepsilon_{i,t+2}$ the error term associated with the ith cow at time t+2 . Given the a priori expectations from equations (1), (2) and (3) the a priori expectations for the bidding differential coefficients are $\lambda_{1..3} \neq 0,\ \lambda_4 < 0,$ and $\lambda_{5..12} \neq 0$.

5.2 Results

The results of the dynamic system of recursive equations are reported in Table 3. Due to the time series aspects of the data, autocorrelation was tested by means of the Durbin-Watson statistic. Though the estimated rho is relatively small, autocorrelation was found to be significant in the *AB* and *WB* equations. Yule-Walker estimates are provided generally due to the presence of autocorrelation in the system.[9]

The first finding is that the CBA purchased cattle for $2.70/cwt less than his rivals. This result is similar magnitude as found by Coatney et al., (2012) (-2.64), when they expressly controlled for the endogeneity between winning bids and bidder concentration. Though this result indicates that the rivals bid passively against the dominant common bidding agent, this result could be partially driven by the *AB* and *OB* strategies of the auctioneer and fringe rival bidders leading up to the winning bid. For instance, if the auctioneer were to consistently ask or lower opening bids on the cattle the *CBA* purchases, the *CBA* would then pay lower prices than the fringe rivals. This result will thus be compared with those of the bidding patterns in the next section.

The *AB* was found to be positively correlated with the previous winning bid and is consistent with a priori expectations. These results indicate that the auctioneer was incentivized by higher winning bids to continue asking for higher prices. The *AB*, however, was found to be negatively correlated with the previous *CHHIA*, contrary to a priori expectations. Instead of responding aggressively to reduced competition, the auctioneer instead gives in the pressure. This result may be driven by two factors. The first is the auctioneer's need to sell cattle quickly

[9] Though minor changes in the level of parameter significance are found when not adjusting for autocorrelation in any equation, there was no change in whether a parameter was significantly different from zero or not.

and the time required to lower the asking bid to find the *OB* offsets the belief of receiving a higher winning bid. The second is connected to the first in that the auctioneer may be relying on the market-support bidder to stimulate bidding.

As expected per a priori expectations, the *AB* is positively correlated with the *OB* ($1.21/cwt) and the *OB* is positively correlated with the *WB* ($0.97/cwt). The partial relationship between the *AB* and *WB* is $1.17/cwt. Unlike Coatney et al., (2012), the *CHHIA* does not significantly impact the winning bid. Instead, bidder concentration reduces the winning bid indirectly through the auctioneer relenting the *AB* as concentration increases. These results together indicate that if the auctioneer yields to higher concentration, the winning bid will be reduced. The degree of which depends on the wiliness and ability of the market-support bidder to 'push' the *CBA*.

Finally, the bidding differential (*BD*) is negatively correlated with CBA purchases (-$0.94/cwt).

6.0 Conclusions

This analysis addresses passive bidding and the impacts of the auctioneer's strategic behavior. To identify bidding passivity, the study collected asking bid, opening bid, and winning bid data, to construct various bidding patterns. The primary pattern of interest regarding passive bidding is the differential between the opening and winning bid. Overall, the results indicate that the opening bid was on average 6.16 percent lower and the winning bid 1.28 percent less than the auctioneer's asking bid (figure 1). Thus, the auctioneer demonstrated that he was leading-the-bidders and more so for ultimately lower priced animals (figure 1). The dominant common bidding agent paid less than fringe rivals, a result consistent with Coatney et al. (2012). However, this is in itself is not evidence of passive bidding by the allegedly disadvantaged rivals.

Results from estimating the bidding differential equation demonstrated that, all else equal, when the dominant bidder won the bid, fewer bids were taken. In all, however, the auctioneer could not overcome the impacts of the reduced competition from the fringe rivals. In fact, it appeared that the auctioneer internalized reduction in competition from previous increases in bidder concentration and lower prices.

The weakness of is study is that the data cannot specifically identify individual bids nor true values. Therefore, the passivity results are not as strong as would be collected in a laboratory setting. However, the preliminary results do indicate that though the auctioneer attempted to solicit the highest possible bid, he could not completely thwart the reduced competition from the presence of the common bidding agent. Future work will entail identifying the relevance of the market-support bidder. Additionally, given the auctioning procedure of the cow auction does not conform with standard common value English or clock auction theory, additional research should include developing what the optimal bidding strategy when the auctioneer starts at or above some or all of the bidders' estimate of value.

References

Department of Justice and Federal Trade Commission, "Antitrust Guidelines for Collaborations Among Competitors," (2000) [PDF document] retrieved from http://www.ftc.gov/os/1999/10/jointventureguidelines .

Bag, Parimal Kanti, Emin Murat Dinlersoz, and Ruqu Wang. "More on phantom bidding." *Economic Theory* 15.3 (2000): 701-707.

Bascom, S. S., and A. J. Young. "A summary of the reasons why farmers cull cows." *Journal of dairy science* 81.8 (1998): 2299-2305.

Bernheim, B. Douglas, and Michael D. Whinston. "Common agency." *Econometrica: Journal of the Econometric Society* (1986): 923-942.

Bernheim, B. Douglas, and Michael D. Whinston. "Common marketing agency as a device for facilitating collusion." *The Rand Journal of Economics* (1985): 269-281.

Besanko, David, and Daniel F. Spulber. "Antitrust enforcement under asymmetric information." *The Economic Journal* (1989): 408-425.

Bikhchandani, Sushil. "Reputation in repeated second-price auctions." *Journal of Economic Theory* 46.1 (1988): 97-119.

Coatney, K.T., S.L. Shaffer, and D.J. Menkhaus. "Auction Prices, Market Share, and a Common Agent." *Journal of Economic Behavior and Organization* 81(2012): 61-73.

Coatney, K.T. and J.B. Tack. "The Impacts of an Antitrust Investigation: A Case Study in Agriculture." *Review of Industrial Organization* 44(4)(2014):423-441.

Dick, Andrew R. "When are Cartels Stable Contracts?." *Journal of Law and Economics* (1996): 241-283.

Eckbo, P.L "OPEC and the Experience of Some Non-Petroleum International Cartels." M.I.T. Energy Lab. Working Paper, June 1975

Graham, Daniel A., Robert C. Marshall, and Jean-Francois Richard. "Phantom bidding against heterogeneous bidders." *Economics Letters* 32.1 (1990): 13-17.

Grassley, Sen. C.E. "Grassley Urges USDA to Employ Attorneys at GIPSA to Keep Anti-competitive Behavior at Bay", News Release Congressional Documents and Publications, Federal Information and News Dispatch, Inc., June 9, 2009.

Harkin, Sen. T. 2005. *Sen. Harkin Calls for Investigation of USDA Oversight of Livestock and Poultry Market Fairness*, US Fed News, HT Media Ltd. April 4, 2005.

Klemperer, Paul. "Auctions with almost common values: TheWallet Game'and its applications." *European Economic Review* 42.3 (1998): 757-769.

Kosmopoulou, Georgia, and Dakshina G. De Silva. "The effect of shill bidding upon prices: Experimental evidence." *International Journal of Industrial Organization* 25.2 (2007): 291-313.

Levenstein, Margaret C., and Valerie Y. Suslow. "What determines cartel success?." *Journal of Economic Literature* (2006): 43-95.

Levin, Dan, John H. Kagel, and Jean-Francois Richard. "Revenue effects and information processing in English common value auctions." *The American Economic Review* (1996): 442-460.

Levin, Dan, and James L. Smith. "Equilibrium in auctions with entry." *The American Economic Review* (1994): 585-599.

Milgrom, Paul R., and Robert J. Weber. "A theory of auctions and competitive bidding." *Econometrica: Journal of the Econometric Society* (1982): 1089-1122.

Penard, T., and S. Souam. "Optimal antitrust policy under asymmetric information and budget constraints." *manuscript, University of Paris I* (1996).

Rose, Susan L., and John H. Kagel. "Almost common value auctions: an experiment." *Journal of Economics & Management Strategy* 17.4 (2008): 1041-1058.

Souam, Saïd. "Optimal antitrust policy under different regimes of fines." *International Journal of Industrial Organization* 19.1 (2001): 1-26.

U.S. Department of Agriculture, Office of Inspector General, 1997. *Grain Inspection, Packers and Stockyards Administration: Evaluation of Agency Efforts to Monitor and Investigate Anticompetitive Practices in the Meatpacking Industry*. Evaluation Report No. 30801-0001-Ch.

U.S. Department of Agriculture, Office of Inspector General, Northeast Region. 2006. *Audit Report: Grain Inspection, Packers and Stockyards Administration's Management and Oversight of the Packers and Stockyards Program*. Report No. 30601-01-Hy. [PDF document]. Retrieved from www.usda.gov/oig/webdocs/30601-01-HY.pdf

U. S. Government Accountability Office. 2000. *Actions Needed to Improve Investigations of Competitive Practices* RCED-00-242.

U. S. Government Accountability Office. 2006. *Packers and Stockyards Programs, Continuing Problems with GIPSA Investigations of Competitive Practices,* Testimony Before the Committee on Agriculture, Nutrition and Forestry United States Senate, GAO-06-532T.

Table 1: Average Ask and Bid Patterns±

Bidding Pattern (BP)	Percent of Data	Mean Opening Differential = (OB – AB)	Mean Bid Differential = (WB – OB)	Mean Ask Differential = (WB – AB)
(1) AB = OB = WB	5.58	0	0	0
(2) AB = OB < WB	29.22	0	2.39	2.39
(3) AB > OB = WB	15.35	-4.39	0	-4.39
(4) AB > OB < WB < AB	26.57	-4.11	2.00	-2.11
(5) AB > OB < WB >= AB	23.28	-1.88	3.10	-1.21

± AB = Auctioneer Asking Bid, OB = Bidders' Opening Bid, and WB = Winning Bid in $ per hundred weight.

Table 2. Multinomial Logit Model Results, Marginal Effects on the Probability of Observing Each Bidding Pattern (*BP*) in Figure 1

Variable Name	Marginal Effect At Means Pr (Y) = (*BP*1&2)	Marginal Effect At Means Pr (Y) = (*BP*3)	Marginal Effect At Means Pr (Y) = (*BP*4)	Marginal Effect At Means Pr (Y) = (*BP*5)
CHHIA	-0.98 E-05	-0.18 E-05	0.30 E-06	0.11 E-04*
L – Independent Dealer & Market Support Buyer	0.19***	-0.15***	-0.08***	0.04**
F – Independent Dealer	0.22***	-0.02	-0.29***	0.09**
T – Independent Dealer	0.17***	-0.24***	-0.15***	0.22***
P – Salaried Packer Buyer	0.16***	-0.18***	-0.06**	0.08***
G – Salaried Packer Buyer	0.35***	-0.25***	-0.01	-0.09*
SF – Small Farmer Buyers	0.10***	-0.24***	-0.05	0.18***
CV - Carcass Value	0.02***	-0.01**	-0.02***	0.005*
HC - Holstein	-0.06***	0.004	0.03***	0.02*
Neg - Negative Attributes	-0.34***	0.18***	0.26***	-0.10***
LW - Livestock Weight	0.0002***	-0.01	-0.0001***	-0.0001***
ST - Sale Trend	0.0004***	-.00002***	-0.0003***	0.56 E-04
T - Overall Trend	-0.15 E-04***	-0.30 E-05	0.67 E-05*	0.12 E-04***
Log Likelihood	-9613.72			
Restricted Log Likelihood	-10397.44			
Chi-Square	1567.45***			
McFadden Pseudo R^2	0.0754			

*** Significantly different from zero at significance level α = 0.01, ** at α = 0.05, and * at α = 0.10.

Table 3: Estimated Recursive System of Equations and the Bid Differential = (Winning Bid – Opening Bid)

Variable	Asking Bid Coefficient (Std. err.)	Opening Bid Coefficient (Std. err.)	Winning Bid Coefficient (Std. err.)	Bid Differential Coefficient (Std. err.)
Intercept	4.80*	-13.11***	-8.02**	-6.68
	(2.75)	(3.53)	(3.74)	(8.63)
Asking Bid est.		1.21***		-0.36
		(0.07)		(0.76)
Opening Bid est.			0.97***	0.17
			(0.07)	(0.66)
Lag1 Winning Bid	0.08***		-0.01	
	(0.01)			
CHHIA			-0.0001	-0.0001***
			(0.0001)	(3.48E-5)
Lag1CHHIA	-0.0003***			
	(0.00004)			
CBA			-2.70***	-0.94***
			(0.10)	(0.05)
Carcass Value	0.19***	-0.02	0.08***	0.11***
	(0.02)	(0.03)	(0.03)	(0.02)
Holstein	-1.58***	0.15	0.10	-0.06
	(0.07)	(0.14)	(0.18)	(0.18)
Negative Attributes	-3.14***	-3.83***	0.13	0.24
	(0.09)	(0.25)	(0.54)	(2.66)
Livestock weight	0.02***	0.01	0.02*	0.02
	(0.01)	(0.01)	(0.01)	(0.01)
Livestock weight2	-5.39E-6	-6.18E-6	-0.00001**	-0.00002
	(4.39E-6)	(5.85E-9)	(6.16E-9)	(5.26E-6)
Livestock weight3	1.78E-9	8.49E-10	2.64E-9*	4.41E-9
	(1.12E-9)	(1.49E-9)	(1.57E-9)	(9.92E-10)
Sale Trend	-0.002***	0.001**	0.0001	-0.001
	(0.0004)	(0.001)	(0.0005)	(0.001)
Overall Trend	-0.0001***	-3.50E-5	3.10E-5	3.54E-5
	(2.47E-5)	(3.03E-5)	(3.21E-5)	(3.11E-5)
R^2	0.57	0.62	0.59	0.12
Durbin-Watson	1.96*	2.02	2.03*	1.89***

*** Significantly different from zero at significance level α = 0.01, ** at α = 0.05, and * at α = 0.10.

Figure 1: Average Bidding Pattern Types (BP#)