Journal of Agricultural and Applied Economics (2025), **57**, 199–217
doi:10.1017/aae.2024.37

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

Willingness to Pay with Reference-dependent Preferences: A Comparative Analysis of Attribute-based and Alternative-based Approach

Manlin Cui[1], Chengyan Yue[1,2], Erin L. Treiber[2] and Matthew Clark[2]

[1]Department of Applied Economics, University of Minnesota, Minneapolis, MN, USA and [2]Department of Horticultural Science, University of Minnesota, Minneapolis, MN, USA
Corresponding author: Chengyan Yue; Email: yuechy@umn.edu

Abstract
Consumer preferences are often influenced by reference-dependent preferences. This study investigates the influence of reference-dependent preferences on the estimation of willingness to pay (WTP) for table grape attributes elicited by a second-price auction. We evaluate two models: the attribute-based reference dependence model, where individuals compare the target product's attributes with their favorite ones, and the alternative-based reference dependence model, where comparisons are made with a reference product. Results show that including reference points impacts the WTP estimation for different attributes, with varying levels of loss aversion, suggesting the attribute-specific influence of reference points.

Keywords: Experimental auction; loss aversion; product attribute

JEL classifications: D44; D91; M30

1. Introduction

Reference-dependent consumer preference and choice have been the focus of marketing and behavioral decision research for decades. In decision making, consumers often compare things of interest to a certain reference level when making judgements and choices (Amaldoss and He, 2018; Dhar et al., 1999; Karle et al., 2015; Kim et al., 2020; Neuman and Neuman, 2008). Similar to other consumer decisions, consumer willingness to pay (WTP) for a product/service or its attributes can be largely influenced by reference points, which are often shaped by consumers' past experiences or previous choices (Foutz, 2004) and are considered internal since they are memory-based and relatively stable (Bell and Bucklin, 1999).

In this paper, we empirically test the influence of reference-dependent preferences on the estimation of WTP for table grape attributes elicited by a second-price auction. Experimental auction settings are particularly suitable for this study because participants need to indicate a dollar value for the auctioned product, leading them to rely more on past experiences as reference points. We employ two approaches that consumers may use to compare the target product with either preferred product attributes or a reference product. Namly the attribute-based reference dependence model, where individuals compare the target product's attributes with their preferred ones, and the alternative-based reference dependence model, where comparisons are made with a specific reference product. We extended the hedonic price model to incorporate these reference points, and compared WTP estimations for marketable attributes, with and without considering participants' reference points.

We chose table grapes for two reasons. First, table grapes are significant economic commodities that can be purchased in many marketplaces. We informed participants in the experimental auction that they could imagine themselves purchasing these table grapes at the marketplaces and consider how much they would be willing to spend. Second, we selected eight table grape varieties of 16-ounce to be bid on in the experimental auction. Five of the eight table grape varieties were newly developed cold-hardy table grape varieties and were unavailable in the local marketplace at the time of the study. This presents a scenario of estimating demand for novel products and determining consumer preferences for their attributes. In 2021, the U.S. produced 6.05 million tons of grapes valued at $5.53 billion. California, with its favorable climate, led production with 5.75 million tons (National Agricultural Statistics Service, 2022). Although grapes can grow in various climates, specific varieties for wine, table grapes, or juice are restricted to certain regions (Agricultural Marketing Resource Center, 2023). Recently, the University of Minnesota has advanced breeding cold-hardy table grapes, developing new cultivars with improved quality and cold-storage attributes (Treiber et al., 2022). These varieties offer locally produced, healthy food and benefit farmers and rural economies.

Our study focusses on key attributes of table grapes - color, taste, and seed character. Previous literature presents mixed evidence on the valuation of table grape attributes. For example, Piva, Garcia, and Morgan (2006) found that Spanish consumers prioritize sweetness in table grapes as the top-quality characteristic, followed by thin skin and few or no seeds. Wu et al. (2018) observed that Chinese consumers prefer sweet, seedless table grapes. However, Wang et al. (2017) found that among Chinese farmers, seed-lessness was less valued, with compact clusters and large, dark red berries being highly preferred. Similarly, Seccia, Viscecchia, and Nardone (2019) discovered that about half of Italian consumers never purchase seedless or organic table grapes. Therefore, this paper also adds to the literature by investigating consumer preferences for table grapes in the U.S. market.

Our findings suggest that compared to the traditional hedonic price model that does not account for reference-dependent preferences, our model shows that reference points have different effects on WTP estimations for various attributes. When the evaluated product deviates from consumer's reference points, their WTP shifts accordingly. Preferences for taste and seed character of table grapes are particularly sensitive to these reference points, resulting in lower WTP for attributes other than seedless grapes and balanced taste. Moreover, deviations from the reference point are seen as gains when the product is better and as losses when it is worse, with losses generally having a stronger effect than equivalent gains. Consumers exhibit the highest loss aversion for seed character of table grapes, followed by their taste. Our results highlight the importance of considering attribute-specific reference points when estimating WTP for products and services, which is crucial for developing effective marketing, pricing, and segmentation strategies. Ignoring reference points, especially for attributes that consumers are likely to feel strong loss aversion toward, could lead to biased WTP estimations.

This paper makes three contributions to existing literature. First, we provide additional evidence on how reference-dependent preferences affect the estimation of WTP for product attributes. Mazumdar et al. (2005) was one of the first few literatures to compare traditional and reference-dependent models incorporating reference prices. Similarly, Caputo et al. (2020) studied consumer decision-making when reference prices are uncertain. Lim and Hu (2023) studied the contextual reference price in choice experiments found that WTP estimates were lower when respondents were reminded of their self-reported reference prices, similar findings are also found in McAdams et al., (2015).

Bansal et al. (2021) explored how product attributes, other than price, serve as reference points for consumer WTP for electric vehicles. They conducted discrete choice experiments using internal combustion engine vehicles with various attribute combinations as reference points. Their findings suggested that considering reference-dependent preferences leads to more accurate WTP estimates. However, their study did not test consumer loss aversion since electric vehicles were

https://doi.org/10.1017/aae.2024.37 Published online by Cambridge University Press

either better or worse in terms of specific attributes. Mao et al. (2020) used the status quo of wetland deterioration as the reference point to study consumer WTP for wetland management policies using a discrete choice experiment. They found that the reference dependence model predicts choices more accurately. However, they applied a single loss aversion parameter across all attributes, which limited their ability to assess how consumers evaluate deviations from the reference point and how this affects WTP estimation. In the food demand literature, Hu, Adamowicz, and Veeman (2006) investigated the labeling context relating to genetically modified food, incorporating both price and reference point effects in their food demand models.

Second, while most previous papers examine reference dependence in discrete choice experiments, this paper adds to the literature by studying it in the experimental auction context (Bansal et al., 2021; Mao et al., 2020; Wang et al., 2021). In the field of experimental auction with reference-dependent preference, Lusk, Feldkamp, and Schroeder (2004) found that endowing participants with a product before eliciting bids can significantly impact their valuations. Similarly, Zhou et al. (2021) demonstrated that a lower reference point in perceived freshness positively impacts consumer's WTP. While these studies primarily test whether the presence of a reference point affects choice, this paper takes a different approach by extending the hedonic price model to incorporate reference points within experimental auction settings to study consumer preferences and valuations of different attributes. This extends the empirical model beyond the widely used choice-based models and adds evidence on the impact of reference points in reveled preference approaches such as experiment auction settings.

Third, we study structural heterogeneity by examining two choice rules that consumers use when making comparisons with a reference point. While preference heterogeneity, such as variations in consumer preferences based on individual characteristics and product types, has been extensively studied, structural heterogeneity - the differences in the decision-making process and the choice rules used - has received limited attention so far (Wang et al., 2021). This paper takes a different aspect by exploring how reference points are structured and their effect on consumer WTP. The literature documents two referencing strategies, namely attribute-based referencing and alternative-based referencing. Attribute-based referencing involves constructing reference points for each attribute and comparing the product's attributes with the corresponding referenced attributes (Scheibehenne et al., 2015; Tereyagoglu et al., 2017). Alternative-based referencing involves constructing a reference alternative for a product and comparing the product's attributes with the corresponding alternative's attributes (Chernev, 2003; Hardie et al., 1993).

The following paragraphs are organized as follows: Section 2 elaborates on the model setup, Sections 3 describes the experiment procedures and data collection, Section 4 presents the results and Section 5 concludes.

2. Model setup

The hedonic price model evaluates differentiated products using a vector of objectively measured characteristics (Rosen, 1974). It has found extensive applications in determining the values of housing attributes and assessing the prices of non-market goods in environmental economics studies. The model has later been applied to marketing and consumer behavior areas to estimate how much consumers are willing to pay for different product attributes that influence consumer utility (Melton et al., 1996). Given the experimental auction data, which provides a point estimate of individual's WTP for each attribute, this study first estimates the consumer WTP for marketable attributes of table grapes, and then expands on the hedonic price model by incorporating reference points to examine their impact on WTP estimation.

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To begin with, the linear hedonic price model is given by:

$$WTP_{ij} = \alpha_k x_{ik} + \beta_j D_j + \varepsilon_{ij} \tag{1}$$

where WTP_{ij} is the bid of table grape sample i for participant *j*, x_{ik} is a bundle of k attributes for each table grape samples *i*, we further control for D_j, a vector of participants' socio-demographic characteristics and their table grape purchasing behavior, and ε_{ij} is a random error term cluster at the individual level. Thus, the marginal price of attribute k is given by the parameter α_k.

Reference-dependent preference indicates that an individual derives utility from both consumption of a good or service (consumption utility) and its comparison with a reference point (gain-loss utility) (Kőszegi and Rabin, 2006, 2007; Amaldoss and He, 2018). An individual's perception of gains or losses is influenced by reference points, with losses typically having a greater impact than equivalent gains (Tversky and Kahneman, 1978, 1991). Given reference dependence preference, consumers' utility depends not only on *k*-dimensional consumption buddle *x* but also on a reference bundle *rx*. The utility function can thus be expressed as a combination of consumption utility and gain-loss utility (Kőszegi and Rabin, 2006):

$$u(x) = c(x) + g(x|rx) \tag{2}$$

Where $c(x)$ represents the consumption utility derived from the attributes of the auctioned product, and $g(x|rx)$ represents the gain-loss utility relative to the reference point. Both $c(x)$ and $g(x|rx)$ are additively separable across attributes as follow:

$$c(x) = \sum_k c_k(x_k) \tag{3}$$

$$g(x|rx) = \sum_k g_k(x_k|rx_k) \tag{4}$$

We assume that $g_k(x_k|rx_k) = \mu(c_k(x_k) - c_k(rx_k))$, where $\mu(\cdot)$ satisfies the properties of Kahneman and Tversky's (1979) value function.

To test for loss aversion, we allow for different loss aversion parameters λ_k across attributes, reflecting varying impacts of reference points on WTP. Thus, the extended empirical model incorporating the reference points and accounting for loss aversion consists of two separate components as follows:

$$WTP_{ij} = \alpha_k' x_{ik} + \gamma_k((x_{ik} - rx_{ik})_{if\,(x_{ik} > rx_{ik})} + \lambda_k(x_{ik} - rx_{ik}))_{if\,(x_{ik} < rx_{ik})} + \beta_j' D_j + \varepsilon_{ij'} \tag{5}$$

where $\lambda_k(\lambda_k > 0)$ represents the level of loss aversion. $\lambda_k > 1$ indicates loss averse and $\lambda_k < 1$ indicates loss seeking.

When constructing the difference variable $(x_{ik} - rx_{ik})$ between the objective attribute and reference points, we employed two approaches. First, we consider an attribute-based model (Scheibehenne et al., 2015). In this model, we assume that individuals compare the attributes of the target product with their favored attribute categories. Therefore, the difference was defined as a binary variable, indicating whether the objective attribute level aligns with their preferred attribute level. In this case, the difference variable was assigned a value of 0 when there was a match between the objective attribute and participants' favorite attribute levels, and a value of −1 when there was a mismatch. In addition, we adopt an alternative-based model (Hardie et al., 1993). In this model, we assume that individuals compare the target product with their reference product and its attributes. By considering their referenced product attribute levels, individuals can perceive a gain if the target product's attribute is superior to that of their reference product, or a loss if it is inferior. Therefore, the difference variable took a value of 1 if individuals perceived a gain, −1 if they perceived a loss, and 0 if there was no difference between the target product and their reference product's attribute levels.

https://doi.org/10.1017/aae.2024.37 Published online by Cambridge University Press

3. Experiment setup and data collection

We conducted a Vickrey second-price auction (hereinafter, referred to as 2nd price auction) in which all bids are sealed and the highest bidder wins the auction but pays the second-highest bid (Lusk and Shogren, 2007; Vickrey, 1961; Yue et al., 2010, 2011, 2016) to investigate consumer preferences and WTP in Minnesota in September 2022. Due to the non-hypothetical nature of experimental auctions, participants are confronted with real economic consequences of their actions. Since the 2nd price auction sets the market price to be independent from what s/he bids, people have the incentive to truthfully reveal their preference and WTP (overcoming the hypothetical bias). More specifically, bidders are motivated to bid on exactly what they are willing to pay to maximize their chance of winning while minimizing the risk of overpaying. Consequently, experimental auctions are regarded as a more reliable method than stated preference methods such as hypothetical choice experiments and contingent valuation surveys. While experimental auctions primarily serve to elicit preferences, they are also frequently used to assess the validity of hypothetical methods (Fox et al., 1998; List et al.,1998; List and Shogren, 1998; Hurley et al., 2013).

We recruited 101 participants through various social media. Participants had to be at least 18 years old and produce purchasers to be eligible for the experiment. It is worth noting that the recruitment did not specify that it was designed for table grapes, to avoid excluding consumers who do not prefer table grapes and might refuse to participate. All participants were compensated $40 for an hour-long session, while auction winners received the 16-ounce table grapes they won and a payment of $40 minus the market price (which was determined in the auction) of the table grapes. We held eight sessions over two days, with an average of 15 participants per session. We dropped two participants whose bids were outliers. Thus, the final sample consists of 99 participants and 792 bids on eight grape samples. We have obtained Institutional Review Board Approval for our study.

During the hour-long session, we began by introducing participants to the 2nd price auction with concrete examples and practices questions, to help them understand why bidding their true WTP is the optimal option. Additionally, we conducted a quiz to test their knowledge and ensure their comprehension of the auction procedures. Each participant received eight coded plastic containers containing two berries from each table grape sample for them to taste before bidding. At the same time, eight coded packages of 16-ounces samples were displayed on a large table so that participants could walk around and examine while tasting and biding. To avoid order effect, we prepared two versions of questionnaires that randomized the order of the eight table grape samples and participants could also start their evaluation from any sample. Additionally, we provided water for participants to drink between different samples to avoid any tasting carryover effects. Participants needed to write down their bids for each of the 16-ounce table grape samples. Within each session, after all participants submitted their bids, the moderator sorted the bids from highest to lowest and determined the market price and the highest bidder for each sample. The winner purchased the sample they won at the market price. To avoid exogenous information, we did not offer market prices or information other than that of the auctioned table grapes.

After the bidding procedure, participants answered a survey about their preferred attributes for table grapes, considering three important marketable attributes such as berry color, taste, and seed character, as well as their reference product for table grapes and their attributes, table grape purchasing behaviors, and demographic background. Regarding participant's favorite attributes for table grapes, we asked participants to select their favorite categories for each attribute, because consumers may have certain expectations or goals they aim to achieve when making choices. Take berry color as an example, participant need to select their preferred categories from the options "Black," "Red," "Green," or "Does not matter." It is worth noting that participants were allowed to select multiple options if applicable. Regarding participants' referenced table grape variety, given that previous studies have suggested that individuals use different reference points (Hardie et al.,

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1993; Kőszegi and Rabin, 2006; Wang et al., 2021), we asked participants to specify which one they use as a reference product when making table grape purchases, either their favorite variety or the most recently purchased variety. Then, participants indicated the specific table grape variety they used as their reference product and identified the attribute categories for the chosen reference grape variety. In addition, participants were asked to rate the importance of table grape attributes using a 7-point Likert scale, ranging from "very unimportant" to "very important," with a rating of 4 being neutral.

4. Results

4.1. Summary statistics of participants

Table 1 presents descriptive statistics of participants' socio-demographic background information and their table grape purchasing behaviors. In our sample, the average age category of participants was 51 to 60 years old. Approximately 77% of participants were female. Around 35% of participants held a collage diploma or higher educational qualification. The majority of participants were married, and their household sizes varied from 1 to 5 people. Around 14% of participants had children under 12 years old. Regarding income, slightly more than half of participants reported an annual income of over $100,000, and 67% had either a full-time or part-time job. Additionally, about 19% of participants were members of environmental groups. In terms of table grape purchasing behaviors, most of participants reported consuming and purchasing table grapes more frequently than once a month. When purchasing table grapes, slightly over half of participants expressed a preference for a 16ozs size over a larger size.

4.2. Summary statistics of the reference points

Table 2 displays the statistics of eight table grape samples' attributes used in the 2nd price auction and the attributes of participants' reference table grape. Comparing eight table grape samples to the reference points of 99 participants for table grapes leads to 792 pairs in our dataset. This means each of the eight table grape samples is compared to the reference points of 99 participants. We conducted the comparison in two approaches. First, we compared the attributes of eight table grape samples to participants' favorite attribute categories (i.e., attribute-based reference points). Second, we compared each of the eight table grape samples to the attributes of participants' reference table grape variety (i.e., alternative-based reference points).

Of the eight table grape samples analyzed, two were black, three were red, and three were green. When examining participants' favorite color of table grapes, it was found that the majority of participants favored red table grapes the most (86.9%), followed by green table grapes (58.6%), and black table grapes (47.5%). Using the attribute-based reference dependence approach, it was observed that 33.6% of the pairs had a mismatch between the color of the table grape sample and their preferred color categories. In contrast, when we asked participants about their reference table grape, 62.6% of participants indicated it was a red table grape variety, 32.3% was a green table grape variety, and only 5.5% was a black table grape variety. Using the alternative-based reference dependence approach, 3.7% of pairs perceived a gain as participants preferred the color of the sample grapes compared to their reference grape, while 29.4% perceived a loss. If the color of table grape sample and participants' reference table grape both matched their favorite color categories, or both mismatched, they did not perceive a gain or loss. The mean value of the difference variable, which takes values of -1, 0, and 1, was −0.258.

Of the eight table grape samples analyzed, three had a balanced taste, four were sweet, and one was sour. Regarding participants' favorite tastes, the majority of participants favored the sweet-taste the most (46.5%), followed by the balanced taste (39.4%), and the sour-taste (14.1%). Since these percentages add up to 100%, this means participants have excluded preferences for table

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Table 1. Summary statistics of participants' socio-demographic background and grape purchasing habit in the experimental auction ($N = 99$)

		Frequency	Percentage
Age			
	1 = 18–30 years old	10	10.10%
	2 = 31–40 years old	17	17.17%
	3 = 41–50 years old	18	18.18%
	4 = 51–60 years old	19	19.19%
	5 = 61–70 years old	26	26.26%
	6 = Older than 70 years old	9	9.09%
Gender			
	1 = Female	76	76.77%
	0 = Male	23	23.23%
Education			
	1 = Collage diploma and higher	35	35.35&
	0 = Other	64	64.65%
Marital status			
	1 = Married	68	68.69%
	0 = Other	31	31.31%
Household size			
	1 people	31	31.31%
	2 people	41	42.41%
	3 people	11	11.11%
	4 people	14	14.14%
	5 people	2	2.02%
Presence of children under 12 years old at home			
	1 = Yes	14	14.14%
	0 = No	85	85.86%
Income			
	1 = $50,000 or under	19	19.19%
	2 = $50,001–$100,000	29	29.29%
	3 = Over $100,000	51	51.52%
Employment status			
	1 = Full time/Part time	66	66.67%
	0 = Other	33	33.33%
Environmental group membership			
	1 = Yes	19	19.19%
	0 = No	80	80.81%

(*Continued*)

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Table 1. (*Continued*)

	Frequency	Percentage
Frequency of fresh grape consumption		
1 = Once a week or more	30	30.30%
2 = Once a month or more	46	46.46%
3 = Less than once a month	23	23.23%
Frequency of fresh grape purchasing		
1 = Once a week or more	20	20.20%
2 = Once a month or more	53	53.54%
3 = Once every half year or more	24	24.24%
4 = Less than once every half year	2	2.02%
Weight of fresh grape when purchase		
1 = 16ozs	53	53.54%
2= More than 16ozs	46	46.46%

grape tastes (i.e., a person who prefers sweet tastes does not like either the balanced or sour tastes). Using the attribute-based reference dependence approach, 60.2% of the pairs had a mismatch between the taste of the sample table grape and participants' preferred taste. On the other hand, using the alternative-based reference dependence approach, 47.5% of participants indicated their referenced table grape was a balanced taste table grape variety, 42.4% was a sweet-taste table grape variety, and only 1.01% was a sour-taste table grape variety. Using the alternative-based reference dependence approach, 30% of the pairs perceived a gain, while 43.2% perceived a loss. Similarly, if the tastes of table grape sample and participants' reference table grape both matched their favorite taste category, or both mismatched, there is neither gain nor loss. The mean value of the difference variable was −0.132.

Regarding table grape samples' seed character, one table grape sample was seeded, three had seed traces, and four were seedless. In terms of participants' favorite seed character for table grapes, the majority of participants favored seedless table grapes (82.8%), followed by table grapes with seed trace (47.5%), and only a small proportion indicate they also prefer seeded table grapes (8.1%). Using the attribute-based reference dependence approach, it was observed that 39.8% of the pairs had a mismatch between the seed character of table grape sample and participants' preferred seed character categories. In contrast, when we asked participants about their reference table grape, 77.8% indicated it was a seedless table grape variety, 19.2% was a seed trace table grape variety, and only 3% was a seeded table grape variety. Using the alternative-based reference dependence approach, 7.2% of pairs perceived a gain, while 33.5% perceived a loss. The mean value of the difference variable was −0.262.

Lastly, we constructed weights for each table grape attribute using participants' importance ratings to adjust valuations. The weights for berry color, taste, and seed character were 0.312, 0.342, and 0.346, respectively, indicating that consumers generally place more importance on seed character and taste than on color when making table grape purchases. Theoretically, we expected that attribute weights would not affect WTP estimation, as the estimated WTP already reflects individual' preference ordering and priorities. However, the difference variable only captures the level of departure from the reference points and does not reflect the relative importance of these attributes. Thus, these weights were used to adjust valuations for those difference variables when examining the impacts of reference points on WTP estimation.

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Table 2. Summary of sample fresh table grapes and reference points in the experimental auction

		Objective measures		Favorite attribute		Reference product		Weights	
		Frequency	Percentage	Mean	SD	Mean	SD	Mean	SD
Berry color								0.312	0.072
	Black	2	25.00%	0.475	0.5	0.051	0.219		
	Red	3	37.50%	0.869	0.338	0.626	0.484		
	Green	3	37.50%	0.586	0.493	0.323	0.468		
	Gain (1 = Yes)					0.037	0.188		
	Loss (1 = Yes)			0.336	0.473	0.294	0.456		
	Difference			−0.336	0.473	−0.258	0.514		
Taste								0.342	0.072
	Balanced	3	37.50%	0.394	0.489	0.475	0.5		
	Sweet	4	50.00%	0.465	0.5	0.424	0.495		
	Sour	1	12.50%	0.141	0.349	0.101	0.302		
	Gain (1 = Yes)					0.3	0.458		
	Loss (1 = Yes)			0.602	0.49	0.432	0.496		
	Difference			−0.602	0.49	−0.132	0.845		
Seed character								0.346	0.067
	Seeded	1	12.50%	0.081	0.273	0.03	0.171		
	Seed trace	3	37.50%	0.475	0.5	0.192	0.394		
	Seedless	4	50%	0.828	0.377	0.778	0.416		
	Gain (1 = Yes)					0.072	0.259		
	Loss (1 = Yes)			0.398	0.49	0.335	0.472		
	Difference			−0.398	0.49	−0.262	0.581		

4.3. Hedonic price model estimation results

Table 3 presents the estimation results from the hedonic price model. The estimated coefficients obtained from this model can be interpreted as the WTP for specific attributes of table grapes. Column 1 presents the estimation results without control variables; Column 2 displays the results while controlling for participants' socio-demographic characteristics and grape purchasing behaviors; and Column 3 additionally controls for individual fixed effects. In all three specifications, the coefficients for berry color, taste, and seed character remained consistent and statistically significant after controlling for additional participants' socio-demographic characteristics and grape purchasing behaviors (Column 2), as well as accounting for individual heterogeneity (Column 3). These findings are not surprising, as these attributes are known to be important factors influencing consumer preferences and their valuation for different table grape varieties.

The constant term represents the participants' WTP for the base group of table grapes with black berry color, balanced taste, and seedless characteristics. Comparing the estimated coefficients provides insights into consumer preference for different attributes that drive consumer behavior in the market. First, the negative coefficients for berry color indicate

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Table 3. Willingness-to-pay estimation using hedonic price model

		(1)	(2)	(3)
Berry color	Base = Black			
	Red	−0.456***	−0.456***	−0.456***
		(0.157)	(0.157)	(0.157)
	Green	−0.400***	−0.400***	−0.400***
		(0.147)	(0.147)	(0.147)
Taste	Base = Balanced			
	Sweet	−0.415***	−0.415***	−0.415***
		(0.111)	(0.111)	(0.111)
	Sour	−1.013***	−1.013***	−1.013***
		(0.215)	(0.215)	(0.215)
Seed character	Base = Seeded			
	Seed trace	0.494**	0.494**	0.494**
		(0.192)	(0.192)	(0.192)
	Seedless	0.575***	0.575***	0.575***
		(0.147)	(0.147)	(0.147)
Constant		2.365***	2.108***	2.363***
		(0.245)	(0.662)	(0.184)
Log-likelihood		−1398.78	−1377.52	−1343.36
Day fixed effect		YES	YES	YES
Order fixed effect		YES	YES	YES
Demographic controls		NO	YES	YES
Individual fixed effect		NO	NO	YES
Pairs		792	792	792

Note: The table shows the means and standard deviations of participants' willingness to pay for certain attributes of table grapes. The base group is the table grape that is black in color, has a balanced taste, and is seeded. Column 1 presents the estimation results without controls; Column 2 displays the results while controlling for participants' socio-demographic characteristics and grape purchasing behaviors; and Column 3 additionally controls for individual fixed effects. *, **, *** indicate significance at 10%, 5%, and 1%, respectively.

significantly lower WTPs for red and green table grapes. Specifically, participants were willing to pay $0.456 less for red table grapes and $0.4 less for green table grapes compared to black table grapes. Besides, the negative coefficients for tastes reveal significantly lower WTPs for table grapes with sweet and sour tastes. Participants were willing to pay $0.415 less for table grapes with a sweet-taste and displayed an even stronger dislike of table grapes with a sour-taste, indicating a preference for table grapes with a balanced taste. Moreover, the presence of seeds also significantly impacted participants' WTP for table grapes. Compared to table grapes with seeds, table grapes with seed traces were associated with a $0.494 higher WTP. Participants were willing to pay an even higher premium by $0.575 for seedless table grapes.

It is noteworthy that most socio-demographic variables were insignificant, suggesting that consumer preferences for these attributes are not strongly influenced by demographic characteristics. However, an exception was observed for participants who belonged to environmental groups. The results indicate that they were willing to pay $0.6 more for 16-ounce table grapes.

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We present parameter estimates for demographic variables and interaction terms in Appendix Table 1. Column 1 are the demographic parameter estimates from Column 2 of Table 3, while Column 2 includes the interaction terms. As shown in Column 2, while we found a few significant interaction effects between participants' socio-demographic characteristics, these interactions do not significantly affect the WTP parameters for table grape attributes. We have tested a comprehensive set of interactions between participants' socio-demographic variables, and found that when including all significant interaction terms, the interaction terms between participants' age, education attainment, marital status, and household size, remain significant. The findings reveal several important patterns in the WTP for table grapes. Specifically, individuals over 40 years old with a lower education level than a college degree are willing to pay more compared to other groups. In contrast, married individuals aged 41 or younger exhibit a lower WTP than their unmarried counterparts. Additionally, older individuals with smaller households show lower WTP. Finally, individuals with lower education levels and larger households generally show a lower WTP.

4.4. Attribute-based reference-dependent model estimation results

Table 4 presents the effects of reference points on WTP estimation using the attribute-based reference dependence model. The effect of the reference points on WTP, which is the effects of the departure of the table grape samples from participants' reference points measured by the distance variable reported in Table 2, may vary across different attributes and be of varying importance for different individuals. Therefore, we weigh difference variable using participants' importance ratings for berry color, taste, and seed characters, and report both the unweighted and weighted estimation results. Similar to Table 3, Columns 1 and 4 present the estimation results without controls; Columns 2 and 5 display the results after controlling for participants' socio-demographic characteristics and grape purchasing behaviors; and Columns 3 and 6 additionally control for individual fixed effects.

Comparing the WTP estimation results in Table 4 to those in Table 3, we observed minimal impact for berry color, while significant changes in the estimated WTPs for taste and seed character after including the difference between table grape sample attributes and attribute-based reference points in the model. Accordingly, the coefficient of the difference variable for color was insignificant, while the coefficients of the taste and seed character were negative and statistically significant. This suggests that the inclusion of reference points had a substantial impact on the estimation of WTP for taste and seed character attributes. Specifically, participants would pay less for table grape's taste and seed character if its taste or seed character did not match their favorite taste or seed character categories for table grapes.

One potential reason for the ambient effect for berry color could be that most people think color does not matter, as reported in Table 2. The percentages of participants' favorite colors for all three colors added up to about 193%, which means that at least 93% of participants prefer any of the two colors or they prefer all three colors. Taken together, these results provide evidence that consumer valuation is not solely based on the attributes of the product, but also taking into account the comparison to their reference points. Moreover, the changes in the magnitude of the estimated WTPs and the difference variable varied across different attributes, highlighting the attribute-specific influence of reference points on WTP estimation.

Furthermore, when examining impacts of the weighted differences for each attribute using participants' importance ratings, we observed that attribute weights had minimal impact on the WTP estimation. However, it noticeably affected the estimated coefficients of the difference variables. This is not surprising, as the estimated WTP for each attribute intuitively reflected individual preferences ordering and priorities, but the coefficients of the difference variables only capture effects of the departure from the reference point for each attribute, without explicitly reflecting the relative importance of these attributes.

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Table 4. Effects of reference points on willingness-to-pay estimation using attribute-based model

		Unweighted			Weighted		
		(1)	(2)	(3)	(4)	(5)	(6)
Berry color	Base = Black						
	Red	−0.475***	−0.476***	−0.485***	−0.467***	−0.470***	−0.478***
		(0.160)	(0.160)	(0.161)	(0.160)	(0.160)	(0.160)
	Green	−0.406***	−0.406***	−0.408***	−0.403***	−0.403***	−0.405***
		(0.145)	(0.145)	(0.145)	(0.145)	(0.145)	(0.145)
	Difference – berry color	0.048	0.050	0.074	0.092	0.112	0.180
		(0.106)	(0.107)	(0.111)	(0.318)	(0.319)	(0.334)
Taste	Base = Balanced						
	Sweet	−0.436***	−0.436***	−0.436***	−0.435***	−0.435***	−0.437***
		(0.110)	(0.110)	(0.110)	(0.110)	(0.110)	(0.110)
	Sour	−0.940***	−0.939***	−0.937***	−0.937***	−0.936***	−0.932***
		(0.213)	(0.213)	(0.213)	(0.213)	(0.213)	(0.213)
	Difference - taste	0.289***	0.292***	0.301***	0.778***	0.785***	0.832***
		(0.084)	(0.084)	(0.084)	(0.237)	(0.237)	(0.239)
Seed character	Base = seeded						
	Seed trace	0.365*	0.372*	0.378*	0.367*	0.374*	0.380*
		(0.194)	(0.194)	(0.194)	(0.194)	(0.194)	(0.194)
	Seedless	0.330**	0.344**	0.356**	0.327**	0.341**	0.351**
		(0.165)	(0.165)	(0.165)	(0.165)	(0.165)	(0.166)
	Difference - seed	0.328***	0.309***	0.293***	0.925***	0.872***	0.834***
		(0.105)	(0.105)	(0.105)	(0.292)	(0.293)	(0.301)
Constant		2.864***	2.561***	2.854***	2.844**	2.582**	2.834**
		(0.268)	(0.672)	(0.218)	(0.268)	(0.673)	(0.216)
Log-likelihood		−1289.31	−1284.29	−1259.12	−1288.54	−1284.11	−1258.97
Demographic controls		NO	YES	YES	NO	YES	YES
Individual fixed effect		NO	NO	YES	NO	NO	YES
Pairs		792	792	792	792	792	792

Note: The table shows the means and standard deviations of participants' willingness to pay for certain attributes of table grapes. The base group is the table grape that is black in color, has a balanced taste, and is seeded. *, **, *** indicate significance at 10%, 5%, and 1%, respectively.

4.5. Alternative-based reference-dependent model estimation results

Table 5 presents the effects of reference points on WTP using the alternative-based reference dependence model, reporting both the unweighted and weighted results. The columns in Table 5 follow the same structure as in Table 4. Unlike the attribute-based model, the alternative-based model allows both gain and loss, enabling the estimation of consumers' loss aversion. Building on

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Table 5. Effects of Reference points on willingness-to-pay estimation using alternative-based model

		Unweighted			Weighted		
		(1)	(2)	(3)	(4)	(5)	(6)
Berry color	Base = Black						
	Red	−0.482***	−0.482***	−0.498***	−0.473***	−0.475***	−0.489***
		(0.164)	(0.164)	(0.164)	(0.163)	(0.163)	(0.163)
	Green	−0.414***	−0.415***	−0.420***	−0.408***	−0.409***	−0.413***
		(0.148)	(0.147)	(0.148)	(0.147)	(0.147)	(0.147)
	Loss aversion – berry color	2.181***	1.528***	1.344***	2.364***	1.732***	1.654***
		(0.176)	(0.183)	(0.222)	(0.223)	(0.254)	(0.238)
Taste	Base = Balanced						
	Sweet	−0.355***	−0.356***	−0.352***	−0.359***	−0.360***	−0.354***
		(0.116)	(0.116)	(0.116)	(0.115)	(0.115)	(0.116)
	Sour	−0.917***	−0.917***	−0.896***	−0.915***	−0.916***	−0.897***
		(0.223)	(0.223)	(0.223)	(0.223)	(0.223)	(0.224)
	Loss aversion – taste	1.299***	2.171***	2.178***	1.047***	1.528***	1.344***
		(0.420)	(0.421)	(0.442)	(0.286)	(0.287)	(0.293)
Seed character	Base = seeded						
	Seed trace	0.300	0.315	0.339*	0.305	0.318	0.340*
		(0.199)	(0.198)	(0.199)	(0.197)	(0.197)	(0.198)
	Seedless	0.187	0.215	0.243	0.186	0.212	0.233
		(0.177)	(0.176)	(0.178)	(0.176)	(0.176)	(0.178)
	Loss aversion – seed character	5.332***	3.565***	3.144***	4.011***	3.338***	3.145***
		(0.420)	(0.421)	(0.442)	(0.384)	(0.299)	(0.300)
Constant		2.903***	2.484***	2.815***	2.853***	2.531***	2.830***
		(0.277)	(0.669)	(0.245)	(0.272)	(0.676)	(0.223)
Log-likelihood		−1235.01	−1232.87	−1212.36	−1235.88	−1233.89	−1210.28
Demographic controls		NO	YES	YES	NO	YES	YES
Individual fixed effect		NO	NO	YES	NO	NO	YES
Pairs		792	792	792	792	792	792

Note: The table shows the means and standard deviations of participants' willingness to pay for certain attributes of table grapes. The base group is the table grape that is black in color, has a balanced taste, and is seeded. *, **, *** indicate significance at 10, 5, and 1%, respectively.

the insights from previous research, we assume that the loss aversion parameters vary across different attributes and estimate participants' loss aversion at the attribute level.

Comparing the WTP estimation results in Table 5 to those in Table 3, we observed that the inclusion of reference points had minimal impact on the WTP estimation for berry color, while resulting in significant changes for tastes and seed character. More importantly, the coefficients for

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seed character became insignificant. Given that 77.8% of participants reported their reference table grapes were seedless and 82.8% of participants chose seedless grapes as their favorite seed character, the insignificance of the coefficients for seed character does not suggest that the presence of seeds is not a significant factor affecting consumer WTP. Instead, it indicates that the departure from the reference point has a greater impact.

In addition, estimated loss aversion parameters greater than one indicated the degree to which consumers were averse to losses compared to gains. The loss aversion parameter was found to be highest for seed character, followed by taste. This suggests that consumers were particularly sensitive to potential losses associated with the seed character and exhibited a moderate level of aversion to losses in taste. It is interesting to note that participants to be risk-seeking regarding berry color though the effect was insignificant. Additionally, introducing attribute weights had little effect on the WTP estimation, similar as in the attribute-based model. However, it led to a decrease in the loss aversion parameter estimations, suggesting that attribute weightings addressed the relative importance of perceived losses and gains for different attributes.

5. Conclusions

Understanding how reference points influence consumers' preferences and valuations is crucial for improving WTP elicitation mechanisms. This study addresses the influence of reference-dependent preferences on the estimation of WTP for table grape attributes elicited by a second-price auction. Methodologically, we employ two different approaches to construct reference-dependent preference: the attribute-based reference dependence model, where individuals compare the target product's attributes with their favorite ones, and the alternative-based reference dependence model, where comparisons are made with a reference product. Empirically, we demonstrate that including reference points impacts the WTP estimation for different attributes, with varying levels of loss aversion. This highlights the importance of considering attribute-specific reference dependence effects in consumer behavior studies.

For the marketing implications, our findings reveal that reference points have little impact on preferences for berry color. This suggests that consumers do not have strong preferences for color and are less influenced by related reference points. However, consumer preferences for taste and seed character are more sensitive to reference points. Deviations from preferences for seedless grapes and balanced taste result in a lower WTP. The alternative-based reference dependence model also indicates that consumers exhibit the highest loss aversion for seed character, followed by taste. Notably, we observe no significant differences in WTP across socio-demographic groups, except for individuals with stronger environmental consciousness, who generally place a higher value on table grapes.

These findings provide valuable insights into product development and pricing strategies. Breeders, for instance, could focus on developing seedless varieties to meet consumer demand, while marketers might price less-preferred attributes, like seeded table grapes, below consumers' WTP to attract buyers, given the strong aversion to seeds in table grapes. Furthermore, marketers could highlight the advancements of their products and compare them to popular or well-known brands to influence consumers' perceptions. Since taste and flavor cannot be evaluated by appearance, strategies like sampling or detailed taste and flavor profiles could help consumers make favorable comparisons. These findings could also guide policymakers in encouraging the production and consumption of products with specific desirable traits, such as those promoting environmental sustainability. Understanding the role of reference points and how deviations from them affect WTP offer opportunities for increased profitability and market growth.

Our study also has limitations, and future studies can take the following directions. We did not account for the possibility that participants may have multiple reference products in the alternative-based reference dependence model, which could potentially influence their

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comparisons and valuations. Additionally, participants might use other fresh fruits as reference points when evaluating table grapes, introducing variability into their preferences and WTP estimates. Moreover, investigating how external reference points, based on all available information and subjects to change in different contexts, shape consumer preferences would enhance our understanding. It would also be useful to explore how exposure to information from outside sources influences consumers' reference points. Finally, future research could extend the exploration of reference-dependent preferences to other product categories and investigate potential differences across consumer segments.

In the broader context of the food industry, applying these methods can be valuable for understanding consumer preferences beyond table grapes. Other food sectors could benefit from similar analyses, such as dairy, meat, or plant-based products, where reference-dependent preferences might drive purchase decisions. For example, in the case of plant-based meat alternatives, consumers often compare these products to conventional meat based on taste, texture, and nutritional value (Michel, Hartmann, and Siegrist, 2021). Reference points, such as the sensory qualities of conventional meat, could affect consumers' WTP for plant-based options. Some consumers may exhibit varying levels of aversion to plant-based meats, with some individuals being more resistant to alternative proteins due to differences in texture or taste. Market segmentation becomes important, as environmentally conscious consumers might place higher value on plant-based alternatives, while others may prefer the familiar taste and texture, leading to differing WTPs across market segments.

In general, this approach helps food producers, marketers, and policymakers better align products with consumer preferences and improve market outcomes. Producers could modify product attributes to match key reference points that consumer favor, reducing resistance to new or unfamiliar products. Marketers could emphasize specific benefits, such as health benefits and environmental sustainability, to appeal to consumer segments willing to pay more for these attributes. Policymakers could use these insights to promote policies encouraging the production and consumption of healthier or more sustainable food options.

Data availability statement. The data were collected by the authors. The data will be made available upon reader request.

Acknowledgements. We thank Minnesota Department of Agriculture for the support of this research.

Author contribution. Conceptualization, M. Cui and C. Yue; Methodology, M. Cui and C. Yue; Formal Analysis, M. Cui and C. Yue; Data Curation, M. Cui, C. Yue, E. Treiber and M. Clark; Writing – Original Draft, M. Cui and C. Yue; Writing – Review and Editing, M. Cui, C. Yue, E. Treiber and M. Clark; Supervision, C. Yue; Funding Acquisition, C. Yue, E. Treiber and M. Clark.

Financial support. This project was funded by Minnesota Department of Agriculture.

Competing interests. None.

AI declaration. AI was not used in generating the paper in anyways.

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Appendix

Table A1. Willingness-to-pay estimation using hedonic price model with interaction terms

		(1)	(2)
Berry color	Base = Black		
	Red	−0.456***	−0.456***
		(0.157)	(0.157)
	Green	−0.400***	−0.400***
		(0.147)	(0.147)
Taste	Base = Balanced		
	Sweet	−0.415***	−0.415***
		(0.111)	(0.111)
	Sour	−1.013***	−1.013***
		(0.215)	(0.215)
Seed character	Base = Seeded		
	Seed trace	0.494**	0.494**
		(0.192)	(0.192)
	Seedless	0.575***	0.575***
		(0.147)	(0.147)
Demographic variables			
	Age	0.004	0.097
		(0.073)	(0.120)
	Gender	0.080	0.111
		(0.232)	(0.212)
	Education	−0.399	1.660
		(0.271)	(1.106)
	Marital status	0.346	0.658**
		(0.257)	(0.275)
	Household size	−0.132	−0.085
		(0.147)	(0.148)
	Presence of children under 12 years old at home	0.370	0.168
		(0.348)	(0.347)
	Income	−0.026	−0.175
		(0.154)	(0.145)
	Employment status	0.361	0.337
		(0.233)	(0.231)
	Environmental group membership	0.703***	0.800***
		(0.258)	(0.239)

(*Continued*)

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Table A1. (*Continued*)

		(1)	(2)
	Frequency of table grape consumption	0.161	0.132
		(0.252)	(0.231)
	Frequency of table grape purchasing	−0.172	−0.185
		(0.256)	(0.234)
	Weight of fresh grape when purchase	0.250	0.273
		(0.215)	(0.207)
	Age (over 40 years old) * Education (below college diploma)		2.713**
			(1.159)
	Age (≤ 41 years old) * Marital status (married)		−0.796*
			(0.443)
	Age (over 40 years old) * Household size (≤4 people)		−2.160**
			(0.917)
	Education (below college diploma) * Household size (more than 4 people)		−3.978***
			(1.321)
	Constant	2.108***	1.753***
		(0.662)	(0.669)
	Day fixed effect	YES	YES
	Order fixed effect	YES	YES
	Observations	792	792

Ms. Cui is a PhD candidate at Department of Applied Economics, University of Minnesota, Twin Cities. Ms. Cui research field of interest is behavioral economics, experimental economics, microeconomics and marketing.

Dr Yue is a professor at Department of Applied Economics and Department of Horticultural Science, University of Minnesota, Twin Cities. Dr Yue's research area is horticultural marketing, behavioral economics, experimental economics and neuromarketing.

Dr Treiber is a postdoctoral research associate at Department of Horticultural Science, University of Minnesota, Twin Cities. Dr Treiber focuses grape breeding, phylloxera resistance, and assessing the quality of cold-hardy table grapes.

Dr Clark is an associate professor at Department of Horticultural Science, University of Minnesota, Twin Cities. Dr Clark's research focuses on using both traditional and molecular plant breeding approaches to develop improved grape cultivars for cold climate wine production.

Cite this article: Cui, M., C. Yue, E.L. Treiber, and M. Clark (2025). "Willingness to Pay with Reference-dependent Preferences: A Comparative Analysis of Attribute-based and Alternative-based Approach." *Journal of Agricultural and Applied Economics* **57**, 199–217. https://doi.org/10.1017/aae.2024.37