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Effects of online one-yuan Dutch auction on the seller's revenue: Evidence from an online community for auctioning agricultural and subsidiary products in China

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Abstract

The traditional Dutch auction usually sets the starting price but does not set the final price. The effects and impact factors on the seller's revenue have not been discussed if the final price of online Dutch auction is set to a teeny number (i.e., one RMB) which is termed as an one-RMB Dutch auction. Based on the regret theory and related literature, the effects of starting price, time pressure (one day and 15 minutes of time interval respectively) and product perishability on buyers' choice behavior and the revenue of sellers were examined. The results showed that there is a negative effect coming from the starting price, time pressure and perishability of products and the overall discount rate of product auction; and buyers are more inclined to bid in the penultimate round of the price reduction cycle.

Keywords: Dutch auction, agricultural and subsidiary products, starting price, time pressure, perishability, discount rate

Introduction

English auction is also known as ascending price auction, that the opening bid was suggested with a relatively lower price, and the asset was sold with a higher price after several bidders adjusted the prices. The increasingly higher bids usually contribute to greater profit for the sellers. In order to attract more consumers to participate into the auction, E-commerce websites, including eBay and JD.com, adopted one-dollar or one-RMB (termed as one-yuan) English auction strategy for secondhand or rare commodities. The previous researches showed that one-yuan auctions can accelerate the price formation, in which starting price only makes little effect (Li 2010; Migheli 2012). However, Dutch auction, also known as descending price auction, starts with a relatively higher price and the price is lowered until the bidders are willing to accept that price. Considering the features of perishability products, such as flowers, food, agricultural and subsidiary products, these products are usually sold by implementing Dutch auction strategies. The previous evidence for Dutch auction indicated that the sellers receive higher revenue, due to the reason that the higher trading cost arises by postponing the bidding, thus bidders tend to make earlier bid because of Dutch auction is a slow process (Carare et al. 2005).

Can English auction be a better method compared with the Dutch auction? Some scholars believed that the commercial effect of English auction is ultimately equivalent to Dutch auction. When there is an ideal commodity, consumers tend to purchase immediately. Even though the lower prices are more favorable to consumers, there are fewer chances to purchase (Mcafee et al. 1987). Other literature showed that Dutch auction performs better and has more steady results in various situations, especially for flowers, even though English auction can avoid the free-ride phenomenon (Katok et al. 2004). No matter for English or Dutch auctions, they both have a price-adjusting process where different price-adjusting periods may add various time pressure to buyers, that may affect their purchasing decisions. Adam et al. (2015) found that the bidders are motivated by social competition in English auction, they tend to have relatively stronger emotions under greater time pressure, which lead them to bid with higher prices and have more intense feeling of joy when winning than feeling frustration of failure. Katok et al. (2004) used the experimental method and found that the sellers' revenue in Dutch auction is significantly lower than in sealed-bid auction when the clock's speed is accelerated. The sellers' revenue in Dutch auction is higher than that in sealed-bid auction when clock speed slows down to an ideal level. Shneyerov (2014) also believed that sellers have more patience than buyers, and the slow process in Dutch auction is more helpful for sellers' gains.

Sellers always promote sales by reducing prices to fasten the goods turnover, and achieve the desired effect (Ailawadi et al. 2006) , besides perishable food and agricultural products. The sellers offer a discount or give out coupons to promote sales. However, in Dutch auctions, buyers are usually not aware of the final prices. If we refer to eBay or related E-commerce websites, compare with one-yuan English auction where the sellers set the starting price at one RMB and Dutch auction (descending price) where the sellers set the final price at one RMB for capacitated products, which strategies the buyers will choose and which strategies would be more profitable to the sellers? For the traditional Dutch auction, there are multiple rounds before the buyers accept the final price, where each round has a corresponding time interval. Does the time interval affect the decisions of buyers when buyers know the final price of one RMB in advance? So far, there are few studies having discussed the above issues. Dutch auction is widely applied to sales of agricultural and subsidiary products, which the quality is easily affected by time. Therefore, we raised the following research questions for the online Dutch auction of the agricultural and subsidiary products:

(1) For online Dutch auction of the agricultural and subsidiary products, whether the starting price would affect the consumers' bidding timing or not? And how the starting price would affect the sellers' revenue?

(2) During online Dutch auction of the agricultural and subsidiary products, does the time interval of reducing prices would affect the consumers' bidding timing? And how the time interval would affect the sellers' revenue?

(3) During online Dutch auction of the agricultural and subsidiary products, how would the perishability affect consumers' bidding timing? And how the perishability would affect the sellers' revenue?

Based on regret theory and related literature, we conducted a natural experiment partnered with GongTianXia.com. We separated our agricultural and subsidiary products into two groups for online Dutch auction, each experimental group has a different time interval set for reducing prices, which are 1 day and 15 minutes lasting for 7 rounds respectively, both with one-yuan as final prices. We gathered the transaction data from the two groups and analyzed the data. Our results evaluated the influence of bidding tendency, product starting price, product perishability and time interval of reducing prices in each round on consumers' bidding choice, also we analyzed the influence of the above factors on sellers' revenue. In our study, we found that consumers are more inclined to bid in the penultimate round of the price reduction cycle, and the consumers' choices are also affected by starting price, time interval of reducing prices and the perishability of commodities. Specifically, buyers tend to bid earlier on higher-priced products than lower-priced products; buyers tend to bid earlier in the 15minute auction than 1-day auction and get less discount, which is beneficial for sellers' revenue; buyers tend to bid earlier for

perishable goods, thus enjoying less discount and bring more profit to sellers. Our study's result had enriched researches on time factors in Dutch auction and related theoretical applications, and also put forward some practical suggestions for sellers that can improve their sales income.

Theory and Hypothesis

The theoretical model is built as shown in Figure 1, the related theory and hypotheses are described as follows.

Dutch Auction

Auction is a set of explicit rules that market agencies use to determine resource allocation and price based on market participants' bids (Mcafee et al. 1987). However, the Dutch auction starts at a higher price and drops the price by the auctioneer or timed clock until the bidder accepts the final price (Cassady 1967). Initially, the Dutch auction was widely used in the traditional markets of the fresh agricultural products such as Dutch cut flowers, Israeli fish and Canadian tobacco (Mcafee et al. 1987). There are many studies on Dutch auctions of traditional agricultural and subsidiary products, such as the traditional Dutch auction of flowers. Steen (2010) explored the impact of seasons, consumer preferences, and supply on the prices of flowers in Dutch auctions including roses, chrysanthemums and carnations. In addition to the sales of fresh agricultural products, Dutch auction is also applied to the related fields including stock issuance/repurchase and online shopping (Bagwell 1992).

Extant research of Dutch auction payed more attention on the Factors influencing buyer behaviors, auction rules and mechanism design, and comparison of different auction way. In researches on the factors influencing buyer behaviors, demand, budget, cost, calendar and clock rhythm etc. have impacts on the behavior of buyers. For instance, Lu et al. (2016) found that demand, budget constraints and transaction costs are also important influential factors of buyer behavior in the B2B Dutch auction. Except for the factors of season, etc., which have a significant impact on the prices and sales volume of fresh agricultural products (Steen 2010), the clock rhythm of the auction also has an impact on the auction results, that is lowering the clock rhythm could enhance the seller's revenue (Shneyerov 2014; Adam et al. 2012). In the comparative researches of different auction methods, there are some meaningful findings for the comparison between the traditional offline and online Dutch auction, Dutch auction and English auction. For example, Carare et al. (2005) deemed that the Dutch auction through Internet is a slow process compared with the traditional offline one. If the buyer postpones the bidding, the increased transaction cost will lead the buyer to bid earlier. So online Dutch auctions bring more revenue to sellers. For the comparison of the English and Dutch auction, most auction theorists consider them to be equivalent (Mcafee et al. 1987). However, Lucking-Reiley (1999) found that the sellers in a relatively slower Dutch auction had higher income compared to the English auction in field experiments. Katok et al. (2004) found that the English auction might avoid free-riding problems well in some circumstances, but Dutch auction performed better and more steadily under various circumstances. Using the method of laboratory experiment, Katok et al. (2008) found the revenue of Dutch auction was significantly lower than that of English auction when accelerating the clock speed of Dutch auction; when the clock speed of Dutch auction was slow enough, the revenue of Dutch auction is higher than that of English auction.

It can be seen from the above content that there are adequate researches on the Dutch auction, and the sales strategy based on price discount has been widely used. Some scholars have also proposed corresponding strategies for the traditional sales taking advantage of the Dutch auction. For example, Besbes et al. (2015) adopted a multi-round price reduction mode for the sales of the trans-seasonal goods until the last lowest discount price appeared. However, with the expanding application of E-commerce, the traditional Dutch auction or discounted sales strategy are also widely used on the Internet. Compared with the traditional offline auctions, the time interval of Dutch auctions is easier for sellers to control on the Internet. It is also more convenient for buyers to participate and observe the price and inventory. But the previous studies mainly focused on the influence of different clock intervals set in the offline Dutch

auctions and different clock rhythms of the Dutch and English auction on sales revenue. Therefore, the impact of clock rhythm of price descending on sales revenue in online Dutch auctions has not been determined. Meanwhile, there are few practical applications and theoretical studies on the one-yuan Dutch auction compared with the one-yuan online English auction. Therefore, it is necessary to explore the buyer's behaviors and the impacts on seller's revenues in the one-yuan Dutch auction with the different clock rhythms of price descending.

Regret Theory

Regret is the painful sensation of recognizing that 'what is' compares unfavorably with 'what might have been' (Sugden 1985). Regret is also an emotional state of individual's disappointment, remorse, guilt and other psychology under the influence of the subjective and objective conditions, resulting from the negative result caused by past actions taken or not taken in the past (Landman 1993). Kahneman and Miller (1986) divided regret into two categories, "done regret" (also called experienced regret) and "undone regret". The former one refers to the regret for doing something, while the latter refers to the regret for not taking some actions. Some literature also called "undone regret" as "anticipated regret" (Janis et al. 1977; Swain et al. 2006). Zeelenberg (1999) believed that both the anticipation of future regret and the experience of retrospective regret influence behavior; the influence of anticipated regret can be considered rational as long as the decision maker can accurately predict the regret that may result from the decision; the influence of experienced regret cannot be considered rational, since decisions should be based on future outcomes, not historical ones. The regret theory refers to the trade-off between the rewards and avoidance of regret when making decisions under uncertainty, and regards anticipated regret or negative feelings of avoiding regret as an important consideration in decision-making process (Bell 1982; Loomes et al. 1982). The regret theory is derived from the simplification of the prospect theory, and also considers that the loss emotions of avoiding regret are much stronger than the gain emotions (Kahneman et al. 1979; Sugden 1985). As a result, people are more inclined to avoid regret.

The regret theory has been applied and verified in many fields. For example, Simonson (2004) believed that people's decisions are often associated with the minimum expectation of regret and expectation of responsibility, and specific to the purchase decision, consumers who thought that wrong decisions may lead to regret are more likely to buy currently available goods instead of waiting for a better promotion. Swain et al. (2006) provided an analytical framework combined with regret theory for the influence of consumer decision-making under discount marketing, which propose that discount levels and time restrictions affect the purchase intentions by influencing the consumers' rational (deal evaluation), emotional (anticipated regret), and visceral (urgency) responses to promotions. Engelbrecht-Wiggans et al. (2007) explained the overbidding issue in the first price auction of sealed bids based on regret theory. Based on regret theory, Inman et. al. (1994) found that consumers will use the coupons maximally focusing on the upcoming expiration in order to avoid regret.

The context in this study is an online Dutch auction. Although the final price is only one RMB, it is very likely that the auction will be completed before the last bidding round since the inventory is limited. In order to avoid anticipated regret, consumers participating in the auction are likely to bid in advance. The study of coupon promotions also found that consumers tend to use coupons maximally before the imminent deadline to avoid regret (Inman et al. 1994) . Assuming the price discounts of the goods participating the online Dutch auction were the same, the higher the starting price was, the higher the absolute value of the consumer's benefit was. In the light of the discount can positively influence the anticipated regret and the transaction evaluation thereby affecting the willingness to buy (Janis et al. 1977), consumers' perceived value should be greater for products with higher starting prices, and anticipated regret should be relatively larger when they could not be purchased if the discount was large enough. Therefore, in order to avoid or reduce the anticipated regret, consumers are more inclined to bid earlier for the products with higher starting prices than those with lower starting prices, resulting in a smaller average price discount rate. So, we propose the following hypothesis:

H1: For an online Dutch auction, the higher the starting price is, the lower the average price discount rate is.

Time Pressure

Time pressure refers to the level of anxiety that decision makers feel increasingly urgent to accomplish their tasks (Svenson et al. 1993). It is an emotional state or similar experience triggered by time constraints or opportunity costs. Extant studies have found that time pressure caused by the time limit would affect people's decision-making process. For instance, Thomas et al. (2010) pointed out, the reaction of time pressure is usually negative, because it can reduce the quality of decision-making. Inbar et al. (2011) also believed that when facing a set of choices, the pressure of time constraints can result in a rush to make a choice, which will lead to more regret. Some scholars also regarded time as a kind of resource which is corresponding to money, consumers would consider the time consumption when they make purchase decisions. Based on the theoretical framework of the prospect theory and psychological account, FranceLeclerc et al. (1995) explored whether consumers regarded time as money in decision-making process and discussed several decision situations of risk seeking and risk aversion. Based on the prospect theory, Pahlke et al. (2013) also believed whether people behaved as risk averse or risk seeking under time pressure depended on the framing of the prospects. Payne et al. (1996) found that people may accept the lower payment when facing lower opportunity costs under the time pressure when accurate decisions are required. However, Kocher et al. (2006) found that people may obtain higher payment under low time pressure than high time pressure, but time-dependent payment function under high time pressure may lead to faster decision-making process and won't reduce the quality of decision.

Sellers often give customers time-limited coupons or use some time-limited promotional measures, and these measures may have effects on promoting sales. For instance, Inman et al. (1994) found that the volume of coupons used is the biggest in the imminent deadline; Using experimental method, Devlin et al. (2007) indicated that time constraints won't directly affect consumers' value perception and purchase behavior, but the interaction effect of discount size and time restraint influences consumers' value perception and willingness to buy. Godinho et al. (2016) further studied price discount promotions and found that when applied to real buying contexts, price discounts may not be so effective anymore, whereas stock-out threats have surprising effects, decreasing deferral and final choice utility. Swain et al. (2006) provided an analytical framework for the impact of consumers' decision-making combining with regret theory under time constraints, that is the role of urgency, anticipated regret and transaction evaluation. He also pointed out that shorter time limitation may be more likely to create a sense of urgency, which in turn promotes the willingness to buy; as for the discounted sales, discount level and time constraints may affect consumers' willingness to buy because they have influence on transaction evaluation, anticipated regret and urgency.

Some scholars have investigated the effects of time constraints in the field of auctions. For example, Adam et al. (2012) conducted a series of Dutch auctions with different clock speeds and found that in fast Dutch auctions bidders are more excited and stay longer in the bidding process; moreover, the unpleasant event of losing a Dutch auction is experienced more strongly than the rewarding event of winning. Shneyerov (2014) argued that slow Dutch auctions are more beneficial to sellers because sellers are more patient than buyers. Carare et al. (2005) compared online and traditional offline Dutch auctions and considered that online auction is a slow process; if bidders postpone bidding, transaction costs will increase and thus bidding will be earlier, which will bring more revenue to sellers. However, Adam et al. (2015) found that under the high time pressure, bidders' emotion is relatively high in English auctions, which will lead to higher bidding price. Katok et al. (2008) found that sellers in fast Dutch auctions may have significantly lower revenue than English auctions while slow Dutch auctions may earn more revenue than English auctions. Lucking-Reiley (1999) also found that the slow online Dutch auctions may bring more revenue for sellers than English auctions.

Based on extant literature, it is still difficult to determine the buyer's choice under different time pressure in online Dutch auctions. However, according to the decision-making studies mentioned before, consumers may obtain more payment under low time pressure than high time pressure (Kocher et al. 2006; Payne et al. 1996). In the lights of the findings of Swain et al. (2006), time pressure positively

affected urgency and anticipated regret, thus positively influencing the purchase willingness. Therefore, for online Dutch auctions, we consider that buyers are more inclined to bid earlier under higher time pressure, resulting in a smaller average discount rate and bringing sellers more revenue. Therefore, we propose the following hypothesis:

H2: For online Dutch auctions, compared with the auctions with smaller time interval (higher time pressure), the average price discount rate is smaller, and the sellers' revenue is higher.

Product Perishability

Flowers, food and other agricultural and subsidiary products often become perish over time, and their value will decline or even disappear. In other words, the product perishability is closely related to the value and will also affect the price of goods. In the past researches, some studies focused on the perishability of goods and related prices and warehousing. For example, depending on product perishability, Wang et al. (2015) provided price-optimized models of perishable foods and concluded that the freshness of foods and the risk of storage shortage have a significant impact on the price which consumers may be willing to pay. Based on the demand rate depended on time and sales price, Roy et al. (2010) put forward a storage optimization model and considered that the deterioration rate of goods need to be included in the storage model.

In online Dutch auctions, the perceived value of perishable goods decreases gradually over subsequent rounds of the auction compared with non-perishable goods, so consumers will be inclined to purchase earlier to guarantee the greater perceived value and less regret, resulting in a smaller average price discount and a higher seller's revenue. Therefore, we propose the following hypothesis:

H3: For online Dutch auctions, the average price discount rate of the perishable goods is lower, and the seller's revenue is higher than that of non-perishable goods.

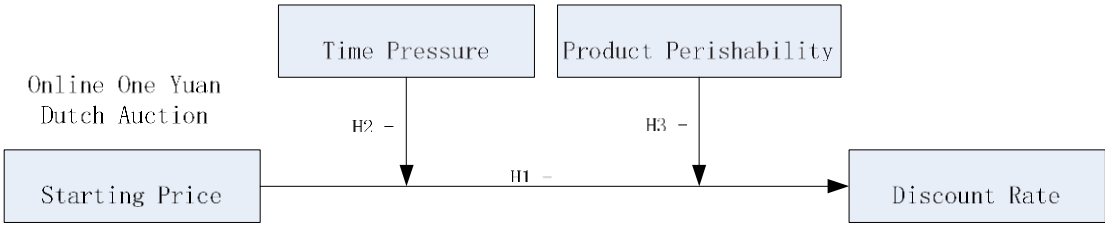

Figure 1. Theoretical model of online one-yuan Dutch auction

Empirical Method

Sample Data

As a leading B2C E-commerce company in China that specializes in local agricultural and subsidiary products, up to 2016, GongTianXia E-Commerce (http://www.gongtianxia.com/articleguanyuwomen-81.html) had sold nearly 400 kinds of products since established in 2011. In order to encourage users to experience local agricultural and subsidiary products, then accept its product value, GongTianXia launched promotional activities of Dutch auctions at the end of 2014. Auction rules include:

1) The platform provides capacitated agricultural and subsidiary products to make online Dutch auctions for consumers;

2) Set 7 different prices from highest to lowest (the highest is the starting price, the lowest is one RMB);

3) Once the auction starts, the price starts from the highest level, decreasing one level at each round. In the meantime, consumers decide at which price to bid according to their own psychological judgment until a limited volume of products is sold out.

In order to compare the auction results for different time intervals of price descending, two kinds of Dutch auctions with time interval of 1 day and 15 minutes are also set. If the sales experience of a product performed well, the platform would repeatedly organize multiple auctions for it.

To control the impact of product differentiation, we worked with GongTianXia and set up two different auctions with different time intervals for the same product. We obtained the actual transaction data of two kinds of auctions of 1 day and 15 minutes between January 2015 and August 2016. Table 1 shows the transaction details of the two types of auction.

Table 1. Transaction details of Online Dutch auction

Auction Type	Product Number	Auction Times	Transaction Records	Auction Period	Auction Product	Notes
15minute	68	221	18223	2015-2-8~ 2016-8-25	6 kinds of perishable goods, such as fresh fruits and vegetables; 62 kinds of nonperishable goods, such as whole grains, dry goods	One consumer and one product can participate in different types of auction
1-day	68	297	20426	2015-1-3~ 2016-8-23		
Total	68	518	38649	Over 1 year		

Variable and Descriptive Statistics

According to the hypotheses in this study, the variables and the related descriptions are shown in Table 2, and the descriptive statistics for the variables are shown in Table 3.

Table 2. Definition of the variables

Variables	Definition
TimePressure	Two-valued variable: 15-minute auction, TimePressure=1; 1-day auction, TimePressure=0
Perishable	two-valued variable: Perishable product=1, Non-perishable product=0
P1	Float: Starting price of the auction
PriceTag	Integer: Bidding round of an auction (between 1 and 7)
OrderPrice	Float: Deal price of each successful bidding
AvgPrice	Float: Average transaction price of each auction item = transaction amount / transaction volume
OrderQty	Integer: Transaction volume of each order
DiscountRate	Float: Discount rate of the transaction price of each item compared with the starting price = (Starting price - Transaction price) / Starting price * 100%
ItemQty	Integer: Limited amount of the goods in each auction
Ratio_Buyers	Float: Ratio of the number of buyers bidding in each round to the total quantity of this auction item
Ratio_ItemQty	Float: Ratio of transaction volume in each round and the transaction volume of this auction item

Table 3. Descriptive statistics

Variables	Obs.	Mean	S.D.	Min	Max
TimePressure=1					
Perishable	18223	0.057	0.231	0	1
P1	18223	34.770	24.509	13	158
PriceTag	18223	5.925	0.563	1	7
OrderPrice	18223	13.574	10.550	1	98
AvgPrice	18223	13.706	10.304	1	59.8
OrderQty	18223	1.934	0.939	1	5
DiscountRate	18223	0.616	0.152	0	0.983
ItemQty	18223	301.122	300.884	13	1018
TimePressure=0					
Perishable	20426	0.105	0.306	0	1
P1	20426	39.192	21.709	11	158
PriceTag	20426	5.865	0.644	1	7
OrderPrice	20426	12.611	9.413	1	98
AvgPrice	20426	12.708	8.783	1.940	68.6
OrderQty	20426	1.978	0.912	1	5
DiscountRate	20426	0.665	0.146	0	0.984
ItemQty	20426	247.611	236.014	49	1001

Notes：Descriptive statistics of Ratio_Buyers and Ratio_ItemQty are not included

Analysis of the Variance and Mean

For Hypothesis H2 and H3, the independent variables are all categorical variables. They can be firstly verified by one-way ANOVA and mean analysis. The detailed transaction data in Table 1 needs to be grouped for doing statistics of the average transaction price and discount rate of each auction item, then we get 518 statistical samples. In addition, in order to examine the consumer's optional bidding behavior in successive rounds of Dutch auctions, the detailed transaction data in Table 1 is statistically grouped to calculate Ratio_Buyers and Ratio_ItemQty of each round, then we obtain 1237 statistical samples. The results of ANOVA analysis are shown in Table 4. To directly view the preliminary statistical analysis results, Ratio_Buyers and Ratio_ItemQty corresponding to the 7 rounds are plotted, which are shown in Figure 3. Figure 2 shows two variables of time interval and product perishability corresponding to the discount rate of the dependent variables.

As Table 3 and Table 4 shows: for Hypothesis H2, the ANOVO result between the time pressure variable and the price discount rate variable is significant ($p < 0.01$, R-squared = 0.021), and the discount rate of the 1-day auction is larger than that of 15-minute auction, which is under higher time pressure ($0.616 < 0.665$). Therefore, it is assumed that H2 is preliminary statistical supported. For Hypothesis H3, The result of ANOVO analysis between the perishable variable and the price discount rate is significant ($p < 0.01$, R-squared = 0.021). Compared to non-perishable goods, discount rate of perishable goods is smaller (as shown in Figure 2). Therefore, we suppose that H3 is supported by preliminary statistics.

In addition, as shown in Table 4 and Figure 3, the variance analysis of Ratio_Buyers and Ratio_ItemQty for each round is significant ($p<0.001$, R-squared is all greater than 0.7), and the mean of corresponding dependent variables in the last second round (PriceTag=6) is also much larger than the other rounds. Table 3 shows that the starting price of agricultural and subsidiary products, among which the lowest is 13 yuan and the highest is 158 yuan, and the price is relatively high. Therefore, it can be concluded tentatively that buyers tend to bid at the last second round.

Table 4. ANOVA results

Source	SS	df	MS	F	p
Ratio_Buyers： Obs. = 1237, R-squared = 0.779					
Between PriceTag	168.257	6	28.043	720.59	0
Within PriceTag	47.868	1230	0.039		
Total	216.125	1236	0.175		
Ratio_ItemQty： Obs. = 1237, R-squared = 0.806					
Between PriceTag	178.326	6	29.721	852.68	0
Within PriceTag	42.873	1230	0.035		
Total	221.199	1236	0.179		
DiscountRate： Obs. = 518, R-squared = 0.021					
Between TimePressure	0.151	1	0.151	11.19	0.001
Within TimePressure	6.965	516	0.013		
Total	7.116	517	0.014		
DiscountRate： Obs. = 518, R-squared = 0.021					
Between Perishable	0.147	1	0.147	10.92	0.001
Within Perishable	6.969	516	0.014		
Total	7.116	517	0.014		

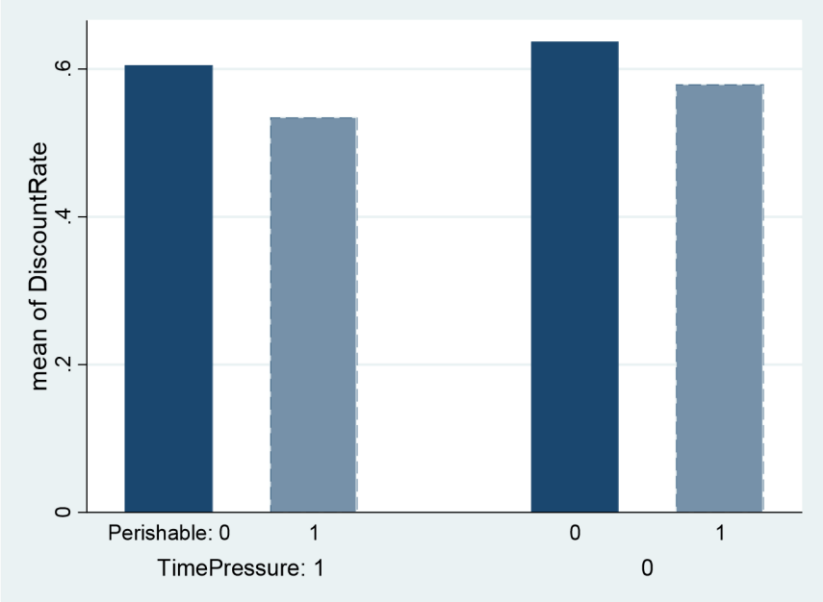

Figure 2. Differences of the time interval of price descending round and perishability

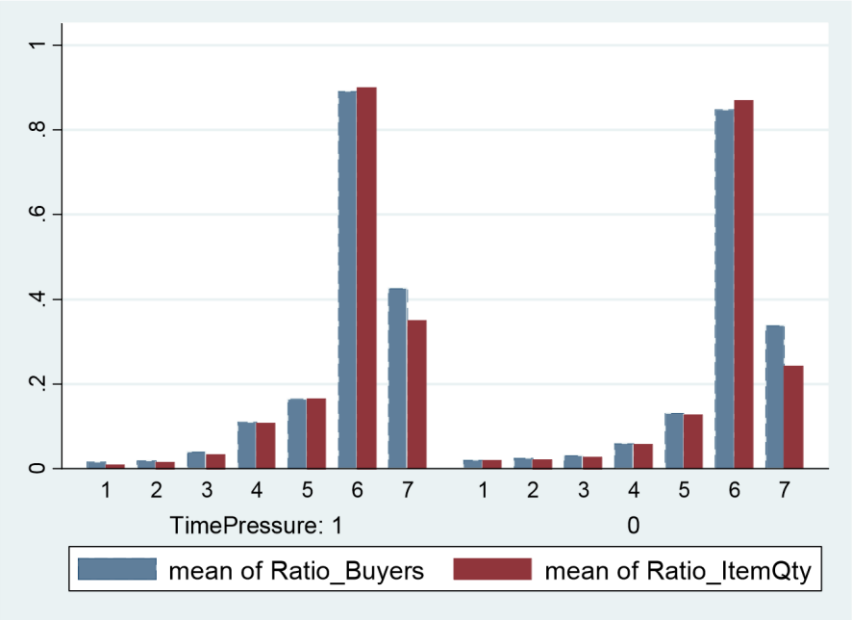

Figure 3. Differences of the price descending round

Regression Analysis

As the dependent variables examined is price discount rate, using the detailed transaction data in Table 1, we summarize the average discount ratio on each auction item to obtain 518 samples. Before the regression analysis, correlation analysis is performed to examine the correlation between variables, and the results show that starting price P1 and product perisability (perishable) are significantly negatively correlated with discount ratio (DiscountRate), which are basically in line with the expectation of H1 and H3. And time pressure (TimePressure) is significantly negatively correlated to discount ratio, which is in line with the expectation of H2.

The results of the ANOVO and correlation analysis are both initially in line with expectations, we take regression analysis as follows. Due to the risk of inventory shortage will affect consumers' willingness to buy (Wang et al. 2015), the limited quantity ItemQty is taken as the control variable. Relative to the main effects of P1, TimePressure and product perishability are moderating variables, then we build interactive items of P1_TimePressure and P1_Perishable respectively. Firstly, let the independent variable P1, the moderating variables TimePressure and Perishable be applied to OLS regression on the variable DiscountRate. Then, the ItemQty which may affect the dependent variable is used as the control variable. Next we carried out the OLS regression with the independent variables on the dependent variable. According to the regression result, we analyzed the effects of control variables and independent variables on dependent variable respectively. The results are shown in Table 5. Finally, the regression results are tested by variance inflation factor (VIF <10) and heteroskedasticity test (Prob> chi2 = 0.508> 0.01), which meet the test criteria.

Table 5. OLS Regression Results

	(1)	(2)
Variables	DiscountRate	DiscountRate
P1	-0.000774*	-0.00108**
	(0.000442)	(0.000436)
TimePressure	-0.0298	-0.0397**

	(0.0191)	(0.0188)
Perishable	-0.128***	-0.161***
	(0.0441)	(0.0437)
P1_TimePressure	7.77e-05	0.000105
	(0.000494)	(0.000485)
P1_Perishable	0.00129**	0.00194***
	(0.000611)	(0.000611)
ItemQty		0.000171***
		(3.45e-05)
Constant	0.628***	0.610***
	(0.0157)	(0.0158)
Obs.	518	518
R-squared	0.051	0.094

Notes: The numbers in brackets are standard errors, *** p<0.01, ** p<0.05, * p<0.1

As shown in Table 5, in the regression equation (1) and (2), the independent variable P1 and the moderating variable Perishable (the coefficient of which is negative with the sum of the coefficients of the interactive term P1_Perishable) have a significantly negative impact on the discount rate, assuming H1 and H3 obtain the statistical support. TimePressure is not significant in the regression equation (1), but in equation (2) except the interaction term P1_TimePressure is not significant, TimePressure coefficient is negatively and statistically significant, indicating that 1-day auction with smaller time pressure has the higher discount rate, while the 15-minute auction with higher time pressure has the lower discount rate, so assuming H2 get the statistical support. In addition, the regression equation (2) shows that the ItemQty positively affects the discount rate, that is, the more auction goods are on sale, the higher the discount rate is also increased, and the explanation level of R-squared rises obviously (from 0.051 to 0.094).

Discussion and Conclusion

Results and Discussion

Based on the empirical analysis mentioned before, we can draw the following conclusions on online Dutch auctions with the final price of one RMB provided for individual consumers:

Firstly, the starting price has a negative impact on the final price discount rate of online Dutch auctions. That is, during an online Dutch auction with multiple rounds of price discounts, the higher the starting price of a product is, the more likely consumers intend to place an order in earlier rounds of discounted prices, resulting in a smaller average discount rate of the auction, which eventually benefits sellers. Although the later the order is placed, the higher the discount rate is, due to the limited volume of an auction, the products with high starting price may be sold out quickly. Therefore, high value products with the same price reduction ratio at each round always have high absolute value of the discount. In the light of regret theory, buyers tend to place orders hurriedly for avoiding the regret not to buy.

Secondly, time pressure negatively affects the final price discount rate of online Dutch auctions. In the context of this study, compared to one-day interval of descending price, Dutch auctions with 15minute interval produce a generally lower discount rate, which is more profitable to sellers. Compared to one day, 15-minute is a shorter interval, which will make higher time pressure on buyers generating a greater sense of urgency. Thus, buyers tend to order earlier to avoid regret, resulting in a lower discount rate.

Finally, the perishability of agricultural and subsidiary products affects the price discount rate of online Dutch auctions, that is the price discount of online Dutch auctions of perishable products is generally lower than that of non-perishable products. Since perishable products may deteriorate in quality over time, the perceived value of buyers may decrease accordingly. To avoid the products with poor quality, buyers tend to place orders earlier, resulting in a lower price discount rate. That is more beneficial to the sellers.

This study has a few limitations. Firstly, the control of the time pressure factor is not elaborately designed. The auction time pressure for this study includes only 1-day and 15-minute time interval respectively, and there are merely 7 price-descending rounds. As a result, conclusions about the influence of the time pressure on online Dutch auction is not robust enough. Secondly, the sample of perishable goods is not balanced enough and there are few samples of perishable products, probably resulting in a bias result. Thirdly, the sample data comes from the natural experiments. That means compared with the laboratory method, the theoretical explanation lacks a survey to accurately investigate the influence of consumer's psychological activity and actual decision-making process. Finally, this study is conducted under the context of the consumer-oriented online Dutch auction of agricultural and subsidiary products, whether the findings have general meaning or not need further exploration for other contexts.

Theoretical and practical implication

Based on the above discussion and analysis, this study provide contributions to the theoretical research on Dutch auctions as follows:

Firstly, the context of the Dutch auction explored in this study is somewhat different from the previous researches. The situation is an online Dutch auction for individual consumers with a final price of one RMB, and initially explores the corresponding consumer bidding behavior. In the past, the practice and related researches of 1-dollar auction were almost focused on English auction with a starting price of 1 dollar (Li 2010), resulting in the lack of researches focusing on an online Dutch auction with a final price of 1 dollar. In addition, this study investigates the impact of starting price, time pressure, product perishability and other factors on the consumers bidding behaviors in the situation of online Dutch auction, whereas the previous studies about online Dutch auctions are mostly related to the comparison between online mode and traditional offline mode, Dutch auction mode and English auction mode (Carare et al. 2005; Lucking-Reiley 1999).

Secondly, based on the regret theory, this study explores the impact of starting price, time pressure and product perishability on the price discount rate for online Dutch auctions of agricultural and subsidiary products. Specific findings are the starting price, the time pressure (reflected by the time interval of the auction) and product perishability negatively affect the discount rate, which positively affect the seller's revenue. The research hypothesis proposed in this paper is closer to the theoretical model proposed by Swain et al. (2006) and Godinho et al. (2016), but the differences lie in the context of online environment and the one-RMB final price. This study also explores the impact of the product perishability on decision-making, and the method of natural experiment is closer to the reality. In addition, studies focused on the context of online Dutch auction with the final price of one RMB/dollar have been rarely found.

Our work also has significant managerial implications for online Dutch auctions. Firstly, for sellers, high priced and perishable goods are more suitable for online Dutch auctions, and the buyers are also more inclined to bid earlier resulting in the lower price discount rate, which is more beneficial to the sellers. Second, since time pressure can negatively affect the final price discount rate of online Dutch auction, sellers might try to set shorter time interval of price descending to facilitate buyers to bid as soon as possible, thereby improving the seller's revenue. Finally, considering the starting price, time pressure and product perishability will affect consumers' bidding timing, we suggest that sellers design the price reduction range for different auction rounds and the discount size should be set from small to large when an auction goes by, which is expected to increase the sellers' income.

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