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Consumers' WTA for GM rice cookie: an experiment study in China

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[Abstract] This paper uses experimental auction method to study the WTA for GM rice cookies of Chinese consumers. The bid data are collected from 353 randomly recruited undergraduate students participated in Wuhan, China, during the spring and early summer of 2008. The experiment auction suggest most participant hold a positive WTA for GM rice cookie, which suggest that consumers regard GM rice an inferior substitutes for non-GM rice. Information favorable of GM rice will decrease the WTA, while negative information will increase the WTA. When information of both sides is revealed, the WTA bids decrease at different pace according to the sequence of discovering information.

[Key words] GM rice, WTA

Introduction

China is a large rice producer in the world, and the rough rice production is 186.5 million tons or 29.3% of the world products in 2007. As one of the important staple food, high rice production is the key to ensure the food safety problems in populated China. The Chinese government always places high values on increasing the productivities of rice. Public funds have been invested in the researched genetically modification technologies on rice, and several GM rice varieties have been developed. However commercialization of GM rice has not proceeded due to various considerations. One reason might be that little is known on the consumers' willingness to accept for GM rice.

There are considerable amount of studies on the willingness to pay for GM foods in developed courtiers, using popular western foods as the experimental materials. But little is done either on the WTP for GM foods in China or using the rice products as the auction materials. There are studies suggest the different characteristics of Chinese consumers from the western consumers, such as a reputation for being highly price-sensitive in food purchase decisions of Chinese consumers(Zhang,2008), unwilling to pay price less premier for quality and safety improvements (Goldman and Vanhonacker 2006), significant but small premium associated with HACCP certification for dairy products(Wang,2008). In the paper, rice cookies are chosen as the auction materials due to three reasons: it is the popular snack, it is mainly produced from rice, and it is suitable for on spot consumption after the success auction transaction.

Literature review

WTP for GM foods using experimental auction

The experimental auction and CVM methods are two popular used methods in the study of consumer intentions. The experimental auction has its own advantages in the pursuits of WTP studies. First, it can focus on the bids of the products specified; secondly, it can avoid hypothetical bias in CVM. And lastly and most importantly, it provides a close-to- the-truth of market mechanism in which consumers can bid and compete for the goods until it is purchased. Experiment auction becomes a popular method in the study of demand for various foods before there are on the market. Those foods includes bison attributes, irradiated pork and chicken, soft citrus(Poole, Martínez, & Giménez, 2007), steak tenderness(Lusk, 2001b), packed beef (Hoffman et al.,1993)(Matthew Rousu, 2005), chocolate cookies, insecticide reduction apples (Rosen et al.1998), and various of genetically modified foods (Huffman, 2003, 2004; Huffman, Rousu, Shogren, & Tegene, 2004; Huffman et al., 2003 ; Charles Noussair et al., 2002; Matthew Rousu et al., 2002).

But experiment auction is generally limited in size, as strict requirement of participants understanding of the procedures and cooperation in implementation. The smallest sample size

is up to 50 participants (Lusk, L., & Coble, 2005; J. L. Lusk & Daniel, 2001), the largest sample size goes up to more than 300 (J. L. Lusk et al., 2005). A sample size around 100-200 is most adopted. However past studies suggested that the small size does not lower validity the effects given good designs and careful implementations.

Past study results

Although the study on theory of experiment valuation has experienced a quickly development and application to the products is vast, the researches on GM foods start only with this decade. Three groups of researches showed their expertise on these issues. One group that study on the GM foods by experiment auction is done by Noussair et al (C. Noussair et al., 2001a, 2001b; Charles Noussair et al., 2002). They had conducted two experiments in 1999, one using BDM auction with a sample of 97 on biscuits, the other being Vickrey auction with a sample of 112. Both are within lab setting. Noussair et al's study reported that the willingness-to-pay of European/French consumers for GM biscuits and chocolate bar is 37% and 30% less than the non- GM ones respectively (C. Noussair et al., 2001b) (Charles Noussair et al., 2002) . Their also suggested the ignorance of the consumers of the labels. Once the GM label at the back is emphasize, the WTP for GM goods drops more than 20%.

Huffman, Rousu and their fellow researchers have analysis the consumers' behavior of GM food choices in several papers using the data from an experiment data on three goods (Veg oil, tortilla chips and potatoes). They conducted a random nth price hybrid methodology combing sample survey in 2 milder west cities in USA: Des Moines, IA and ST. Paul. Their experiment results reported 14% higher WTP for non -Gm foods compared to GM foods on average, and even higher discount of GM foods (35%) if the bidders are only exposed to the information from environmental group. Their study illustrated the attributes of the information that the bidders exposed to significantly affect their WTP. The size of the impact on WTP of the information significantly varies according to where information comes from, whether it is positive, or verified. Furthermore, it is suggested by their studies that uninformed consumers are affected more than informed consumers.

Lusk et al's early study also conducted the survey in USA. Their experiment auction of GM foods is abased on a small unrepresentative sample draw from undergraduate agribusiness students in the Kansas state university. Given their educational background and geographic location, the majority of the participants refuse to pay to upgrade to non-GM corn chip and only 20% of consumers bid \$0.25/oz. or more as price premier. The authors also suggested that the results is due to the sample have more favorable opinions toward GM foods. At a latter experiment auction used chocolate cookie in USA, France and England, Lusk et al have suggested that consumers place a positive value on the information about the benefit of GM foods (J. L. Lusk et al., 2005). Also the country effects are obvious. The French consumers are more skeptical on GM foods, illustrated by higher compensation for GM chocolate consumption. The European consumers place higher values on the health characteristics of GM foods, while American consumers place higher values on the environmental benefit. This study also agrees Huffman et al 's study on the effects of prior information (Huffman et al., 2007).

(Dannenberg et al., 2008) had conducted a lab action in Mannheim, Germany, with a sample of 164. They used Soybean oil and chocolate bar as the goods auctioned. Their study suggested

that German people require an average price discount of 47 – 59 % to buy GM foods. And their study also investigated the WTP under mandatory and voluntarily labeling schemes. It is reported that both labeling schemes do not enable consumers to express their true preferences for GM content when the product does not carry a label.

Some studies analysis the information effects on WTP, such as the source of information (Roe & Teisl, 2007) (Huffman et al., 2004), consumers' prior information on the willingness to pay(Huffman et al., 2007), no one simulate the information flow in the reality, the various information are affluent, different individuals are exposed to them in different way. This study will simplify the information flow by only two kind of information, negative and positive, revealed in two sequences.

Experiment

Implementation

In the spring and early summer of 2008, a total of 353 randomly recruited undergraduate students participated in the HZAU, China. 22 sessions have been hold with 353 participants, with 12-18 participants in each session, in which 334 observations are valid. In the auction, the gender balance is controlled with at least 4-5 female participants in each session.

Upon arrival at each session subjects were randomly assigned an Id number and given some basic information about GM foods. Then they were asked to spare 30-50 minutes to participate in an auction. A pop candy is given to each participate as the show-up token. Then a brief introduction of the procedure is announced. Before the rice cookie auction, and example auction of chocolate is shown for the better understanding of the auction mechanism. And then the despondences are required to fill up a pre-auction questionnaire. After subjects completed the pre-auction survey, subjects participated in an experimental auction. Following previous studies (Shogren et al., 1994; Lusk et al.), subjects were endowed with a non-GM rice cookie and were asked to bid, in an incentive compatible auction, the minimum amount they had to be paid to exchange their non-GM rice cookie for a GM rice cookie¹. The two kinds of cookie are identical and only the GM cookie with GM label content at the front. Then subjects bid in an incentive compatible fifth price auction the amount they had to be paid to exchange their endowed cookie for an otherwise identical cookie that was labeled as being made with GM ingredients. They were told that the auction will go for nine rounds, the id of the four lowest bidders and the fifth lowest price will revealed once each round is over. After finishing the ninth round, one random round selected as binding. In another word, in the selected round four participates with lowest bids will actually exchange to the GM cookies using the fifth lowest bid as the price. And all subjects were required to eat the cookie they possessed at the end of the auction. It is also announced before that auction process that extra information are provided after round 3 and round 6. Among a wide choice of food made of rice, rice cookies is selected due to the reasons below: they are popular and widely consumed in China, and forcing

¹ As GM rice cookies are not available in the Chinese marketplace, we actually used the non-GM rice cookie instead.

consumption of this product was feasible in a lab setting. After the round 9, one round is randomly selected as the binding round to avoid the sensation effects. After the auction, the participants were required to fill out a post auction questionnaire to reveal their attitudes after the auction, and the whole survey is finished.

Information treatment

Previous studies have discussed the effects of information with different characteristics. Their study suggest that the source of the information matters

Our experiment contains two different treatments: Treatment A: positive information (after round 3) followed by negative information (after round 6), and Treatment A: negative information (after round 3) followed by positive information (after round 6). Among the 22 sessions, half sessions are subject to treatment A with 162 valid observations, and the other 11 session are subject to treatment A with 191 valid observations. The content of the information provided in both treatment are identical, except for the sequences are different.

Existing literatures have investigated the effects of the source of information, or the categories (whether it is on health, production environment aspects), and presented valuable results. However the magnitude (positive or negative) and the sequence of the information follow are covered instead. Our design aims to investigate this particular topic. We choose this study aspect also due to the practical problems arising from the real world.

Nowadays there is vast of information about the GM foods from different parties and on various perspectives. Although the society provides the same information pool, each consumer is exposed to information differently according to his receiving channel of public information based on his own private life styles.

The information of GM rice is based on the first generation insect-resist rice, the benefit information mainly based on Huang's results. The negative information is from the popular Chinese media. The information is also on the health, production and environment, but the aspects of information are not emphasized. The information sheet is attached.

Positive information:

When planting the insect-resist GM rice, the farmers reduces the 80% pesticide use compared to the non-GM rice,

The average output of GM rice is 6%—9% higher than non-GM rice,

Reduced pesticide use can lower the cost of rice grow input

Reduced pesticide use can decrease of probability of farmers diseases, have benefit to farmers' health

Reduced pesticide can reduce the environment pollution due to pesticide use, maintain the balance of the ecosystem, increase the sustainability of the environment

negative information:

GM technology is a new technology, however there is no sufficient safety tests for GM crops, animal and foods;

Scientific methods has not yet to predict precisely the effects of GM foods on human beings;

One type of GM corn named Starlink for feed commingled with foods in 2000, and results in the healthy panic among people;

Since the planting of commercialization GM rapeseed in 1994, some weeds have developed the characteristic of chemical resistance

Greenpeace reported that GM rice appeared in Chinese market without verification, the farmers dare not to eat the GM rice grown by themselves

Results

WTA for GM rice cookies

The bid values of rice cookies are reported to provide a general idea of WTA level. In round 3, this is the last round without information treatment, bids range from -5 to 1250, with a mean of 6.433, a median of 0.4 and a mode of 0.5. In the last round, when all the participants had been exposed to the information by alternative sequences, the highest bid is 562 while the lowest bid is -3.5. The average bid reduced to 2.39 and median is 0.3, while the mode is 0. Extreme values, which considerably affects on the mean and deviation of the bid results, always shown in the experiment auction and were treated as outliers in most analysis (Jaeger et al., 2004)..... This is reasonable as extreme high WTA values make them not entering the GM market, thus the high bid value only suggest those participants taking the position of agonist of the GM foods. Our study also presents the result in the table below after moving the extreme values. In the market analysis for the GM foods, it is suggested that certain consumer segments are reluctant to GM foods (Kaye-Blake & Lamb, 2007; Verdurme & Viaene, 2003). For those who required high compensation, we regard them as the persons with less potential to act as GM food consumers. We remove the highest 35% and lowest 2% of the bid value with the rationale that correspondents with middle range bids is with higher preventative potential buyers of GM foods. Table 1 and Table 2 below show the simple statistics of the results of all 9 bid rounds of two treatments. The WTA is positive measured by mean, ranging from 0.070 to 0.394. The bid value converged for each information treatment. So we use the last round of each repetition. When no information is provided the mean bid is 0.174 and 0.242 for two treatments, which suggest the participants accept a price discount of 35%-48% for GM foods. However, when information is provided, the mean bids decreased to 0.15 and 0.124, which equals to 25%-30% price decrease.

Mean bid is smaller when positive information is provided. In round 6 of treatment B, when the last round after positive information provision, the mean bid is 0.070, which suggests a 14% reduction in the price of non-GM variety. This results is interesting for GM rice communication, a lot of studies has suggest the “consumers’ right to know”. Actually the exposition to the information will alleviate the fear of the GM foods; consumers can choose facing the conflicting information and attitudes.

Table 1 simple statistics of bid values in treatment A

rounds	1	2	3	4	5	6	7	8	9
Df	101	101	101	101	101	101	101	101	101
Mean	0.337	0.22	0.174	0.367	0.345	0.322	0.202	0.178	0.15
Sd	0.33	0.209	0.188	0.286	0.226	0.226	0.216	0.199	0.213
median	0.3	0.2	0.185	0.3	0.4	0.388	0.2	0.2	0.15
mode	0.5	0.5	0	0.5	0.5	0.5	0	0	0
max	1	0.6	0.5	1	0.8	0.8	0.5	0.5	0.5
min	-0.5	-0.5	-0.2	-0.1	0	-0.15	-0.5	-0.5	-0.5

Source: own auction experiment

Table 2 simple statistics of bid values in treatment B

rounds	1	2	3	4	5	6	7	8	9
Df	107	107	107	107	107	107	107	107	107
Mean	0.394	0.243	0.242	0.106	0.07	0.042	0.213	0.191	0.124
Sd	0.346	0.243	0.261	0.214	0.193	0.192	0.303	0.264	0.278
median	0.3	0.2	0.2	0.1	0.1	0.06	0.25	0.2	0.1
mode	0.5	0.5	0.5	0	0	0	0.5	0.5	0
max	1.5	0.7	0.7	0.5	0.4	0.3	0.6	0.5	0.5
min	-0.2	-0.5	-0.5	-0.5	-0.7	-1	-1	-1	-1.23

Source: own auction experiment

Contrasting effects of positive and negative information

From this part, we will investigate the different effects of positive and negative information. We will focus on the differences of bid values between round 6 and round: the differences of these two rounds in treatment A as the result of negative information, the difference in treatment B being the result of negative information. Although Table 1 and Table 2 above shows that the mean, median and mode of the bids increases when only negative information is provided, while all those statistics decreases when only positive information is provided. Statistical tests are further conducted to elaborate significances of the gaps.

This paper mainly uses two tests, T- test and Wilcox rank test. For paired data, paired T- test and Wilcox rank test applied; otherwise T- test and Wilcox rank test are used. As the distribution of the bids data are far from normal distribution, we would expects the non-parametric test is more suitable in analysis our data. Another problem arises due to the distribution of bid data is the effectiveness of the extreme values.

It is common sense that extreme values can greatly effects the sample mean and test statistics. Past auction studies on GM food WTP showed that extreme values always occurs in the bids values, which may reflect the objection of GM foods by certain groups of consumers, who has less potential to participate in GM foods purchase, but influences greatly on the valuation of

the average WTP of those with higher potential to participate. Although statistical theories give clearly definition of outliers as well as the description of their characteristic, there still lack universal rules to delimitate outlier from the other observations in sample. Thus we did some manipulation of the extreme values. Exchange those extreme values by sample mean, mode or median give more weight on the value that most people hold.

At the beginning both tests are done when all the observed bid value are untouched, and the result is reported in the column “ALL”. later we also did some manipulation of the extreme using the following rules: 1) EXT: exchange the 35% highest values with the 35%th high value, and exchange the 3% lowest with the 3%th low value; 2) MED: exchange the 35% highest and the 3% lowest values with the median; 3) MEAN: exchange the 35% highest and the 3% lowest values with the mean; 4) MOD: exchange the 35% highest and the 3% lowest values with the mode; 4) SMALL: delete the bidder, when any round of his bid falls into the 35% highest and the 3% lowest values group.

Table 3 the tests on the effects of negative information

A6-A3	ALL	EXT	MED	MEAN	MOD	SMALL
N	158	162	162	162	162	52
Diff	-6.5899	0.198	1.37	0.129	0.25	0.181
t	-0.96	9.37	7.58	8.6	12.72	3.52
Pr> t	0.3397	<.0001	<.0001	<.0001	<.0001	0.0009
s	1757.5	3632.5	3602	3495.5	3846	339.5
Pr> s	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Source: own auction experiment

All the tests, expect for the column 1 in Table 3 suggest that negative information significantly increases the WTA for GM rice cookies, and we use EXT and SMALL column suggested that WTA increase 0.18-0.19, equivalent to 36-38% of non-GM rice cookie price.

Table 4 suggested that positive information decreased the bidders' WTA for GM cookies, SMALL column suggested that the differences is 0.31, consider the mean of 0.39 in the third round, we find that WTP for GM rice is quiet low, 0.08, that is 16% discount of regular rice cookies.

Table 4 the tests on the effects of positive information

B6-B3	ALL	EXT	MED	MEAN	MOD	SMALL
N	170	171	171	171	171	59
Diff	-0.783	-0.2783	0.822	-0.2111	-0.3202	-0.3084
t	-6.34	-13.52	4.37	-12.467	-16.61	-2.44
Pr> t	<.0001	<.0001	<.0001	<.0001	<.0001	0.0179
s	-4009.5	-5283	1433.5	-5447.5	-5552	-372
Pr> s	<.0001	<.0001	0.0084	<.0001	<.0001	<.0001

Source: own auction experiment

Although the results in Table 3 and Table 4 indicate that positive and negative information has contrasting effects on the changes of WTA for GM rice, this paper further conduct test direct on

the differences of alternative information. The null hypothesis is: the change of WTA results form negative information is same as the change of WTA results form positive information. Results in Table 5 reject the null hypothesis, and further verify that different effects of diversified information on WTA of GM rice cookies.

Table 5 the tests on the differences of effects between positive and negative information

A6-A3 VS B6-B3		ALL	SMALL
Non-parametric test	Z	10.0774	6.0111
	Pr> Z	<.0001	<.0001
Parametric test	F	2891.24	6.86
	Pr>F	<.0001	<.0001

Source: own auction experiment

Effects of sequence of information

Previous studies have suggested that prior attitude towards GM foods is a key factor that influence WTA, acceptance and perception (Carlsson & Lagerkvist, 2007; Costa-Font et al., 2008; Loureiro & Hine, 2004; Verdurme & Viaene, 2003). However the formation of the prior attitudes is subject to the GM information communication at the early stage. So in this section, we compare the differences of WTA between round 9 and round 3 of two treatments. The differences of WTA between round 9 and round 3 are shown in Table 6, while further test statistics is presented in Table 7. Table 6 illustrates that WTA for GM rice cookie all decreases by different amount except for that in treatment A measured by the compact sample. Table 7 calculates the differences of WTA change of the two rounds by the various measurements, and results indicate a higher WTA deduction of the final round in treatment B. Based on the previous proofs that positive information decreases the WTA of rice cookies, we would hypothesis that the larger deduction in treatment B results from the fact that the favorable information is exposed earlier than the unfavorable information in treatment B, given identical content of information in these two treatments.

Table 7 shows the statistics test on the effects of sequences of information provision. The null hypothesis is that the sequence of information does not matter. The mean differences of WTA changes of the 2 rounds among treatment A and B is significant at 0.10 level for every test, and at least of one test for each measurement is significant at 0.01 level. We reject the null hypothesis and come to a conclusion that the sequence of information does matter.

Table 6 Simple statistics of WTA change resulted from of information treatment

		ALL	EXT	MEAN	MOD	SMALL
treatment A	Df	163	159	163	163	53
A9-A3	Mean	-0.024	-7.879	-0.038	-0.03	0.039893
	Sd	0.266	98.35	0.22	0.24	0.271388
treatment B	Df	172	167	172	172	60
B9-B3	Mean	-0.154	-0.264	-0.091	-0.221	-0.02468
	Sd	0.3023	2.195	0.26	0.299	2.028571

Source: own auction experiment

Table 7 the tests on the differences of effects between alternative sequences of information

A9-A3 VS		ALL	EXT	MEAN	MOD	SMALL
B9-B3						
Diff in mean		0.13	-7.615	0.053	0.191	0.064573
Non-parametric test	Z	1.8641	5.3131	2.7868	6.3211	1.8678
	Pr> Z	0.0632	<.0001	0.0056	<.0001	0.0644
Parametric test	F	2007.66	1.3	1.34	1.53	55.87
	Pr>F	<.0001	0.0968	0.06	0.0068	<.0001

Source: own auction experiment

Discussions and limitations

The experiment auction suggest most participant hold a positive WTA for GM rice cookie, which suggest that consumers regard GM rice products as inferior substitutes for non-GM rice counterparts. Information favorable of GM rice will decrease the WTA, while negative information will increase the WTA. When information of both sides is revealed, the WTA bids decrease at different paces according to the sequence of discovering information. The results suggests the importance of risk and benefit communications in the rice industry on the way of commercialization of GM rice. Those who control the voice of the media will play an important role in determining the future of GM rice and its products. Actually the supporters and the opposites gradually recognized the importance of “the right of voice” in the arena of GM foods battle in the really world. Active provision of information of GM foods in favor of their own position witnessed the conflicts of the two sides.

However as the risk communication is very complex. And how the information helps to form the attitudes and attitudes results in the consumption behavior is a dynamic process. In this study, the participant is limited to undergraduate students as the research budget, and the information treatment is simplified to positive information and negative information. More combination of information flow and more preventative sample can be used in further studies.

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