Application of Regression Discontinuity Approach in Experimental Auctions: A Case Study of Gaining Participants' Trust and Their Willingness to Pay (Draft)

Hao Li

Washington State University

School of Economic Sciences

haoli.li@wsu.edu

Levan Elbakidze

West Virginia University

Division of Resource Management

levan.elbakidze@mail.wvu.edu

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1. Introduction

Experimental auctions have been widely used in research of agricultural and food economics (Corrigan 2005). In practice, the research conductor creates an environment that intimates the real auction environment and induces the experiment participants to act as in a real auction to elicit the participants' willingness to pay (WTP). However, it is not possible to totally eliminate the participants' distrust: the participants may still think the experimental auctions are not real and they may not perform as in a real auction even when they are provided with enough incentive (Morawetz, De Groote and Kimenju 2011). Ignoring the effects of participants' trust could potentially jeopardize the accuracy of revealed WTP (Lusk, et al. 2006).

To address potential problems resulted from participants' distrust, researches apply various methods to increase participants' trust in economic experiments. Those methods can be categorized to two types: to maximize mundane realism and to maximize experiment realism. Some experimental designs maximize mundane realism by simulating the real world experiences (Privitera 2014). Experiment conductors create an auction-like environment and guide the participants to behavior like in actual auctions. This method emphasizes the necessity of physically making the experimental auction look like a real one. "If the experiment appears to be a real one, then the study has high mundane realism" (Privitera 2014). Limited by disposable resources that a researcher usually has, the mundane realism is not commonly seen in experimental auction research. The other method is to maximize the experimental realism. Usually experimental auctions are conducted in laboratories or classrooms, and the participants may not feel like they are in a real auction. Therefore, to maximize the experimental realism means to involve the participant and get them to behave in a way that it is meaningful to what they are doing.

Compared to the mundane realism that underlies physical resemblance of an actual auction, the mundane realism addresses more participants' physiological comprehension and compliance. Current experimental auctions more or less reflects both methods, but as far as concerned, numerous experimental auctions are conducted in laboratories rather than in actual auction fields, so to maximize the experimental realism becomes fundamentally important.

Despite the popularity of treating experimental realism and participants' trust as an exogenous factor (Elbakidze, et al. 2014, Corrigan, et al. 2009, Lusk, et al. 2006) in previous experimental research, we believe the nature of experimental realism revealed by an experiment participant is still arguable. Preceding comprehension of trust effects rely on a strong assumption, i.e. trust is exogenous and is not affected by other control variables. In contrast, the foundation of the exogenous assumption is evidently shakable especially when some familiarization scheme is introduced ahead of the experiment auctions, because a participant's trust is also influenced by the exposure of information and his/her socioeconomic characteristics such as the introductory lecture that we use in our research. The indeterminacy of trust's exogenous property leads to statistically inconsistent estimation of participants' WTP.

Our research is based on a series of experimental auctions, which are designed to reveal consumers' WTP for animal products featured with humane care. To increase the overall experimental realism and participants' trust in experiments, we bring in "introductory lectures" for some of the participants. One introductory lecture lasts for 10-15 minutes. During a lecture, the participants are given information regarding the idea of humane-cared productions and the products being experimented. The participants are also allowed to ask questions regarding these topics freely. The lectures play an important role in familiarizing the participants with the

background information and imparting potential benefits from rationally playing in the auctions, which is supposedly increase their trust in the experiments.

Our research applies regression discontinuity to assess the effects how the introductory lectures influence on participants' trust and then their WTP in experimental auctions. Regression discontinuity has been widely used recently (Lee, 2010). This method takes advantage of an exogenous threshold or cutoff point to evaluate causal effects. Lee and Lemieux (2008) consider that in the context of unavailability of perfectly randomized experiments, regression discontinuity proves to be an effective tool to estimate the causal relation when endogeneity is existent. In our research, we consider the participants' age to be the assignment variable, which is also called as forcing variable. We select a cutoff line in participants' age and based on the cutoff line, we apply regression discontinuity technique. We conduct several sessions of experiments and we group the participants into two groups, where some participants' ages are below the cutoff line and the rest are above it. Participants with ages above the cutoff line are exposed to introductory lectures and then the rest participants are not exposed to the lectures. We assume there is a discontinuous jump in their willingness to pay between and after application of introductory lectures. We choose local nonparametric regression (kernel) estimation methods over the global/parametric methods as non-parametric methods exhibits more robustness. We choose several potential bandwidths based on sample size (Hahn et al. 2001). We also compare the estimation results between with and without covariates.

2. Animal Welfare Recognition and Assessment

2.1 Background on Animal Welfare

In the past thirty years, the United States has undergone a significant adjustment in the ethics of animal treatment due to dramatic social changes such as the urbanization of society, the

popularity of the media, the rising number of NGOs and the revision of moral standards (Rollin 1995). In part, the change is reflected in the increasing emphasis on the appreciation of the interest, care, and welfare of animals and the protection of some elementary animal rights.

Concerns about animal welfare have been increasing in recent years (Harper and Makatouni 2002). To economists, one of the major interests regarding animal welfare is how much are consumers willing to pay for animal welfare attributes. Though the definition of "animal welfare attributes" varies by animals and production procedures, it is generally believed to be associated with a strong emphasize on animal wellbeing and it must follow some detailed principles regarding raise, breeds, health management, food and water provision, sheltering and slaughter. Specifically, those principles include but are not limited to s alleviation of animal pain, free access to clean water, limitation on food competition, maintenance of animal health record and on-farm slaughter.

The research of animal welfare and related issues is especially important for the economy. The dairy industry is one of the most important industries in United States. The newly emerged concern about animal welfare may offer opportunities for producers to generate additional revenues, which can be especially significant for the small producers.

2.2 Design of Experimental Auctions

Experimental auctions are widely used to estimate the value of the special product attributes. Fox (1994) follows Hoffman's procedure and performs experiments to reveal undergraduate students' acceptability of bST treated milk. His results show that more than half of the students are willing to buy bST treated milk under some discount programs. Hayes et al. (1995) also perform similar experiments. They assess the value of food safety in a non-hypothetical setting. The participants are exposed to different levels of information related to food security. The results show that "marginal willingness to pay decreases as risk increases, suggesting that the perceived

quality of new information can affect the weight the individuals place on the information." Melton, Huffman, and Shogren (1996) perform a similar experiment to reveal consumer preferences for fresh food.

We use both second price Vickrey auction and random Nth price auction in our experiments. Vickrey auction is a sealed-bid auction. "Sealed-bid" means that in this auction no participants have access to others' bids. "Second price" means that each participant bids for one unit, and the winner pays the second highest price, which is believed to give the participants the incentive to disclose the true value that they are willing to pay. "Nth Price" means the participants pays the Nth highest price if he/she wins.

We conduct five rounds of experiments in each session. The binding round is determined randomly. Hayes et al. (1995) and Roosen (1998) present the evidence of the considerable advantage of using a randomly determined binding round. Lusk, Feldkamp, and Schroeder (2004) state that the participants' valuation will be affected by demand reduction or wealth effects if no prevention mechanism is provided. Specifically, if a participant buys one good in one round of an experiment, his/her demand for the good may fall in the subsequent rounds because his/her demands move along the demand curve. However, with the introduction of binding round mechanism, this problem can be easily erased. If the binding round is drawn from all the rounds in an experiment, the participants have to act rationally to maximize their utility. Participants are $30 in each session of experiment. They are told that the cash can be used towards purchase of the products being auctioned. They can also spend none of cash in the experiments and keep all the cash for personal use thereafter.

In the following research of regression discontinuity, we focus on the participants' willingness to pay for ice cream made from ingredients that are consistent with humane-care

definitions. The item is well labeled and the participants are encouraged to taste it before auction. In each round of auction, the participants are instructed to submitted a bid for each of the 1, 2, 3,4, and 5 units of humane-cared ice cream. According to utility maximization theory, the customer demonstrates his/her WTP by submitting the highest bids for corresponding quantities. We choose to calculate their average bids as their average WTP, and we use their average WTP to conduct the following research and the model estimation.

The participants' socioeconomic characteristics are also recorded during the experiments. In the Questionnaires, we instruct the participants to answer their socio-demographic questions including gender, age, education, personal and family monthly incomes, occupation, etc. We also ask the participants to provide information regarding their recognition of with agricultural production, awareness of animal welfare issues in agricultural production, time since last meal or snack before the experiment, frequency of purchasing cheese and ice cream, and inventory of cheese and ice cream at home at the time of the experiment. These facts help us have a more insightful understanding of their behaviors in the experiments. The summaries are listed in Table 1.

3. Application of Regression Discontinuity

3.1 Regression Discontinuity Design and Estimation Methods

The regression discontinuity is applied to detect the leap of the participants' willingness to pay (WTP) at the cutoff age. So we define the regression discontinuity model as:

$$Y_{ia} = \beta_0 + \beta_1 T + \delta(a) + \varepsilon_{ia}$$

Where Y_{ia} stands for participant i's WTP for humane-cared ice cream, and a represent his/her age. T stands for the treatment (introductory lectures in this research), which we will elaborate in the following. We assume $\delta(a)$ is twice-differentiable smooth function and it captures the effects of

the age on participant i's WTP. We choose the cutoff line at the age of 30. So we define the treatment T as:

$$T = \begin{cases} 0, & a < 30 \\ 1, & a \geq 30 \end{cases}$$

This RD specification is also called sharp design as treatment T is a deterministic (rather than a conditional probability) function of regression covariate age.

The estimation of this model consist two parts. The first part is the treatment effects on the participants' WTP, β_1, which can be obtained by estimating the empirical regression function at the cutoff point (at age of 30 in this research) where the treatment variable switches from 0 to 1 at. The other part of the estimation is to estimate the effects of the age, i.e. the smooth function $\delta(a)$. There are two ways to estimate the smooth function: the global/parametric regression and the local/non-parametric method. The global method takes advantage of all the observations in the model to estimate the overall effects near the cutoff line. The local method estimates the treatment effects near the cutoff line using local observations within a certain area of the cutoff line. The bandwidth can be chosen by visual examination, economic theirs or cross-validation criteria. The determination of bandwidth is a key process and it underlies the linearization of estimated model by applying polynomial expansion. Once the model is properly linearized, it can be estimated linearly by traditional regression methods such as OLS. Another key point that differentiates RD with traditional regression methods is that the parameterization of the smooth function is the requirement of a kernel function. The kernel function is a weighting function that based on nonparametric techniques, so the local estimation method is also called nonparametric method. There trade-offs when choosing one over the other. The global method uses all the observations and thus it is presumably able to provide more accurate estimation of the treatment effects. However, it puts more weight on the points that are far away from the cutoff line, and it also

potentially results in misspecification of conditional mean, causing a bias estimation. Also, some research shows that "the bias could be substantial in finite samples" when using global method.

Thus, we choose the kernel regression method over the parametric polynomial expansion method to address those concerns above. First, local/nonparametric method proves to be more robust in specifying conditional means. Recent RD researches overwhelmingly use local method and their estimation results suggests the local method provides more robustness given proper specification of kernel functions and bandwidth. Second, we have relatively limited sample size. The experimental auctions that involve in both cash incentives and products purchases are costly, limiting the sample size to a relatively low level compared to the research that are based on contingent valuation methods.

3.2 Empirical Results

The RD model is estimated using local kernel regression. We choose Epanechnikov and triangle kernel functions as the weighting functions. We also choose various differences of age as the bandwidth. The estimation results are listed in Table 2. From the estimation results, we can infer that the treatment (introductory lectures) generally plays a positive role in promoting participants' WTP for humane-cared ice cheese. In most scenarios, the treatment effects are positive for both kernel functions. We can also infer that Epanechnikov kernel is a little bit more sensitive to a smaller bandwidth. One nice attribute of the results is that the two kernel functions that measure the treatment effects provide us with remarkably similar estimates of treatment effects that range from around 0.08 to 0.30, and when choose the smallest possible bandwidth, they obtain the same estimates. This suggests that the RD approach is appropriate for the models that use random age as the forcing and assignment variable in experimental auctions.

We also use graphic evidence to demonstrates the leap of WTP on the left hand side and right hand side of the cutoff line. Limited by the space, we only provide two representative plots.

Figure 1 and Figure 2 are plotted after the kernel regressions. Figure 1 is plotted using Epanechnikov kernel with bandwidth of 15, and figure 1 is plotted using triangle kernel with bandwidth of 15. From the two plots, we can see there are discontinuities at the cutoff. As the forcing variable age exceeds 30, the WTPs jump sharply along with the movement of assignment. This result confirms the estimation results that the treatment has a notably increased the participants' WTP.

4. Conclusions

Research that aims to have a better and insightful understanding of how experiment participants respond to incentives and the products being auctioned requires both proper framework that is based on comprehension of behavior patterns of participants, the mechanism of experimental auction, and the empirical data that are associated with the experiments. In our research, we attempt to meet these requirements. First, we attempt to maximize the experimental realism by familiarizing them with introductory lectures and this method is proved to be effective in our RD research. Second, we propose a feasible and appropriate way of assessing the treatment effects of the introductory lectures. The idea behind our research tool, i.e. the RD design, is to figure out the sudden jump as the assignment variable (age in our case) changes. Third, we are able to identify collect data that is substantially reliable and accurate for the proposed RD method. With these empirical data, the time series tools that are proposed by the framework can be applied to explore participants' behaviors in the experimental auctions.

Our empirical results reveal that the effects of the introductory lectures remarkably influence the participants' willingness to pay for humane-cared ice creams in a positive manner. The RD regression that applies two different kernel functions demonstrates equivalent results, and those results follow similar patterns. We do find one of the kernel functions is more sensitive to a smaller bandwidth. We also provide more intuitive way of demonstrating sharp change of

participants' behaviors: the RD plots illustrate visually sudden jump of WTP resulted from the treatment aiming to increase their trust of the experimental auctions.

Previous literatures record that RD design is commonly used to evaluate implementations of public policies that potentially influence a large amount of population, however, its application has not been seen in the much smaller scope of experimental auctions, as far as we are concerned. As we present in this paper, RD design is also a powerful tool of assessing the effectiveness of certain treatment or procedure in experimental auctions as it could potentially avoid some misspecification problems such as missing control variables. We are still working on this research and improve the applicability of RD methods. Essentially, our research is a balance between economic theories, experimental auction practice, the empirical information and some creativity in applying econometric tools.

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Table 1. Statistic Summaries

Variables		2nd Price Experimental Auctions			Nth Price Experimental Auctions			OECE		
		Participants: 79			Participants: 83			Participants: 56		
		Median	Mean	S. D.	Median	Mean	S. D.	Median	Mean	S. D.
Trust Scores		4	3.993671	0.893329	4	3.777108	0.914827	4	3.6375	1.045608
Age		23	27.8481	11.76271	23	29.95181	12.90481	23	27.30357	11.87039
Individual Income*		1	1.78481	1.823429	1	1.759036	1.91649	1.5	1.589286	1.592902
Family Income*		3	4.177215	4.075441	4	4.096386	3.617756	2.5	3.607143	3.148902
	Category					**Percentage**				
Gender	Male		43.04%			36.14%			41.07%	
	Female		56.96%			63.86%			58.93%	
Formal Education	Up to high School		3.8%			1.2%			0%	
	Associate Degree/		72.15%			72.29%			69.64%	
	Post graduate		24.05%			26.51%			30.36%	
Awareness About Animal Welfare	Yes		79.75%			78.31%			83.93%	
	No		20.25%			21.69%			16.07%	
Belief on Superior Quality of Animal	Yes		43.04%			40.96%			42.86%	
	No		56.96%			59.04%			57.14%	

Table 2. RD Regression Estimation Results

Bandwidth (Years)	Treatment (Introductory Lectures) Effects on WTP	
	Epanechnikov Kernel	Triangle Kernel
± 30	.09723***	.10727***
± 20	.08731***	.078***
± 15	.12079***	.07595***
± 10	.14136***	.16172***
± 8	.14839***	.13421***
± 5	.2832***	.30127***
± 3	.08688	.2141***
± 2	.08021	.08021

Figure 1. Epanechnikov Kernel Regression

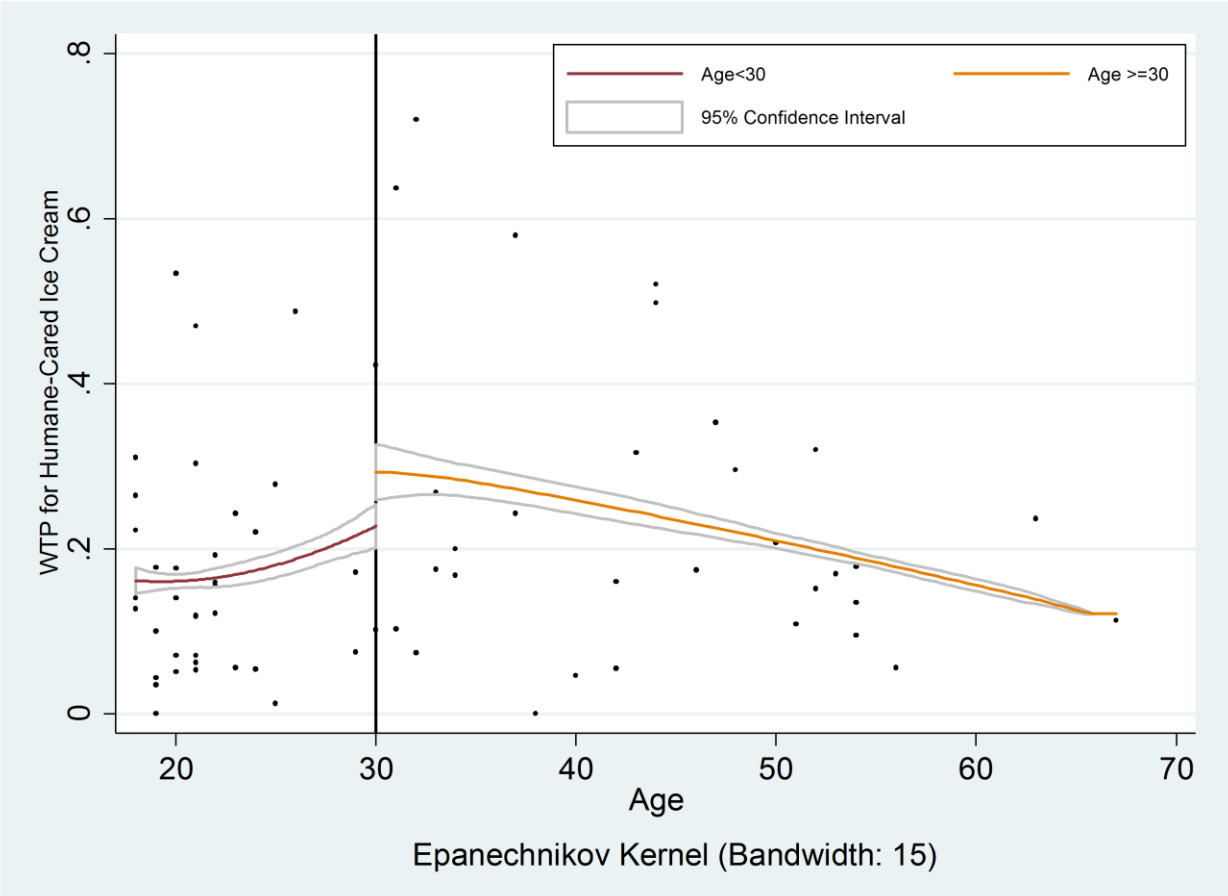

Figure 2. Triangle Kernel Regression