Unilateral and Exclusionary/Strategic Effects of Common Agency: Price Impacts in a Repeated Common Value English Auction

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Abstract

The business justification for multiple principals to hire a common agent is efficiency. Our empirical study demonstrates that the creation of the common agent unilaterally depresses winning bids. Additionally, the common agent was not only observed to be the dominant bidder but also paid significantly lower prices than fringe competitors (price/quantity differential). The observed price/quantity differential is consistent with the *almost common value* English auction theory developed by Rose and Kagel (2008) in which a cost advantaged bidder is able to reduce competition by credibly raising the costs of disadvantaged rivals associated with the winner's curse.

Introduction

This is an empirical investigation into the impacts due to principal forming buyer collaborations at auctions. Buyer collaborations are formed when subsets of principal purchasers, either jointly or independently, share a common agent to bid on the behalf of the principals at auction. Common agency has a long history and remains pervasive throughout the cattle industry today. When principals hire common agents to conduct transactions, gross industry analyses overlook the true nature of competition between the firms. Therefore, the current analysis focuses on a specific auction and the market power exerted by concentrated agents, rather than on aggregate industry or broad market data, which could easily mask the effects of market power (Sexton 2000).

Auction owners and sellers of cattle have long been concerned that common agency has adverse unilateral effects on prices, especially in already highly concentrated industries.[1] Furthermore, dominant bidders are typically associated with collaborations and allegedly have additional negative price impacts via exclusionary conduct.

The objective setting for this analysis is a local English auction for cull cows.[2] Most cull cows are purchased for slaughter. Auctions for live cattle in general are characterized as common value auctions because the true value is unknown at the time of purchase. For example, a packer buyer derives a fairly inaccurate estimate of the true slaughter value while observing the animal on the hoof at auction. [3] This is an extremely demanding job in the fast paced environment of an auction.

Cull cow auctions are regularly attended by commission agents, dealers, salaried buyers and producers. Agents provide their principals expertise in live animal evaluation and appraisal, strategic bidding in an extremely fast-paced environment, as well as market information and surveillance when the principal simultaneously competes across multiple auction locations. The bidder of interest is an independent commission order-buying agent representing three beef packers and one order-buying firm and is thus a common agent.[4] The common agent observed in this analysis purchases nearly 75 percent of the cattle auctioned and is thus a dominant buyer as defined from generalizations of antitrust litigation.[5] The Herfindahl-Hirschman Index (HHI) estimates of firm-level concentration are 2160 while concentration at the bidder level is 5667.[6] On its face, both the dominance of the common agent and common agency raise legitimate concerns for sellers at this auction.

Though common agency necessarily reduces the number of bidders at auction, the issue has raised scant attention in antitrust enforcement. Though there is a large body of theoretical literature on auctions, nothing is known about the impacts of common agency and little is known about the underlying creation of dominant bidders, especially in the repeated setting (Klemperer 1999). The research presented is an econometric analysis of the price impacts due to common agency and the presence of a dominant bidder. The development of the empirical model utilizes both related auction theory and antitrust precedent. As such, this research extends traditional auction price analysis to include more game theoretic ideology and incorporates *ex ante* firm level decisions.[7] The product of this work provides regulatory agencies additional insights into the impacts of common agency at auction, as well as develops an empirical model that could be used to further assess the net competitive implications common agency *when* common agency is not considered *per se* illegal.[8]

Antitrust Concerns and Justification for Common Agency

Buyer collaborations and common agency poses three main anticompetitive concerns based primarily from industrial organization theory. The first is its direct influence upon increasing the concentration of bidders.[9] Secondly is the possibility that common agency facilitates the creation of a dominant agent which in turn may lead to additional exclusionary effects through the exertion of market power.[10] Finally is the potential for the facilitation of collusion among the members of the buyer collaboration.[11]

Those who promote the practice of using common agents argue that common agency enhances efficiency by reducing transactions costs in order for small to medium sized firms to be able to compete with larger rivals (Koch Group 2005; and Telser 1985). This justification is based on the premise that smaller firms would be able to compete more effectively, via economies of size, with more efficient firms thus keeping pace with competition rather than destroying it. In the context of mergers the Supreme Court recognized an "against giants" defense in *Brown Shoe v. United States*: "when concern as to the [Sherman Antitrust] Act's breadth was expressed, supporters of the amendments indicated that it would not impede, for example, a merger between two small companies to enable the combination to compete more effectively with larger competitors dominating the relevant market.".[12]

Specific to the cattle industry, principals bear the cost of sending employees to auction whether they purchase cattle or not. By hiring an independent commission agent, the agent bears the costs of attending the auction and the principal pays nothing if the agent makes no purchases.[13] The collaborators may then be able to reduce their transactions costs depending upon the negotiated price of the service. However, while collaborations of small firms may be able to match the competition of larger firms, collaborations of large firms are likely to gain a competitive advantage over smaller rivals.

Scope of Common Agency and Livestock Auctions

Since 1999, cull cow packers' report that they have consistently purchased slightly over 50 percent of their inputs from auction markets from 1999 to 2006 (USDA, GIPSA 2001 – 2008).[14] There were 1,413 registered auctions that traded $25 billion of livestock in 2006 of which an estimated $2.4 billion were cull cow sales (USDA, GIPSA 2008).[15] During 2006, 3,883 common agents, such as commissioned cattle order-buyers and dealers[16] purchased $4.5 billion and $21.9 billion (USDA, GIPSA 2008) totaling on average $26.4 billion in livestock. From the government statistical reports, it is difficult to assess the pervasiveness of common agency specifically at auction. However, it is quite clear that common agents, in general, purchase a significant portion of livestock, and potentially to a greater extent cull cows.

Common Agency: Statutes, Regulation and Case Precedent

Packers, commissioned order-buying agents and dealers are registered and bonded per the requirements of the 1921 Packers and Stockyards Act, as amended and regulations promulgated by the Secretary of Agriculture. The Act and regulations are enforced by the United States Department of Agriculture, the Packers and Stockyards Programs (P&S) which is a branch of the Grain Inspection Packers and Stockyards Administration (GIPSA). Competition issues related to packers, commission order-buyers and dealers are also regulated under the Packers and Stockyards Act (1921) as amended and enforced by P&S.[17]

It has been reported by GIPSA that: "P&SP investigates all complaints about the use of common agents, packers buying livestock for each other, and dealers or order buyers having orders from multiple packers for the same type and quality of livestock." (USDA, GIPSA 2005).[18] Recently, P&S announced establishing a cull cow competition monitoring program, noting that they have already sent one notice to packers indicating a failure to "conduct their buying operations independently of and in competition with each other" (USDA, GIPSA 2009).[19] Though common agency is pervasive in the livestock industry, P&S has only brought three allegations involving joint buying arrangements (common agency) since 1968. The first was *Swift & Company v. United States* in which the act of a dealer purchasing on behalf of, and in conjunction with, a rival lamb packer buyer was condemned by the court as *per se* illegal.[20] Later in *San Jose Valley Veal* when a dealer was purchasing veal calves for multiple packers and rival dealers, the court found the collective action as a failure to compete and clearly violated the Packers and Stockyards Act.[21]

Most recently in *Hennessey*, the court found that a commission buyer purchasing on behalf of multiple cow packers did not violate the Packers and Stockyards Act when the packer principals are not competitors in the relevant market. The relevant market was arguably delineated along "quality" lines.[22] However, other judicial findings related to cattle have not allowed product lines to be drawn based solely on quality classifications because quality is not a well definable market.[23]

Though typically deferring to GIPSA on most competition issues in the livestock industries, jurisdiction over the livestock industry also falls under the purview of the Department of Justice under the Sherman Antitrust Act (1890)[24] and Clayton Antitrust Act (1914)[25], as well as the Federal Trade Commission under the Federal Trade Commission Act (1914)[26]. However, there are no recorded Department of Justice or Federal Trade Commission cases in any industry related to common agency.

Research Questions

There are two key competitive implications of common agency addressed in this research. What is the unilateral effect of common agency on auction prices? And, does the presence of a dominant bidder further depress auction prices? Although exploring whether the buying collaborators can result in collusively outside the auction environment is a very important question, to maintain focus on the impacts of common agency at auction, collusion is relegated for future research.

The research conducted to answer these key questions proceeds in the following manner. First, a review of empirical economic literature related to bidder concentration and dominant bidders is conducted. Data and descriptive statistics are then presented. Next, the derivation of buyer concentration used in this analysis is provided. Next, the empirical models estimated along with statistical considerations are presented followed by the results and conclusions.

Literature Review Repeated Common Value Auctions

Bidder Concentration

The most recent English Auction empirical studies accounting for the impact of bidder concentration on winning bids are Nelson (1997) and Bailey, Brorsen and Fawson (1993). Nelson analyzed winning bid data from used car auctions in Pennsylvania, while Bailey, Brorsen and Fawson analyzed winning bid data from live and video feeder cattle auctions (Oklahoma City and Superior Livestock Video Auction). Both studies verify the negative relationship between the level of concentration and prices. Because both studies calculated concentration *ex* *post*, the dynamics of competition impacts of within and across auction predicted from theory could not be observed.

Nelson used two calculations of winning bidder concentration. The first was the number of winning bidders and the second was a ratio of number of units to winning bidders.[27] Nelson noted that the bidder concentration measure represents only a proxy for the theoretical requirements of potential bidders and that the number of bidders is endogenously determined.

A novel approach taken by Bailey, Brorsen and Fawson was to include an HHI bidder concentration measure. However, their concentration measure was aggregated sometimes across multiple auction sessions.

Dominant Bidders in Common Value Auctions

Dominant bidders may form when bidders are asymmetric regarding their true common values. Dominant bidders are expected to simultaneously pay lower prices than fringe rivals thus depressing overall market prices. Theoretical work regarding the formation of and outcomes from dominant bidders in second-price and English auctions is limited with mixed results depending heavily upon the characteristics of the model (Bikhchandani 1988; Klemperer 1998; Levin and Kagel 2005; Rose and Kagel 2008). Experimental studies also yield mixed results (Rose and Levin 2008; Rose and Kagel 2008). However, empirical studies of the influence of dominant buyers in real-world repeated English auctions are less mixed (Nelson 1997; Zulehner 2009).

To begin a brief discussion of the theory, let $n \geq 3$ risk-neutral bidders in a single period or finitely repeated pure common value second-price and English auctions where information is complete. If bidders are symmetric, the risk-neutral Nash equilibrium bidding strategies, which account for the adverse selection conditional on winning, is symmetric resulting in symmetric outcomes (Milgrom and Weber 1982). However, when $n = 2$ and bidders are asymmetric and their asymmetry is common knowledge then bidding strategies and outcomes will also be asymmetric in both second-price and English auctions. For instance, if bidder 1 is endowed with a cost advantage then they will value the item more than bidder 2. Therefore, bidder 1 is able to bid more aggressively to win. Aggressive bidding by 1 increases the likelihood and severity of the winner's curse for bidder 2 if they win. Therefore, bidder 2 must account for the heightened winner's curse by further reducing their bid. Realizing bidder 2's predicament, bidder 1 continues to increase their bid as the winner's curse for 1 is reduced by bidder 2's increased passivity. In equilibrium, the advantage bidder bids higher, wins the unit (all units prior to the last) more often and is able to pay a lower price than in the symmetric case when they win (Bikhchandani 1988; Klemperer 1998). [28]

In *large* finitely repeated sealed-bid second-price and English common value auctions when $n = 2$ and where the probability of bidder type is common knowledge, even small degrees of incomplete information about bidder type facilitate reputation building (Bikhchandani 1988).[29] According to the prediction of the theory, when information about a cost-advantaged player is asymmetric, the informed bidder is able to buy most, if not all, units at minimal prices. Because repeated bidding releases information about the bidder's type, only if the informed bidder is not advantaged will the uniformed player win some units toward the end of the auction. Hence, even if bidders are truly symmetric as to their costs, even an information advantage manifests itself into a strategic advantage. The explosive effects of the increased aggressiveness of the advantage player and the passivity by the uninformed bidder, not only reduces prices paid at auction, but also, results in increased dominance of the informed bidder.

However, the degree of the explosive effects found by Bikhchandani and Klemperer has been brought into question. Levin and Kagel (2005) demonstrate that when there is more than one disadvantaged bidder (*n* = 3) the strategic advantage in a single period second-price and English common value auctions where information is symmetric[30], the earlier results do not generalize. First, they find that in a second-price auction that the advantage is continually dampened as the number of disadvantaged bidders' increases though the private-value advantage remains. In return, disadvantaged bidders are able to mitigate the heightened winner's curse generated by the advantaged bidder's aggressive bidding. In return, the aggressiveness of the advantage bidder decreases. However, because the private-value advantage does not dissipate, the advantaged bidder is still expected to win more often at lower prices. As such, the level of dominance is dependent upon the degree of the advantage relative to the number of disadvantaged bidders and the degree of advantage corresponds to the degree in the reduction in seller revenue.

Levin and Kagel also demonstrate that in an English auction the strategic advantage still results in a higher probability of winning but potentially at higher prices than in the symmetric case. This is due to the disadvantage bidders' ability to form their optimal bidding strategies by relying upon the bidding information released from both the advantaged and disadvantaged bidders' drop-out bids. However, the authors conclude that one cannot rule out that prices (seller surplus) could decrease. [31] Finally, because the authors did not consider a repeated auction with asymmetric information, a generalization of this aspect of Bikhchandani to more than one disadvantaged bidders remains in question.

Experimental work has not substantiated the predictions of Bikhchandani and Klemperer in second-price or English auctions when $n \geq 2$ (Rose and Levin 2008; Rose and Kagel 2008).

Rose and Levin (2008) conducted an English ‘clock auction’ experiment when $n = 2$ inexperienced bidders were randomly and anonymously paired where each other. Within each pairing one bidder was randomly chosen as the advantaged player where identity of the advantaged player is common knowledge. The authors found that the bidding strategies employed were simply proportional to their advantage and not explosive as predicted by Klemperer. Seller revenues were higher than expected as all players suffered from the winner’s curse.

Concerned that the inexperience of the bidders may have played a role in the results of Rose and Levin, Rose and Kagel (2008) conducted another experiment with $n = 4$ experienced bidders better suited to overcome the adverse selection effect conditional on winning. The authors first prove that there exist explosive risk-neutral Nash equilibrium strategy equilibia where a single advantaged bidder always wins over three disadvantaged rivals. However, the experimental results indicated that the advantage remained proportional and not explosive. The authors conclude (citing earlier work by Levin, Kagel and Richard (1999)) that subjects may have employed a simple signal averaging rule that does not require bidders to fully incorporate the adverse selection effect conditional on winning. As such, the authors speculate that economic agents outside the laboratory would have to employ tools not present in the lab or theory or must be sophisticated enough to employ theoretical equilibrium bidding strategies.

Two traditional empirical studies of winning bid impacts related to dominant buyers in real-world English auctions have been mixed using different econometric approaches (Nelson 1997; Zulehner 2009). Nelson (1997) did not find a robust relationship to exist while Zulehner (2009) found that, as a group, bidders who typically purchase a larger percentage of the market paid less than smaller rivals. In both studies the authors concluded that the price differentials were explained primarily by differences in quality preferences and to a lesser extent on strategic bidding.

Nelson estimated the changes in winning bids based upon the presence of three dominant buyers in an attempt to test the predictions of Bikhchandani (1988). The author employed a simple hedonic linear regression technique controlling for the fixed effects of each dominant bidder. The market was narrowly defined as used Caprice sedans cars.

The overall proportion of units purchased by the largest of the three buyers was less than 12 percent and each bidder was not consistently dominant. Interestingly, Nelson previously used these data to demonstrate the negative structural shift in prices when the bidding ring was operational (Nelson 1993). The bidding ring, which did not include any of the three dominant bidders, purchased nearly 50 percent of the available units during its existence. If the ring members were fully coordinated, the ring would have constituted the dominant bidder. In Nelson (1997), the time period of the bidding ring existed was found to significantly depress prices with or without the inclusion of the three smaller dominant bidders. Including the less dominant bidders resulted in one of the three less dominant bidders paying significantly lower prices. However, the author did not find a robust relationship related to the smaller dominant bidders when the period of the bidding ring was removed.

Zulehner (2009) estimated group impacts on winning bids for Austrian dairy cattle. Relying on private value auction theory as guidance, the author employed a hedonic Oaxaca-Blinder decomposition technique to identify differences in bidding strategy between groups.[32] Bidder groups were delineated along two lines; professional traders representing single/multiple firms and farmers. Traders typically purchased more cattle on an individual basis than farmers. The actual number of traders or farmers was not identified in the study either within or across auction sessions. Arguably, the market was not well defined including a wide array of cattle ages from calves to mature cows. Therefore, bidder concentration could not be controlled for. Nonetheless, the author found that professional traders as a group paid lower prices on average than farmers.

Winning Bid-Concentration Endogeniety

Price is a function of the number of bidders in every auction theory model, where the number of bidders is typically treated as exogenous. This presupposes that all bidders are committed to bidding from the outset (Levin and Smith 1994). However, in real-world auctions bidders freely enter and exit the bidding process, thus entry and exit are endogenously determined (Klemperer 1999; Levin and Smith 1994). It has been shown by experimentation that as bidders evaluate their opportunity costs of entry, declining prices invite entry thus increasing the size of the market (Cox, Dinkin and Swarthout 2001). Therefore, winning bids are expected to decrease with increases in concentration indicating that the level of competition is decreasing, *ceteris paribus*. Concentration is expected to decrease with an increase in prices as the increase in price indicates a higher level of competition, *ceteris paribus*. As such, simultaneity is expected between the two structural variables, concentration and winning bids.

However, according to Carlton and Perloff (2005, 258), buyer concentration is less likely to be endogenous. Although they do not explain this position, it assumes that the firm is basing its input decisions solely on its output market and be taking its input price as given. Therefore, buyer concentration would be a function of the competition in the output market rather than the price in the input market.

Data, Descriptive Statistics and Data Limitations

The data used for the analyses are from an auction firm that sells primarily cull dairy cows in the upper Midwest. The data cover the period from October 4, 1999 through January 26, 2000. There are 34 sale dates or auctions during this time frame and 7,722 individual observations or sale tickets. Each sale ticket is for a single animal as each animal is sold individually. A sale ticket has a ticket number, a back tag number to identify the animal, the date and time of the sale, breed, weight, and negative physical attributes[33] of the animal (if any). All of this information is publicly observable. Verification of buyer agency was conducted by matching agent signatures on the principal's final billing invoices. Buyers representing themselves signed their own invoices.

The auction firm supplied information regarding the type of business engaged in by the principals and the principal represented by each bidding agent. The configuration of principals and agents at the 34 auctions is detailed in appendix table A.1 and is summarized as follows: Four principal firms owning five meat processing facilities are relevant to the auction. We refer to these as Prin1, Prin3, Prin4, Prin5 and Prin7. Prin3 and Prin4 were plants owned in common. Prin5 is the largest packer processor in the region by volume (cows and fed cattle), however, Prin1 and the firm that owns Prin3 and 4 are two of three the largest cow packers in the region. Additional principal purchasers include, Prin2 who is known to be a cow feeder and commission buying firm, Prin9 is an 'independent' dealer, Prin6 is a producer/independent' dealer and Prin8 is a producer. Prin6 also provides a market support function for the auction and *may* send cows to packing processors, some of whom may actually be represented by other agents at the market analyzed.[34] Another category of principal is "Other," which included one-time or infrequent purchasers[35].

There is only one commissioned order-buying agent who bid on behalf of three processing plants (Prin1, Prin3 and Prin4) and the one feedlot/order-buying firm (Prin2). No other bidders were known to represent multiple principals. The ultimate destination of the cattle purchased for Prin2 is unknown, though it is suspected that most of the cattle were delivered to the third of the three largest packers in the region. The other two processors (Prin5 and Prin7) each sent a salaried agent to the auctions. All other buyers represented themselves at these auctions (Prin6, Prin8, Prin9 and Other).

Appendix table A.1 also reports the number of head, prices paid and average live weight purchased by each principal over the 34 auctions. The common commission order-buyer was also the dominant buyer (DOM) purchasing 73.72 percent of the total available units for sale.[36] All other bidders purchased the remaining 26.28 percent and are collectively referred to as the fringe (FRNG). From the principal's perspective, no principal purchased more than 23.98 percent of the total units sold and no single principal held a dominant position in the market. Interestingly, DOM managed to purchase nearly identical numbers of cattle for Prin1, 2 and 3 during the period of study, roughly 24 percent each. DOM represented Prin4 only from October 4 through November 8; no additional cattle were purchased for that plant at later auctions.

The average price of all 7,722 animals sold was \$33.71/cwt, and the average live weight was 1,283.18 pounds (appendix table A.1). DOM's average winning bid was \$1.23/cwt (3.6 percent) below the average winning bid. FRNG paid on average \$3.41/cwt (10.11 percent) above the average winning bid which constituted a spread between the two of \$4.64/cwt. The average weight of cows purchased by DOM was 1,257.74 pounds, while the average weight of animals purchased by FRNG was 1,354.56 pounds. There are most likely preferences over characteristics since Prin5 purchased the heaviest cull cows (1,602.64 pounds) at the highest average price ($40.77/cwt), while Prin1 purchased the lightest animals (1,095.57 pounds) at an average price of ($26.61/cwt). These price-weight relationships are expected, because heavier cows tend to have fewer negative attributes and yield not only more red meat, but also higher quality cuts of meat which is a primary interest for processors. On the other hand, extremely light weight cows tend to be nearly un-merchantable.

Holstein dairy cows constituted the majority (75.33 percent) of cull cows sold and on average they sold for $33.44/cwt. Beef breeds, such as Herefords, made up about 21.39 percent of the animals sold at the auctions, for an average price of $34.82/cwt. Beef breeds are more valuable because they tend to yield more red meat on a percentage basis than Holsteins and also tend to be more efficient converters of feed to meat. As a result, beef breeds commanded a higher per unit price on average. Every principal purchased both dairy and beef cows. However, the proportions of Holsteins by principals were variable, ranging from 56.95 percent to 93.29 percent, indicating preference differentials.

The average price of cull cows with no negative attributes was $35.05/cwt, as compared to the average price of cull cows with negative attributes of $25.66/cwt.[37] All principals purchased cull cows with and without negative attributes. However, preferences proved to be important as Prin1 was the only principal to purchase a high percentage of cull cows with noticeable defects relative to total purchases (42.41 percent). This partially explains in aggregate the lower average price paid by DOM, because a significant percentage of DOM's purchases with negative attributes were for Prin1 (25.28 percent). All other principals tended to purchase cull cows with a lower incidence of negative attributes – the proportion of purchases with no negative attributes ranged from 88.38 percent to 97.63 percent of their total purchases.

Consequently, characteristic preferences matter and must be accounted for in the empirical work which follows.

Limitations of the Data

Common to empirical work of real-world oral ascending auctions, there are constraints in collecting important data due to logistics and the proprietary nature of some information. The three biggest data limitations are the lack of recorded agent bids, buy-orders held by each agent and the profit-loss performance of each agent or principal. [38,39] Without tracking buyer entry and exit from the bidding process, comparing final bids against the buy-order and subsequent profit-loss statement, surplus effects of strategic bidding behavior such as aggressive/passive bidding cannot be directly identified. Therefore, any estimated price differentials between the dominant bidder and fringe bidders are relative without controlling for potential differences in principal marginal value schedules. Finally, welfare estimates of any kind cannot be estimated unless price impacts can be directly compared to a theoretical competitive price. These are common limitations in real-world auction analyses, thus any antitrust implications derived from this analysis can only be considered preliminary.

Measuring Bidder Concentration in Repeated Auctions

The first step in analyzing the competitive impacts stemming from competitor conduct, the relevant market must first be defined. The definition of the relevant market contains two attributes; product and geographic.[40] Once the relevant market is defined, the relevant competitors are identified and concentration measures are calculated.

Properly defining the relevant market is probably the most contentious and costly issue in antitrust litigation and "although market definitions, once resolved, often are blindly applied as a surrogate for more sensitive market analysis, lawyers and courts continue to rely on market definitions as the key to disposing of market power issues." (Sullivan and Grimes 2000, 60). However, a proper analysis required to define the relevant market is far beyond the scope of this analysis. For the purposes of this analysis, the relevant market is arguably defined as a local cull cow auction.[41] We base this assertion on the fact that bidders in the auction, though apparently preferring different types of cattle, significantly overlapped in their purchases based on weight (figure B.1).[42]

Cumulative Herfindahl-Hirschman Index

Static *ex post* concentration calculations used in previous empirical work suffers from not incorporating historical strategic information. In a time-series analysis of auction competition, non-collusive bidders are unable to incorporate information regarding overall concentration *ex ante*, but rather observe the development of concentration *simultaneously* as competition plays itself out. From the theory of repeated auctions discussed, observed changes in bidder concentration are a result of past strategic decisions and historical information is used by bidders in making future strategic decisions. Bidders signal their competitiveness not only by entering or exiting the bidding process within each unit sold, but more credibly by winning or losing bids across units sold. In order for concentration to provide information about the relevant history of play for purposes of updating, capturing the dynamics of the changing competition, the concentration measure must accumulate information. Given the likelihood for changes in buy-orders between auction sessions, the immediate history of play should be carried over from the previous auction session as buyers take a 'wait and see' position which is quickly forgotten as the new game begins. The timing of each competitors winning bid is not expected to be consistent outside a repetitive turn-taking scheme and when bidders have clear preferences but the heterogeneous units are randomly ordered.[43] In order to correct for the lack strategic information provided by *ex post* concentration calculations, the following concentration measure is proposed and tested.

As noted earlier, one of the data limitations noted is that data collected does not contain the number of bidders per unit. Suffering from this limitation does not preclude developing at least a *proxy* for measuring changes in competition across units. Though individual auctions may be thought of as Bertrand pricing, our proposed concentration measure is based on the HHI, appropriate for Cournot oligopsony firm behavior.[44]

Packer principals make production decisions based on output orders leaving input pricing decisions to be managed across multiple auction locations. Packer principals develop buy-orders for agents based on their estimated optimal input price. The buy-order provides the agent with a schedule of the principal's pricing demands for discrete classifications of cattle. The prices observed at auction represent the true realization of competition. Thus, we assert that if the impacts of concentration at the firm level can be disaggregated across auctions then the HHI is an applicable, though a second best, indicator of changes in competition at a single auction location within and across auction sessions.

From the previous arguments, the concentration measure developed here is a Cumulative Herfindahl-Hirschman Index (CHHI): where, $\text{CHHI}_q = \sum_{i=1}^{n} s_{iq}^2 \equiv$ sum of the squared $i^{\text{th}} = (1,n)$ bidders market shares (s_i) up to the $q^{\text{th}} = (1,Q)$ unit sold in the auction session. Market share is simply measured by a buyer's proportion of winning bids during an auction and is continually updated throughout the sale. The boundaries are the same as the HHI where a value of 10,000 represents a monopoly. As currently calculated, the CHHI is repeated for each auction session.

For instance, the CHHI calculated for Monday's sale is separate from the following Wednesday's sale.

There are two shortcomings to using this concentration calculation in its current form. First, it considers each auction session as a discrete auction with no possibility for information spillover (adaptive learning) to the next auction. The second is that the CHHI as given calculates highly unstable levels of concentration early in an auction converging to more stable levels as the auction progresses.

Since the concentration information conveyed from each auction is not likely considered separate and independent of the previous auction, the following procedure is devised to reduce the uninformative wide swings in the CHHI calculation. A graphical example of the procedure is depicted in appendix figure B.2. *Ad hoc* as the procedure may seem, the calculated transition periods did not appear to be sensitive to choosing a five-, ten- or fifteen-period moving average standard deviation. Therefore, the transition period at the beginning of each auction was determined by the mean ten-period moving average standard deviation of the CHHI across all auction sessions and is then compared to each within-auction session ten-period moving standard deviation of the CHHI. The first unit where the within-auction session CHHI ten-period moving average standard deviation equals the overall mean of the ten-period moving average standard deviation marks the transition length for that auction session. The transition length averaged 34 observations or about 15 percent of the units sold at an average auction and 22 observations or about 10 percent for the average auction for the winning bidder concentration and principal concentration calculations.

Once the transition period length was determined, an adjusted CHHI is calculated. Within the transition period the CHHI is calculated by giving progressively greater weights to the current auction's CHHI, while giving progressively less weight to the previous auction's overall CHHI. [45] After the transition period is complete, full weight is given to the current auction session's CHHI. The converged value of the CHHI at the end of the auction session is then used in the calculation of the next auction session's transition period CHHI, and so on. Therefore, the CHHI calculation not only allows for within auction variation, but also bridges the information gap in concentration used by the agent buyers.[46]

Appendix figure B.3 depicts the progression of the adjusted CHHI for winning bidder concentration with common agency (CHHIA) and represented principal concentration (CHHIP) across three example auctions from the data. On average, the CHHIP is 2,160 and the CHHIA is 5,667.[47] The CHHIP is less than CHHIA because the principal concentration presupposes that principal buyers are independently represented at auction. Common agency more than doubled the derived HHI. The significant increase is primarily due to the fact that the common agent is the dominant agent. When bidder concentration is calculated at the principal level, any measurable difference in price impacts between the two measures are due to the common agent's influence over the apportionment and pricing within the collaboration of principals.

Empirical Model Development, Hypotheses and Estimation Procedures

In this section, structural estimation issues are addressed, empirical models developed and statistical hypotheses stated. Finally, estimation procedures and data issues are discussed. A hedonic system of simultaneous equations, which accounts for simultaneity of price and concentration, bidder concentration and dominance, is estimated. From the results of econometric analysis, direct evidence of the unilateral effects of common agency and dominance are provided. Also, weak evidence of exclusionary rivalry between the common agent and rival bidders is demonstrated through t-tests and graphical analysis.

Structural Estimation of English Auction Data

We would prefer to impose theoretical bidding structure in analyzing the data. Imposing a theoretical structure on an auction model based on optimal bidding behavior allows for econometric comparisons of market outcomes to predicted equilibrium prices (Paarsch and Hong 2006). In essence, the modeler estimates the demand for each bidder from estimates of the distribution of private signals. From this information the modeler is able to calculate the competitive price, *given the number of bidders and their theoretical optimal strategy*, and compare these estimates to the observed price. However, the extremely sophisticated nature of information in real-world auctions makes it difficult to convincingly impose a unique structural auction model in an econometric way. Furthermore, structural methods have yet to adequately identify the unknown stochastic nature of common value auctions, especially in English auctions (Paarsch and Hong 2006; Athey and Haile 2002; Laffont and Vuong 1996). As such, no theoretical strategic structure is imposed on the current econometric model and all results will be relative in nature, that is, bidder price differentials are estimated rather than comparing overall auction prices to the predicted competitive equilibrium based on the mechanism design.

Unilateral Effects of Common Agents

If the econometrician is able to observe data generated prior to and after the formation of the common agent, an event analysis can be employed. However, when agency contracts such as the one analyzed in this study have been in existence for many years, gathering the data for an event analysis is prohibitive. Therefore, estimates of the impact of common agency must be derived by extrapolation from the estimates of the impacts of concentration within the data series.

Separation of Unilateral and Exclusionary/Strategic Effects

Because the common agent is also the dominant agent and since winning bids and concentration are endogenous, there is a potential for simultaneity between the unilateral effects of common agency and dominance. Primarily due to the cumulative nature of the CHHIA, this problem is alleviated and is justified as follows.

First, common agency is neither a necessary nor sufficient condition for dominance. For instance, a group of small principals seeking increased efficiencies may hire a common agent who in turn purchases an equal share of the market. Also, a principal buyer may independently purchase the largest portion of the market if they are geographically advantaged over equally sized rivals. Only when symmetric capacity constrained principals combine their purchase orders with a common agent will common agency necessarily result in a dominant agent. Because firms are highly unlikely to be perfectly symmetric in real-world markets, it also highly unlikely that the unilateral effects of common agency and the exclusionary/strategic effects of a dominant bidder are perfectly correlated in this analysis.

Secondly, the CHHIA is *independent* of which bidder purchases the item. However, it is noted that as the size of the dominant bidder increases, the degree of correlation between dominance and common agency is expected to increase.

Identifying Exclusionary from Strategic Effects

From the data separating exclusionary conduct from strategic advantage cannot be accomplished. Both dominant firm and auction theory agree that the initial condition to establish dominance is the presence of an advantaged player. The fear by antitrust authorities is that a dominant buyer may be in position to credibly *extend* their market power by engaging in *exclusionary* conduct. Exclusionary conduct in auctions would be predatory pricing designed to "raise rivals costs".[48] By credibly "raising rivals costs", the disadvantaged firm either reduces their presence or exits the market entirely. Interestingly, this sounds exactly like the explanation of the explosive effects of advantaged bidders in common value auctions. Therefore, it does not appear that evidence of aggressive bidding is actually an *extension* of market power in auctions, but could simply be the result of the optimal strategy for an advantaged bidder.

Cattle Characteristics

Hedonic price functions are based on the premise that within-product heterogeneity exists, as is the case for the cull cows in this study. Mintert, Schroeder and Brazel (1990) is the only previous study known to the author which specifically addressed input characteristic impacts on demand for cull cows in an auction setting. Breed, weight and poor health attributes were included in the model resulting in a net negative price impact for dairy breeds and negative price impacts for weight and poor health.

These authors also included an estimate of dressing percentage as an independent variable. However, estimates of an unobservable attribute, such as dressing percentage, rely on observables such as weight, frame size, flesh condition and muscling to develop the proxy. Estimates regarding dressing percentage and weight suffered from multicollinearity because "biological entities are by nature a conglomeration of many individual, yet dependent, characteristics." (Coatney, Menkhaus and Schmitz 1996).

Declining Price Anomaly

Before the introduction of the declining price anomaly in the economics literature for homogenous goods put forth by Ashenfelter (1989) and formalized by McAfee and Vincent (1993) and Buccola (1982) noted that in livestock auctions the same anomaly was observed for quality-corrected prices. Buccola attributed the decline to risk-averse buyers who are minimizing their risk of failing to make their required purchases. These types of buyers are willing to bid their maximum willingness to pay early in the sale. Thus, buyers are satiated in order of their risk aversion resulting in the downward trend in quality adjusted prices. As such, we should expect to observe buyers, potentially with large orders, filling the majority of those orders early in the sale at higher prices.

Empirical Model Development

The data in this study are a time-series of repeated unit auctions, with intermittent breaks across auction sessions.[49] To account for simultaneity between selling prices and concentration, two sets of systems of linear equations are estimated to explain 1) how selling price (SP) is impacted by the dominant bidder (DOM) and agent concentration (CHHIA).

Both the price and CHHIA equations contain cattle characteristics as regressors, to account for the private marginal value products related to these characteristics. The cattle characteristics included in the data are Holstein cows (HC), whether a cow has a negative attribute (Neg) and the weight of the cow (Wt). If a characteristic is more (less) preferred by principals and the agent accurately carries accounts for that preference, we would expect positive (negative) impacts on the concentration measures.

The cattle characteristic variables are limited by the data and are by no means complete. Frame, flesh condition and muscling are important observable characteristics for buyers to estimate value related to both red meat yield and further production capability. However, the cubic weight to price relationship is assumed to be a good proxy in the price equation because weight is naturally a function of these missing characteristics (Coatney, Menkhaus and Schmitz 1996). A squared weight relationship is assumed in the concentration equations, due to fewer principals desiring cattle at the extremes (appendix figure B.1).

Lagged endogenous variables are included in each equation to capture concentration and price dynamics related to bidders learning the degree of competition and learning about rival valuations. Players in repeated games are adaptive learners (Roth and Erev 1995 and Camerer 2003, 469-470). Camerer concludes that there is ‘strategic teaching’ between players. Gavin and Kagel (2002) analyze simple learning processes of bidders in repeated common value auctions. Referring to 1.B.1, market dynamics in cattle auctions are constantly in flux. Therefore, past price and concentration information is assimilated into the bidder’s current strategic choices.

Looking back at the development of the CHHI, it was simply noted that buyers incorporate the information about the level of concentration across auctions to adapt to the weak information provided from purchases of early units. What was argued is that bidders maintain a history of play from the previous auction and use this information to make strategic decisions for units early in the next auction. The appropriate lag structure of concentration is one period as the measure already includes the history of play up to the point immediately prior to the current unit and is represented in the models as L1CHHIA.

Determining the appropriate lag structure for price is problematic. The reason being is that because cattle are heterogeneous, it would be difficult to find a lag structure that matches the current animal with the most recent animal of “similar” characteristics. Even if such an animal can be found by the researcher, it is uncertain whether the bidders would consider the same animal as *sufficiently* similar. Therefore, price is lagged only one period to at least incorporate some learning dynamics and is represented in the model as L1SP.

Finally, a within auction trend variable (ST) is also used to test for the ‘declining price anomaly’ which relies on the model’s ability to adequately control for heterogeneity. Also, a trend variable (T), measured by the unit sold over the entire series of auctions, is included in each equation to capture outside influences not explained over all auction periods.

A simple description of the models estimated are as follows: the expected sign of the estimated coefficient associated with each variable is in parentheses. Descriptive statistics of for each variable are provided in appendix table A.2.

Estimating the Influence of the Dominate Common Agent

$$SP = f(CHHIA, DOM, L1SP, HC, Neg, Wt, Wt^2, Wt^3, ST, T) \quad (1)$$
$$\qquad (-) \quad (-), \quad (+), \quad (-), \quad (-), \quad (+), \quad (-), \quad (+), \quad (-), \quad (-)$$

where:

$$CHHIA = f(SP, L1CHHIA, HC, Neg, Wt, Wt^2, ST, T) \quad (2)$$
$$\qquad (-), \quad (+), \quad (?), \quad (?), \quad (?), \quad (?), \quad (-), (?)$$

where:

- SP = Selling Price in \$/cwt;
- CHHIA = Cumulative Herfindahl-Hirschman Index of winning bidders for the agents/principals present at sale;
- DOM = Dominant bidder dummy variable, taking a value of 1 if the common agency (dominant bidder) buys and 0 otherwise;
- HC = Holstein cow dummy variable, non-Holstein = 0;
- Neg = Negative attribute dummy variable, non-negative = 0;
- Wt = Animal weight in pounds;
- ST = Within sale trend ➔ order of units sold per auction.
- T = Overall trend observation, 1 – 7,722;
- L1SP = Predicted Selling Price lagged one unit sold in \$/cwt;
- L1CHHIA = Predicted Cumulative Herfindahl-Hirschman Index of winning bidders for the agents/buyers lagged one unit sold;
- ∑PR = Principal dummy variable, taking a value of 0 if Prin6 principal purchases and 1 otherwise.

Statistical Hypotheses

Three primary statistical hypotheses are tested:

The impact on price relative to the dominant agent,

1) Ho: (SP|Dom=1) – (SP|Dom=0) = 0

Ha: (SP|Dom=1) – (SP|Dom=0) ≠ 0 regardless of concentration measure utilized.

The direct impact on price due to changes in bidder concentration,

2) Ho: $\partial SP/\partial$ CHHIA = 0

Ha: $\partial SP/\partial$ CHHIA $\neq$ 0.

Estimation Considerations of Simultaneous Equations

To test the appropriateness of various system-estimation procedures, the Hausman's specification test is used to test a hypotheses regarding inconsistency of the estimators (Hausman, 1978). Hausman's specification test, or *m*-statistic, can be used to determine if it is necessary to use an instrumental variables method. Hausman's *m*-statistic can also be used to compare 2SLS with 3SLS for a class of estimators where 3SLS is asymptotically efficient (similarly for OLS and SUR) (SAS Institution chpt. 14: pp. 786-787).

Autocorrelation may originate from the nature of the data in that the price of the previous animal sold may have some residual impact on the price of the current animal being sold. If, however, buyers update their bids on a per unit basis then severe autocorrelation is not expected in the price equation. Severe autocorrelation is expected in the concentration equations. Under-prediction of the concentration variables in one period is expected to be followed by an under-prediction in the next, due to the cumulative nature of the calculation of the concentration variables.

Inclusion of lagged dependent variables in each structural equation in the presence of autocorrelation results in inconsistent estimators including that of the autocorrelation coefficient. An alternative to using lagged dependent variables is to lag estimated instrumental variables (Greene 1993, 609). This results in lagged predicted endogenous variables L1SP and L1CHHIA. The SP and CHHIA variables are first predicted from the reduced form equations in which each endogenous variable is regressed against the full set of instruments which include all exogenous variables in the system; all exogenous variables are lagged once, and all endogenous variables lagged once and twice.[50] This instrumental variable approach is a variation suggested by Sargan (1961). Fair (1970) suggested reducing the number of instruments if the number of instruments exceeds the number of observations. With over 7000 observations and only 17 instruments, this did not appear to be of concern for this analysis. The predicted values are then lagged and used as instruments in further stages of either 2SLS or 3SLS (depending on the results of Hausman's specification test).

The estimated system of equations meets the rank and order conditions for identification, as each equation contains at least its own predetermined variable (Greene 2003, 393). The price equation is exactly identified, while the concentration equation is overidentified.[51] The validity of the restrictions placed on the concentration equation will be tested by a statistical procedure developed by Basmann (1960) where "the null hypothesis is that the predetermined variables not appearing in any equation have zero coefficients" (SAS Institute 2009, chapt. 14, 1089-90).[52] After testing for suspected autocorrelation, either the second- or third-stage equations will be estimated using the conditional least squares method to adjust for a first order autoregressive process (SAS Institute 2009, chapt. 14, 794-799).

Finally, multicollinearity between the DOM and CHHIA was not detected by means of either the variance inflation factor or condition indices. The variance inflation factor equaled 1.10 for DOM and 1.06 for CHHIA, where values of over 5 are considered sufficiently correlated with other variables in the model to warrant suspicion of severe multicollinearity (Marquardt and Snee 1975). Therefore, the price effects of dominance and concentration are statistically identified.

Results

The results for equations (1) and (2) are as expected and are reported in appendix table A.3. The alternative model specifications, selling price with CHHIA, were estimated using 3SLS and 2SLS, based on the results of the Hausman *m*-statistic. By the results of the Basmann statistic, the restrictions on the concentration equation appear to be valid. Because lagged endogenous variables are instrumented, the Durbin-Watson statistic is an appropriate test statistic for autocorrelation. The Durbin-Watson statistic indicated that first-order autocorrelation was an issue for the concentration equations. However, autocorrelation may not have been a serious issue regarding the price equations given the indeterminacy of the Durbin-Watson statistic. This result suggests that: 1) buyers rely on individual estimates of value and 2) the single lag in price was likely enough.

Hedonics, Declining Price Anomaly and Market Definition

As expected, cattle characteristics are important determinants of price and exhibit the expected relationships with price. Cattle traits also are important determinants of agent and principal concentrations and the respective coefficients have the same signs in both price equations, suggesting preferences exist among principals. The Durbin-Watson statistic and the estimated *rho* did not indicate that a first-order positive autocorrelation was a serious issue in the price equation.[53] This result suggests agent bidders primarily value each randomly ordered animal separately. This is to be expected when visual appraisal is crucial in determining each animal's expected value. In so far as possible, accounting for the cattle characteristics created a fairly homogenous product from which to evaluate the impacts of the dominant bidder and winning-bid structure variables on price. Furthermore, by adequately accounting for the cattle characteristics, the estimation procedure treats each unit sold as a series of independent repeated unit sales, leaving strategic behavior to be accounted for in other variables such as the CHHIA and DOM variables.

Regardless of the model estimated in this study, the declining price anomaly was observed. In previous theoretical and empirical work, the anomaly was found when the objects were considered homogenous lending further support that the product market is adequately defined. It has been demonstrated that the relevant quality characteristics have been adequately held constant; therefore the result lends further support to previous theoretical and empirical findings related to this anomaly. Regardless of the noncooperative or cooperative relationship between the dominant agent and fringe, some hedging of risk aversion may remain.

Bidder Concentration and Price Endogeneity

Similar to past econometric results relating to the theory of the firm, selling price and concentration in these results are inversely related – lower (higher) prices are a result of higher (lower) winning-bidder concentration. Results from the Hausman *m*-statistic further support an endogeneity issue between concentration and the prevailing auction price. Therefore, at least in an auction setting, these results do not support the assertion made by Carlton and Perloff (2005) that endogeneity is not to be expected when analyzing the structural impacts of buyer concentration.

Unilateral Impacts CHHIA v. Ex Post HHIA

For comparison purposes equation (1) was re-estimated using the *ex post* calculated HHIA following Bailey, Brorsen and Fawson (1993) and the CHHIA as regressors in a single equation ignoring the endogeneity of concentration and price. The results are provided in appendix table A.4.

The fit of the price equation in the system was not improved by single equation estimation. Serial correlation in the single equation approach is on par with the systems approach. Signs and significance remain unchanged for all variables in the model. However, by ignoring endogeneity and following the *ex post* approach; DOM's price impact is reduced from -$4.49/cwt to -$2.66. Concentration impacts are reduced from -0. 95 per 1000 increase in the system CHHIA to a -0.30 per 1000 increase in the HHIA. By ignoring endogeneity but accounting for the informational updating of the CHHIA, the price impacts by DOM and concentration remain basically unchanged. Inclusion of the CHHIA in the equation provided basically no additional explanatory power over the HHIA.

Interpretation of these results indicates that the Ordinary Least Squares estimators suffer from simultaneity bias. By ignoring endogeneity significantly impacts the magnitude of the coefficients of interest, reducing the estimated coefficient on DOM by less than 50 percent and the coefficient on CHHIA by over 60 percent. However, an important result of alternative estimation procedure is that the negative price impact by DOM and concentration is robust.

Dominant Agent Price Impacts

The common agent (DOM) contributed to a significant reduction in the average winning bid price of $4.49/cwt. This result is similar in magnitude to the average price differential of $4.64/cwt previously reported. The consistency of these results suggests that both dominant and fringe groups purchased cattle displaying similar characteristics. In other word, controlling for cattle characteristics did not a play significant role in the resulting price differential. Therefore, the product market is appropriately broadly defined as cull cows.

Agent Rivalry and Exclusion

Appendix figure B.4 demonstrates the price impacts when Prin5 (packer) and the Prin6 (market support bidder) challenged the dominant buyer for market share in auctions 10 and 23. Prin5 significantly increased their market share from an average of roughly 8 percent to 22 percent in auction 23. Prin6 also significantly increased their market share from an average of roughly 8 percent to 23 percent in auction 10. In both instances, DOM significantly lost market share.

Only in auction 23 when Prin5 significantly deviate from their average market share did prices significantly increase. The large packer processor apparently was required to pay for its deviation in market share. However, Prin6 did not experience the apparent rivalry as did the large processor. The statistical results of price and market share by bidder and principal purchaser are provided in appendix table A.5. The statistical results do not support a conclusion that the significant price change in auction 23 versus all other auctions was due to significant increases in higher-valued cattle characteristics (LW), a trait which Prin5 apparently prefers (refer to appendix figure B.1).

It is only speculative whether DOM was the bidder who engaged in exclusionary/strategic conduct fearing an increased foot-hold by the large processor or instituted a grim strategy to solicit an agreement of cooperation. Without bidding data and further evidence, these observationally-equivalent strategies cannot be confirmed. In either event, Prin5 resumed their longer run market share position in the next sale.

In regards to Prin6, we would not expect there to be a significant price differential when the market support bidder increased market share. This is because their role is to simply support the market, not take away market share.[54] It could be the case that DOM simply demanded fewer units for their principals on that particular day and the market support person was able to advantage of the situation without experiencing rivalry from DOM.

Market Support

As noted in the data section, Prin6 allegedly provided market support and is an ally of the marketing institution. However, the effectiveness of market support is difficult to estimate. The dominant buyer was able to pay prices significantly below Prin6 (basis of comparison) for Prin1, Prin3 and Prin4, but paid higher prices for Prin2, *ceteris paribus*. These deviations may depend upon the intended use of similar animals resulting in heterogeneous values of marginal products; it is unlikely Prin6 was able to obtain competitive dealer bids from principals who were represented at the auction. If the results from appendix figure B.3 are indicative of the market support bidder's role, it is merely to maintain a floor on prices rather than to aggressively maintain average sale prices, which could not be accomplish without buy-orders from rivals principals.

Summary of Collaboration Benefits

Assuming increases in concentration are linear given the similar magnitudes of the two concentration measures, increases in concentration from CHHIP equaling 2,160 to the CHHIA equaling 5,667 on average constitutes a 3,507 increase in concentration.[55] A decrease in average price of roughly \$1.00/cwt per 1000 increase in concentration would indicate that increasing concentration by common agency alone decreased price by \$3.51/cwt (again, nearly equal to the auctioneer's alleged average price impact resulting from the common agency). This would constitute an unobserved up-front aggregate cost savings of \$250,964.46 for the collaboration over the four month course of the study (calculated over only the dominant agent's purchases). Though increases in concentration reduce all principal purchasers' costs, the lion's share of the award goes to the largest purchasers. Additionally, comparing further price reductions by the dominant agent alone reduces the aggregate cost of cattle for the collaboration by $321,498.09 (calculated over only the dominant agent's purchases).

Conclusions and Implications for Antitrust

Buyer collaborations may have significant impacts on prices paid at auction. The primary purpose of this study was to estimate the unilateral price impacts of common agency and the exclusionary/strategic price impacts associated with the presence of a dominant bidder. As a whole, the empirical findings support the competition concerns raised by market participants regarding common agency and dominant bidders. Clearly the increased concentration, due to common agency and the negative impacts of a dominant bidder, significantly reduced average prices paid to sellers. In return, the collaboration was able to gain substantial benefits from hiring a common agent.

The auction market's attempts to combat the reduced competition are not completely ineffective. The market support provided a credible reservation price, though clearly less than the price that would have been paid if collaborators represented themselves at auction.

The amount of information utilized seemed to adequately define the relevant market; evidenced by an indeterminate omitted variable problem in the price equation and the observation of the declining price anomaly typically associated with homogeneous units. Given the definition of the relevant market in this study, the CHHIA is defensible on both theoretical and institutional grounds and appears to respond well to estimation in a more structural paradigm.

Finally, efficiency has been noted as a pro-competitive benefit of common agency, as well as a cause for creating a dominant bidder. If common agency is not considered *per se* illegal, antitrust authorities must take a *rule of reason* approach, weighing the pro and anticompetitive impacts to determine the net impact on competition.

From the available data, we can only speculate as to the degree of efficiency. DOM earned an estimated $35,802 over the course of four months at this particular auction location (appendix table A.1). This translates, for example, into roughly $51,000 per annum paid by Prin2 alone. Since commission agents do not receive benefits, such as health and retirement benefits or bonuses from their principals, hiring a commission agent may be more cost effective than hiring an employee whose base salary alone is approximately $50,000 per annum.

Interestingly in an auction setting, the theories developed by, if there are efficiencies in hiring common agents, efficiency gains do not result in higher, but lower prices paid at auction (Rose and Kagel (2008); Klemperer 1998; Bikhchandani 1988). Though Rose and Kagel (2008) failed to find the explosive effects of advantaged bidders in a laboratory setting the result here affirms that the author's speculation that economic agents outside the laboratory would have to employ tools not present in the lab or theory or must be sophisticated enough to employ theoretical equilibrium bidding strategies may be justified. This brings a new paradigm for antitrust regulation to consider when evaluating an efficiency defense for principals hiring a common agent, whether independently or jointly, in auctions.

Appendix A: Tables of Statistical Results

Table A.1: Total Number of Head, Average Prices and Average Live Weights Purchased by Principals and Common Agent (DOM)

Principal/Plant/Agent	Number of Head	Price ($/cwt)	Live Weight (lbs)	Commission ($)[1]
Prin1*	1832	26.61	1095.57	10035.42
Prin2*	1851	36.29	1388.44	12850.01
Prin3*	1852	34.52	1294.10	11983.37
Prin4*	158	32.32	1180.57	932.65
Prin5	627	40.77	1602.64	--
Prin6	610	34.82	1256.38	--
Prin7	169	35.96	1315.75	--
Prin8	164	36.83	1220.61	--
Prin9	149	36.41	1188.56	--
Other	310	35.44	1217.81	--
Total/Average	7722	33.71	1283.18	35801.45
DOM	5693	32.49	1257.74	35801.56
FRNG	2029	37.13	1354.56	
Mean/Std Collab. MS	33.3/5.5**			
Mean/Std FRNG MS	16.7/13.4**			

*Collaboration of principals represented by common agent- Principal 1 and 4 are actually plants owned by the same processor. [1]Estimated commission earnings based on an industry average.
**F-Test results - Std Collaboration MS is significantly smaller than Std FRNG at $\alpha = .01$

Table A.2: Descriptive Statistics of Data and Calculated Variables

Variable	Mean	Standard Deviation	Minimum	Maximum	Frequency	Percent of Total
SP	33.71	5.85	5	50		
CHHIA	5677.20	785.12	3735.15	8383.74		
CHHIP	2160.01	280.20	1551.01	3956.69		
DOM					5693	73.72
HC					5817	75.33
Neg					1103	14.28
Wt	1283.18	220.77	480	2160		
ST	227.12	55.73	93	334		
L1SP	33.71/	4.49/	14.88/	46.35/		
	33.71	4.48	14.90	46.10		
L1CHHIA	5677.26	782.11	3769.52	8358.74		
L1CHHIP	2159.97	274.80	1545.25	3923.37		

Table A.3: Dominant-Fringe Price Differentials

Regressors	Selling Price 3SLS (std.err.)	CHHIA 3SLS (std.err.)
Intercept	19.63* (1.78)	1030.79* (71.66)
SP		-22.17* (0.77)
L1SP	0.03* (0.006)	
CHHIA	-0.00095*,[4] (0.00008)	
L1CHHIA		0.88* (0.01)
DOM	-4.49*,[4] (0.07)	
HC	-1.86* (0.09)	-42.71* (4.17)
NEG	-6.89* (0.11)	-144.92* (7.12)
WT	0.03* (0.004)	0.48* (0.06)
WT^2	-0.00001* (2.90E-6)	-0.0001* (0.00002)
WT^3	1.93E-9* (7.31E-10)	
ST	-0.002* (0.001)	-.06 (.10)
T	0.0002* (0.00003)	0.0009 (0.003)
Hausman's Specification Test	744.10 3SLS preferred	
R^2	0.53	0.97
Rho	-0.12	-0.48
Durbin-Watson	1.77[1]	1.05[2]
Bassman's OverID[3]	34.49**	10238**

* Significantly different from zero, α = 0.01.

** Significantly different, α = 0.01.

[1,2] Rho and Durbin-Watson were calculated during the second-stage before implementing the AR1 process in the system. Though D-W is in the indeterminate region of the Durbin-Watson statistic for the price equation; estimates are reported are corrected for first-order autocorrelation.

[3]Due to statistical package constraints, the statistic is calculated without correcting for autocorrelation.

[4]Variance inflation factor for CHHIA = 1.06 and DOM = 1.10 were a value greater than 5 indicates severe multicollinearity (Marquardt and Snee 1975). Variance inflation factors over 5 are associated only with the weight variables.

Table A.4: HHIA vs CHHIA: Estimated Coefficients and (Standard errors)

Regressors	Selling Price OLS (std.err.)	Selling Price OLS (std.err.)
Intercept	6.90 (3.32)	7.02 (3.31)
L1SP	0.09* (0.01)	0.09* (0.01)
HHIA	-0.0003* (0.0001)	
CHHIA		-0.0003* (0.0001)
DOM	-2.66* (0.10)	-2.62* (0.10)
HC	-1.89* (0.10)	-1.88* (0.10)
NEG	-7.23* (0.13)	-7.24* (0.13)
WT	0.05* (0.01)	0.05* (0.01)
WT^2	-0.00002* (6.10E-6)	-0.00002* (6.10E-6)
WT^3	5.49E-9* (1.55E-9)	5.56E-9* (1.56E-9)
ST	-0.002* (0.001)	-0.002* (0.001)
T	0.0002* (0.00002)	0.0002* (0.00002)
R^2	0.58	0.59
Rho	-0.12	-0.11
Durbin-Watson	1.77[1]	1.77[1]

*Significantly different from zero, $\alpha = 0.01$.

[1]Though D-W is in the indeterminate region of the Durbin-Watson statistic; Yule-Walker estimates are reported

Table A.5: Variables and t-tests Related to Price, Cattle Characteristics and Market Shares for Sales 10 and 23, Figure B.4.

Variable per Principal	Mean for Sale 10	Mean for All Other Sales	Mean for Sale 23	Mean for All Other Sales
SP	33.73	32.73	33.59*	37.78*
NEG	0.14	0.21[1]	0.14	0.14
HC	0.75	0.81	0.75*	0.85[1]*
WT	1283.32	1276.39	1282.57	1304.79
Market Share Prin1	0.24	0.20	0.24	0.21
Market Share Prin2	0.24	0.21	0.24	0.23
Market Share Prin3	0.24	0.21	0.24	0.18
Market Share Prin4	0.02	0.01[1]	0.02	0.0[1]*
Market Share Prin5	0.08	0.07	0.08*	0.22[1]*
Market Share Prin6	0.08*	0.23[1]*	0.08	0.07
Market Share Prin7	0.02	0.01[1]	0.02	0.02
Market Share Prin8	0.02	0.02	0.02	0.03[1]
Market Share Prin9	0.02	0.05[1]	0.02	0.01[1]
Market Share OtherBuyer	0.04	0.01[1]*	0.04	0.01[1]
Market Share DOM	0.74*	0.62*	0.74*	0.63*

[1]Mean differences using Cochrane and Cox t-tests are reported when the equal variance assumption was violated according to the Folded form F-statistic; otherwise the results of pooled t-tests are reported (SAS Institute 2009, Chapt. 67, 3578-3579).

*Reject the Ho: equal means, $\alpha = 0.01$.

Appendix B: Figures of Data Description

Figure B.1: Distribution of Principal Live Weight Purchases

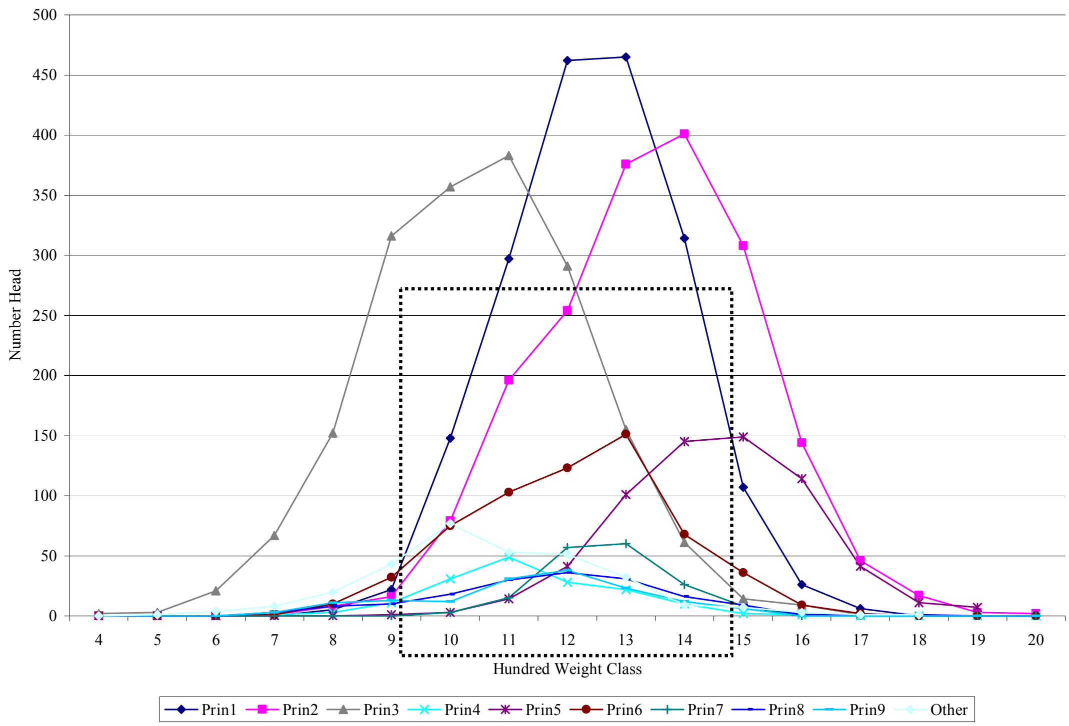


Figure B.2: Example Transition Period Determination Comparing the Overall 10 Period Moving Average Standard Deviation CHHIA to the Sale Specific 10 Period Moving Average Standard Deviation CHHIA

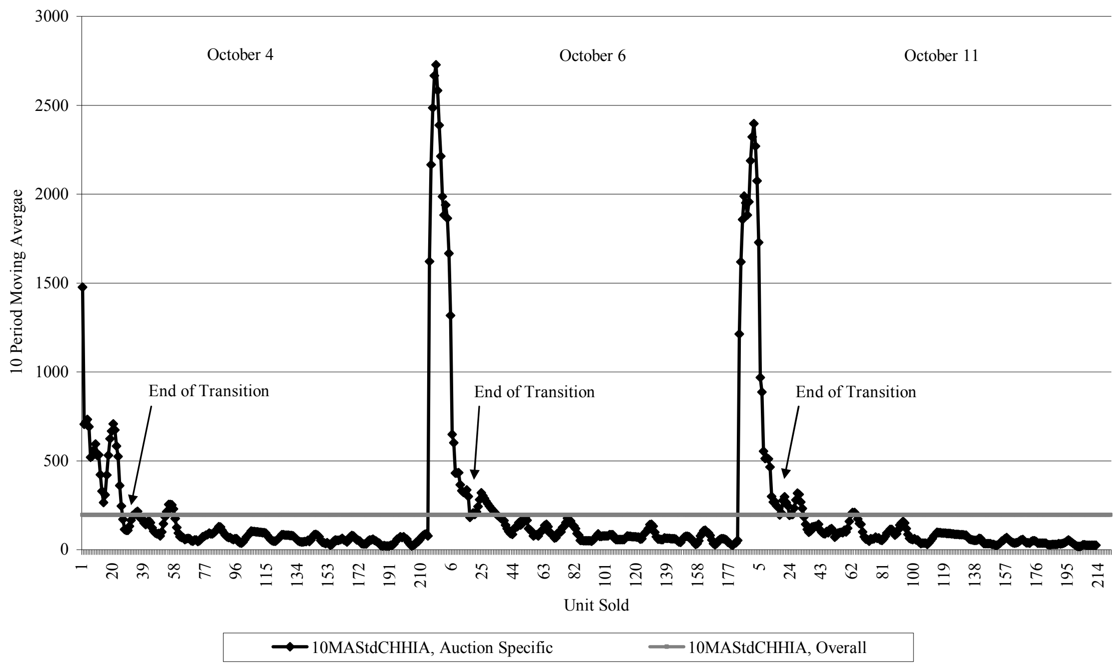


Figure B.3: Example CHHI for Agents and Principals – October 4, 6 and 11 Sales

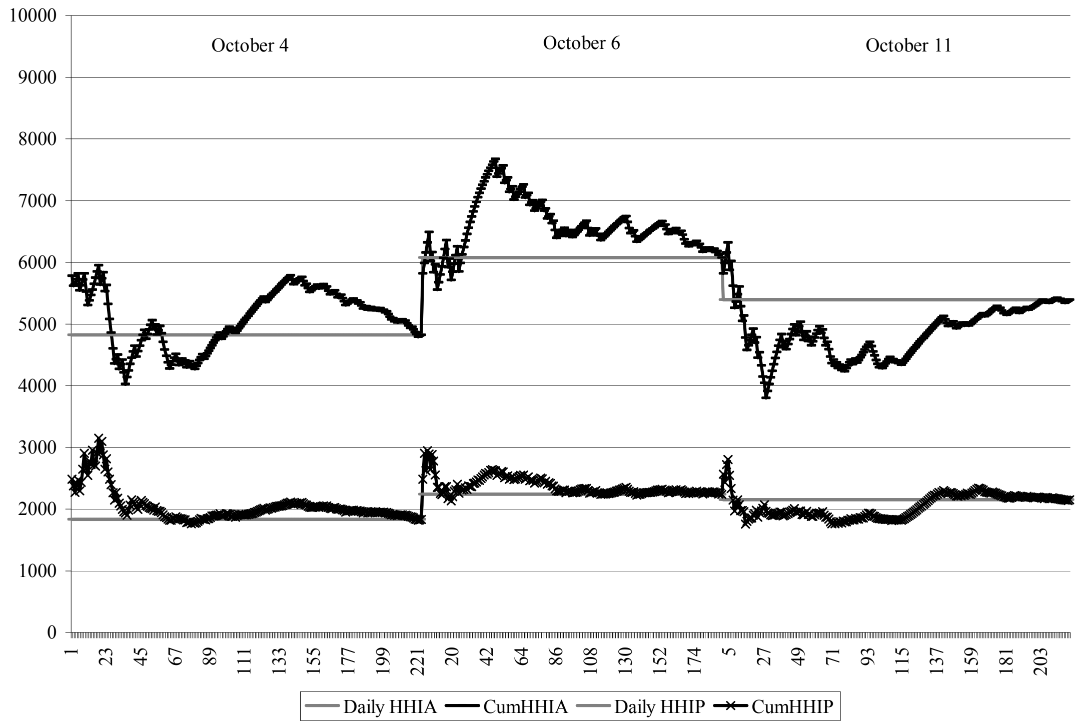
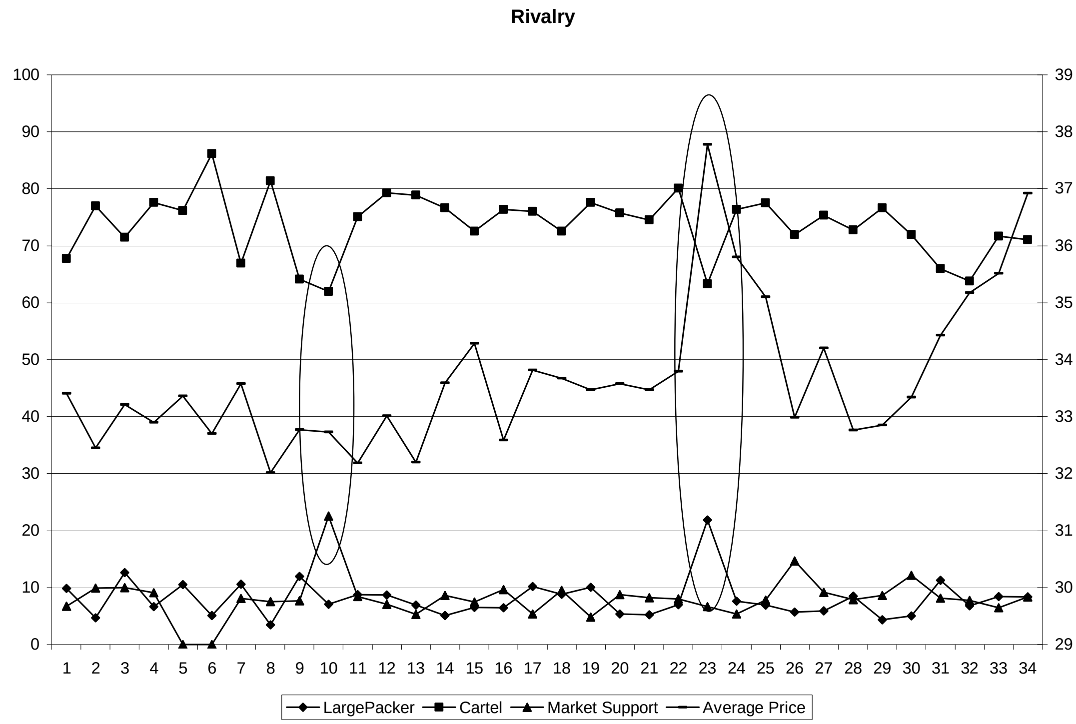


Figure B.4: Deviations in Agent Market Share and Average Price Impacts



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1.11 Endnotes

[1] See GIPSA Industry assessments from 2000 to 2005. http://www.gipsa.usda.gov/GIPSA/webapp?area=home&subject=lmp&topic=ir-as
[2] Cull cows do not meet the productivity requirements of their current owner, typically ranchers, dairymen and feeders. The cows may be suffering from lameness, cancer, infertility, mastitis or simply old age. These cows vary regionally and may be dairy or beef cows. In economic terms, these cattle could be accurately described as salvage goods.
[3] For a discussion related to live animal predictors see Gresham et al. 1986: O'Mara et al. 1998.
[4] Commission agents are paid on a flat-fee for service basis. The commission agent's payment is calculated by taking the $/cwt multiplied by the # cwt purchased. For example, for a commission agent that purchases a 48,000 lb truck load of cattle at a rate of $0.50/cwt, the agent's payment would be $240.00. To alleviate the incentive compatibility problem of this type of compensation scheme, commission agents maintain and expand their contracts by purchasing at or below the principal's minimum profit/loss requirements. Typically, buyers for packers are allowed up to only a 1 percent error in pricing any classification of cattle.
[5] A dominant purchaser may be simply described as one that maintains the largest market share. However, we use the more strict antitrust inference of monopoly power arising from a firm controlling at least 75 percent of the market before *sufficient* market power has been established. This has been a general standard that courts have used before determining whether a defendant has enough market power to be charged with a section 2 violation of the Sherman Antitrust Act (Gavil, Kovacic and Baker 2002, 575-576).
[6] According to the 1992 Horizontal Merger Guidelines, when the post-merger HHI exceeds 1800, it will be presumed that mergers producing an increase in the HHI of more than 100 points are likely to create or enhance market power or facilitate its exercise. In accordance to Antitrust Guidelines for Collaborations Among Competitors, 2000 a buyer collaboration is essentially a 'merger-in-part'.
[7] Traditional meaning that auction prices are analyzed without structural identification of optimal bidding strategies derived from observed bids and the unobserved underlying private and common value distributions. For further discussion of structural estimation techniques for pure and common value auctions see Paarsch, H.J. and H. Hong (2006), Athey, S. and P.A. Haile (2002) Laffont, J. and Q. Vuong (1996).
[8] Common bidding agency raises competition concerns and, depending upon the business purpose for the agreement and the potential harm to competition, may be condemnable by the courts either under a *per se* or *rule of reason* analysis. The difference between a *per se* and *rule of reason* analysis is that a *per se* violation necessarily reduces competition and shows no potential for procompetitive benefits, while a *rule of reason* analysis is applied when the actions of the party or parties may result in significant efficiencies which could not be attained by a less restrictive means. For a more detailed discussion see FTC, USDJ 1999. "Types of agreements that have been held *per se* illegal include agreements among competitors to fix prices or output, rig bids, or share or divide markets by allocating customers, suppliers, territories, or lines of commerce." (p 3). "Rule of reason analysis focuses on the state of competition with, as compared to without, the relevant agreement. The central question is whether the relevant agreement likely harms competition by increasing the ability or incentive to profitably to raise price above or reduce output, quality, service, or innovation below what likely would prevail in the absence of the relevant agreement." (p 4).
[9] See 1992 Horizontal Merger Guidelines and the Antitrust Guidelines for Collaborations Among Competitors, 2000.
[10] For an overview of potential exclusionary anticompetitive behavior by dominant firms see Gavil, Kovacic and Baker (2002), chapter 6, Dominant Firm Behavior Having Exclusionary Effects. Based on research by Krattenmaker and Salop (1986) and Salop and Scheffman (1983), Gavil, Kovacic and Baker raise two main competition concerns arising from the presence of a dominant firm: 1) the ability of the dominant firm to 'raise rivals costs' thus reducing competition by reducing the competitiveness of rival firms and 2) the potential of the dominant firm to create an involuntary cartel member via credible threats of 'raising rivals' costs' (pp.634-641). Gavil, Kovacic, and Baker also summarize Spectrum Sports, Inc. v. McQuillan, 506 U.S. 447, 456, 113 S.Ct. 884, 890 (1993), where they state "[I]t is generally required that to demonstrate attempted monopolization a plaintiff must prove (1) that the defendant has engaged in predatory of anticompetitive conduct with (2) a specific intent to monopolize and (3) a dangerous probability of achieving monopoly power.", 562-563. The potential for

exclusionary effects are also noted, but not discussed, in the Antitrust Guidelines for Collaborations Among Competitors (FTC and USDJ 1999), footnote 5.

[11] Sharing a common agent facilitates collusion among collaborating principals even if the principals engage the services of the common agent independently (Bernheim and Whinston 1985, 1986). Also, for an overview of the concentration and collusion concerns related to competitor collaborations see FTC and USDJ 1999.

[12] See *Brown Shoe Co. v. U.S.*, 370 U.S. 82 S.Ct. 1502, page 319. Also cited by the district court in *FTC v. Heinz*, 116 F.Supp.2d 190 as one justification to allow two smaller but significant firms to merge (Heinz and Beech-Nut) to enhance product innovation competition with the baby food industry's giant (Gerber). The appellate court did not argue with the District Court's use of *Brown Shoe*, but did not support the District Court's findings based on the facts presented at trial (see *718 **374 b. Rebuttal Arguments rebuttal arguments, 3. Innovation in *FTC v. Heinz*, 246 F.3d 708, 345 U.S.App.D.C. 364.)

[13] Refer to footnote 4.

[14] This percentage is likely much higher as the reporting requirements for packers allow them to report dealer purchases as non-market purchases. Recently P&S reported that in fact cull cow packers purchase most of their cattle at auction (USDA, GIPSA 2009).

[15] USDA, GIPSA 2008 reports that 3,101,000 head of cows were sold through public auctions. The estimate was derived assuming that cows weigh on average 1500 pounds. The average price for cull cows is $0.51 per pound, which is a simple average calculated from information collected by the Livestock Marketing Information Center.

[16] Dealers, though allegedly principals themselves, receive multiple resale offers (fixed order-prices) from other principals. Dealer profit is calculated from the winning-bid to order-price spread less expenses. It is not uncommon that dealers are willing to accept market location assignments by principals. This request is made by the principal to eliminate inter-agent competition. By accepting the competition restriction, the dealer becomes an agent of the principal. Therefore, it is quite likely that a significant portion of the dealer purchases are truly made by common agents, rather than by independent purchasers as the statistic suggests.

[17] 7 U.S.C. §§ 181-229b.

[18] Though GIPSA has recently dropped common agents (joint buying) as a serious industry issue, the complaint has continued to be unresolved. See GIPSA Industry assessments from 2000 to 2004 (http://www.gipsa.usda.gov/GIPSA/webapp?area=home&subject=lmp&topic=ir-as).

[19] No indication in the report was given whether this violation was related to collusion or common agency.

[20] See *Swift & Company v. United States*, 393 F.2d. 247 (7th Cir. 1968).

[21] See *San Jose Valley Veal, Inc*., 34 Agric.Dec. 966 (1975) 3.

[22] In *Hennessey*, 57 Agric.Dec. 1432 (1998). The agency provided no evidence that the two firms sharing the common agent were competitors. Forced to rely on the collaborators product market definition, the court ruled that since the collaborators were not competitors, the common agency would have no foreseeable anticompetitive effect. The agency, relying on past precedents *per se* illegality of common agency did not provide any statistical analysis of price impacts at trial.

[23] See *Monfort of Colorado v. Cargill, Inc*., 591 F. Supp. 683, 706 (D. Colo. 1983), aff'd, 761 F.2d 570 (10th Cir.1985), judgment rev'd, 479 U.S. 104 (1986).

[24] July 2, 1890, ch. 647, 26 Stat. 209, 15 U.S.C. § 1.

[25] 5 U.S.C § 14, § 18, and § 19.

[26] 15 U.S.C §§ 41-58, as amended.

[27] Nelson considered only the number of winning bidders as his concentration measure and the ratio of cars to bidders as measuring the size of the auction. However, the ratio of cars to bidders is clearly another concentration measure and was likely highly correlated with the number of bidders.

[28] For repeated private value auctions see von der Fehr (1994).

[29] When $n = 2$, optimal strategies in second-price and English auction and outcomes are identical.

[30] This also applies when the probability that the advantaged bidder in fact has an advantage approaches 1.

[31] The authors note that there exist 'bully-sucker' equilibria in pure common value auctions and that the advantaged bidder may be emboldened by their common value advantage.

[32] The study justified the strategic bidding behavior for cattle as a private value auction based on the inclusion of all relevant cattle characteristics guaranteed by the seller. However, the fact that characteristics are guaranteed has little bearing upon the correct definition of the bidder's information set. For instance, the seller only guarantees that a cow has milked X liters per day prior to the auction but cannot guarantee how long the cow will continue to produce

at X liters per day. Typically with guaranteed production, there is a time limit associated with how long the guarantee will last. For instance, sellers of guaranteed bred cows in the U.S. cannot guarantee that the cow will ultimately have the calf because the seller cannot be held liable for the production practices of the buyer which impact the likelihood that the cow will carry the calf to term. Also, and more importantly, sellers do not guarantee how good the calf will grow once born. Therefore in regards to live animal purchases, if either a structural bidding model is to be econometrically identified or if a traditional model is to be employed, the structural model or a priori expectations must admit that bidders are faced with at least a pure or almost common value unknown at the time the animal is purchased.

[33] Refer to footnote 2.

[34] Auction companies typically 'support' their markets by occasionally purchasing cattle they feel did not bring a deserving value for the seller. This is a costly enterprise as the auction company out bids the buyers, and then resells the animal later in the sale to the same buyers who either bid the original low price or strategically reduce the price to increase the market support costs of the auction company. Auction companies can also engage a competitive buyer to function as market support. However, the buyer will not accept purchasing at any price higher than need be as he is left with the animal to resell, hopefully at a profit. Mainly, the value of an outside market support buyer is to guarantee a credible price floor, or in the current case, simply another buyer.

[35] Cow feeders either feed cull cows they have purchased or feed cull animals on behalf of other firms. Dealers are speculators by trade who purchase on their own accounts, reselling animals without significantly subjecting their purchases to further processing or production. Producers are typically dairy, feeder, farmer or ranchers. "Other" includes one-time or infrequent purchasers who were producers.

[36] According to the auction firm, the common agent's dominance has existed for many years prior to the analysis period and has maintained one of their orders even though the principal packing plant has changed ownership since the time frame of this analysis.

[37] These attributes are visual appraisals and were recorded by the auctioneer. Examples of negative attributes would be lameness, mastitis udders or cancer eyes. These negative attributes affect the usefulness of the animal for further production (feeding, milking, calving or slaughter), and are in fact causes for culling from production. Negative attributes such as lameness reduce the red meat yield as the effected areas are normally condemned.

[38] At a typical auction for cattle bids are submitted by gestures. It may take only 30 seconds to sell an animal during which numerous bids may occur. Recording all bids would be a formidable task in this auctioning environment. However, electronic auctions that record all bidding activity would not suffer from this limitation.

[39] Access to buyer profit and loss statements and principal buy-orders fall under the jurisdiction of regulatory agencies.

[40] See 1992 Horizontal Merger Guidelines and the Antitrust Guidelines for Collaborations Among Competitors, 2000.

[41] Though not specifically addressed in *Hennessey*, the relevant geographic market is defined to include a single auction market location. The government's definition of geographic submarkets which are based on delivery points by suppliers, see *U.S. v. Cargill, Inc*., 2000 WL 1475752, 2000-2 Trade Cases P 72,966, Comm. Fut. L. Rep. P 28,212 (D.D.C. Jun 30, 2000) (NO. CIV. A. 991875GK).

[42] When live animal evaluations are adjusted for major flaws, live animal weight becomes a good indicator of red meat yield and cutability, though other contributing factors such as fat cover and muscling would provide a more accurate description (Gil 1998; and O'Mara et al. 1998). However, delineations along these live animal attributes is flawed because: 1) live animal evaluation is not precise even with trained buyers[42] and 2) carcass quality definitions drawn on grading systems result in significant overlap of the multiple traits that consumers prefer (Hodgson et al. 1992).

[43] The auction market currently analyzed does not pre sort cull cows based on weight or any other physical characteristic.

[44] According to Kreps and Scheinkman's seminal work (1983), under some stringent rationing rules (i.e., posted prices), if firms first choose output before price, the resulting competition is Cournot rather than Bertrand. Since a dominant bidder is analyzed and the concentration is high, a cumulative CR4 may also be an appropriate concentration measure (Sleuwaegen and Dehandschutter, 1986).

[45] The CHHI calculated from the entire data series was used for the first auction's starting CHHI measure.

[46] A sensitivity analysis of various transition weighting procedures is not currently provided in the results section. However, there is noticeable improvement in fit by using the described weighting scheme over the initial CHHI.

[47] This is much higher than the nationally calculated HHI of 936 for 2006 as reported by GIPSA for the cull cow packing industry (USDA, GIPSA 2008). The reported concentration index is more appropriate for calculating the concentration of firm output.
[48] See footnote 10.
[49] While unobserved outside market factors are expected to continually change influencing buy-orders in real-time, these factors are also expected to change between auction sessions. For instance, firms continually update their purchasing decisions based on their net positions in the futures market, simultaneous purchases made at other auction locations and completion of current output orders. However, new output orders and production difficulties are expected to be lumpy in nature and may or may not change drastically between auction sessions. Agents are able to incorporate outside market factor information from their principals and observe the influence of these outside market factors upon their rivals bidding during the auction session.
[50] The total R^2 for the OLS first stage price equation related to the alternative agent and principal concentration measures was 0.59 and 0.59. The total R^2 values for the OLS first stage agent and principal concentration equations were 0.99 and 0.96.
[51] Order condition states: $\text{Rank}(R_1)=J \geq M-1$, where J is the #restrictions and M is number of endogenous variables. Rank condition states $\text{Rank}(R_1\Delta)=M-1$, where Δ is the composite matrix of endogenous and exogenous coefficients to be estimated including the restrictions on all coefficients. Sales Price order condition: J=M-1=1 and Rank condition = 1 => equation exactly identified. CHHI(A,P) order condition: J>M-1 (3>1) and Rank condition = 1 => equation overidentified.
[52] Cautionary note: due to procedural constraints in SAS, Basmann's statistic was calculated without correction of autocorrelation.
[53] The Durbin-Watson statistic is an appropriate indicator of autocorrelation in this model because the lagged endogenous variables are instruments (Green, 2003, pp 277-78). First order autocorrelation was adjusted for with no expected improvement or harm to the estimation of the standard errors. There did not appear to be a significant difference between the OLS and autocorrelated adjusted standard errors.
[54] These were in fact the claims made by the market support agent.
[55] Though the relationship between the HHI and Lerner Index is nonlinear, the relationship between the HHI and winning bids is unknown.