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Information and consequentiality: Evidence from willingness to pay for eco-labelling products based on Becker-Degroot-Marschak mechanism

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ABSTRACT

This study investigates the impact of informational interventions on consumers' willingness to pay (WTP) for eco-labeled grassland-fed lamb under real-payment and hypothetical contexts. Using the Becker–DeGroot–Marschak (BDM) auction method, we conducted a field experiment with consumers in Beijing, China. On average, consumers were willing to pay a 26% premium for grassland-fed lamb compared with fence-fed lamb, highlighting the perceived value of grassland-based products. We find no significant difference in WTP between real and hypothetical contexts. In the pooled sample, the text treatment emphasizing on donation increased WTP by 1.2 yuan/kg, while the video treatment highlighting product attributes raised WTP by 2 yuan/kg. Treatment effects, however, varied across contexts: the text treatment generated a significant gap between real and hypothetical groups, whereas the video treatment did not. These results demonstrate how eco-labels and tailored information strategies can enhance consumer valuation of ecological products and provide policy-relevant insights for promoting ecosystem services through markets.

1. Introduction

Eco-labels serve as a crucial mechanism for signaling the environmental attributes of products to consumers, such as sustainable production practices, reduced ecological impact, and corporate social responsibility (Davidson et al., 2025; Johnston and Roheim, 2006). Eco-labels reduce consumers' search costs and enhance demand for environmentally friendly products by providing credible and easily accessible information (Davidson et al., 2025; Heyes et al., 2020; Tranter et al., 2009; White et al., 2019). Transitioning to sustainable production methods often entails higher costs for producers. To offset these costs, producers may need to realize the price premiums associated with eco-labeled products (Kilders and Caputo, 2024). In two aspects, consumers' WTP plays a critical role in the sustainable production transition. First, consumers' WTP is a fundamental measure of the market premium for eco-label products, determining the economic viability. If WTP fails to offset the additional costs of sustainable production sufficiently, the financial justification for eco-labels weakens. Second, WTP is essential for valuing ecosystem services. Although extensive research has valued ecosystem services using various methodologies (Costanza et al., 1997; de Groot et al., 2012; Xie et al., 2017; Li et al., 2019), observed market prices may not fully capture these values, particularly in markets characterized by information asymmetries. For instance, consumers often struggle to distinguish between grassland-fed and fence-fed lamb in China, resulting in similar prices for both. This study examines consumers' WTP for eco-labeled grassland-fed lamb and identifies key determinants of consumer preferences.

A well-documented challenge in WTP assessments is hypothetical bias, where consumers overstate their WTPs in hypothetical contexts (Loomis, 2011; Penn and Hu, 2018; Liu and Tian, 2021). Murphy et al. (2005) estimated a median hypothetical-to-actual WTP ratio of 1.35, highlighting this inflationary tendency. Haghani et al. (2021) reaffirmed the pervasiveness of hypothetical bias, though its magnitude varies across contexts. While most studies have focused on mitigating bias in choice experiments, the BDM mechanism received less attention regarding its susceptibility to hypothetical bias. Penn and Hu (2018) found that auction-based methods, including BDM, do not consistently outperform alternative approaches in reducing hypothetical bias. Our

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study contributes the performance of the BDM mechanism in estimating consumer WTPs under hypothetical and real-payment conditions.

Existing research has also explored the impact of information treatments on WTP in real-payment or hypothetical settings. However, few have directly compared the effects of information across both hypothetical and real contexts within the same experimental framework based on an incentive-compatible approach such as BDM. For example, Oparinde et al. (2016) used a BDM experiment in a real-payment setting to assess Nigerian consumers' WTP for biofortified yellow cassava, finding that nutritional information significantly increased acceptance. In contrast, Davidson et al. (2025) used a hypothetical online survey to evaluate U.S. consumers' WTP for low-methane ground beef, demonstrating that environmental information raised WTP, particularly among lower-income consumers. Our study extends the literature by investigating how information treatments influence WTP for grassland-fed lamb in both real-payment and hypothetical contexts, offering new insights into the interaction between information and consequentiality in consumer decision-making.

We conducted a field experiment in Beijing supermarkets to estimate consumers' WTP for substituting fence-fed lamb with grassland-fed lamb. Using the BDM mechanism, we measured WTP and evaluated the impact of information treatments through a randomized design. Participants were randomly assigned to either a real-payment group, where they made actual payments and received home-delivered grassland-fed lamb, or a hypothetical group, where they completed the survey experiment without real transactions. Within each group, participants were further randomized into three information treatments: (i) no information (baseline), (ii) text information highlighting donations for grassland protection,[2] and (iii) video information explaining the differences between grassland-fed lamb and fence-fed lamb.[3]

As the world's largest lamb producer, accounting for 30 % of global production (FAOSTAT, 2021), China has a long tradition of lamb consumption (Liu et al., 2022), where the lamb production follows the grassland-fed or fence-fed system. Grassland-fed lamb, as an ecological product of grassland ecosystems, is valued for its superior taste, higher nutritional value, cultural significance, and embodiment of traditional pastoral practices that have sustained grassland ecosystems for centuries. Specifically, well-managed grazing in grassland ecosystems is associated with the maintenance of biodiversity, soil carbon sequestration, and improved soil health (Zhang and Shao, 2021; Lei et al., 2023; Wróbel et al., 2023). Furthermore, grass-fed meat is often perceived by consumers as being more natural, healthier, and environmentally sustainable compared to conventionally raised alternatives (Xue et al., 2010; McCluskey, 2015; Klopatek et al., 2021; Eshel et al., 2025). However, consumers struggle to distinguish between the two due to the absence of eco-labels and reliable verification channels. Without a price premium for grassland-fed lamb, herders face income pressures, potentially leading to increased grazing intensity and ecosystem degradation. An eco-label for grassland-fed lamb could enhance consumer awareness, support herders' livelihoods, and promote sustainable grazing practices.

Our findings demonstrate that consumers recognize and are willing to pay for the ecological value inherent in grassland-fed lamb. Specifically, consumers are willing to pay a 26.06 yuan/kg premium for grassland-fed lamb, representing an approximately 26 % price increase over fence-fed lamb. The comparison between the real-payment and hypothetical experiment groups provides several key findings. First, we find no significant difference in WTP between real and hypothetical contexts for substituting fence-fed with grassland-fed lamb under the BDM auction. Second, text and video information treatments significantly increase consumers' WTP for grassland-fed lamb. The text treatment with donation practice increases WTP by 1.2 yuan/kg in the pooled sample, while the video treatment demonstrates a substantial impact, with participants willing to pay an additional 2 yuan/kg. Moreover, the two information treatments show different patterns across payment contexts. The text information emphasizing donation increases participants' WTP more in the real-payment context than in the hypothetical context, whereas the video information emphasizing product attributes showed no significant difference between the two contexts.

This study makes two primary contributions to the literature. First, it provides empirical evidence on the role of eco-labeling in enhancing the valuation of grassland ecosystem services through consumer preferences. Eco-labels convey credible information about the environmental attributes of food products, thereby reducing information asymmetry and encouraging consumers to pay price premiums for more sustainable options. Based on a randomized field experiment, we find that consumers are willing to pay approximately 26 % more for eco-labeled grassland-fed lamb than fence-fed lamb. However, in existing markets, these products are typically sold at the same price, and consumers are generally unable to distinguish between them, which suggests that the current pricing structure may not fully reflect the ecological value of grassland-based production systems. This underscores the potential of eco-labeling as a market-based tool for supporting ecosystem services and promoting more sustainable livestock practices. Our study leverages the documented ecological associations and perceived benefits of grass-fed systems to test this market potential. While considerable research has examined consumer WTP for beef and other grassland-fed products, much less attention has been given to lamb. For example, Li et al. (2016) found that U.S. consumers were willing to pay an additional $64 per year for climate-friendly beef bearing greenhouse gas reduction labels. Similarly, Davidson et al. (2025) reported that U.S. consumers would pay an extra $0.30–$0.40 per pound for low-methane beef, with eco-labels and pre-purchase information significantly shaping consumer preferences. Our findings extend this line of research and contribute to a more complete and policy-relevant valuation of grassland ecosystem services.

Secondly, this research contributes to the literature by addressing a notable gap concerning the role of information interventions in shaping WTP under varying levels of consequentiality. Although many studies have investigated the effects of information interventions on WTP in either real-payment or hypothetical contexts, only a limited number have compared these effects under the same experimental conditions across both contexts. A related study by Chowdhury et al. (2011) analyzed WTP for biofortified orange sweet potatoes under varying experimental conditions. In the real-payment context, participants were split into groups receiving information and those serving as controls, while in the hypothetical setting, all participants were provided with identical information. The findings indicated a higher WTP in the hypothetical group when exposed to information treatment; however, the lack of a control group hindered the ability to distinguish the influence of information across varying degrees of consequentiality. Our study investigates the impact of information interventions on WTP for grassland-fed lamb in both real-payment and hypothetical environments to shed light on the interplay between information provision and consequentiality in shaping consumer choices.

The remainder of the paper is structured as follows. Section 2 outlines the research design and data collection methods. Section 3 details the empirical strategy. Section 4 presents the results, and Section 5

[2] The interviewees were provided with the following text-based information: 20% of the premium you pay is donated to the Grassland Environmental Protection Project of the China Greening Foundation. (The China Greening Foundation is an important organization approved by the state to raise private funds for greening. Its mission is to promote land greening, maintain ecological balance, and promote harmonious development between humans and nature.).

[3] The interviewees watched a video. The main information of the video is about the differences between grassland-fed lamb and fence-fed lamb, including aspects such as taste, nutrition, living environments, and animal welfare. For details about the video (with the audio translated in English), please refer to the link: https://youtu.be/eX9SJVFaEQg.

concludes with a discussion of the key findings and their implications.

2. Research design and data collection

2.1. Experimental design

To estimate participants' WTPs for grassland-fed lamb relative to fence-fed lamb, we employed the BDM auction mechanism. The BDM auction was chosen for its transparency, adaptability to individual and group settings, and the property of incentive compatibility in theory (De Groote et al., 2011; Feldkamp et al., 2005; Wertenbroch and Skiera, 2002). The BDM auction effectively captures individual decision-making (Corrigan and Rousu, 2006) and more closely reflects real-world purchasing behavior (Sichtmann and Stingel, 2007). Additionally, the BDM imposes symmetrical penalties for overbidding and underbidding, ensuring neutrality about participants' risk preferences (Lusk and Schroeder, 2004). Under the BDM format, a participant submits a bid, which is then compared to a randomly drawn "competing price" from a pre-determined distribution. If the participant's bid meets or exceeds this price, she purchases the product at the competing price; otherwise, no transaction occurs.

Our BDM experiment follows the procedures outlined in Berry et al. (2020) and Goeb et al. (2020) to minimize potential misunderstandings among participants and ensure high-quality data collection. Participants were presented with two types of lamb, fence-fed and grassland-fed, using intuitive visual aids, including images that illustrated their respective breeding environments (see Fig. 1). Since no official eco-label exists for grassland-fed lamb, we developed a custom eco-label verified and endorsed by the School of Advanced Agricultural Sciences at Peking University in China to enhance its credibility.

In each round, participants specified their maximum WTP in each round to exchange a 250 g box of fence-fed lamb for an equivalent portion of grassland-fed lamb. Bids were placed in ¥1 increments from ¥0 to ¥10,[4] with ¥ denoting the Chinese currency symbol for RMB. The upper bound of this bidding range was informed by a preliminary market survey conducted by the research team. Each participant's bid was then compared to a randomly generated price.

"Suppose we offer you a free 250 g box of fence-fed lamb. How much are you willing to pay to exchange this box for an equivalent weight of grassland-fed lamb? Please specify the maximum amount you are willing and able to pay (in whole yuan between ¥0 and ¥10). If you answer ¥0, it indicates that you are unwilling to pay anything for the exchange."

To examine the presence of hypothetical bias, we randomly divide the participants into the real-payment and the hypothetical groups (Fig. 2). All participants receive ¥10 as a participation fee. In the real-payment group, each participant was given a 250 g box of fence-fed lamb at the beginning of the experiment. Those whose bids met or exceeded the randomly drawn price were required to pay that amount. In return, their fence-fed lamb will be exchanged for grassland-fed lamb, which the research team delivered to their homes. No exchange occurred if a participant's bid was lower than the drawn price. In the hypothetical group, participants were informed that they were being offered a 250 g box of fence-fed lamb. They completed the same bidding process as the real-payment group; however, no actual payments were made, and no lamb was delivered in the hypothetical group.

To further examine the effect of information treatment on consumers' WTP and assess heterogeneous treatment effects across different consequentiality contexts, we randomly assigned participants in the real-payment and hypothetical groups to one of three subgroups: two treatment groups and one control group. During our field pretest survey, we observed that consumers often lacked sufficient knowledge about eco-labeled lamb, which could hinder their willingness to purchase it. Additionally, some consumers indicated that their desire to pay a premium depended on whether a portion of the additional cost would be allocated to grassland protection. We designed two information treatments to address these concerns based on this feedback. Participants in the control group received no additional information and proceeded with a second BDM experiment identical to the first. In the video treatment group, participants watched an informational video detailing the differences between grassland-fed and fence-fed lamb, covering aspects such as taste, nutrition, living conditions, and animal welfare. In the text treatment group with donation, participants were provided with written information stating that some of their premium payment would be donated to support grassland conservation. A comprehensive description of the experimental procedure is provided in Appendix A.

2.2. Sampling method

In July 2021, we conducted a six-day field survey across 13 supermarkets in Beijing, China, using tablet computers for data collection. Beijing consists of 16 districts; however, three districts without subway access at that time (Yanqing, Huairou, and Miyun) were excluded from the survey. In each of the remaining districts, we identified the comprehensive supermarket with the highest monthly sales within 10 km of the district government offices, which are typically in high-traffic, densely populated areas.[5] 610 participants were recruited and randomly assigned to the real-payment or hypothetical groups (305 participants each). The allocation of participants across the two groups is shown in Fig. 2.

To minimize selection bias, we employed a systematic sampling method. Two enumerators were stationed at each supermarket entrance. The first enumerator approached the first consumer they observed, while the second enumerator engaged the third consumer. After completing an interview, the process was repeated. If a selected participant declined to participate, the next eligible consumer was approached using the same procedure. Participants were assured anonymity and confidentiality. Those who agreed to participate were randomly assigned to the real-payment or hypothetical group, and then further randomized into one of three subgroups, i.e., one control group and two information treatment groups. This assignment process was automated through the questionnaire randomization program, ensuring an unbiased distribution across groups.

We carefully selected 26 senior undergraduate and graduate students from multiple universities in Beijing as enumerators. All the enumerators had backgrounds in economics or management and experience in social research. Before the survey, they underwent professional training and participated in pre-survey exercises to ensure high-quality data collection. During the first half, two enumerators were randomly assigned to each supermarket; enumerators were reassigned to different supermarkets in other districts for the second half to reduce potential enumerator bias. Each enumerator conducted face-to-face interviews using tablet computers, spending approximately 30 min per participant. Appendix B features photographs from the field research.

[4] The bidding range (¥0–10) in the BDM experiment was determined based on a preliminary market survey conducted by the research team. Specifically, we compared retail prices of six pairs of grassland-raised and non-grassland lamb products from wholesale markets, online platforms (Taobao), and offline supermarkets. The observed price premiums generally fell within this interval. Detailed comparisons are reported in Appendix B, Table B1.

[5] The selection of supermarkets followed a standardized procedure. Using AMap, the Chinese equivalent of Google Maps, we first identified each district government office and then searched for nearby supermarkets. Among these, we selected the supermarket with the highest monthly sales within a 10-kilometer radius of the district government. A full-service supermarket is defined as one that offers a wide range of goods, including food, clothing, household items, and appliances, with extensive product variety. Such supermarkets are often integrated into shopping centers, such as Walmart, RT-Mart, or Carrefour.

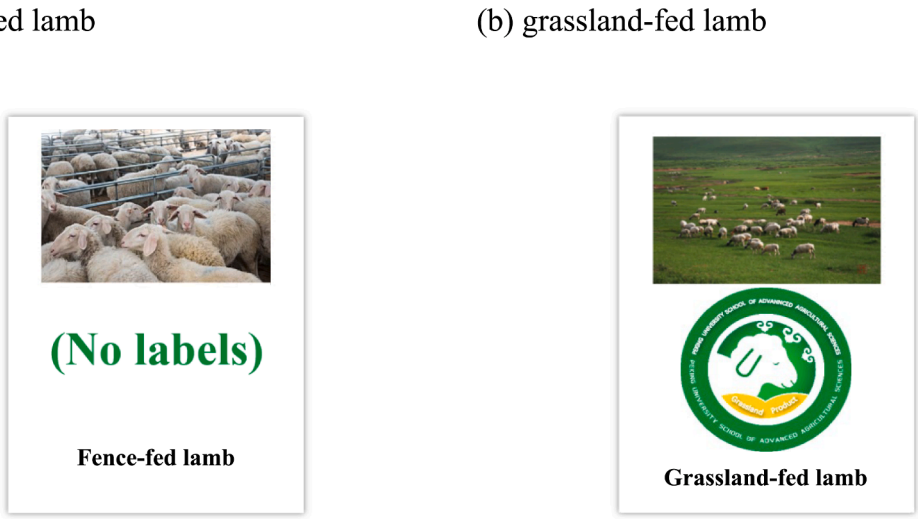


Fig. 1. BDM experiment Notes: Participants were shown two images illustrating the different breeding environments of fence-fed and grassland-fed lambs. The specific question posed to participants was:

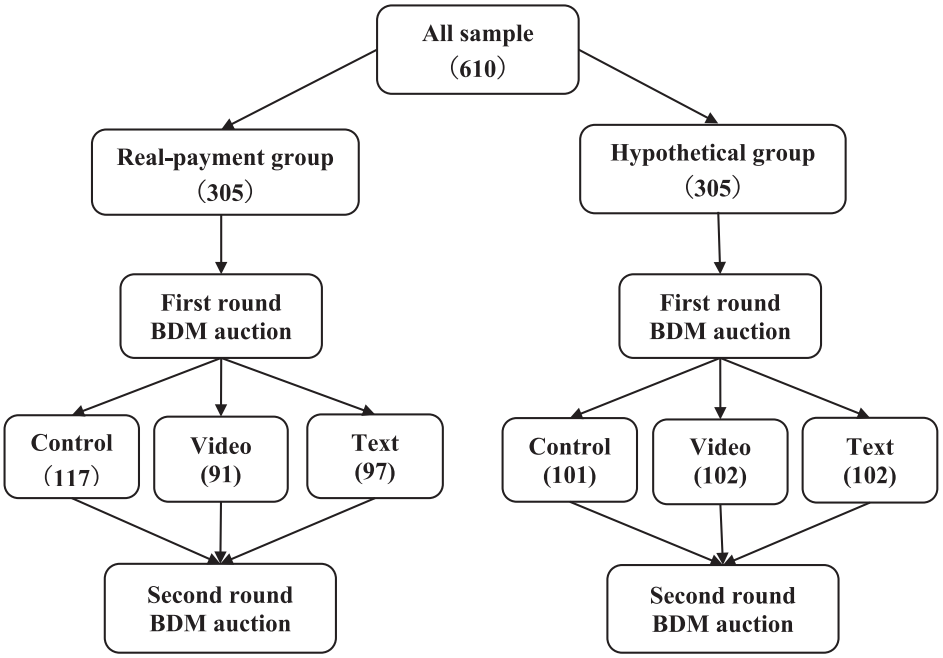


Fig. 2. Experiment design Notes: This figure presents the overall structure of the experiment, including the assignment of participants to the real-payment and hypothetical groups. The number of participants in each group is indicated in parentheses.

The questionnaire consisted of four sections: (1) BDM1 (first-round BDM auction), (2) information treatments, (3) BDM2 (second-round BDM auction), and (4) a demographic and environmental attitude survey. The demographic section collected detailed personal information on participants' individual characteristics (e.g., gender, age, education level), family information (e.g., number of children, household income), and consumption behavior (e.g., monthly lamb consumption, trust in market labeling). Environmental attitudes were assessed using the New Ecological Paradigm (NEP) scale, originally developed by Dunlap and Van Liere (1978) and later revised by Dunlap et al. (2000). The NEP scale consists of 15 statements evaluating perspectives on ecological limits, the balance of nature, human dominance over nature, and general environmental concerns. Responses were recorded on a five-point Likert scale (1 = "strongly disagree" to 5 = "strongly agree").

To familiarize participants with the BDM auction process, a practice round was conducted using a soap experiment, modeled after the trial BDM session described in Berry et al. (2020). The study was approved by the Ethics Committee of Peking University (Ethics Number: IRB00001052-20110), and all participants provided written informed consent.

2.3. Data and variable description

Table 1 presents the descriptive statistics of the key variables. Columns (1) to (3) report the mean values for the full sample, hypothetical group, and real-payment group. Column (4) displays the *p*-values from the *t*-test comparing the real and hypothetical groups. The *p*-values in column (4) indicate no notable statistical differences in the distribution of these variables between the real-payment and hypothetical groups, suggesting that the randomization process was effective, ensuring

Table 1
Descriptive statistics and balance check.

	All sample	Hypothetical group	Real group	*p*-value
	(1)	(2)	(3)	(4)
Female (1 = Yes)	0.59	0.59	0.58	0.81
Age [a]				
Youth (1 = Yes)	0.17	0.17	0.17	0.91
Young adult (1 = Yes)	0.31	0.32	0.30	0.54
Middle-aged (1 = Yes)	0.24	0.24	0.24	0.92
Senior (1 = Yes)	0.29	0.28	0.30	0.66
Education				
Below high school (1 = Yes)	0.12	0.12	0.13	0.71
High school (1 = Yes)	0.25	0.27	0.22	0.13
Undergraduate (1 = Yes)	0.53	0.50	0.55	0.17
Graduate (1 = Yes)	0.10	0.11	0.10	0.60
Household per capita monthly income [b]				
Low income (1 = Yes)	0.22	0.22	0.22	0.85
Lower middle income (1 = Yes)	0.23	0.22	0.24	0.70
Upper middle income (1 = Yes)	0.25	0.28	0.22	0.11
High income (1 = Yes)	0.22	0.22	0.32	0.33
Lamb consumption per month per capita [c]				
Low lamb consumption (1 = Yes)	0.39	0.37	0.40	0.56
Medium lamb consumption (1 = Yes)	0.31	0.30	0.32	0.60
High lamb consumption (1 = Yes)	0.31	0.33	0.29	0.25
Primary household food purchaser (1 = Yes)	0.55	0.54	0.56	0.75
The degree of trust in labels on the market [d]				
Low market trust (1 = Yes)	0.02	0.02	0.03	0.79
Moderately low market trust (1 = Yes)	0.16	0.15	0.18	0.27
Neutral market trust (1 = Yes)	0.39	0.41	0.38	0.46
Moderately high market trust (1 = Yes)	0.38	0.38	0.39	0.87
High market trust (1 = Yes)	0.04	0.04	0.03	0.39
Environmental attitude [e]				
Low environmental attitude (1 = Yes)	0.01	0.01	0.01	0.70
Moderately low environmental attitude (1 = Yes)	0.06	0.05	0.07	0.40
Neutral environmental attitude (1 = Yes)	0.14	0.14	0.13	0.56
Moderately high environmental attitude (1 = Yes)	0.40	0.40	0.41	0.80
High environmental attitude (1 = Yes)	0.39	0.39	0.39	0.87

Notes: The table provides the means of key variables across different groups. Columns (1) to (3) present the means for the full sample, hypothetical group, and real-payment group. Column (4) provides p-values from t-tests comparing the hypothetical and real-payment groups, serving as a baseline balance check. For reference, according to the 2021 Beijing census, 49 % of the population was female, with an average age of 40 years. Educational attainment was distributed as follows: 22 % below high school, 23 % with a high school diploma, 46 % holding an undergraduate degree, and 9 % with a graduate degree. Asterisks denote the level of statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[a] Age categories: Youth (<25 years old), Young adult (25–35 years old), Middle-aged (35–45 years old), and Senior (>45 years old).

[b] Household per capita monthly income categories: low income (~6,000 yuan), lower middle income (~16,000 yuan), upper middle income (~30,000 yuan), and high income (~72,000 yuan).

[c] Lamb consumption categories: low consumption (~0.21 kg per capita per month), medium consumption (~ 0.50 kg), and high lamb consumption (the group average is approximately 1.47 kg).

[d] Trust in market labels categories: low (complete distrust), moderately low, neutral, moderately high, and high (complete trust).

[e] Environmental attitude: measured by a representative item from the 15-item NEP scale: "Do you agree that the Earth is like a spaceship, with limited space and resources?" Responses were recorded on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Environmental attitudes were categorized into five levels: low, moderately low, neutral, moderately high, and high.

comparability across key variables. These tests serve as a balance check to verify that the distributions of key variables do not differ significantly between the two groups, confirming the effectiveness of our randomization process.

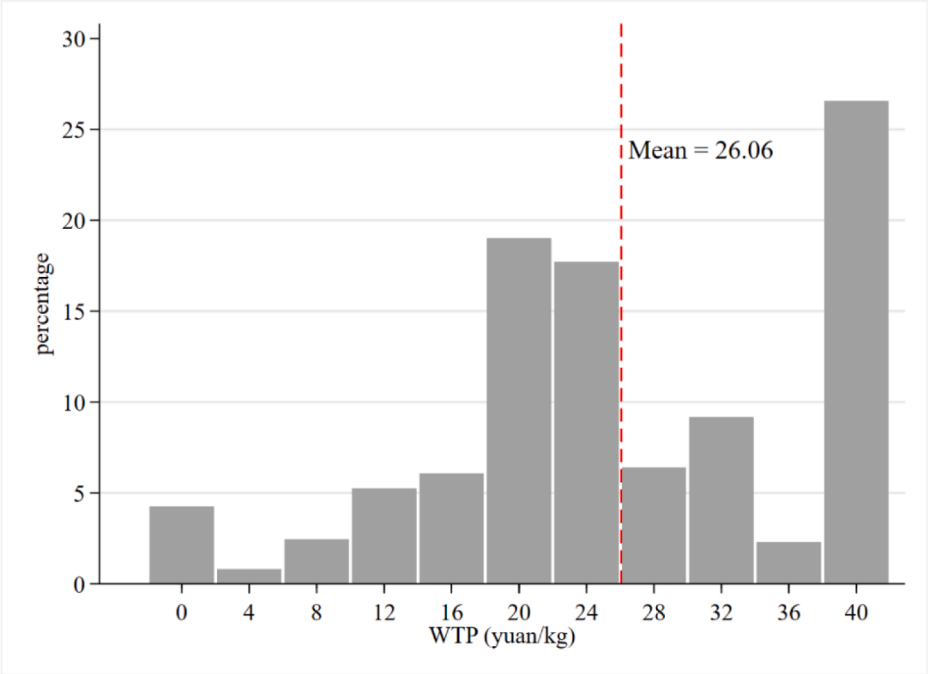
The sample in our study comprises 59 % female participants, a proportion that aligns with expectations, as women play a more significant role in household purchasing decisions and supermarket visits, particularly regarding food consumption (e.g., Loureiro and Umberger, 2003). The age distribution was around 38, with some variance between groups. Specifically, 17 % of participants were under 25 years old (Youth), 31 % were between 25 and 35 years old (Young adult), 24 % were between 35 and 45 years old (Middle-aged), and 29 % were over 45 years old (Senior). Participants generally had a higher educational attainment than the average Beijing population, with approximately two-thirds holding a bachelor's degree or higher. Regarding monthly household per capita income, 22 % earned less than 9,750 yuan (low income), 23 % earned between 9,750 and 20,000 yuan (lower middle income), 25 % earned between 20,000 and 36,000 yuan (upper middle income), and 22 % earned above 39,000 yuan (high income).

On average, participants reported consuming 0.69 kg of lamb per month. Participants were categorized into three groups: 39 % consumed an average of 0.21 kg of lamb per month (Low lamb consumption), 31 % consumed an average of 0.50 kg per month (Medium lamb consumption), and 31 % consumed an average of 1.46 kg per month (High lamb consumption). Additionally, 55 % identified themselves as the primary food shoppers for their households. Regarding market label trust, over 82 % of respondents indicated a level of trust rated as neutral or higher, reflecting a generally high level of trust in market labels. Similarly, 93 % of respondents demonstrated an environmental attitude rated as moderate or higher, indicating a predominantly positive stance on environmental issues.

3. Empirical strategy

To examine the effect of hypothetical bias and the impact of information interventions on consumers' WTP, we first employ regression models using data from the first phase of the BDM experiment.

(a) All samples



(b) Hypothetical sample

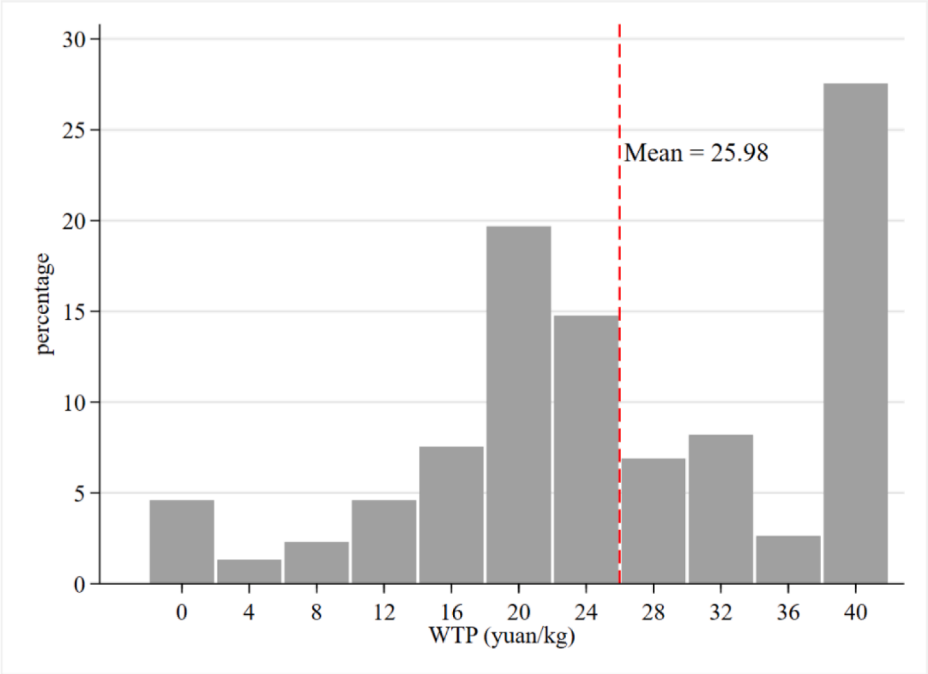


Fig. 3. Distribution of WTP for grassland-fed lamb over fence-fed lamb Notes: The figure presents the distribution of participants' WTP for grassland-fed lamb to fence-fed lamb. Panel (a) shows the distribution for the pooled sample, while panels (b) and (c) show the distribution for hypothetical and real samples, respectively.

(c) Real sample

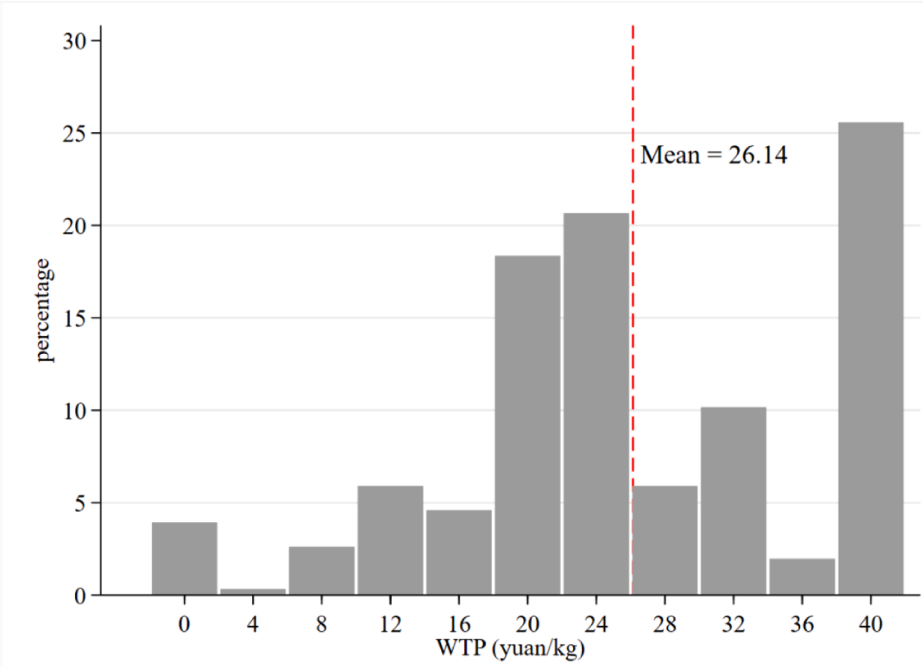


Fig. 3. (*continued*).

3.1. Hypothetical bias

We examine participants' WTP for substituting fence-fed lamb with grassland-fed lamb. We compare the WTP in the real payment to the hypothetical group to assess the presence of hypothetical bias. We estimate the following linear regression model:

$$WTP1_i = \alpha_0 + \alpha_1 Real_i + \alpha_2 X_i + Sup_j + Day_t + \varepsilon_i, \quad (1)$$

where $WTP1_i$ represents the amount that subject i is willing to pay for exchanging fence-fed lamb for grassland-fed lamb in the first round of the BDM auction. $Real_i$ is a binary indicator that equals 1 if subject i is assigned to the real-payment group, and 0 otherwise. X_i is a vector of socio-demographic variables (e.g., gender, age, education, household income, monthly lamb consumption, primary household food purchaser, trust in market labels, and environmental attitude). Even though our treatment is randomized, we still include the demographic controls to reduce standard errors. Sup_j controls for the fixed effects of the supermarkets. Day_t controls for the fixed effects of the survey dates. The coefficient of primary interest, α_1, captures the difference in impact between the real and hypothetical treatments on the WTP. ε_i is the random error term.

3.2. Effect of information interventions

Next, we examine how different information treatments influence participants' WTP between the first and second rounds of the BDM auction. This is assessed using the following regression model:

$$WTP2_i = \beta_0 + \beta_1 Text_i + \beta_2 Video_i + \beta_3 WTP1_i + \beta_4 X_i + Sup_j + Day_t + \varepsilon_i. \quad (2)$$

where $WTP2_i$ represents the amount subject i is willing to pay for exchanging fence-fed lamb for grassland-fed lamb in the second round of the BDM auction. $Text_i$ is a binary indicator variable that equals 1 if subject i receives text information about donations for grassland protection, and 0 otherwise. $Video_i$ is a binary indicator variable that equals 1 if subject i watches a video highlighting the differences between grassland-fed and fence-fed lamb, and 0 otherwise. $WTP1_i$, X_i, Sup_j and Day_t follow the same definitions as in equation (1). The coefficients of primary interest, β_1 and β_2, measure the effects of the text and video information treatments on subject i's WTP, respectively. ε_i is the random error term.

3.3. Variation between real-payment and hypothetical groups

Finally, we investigate whether the effects of the information treatments differ between the real-payment and hypothetical groups. We employed the following regression model:

$$WTP2_i = \gamma_0 + \gamma_1 Text_i + \gamma_2 Video_i + \gamma_3 Real_i + \gamma_4 (Text_i \times Real_i) + \gamma_5 (Video_i \times Real_i) + \gamma_6 WTP1_i + \gamma_7 X_i + Sup_j + Day_t + \varepsilon_i, \quad (3)$$

where $WTP1_i$, $WTP2_i$, $Text_i$, $Video_i$, $Real_i$, X_i, Sup_j and Day_t are defined as earlier. γ_4 and γ_5 are the coefficients of primary interests, as they measure the different effects of the text and video information treatments between hypothetical and real-payment groups.

4. Results

4.1. Willingness to pay for grassland-fed lamb

Our research focused on consumers' WTPs for grassland-fed lamb as a substitute for fence-fed lamb. The sample's average WTP for substituting fence-fed lamb with grassland-fed lamb was 26.06 yuan/kg (Fig. 3a), indicating a strong preference for grassland-fed lamb over fence-fed alternatives. According to data released by the Beijing Municipal Commission of Development and Reform, the average price of lamb in Beijing supermarkets in July 2021 was 100 yuan/kg,[6] suggesting that eco-labeling could potentially increase the price of grassland-fed

[6] Data source: https://fgw.beijing.gov.cn/gzdt/fgzs/gzdt/202110/t20211011_2510201.htm.

Table 2
Hypothetical bias between the real-payment and hypothetical groups.

	Dependent variable = WTP1			
	OLS		Tobit	
	(1)	(2)	(3)	(4)
Real or hypothetical group (1 = real, 0 = hypothetical)	0.16	−0.04	0.03	−0.18
	(0.175)	(−0.044)	(0.020)	(−0.141)
Constant	25.98***	21.31***	28.11***	22.23***
	(39.906)	(7.032)	(30.782)	(5.409)
Controls	No	Yes	No	Yes
Supermarket fixed effects	No	Yes	No	Yes
Date fixed effects	No	Yes	No	Yes
Observations	610	610	610	610
R-squared / Pseudo R2	0.000	0.094	0.000	0.016

Notes: The table presents the regression results testing for hypothetical bias in consumers' WTP for substituting fence-fed lamb with grassland-fed lamb between the real-payment and hypothetical groups. Columns (1) and (2) show the OLS regression results, while columns (3) and (4) display the Tobit regression results. The Tobit estimates are based on two-limit model with lower limit = 0 and upper limit = 40 yuan/kg. Compared to columns (1) and (3), columns (2) and (4) include control variables, supermarket fixed effects and time fixed effects in the regression. "R-squared / Pseudo R2" indicates the goodness-of-fit for OLS and Tobit models, respectively. t-statistics are shown in parentheses; asterisks denote the level of statistical significance, *** indicates $p < 0.01$, ** indicates $p < 0.05$, * indicates $p < 0.1$.

lamb by approximately 26 %. By comparing Figs. 3b and 3c, the WTP has a similar distribution, resulting in a similar average WTP, i.e., 26.16 yuan/kg for the real-payment group and 25.98 yuan/kg for the hypothetical group. Fig. B1 in Appendix B also presents the distribution of WTP across treatment arms, payment scenarios, and elicitation rounds.

Furthermore, we assess the potential presence of hypothetical bias by estimating the regression specified in equation (1). Since the dependent variable (WTP) is constrained by the survey design to the range of 0–40 yuan/kg, Fig. 3 shows that 31 % of observations are concentrated at the upper limit of 40 yuan/kg and the lower limit of 0 yuan/kg. Therefore, we employ both OLS and two-limit Tobit (Tobit) model to estimate the results. Columns (1) and (2) of Table 2 present the results from OLS estimation, both without and with control variables, respectively. Columns (3) and (4) display the results from the Tobit model. Across specifications, the coefficient on the hypothetical-group indicator is no statistically significant, indicating no meaningful difference in the WTP for substituting fence-fed lamb with grassland-fed lamb between the hypothetical and real-payment groups.

This finding may reflect several experiment-specific factors. First, we implemented multiple measures to enhance perceived consequentiality to mitigate hypothetical bias. Before the experiment, participants signed an informed consent form emphasizing the survey's policy relevance for grassland conservation and pastoral economic development.[7] Additionally, prior to each BDM round, participants were reminded that their choices could meaningfully influence grassland livestock policy.[8] Previous studies have shown that emphasizing perceived consequentiality can substantially reduce hypothetical bias (Carson and Groves, 2007; Vossler, Doyon, and Rondeau, 2012; Atozou et al., 2020).

Moreover, our BDM procedure closely follows Berry et al. (2020) and Goeb et al. (2020), providing participants with extensive training and practice rounds (e.g., a soap auction exercise) to ensure understanding of the mechanism. We also implemented a bid confirmation step, allowing participants to revise their initial bids before finalization, which reinforced learning and supported more deliberate decision-making.

To better understand the underlying motivations and preferences of consumers, we identified the factors that shape consumers' WTP for substituting fence-fed lamb with grassland-fed lamb. Fig. 4 presents the regression results for the factors influencing WTP. Age emerges as a significant determinant. Consumers aged 35–45 consistently show a higher WTP, approximately 3–4 yuan/kg more than younger consumers across all model specifications. This age group is typically more financially stable and places greater emphasis on food quality, health, and sustainability. Income also shows a strong, positive relationship with WTP, with high-income consumers paying an additional 3–4 yuan/kg in the full sample specifications.

Trust in market labels and environmental attitudes further influence WTP. A higher level of trust in market labels corresponds to a significant increase in WTP, with consumers trusting market labels willing to pay an additional 6–8 yuan/kg for grassland-fed lamb compared to those with neutral trust. Similarly, individuals with strong environmental attitudes are eager to pay 3–4 yuan/kg more, as evidenced by the significant positive coefficient for high environmental attitudes relative to the neutral baseline. Detailed regression results are provided in Appendix B, Table B2.

4.2. The impact of information treatment

To identify more effective information interventions that promote consumer WTP, we conducted an information treatment experiment between the first and second rounds of the auction. Table 3 presents the effects of these information treatments on consumers' WTP for substituting fence-fed lamb with grassland-fed lamb. The dependent variable is the WTP in round 2, while WTP from round 1 is included as a control variable. We estimated the effects using OLS models. The full regression results, including additional Tobit estimations, are reported in Appendix B (Tables B3 and B4).

Column (1) shows the pooled sample's results for both treatment conditions. The text treatment with donation significantly increases WTP by 1.2 yuan/kg compared to the control group. Separately, the video treatment substantially impacts consumer preferences, with participants willing to pay an additional 2 yuan/kg for grassland-fed lamb relative to the control condition. Both interventions effectively increase consumers' WTP premiums for grassland-fed lamb through different mechanisms and content approaches.

Columns (2) and (3) present separate analyses for hypothetical and real-payment groups, respectively. For the text treatment with donation practice, the text intervention demonstrates a positive effect on WTP (0.4 yuan/kg) in the hypothetical group, though this effect does not achieve statistical significance. In contrast, the real-payment group shows that the text treatment significantly raises WTP by 2.2 yuan/kg, demonstrating a stronger effect in real-payment settings compared to both the pooled sample and the hypothetical group.

[7] The informed consent specifically stated: "This survey aims to identify Chinese consumers' WTP for grassland-fed lamb to reflect the ecological value of grasslands, contribute to pastoral economic development and grassland ecological protection, and provide empirical evidence for national policies on quantifying natural resource values and implementing the 'lucid waters and lush mountains are invaluable assets' principle." It also noted: "Your participation will help the research team provide policy recommendations to relevant government departments, contributing to national ecological policy formulation. This will raise national and public awareness of grassland and ecological protection, benefiting you and future generations through improved environmental quality.".

[8] The specific reminder stated: "Your choices are of great significance to our research and the formulation of grassland livestock policies. Please make your choices based on your true preferences as much as possible." (See Appendix A for detailed experimental information).

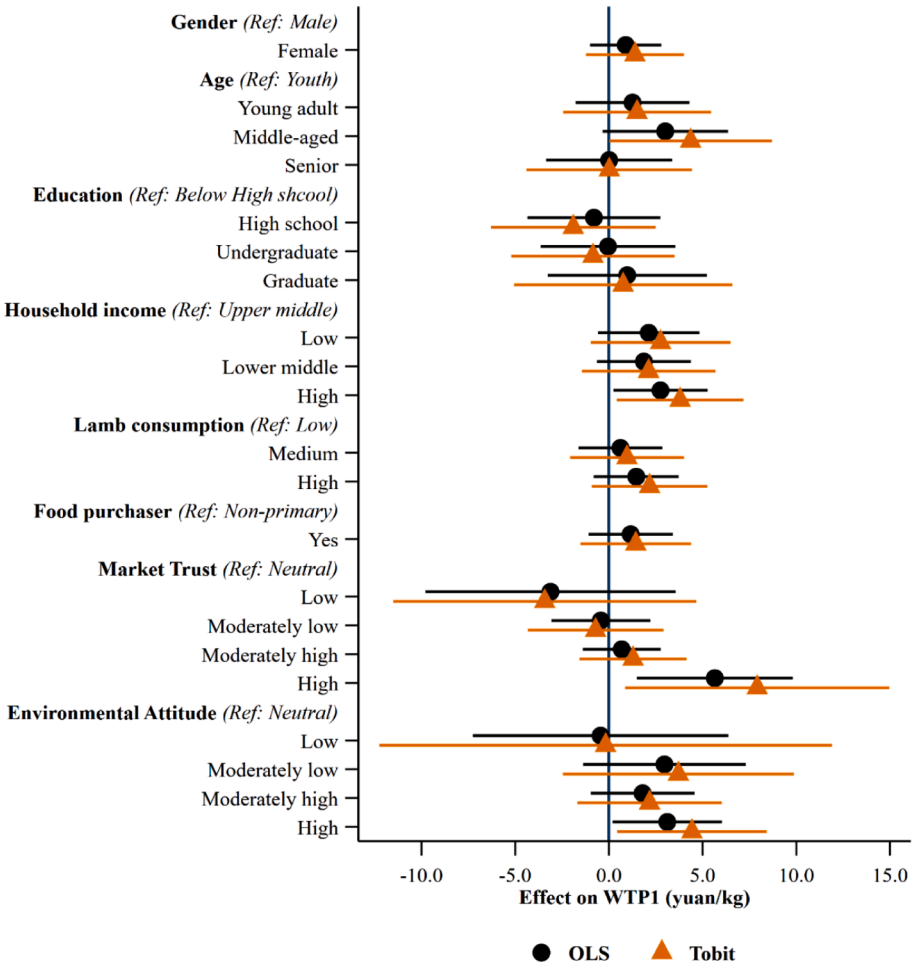


Fig. 4. Regression results of factors influencing consumers' WTP for grassland-fed lamb Notes: The figure presents the regression results of factors influencing consumers' WTP for substituting fence-fed lamb with grassland-fed lamb. Both OLS (blue circles) and Tobit (orange triangles) models are estimated with 95 % confidence intervals shown as horizontal lines. The Tobit estimates are based on two-limit model with lower limit = 0 and upper limit = 40 yuan/kg. The points indicate the estimated coefficients of different explanatory variables relative to their respective baseline categories. Reference categories (Ref in the figure above) are: Male for gender, Youth for age groups, Below high school for education levels, Upper middle income for household income categories, Low consumption for lamb consumption levels, Non-primary purchaser for food purchasing responsibility, Neutral trust for market trust levels, and Neutral attitude for environmental attitude categories. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

For the video treatment, in the hypothetical group, the video intervention shows a positive effect on WTP (1.1 yuan/kg), but similarly lacks statistical significance. However, in the real-payment group, the video treatment yields a significant increase in WTP, with respondents willing to pay an additional 2.6 yuan/kg for grassland-fed lamb, representing a slightly stronger effect than the pooled sample.

These findings indicate that video treatment, which provides detailed comparisons of grassland-fed and fence-fed lambs, significantly increases the premium for substituting fence-fed lamb with grassland-fed lamb in both hypothetical and real contexts, with a more pronounced effect in real-payment settings. The text treatment with a donation practice also has a positive impact on premiums, demonstrating the effectiveness of this intervention approach. The visual nature of vide content may contribute to its efficacy through enhanced consumer attention and engagement (DeLong et al., 2021; Penn and Hu, 2021; Schifferstein, Lemke, and de Boer, 2022), while text-based interventions with donation framing may influence consumer preferences through different psychological mechanisms (He and Gao, 2015; Kilders and Caputo, 2021; Musto et al., 2015).

To examine whether treatment effects differ between payment contexts, column (4) presents the interaction analysis. For the text-based information, the results indicate a significant difference between the two payment groups. Specifically, text information has a stronger positive effect on participants' WTP in the real-payment context compared to the hypothetical context. This difference is likely due to the absence of actual financial consequences in the hypothetical condition, which may reduce participants' motivation to process the information carefully, weakening the intervention's effectiveness (Lusk et al., 2005; Olesen et al., 2010; Penn and Hu, 2018). In contrast, the real-payment condition involves actual financial commitments and product acquisition, prompting consumers to behave more cautiously and rationally. Consequently, they are more likely to engage with and reflect on the text information provided, resulting in a deeper understanding of the product and a corresponding increase in their WTP.

For the video information, the interaction analysis shows no significant difference between the real-payment and hypothetical contexts. This suggests that video content captures participants' attention and influences their WTP regardless of payment context (Kilders and Caputo, 2021; Penn and Hu, 2021; Schifferstein, Lemke, and de Boer, 2022). The sensory-rich and vivid nature of video appears to consistently shape consumer valuation, making it less sensitive to contextual differences between payment contexts.

5. Discussion and conclusion

This study investigates the WTP of Chinese consumers for

Table 3
Effects of information treatments on WTP for grassland-fed lamb: Comparison between real and hypothetical payment groups.

	Dependent variable = WTP2			
	All sample	Hypothetical group	Real group	All sample × Interaction
	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)
Text treatment (1 = Yes)	1.246**	0.381	2.168**	−0.08
	(1.994)	(0.438)	(2.455)	(−0.095)
Video treatment (1 = Yes)	2.041***	1.133	2.613***	1.08
	(3.452)	(1.331)	(3.097)	(1.297)
Real or hypothetical group (1= real, 0 = hypothetical)				−1.81**
				(−2.322)
Text × Real				2.53**
				(2.085)
Video × Real				1.78
				(1.494)
WTP1	0.732***	0.733***	0.722***	0.73***
	(25.926)	(17.658)	(18.167)	(25.520)
Controls	Yes	Yes	Yes	Yes
Supermarket fixed effects	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes
Constant	8.344***	5.388*	11.309***	9.36***
	(4.018)	(1.750)	(4.280)	(4.177)
Observations	610	305	305	610
R-squared	0.663	0.686	0.690	0.666

Notes: This table presents OLS regression results examining the effects of information treatments on WTP for grassland-fed lamb over fence-fed lamb. Column (1) shows results for the full sample, columns (2) and (3) present separate results for hypothetical and real payment groups, respectively, and column (4) includes interaction terms to test for differential treatment effects between payment conditions. t-statistics are reported in parentheses; asterisks denote the level of statistical significance, *** indicates $p<0.01$, ** indicates $p<0.05$, and * indicates $p<0.1$.

substituting fence-fed lamb with grassland-fed lamb and the impact of information treatment on their WTPs, particularly the differences between the real-payment group and the hypothetical group. We implemented a field experiment in Beijing supermarkets utilizing the BDM auction mechanism to estimate consumers' premium valuation of grassland-fed lamb compared to fence-fed lamb. To further investigate the effect of information treatment on consumers' WTP and assess heterogeneous treatment effects across different consequentiality contexts, we randomly assigned participants in both the real-payment and hypothetical groups to receive text (with a donation practice) or video (comparing product attributes) information interventions. Our hypothetical treatment applies the BDM method as a comparative benchmark. We acknowledge that the use of BDM in a hypothetical setting is uncommon in the literature, since the mechanism's incentive compatibility fundamentally depends on real payments and consequentiality (Becker et al., 1964). Although a hypothetical BDM is not incentive compatible in a strict sense, as it lacks the financial consequences that induce truthful revelation, we employ it to provide a benchmark for systematic comparison with real-payment contexts. This approach enables us to examine how the presence or absence of consequentiality influences the effects of information treatments on consumers' stated willingness to pay. Recent literature has used a similar approach to estimate the impact of different levels of payment probability in welfare measurement (Liu and Tian, 2021).

Our findings reveal an average WTP premium of 26.06 yuan/kg for grassland-fed lamb, representing a 26 % price premium over conventional fence-fed lamb. This demonstrates that consumers recognize and value grassland-fed lamb as an ecological product that reflects underlying grassland ecosystem services. The substantial premium further suggests that current market prices do not fully capture the economic value of these services, as grassland-fed and fence-fed lamb are generally sold at similar prices despite their different ecological attributes.

As the first empirical estimation of WTP for grassland-reared lamb, our study provides critical evidence for valuing grassland ecosystem services. The findings inform the design of policies that promote sustainable grassland management and support ecological compensation mechanisms. Importantly, the observed premium shows that consumers place tangible value on ecological attributes. This suggests that transparent eco-labeling and clear communication of grassland-fed lamb's environmental benefits and cultural heritage can reduce information asymmetries and enable consumers to recognize and pay for ecosystem services embedded in pastoral products.

Moreover, we found no significant difference in consumers' WTP for substituting fence-fed lamb with grassland-fed lamb between real-payment and hypothetical payment contexts. The result likely reflects our use of consequentiality framing (Carson and Groves, 2007; Vossler et al., 2012; Atozou et al., 2020) and a carefully designed BDM procedure with training and bid confirmation (Berry et al., 2020; Goeb et al., 2020). These methodological features enhance the credibility of our findings and provide guidance for future valuation studies. Importantly, wealthier, environmentally conscious, and label-trusting consumers exhibited higher WTP, suggesting that eco-labeling policies should be paired with targeted awareness campaigns to expand their effectiveness.

In the information treatment experiment, both treatments increased consumers' WTP for grassland-fed lamb, but their effects differed across real-payment and hypothetical settings. The text intervention, framed with a donation practice, significantly increased WTP in the real-payment context, suggesting that such framing may be particularly effective when consumers face actual financial trade-offs. This finding aligns with prior studies showing that donation-related messages can enhance prosocial motivations and willingness to support ecological products (He and Gao, 2015; Kilders and Caputo, 2021; Musto et al., 2015). Moreover, the video intervention, which emphasized detailed comparisons between grassland-fed and fence-fed lamb, produced consistent positive effects across both contexts. The visual nature of video content likely enhances consumer attention and comprehension of product attributes, allowing it to maintain its influence regardless of payment context (Richardson, 1977; Riding, 2001; Mayer and Massa, 2003; DeLong et al., 2021; Lin et al., 2024).

This study has several limitations. First, the sample was drawn from 13 major supermarkets in densely populated urban areas, which may not fully represent the broader Chinese consumer population. Although we controlled for observable characteristics such as education and income, unobserved specific to supermarket shoppers could introduce selection bias. In addition, restricting the analysis to urban consumers in Beijing may limit generalizability, as preferences, information processing, and willingness to pay may differ in rural areas or other provinces. Future research should therefore draw on more geographically and socioeconomically diverse samples to better capture the heterogeneity of Chinese consumers.

Second, the study relied on a custom eco-label certified by Peking University's School of Advanced Agricultural Sciences, rather than a nationally recognized or widely marketed third-party label. Although the university endorsement provides credibility in the absence of established grassland-fed lamb certifications in China, its perceived trustworthiness may differ from that of official or commercial labels. This could lead to an underestimation of WTP and limits external validity of our findings. Future research should examine how different types of endorsements, such as governmental, industry, or internationally recognized labels, affect consumer valuation and the effectiveness of

informational interventions.

Third, a limitation concerns the informational interventions. Although framed as "video" versus "text," they also differed in content: the video emphasized intrinsic product attributes (private benefits), while the text highlighted a pro-social donation (prosocial motivations). As a result, the study cannot fully disentangle media format from message content. Nonetheless, we report results for each intervention separately to avoid misleading comparisons. Future research could design treatments that systematically vary content and format to more rigorously isolate their respective effects.

CRediT authorship contribution statement

Lingling Hou: Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization. **Na Liu:** Writing – original draft, Software, Methodology, Formal analysis, Data curation. **Pengfei Liu:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Xinxin Lv:** Writing – original draft, Investigation, Data curation. **Saiwei Li:** Writing – review & editing, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Appendix A:. Field survey questionnaire

The detailed steps of the BDM experiment.

For a participant, the BDM experiment is divided into four steps: BDM experimental practice, the first round of the BDM experiment, information intervention, and the second round of the BDM experiment.

Step 1: BDM experimental practice

Before delving into the BDM auction experiment, let me first explain the process of a BDM auction **using soap as a simple example** to illustrate how it works.

Regular soap

Essential oil soap

Assuming you have a regular soap weighing 108 g, you can exchange it for an essential oil soap of the same weight by paying a certain amount.

- Step 1: You need to write down the highest amount (an integer between 0 and 10) that you are willing and able to pay.
- Step 2: The system automatically generates an integer between 0 and 10.
- Step 3: If the number you wrote down is greater than or equal to the number generated by the system, you can exchange the regular soap for the essential oil soap and pay the lower amount generated by the system. For example, suppose the highest amount you are willing and able to pay is 8 yuan, and the system generates a value of 6 yuan. In that case, you will pay 6 yuan to exchange the regular soap for the essential oil soap (see details in Table A1).
- Step 4: If the number you wrote down is less than the number generated by the system, you cannot exchange it for essential oil soap. For example, suppose the highest amount you are willing and able to pay is 8 yuan, and the system generates a value of 9 yuan. In that case, you will not be able to exchange the regular soap for essential oil soap (see details in Table A1).

Table A1
Examples of criteria for experimental result determination.

The highest amount that you are willing and able to pay	The number randomly generated by the system	The result of whether it is possible to switch to grassland-fed lamb	The actual payment amount (yuan)
8	10	No	–
8	9	No	–
8	8	Yes	8
8	7	Yes	7
8	6	Yes	6
8	5	Yes	5
8	4	Yes	4
8	3	Yes	3
8	2	Yes	2
8	1	Yes	1
8	0	Yes	0

Let's start the soap practice experiment

==========.

Regular soap

Essential oil soap

1. Assume you have a regular soap weighing 108 g in your hand, and you can pay a certain amount to exchange it for an essential oil soap of the same weight. Please write down **the maximum amount you are willing and able to pay**. 【X】 yuan (Please enter an integer between 0 and 10)

==========.

2. The maximum amount you are willing and able to pay is 【X】. The system will randomly generate an integer between 0 and 10. If the number you write down is greater than or equal to the number generated by the system, then you will exchange for the essential oil soap at the amount generated by the system; if the number you write down is less than the number generated by the system, then even if you are willing to pay the larger number generated by the system at this time, you will not be able to exchange for the essential oil soap. Do you understand?

[Understood, next step.] [Go back to the previous page to modify.]

==========.

3. (1) What would you do if the system generates a number of 【X + 1】?

A. Cannot exchange for essential oil soap.

B. Pay X + 1 to exchange for essential oil soap.

C. Pay X to exchange for essential oil soap.

(2) What would you do if the system generates a number of 【X-1】?

A. Cannot exchange for essential oil soap.

B. Pay X-1 to exchange for essential oil soap.

C. Pay X to exchange for essential oil soap.

(Note: If X = 0, only ask the first question; if X = 10, only ask the second question. If both questions are answered correctly, proceed to question (4); otherwise, the system will prompt "Answer to (n) is incorrect, please read the rules of this experiment again." If X = 10 and the answer is correct, proceed directly to question (6).).

==========.

4. If the system generates 【X + 1】, would you like to pay 【X + 1】 to switch to essential oil soap?

[Yes]→ (5) [No] → (6)

==========.

5. Would you like to change your bid to 【X + 1】?

[Yes]→ (2) (and replace X with X + 1) [No] → (6)

==========.

6. Is X really the amount you most want to pay? [Yes]→ (7) [No]→ (1)

[Yes]→ (7) [No] → (1)

==========.

7. If you choose X, you must be able to pay X. Can you pay X?

[Yes]→ (Record X in the background) [No] → (1)

==========.

8. Now you need to click the button below to draw one of the 11 balls marked with numbers from 0 to 10

(Note: Record the number Y in the background).

(If X > Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is greater than the random number generated by the system, so that you can switch to essential oil soap, and the amount to be paid is Y.").

(If X = Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is equal to the random number generated by the system, so that you can switch to essential oil soap, and the amount to be paid is Y.").

(If X < Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is less than the random number generated by the system, so you cannot switch to essential oil soap.").

==========.

Step 2: The first round of the BDM experiment

Participants will be randomly assigned to either the real or the hypothetical groups. The underlined and highlighted text below represents the most significant difference between the real and hypothetical groups.

Let's begin the formal experiment with lamb.

【Real group】

In the first group of experiments, we will pay you a research compensation of 10 yuan, which will be transferred to you via WeChat after completing the questionnaire. Additionally, you will receive half a catty (250 g) of fence-fed lamb for free, and you can choose to exchange it for half a catty (250 g) of grassland-fed lamb by paying a certain amount. Whether you can make the exchange and the amount you need to pay will depend on your bid and a random number generated by the system. This is a common rule used in the BDM auction method, which is very scientific. However, the amount you ultimately pay will not exceed your bid, and you might even be able to exchange for grassland-fed lamb for less money. After you answer the questions, we will send you either fence-fed lamb or grassland-fed lamb based on your responses. If you choose grassland-fed lamb, you will need

to pay the corresponding amount, which will be deducted from the 10 yuan we give you, and there is no need for you to pay extra. Your choices are of great significance to our research and the formulation of grassland livestock policies. Therefore, please make your choices based on your true behavior as much as possible.

Now let's begin the experiment:

(No labels)

Fence-fed lamb

Grassland-fed lamb

1. We give you a free half-catty (250 g) of fence-fed lamb. You can pay a certain amount to upgrade to 250 g of grassland-fed lamb. What is the maximum amount you are willing and able to pay? based on your honest response, we will send you either fence-fed lamb or grassland-fed lamb within 7 working days after you submit the questionnaire. If you choose grassland-fed lamb, you will need to make a real payment, which will be deducted from the 10 yuan compensation we provide you, and you do not need to pay extra. 【X】 (Please enter an integer between 0 and 10). If you enter 0 yuan, you will not pay any amount to upgrade to 250 g of grassland-fed lamb

==========.

2. The number you have chosen is 【X】. The system will randomly generate an integer between 0 and 10. If the number you wrote is greater than or equal to the number generated by the system, then you can upgrade to grassland-fed lamb for the number generated by the system. If the number you wrote is less than the number generated by the system, and even if you are willing to pay the larger amount generated by the system at this time, you will not be able to upgrade to grassland-fed lamb. Do you understand?

[Understood, next step.] [Go back to the previous page to modify.]

==========.

3. What would you do if the system generates a number of 【X + 1】?

A. Cannot exchange for grassland-fed lamb.

B. Pay X + 1 to exchange for grassland-fed lamb.

C. Pay X to exchange for grassland-fed lamb.

(2) What would you do if the system generates a number of 【X-1】?

A. Cannot exchange for grassland-fed lamb.

B. Pay X-1 to exchange for grassland-fed lamb.

C. Pay X to exchange for grassland-fed lamb.

(Note: If X = 0, only ask the first question; if X = 10, only ask the second question. If both questions are answered correctly, proceed to question (4); otherwise, the system will prompt "Answer to (n) is incorrect, please read the rules of this experiment again." If X = 10 and the answer is correct, proceed directly to question (6).).

==========.

4. If the system generates 【X + 1】, would you like to pay 【X + 1】 to switch to grassland-fed lamb?

[Yes]→ (5) [No] → (6)

==========.

5. Would you like to change your bid to 【X + 1】?

[Yes]→ (2) (and replace X with X + 1) [No] → (6)

==========.

6. Is X really the amount you most want to pay? [Yes]→ (7) [No]→ (1)

[Yes]→ (7) [No] → (1)

==========.

7. If you choose X, you must be able to pay X. Can you pay X?

[Yes]→ (Record X in the background) [No] → (1)

==========.

8. Now you need to click the button below to draw one of the 11 balls marked with numbers from 0 to 10

(Note: Record the number Y in the background)

(If X > Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is greater than the random number generated by the system, so that you can switch to grassland-fed lamb, and the amount to be paid is Y.")

(If X = Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is equal to the random number generated by the system, so that you can switch to grassland-fed lamb, and the amount to be paid is Y.")

(If X < Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is less than the random number generated by the system, so you cannot switch to grassland-fed lamb.")

==========.

【Hypothetical group】

In the first group of experiments, we will pay you a research compensation of 10 yuan, which will be transferred to you via WeChat after completing the questionnaire. Suppose we give you half a catty (250 g) of fence-fed lamb, you can exchange it for half a catty (250 g) of grassland-fed lamb by paying a certain amount. Whether you can make the exchange and the amount you need to pay will depend on your bid and a random number generated by the system. This is a common rule used in the BDM auction method, which is very scientific. However, the amount you ultimately pay will not exceed your bid, and you might even be able to exchange for grassland-fed lamb for less money. Although in this experiment you do not need to make actual payments, nor do you need to exchange the lamb, your choices are significant to our research and the formulation of grassland livestock policies. Therefore, please make your choices as much as possible based on your true behavior.

Now let's begin the experiment:

(No labels)

Fence-fed lamb

Grassland-fed lamb

1. Suppose we give you a free box of half a catty (250 g) of fence-fed lamb. You can pay a certain amount to switch to 250 g of grassland-fed lamb. What is the maximum amount you are willing and able to pay? **【X】** (Please enter an integer between 0 and 10). If you enter 0 yuan, you will not pay any amount to switch to 250 g of grassland-fed lamb

==========.

2. The number you have chosen is 【X】. The system will randomly generate an integer between 0 and 10. If the number you wrote is greater than or equal to the number generated by the system, then you can upgrade to grassland-fed lamb for the number generated by the system. If the number you wrote is less than the number generated by the system, and even if you are willing to pay the larger amount generated by the system at this time, you will not be able to upgrade to grassland-fed lamb. Do you understand?

[Understood, next step.] [Go back to the previous page to modify.]

==========.

3. (1) What would you do if the system generates a number of 【X + 1】?

A. Cannot exchange for grassland-fed lamb.

B. Pay X + 1 to exchange for grassland-fed lamb.

C. Pay X to exchange for grassland-fed lamb.

(2) What would you do if the system generates a number of 【X-1】?

A. Cannot exchange for grassland-fed lamb.

B. Pay X-1 to exchange for grassland-fed lamb.

C. Pay X to exchange for grassland-fed lamb.

(Note: If X = 0, only ask the first question; if X = 10, only ask the second question. If both questions are answered correctly, proceed to question (4); otherwise, the system will prompt "Answer to (n) is incorrect, please read the rules of this experiment again." If X = 10 and the answer is correct, proceed directly to question (6).).

==========.

4. If the system generates 【X + 1】, would you like to pay 【X + 1】 to switch to grassland-fed lamb?

[Yes]→ (5) [No] → (6)

==========.

5. Would you like to change your bid to 【X + 1】?

[Yes]→ (2) (and replace X with X + 1) [No] → (6)

==========.

6. Is X really the amount you most want to pay? [Yes]→ (7) [No]→ (1)

[Yes]→ (7) [No] → (1)

==========.

7. If you choose X, you must be able to pay X. Can you pay X?

[Yes]→ (Record X in the background) [No] → (1)

==========.

8. Now you need to click the button below to draw one of the 11 balls marked with numbers from 0 to 10

(Note: Record the number Y in the background)

(If X > Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is greater than the random number generated by the system, so that you can switch to grassland-fed lamb, and the amount to be paid is Y.")

(If X = Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is equal to the random number generated by the system, so that you can switch to grassland-fed lamb, and the amount to be paid is Y.")

(If X < Y, display "The system randomly selected the integer Y. The maximum difference you are willing and able to pay is less than the random number generated by the system, so you cannot switch to grassland-fed lamb.")

==========.

Step 3: Information intervention

Participants will be randomly assigned to three different information intervention groups: the control group, the text information intervention group, and the video information intervention group.

【Control group】

None.

【Text information intervention group】

Before conducting the second round of BDM experiments, the following text information will be explained to the interviewees.

Text information

20 % of your premium is donated to the Grassland Environmental Protection Project of the China Greening Foundation.

(Note: The China Greening Foundation is an important organization approved by the state to raise private funds for greening. Its mission is to promote land greening, maintain ecological balance, and promote harmonious development between humans and nature.)

【Video information intervention group】

Before conducting the second round of BDM experiments, the interviewees will be shown the following video.

Video information brief introduction

The video is approximately 2 min long and primarily covers the advantages of grassland-fed lamb in terms of taste, nutrition, etc. It compares the living environments of grassland-fed and fence-fed lamb and provides information on differences in animal welfare.

Step 4: The second round of the BDM experiment

Respondents from the real group who participated in the first round will carry out the second round of BDM experiments within the real group, and respondents from the hypothetical group who were part of the first round will do the same for their respective hypothetical group.

We will conduct the second round of BDM experiments, which will be identical in method and procedure to the first set of experiments. Please note that your bid does not need to be the same as in the first set of experiments.

【Real group】

Consistent with the first round mentioned above, details are omitted.

【Hypothetical group】

Consistent with the first round discussed above, details are omitted.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodpol.2025.103001.

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