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ABSTRACT

Econometric Analysis of Cattle Auctions

by Christine Zulehner*

This paper provides an empirical analysis of cattle auctions taking place in Amstetten, Austria. The particular auctions we focus on are ascending or English auctions. In this market the sellers are usually farmers and the buyers are either farmers as well or resale trade firms. A further characteristic of this market are two large bidders, each representing a resale trade firm. As all important characteristics of the cattle are known the independent private value model is adopted. The parameters that characterize the distribution of bidders' unobserved private values are then estimated using a simulated nonlinear least square estimator.

ZUSAMMENFASSUNG

Ökonometrische Analyse von Rinderauktionen

In diesem Aufsatz wird eine empirische Analyse von Rinderauktionen im Amstetten, Österreich, beschrieben. Es werden vor allem Englische Auktionen analysiert. In diesem Markt sind Verkäufer üblicherweise Bauern und Käufer entweder Bauern oder Repräsentanten von Handelsfirmen. Eine weitere Charakteristik des Marktes in Amstetten sind jene zwei Händler, die je ein Handelsunternehmen repräsentieren sowie einen relativ großen Marktanteil besitzen. Da alle wichtigen Merkmale der Rinder bekannt sind, kann das „independent private value" Modell angewandt werden. Jene Parameter, die die Verteilung der nicht beobachtbaren „private values" der Bieter charakterisieren, werden mittels simulierter nichtlinearer Kleinste-Quadrat-Schätzer berechnet.

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1 Introduction

A lot of auctions are conducted all over the world. Usually the data of these auctions is quite rich and more easily made public than data needed for an analysis of other markets. Therefore it seems to be promising to empirically test game theoretic models in this context. For a review of the existing literature on empirical work concerning auctions see Hendricks and Paarsch [6] and Laffont [9]. Two approaches have emerged: Some of the papers concentrate on reduced form econometric models to test some implications of auction theory, with the observed bids as explained variables. Explanatory variables might then be the reservation price, the number of bidders, and some characteristics of the auctioned object. Whereas the second approach, the structural approach, relies on the hypothesis that the observed bids are the equilibrium bids of the considered auction model. As the optimal strategy is a function of private values or signals, depending on the model (private vs. common), the equilibrium strategy gained from the theoretical model can be used to estimate the characteristics of the distribution of private values or signals, respectively. The main difficulty with this approach is the typically highly nonlinear equilibrium bid function. In some cases, there exist no closed form solutions for the equilibrium bid functions. Another difficulty arise from the complex density of the winning bids. Laffont, Ossard and Vuong [11] have developed a simulated non-linear least square estimator, which is based on simulations following McFadden [12] and Pakes and Pollard [14]. It can handle a broad class of distributions. In contrast to other methods, which require that the joint distribution belongs to particular families of distributions (see e.g. Donald and Paarsch [2]). Nevertheless a specific distributional assumption must still be made. To avoid these distributional assumptions Elyakime, Laffont, Loisel, and Vuong [4] have proposed nonparametric methods for estimating the probability law of valuations. However, in contrast to parametric methods, this approach requires knowledge of all of the bids, not just the winning bid.

In this paper we follow the structural approach. We focus on English or ascending auctions, considering this type of auction in the private value paradigm. We have data on cattle auctions held in Amstetten, Austria and estimate the characteristics of the distribution of bidders' private values. The heterogeneity of the auctioned objects is taken into account. In particular, we concentrate on the first moment, as it characterizes the expected gain for the seller. In contrast to Engelbrecht-Wiggans and Kahn [5] who investigated dairy auction in the US we do not find declining prices over the course of different auction days. Thus we do not consider these auctions in a dynamic context. The paper is organized as follows: In Section 2 we give a description of cattle auctions in Amstetten, Lower Austria and of the data we use for estimation. Further some (summary) statistics and an analysis of the winning bids are presented. The employed theoretical model is introduced in Section 3. Section 4 analyzes the applied estimation method and gives then the empirical results. Section 5 concludes.

2 Cattle Auctions

2.1 Description

To sell cattle, pigs, or other animals ascending auctions are frequently used. The particular auction we focus on is a cattle auction and takes place in Amstetten, Austria. Most of the cattle auctioned there are (dairy) cows and stock bulls. In this market the sellers are farmers and the buyers are farmers as well and two resale trade firms which are represented by one trader each. From January to April 1996 these two large traders bought on average 22% of all the auctioned cattle. Eleven times a year an auction takes place. Each of these auctions lasts for two days. On the first day the cattle to be auctioned is displayed. So that every interested person can have a look at the cattle. Besides everyone can buy a catalog with a detailed description of every cattle. The description includes various quality criteria like the milk production, the milk components, the owner, the date of birth, the parents and grandparents of the cattle as well as some of their quality criteria. Further, medical checks are carried out during the animals' stay in the auction stable and the results are published in the morning of the second auction day. On this day also the auction takes place. It begins in the morning and lasts till afternoon. In 1994 on average 340 heads of cattle have been sold per auction day [17].

The auction is held by an auctioneer who announces the prices. The auctioneer is paid by the Chamber for Agriculture in Lower Austria. Neither the sellers nor the bidders have to pay anything for the auction house like at privately organized auctions (e.g. by Sotherby's)[2]. The auctioneer starts the auction at a fixed price and raises the price in a fixed step size. The bidders have so-called "Winkers". They look like small traffic signs and also have a number on it, with which they indicate to accept the bid. This "Winker" is not free. Everyone who wants to bid has to pay for that "Winker". The auction lasts until nobody is willing to accept the next highest bid. When the bidding stops the object for sale is hammered down, but not necessarily sold. Since the seller has the possibility to reject the price. During the auction the respective seller represents his or her cattle in front of the bidders. If nobody is willing to accept the starting price the auctioneer lowers the price like in a Dutch or descending auction until somebody accepts that price. Then again the auctioneer starts to raise the price with the same fixed step size as before and the procedure goes on in the same way as described above.

2.2 Data

The data covers four days of cattle auctions in 1996. These auctions took place on January 24th, February 21st, March 20th and April 24th. On average at each auction about 230 heads of cattle have been sold. For each animal the winning bid, the weight, the breed, two quality criteria, the auction day, the number of the "Winker" and the number of order on the specific auction day is known. Further we know the total number of given

[2]However, every Austrian farmer has to be member of the Chamber for Agriculture and has to pay a membership fee.

out “Winker” for each auction. The cattle is divided into four categories, namely bulls, female calves, young female calves and cows. For reasons of simplicity the bulls are not considered for estimation. Further the cattle are of two different breeds: “Fleckvieh” or “Braunvieh”. The first quality criteria has six different classifications, 1A to 3B. For cows and female calves this quality criteria gives the minimum requirements for the output and the structure (fat, protein) of their milk. In case of young female calves it gives the minimum requirements of their mother's milk. However, a cattle of the highest classification, 1A, was not sold on one of these four auction days. The second quality criteria has three classifications, 1 to 3. As everybody, who wants to bid, has at least one “Winker”, the seller can be identified in an anonymous way. Usually bidders have different numbers on their “Winkers” at different days. However, the two large traders always get the same number. Therefore they can be identified throughout the four auction days. That can in fact be very helpful in determining possible asymmetries among bidders (valuations). The number of potential bidders is the total number of given out “Winkers”. But this is not the number of bidders actually participating at each auction round, since people are not staying at the auction the whole day long. Besides they are not interested in every cattle. Therefore we consider the number of bidders as unknown and estimate it from our data.

2.3 Winning Bids

The average sale price for all four auctions days is ATS 19.839[3] with a standard deviation of ATS 4.136 (see also Table 1). The highest winning bid is ATS 33.200 and the lowest is ATS 7.800. The variation of the average winning bid across the four auction days is quite substantial. The difference between the average sale price on February 21st and April 24th is ATS 2.273, which is about 11% of the overall mean. The variation of the average winning bid is also given across other subgroups like the milk quality criteria. The mean selling price in the classification 1B is ATS 26.709, whereas in the lowest classification 3B it is only ATS 11.203 (see Table 1). In particular, the difference in the average winning bid

[3]The prices are in 1000 ATS=Austrian Schilling.

between the small bidders and the two large traders is interesting. This difference can also be shown to be significantly, when testing for mean differences using the Mann-Whitney test. As we do not control here for other variables like quality or category, an ordinary least square estimation has been conducted (see Table 2). The set of explanatory variables include dummies for the date, the breed, the category and the two quality criteria[4]. Further the weight of the cattle is used as an independent variable. Three subsets of the sample data are considered: all bids, the bids of the small bidders and the bids of the two large traders. A Chow test for equality of the coefficients using all bids versus those obtained from small bidders' bids and large traders' bids separately can be performed. The test statistic, which is distributed as an F random variable with (13,873) degrees of freedom under the null, equals 1.40. The null of no differences can not be rejected. The bidding behaviour does not significantly differ across small bidders and the two large traders. But on average the two large traders buy more low quality cattle than the small bidders. The two large traders can be considered as agents of retail sellers who have placed orders at specific prices before the opening of the market. These prices are the valuations of the traders in the auction (see also Laffont, Ossard and Vuong [11]).

Given the above description we can model this cattle auction within the independent private value paradigm (see also Engelbrecht-Wiggans and Kahn [5]). The assumption of private values can be justified by the available information about the cattle. As nearly every detail of the cattle's quality is known to all bidders there is rather no uncertainty about the common value of the cattle. Therefore none of the bidders should have private information about the cattle's characteristics. Besides, in cattle auctions bidders tend to agree on the various characteristics of the animals. As a consequence the bidders preferences are of pure private nature. Every bidder ranks the different characteristics in another order depending on breeding program goals. The second source of common values is the possibility of resale. However, as transportation and resale costs in this market are high it is unlikely that short term speculation does play a significant role. Further the

[4]For an exact definition of the independent variables see Section 4.1, Equation (3) and below.

auctioned cattle has to be in possession of the owner for at least six months. This fact itself does not prevent resale, but the cattle can at least not be sold at the next auction.

As noted above on one auction day a lot of cattle is auctioned off. Therefore we cannot exclude dynamic considerations beforehand. In a general symmetric setting, which includes the private value setting as well as the common value setting as special cases, with two stages Hausch [7] showed, that bidders' optimal strategy for the first object is to shade the bid in contrast to the one-stage game. This result holds for the first-price and the second-price auction. However, assuming independent private values the term of shading in a second-price auction is equal to zero. These cattle auctions also differ from sequential auctions considered in Laffont, Loisel and Vuong [10] or Donald, Paarsch and Robert [3], where identical units of a good or identical lots of a given commodity is auctioned off (e.g. wine, flowers, fish, tobacco). Laffont, Loisel and Vuong [10] find, that winning bids of descending or Dutch auctions for eggplants exhibit a regular inverse U-shape. In his description of wine auctions, Ashenfelter [1] noticed a so called declining price anomaly: winning prices decrease during the day. In our data we do not find any of these phenomena. The winning bids do not exhibit any notable price decline at the end of the fourth auction day (see Figure 1). The pattern of the other three auction days does not substantially differ. To be more precise also a Chow test for equality of the coefficients using all bids versus the last 5 bids of one auction day and the other bids separately can be constructed. With an F statistic with (13,872) degrees of freedom and a value of 0.002038 we cannot reject the null of no differences. Besides, if we perform another ordinary least square estimation with an additional independent variable, namely a variable that assigns, how many objects are left over on that auction day, the coefficient of this variable does not significantly differ from zero. Thus we cannot observe the so called afternoon effect at these cattle auctions. This stands in contrast to certain cattle auctions in the USA. Engelbrecht-Wiggans and Kahn [5] examined 18 dairy cattle auctions and found that prices decline over the course of an auction, with the main decline occurring towards the end of the day.

We have to ignore the fact of an existing secret reservation price. As the seller has the possibility to reject the hammered down price. This primarily due to the unavailability of appropriate data for cases, when the seller rejects the price.

3 The Model

In the independent private value setting a single indivisible good is to be sold to one of n risk neutral bidders. Any of the bidders knows the value of the item to herself, and nothing about the values of the other bidders. The values are then modeled to be independent draws from some continuous probability distribution. As the bidders are assumed to behave competitively, i.e. there is no collusion, the auction can be treated as a non-cooperative game. Assuming symmetry among bidders implies that the independent draws are from the same distribution. In case of asymmetry bidders' valuations would be from different distributions. Further the bidders are supposed to be risk neutral. In this setting the English or ascending auction is equivalent to the second-price auction[5]. Bidders's dominant strategy in a second-price auction is to bid one's own valuation. These results do not depend on the symmetry of the model (see e.g. Milgrom and Weber [13]).

Let $X = (X_1, \ldots, X_n)$ be a vector. The components of this vector are real-valued *signals* observed by the individual bidders. Let X_i denote the actual value of the object to bidder i. And let $Y_{i,1}, \ldots, Y_{i,n-1}$ denote the largest, ..., smallest estimates from among $X_j, j \neq i$. Further let $f(x)$ denote the joint probability density of the random elements of the model. Following assumptions are made:

- For each i, $E[X_i] < \infty$.
- The bidders' valuations are in monetary units and the bidders are risk neutral. Therefore, bidder i's payoff is $X_i - b$, if she receives the auctioned object and pays

[5] A second-price auction is a sealed-bid auction in which the bidder with the highest bid gets the object but pays only the amount of the second highest bid.

the amount b.

- f is symmetric.
- The variables $X_1, \ldots, X_n$ are independent.

A strategy for bidder i is a function mapping her value estimate x_i into a bid $b = b_i \geq 0$. Supposing bidders $j \neq i$ adopt strategy b_j then the highest bid among them will be $W = max_{j \neq i} b_j(x_j)$. Bidder i will win the auction if her bid exceeds W, which will also be the price bidder i has to pay. The decision problem bidder i is facing now is to choose a bid b that maximizes the expected actual value minus the price, ignoring the cases where her bid is not the highest, conditional on her signal. It can be shown that the dominant equilibrium strategy in a second-price auction is to bid (see e.g. Milgrom and Weber [13])

$$b_i^*(x_i) \quad = \quad x_i$$

for every player i. As the bidder with the highest valuation will stop raising her bid after the bidder with the second highest valuation has left the auction, the observable winning bid is

$$b^w = x_{[2]}, \tag{1}$$

where $x_{[2]}$ denotes the second highest of n independent draws of the distribution function F.

The expected selling price is the expected price of bidder i conditional on bidder i winning the auction:

$$\begin{aligned} R &= E[Y_{i,1} | X_i > Y_{i,1}] \\ &= E[X_{[2]}] \end{aligned} \tag{2}$$

where $X_{[2]}$ denotes the second-order statistic.

4 Econometrics

4.1 Distribution of Private Values

We assume private values to follow a log-normal distribution. This distribution depends on various characteristics concerning the auction day, the breed, the category, the quality and the weight of the cattle. In particular, we assume that the expectation of the private values follows a linear function of fourteen exogenous variables:

$$\begin{aligned} E[x_l] = exp(&\theta_1 + \theta_2 \text{Date1}_l + \theta_3 \text{Date2}_l + \theta_4 \text{Date3}_l + \theta_5 \text{Breed}_l + \theta_6 \text{Cate1}_l \\ &+ \theta_7 \text{Cate2}_l + \theta_8 \text{Qual11}_l + \theta_9 \text{Qual12}_l + \theta_{10} \text{Qual13}_l \\ &+ \theta_{11} \text{Qual14}_l + \theta_{12} \text{Qual21}_l + \theta_{13} \text{Qual22}_l + \theta_{14} \text{Weight}_l) \end{aligned} \tag{3}$$

and that $Var[x_l]$ is constant. The reason for the latter assumption is that the estimations become easier. In a sense that we have less convergence problems.

Depending on the day, on which the different objects have been auctioned, the dummy variables Date1-Date3 have been introduced. The variable Date1 (Date2, Date3) is equal to one for items sold on January 24th (February 21st, March 20th) and zero else. The dummy variable Breed is equal to one for "Fleckvieh" and zero for "Braunvieh". There are three different categories. They are introduced by two dummy variables. The dummy variable Cate1 is assigned the value one for female calves and zero otherwise, while Cate2 takes the value one for young female calves and zero otherwise. There are two quality criteria, Qual1 and Qual2. Qual1 has five different classification (see also Section 2.2) and Qual2 has three classifications. Both variables together imply six dummy variables, which are equal to one, when the particular classification is met and zero else.

4.2 Estimation Method

The main problem in empirical auction theory is that the valuations of the bidders are unobservable. In contrast to that, bids can be observed. As the optimal strategy is a function of private values the equilibrium strategy gained from the theoretical model can be used to estimate the moments of the distribution of private values. Especially, the first moment is of interest, as it characterizes the expected gain for the seller. Implicitly we assume bidders to bid according to the equilibrium function of the underlying game. However, due to experimental evidence this assumption is no restriction. In English clock auctions in an independent private value setting market prices rapidly converge to the dominant strategy price (Kagel [8]).

In general, the auctioned objects are not identical. Therefore we have to take into account possible heterogeneity. That means that the distribution of private values for the $l-th$ auction may depend on some characteristics z_l of the object to be sold. Hereafter, L denotes the total number of auctions and subscript l denotes all relevant quantities concerning the $l-th$ auction. We assume that z_l is fully observed. We have further to assume mutually independence among observed auctions. This assumption does not seem to be too restricting as we the winning bids do not decline during auction days (see Section 2.3).

Adopting a parametric formulation means that $F_l = F(., z_l, \theta)$ for all $l = 1, \ldots, L$, where $\theta \in \Theta \subset R^k$ and $F(., z_l, \theta)$ is a chosen distribution function.

We consider now the winning bid (1). Its density h can be expressed as

$$h(b_l^w) \quad = \quad n(n-1)F_l^{n-2}(x)(1-F(x))f_l(x).$$

where F and f denotes the distribution and the density function of the private values (see Section 3).

One way to obtain an estimator for θ is to calculate the likelihood function and to maximize it with respect to θ. But in this case a theoretical problem arise: For each auction l the equilibrium function (1) has an upper bound at $\overline{b}_l(\theta) \equiv E(X_{[1],l})$, where $X_{[1],l}$ denotes the first-order statistic of n independent draws of the distribution of F_l. This implies that the support of the distribution of the winning bid depends on θ for every auction l (see Donald and Paarsch [2]). This fact violates the usual assumptions used to demonstrate consistency and asymptotic normality of the maximum likelihood estimator. A further difficulty with the maximum likelihood estimator can be computational. Especially when the inverse of the equilibrium function, which is necessary to calculate the density of the winning bid, is not analytic, but can only be evaluated numerically. Thus we estimate the parameters of the underlying distribution of private values with a simulated nonlinear least square estimator, which has been proposed by Laffont, Ossard and Vuong [11] to circumvent above described obstacles. Another possibility would be to use a so-called piecewise maximum likelihood estimator, which has been developed by Donald and Paarsch [2]. However, this estimator requires all the exogenous variables z to be discrete.

Simulated Non-Linear Least Square Estimator Let now $E[b_l^w] \equiv R_l(\theta) \equiv R(z_l, \theta)$ denote the conditional expectation of the winning bid b_l^w given n, which is now assumed to be constant for simplicity, and z_l. The usual non-linear least square (NLLS) estimator minimizes the objective function

$$Q_L(\theta) = (1/L) \sum_{l=1}^{L} (b_l^w - R_l(\theta))^2 \tag{4}$$

with respect to θ. As the expected winning bid is equal the expected selling price (2), and because (2) is not readily available, it is natural to replace $R_l(\theta)$ by an unbiased simulator $\overline{X}_l(\theta)$.

Equation (2) can be viewed as an integral with respect to the density of $X_{[2]}$. Using the fact, that the density of the second order statistic $X_{[2]}$ can be expressed as a function of the density f and the distribution function F of private values Equation (2) becomes

$$R = \int_{\overline{T}} n(n-1)xf(x)F^{n-2}(x)[1-F(x)]dx.$$

where $\overline{T}$ is the support of the distribution of the second-order statistics (see e.g. Poirier [15]). Alternatively, $X_{[2]}$ can be viewed as a function of $X_1, \ldots, X_n$, which are independently drawn from distribution F. Then (2) becomes

$$\begin{aligned} R &= \int_T \cdots \int_T u_{[2]} f(u_1) \ldots f(u_n) du_1 \ldots du_n \\ &= \int_T \cdots \int_T u_{[2]} \frac{f(u_1) \ldots f(u_n)}{g(u_1) \ldots g(u_n)} g(u_1) \ldots g(u_n) du_1 \ldots du_n \end{aligned}$$

where g is an arbitrary chosen density with support T called the importance function (see e.g. Rubinstein [16]). Now, for every $l = 1, \ldots, L$, we draw S independent samples, each of size n, denoted by $u^s_{1,l}, \ldots, u^s_{n,l}$, where $u^s_{i,l}$ is independently drawn from the distribution with density $g_l(.)$ for $s = 1, \ldots, S$. Then, for every l, $E[b^w_l]$ can be approximated by the sample mean

$$\begin{aligned} \overline{X}_l(\theta) &= \frac{1}{S} \sum_{s=1}^{S} X_{s,l}(\theta) \qquad \text{where} \\ X_{s,l} &= u^s_{[2],l} \frac{f(u^s_{1,l}) \ldots f(u^s_{n,l})}{g(u^s_{1,l}) \ldots g(u^s_{n,l})}, \end{aligned} \tag{5}$$

where $u^s_{[2],l}$ denotes the second highest element of each random sample with respect to the number of bidders, for each $s = 1, \ldots, S$ and each $l = 1, \ldots, L$. But now the objective function (4) produces an inconsistent estimator for any fixed number of simulations S as L increases to infinity.

Laffont, Ossard and Vuong [11] have shown, that with the "simulated" non-linear least square (SNLLS) objective function

$$Q^*_{S,L} = \frac{1}{L} \sum_{l=1}^{L} [(b^w_l - \overline{X}_l(\theta))^2 - \frac{1}{S(S-1)} \sum_{s=1}^{S} (X_{s,l}(\theta) - \overline{X}_l(\theta))^2], \tag{6}$$

minimized over θ gives a consistent and $\sqrt{L}$-asymptotically normal estimator $\hat{\theta}$ for fixed S as $L \to \infty$. Further can be shown that the SNLLS estimator becomes as efficient as the NLLS of θ, as S increases to infinity.

Up to now we have assumed that the number of bidders is constant and that it is known to the investigator. In practice, this may not the case. However, it plays a crucial rule in determining the expected winning bid (2). Therefore it is important to find a way estimating the true number of bidders participating in the auctions. Laffont, Ossard and Vuong [11] have shown that the true number of bidders can be estimated consistently by the integer $\hat{n}$ that minimizes $Q^*_{S,L,n}(\hat{\theta})$ with respect to n.

4.3 Estimation Results

By minimizing the objective function (6) we get estimates for the structural model derived from the theoretical model, that is described in Section 3. We use 20 simulations per auction. For the choice of the importance function g_l we follow Laffont, Ossard, and Vuong [11], who suggested g_l to be a log-normal density with mean given by Equation (3) where θ is equal to some preliminary consistent estimate $\tilde{\theta}$[6] and a standard deviation equal to 0.05. The function f_l in Equation (5) is also chosen to be the density of a log-normal distribution (see Section 4.1) with mean given by Equation (3). A starting value θ_0 close to $\tilde{\theta}$ is selected and the parameters of Equation (3) are then estimated.

The first estimation step is to determine the number of bidders participating in the auctions. We follow the procedure described in Section 4.2. To illustrate the decision process we show the different values for the objective function $Q^*_{S,L}$ in Figure 2, which shows a minimum at six bidders. Having fixed the number of bidders we now look at the estimation results of the parameters. These are given in Table 3 as well as standard errors and the value of the objective function, which is the quantity $Q^*_{S,L}$. T-statistics and the p-values are omitted, as all parameters are significant. Furthermore an R^2 measure is computed as $1 - Q^*_{S,L}/v\hat{a}rb^w$. Given the choice of the log-normal distribution and given the parameterization (3), each parameter estimate of Table 3 can be interpreted as the

[6]How to obtain this preliminary estimator for θ is described in more detail in Laffont, Ossard, and Vuong [11].

percentage change of the expected value of the auctioned item. That means for instance in the case of the dummy variables "Qual11" to "Qual14", that quality 1B, which is the highest quality class, quality 2A, 2B and 3A are 46%, 41%, 34% and 8% more valuable than the fifth quality 3B. The other parameters shown in Table 3 have also the expected signs. The parameter estimates of the dummy variables for the three first auction days Date1 to Date3, with values of 10%, 11% and 8%, are significant and reflect the market situation in comparison to the last auction day. The sign of breed parameter with a value of 4% specifies that the breed "Fleckvieh" yield a higher expected average selling price than "Braunvieh" after controlling for quality or category. The dummy variable Cate1 is significantly positive indicating that female calves are most valuable in comparison to young female calves and cows. Female calves are 27% more worth than cows, whereas cows again are more valuable than young female calves, as the negative sign and a value of 10% for the dummy variable Cate2 shows. The signs and the order of magnitude for the first set of quality dummies agree with common believe in a significant way as noted above. The same is true for the second quality criteria. The parameter values for Qual21 and Qual22, respectively, indicate that these two classification are 16% and 6% more worth than Qual23. The significantly positive coefficient of 48% for the weight also coincides with conventional wisdom. For the R^2 measure of our estimated model we get a value of 0.965.

5 Conclusion

In this paper we described the econometrics of English auctions in the independent private value model and applied it to field data. For this purpose we used data of cattle auctions in Amstetten, Austria. The data covers four auction days from January to April 1996. Although two large traders participate in these auctions their bidding behavior does not significantly differ from that of small bidders. Further we could not find declining prices at the end of the auction day. As all important characteristics of the cattle are known we assume the independent private value paradigm. Adopting a structural approach we estimated the characteristics of the distribution of bidders' private values. In particular we concentrated on the first moment as it expresses the gain for the seller. The estimation results coincide with common wisdom.

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A Tables and Figures

Table 1: Winning Bids in Different Subgroups

Variable	Name	Number of Observations	Average Winning Bid*	Standard Deviation
Date1	January 24th	190	20.556	4.136
Date2	February 21st	196	21.116	3.400
Date3	March 20th	238	19.371	5.350
Date4	April 24th	276	18.842	4.205
Breed1	"Fleckvieh"	804	19.821	4.218
Breed2	"Braunvieh"	96	19.988	3.319
Cate2	Female Calves	839	20.425	3.556
Cate3	Young Female Calves	50	10.824	1.498
Cate4	Cows	11	16.091	3.528
Qual11	1B	22	26.709	2.607
Qual12	2A	34	24.571	2.343
Qual13	2B	573	21.178	2859
Qual14	3A	236	16.546	3.022
Qual15	3B	35	11.203	2.383
Qual21	1	544	20.024	4753
Qual22	2	270	19.714	2.932
Qual23	3	86	19.063	2.832
Objects0	Small Bidders	704	20.228	4.206
Objects1	Large Traders	196	18.440	3.517
Weight	Weight	-	-	-
All Data		900	19.839	4.128

* in 1000 ATS

Table 2: Ordinary Least Square Estimation

Variable	Estimate	Standard Error	t-value	Prob $> \|t\|$	Standardized Estimate	Corr with Dep Var
CONSTANT	-1.870519	1.227742	-1.523544	0.128	-	-
Date1	2.218483	0.200417	11.069312	0.000	0.219319	0.089891
Date2	2.369285	0.197989	11.966773	0.000	0.236889	0.163202
Date3	1.797406	0.194712	9.231103	0.000	0.192033	-0.068037
Breed	0.868602	0.230607	3.766592	0.000	0.064953	-0.012431
Cate2	4.441899	0.658483	6.745656	0.000	0.270476	0.526813
Cate3	-0.457273	0.794727	-0.575384	0.565	-0.025374	-0.529660
Qual11	10.221983	0.670611	15.242792	0.000	0.382390	0.263440
Qual12	8.690535	0.616200	14.103443	0.000	0.401382	0.227114
Qual13	6.505931	0.508515	12.793987	0.000	0.758008	0.429493
Qual14	1.757672	0.489083	3.593811	0.000	0.187280	-0.475610
Qual21	3.005812	0.267979	11.216599	0.000	0.356041	0.055368
Qual22	1.192056	0.262328	4.544143	0.000	0.132331	-0.019870
Weight	12.272104	1.313772	9.341120	0.000	0.192278	0.513401

Valid cases:	900	Missing cases:	0
TSS:	15336.661	Degrees of freedom:	886
R-squared:	0.745	Rbar-squared:	0.741
RSS:	3916.743	Std error of est:	2.103
F(13,886):	198.714	Probability of F:	0.000
Durbin-Watson:	2.010		

Table 3: Simulated Nonlinear Least Square Estimation

Variable	Estimate	Standard Error
Constant	6.020391	0.1437
Date1	0.106099	0.0052
Date2	0.119838	0.0050
Date3	0.082346	0.0049
Breed	0.039547	0.0069
Cate1	0.270367	0.0166
Cate2	-0.095242	0.0202
Qual11	0.463851	0.0169
Qual12	0.417216	0.0157
Qual13	0.341310	0.132
Qual14	0.080925	0.0125
Qual21	0.160149	0.0066
Qual22	0.054630	0.0064
Weight	0.480381	0.0221
R-squared:	0.965	
Value of objective function:	0.58945	

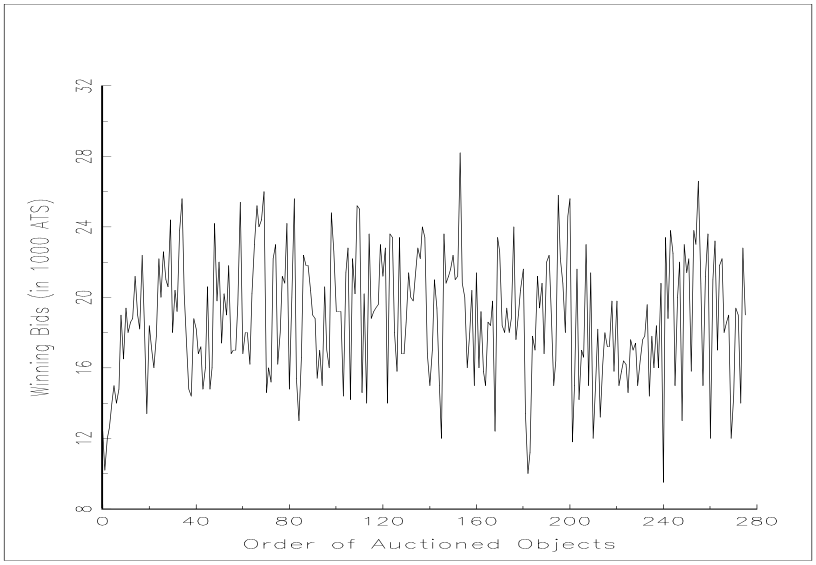

Figure 1: Winning Bids of April 24th, 1996

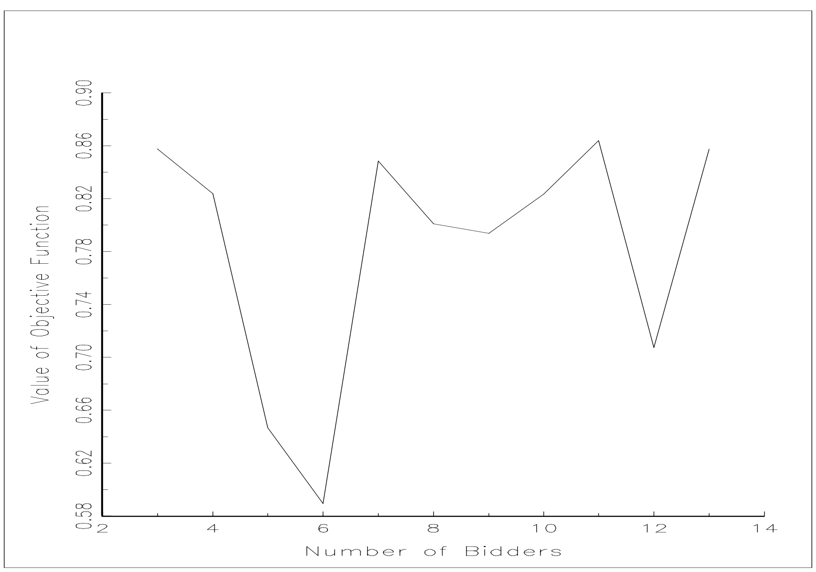

Figure 2: Market Size