Research on Items Suitable for Online Auctions*

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Abstract Based on the classification to the attribute information of auctioned commodity, the valuation signal of auctioned commodity is categorized into two groups: codable valuation signal and un-codable valuation signal. A valuation signal model is developed and used to reason under the environment of common valuation auction. The results show that the value of commodity auctioned online tends to be lower and the commodity with bigger factor that can be described online is more suitable for online auction.

Key words online auction; valuation signal; common valuation

Early before the online auction websites appeared, Malone, Yates and Benjamin had studied the issue on what kind of commodity suits for sale on markets related to Internet[1]. Their result suggested the commodity easy to describe is more fit for Internet markets. Since bidders who bid by Internet can’t see over or check commodities for themselves, many of them usually only bid for commodities with higher standardization and characteristics easy to identify (e.g. CPU speed, hard disk volume, brand and specification of mobile telephone). So it is common to see such commodities as computer hardware/software and home electronic appliances to be auctioned online. Beam and Segev investigated the common characteristics of commodities provided by Internet auction websites and pointed out commodities with the following characteristics are fit for online auction[2]: 1) commodities easy to describe and understand over Internet; 2) commodities easy to distribute; 3) commodities with middle value. Lucking-Reiley clearly explored the problem on what kind of commodity suits for online auction and explained it through product catalog data collected from online auction websites[3]. However, all of above-mentioned researches focused on qualitative analysis and didn’t employ quantitative methods to demonstrate the problem. In contrast, with artwork auction market as exploratory domain, Kazumori and McMillan quantitatively compared online auction and traditional live auction[4]. They derived that it is not the expected price but the uncertain degree of valuation that determines whether sellers employ online auction or not. Here, also quantitatively but differently, we first develop a valuation signal model based on the attribute information of auctioned commodity. Then, we define the auctioned commodity’s factor that can be described online and explore the problem on what kind of commodity suits for online auction under the auction environment of common valuation by employing model reasoning method.

1 Formation of the Bidder’s Valuation Signal

Whatever the auction type is, the bidder’s decision on bidding depends on his valuation to auctioned item. In order to form the valuation to auctioned item, the bidder need collect information about auctioned item from the holding process of auction first and then sort collected information to form the ultimate valuation to auctioned item.

1.1 Classification to the Attribute Information of Auctioned Item

Items possess inherent attribute features, which distinguish one kind of items from another kind of items. Of all attributes characterizing an item, some are
descriptive, canonical and codable such as weight or material. This kind of attributes can be expressed completely by code. It is structured and can be conveniently elicited by people. We refer to this kind of attributes as codable attribute. While some other attributes, such as the texture and the color thickness of a canvas, are intangible, un-codable or difficult to code. They possess high personalization. This kind of attributes relies on individual’s experiences, intuitions and insights. It deeply roots from the individual’s behavior itself and is difficult to separate from the subject. We refer to this kind of attributes as un-codable attribute. Codable attribute mostly reflects public information, while un-codable attribute reflects more individual information. Under given technical conditions, these two kinds of attributes are independent on each other. But on the other hand, with the increasing improvement of communication technology, un-codable attribute information can be transferred into codable attribute information.

These two kinds of attributes describe all the value characteristics of items. So the judgment to the value of an item can be realized by getting them from various channels. For value description of different kind of items, the requirement to these two kinds of attribute information is different. The description to some auctioned items possibly need more un-codable attribute information and un-codable attribute information in this case plays a more important role to characterize such item’s value as artwork and antique. However, when describing some other auctioned items, one possibly need less un-codable attribute information due to its less role to characterize an item’s value, such as software product, book and other electronic products. The difference in importance played by these two kinds of attributes when they characterize an item’s value shows the possibility to make a distinction between them in terms of the item’s value.

The dissemination performance on Internet of these kinds of attributes information is inconsistent. Since codable attribute information can be formed by encoding, it can be disseminated over Internet in the form of web page. In contrast, the un-codable feature of un-codable attribute information makes it be not disseminated over Internet in the form of web page. Under the environment of online auction, sellers can exhibit the attribute information of auctioned items to bidders only by such means as filling out product name, locus, old degree or posting electronic pictures. So bidders only can obtain codable attribute information under the context of online auction.

1.2 Valuation Signal Model

Before bidding, the bidder taking part in auction need to obtain two kinds of attribute information and value them to form his valuation. Codable attribute information forms codable valuation signal and un-codable attribute information forms un-codable valuation signal. Since the valuation of a bidder giving to related auctioned item ultimately appears in the form of scalar, the bidder need aggregate two kinds of valuation signal to form the ultimate scalar valuation.

Let stochastic variable \( x_c \) denote codable valuation signal formed by codable attribute information, and stochastic variable \( x_u \) denote un-codable valuation signal formed by un-codable attribute information. According to the independent property between codable attribute information and un-codable attribute information, we can obtain codable valuation signal and un-codable valuation signal are also independent each other. Codable valuation signal and un-codable valuation signal are aggregated to form the process of bidder’s valuation signal, which is described by function \( x = V(x_c, x_u) \) and function \( V \) is called the valuation function of the bidder. For simplifying analysis, the valuation function is, by assumption, a linear function as following:

\[
V(x_c, x_u) = a x_c + b x_u
\]

where \( 0 \leq a, b \leq 1, a + b = 1 \).

Proposition 1 If codable valuation signal \( x_c \) and un-codable valuation signal \( x_u \) create the valuation signal of the bidder \( x \) through valuation function \( x = V(x_c, x_u) \), and codable valuation signal \( x_c \) is from distribution function \( F_c \); un-codable valuation signal \( x_u \) is from distribution function \( F_u \). \( F_c \) and \( F_u \) belong to the same type of distribution function (e.g. normal distribution). They have continuous differentiable density function \( f_c \) and
respectively, and both \( f_{nc} \) and \( f_{yc} \) belong to the distribution type with mean and variance. The mean and variance of distribution function \( F_{nc} \) are \( \mu_{nc} \) and \( \sigma_{nc} \) respectively. The mean and variance of distribution function \( F_{yc} \) are \( \mu_{yc} \) and \( \sigma_{yc} \) respectively. Furthermore, if valuation signal \( x \) comes from distribution function \( F \), then the distribution function \( F \) also belongs to the distribution type of mean and variance. It has continuous differentiable density function \( f \) and its mean and variance are
\[
\mu = a\mu_{yc} + b\mu_{nc}
\]
and
\[
\sigma = a^2\sigma_{yc} + b^2\sigma_{nc}
\] respectively.

1.3 Auctioned Item’s Factor that can be Described Online

In terms of the classification to the attribution information of items, for given items, the importance of codable attribute information and un-codable attribute information in describing item’s value, does not change over the difference of bidders taking part in auction. From Eq.(1) we can see, the weights of valuation function \( a \) and \( b \) reflect the importance of codable valuation signal and un-codable valuation signal in describing item value respectively. The bigger the coefficient \( a \) is, the bigger the effect of codable valuation signal on the value of auctioned item is and the easier the description to the value of auctioned item is by using codable attribute information. Similarly, the bigger the coefficient \( b \) is, the bigger the effect of un-codable valuation signal on the value of auctioned item is and the more difficult the description to the value of auctioned item is by using codable attribute information. The valuation difference of bidders taking part in auction represents the scale of codable valuation signal and un-codable valuation signal that is differentiated by \( x_{nc} \) and \( x_{yc} \).

Since only codable attribute information can be disseminated over Internet while un-codable attribute information can not, only codable attribute information can be displayed through the web page of online auction websites. If the bigger the \( a \) is, then the higher the proportion that codable valuation signal takes in item valuation is, which shows it is easier to describe the item’s value by using the web page of online auction websites. In like manner, if the bigger the \( b \) is, then the higher the proportion that un-codable valuation signal takes in item valuation is, which shows it is more difficult to describe the item’s value by using the web page of online auction websites. As long as there exists un-codable attribute information, it is nearly impossible to completely describe items on the web page of websites. Thereby we have the definition.

Definition When \( b > 0 \), if let \( \rho = a/b \), then \( \rho \) reflects the degree to which the value of auctioned item can be described on the auction websites. Here \( \rho \) is called the item’s factor that can be described online.

According to the applicable range of auction, if item can be described completely by codable attribute information, that is \( b = 0 \), then the market value of items can be determined completely by the relationship between supply and demand. Thereby we can derive: for those items with small un-codable valuation signal, even the demand on them fluctuates greatly, they are still fit for sale by means of auction. But if the market demand is relatively stable, then it hasn’t essential difference to use fixed pricing or auction to sell items. For many electronic products, we usually have \( b \rightarrow 0 \), that is \( \rho \rightarrow \infty \). But for most of items, the proportion of un-codable valuation signal \( b \) is usually bigger than 0.

2 Auction Model

Assuming that a seller with neutral risk wants to sell one unit asset \( g \) with a single objective value \( \nu \) on a certain auction website and auction website employs the auction way with ascendant price. The seller can enter items after he pays a fee for entry \( c_\epsilon \in (0,C) \). When the seller entries his items, the web page of auction website displays information about auctioned items. According to the feedback evaluation system and guarantee regulation for transaction of the auction website, the seller guarantees to exhibit the information on auctioned items truly. No participant knows how high the value \( \nu \) is. When a bidder \( i \) with neutral risk enters the auction website, he collects the attribute information of auctioned items from the web page to form his codable valuation signal \( x_{yc}^i \) and
un-codable valuation signal $x_{ic}^i$. The codable valuation signal $x_{ic}^i$ of bidder $i$ comes from distribution function $F_{ic}$, and the un-codable valuation signal $x_{uc}^i$ comes from distribution function $F_{uc}$. The bidder $i$ obtains his valuation signal $x^i$ according to valuation function $x^i = V(x_{ic}^i, x_{uc}^i)$. Assuming that only the bidder $i$ knows how high his codable valuation signal $x_{ic}^i$ and un-codable valuation signal $x_{uc}^i$ are. At the same time, other bidders only know the valuation function of the bidder $i$ is $V(\cdot)$ and his codable valuation signal comes from distribution function $F_{ic}$ and un-codable valuation signal comes from distribution function $F_{uc}$. The codable valuation signal and un-codable valuation signal of any bidder are statistically independent of other bidders’. Also we assume that distribution function $F_{ic}$, $F_{uc}$ and valuation function $V(\cdot)$ are common knowledge, and distribution function $F_{ic}$ and $F_{uc}$ are the same type of distribution function and are both the distribution type with mean and variance. In fact, many distribution functions belong to the distribution type with mean and variance such as normal distribution, Gauss distribution, Poisson distribution, uniform distribution and so on. Without loss of generality, setting the mean and variance of $F_{ic}$ are $\mu_{ic}$ and $\sigma_{ic}$ respectively, the mean and variance of $F_{uc}$ are $\mu_{uc}$ and $\sigma_{uc}$ respectively, then the following Proposition 2 holds.

**Proposition 2** If the valuation signal $x_i$ of bidder $i$ stems from distribution function $F$, then distribution function $F$ also belongs to the distribution type with mean and variance and its mean and variance are $\mu = a\mu_i + b\mu_{uc}$ and $\sigma = a\sigma_i + b\sigma_{uc}$ respectively.

Proposition 2 can be directly derived according to above assumptions and proposition 1.

In the symmetry model where there are $n$ bidders to take part in auction and their valuation signals stem from distribution function, the auction with ascending price has the superior strategic equilibrium: given the premise that a bidder has observed the signals of other bidders who has dropped out; each bidder quits from auction when the price is equal to the expected value of the item; and other bidders who still participate in auction at least have the same valuation signal as that of the given bidder. Defining $x = (x_1, \cdots, x_n)$, and the expected profit of seller in online auction is given by the following Proposition 3.

**Proposition 3** In the online auction joined by $n$ bidders, when the seller sets the reserved price $0$, the payment each bidder gives in advance follows that

$$\pi_i = \int \phi(x_i, n)(1 - F(x_i))dx_i$$

where

$$\phi(x_i, n) = \int_{x_{i-j}}^\infty \frac{\partial \nu(x_i, x_j)}{\partial x_j} f(x_i \mid x_j \leq x_i, j \neq i)dx_i$$

when $n$ bidders join the auction, the payment that the seller expects in advance is given by

$$\pi_s = Ev - n\int \phi(x_i, n)(1 - F(x_i))dx_i - c$$

### 3 Item Type Suit for Online Auction

Exchange cost and online dissemination capability of information about auctioned items are the two factors that mainly affect online auction. It takes two steps to determine the item type suitable for online auction. First, the value-information space of items suitable for auction is constructed. Then items suitable for online auction are found from constructed value-information space. In the symmetry equilibrium, for $i, j \in \{1, \cdots, n\}$, we have

$$\frac{\partial}{\partial x_i} E[\nu \mid X = x] = \frac{\partial}{\partial x_j} E[\nu \mid X = x]$$

For the simplicity of analysis, set

$$Ev = \frac{1}{n} \sum_{i=1}^{n} x_i$$

Let $\sigma$ directly denotes the valuation signal obtained by bidder, then the value-information space for items suitable for online auction should be constructed within the space $Ev \times \sigma = (0, \infty) \times (0, \infty)$. Hence, Proposition 4 is obtained.

**Proposition 4** There exists $\alpha^*, \beta^*$ which make items suitable for online auction can be found in the value-information space

$$Ev \times \sigma = [\alpha^*, +\infty) \times (0, \beta^*)$$
According to Proposition 4, in online auction, as the seller’s exchange cost reduces, the value of items that can be auctioned tends to be low. This interprets why some items with low value and profit suffer from embarrassment in the traditional live auction and why they only appear in stores or flea markets rather than in traditional auction markets before. The lower trade cost makes online auction overcomes this disadvantage of traditional auction and makes auction is not limited to items with higher value any more.

Next, the problem on what items suit for online auction will be discussed from the facet of the difference of information dissemination capability when the information is distributed over Internet.

**Proposition 5** The bigger the factor that can be described online is, the more suitable for online auction the item is.

It means that the item with bigger factor $\rho$ that can be described online will has less un-codable attributes and more codable attribute. Hence the value feature of item displayed by web page of website is closer to the true value feature of item and the probability that item’s value distorts is lower. At the same time, the valuation signals of bidders are closer to the true value of items. If a bidder is surer of valuation signals of items, his bid will be more proactive, which results in higher auction price. Thereby, the easier the items can be described online, the more suitable for online auction the items are. This conclusion has been testified by the data of China online auctions sites.

**4 Conclusions**

Based on the classification to the attribute information of auctioned item, the information about auctioned item which affects the bidder’s valuation is categorized into two groups: codable valuation information and un-codable valuation information. Codable valuation information forms the codable valuation signals of bidders to auctioned items. And un-codable valuation information forms the un-codable valuation signals. These two kinds of signals together form the bidders’ valuation to auctioned item. A valuation signal model was developed and used to reason. The results show that under the environment of common-valuation auction, the items with middle value and items with bigger factor that can be described online are more suitable for online auction. The results provide quantitative foundation for traditional qualitative results on what items suit for online auction.

**References**


**Appendix 1** Proof of Proposition 4

Proof since

$$\int_{x_{ij}} f(x_j | j \leq i, j \neq i)dx_{ij} = F(x_i)^{n-1}$$

(5)

Inserting Eq. (4) and Eq. (5) into Eq.(2), it follows that

$$\varphi(x,n) = \int_{x_{ij}} \frac{\partial v(x_{ij})}{\partial x} \bigg|_{x_{ij}} f(x_j | j \leq i, j \neq i)dx_{ij} = \frac{1}{n} F(x_i)^{n-1}$$

(6)

Intuitively, many distributions with mean and variance can be obtained by moving the mean $\mu$ and variance $\sigma$ of standard distribution. Setting the distribution of stochastic variable $Z$ to standard distribution with mean and variance. Its distribution
function is $F^Z$, and it has continuous differentiable density function $f^Z$, then distribution function $F$ of scalar valuation $x_i$ is denoted by

$$F(x_i) = F^Z\left(\frac{x_i - \mu}{\sigma}\right)$$

hence according to Eq.(6), it follows

$$\int \varphi(x_i, n)(1 - F(x_i))dx_i = \frac{1}{n} \int F(x_i)^{n-1}(1 - F(x_i))dx_i = \frac{1}{n}(EY^z_{1s} - EY^z_{2s}) = \frac{\sigma}{n}(EY^z_{1s} - EY^z_{2s})$$

(7)

where $Y^z_{1s}$ and $Y^z_{2s}$ represent, in standard distributions with mean and variance of $n$ bidders, the first high bidder’s valuation and the second high bidder’s valuation respectively. From

$$E\nu = \frac{1}{n} \sum_{i=1}^n x_i$$

it follows that

$$\frac{\partial}{\partial x_i} E[\nu | X = x] = \frac{1}{n} \quad i = 1(1)n \quad (8)$$

When a seller sells his items on online auction website, the expected profit of a rational seller must be bigger than 0. Inserting Eq.(7) and Eq.(8) into Eq.(3), the value of items suitable for online auction must follow that

$$E\nu \geq \gamma^\nu \sigma + c = \alpha^\nu$$

Hence

$$\sigma \leq \frac{E\nu - c}{\alpha^\nu} = \beta^\nu$$

Therefore, the value-information space of items suitable for online auction is given by

$$E\nu \times \sigma = [\alpha^\nu, +\infty) \times (0, \beta^\nu]$$

### Appendix 2 Proof of Proposition 5

Proof assuming that $\sigma_{w} = \delta > 0$, setting $\sigma_{w} = \lambda \delta$, where $\lambda \geq 1$. Since only codable valuation signal can be disseminated over Internet in online auction, $\lambda$ describes the uncertain degree of un-codable valuation signal in online auction. In online auction, since $\rho = \frac{a}{b}$, $a + b = 1$, it follows that

$$\sigma = a\sigma_{w} + b\sigma_{w} = \delta \left[\frac{\lambda}{(\rho + 1)^2} + 1\right]$$

thereby

$$\frac{\partial \sigma}{\partial \rho} = -\frac{2\lambda \delta}{(\rho + 1)^3}$$

where $\lambda \geq 1$, $\delta > 0$, $\rho > 0$, hence

$$\frac{\partial \sigma}{\partial \rho} \leq 0$$

It means as the factor $\rho$ that can be described online increases, $\sigma$ reduces, hence $\pi_s$ reduces. Since

$$\pi_s = E\nu - n\pi_b - c_s$$

as $\rho$ increases, $\pi_s$ increases, that is items with bigger $\rho$ are more suitable for online auction.

### Brief Introduction to Author(s)

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