sustainability

MDPI

Article

Meeting the Expectations of the Customer: Consumer Valuation of Broccoli Produced in the Eastern United States and the Impact of Local Marketing

Rebecca Wasserman-Olin [1,*], Miguel I. Gómez [2] and Thomas Björkman [3]

[1] Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO 80526, USA
[2] Charles H. Dyson School of Applied Economics and Management, Cornell University, Ithaca, NY 14850, USA
[3] Section of Horticulture, School of Integrative Plant Science, Cornell University, Geneva, NY 14456, USA
* Correspondence: rebecca.wasserman-olin@colostate.edu

Abstract: Regional vegetable production can only displace high-quality centralized production if consumers specifically desire regional produce. California leads the United States (US) in vegetable production and sets the industry standard for broccoli; however, there is increasing production in the Eastern US to shorten the broccoli supply chain for East Coast consumers. With new varieties suited for East Coast production, more information is needed as to how they compete based on appearance, taste, and the influence of marketing them as local. In this article, we design and employ an experiment to compare a California product to four new broccoli breeds better suited for East Coast conditions. Our results show that the new varieties are becoming more competitive based on appearance and are valued higher when marketed as local. Additionally, consumers are willing to pay the same amount as the California variety for two of the New York varieties based on taste. In these two cases, local information is not associated with increased willingness to pay. Our results show that local marketing can increase a consumer's willingness to pay, but the effect may decrease as the product quality meets the expected industry standard. These findings indicate that grocery stores have the potential to compensate for broccoli that does not quite meet a consumer's appearance expectations by marketing it as local. However, as the product approaches a consumer's expectations, local marketing is unlikely to increase a consumers' willingness to pay.

Keywords: willingness to pay; regional food system; consumer preference; broccoli

Citation: Wasserman-Olin, R.; Gómez, M.I.; Björkman, T. Meeting the Expectations of the Customer: Consumer Valuation of Broccoli Produced in the Eastern United States and the Impact of Local Marketing. *Sustainability* **2023**, *15*, 7878. https://doi.org/10.3390/su15107878

Academic Editor: Petjon Ballco

Received: 28 February 2023
Revised: 2 May 2023
Accepted: 4 May 2023
Published: 11 May 2023

1. Introduction

Americans eat on average 8.5 pounds of broccoli per year, and it is an integral part of the fresh produce sector [1]. As of 2017, over 80% of United States (US) produced broccoli is grown in California compared to 90% in 2007 [2]. Industry standard varieties tend to be well suited for Californian growing conditions and have been shown to produce a lower quality product in other regions. When these varieties are grown in the Eastern US, increased humidity tends to create less uniform and desirable looking broccoli crowns [3]. When presented with purchasing opportunities of broccoli grown in other regions, food retailers have expressed the need for broccoli from outside California to maintain a similar appearance to the current industry standard [4].

With projected temperature increases in broccoli growing regions in California, the time periods conducive to growing broccoli or other leafy greens will shift [5]. Climate change and continued use of groundwater may threaten agricultural access to water for irrigation unless water usage is changed [5,6]. Having centralized production of an agricultural product in an area with increased environmental pressure threatens the consistent supply of broccoli for US consumers.

An initiative to increase broccoli production outside of California was undertaken by university partners throughout the Eastern Seaboard [7]. Increasing production on the

East Coast has the potential for decreased transportation and supply chain costs without increasing the cost for East Coast consumers when compared to broccoli shipped from California [8]. As it is often 7–14 days before broccoli harvested in California is available for purchase in a supermarket on the Eastern Seaboard, the quality of the product has already decreased by the time it is purchased [9]. The time between harvest and consumption could be part of why when consumers are faced with a "used by" date of one week after purchasing, consumers expect to eat only 65% of the broccoli bought [10]. Shortening the time between harvest and consumption could lessen food waste and improve attitudes towards broccoli consumption.

While it may be feasible to sell East Coast produced broccoli for a similar price as Californian produced broccoli based on production and transportation costs, grocery buyers still expect the quality and appearance to match the industry standard [4,8]. With new broccoli breeds in development that are aiming to match the appearance of the industry standard California grown varietals, there is an opportunity to understand how marketing regionally produced broccoli as "local" can change the willingness to pay and help make up for potential differences between products.

It was found that while labels such as organic, fair trade, and carbon intensive may influence willingness to pay for fresh produce, locally grown labels were associated with the highest increase in a choice experiment [11]. In another study utilizing a choice experiment, Printezi and Gerbitus tested whether willingness to pay changes based on where items were being sold [12]. They found that there was no statistically significant difference between willingness to pay for local products at a grocery store versus a farmers' market. This further supports the hypothesis that labeling broccoli as local in grocery stores could support a higher price per pound.

Premiums for locally marketed products are well established in the literature through both meta-analysis and literature reviews. Comparing choice experiment and contingent valuation methods, Li and Kallas presented a meta-analysis of consumer willingness to pay for sustainable products [13]. Feldmann and Hamm conducted a review of qualitative and quantitative methods analyzing consumers' preferences for local products and found that while consumers do not view local as a premium product, they are often willing to pay more for "local" than non-local [14]. Kilduff and Tregeagle used a meta-regression analysis to measure differences between willingness to pay by consumers and willingness to pay for new varieties by agricultural producers [15]. Local premiums were also verified in a review article by Enthoven and Van Den Broeck [16].

Other studies have identified premiums for specific products such as beef in Maryland, lamb in Spain, honey in Serbia, and blueberries in Kentucky [17–20]. Further variables, such as number of food miles traveled, have also shown willingness to pay premiums for locally produced products [21].

Our experiment and subsequent analysis is an extension of previous work by Fan et al. [22]. They found that while consumers rated locally produced broccoli lower without information, these ratings and willingness to pay values increased when knowing the production location. Our aim is to understand how consumer valuation of broccoli and local products have changed over time. Additionally, this study looks to understand how more advanced broccoli breeding lines aimed at being grown on the East Coast compete with the Californian standard product, both with and without production location treatments.

In this article, we study the influence of knowing local production information on consumer perception and the willingness to pay for broccoli, which is specifically bred for East Coast production. We design and then analyze data from a Becker–DeGroot–Marschak (BDM) auction to evaluate five types of broccoli over two years. We use this experiment data to analyze how production location information influences the ratings for broccoli using a seemingly unrelated regression (SUR). Price evaluations for one pound of broccoli are used to estimate changes in willingness to pay using a Tobit model.

Our results show that providing production location information can help a product compete with the industry standard and help compensate for differences in appearance

and/or taste, with more of an effect seen as the difference between the local and non-local increase. The results also show that regionally adapted breeding lines help provide product qualities more closely matching what is expected in a grocery store and can compete without any local marketing when the appearance and taste match the consumers' expectations. Our analysis further indicates that local varieties perform better when evaluated on taste and appearance instead of only appearance. This provides important information to those both working to expand consumption of regionally produced products and expand the East Coast supply chain for broccoli.

2. Materials and Methods

We designed and facilitated an experiment to estimate the willingness to pay for five broccoli varieties over two years based on both their appearance and a combination of their appearance and taste. Data from a total of 299 participants were included for data analysis.

2.1. Experimental Design and Data Management

The data were collected using a Becker–DeGroot–Marschak (BDM) auction approach [23]. This approach is similar to that of Fan et al., measuring willingness to pay for local broccoli, as well as Shi et al., measuring how purchasing intent changes willingness to pay in a BDM setting [22,24]. While there are various methods for understanding willingness to pay, the BDM method best fits our research question. Prior to this experiment, new broccoli varieties were bred that were better suited to East Coast growing regions. While many of these varietals were not yet available to consumers, project partners were able to supply the experiment with products that could be used for evaluation. This supported using a method that rates an actual product, such as BDM. While the method is often criticized for underreporting the true willingness to pay [25,26], Shi et al. reported that this is often due to a subset of consumers who want to receive a discount or a deal [27]. During the experiment, careful language was used as an attempt of preventing "deal-prone" participants from underrepresenting their true willingness to pay amount in a grocery setting. Asioli et al. stated that while multiple price list valuation mechanisms, an alternative to BDM, may be easier for participants to understand, the estimated willingness to pay values were not different between the two methods [27,28].

A BDM auction asks participants to state the amount they would pay for a product in a real-world setting. It does not allow participants to change willingness to pay values after submitting them. Participants were notified at the beginning of the experiment that their compensation could include purchasing a pound of broccoli if their stated value was at least as high as a randomly selected market price. The willingness to pay values were explained to participants as the price where they do not regret their actions. If they purchased the broccoli at that price, they did not feel as if they overpaid. Alternatively, if they did not purchase the broccoli at the selected market price, they did not wish they had bid higher because they felt the broccoli was worth the selected market price. Due to this, participants were encouraged to provide realistic willingness to pay prices since their compensation could include purchasing broccoli at their stated prices. This explanation of the method was used to try and prevent participants that were "deal-prone" from underreporting their true willingness to pay value.

The types of broccoli used were a combination of a publicly available product and new varieties bred to thrive when grown in the Eastern US. One variety remained constant between both years, *CA*, a broccoli variety purchased in a grocery store with a large uniform appearance and a tight dome grown in California. This *CA* variety represented the industry standard. *NY1* and *NY2* were used during the first year of the experiment, and *NY3* and *NY4* were from the second. *NY1* and *NY2* were newly developed cultivars to grow well in East Coast conditions. *NY3* was from an experimental breeding line intended to create a head with an appearance similar to that in a grocery store but intended to be grown well in Eastern US climates. *NY4* was also from an experimental breeding line but was being bred with the intent of being a one-cut floretting variety, which is preferred in commercial

kitchens. With the intent of separating into smaller pieces, this variety had a longer main stem and less uniform heads than the others.

The experiments were run at a university managed laboratory (IRB protocol number: 1308004067). Participants were recruited from a pool managed by the laboratory as well as staff from the University and was limited to non-undergraduates over 18 years of age. They were compensated $25 for their time: $5 for showing up and $20 for completing the experiment. Participants could participate in both the 2017 and the 2018 experiments, which were held one year apart from each other. Each year's experiments were conducted in multiple sessions, and each session contained up to 24 participants. As many participants as possible were recruited up to the budget allowed for total compensation. The aim was to have more than that of Fan et al., who had 80 participants to improve upon information already learned about broccoli consumption and the impact of local information [22].

After arriving at the experiment, participants signed a consent form. Instructions and a brief overview of the entire process were given. The participants recorded information using paper surveys. Two example rounds were given to help participants become comfortable with the rating method. First, participants provided a willingness to pay amount for a US dollar bill, they next provided a 1–9 rating as well as a willingness to pay rating for a pen. Half of the sessions were provided information about where the broccoli was grown, and half did not receive any location information. No other unique traits were pointed out about the broccoli such as growing conditions or any descriptors identifying differences between the types. Participants then rated each of the three broccoli types based on its appearance only. They had florets in front of them on a plate as well as access to example heads placed in front of the group. They rated them on a 1–9 scale as well as providing the price they would pay for one pound of each type within a range of $0.00–$5.00. Once they completed this section, they could not go back and change the ratings. They then tasted the broccoli and provided ratings and prices (per pound again) based on both the taste and appearance, as these two attributes are important to how consumers value produce [29]. Participants then participated in a sensory evaluation of food and a short questionnaire about their general taste preferences. Finally, participants answered a short section of demographic questions about themselves before receiving compensation for their time.

As part of the BDM structure, participants were informed that one of the prices provided would be used to determine whether they purchased a pound of that type of broccoli as part of their compensation for participation. During each session, one of the six stated prices during the experiment was randomly selected to determine the binding round. A random market price was then selected from $0.00 to $5.00. If the price participants stated as the amount they would be willing to pay for one pound of broccoli from the binding round was under the randomly determined market price, they would be compensated with $25.00. If their stated price was higher or equal to the market price, they would receive one pound of broccoli and $25.00 minus the market price for that round.

Each year after the experiments were complete, the paper surveys were recorded electronically on a spreadsheet. After entering the surveys, research assistants double checked for any data entry errors. The survey responses were then imported to Stata 16 to be cleaned and used for analysis, including combining the two years of experiment data into a single dataset. Any surveys that did not contain responses for all variables used in the econometric methods were deleted from the sample.

2.2. Econometric Methods

To understand the influence of knowing the production location on willingness to pay, we followed the procedure used by Fan et al. and ran a seemingly unrelated regression (SUR) using the 1–9 ratings followed by a panel Tobit model [22].

By using a SUR, we could better understand how knowing the production location influenced the perception of each broccoli type. Since participants were asked to provide ratings first on appearance and second on both appearance and taste, the SUR accounted

for the fact that the error terms in both regression results could be related across both responses for each individual. The SUR model was defined as:

$$Appearance_{ij} = \alpha^A + \beta_j^A V_j + \gamma^A I + \delta_j^A T_j I + \theta^A X_i + v_i^A + \varepsilon_{ij}^A \quad (1)$$

$$Taste_{ij} = \alpha^T + \beta_j^T V_j + \gamma^T I + \delta_j^T T_j I + \theta^T X_i + v_i^T + \varepsilon_{ij}^T, \quad (2)$$

where the superscripts A and T represent that the coefficients are related to the results for appearance (Equation (1)) and taste (Equation (2)). The subscript i represents each individual, and j represents the type of broccoli for each of the equations including New York 1 (*NY1*), New York 2 (*NY2*), New York 3 (*NY3*), New York 4 (*NY4*). In the SUR, α is the constant that represents the rating for the broccoli from California (*CA*) without any information provided; β is the increased rating from consumers for each New York type j (compared to the base level of broccoli from California); γ is the impact of knowing production location (*information*) on the base type of the Californian broccoli, δ is the interaction of participants knowing production location information for each of the New York types of broccoli (represented by j), and θ is a group of demographic variables relating to the participants. These demographics include the year of the experiment (*year*), how old they are (*age*), if they identify as a non-male gender (*non-male*), if they have at least an associate degree (*education*), if they are the primary grocery shopper in their household (*primary grocery shopper),* how often they consume broccoli per month (*frequency*), and the portion of their diet that is USDA certified organic (*percent organic*).

The Tobit model considered that the data represented a panel and included the same respondent answering multiple questions. It also considered that the data represented a censored range from \$0.00 to \$5.00. This was represented by the observed willingness to pay $\left(WTP_{ij}\right)$ and the latent variable (WTP_{ij}^*), represented by:

$$WTP_{ij}^{*A} = \mu^A + \rho_j^A T_j^A + \sigma^A + \varphi_j^A V_j^A I^T + \omega^A X_i^A + \nu_i^A + \epsilon_{ij}^A \quad (3)$$

$$WTP_{ij}^A = max\{0, WTP_{ij}^{*A}\} \quad (4)$$

$$WTP_{ij}^{*T} = \mu^T + \rho_j^T T_j^T + \sigma^T + \varphi_j^T V_j^T I^T + \omega^T X_i^T + \nu_i^T + \epsilon_{ij}^T \quad (5)$$

$$WTP_{ij}^T = max\{0, WTP_{ij}^{*T}\}. \quad (6)$$

Tobit calculations were run for both willingness to pay ratings for each type of broccoli (j) for each individual (i) for both appearance only (A) and appearance and taste (T). This analysis included estimates for the value of each type of broccoli (T_j) including the same four from the SUR model (*NY1, NY2, NY3, NY4*), whether information about the production location was provided (I), and various demographics of the respondents (X_i). As the data were formatted as a panel, we employed the random effects Tobit model, which included an error term for each person (ν_i) and a general error term for the model (ϵ_{ij}). The coefficients of Equations (3) and (5) represented the same variables as explained for Equations (1) and (2). The subscript i represented each individual, and j represented the type of broccoli for each of the equations. The μ coefficient was the constant that represented the rating for the broccoli from California without any information provided; ρ was the rating for each New York type j (compared to *CA*); σ was the impact of production location on the base type of the Californian broccoli (*information*), φ was the interaction of production location information (represented by j), and ω was a group of demographic variables relating to the participants. These demographics are the same as the SUR and include the year of the experiment (*year*), how old they are (*age*), if they identify as a non-male gender (*non-male*), if they have at least an associate degree (*education*), if they are the primary grocery shopper in their household (*primary grocery shopper),* how often they consume broccoli per month (*frequency*), and the portion of their diet that is USDA certified organic (*percent organic*).

3. Results

The data collected in the experiments will first be described generally as a summary of demographic characteristics of the participants and average responses to stated ratings and willingness to pay for the five different types of broccoli. This information will then be used in the econometric approach using a SUR and Tobit model to measure the influence of knowing the location information of the broccoli.

3.1. Data Summary

A total of 299 usable observations (after data cleaning) were recorded between both years' experiments. Table 1 shows the descriptive statistics of those in the experiment. The responses were distributed almost evenly across both years. The average age of the participants was about 44. The minimum age was 21, and the maximum was 71. About 73% of the sample identified as non-male. This category includes female and a "neither/I prefer not to answer" category. About 86% of the sample had an education level of at least an associate degree. A total of 78% of the sample identified as the primary grocery shopper in their household. Broccoli consumption frequency was a categorical variable, with levels being less than once a month, 1–4 times a month, 5–10 times a month, 11–15 times a month, or more than 15 times a month. The most common response was 1–4 times per month. The average percentage of diet USDA-certified organic was 27.8% and ranged from 0 to 100%. Our sample was quite similar to that of Fan et al. but was younger [22].

Table 1. Demographic Characteristics of Experiment Participants (%, unless stated otherwise).

	Sample
Year	
2017	50.8
2018	49.2
Age (Average from sample)	44 (13.2)
Gender	
Male	27.4
Non-male	72.6
Education:	
Less than associate degree	13.7
Associate degree or more	86.3
Primary grocery shopper	78.2
Broccoli consumption frequency	
Less than 1 time per month	8.0
1–4 times per month	42.3
5–10 times per month	34.6
11–15 times per month	10.4
More than 15 times per month	4.7
Percent of Diet USDA Certified Organic (Average from sample)	27.8 (27.3)

Note: Standard Deviation are shown in parentheses.

Table 2 provides the mean values for both the ratings and willingness-to-pay amounts from the experiments. Of the 299 participants, 160 were in the control group and did not receive any information on the location, and 139 were in the treatment group and were told which broccoli was local and which was not. Each participant gave six ratings and six willingness to pay values, three based on appearance and three based on appearance and taste. The ratings were based off a 1–9 scale, and the overall average ratings based on appearance and taste, respectively, were 6.59 and 6.34.

Table 2. Summary Statistics of Willingness to Pay and Rating for Appearance and Taste.

	Observations	Ratings				WTP ($/Pound)			
		Appearance		Taste		Appearance		Taste	
All Observations	897	6.59	(1.95)	6.34	(2.03)	2.00	(1.04)	1.96	(1.08)
No Location Information	480	6.47	(2.06)	6.30	(2.02)	1.96	(1.04)	1.95	(1.06)
California	160	7.46	(1.79)	6.64	(1.87)	2.18	(1.10)	2.06	(1.10)
NY1	70	5.99	(1.97)	6.01	(2.00)	1.94	(0.93)	2.00	(0.97)
NY2	70	5.74	(1.66)	5.63	(2.27)	1.80	(0.86)	1.76	(1.03)
NY3	90	6.18	(2.39)	6.50	(1.83)	1.83	(1.06)	1.94	(1.03)
NY4	90	5.97	(1.91)	6.24	(2.15)	1.83	(1.96)	1.91	(1.10)
Location Information	417	6.72	(1.80)	6.38	(2.03)	2.05	(1.03)	1.96	(1.10)
California	139	6.83	(1.75)	6.44	(2.04)	2.04	(1.05)	1.92	(1.06)
NY1	77	6.81	(1.88)	6.57	(1.92)	2.01	(0.89)	1.92	(1.12)
NY2	77	6.74	(1.60)	6.20	(1.93)	2.01	(0.97)	1.83	(1.07)
NY3	62	6.56	(1.79)	5.94	(2.13)	2.07	(1.14)	2.03	(1.12)
NY4	62	6.50	(1.80)	6.69	(2.14)	2.19	(1.15)	2.16	(1.19)

Note: Standard Deviation are shown in parentheses.

The average rating for no location information based on appearance compared to taste was 6.47 and 6.3 across all types of broccoli. While the average rating decreased after tasting, there were differences across the types of broccoli. Although the California broccoli remained the highest rated in both ratings, it decreased from 7.46 to 6.64 after tasting. Three of the four New York broccolis ratings increased after tasting, NY2 was the only one that decreased. NY2 was also rated the lowest in both appearance and taste ratings when no location information was provided.

The average rating across types when location information was provided was 6.72 based on appearance and 6.38 based on taste. All the types of broccoli had their scores decrease other than NY4, whose score increased from 6.5 to 6.69. NY4 was the lowest rated broccoli based on appearance and the highest rated for taste when information was provided.

The appearance scores for the four types of New York broccoli were rated higher in the treatment groups when information was provided where the score for the Californian broccoli decreased. A consistent trend was not observed for ratings after tasting the broccoli. The scores of the California and NY3 types increased in treatment groups where NY1, NY2, and NY4 had higher ratings in the treatment groups. The trends in the mean scores will be further analyzed with a seemingly unrelated regression to understand the influence of information when controlling for demographics.

The participants provided ratings for how much they would pay for one pound of each type of broccoli. The average willingness to pay for the whole sample based on appearance was $2.00, and it was $1.96 after tasting. At the time of both years of the experiment, broccoli was $1.99 in the region's most popular grocery store.

For the control group, the average price for appearance and tasting were almost the same: $1.96 compared to $1.95. Although the averages were similar, different types of broccoli had different trends. Both the California and NY2 types had their averages decrease after tasting. Whereas NY1, NY3, and NY4 saw an increase in average willingness to pay after tasting.

The average willingness to pay for the treatment group based on appearance was $2.05 and decreased to $1.96 after tasting. All the individual types of broccoli also saw a decrease in willingness to pay after tasting the product. NY2 saw the largest decrease from $2.01 to $1.83. NY4 had the smallest decrease from $2.19 to $2.16. It also had the highest average value for willingness to pay in the treatment group for appearance and taste.

When comparing the average willingness to pay values between the control and treatment groups, all the types of New York broccoli were rated higher based on appearance in the treatment group when location information was provided. Based on taste, the California and NY1 types were valued lower in the treatment group, but the others were valued

higher. The Tobit models following will help understand the trends in the willingness to pay values and the influence of knowing location information.

3.2. Econometric Results

We look at the relationship between preference for broccoli and knowing the production location of the product using regression techniques. We employ a SUR to better understand ratings for the product and a Tobit methodology to estimate willingness to pay.

As seen in Table 3, based on appearance, the constant was 5.998 and statistically significant at the 1% level. All four of the types of broccoli were rated lower than the Californian type at the 1% level. NY2 was rated the lowest, followed by NY1, NY4, and NY3. Knowing information lowered ratings by 0.684 points and is statistically significant at the 1% level. All four interactions of information and broccoli types were statistically significant and positive at the 1% level. The types rated the lowest without information received the largest increase in ratings when information was provided. From largest to smallest, the order was NY2, NY1, NY4, and NY3. Of the demographic control variables, age and broccoli consumption frequency were the only two that were statistically significant, both at the 5% level. Each additional year older is associated with an increased in broccoli ratings by 0.011 points, and increased broccoli consumption ordinal levels were associated with a 0.152-point increase in ratings. Importantly, the *year* of the experiment was not statistically significant in the sample.

Table 3. SUR Estimating the Impact of Production Origin Information on Ratings for Broccoli.

	Ratings Based on Appearance		**Ratings Based on Appearance and Taste**	
	(1)		**(2)**	
Constant	5.998 ***	(0.396)	5.474 ***	(0.419)
Broccoli Type				
NY1	−1.647 ***	(0.295)	−1.161 ***	(0.312)
NY2	−1.908 ***	(0.295)	−1.566 ***	(0.312)
NY3	−1.161 ***	(0.264)	0.304	(0.279)
NY4	−1.352 ***	(0.264)	0.08	(0.279)
Information	−0.684 ***	(0.22)	−0.364	(0.233)
Interacting Broccoli Type with Information				
NY1 × Information	1.380 ***	(0.379)	0.793 **	(0.401)
NY2 × Information	1.572 ***	(0.38)	0.817 **	(0.402)
NY3 × Information	1.134 ***	(0.379)	−0.273	(0.401)
NY4 × Information	1.276 ***	(0.379)	0.788 **	(0.401)
Year: 2018	0.354	(0.219)	0.979 ***	(0.231)
Age	0.011 **	(0.005)	0.001	(0.005)
Non-male	0.222	(0.151)	0.102	(0.159)
Education: Associate Degree or More	0.259	(0.19)	0.436 **	(0.201)
Primary grocery shopper	0.136	(0.162)	−0.182	(0.171)
Broccoli consumption frequency	0.152 **	(0.068)	0.177 **	(0.072)
Percent of diet USDA certified organic	−0.002	(0.002)	−0.001	(0.002)

Notes: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$, standard errors are shown in parentheses.

The patterns in ratings for taste and appearance in Table 3 were different than those for taste only. The constant was 5.474 and statistically significant at the 1% level. The two broccoli types from 2017 were both rated lower than the Californian at the 1% significance level. NY1 is 1.161, and NY2 is 1.566 points lower. NY3 and NY4 were not significantly different from the Californian. Information was not statistically significant in this model. All broccoli types but NY3 were significant at the 5% level and positive when interacted

with information. All three of the significant types had coefficients of about 0.8. Of the demographic control variables, year, education, and broccoli consumption frequency were statistically significant. Broccoli from 2018 was rated about 1 point higher than in 2017 and is statistically significant at the 1% level. Education of at least an associate degree was associated with a 0.436-point increase in ratings. Higher broccoli consumption frequency was related to an increase in ratings of the broccoli types. These two demographics were statistically significant at the 5% level.

The four models for estimating willingness to pay are in Table 4. Models with and without demographic control variables are presented for willingness to pay for appearance only and both appearance and taste. The coefficient estimates of interest were similar when analyzed alone or with demographic control variables.

Table 4. Tobit Model Estimating the Impact of Production Origin Information on Willingness to Pay for Broccoli ($/Pound).

	WTP Based on Appearance				**WTP Based on Appearance and Taste**			
	(1)		**(2)**		**(3)**		**(4)**	
Constant	2.12 ***	(0.099)	2.06 ***	(0.309)	1.93 ***	(0.104)	1.82 ***	(0.324)
Broccoli Type								
NY1	−0.42 ***	(0.097)	−0.38 ***	(0.096)	−0.30 ***	(0.11)	−0.30 ***	(0.111)
NY2	−0.56 ***	(0.097)	−0.52 ***	(0.096)	−0.55 ***	(0.11)	−0.56 ***	(0.111)
NY3	−0.22 **	(0.086)	−0.22 **	(0.085)	0.08	(0.097)	0.09	(0.098)
NY4	−0.21 **	(0.086)	−0.20 **	(0.085)	0.05	(0.098)	0.06	0.062
Information	−0.16	(0.122)	−0.19	(0.121)	−0.17	(0.129)	−0.23 *	(0.129)
Interacting Broccoli Type with Information								
NY1 × Information	0.43 ***	(0.131)	0.39 ***	(0.13)	0.28 *	(0.149)	0.28 *	(0.15)
NY2 × Information	0.56 ***	(0.131)	0.53 ***	(0.13)	0.43 ***	(0.149)	0.44 ***	(0.15)
NY3 × Information	0.21	(0.131)	0.20	(0.13)	0.07	(0.148)	0.06	(0.15)
NY4 × Information	0.34 **	(0.131)	0.32 **	(0.13)	0.24	(0.149)	0.23	(0.15)
Year: 2018	0.13	(0.122)	0.13	(0.119)	0.27 **	(0.129)	0.29 **	(0.128)
Age	-	-	−0.01 *	(0.004)	-	-	−0.01 *	(0.004)
Non-male	-	-	0.16	(0.125)	-	-	0.14	(0.13)
Education: Associate Degree or More	-	-	0.12	(0.158)	-	-	0.20	(0.165)
Primary grocery shopper	-	-	−0.21	(0.134)	-	-	−0.24 *	(0.14)
Broccoli consumption frequency	-	-	0.04	(0.057)	-	-	0.07	(0.059)
Percent of diet USDA certified organic	-	-	0.01 ***	(0.002)	-	-	0.01 ***	(0.002)

Notes: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$, standard errors are shown in parentheses.

The estimated willingness to pay of $2.06 (constant in model 2) was very close to the price in a grocery store at the time of the experiment. Consumers were willing to pay less for all four broccoli types because the indicator variables were statistically significant and negative: NY1 and NY2 at a 1% level and NY3 and NY4 at a 5% level. The willingness to pay for the four types were lower than the Californian by $0.38, $0.52, $0.22, and $0.20 for NY1, NY2, NY3, and NY4. Presenting origin alone had no effect; the coefficient on information was not statistically significant. This term could be interpreted as knowing the CA broccoli was not local. However, presenting the local origin of the NY products did increase the willingness to pay. The interaction between information and broccoli type was positive for all but NY3. When information was provided, NY1 was valued $0.39 higher than the Californian, and NY2 was $0.53 higher. NY4 was valued $0.32 higher than the Californian

and is statistically significant at the 5% level. Importantly, the results were the same each year, and Year:2018 was not statistically significant. Consumers were willing to pay the same regardless of their demographics; age was weakly statistically significant, and percent of diet USDA certified organic was highly statistically significant and increased willingness to pay by $0.01 per 1% increase.

When looking at model 4 in Table 4, the willingness to pay based on taste and appearance, there are different trends than when willingness to pay is only analyzed based on appearance. The constant in this model was $1.82 and was highly statistically significant. Only the NY1 and NY2 coefficients of broccoli type indicators were statistically significant. They are valued $0.30 (NY1) and $0.56 (NY2) lower than the Californian. Information was weakly statistically significant (at the 10% level), and the coefficient is −$0.23 when location information was presented. When the information and broccoli type variables interacted, NY1 showed a weak effect of a $0.28 increase in willingness to pay, and NY2 showed a $0.44 increase significant at the 1% level. The coefficient on Year:2018 was positive and statistically significant. Age and percent of diet USDA certified organic have the same estimations as model 2. Additionally, Primary grocery shopper was weakly statistically significant in model 4, and the coefficient shows a $0.24 decrease in willingness to pay for primary shoppers.

4. Discussion

When comparing the SUR models to the Tobit models, there are similar trends throughout the two but some differences. The SUR shows a strong influence of information on increasing the ratings for the New York grown products. The impact of the local information has a stronger influence on the types of broccoli rated lower than the Californian without information. This trend is seen in the model based on appearance only as well as appearance and taste. Interestingly, broccoli consumption frequency is statistically significant in this model but not in the willingness to pay models.

4.1. Theoretical Implications

Our results show that there is an increase in willingness to pay for New York broccoli when labeled as "local". This is seen in other studies valuing willingness to pay for local products [13,14,16]. Marketing items as "local" has been shown as one way to support higher prices for products and is confirmed in this analysis [11]. The willingness to pay models from this experiment show that although some of the New York types were valued lower based only on appearance, they were competitive with the Californian based on appearance and taste. The newer varieties are helping provide a product that is closer to matching the standard from California, and, for some varieties, the taste of the product makes up for a slightly lower valued appearance. This study adds to information from Fan et al. about how willingness to pay changes when valuing products on appearance versus appearance and taste [22].

It is important to compare the results in this experiment with those by Fan et al., who used a very similar methodology and also studied broccoli [22]. Our SUR results showed less of an influence of demographics on our ratings. Our ratings for the constant in both appearance and taste were lower. This study identified more variation in preferences for the different types of broccoli based on taste. When comparing the willingness to pay, our constant is slightly lower than the previous study but still close to the grocery price at the time. Although Fan et al. only analyzes willingness to pay for taste and appearance, we also report results based only on appearance. This adds to the understanding of broccoli purchasing decisions.

This study finds that the smaller the difference between the two types of broccoli, the smaller the premium for local information. This trend has not been previously noted and should be further investigated in future work. Future studies could help understand if this trend is specific to broccoli or a progression of the influence of local marketing.

4.2. Industry Implications

Retailers could use key implications from this work to support sales of East Coast produced broccoli. The results from Coles et al. showed that retail buyers did not want to purchase broccoli with an appearance that does not match California broccoli [4]. This study showed that including "local" marketing could help compensate for difference in visual appearance between regional products and the industry standard grown in California. Our study also suggested that as the regional product meets consumers' expectations, the regional marketing may not influence purchasing decisions. The New York grown products were also valued higher when consumers were able to taste the product. This implied that in-store tastings of regional produce would increase sales by allowing non-visual attributes to better influence the buying decision, thereby making regional broccoli more competitive on a grocery shelf with a California-grown broccoli crown.

5. Conclusions

With greater challenges in growing broccoli in California, it is important to support other US production regions to ensure a continuous broccoli supply for consumers. When looking to grow broccoli on the East Coast, farmers have historically grown varieties not well adapted for their growing conditions. Plant breeders set out to develop varieties specifically suited to East Coast growing conditions that matched the appearance of broccoli grown in California. Past research has shown that consumers may be willing to pay more for a product if it is labeled as "local". In this article, we investigated if newly developed broccoli varieties grown in New York could compete with the Californian product with and without local information through a BDM auction and subsequent econometric analysis.

The results from this study provide an important benchmark for broccoli breeders working to create East Coast specific varieties. Although newer varieties were rated slightly lower than Californian based on appearance, they were competitive based on the combination of appearance and taste. In addition, the premium associated with knowing local information was higher for varieties rated lower without information. The varieties from the second year of the experiment were valued similarly to the Californian variety, showing promise for the new broccoli breeds.

This analysis has practical implications for the East Coast broccoli sector. First, the results supported the importance of the breeding programs and showed how integral it is to have varieties aimed at various growing regions. Second, as the New York grown products often compete on taste, in-store samples could help bridge the gap between customers' appearance expectations and the East Coast grown products. Third, as the premiums for local were a larger influence for varieties rated lower than the Californian product, local marketing can be used to encourage sales, even though the product may not meet consumer expectations. This could encourage producer buyers for grocery stores to purchase East Coast grown broccoli.

Overall, this work demonstrates that East Coast broccoli can compete with California-grown broccoli from a consumer's perspective, especially if origin information is provided. It motivates the need for regional fresh produce varieties and the power of marketing and samples for local products.

Author Contributions: Conceptualization, M.I.G. and T.B.; methodology, M.I.G. and R.W.-O.; software, R.W.-O.; formal analysis, R.W.-O. and M.I.G.; investigation, R.W.-O., M.I.G. and T.B.; resources, T.B. and M.I.G.; writing—original draft preparation, R.W.-O.; writing—review and editing, M.I.G. and T.B.; visualization, R.W.-O.; supervision, M.I.G.; project administration, T.B.; funding acquisition, T.B. and M.I.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the USDA's National Institute of Food and Agriculture through the Specialty Crops Research Initiative, under award number 2016-51181-25402.

Institutional Review Board Statement: The experiment protocol was deemed exempt by the Institutional Review of Cornell University (protocol number: 1308004067).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study before participation.

Data Availability Statement: Data used in this study and the study questionnaire are available from the authors upon request.

Acknowledgments: Thank you to the whole Eastern Broccoli Project team for the support and feedback on this work.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. USDA ERS. Food Availability (Per Capita) Data System. Available online: https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system/ (accessed on 29 January 2023).
2. USDA/NASS. QuickStats. Available online: https://quickstats.nass.usda.gov/ (accessed on 29 January 2023).
3. Griffiths, P.; Farnham, M.; Hutton, M.; Davis, J.; Morris, W.; Björkman, T. Performance of Current Broccoli Varieties under Eastern U.S. Conditions. In *HortScience*; Amer Soc Horticultural Science: Alexandria, VA, USA, 2012; Volume 47.
4. Coles, P.S.; Cong, J.; Gomez, M.I.; Bjorkman, T. Produce Buyer Quality Requirements to Form an Eastern Broccoli Industry. *J. Food Distrib. Res.* **2019**, *50*, 63–83. [CrossRef]
5. Marklein, A.; Elias, E.; Nico, P.; Steenwerth, K. Projected Temperature Increases May Require Shifts in the Growing Season of Cool-Season Crops and the Growing Locations of Warm-Season Crops. *Sci. Total Environ.* **2020**, *746*, 140918. [CrossRef]
6. Scanlon, B.R.; Faunt, C.C.; Longuevergne, L.; Reedy, R.C.; Alley, W.M.; McGuire, V.L.; McMahon, P.B. Groundwater Depletion and Sustainability of Irrigation in the US High Plains and Central Valley. *Proc. Natl. Acad. Sci. USA* **2012**, *109*, 9320–9325. [CrossRef]
7. Rozyne, M.; Bilinski, C.; Cancalosi, A. *Eastern Broccoli Market. Opportunity Assessment for New York State*; Cornell University: Ithaca, NY, USA, 2021.
8. Atallah, S.S.; Gómez, M.I.; Björkman, T. Localization Effects for a Fresh Vegetable Product Supply Chain: Broccoli in the Eastern United States. *Food Policy* **2014**, *49*, 151–159. [CrossRef]
9. Pellegrino, R.; Wheeler, J.; Sams, C.E.; Luckett, C.R. Storage Time and Temperature on the Sensory Properties Broccoli. *Foods* **2019**, *8*, 162. [CrossRef]
10. Grant, K.; Gallardo, R.K.; McCluskey, J.J. Are Consumers Willing to Pay to Reduce Food Waste? *Choices* **2019**, *34*, 1–7.
11. Onozaka, Y.; McFadden, D.T. Does Local Labeling Complement or Compete with Other Sustainable Labels? A Conjoint Analysis of Direct and Joint Values for Fresh Produce Claim. *Am. J. Agric. Econ.* **2011**, *93*, 693–706. [CrossRef]
12. Printezis, I.; Grebitus, C. Marketing Channels for Local Food. *Ecol. Econ.* **2018**, *152*, 161–171. [CrossRef]
13. Li, S.; Kallas, Z. Meta-Analysis of Consumers' Willingness to Pay for Sustainable Food Products. *Appetite* **2021**, *163*, 105239. [CrossRef]
14. Feldmann, C.; Hamm, U. Consumers' Perceptions and Preferences for Local Food: A Review. *Food Qual. Prefer.* **2015**, *40*, 152–164. [CrossRef]
15. Kilduff, A.; Tregeagle, D. Willingness-to-Pay for Produce: A Meta-Regression Analysis Comparing the Stated Preferences of Producers and Consumers. *Horticulturae* **2022**, *8*, 290. [CrossRef]
16. Enthoven, L.; Van den Broeck, G. Local Food Systems: Reviewing Two Decades of Research. *Agric. Syst.* **2021**, *193*, 103226. [CrossRef]
17. Adalja, A.; Hanson, J.; Towe, C.; Tselepidakis, E. An Examination of Consumer Willingness to Pay for Local Products. *Agric. Resour. Econ. Rev.* **2015**, *44*, 253–274. [CrossRef]
18. Gracia, A. Consumers' Preferences for a Local Food Product: A Real Choice Experiment. *Empir. Econ.* **2014**, *47*, 111–128. [CrossRef]
19. Vapa-Tankosić, J.; Ignjatijević, S.; Kiurski, J.; Milenković, J.; Milojević, I. Analysis of Consumers' Willingness to Pay for Organic and Local Honey in Serbia. *Sustainability* **2020**, *12*, 4686. [CrossRef]
20. Hu, W.; Woods, T.; Bastin, S. Consumer Acceptance and Willingness to Pay for Blueberry Products with Nonconventional Attributes. *J. Agric. Appl. Econ.* **2009**, *41*, 47–60. [CrossRef]
21. Grebitus, C.; Lusk, J.L.; Nayga, R.M. Effect of Distance of Transportation on Willingness to Pay for Food. *Ecol. Econ.* **2013**, *88*, 67–75. [CrossRef]
22. Fan, X.; Gómez, M.I.; Coles, P.S. Willingness to Pay, Quality Perception, and Local Foods: The Case of Broccoli. *Agric. Resour. Econ. Rev.* **2019**, *48*, 414–432. [CrossRef]
23. Becker, G.M.; Degroot, M.H.; Marschak, J. Measuring Utility by a Single-Response Sequential Method. *Behav. Sci.* **1964**, *9*, 226–232. [CrossRef]
24. Shi, L.; House, L.A.; Gao, Z. Impact of Purchase Intentions on Full and Partial Bids in BDM Auctions: Willingness-to-Pay for Organic and Local Blueberries. *J. Agric. Econ.* **2013**, *64*, 707–718. [CrossRef]
25. Lusk, J.L.; Feldkamp, T.; Schroeder, T.C. Experimental Auction Procedure: Impact on Valuation of Quality Differentiated Goods. *Am. J. Agric. Econ.* **2004**, *86*, 389–405. [CrossRef]
26. Alphonce, R.; Alfnes, F. Eliciting Consumer WTP for Food Characteristics in a Developing Context: Application of Four Valuation Methods in an African Market. *J. Agric. Econ.* **2017**, *68*, 123–142. [CrossRef]

27. Shi, L.; Xie, J.; Gao, Z. The Impact of Deal-Proneness on WTP Estimates in Incentive-Aligned Value Elicitation Methods. *Agric. Econ.* **2018**, *49*, 353–362. [CrossRef]
28. Asioli, D.; Mignani, A.; Alfnes, F. Quick and Easy? Respondent Evaluations of the Becker–DeGroot–Marschak and Multiple Price List Valuation Mechanisms. *Agribusiness* **2021**, *37*, 215–234. [CrossRef]
29. Moser, R.; Raffaelli, R.; Thilmany, D.D. Consumer Preferences for Fruit and Vegetables with Credence-Based Attributes: A Review. *Int. Food Agribus. Manag. Rev.* **2011**, *22*, 121–142. [CrossRef]