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Market Intermediaries' Willingness to Pay for Apple, Peach, Cherry, and Strawberry Quality Attributes

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ABSTRACT

This study uses discrete choice experiments to determine the valuation that individual market intermediaries (e.g., packers, shippers, marketers, and processors) place on targeted fruit quality traits in apple, peach, cherry, and strawberry for both the fresh and processing market. In general, market intermediaries assigned the greatest value to fruit quality traits that would enhance their profitability through increased consumer appeal, increased marketing time windows, or more efficient processing. These results should inform decisions among fruit marketing intermediary enterprises and contribute knowledge to breeding programs to ensure breeding efforts are focused and relevant to the industry and consumers' needs and desires. [EconLit citations Q130, Q160] ©2010 Wiley Periodicals, Inc..© 2014 Wiley Periodicals, Inc.

1. INTRODUCTION

Food supply chains have experienced significant technological progress at all levels during the last thirty years. Concentration has increased in most food distribution and processing sectors, resulting in fewer but larger agricultural operations providing most of the production volume. For example, the total number of apple-packing operations in the state of Washington has declined from 44 in the late 1990s to 24 in 2008 (US International Trade Commission, 2010). Large-scale operations have become more vertically integrated and it is now common for partially and fully integrated growing and shipping operations to encompass most or all aspects of the supply chain prior to delivery at the retail or consumer level (US International Trade Commission, 2010).

For both fresh and processed fruit markets, a continuum of distinct links in the supply chain—packers, shippers, processors, and marketers—make critical economic decisions. Packers receive, clean, sort, and grade fruit for a range of attributes, making sure their product is packed to meet their market specifications and applicable government regulations. Depending

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on the crop, they store their fruit from short- to long-term and strive to retain critical quality characteristics that permit shipment at opportune market times. Packers place fruit in containers that minimize damage during handling and transporting, while shippers transport and deliver the fruit to locations designated by customers under conditions that maintain appropriate quality standards. Processors provide fruit to their customers in varied and convenient forms: fresh-sliced, frozen, juice, sauce, dried, etc.

Despite the intrinsic importance of packers, shippers, marketers, and processors (hereafter referred to as "market intermediaries") in contributing to an efficient and profitable fruit-crop supply chain, no published studies have investigated the preferences and values that market intermediaries place on fruit quality. This study aims to fill this gap in the literature by estimating market intermediaries' willingness-to-pay (WTP) for targeted genetic traits of apples, peaches, sweet and tart cherries, and strawberries.

2. BACKGROUND

This study is part of a larger project called RosBREED, dedicated to the genetic improvement of US rosaceous crops by targeted applications of genetics knowledge and tools to increase the efficiency of breeding programs and accelerate the development of improved cultivars (Weebadde et al., 2010). RosBREED focuses on fruit quality traits for apples, peaches, sweet and tart cherries, and strawberries, which are economically significant specialty crops that are produced in numerous US regions. The project includes a socio-economic component that seeks to systematically collect information on the values assigned by stakeholders along the supply chain and apply results to ensure breeding efforts are focused and relevant to the industry and consumers' needs and desires (Peace, 2013). This study is centered on market intermediaries' values for fruit quality attributes. One question of interest is how close are breeders' priorities aligned with market intermediaries' values? A recent survey, asked US breeders about the fruit quality attributes with the highest probability of being included when developing a new cultivar (Yue et al. (2012) and Gallardo et al. (2012). Apple breeders stated that they would likely include fruit crispness, fruit juiciness, consistent quality during storage, and shelf-life in their selections for new cultivar development. Peach breeders would likely include fruit firmness, fruit uniformity, fruit shape, fruit size, and production consistency. Strawberry breeders would include flavor, plant productivity, shelf life at retail, fruit size, and skin color. Sweet cherry breeders would include fruit firmness, fruit size, powdery mildew resistance, extended harvest season, and self-fertility. And tart cherry breeders would include fruit firmness, fruit shape, fruit uniformity, pit shape and size, pit splitting, machine harvest ability, graft compatibility, and production consistency. Our study will inform breeders on how close they are to matching market intermediaries' preferences, and the entire body of RosBREED socio-economic experiments and survey results will inform breeders on how close they are to target preferences from the whole supply chain.

3. LITERATURE REVIEW

To date, most studies of valuations for apple, peach, cherry, and strawberry quality traits have been undertaken from the consumer perspective. For apples for the fresh market, Manalo (1990) concluded that consumers in the northeastern US value apple crispness the most, followed by size, color, and flavor. Tronstad, Huthoefer, and Monke (1992) found that larger fruit sizes, controlled atmosphere storage, "Extra Fancy" grades, and summer-months' seasonality positively influenced apple prices in the United States. Kajikawa (1998) reported that Japanese wholesale prices for apples imported from New Zealand and the United States were positively associated with soluble solids concentration (an indicator of fruit flesh sweetness, hereafter SSC), acidity, and juice content. Jesionkowska, Konopacka, and Ploscharski (2006) determined that Polish consumers valued flavor and juiciness the most, followed by sweetness and firmness.

McCluskey, Mittelhammer, Marin, and Wright (2007) found that a premium of $0.26/lb could be obtained from consumers in Portland, Oregon, if apples had a firmness of at least 14 lbs. (lbs. is a measure for fruit flesh firmness, where higher lbs. indicate firmer flesh) and SSC of at least 13.5 °Brix (°Brix is a measure for SSC, where higher °Brix denotes sweeter fruit flesh). McCluskey, Horn, Durham, Mittelhammer, and Hu (2013) found that consumers in Portland, Oregon were willing to pay more for an increase in firmness (measured in lbf) in 'Red Delicious' than in 'Gala' ($0.58/lbf. versus $0.04/lbf.), but were willing to pay more for sweetness in 'Gala' as compared to 'Red Delicious' ($0.40 versus $0.37).

Few studies have investigated consumer valuation for peach quality traits. Jordan, Shewfelt, and Prussia (1987) and Parker, Zilberman, and Moulton (1991) determined that freedom from defects, color, maturity, and size were positively correlated with US fresh peach prices. Ravaglia, Sansavini, Ventura, and Tabanelli (1966) and Parker et al. (1991) indicated that consumer acceptance was positively associated with high SSC, and Kader (1994) proposed a minimum of 10% SSC for yellow flesh peaches in California. Hilaire (2003) established that the relationship between SSC and acidity levels influences consumer preferences, indicating that a minimum of 10% SSC should apply for peaches with low TA (titratable acidity) and 11% SSC for peaches with high TA, for consumers' positive overall acceptability. Crisosto (2005) concluded that the relationship between SSC and acidity levels varied across peach cultivars, and Predieri (2006) found that acidity, astringency, and sweetness were positively correlated with overall appreciation of "Royal Gem," a yellow peach variety, and "Silver Rome," a white peach variety. Park and Florkowski (2003), who analyzed peach fruit quality traits important to growers, found that taste, texture, pit characteristics (absence of split pit and a pit that does not separate from the fruit), and absence of decay and bruising were positively correlated with growers' acceptance of a new peach cultivar.

For sweet cherries, Miller, Casavant, and Buteau (1986) investigated Japanese consumer preferences and purchase patterns and found that taste, freshness, color, and shape/size were positively correlated with purchase intent. Guyer, Sinha, Chang, and Cash (1993) reported that sweet cherry sweetness, flavor, and firmness were positively correlated with overall acceptability for Michigan consumers. Lyngstand and Sekse (1995) found that Norwegian consumers preferred large, dark sweet cherries. Kappel, Fisher, Fleming, and Hogue (1996) found that Canadian consumers preferred sweet cherries 29–30 mm in diameter with minimum SSC between 17–19% and optimum acidity expressed in pH units of 3.8. Cliff, Dever, Hall, and Giraud (1996) reported that Canadian consumers positively correlated uniformity of color, size, flavor intensity, and sweetness with sweet cherry acceptability. Crisosto, Crisoto, and Metheney et al. (2003) found that California consumers' acceptance was positively influenced by SSC, titratable acidity (TA), SSC/TA ratio, and dark skin color. Hu (2007) estimated that consumers in Portland, Oregon, were willing to pay a price premium of $0.87 for an extra unit of sweetness and $0.35 for an extra unit of firmness.

For strawberries, most previous studies have focused on consumer preferences for quality, with no estimation of consumers' values. Ford, et al. (1996) determined that flavor, sweetness, and juiciness were the most important strawberry attributes to consumers. Safley, Wohlgenant, and Suter (1999) identified freshness, taste, firmness, fruit color, and fruit size as the important factors influencing consumer decisions to purchase strawberries. Keutgen and Pawelzik (2007) concluded that consumers were less willing to purchase strawberries with low SSC. Lado, Vicente, Manzzioni, and Ares (2010) found that consumers preferred a sweeter, firmer strawberry cultivar. Colquhoun et al. (2012) determined that sweetness and complex flavors were the most important strawberry fruit attributes for consumers.

In summary, the existing literature for the fruit crops in this study identifies the importance of quality traits such as flavor (e.g., sweetness and acidity), texture (e.g., flesh firmness and crispness), and appearance (e.g., external color and size) with respect to purchase intent and WTP price premiums. All these studies focus on consumers' preferences for fruit quality, but not on other supply chain members such as marketing intermediaries.

TABLE 1. Marketing Intermediary Survey Response by Crop Group

Survey version	Initial sample size	Mail complete	Web complete	Total complete	Response rate
Fresh apples	146	27	12	39	27%
Processed apples	79	14	6	20	25%
Fresh peaches (California)	132	15	12	27	20%
Fresh peaches (NOT California)	161	30	6	36	22%
Processed peaches	49	5	2	7	14%
Fresh sweet cherries	97	22	9	31	32%
Processed tart cherries	47	11	2	13	28%
Fresh strawberry	184	15	7	22	12%
Processed strawberries (California)	26	1	3	4	15%
Processed strawberries (NOT California)	16	1	2	3	19%
Overall	937	140	61	201	21%

4. DATA

We surveyed US business operations that act as market intermediaries for the rosaceous fruit crops included in this study. We created our list of US market intermediaries operations using several different sources, including Blue Book Online Services (a credit and marketing information agency serving the international wholesale produce industry), Washington State Fruit Association, Cherry Marketing Institute, and Yakima Valley Growers' and Shippers' Association. We conducted ten separate mail/internet surveys of market intermediaries, which were differentiated by fruit crop type, end-use of the fruit (fresh or processing), and location. For example, for apples and cherries, one survey version applied to the fresh and the other to the processing market. For peaches, there were three versions: fresh market in California, fresh market not in California, and the processing market. Similarly, there were three versions for strawberries: fresh market, processing market in California, and processing market in California and in Oregon and Washington. The different versions followed regional differences in scale of operations and marketing factors between fruit produced and handled in California and other states.[1]

We used a mixed mode survey (mail and online) following the total design method (TDM) protocol –survey, then reminder card, and then survey- to mitigated nonresponse bias (Dillman, Smyth, & Christian, 2009). The survey package contained a cover letter, a booklet questionnaire, postage-paid return envelope, and a $4 pre-incentive. The email included the survey URL and a personal access code. The data collection period lasted from April through August 2011. Of the 937 agribusiness operations on the sampling frame, 201 completed the survey (140 of the completed surveys were sent by mail and the remaining 61 were completed online). Across all crops, a 21% response rate was obtained. Due to the limited number of complete responses received for processed peaches (7), processed strawberries in California (4), and processed strawberries in Oregon and Washington (3), we excluded them from the analyses. Table 1 shows a list of the response rates by crop group.

[1]There are production/marketing differences between California and other peach producing states. In order for California market intermediaries to deliver their product as far as the East Coast (the largest market for fresh peach in the United States) with minimal damage while handling, they typically harvest fruit when mature but not yet physiologically ripe. Firmer fruit is less susceptible to damage during shipping, but at point of sale it has not yet developed a full, characteristic aroma and flavor profile (Reighard, 2013). Fresh peaches produced and shipped from California are consistently firm, free of external defects, and achieve relatively large size and color. Non-California peaches have much shorter transport distances, often in a direct farm-to-market setting, and tend to be harvested and shipped when more physiologically mature. Therefore, they are typically juicier, sweeter, and have a softer, melting flesh at point of sale, but are more susceptible to damage during shipping and handling.

Quality trait	Option A:	Option B:	Option C:
External appearance-Free from defects	Less than 3% defects per lot	More than 3% defects per lot	Neither Option
Crispness	Not crisp	Very crisp	
Firmness	More than 14 lbs.	Less than 14 lbs.	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Full/intense flavor	Weak/mild flavor	
Size	Less than 2.9 inches (100count)	More than 2.9 inches (100count)	
Shelf life at retail	Good (More than 1 week)	Poor (Less than 1 week)	
Total cost of production/storage/handling	$25 /carton (42 lbs.)	$15 /carton (42 lbs.)	
Which option would you choose?	☐	☐	☐

Figure 1 Example of a Survey Scenario for Fresh Apple

Survey instructions requested that the owner or manager of the market intermediary facility with final responsibilities for making marketing management decisions respond to the survey. All surveys consisted of seven sections, with variations in questions as appropriate for the crop group. The first section asked about the facility, including year of establishment, number of employees, function(s) the facility performed (since the facility could performed more than one function, we asked the percentage of total sales volume being handled as either packers, shippers, brokers, processors, or others), and sales volume of crops handled (because the facility handled more than one crop we asked for the percentage in terms of sales volume of apple, strawberry, peach, tart cherry, sweet cherry, other fruits and other nonfruits being handled). The second section included questions regarding the attributes of the fruit of interest. Questions included the ranking of the fruit attributes according to their importance for the business and the eight discrete choice scenarios detailed below. The third section inquired about aspects of production, including the importance of horticultural attributes of the crop of interest for the business and the rating of the importance of various supply chain factors on setting priorities for fruit attributes. The fourth section consisted of questions concerning the importance of availability of new fruit cultivars and the importance of factors relative to handling a new fruit cultivar. The fifth and sixth sections asked about the relationships among the company and its customers and suppliers. The seventh section asked about the existence of contracts, contract requirements, total sales in dollars for 2010, and size of the operation.

The discrete choice scenarios section presented eight (or six for tart cherries) scenarios depicting a situation for procuring the fruit of interest. For consistency across all regions and fruit crops, we assumed in the scenarios that intermediaries exerted full ownership of the fruit. Each scenario was comprised of two choice options (A and B), each representing different combinations of fruit quality traits and cost levels. Respondents were asked to choose one option from each choice set. If neither option was of interest, respondents could choose a "neither" option (labeled as C). An example choice experiment question is presented in Figure 1.

The scenarios for most fruits included six fruit quality traits (except for processed peaches and processed strawberries, which had five quality traits, and processed tart cherries, which had four). The fruit quality traits, the trait levels, and the cost of handling/storage levels in the choice scenarios were selected in consultation with fruit breeders, industry leaders, and fruit business representatives. Each fruit quality trait and cost had two different levels, for a total of $2^7 = 128$ possible combinations. We used a main effects fractional factorial design to choose sixteen options from the remaining set. The selected options were paired (Options A and B), and Option C was added to each of the eight (or six for processing cherries) choice sets. Table 2 includes a list of all attributes and their levels included in each survey version.

TABLE 2. Fruit Attributes and Attribute Levels Used in Discrete Choice Scenarios

Quality trait	Level 1	Level 2
	Fresh apples	
External appearance	Less than 3% defects per lot	More than 3% defects per lot
Crispness	Not crisp	Very crisp
Firmness	Less than 14 lbs.	More than 14 lbs.
Flavor	Weak/mild flavor	Full/intense flavor
Size	Less than 2.9 inches (100 count)	More than 2.9 inches (100 count)
Shelf life at retail	Poor (Less than 1 week)	Good (More than 1 week)
	Processed apples	
Size	Less than 2.5 inches	More than 2.5 inches
Firmness	Less than 14 lbs.	More than 14 lbs.
Aroma	Noncharacteristic	Characteristic
Tartness (Acidity)	Low (Less than 0.3 g malic acid / 100mL)	High (More than 0.3 g malic acid/100mL)
Sweetness (Soluble solids)	Low (Less than 12 °Brix)	High (More than 12 °Brix)
Internal defects	Less than 3% per lot	More than 3% per lot
	Fresh peaches California	
External color	Not desirable (lack of skin blush/color)	Desirable (cream/yellow background color with a red blush color)
Size	Size 80 to size 56 (smaller than 3 inches diam.)	Size 50 and larger (larger than 3 inches diam.)
External appearance	Fair (<70% packout)	Good (>85% packout)
Firmness	Less than 10 lbs.	More than 10 lbs.
Flavor	Weak/mild flavor	Full/intense flavor
Sweetness (Soluble solids)	Low (Less than 11 °Brix)	High (More than 11 °Brix)
	Fresh peaches NOT California	
External color	Not desirable (lack of skin blush/color)	Desirable (cream/yellow background color with a red blush color)
Size	"Quarters" (2.25 inches diam. and up to 2.5 inches)	Three-quarters (2.75 inches diam. and up to 3 inches)
External appearance	Fair (<70% packout)	Good (>85% packout)
Firmness	Less than 10 lbs.	More than 10 lbs.
Flavor	Weak/mild flavor	Full/intense flavor
Sweetness (soluble solids)	Low (Less than 11 °Brix)	High (More than 11 °Brix)
	Processed peaches	
Size	Less than 2 3/8 inches diam.	More than 2 3/4 inches diam.
Appearance	Less than 3% defects per lot	More than 3% defects per lot
Absence of split pits	No	Yes
Firmness	Low (Less than 2.9 lbs.)	High (More than 2.9 lbs.)
Sweetness (soluble solids)	Low (Less than 10 °Brix)	High (More than 10 °Brix)
	Fresh sweet cherries	
External Color	Light red	Dark red
Size	Less than 11 row (more than 1 inch diameter)	More than 10 row (less than 1 inch diameter)
Firmness	Soft (less than 300 g/mm)	Firm (more than 300 g/mm)
Sweetness (Soluble solids)	Low (Less than 18 °Brix)	High (More than 18 °Brix)
Flavor	Weak/mild flavor	Full/intense flavor
Shelf life at retail	Less than 1 week	More than 1 week

(*Continued*)

TABLE 2. Continued

Quality trait	Level 1	Level 2
	Processed tart cherries	
External color	Poor red color	Characteristic red color
Size	Non-uniform	Uniform
External appearance-	Less than 4% defects per lot	More than 4% defects per lot
Pit removal	Poor	Good
	Fresh strawberries	
Size	Less than 25 g/fruit	More than 25 g/fruit
Internal color	Too light or too dark color	Ideal red color
External color	Too light or too dark color	Ideal red color
Firmness	Soft	Firm
Flavor	Weak/mild flavor	Full/intense flavor
Shelf life	4 days after harvest	9 days after harvest
	Processed strawberries	
External color	Too light or too dark color	Ideal red color
Size	Less than 25 g/fruit	More than 25 g/fruit
Internal color	Too light or too dark color	Ideal red color
Calyx (Cap)	Absence	Presence
Flavor	Weak/mild flavor	Full/intense flavor

5. EMPIRICAL SPECIFICATION

Choice modeling is based on the premise that there is an underlying rational decision process when making individual choices. In particular, the discrete choice models used in this study are based on consumer random utility theory, which can easily be extended to producers (Lusk & Hudson, 2004). Based on producer theory, firms choose the option from a choice set that maximizes their profit. Suppose a choice set has M alternatives ($j = 1, 2, \ldots, M$). For firm i ($i = 1, 2, \ldots, N$) the profit derived from the j^{th} alternative, Π_{ij} can be represented as

$$\Pi_{ij} = Z_{ij} + \varepsilon_{ij}, \tag{1}$$

where Z_{ij} is the deterministic component that includes the set of quality traits and the fruit cost for each crop group and firm characteristics The term ε_{ij} is usually unknown and is treated as a random component, and captures the unobserved characteristics of the crop group or the individual firms that are not included in Z_{ij}. The assumption is that among the M alternatives, the firm would choose alternative j if and only if alternative j maximizes the firm's profit. Let $Y_i$be a random variable whose value indicates the choice made by firm i. The probability that firm i would choose alternative j is

$$Pr\left(Y_i = j\right) = \Pr\left(\Pi_{ij} > \Pi_{ik}\right) for\ all\ k = 1, 2, \ldots, M; k \neq j. \tag{2}$$

Different assumptions on the error term lead to different model specifications. For example, if the error term ε_{ij} is independently, identically distributed (iid) with Gumbel distribution (type 1 extreme value), then we have a conditional logit model. While the conditional logit model has provided the foundation for analysis of discrete choice and has been widely used in different research areas, it suffers from a number of limitations. First, it is does not exhibit independence of irrelevant alternatives (IIA) properties. Second, it does not enable the presence of preference

heterogeneity within the choice data. Third, it imposes a constant error variance assumption across all alternatives (Louviere, Hensher, & Swait, 2000; Bliemer & Rose, 2010).

An alternative to the conditional logit is the heteroscedastic extreme value (HEV) model. The HEV model relaxes the iid restriction by enabling error terms to be independent but nonidentically distributed (Bhat, 1995). Another alternative is the mixed logit model, which relaxes the IIA property and enables the control of both observed and unobserved heterogeneity across individuals (Brownstone, Bunch, Train, 2000; Greene, Hensher, & Rose, 2006; Train, 2009). Another model specification alternative is the multinomial probit, which enables the error term to be both nonindependent and nonidentical (Train, 2009).

Rather than making restrictive assumptions and using only the conditional logit model, we estimated alternative models and tested for the validity of the assumptions. We tested each fruit model for IIA using a Hausman test (Hausman & McFadden, 1984) and iid, comparing likelihood ratios. If these assumptions held, we used the conditional logit model. However, if any assumption was violated, we used the alternative model. As a result, we used the conditional logit model to estimate the parameters for fresh peaches not in California, fresh strawberries, and processed tart cherries. The HEV model was used for fresh and processed apples. The mixed logit model was used for fresh sweet cherries and the multinomial probit model for fresh peaches in California. A potential explanation for the preferred model specifications varying across products is linked to the different levels of heterogeneity across market intermediary segments. The heterogeneity is the result of different production and marketing conditions for each fruit.

In discrete choice models, the explanatory variables typically describe attributes of alternatives rather than characteristics of decision makers. In this study, we were also interested in firms' characteristics that might influence the decision of selecting a choice set. Thus, factors specific to both the alternatives and to the firms were included in the model. Suppose there are R factors specific to the firm and S factors specific to the choice. We used Q_{ir}, $r = 1, 2, \ldots, R$ to represent the vector of R firm characteristics such as size of the firm, employee numbers, sale volume, etc., for firm i. We used W_{js}, $s = 1, 2, \ldots, S$ to represent the vector of the S fruit quality attributes such as size, appearance, firmness, flavor, etc. for choice alternative j. Note that the attributes of the choices, for a given fruit, do not vary across firms, which means all the firms face the same attribute levels for a given fruit. The profit of firm i derived from the j^{th} alternative for a specific fruit type can be rewritten as

$$\Pi_{ij} = Z_{ij} + \varepsilon_{ij} = \sum_{r=1}^{R} \alpha_r Q_{ir} + \sum_{s=1}^{S} \gamma_s W_{js} + \lambda P_j + \varepsilon_{ij}, \tag{3}$$

where α is a vector of coefficients for the firm characteristics, γ is a vector of coefficients for fruit quality trait s, and λ is the vector of costs for each alternative j.

To reduce the large number of firm-specific characteristics only, a three-step procedure was conducted. First, a bivariate analysis was used to eliminate the variables that had little power to explain individuals' choice decisions (Mays, 2004). More specifically, we ran a model including all choice specific alternative variables plus one firm specific variable at a time and used the p-value (at 0.05) to determine the significance of the firm specific variable parameter. Second, a cluster analysis was used to eliminate firm specific variables with redundant information. Cluster analysis divided the variables into smaller sets of variables that were highly related. We selected a single firm-specific variable to represent each cluster. After the previous steps, the model had a considerably smaller number of firm specific variables. Third, forward selection, backward elimination, and stepwise methods were used to further select variables. During this process, we compared parameter significance, AIC, SBC, and McFadden's R-Square to select the model with the variable that best fit the data. Across all crops, the firm specific variables included in the model were related to the number of years in the business, size in terms of number of employees, function in the supply chain (e.g., shipper, packer, broker, processor), mix of fruits handled expressed by the percentage of total sales volume, rating of importance of

different factors affecting intermediaries' selection of fruits to handle, firm's immediate clientele expressed as the entity they sold fruit to, and use of labels.

To include the firm specific variables in the model, we interacted these variables with the binary variables corresponding to Options A and B presented to respondents in each survey scenario (Greene, 2008). The interaction with binary variables was included to avoid perfect multicollinearity, enabling the coefficients of the interactions to vary across options A and B presented to respondents.

The model parameter estimates were used to calculate the WTP difference between the two levels for each fruit quality attribute. Since the two attribute levels were considered to be inferior and superior levels of the quality attribute, the WTP differences were interpreted as the WTP for moving from the low to the high quality attribute level, assuming all other quality attributes remained the same. Since the costs for each fruit were different, the WTP units for each crop were different. For example, the unit for fresh apples was dollars per forty-two-pound carton; for processed apples, dollars per ton; for fresh peaches in California and not in California, dollars per twenty-five-pound carton; for fresh sweet cherries, dollars per pound; for processed tart cherries, dollars per ton; and for fresh strawberries, dollars per twenty-five-pound carton. We converted the WTP units for all fruits to dollars per pound. The WTP for a crop is equal to the marginal rate of substitution between quality trait levels and the cost coefficient, as follows:

$$WTP_S = \frac{\gamma_{2s} - \gamma_{1s}}{\lambda} \tag{4}$$

where WTP is the willingness to pay for the fruit attribute s, $\gamma_{2s}$and $\gamma_{1s}$are the parameter estimates for fruit quality attribute level 2 (high) and 1 (low), and λ is the parameter estimate for the cost of fruit. The standard deviation for each WTP was estimated by simulating 1,000 random observations from a multivariate normal distribution for each parameter estimate (γ_{2s}, γ_{2s}, andλ). For each of these 1000 observations, the WTP was calculated following expression (4) generating an empirical distribution. Finally the standard deviation of the distribution was obtained (Krinsky & Robb, 1986).

6. RESULTS

Tables 3–6 present model parameter estimates for the discrete choice models for all crops in this study. The specific econometric specification used for the fruit crop groups was based on the testing of the assumptions and is indicated in the heading of each table. Results for all crops were consistent with our expectations that market intermediaries disliked higher costs for production/handling/storage.

For apples for the fresh market, intermediaries preferred apples with more than 1 week shelf life at retail, crispy, with intense flavor, with a firmness of more than 14 lbs. and disliked apples with more than 3% defects per lot (Table 3). More established facilities (i.e., with greater number of years since establishment) were not satisfied with the quality attributes presented in option A and B in the discrete choice scenarios and more frequently chose the "neither option". Facilities whose highest percentage of total sales volume was functioning as shippers, who assigned higher ratings of importance to available premiums when selecting fruits to handle, who sold fruit to wholesalers, and who did not use labels or claims were less likely to chose the "neither" option. Apple processors preferred apples with internal defects less than 3% per lot, sweetness higher than 12 °Brix, and firmness higher than 14 lbs. (Table 3). Apple processors who less frequently chose the "neither" option were those who functioned as either growers, retailers, and direct marketers; assigned higher ratings of importance to the potential market share when considering handling a new fruit cultivar; and sold directly to consumers. Apple processors who chose the "neither" option more frequently handled strawberries (in addition to apples for processing) and rated the experience of peer firms higher in importance when selecting fruit to handle.

TABLE 3. Parameter Estimates for Market Intermediaries' Preferences for Apple Quality Traits and Firm Characteristics

Quality traits and firm characteristics	Apple fresh market	Apple processing market
	Heteroscedastic extreme value	
External appearance (% of defects per lot)	−10.039***[a]	–
	(1.508)[b]	
Size	0.189	0.041
	(0.166)	(0.088)
Internal defects	–	−1.418***
		(0.156)
Aroma	–	0.303
		(0.343)
Flavor	10.450***	–
	(1.598)	
Sweetness	–	1.374***
		(0.175)
Tartness (Acidity)	–	0.163
		(0.229)
Firmness	0.747***	1.053**
	(0.258)	(0.465)
Crispness	10.556***	–
	(1.670)	
Shelf life at retail	10.990***	–
	(1.625)	
Cost of production/handling/storage	−1.951***	−0.025***
	(0.306)	(0.006)
Years facility was established x option A	−0.028***	–
	(0.010)	
Years facility was established x option B	−0.033***	–
	(0.010)	
Number of employees x option A	0.0004	–
	(0.000)	
Number of employees x option B	0.0003	–
	(0.000)	
Percent. total sales vol. facility performed as shipper x option A	0.016***	–
	(0.006)	
Percent. total sales vol. facility performed as shipper x option B	0.023***	–
	(0.007)	
Percentage of apple sales volume x option A	0.016**	−0.01**
	(0.007)	(0.004)
Percentage of apple sales volume x option B	0.008	0.002
	(0.009)	(0.004)
Rating of importance of available premiums x option A	0.431**	–
	(0.179)	
Rating of importance of available premiums x option B	0.543***	–
	(0.171)	
Facility sold fruit to wholesalers x option A	0.839*	–
	(0.466)	
Facility sold fruit to wholesalers x option B	1.513**	–
	(0.584)	
Facility sold fruit to club stores (e.g., Costco) x option A	−0.272	–
	(0.316)	
Facility sold fruit to club stores (e.g., Costco) x option B	−0.592	–
	(0.435)	

(*Continued*)

TABLE 3. Continued

Quality traits and firm characteristics	Apple fresh market	Apple processing market
	Heteroscedastic extreme value	
Firm did not use labels or claims x option A	1.471***	–
	(0.493)	
Firm did not use labels or claims x option B	1.093*	–
	(0.576)	
Firm use sustainable agriculture label x option A	−0.727	–
	(0.875)	
Firm use sustainable agriculture label x option B	−0.824	–
	(0.281)	
Percent. total sales vol. fac. perform as other function x option A[c]	–	0.128***
		(0.021)
Percent. total sales vol. fac. perform as other function x option B	–	0.103***
		(0.021)
Percentage of strawberries sales volume x option A	–	−4.937***
		(0.721)
Percentage of strawberries sales volume by the firm x option B	–	−4.899***
		(0.758)
Rating of importance of experience of peer firms x option A	–	−0.426***
		(0.081)
Rating of importance of experience of peer firms x option B	–	−0.636***
		(0.120)
Rating of importance of potential market share x option A	–	0.669***
		(0.076)
Rating of importance of potential market share x option B	–	0.633***
		(0.134)
Firm sold fruit directly to consumers x option A	–	2.225***
		(0.189)
Firm sold fruit directly to consumers x option B	–	3.636***
		(0.472)
Scale 2	–	0.635***
Scale 3	12.668	115.457
Number of observations	930.000	453.000
Log likelihood	−227.463	−95.034

[a]Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 0.1, 0.05 and 0.01 levels.
[b]Numbers in parenthesis are standard errors.
[c]Other functions include growers, retail, and direct marketing.

Fresh peach market intermediaries both in and outside California preferred to handle peaches with sweetness higher than 11°Brix, and firmness higher than 10 lbs. (Table 4). In addition, facilities not in California preferred size 50 or larger peaches (more than 2.75 inches diameter). Peach market intermediaries not in California who chose the "neither" option less frequently, tended to sell fruit to distributors and functioned as packers. Facilities not in California, who chose the "neither" option more frequently had a larger number of employees, assigned higher ratings of importance to marketers preference when considered fruit to handle, and sold fruit to re-packers.

Sweet cherry intermediaries preferred cherries with shelf life at retail more than 1 week, sweetness higher than 18 °Brix, intense flavor, a dark red external color, sizes larger than 10 row (more than 1-inch diameter), and firmness higher than 300 g/mm. (Table 5).

Facilities who chose the "neither" option more frequently handled tart cherries (in addition to sweet cherries), rated consumers' preferences as higher in importance, and sold fruit to

TABLE 4. Parameter Estimates for Market Intermediaries' Preferences for Fresh Peach Quality Traits and Firm Characteristics

Quality traits and firm characteristics	Fresh peaches (California)	Fresh peaches (not California)
	Multinomial probit	Conditional logit
External appearance	0.353	0.365
	(0.489)[a]	(0.314)
External color	0.647	0.591*[b]
	(0.405)	(0.339)
Size	0.148	1.448***
	(0.191)	(0.263)
Flavor	−0.565	0.293
	(0.405)	(0.465)
Sweetness	1.385*	0.987***
	(0.729)	(0.344)
Firmness	0.837*	1.224***
	(0.493)	(0.388)
Cost of production/handling/storage	−0.342*	−0.238*
	(0.188)	(0.125)
Percent. total sales vol. fac. perform as broker x option A	−0.010*	–
	(0.006)	
Percent. total sales vol. fac. perform as broker x option B	−0.010	–
	(0.008)	
Percentage of peaches sales volume x option A	−0.003	–
	(0.005)	
Percentage of peaches sales volume x option B	−0.032*	–
	(0.017)	
Rating of importance of packers/shippers' preference x option A	−0.385	–
	(0.236)	
Rating of importance of packers/shippers' preference x option B	−0.442	–
	(0.358)	
Rating of importance of marketer's preference x option A	0.418*	–
	(0.232)	
Rating of importance of marketer's preference x option B	0.188	–
	(0.260)	
Facility sold fruit to wholesalers x option A	1.411*	–
	(0.818)	
Facility sold fruit to wholesalers x option B	1.169	–
	(1.224)	
Facility sold fruit to distributors x option A	−1.115*	1.788***
	(0.620)	(0.585)
Facility sold fruit to distributors x option B	−0.602	2.699***
	(0.731)	(0.761)
Number of employees x option A	–	−0.015***
		(0.005)
Number of employees x option B	–	−0.029*
		(0.016)
Percent. total sales vol. fac. perform as packer x option A	–	0.017***
		(0.006)
Percent. total sales vol. fac. perform as packer x option B	–	0.027*
		(0.010)
Percentage of strawberries sales volume x option A	–	1.709
		(1.091)
Percentage of strawberries sales volume x option B	–	1.75
		(1.119)
Percentage of peaches sales volume x option A	–	−0.001

(*Continued*)

TABLE 4. Continued

Quality traits and firm characteristics	Fresh peaches (California)	Fresh peaches (not California)
	Multinomial probit	Conditional logit
		(0.006)
Percentage of peaches sales volume x option B	–	0.004
		(0.007)
Rating of importance of marketers' preference x option A	–	−0.752***
		(0.155)
Rating of importance of marketers' preference x option B	–	−1.114***
		(0.174)
Facility sold fruit to re-packers x option A	–	−2.934***
		(0.808)
Facility sold fruit to re-packers x option B	–	−2.522**
		(1.205)
Facility did not use labels or claims x option A	–	−1.09*
		(0.562)
Facility did not use labels or claims x option B	–	−0.527
		(0.680)
Number of observations	630.000	888.000
Log likelihood	−140.979	−185.608

[a]Numbers in parenthesis are standard errors.
[b]Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 0.1, 0.05 and 0.01 levels.

grocery retailers. Facilities choosing the "neither" option less frequently were packers and sold fruit to wholesalers. Tart cherry intermediaries preferred a characteristic external red color, good pit removal, and uniform sizes. Facilities who chose the "neither" option more frequently had a larger number of employees and sold fruit directly to consumers. Fresh strawberry intermediaries preferred berries with intense flavor, firm, and size more than 25 g/fruit (Table 6). Facilities who chose the "neither" option more frequently rated shipper/packers' preferences as higher in importance, and used their own brand label.

In general, intermediaries handling fruit for the fresh market stated a higher preference for quality traits relevant to the consumer (e.g., flavor, sweetness), for traits that facilitate fruit handling as intermediaries (e.g., firmness), and for traits linked to US grades and standards (e.g., size, external color). Those handling fruit for the processing market preferred quality traits that would benefit their processing operations (e.g., freedom from internal defects, size uniformity). No clear pattern was observed for the impact of firm characteristics on preferences for quality traits.

Table 7 reports the WTP estimates for all fruits in this study. For fresh apples, market intermediaries were willing to pay \$0.13/lb more to improve shelf life from less to more than one week, all other factors held constant. Expanding the time window for the fruit to retain its initial (after harvest) quality traits is crucial for market intermediaries, as it enables an improved control of inventories (Grim, 2010). Market intermediaries were willing to pay \$0.12/lb more to improve external appearance of fresh apples from more to less than 3% defects per lot. External appearance is a criterion for the US standards for grades of apples (US Department of Agriculture, 2002), which commands apple market prices and improves intermediaries' profitability. Intermediaries were willing to pay \$0.13/lb more to improve fresh apple firmness from less to more than 14 lbs., \$0.009/lb more to improve flavor (from weak to full flavor) and \$0.002/lb to improve crispness (from not to very crisp). These results are aligned with the general industry attitude to focus on consumer related fruit attributes (Grim, 2010). The results are also consonant with previous studies analyzing consumer preferences for fresh apple quality in which attributes such as flavor and firmness were highly preferred (Manalo, 1990;

TABLE 5. Parameter Estimates for Market Intermediaries' Preferences for Fresh and Processed Cherry Quality Traits and Firm Characteristics

Quality traits and firm characteristics	Fresh sweet cherry Mixed logit	Processed tart cherry Conditional logit
External appearance	–	−0.842
		(0.964)[a]
External color	3.662**[b]	4.152*
	(1.652)	(2.167)
Size	2.536***	1.787*
	(0.619)	(1.003)
Flavor	4.381***	–
	(1.586)	
Sweetness	4.857***	–
	(1.709)	
Firmness	2.406***	–
	(0.607)	
Pit removal	–	3.797***
		(1.117)
Shelf life at retail	5.060***	–
	(1.697)	
Cost of production/handling/storage	−0.706**	−37.697**
	(0.288)	(18.464)
External color standard deviation	−0.035	–
	(6.414)	
Size standard deviation	0.113	–
	(3.221)	
Flavor standard deviation	−0.040	–
	(3.256)	
Sweetness standard deviation	0.371	–
	(0.958)	
Firmness standard deviation	0.005	–
	(6.691)	
Shelflife at retail standard deviation	0.120	–
	(1.876)	
Percent. total sales vol. fac. perform as packer x option A	0.033***	–
	(0.012)	
Percent. total sales vol. fac. perform as packer x option B	0.027**	–
	(0.011)	
Percentage of tart cherries sales volume x option A	−0.154*	–
	(0.083)	
Percentage of tart cherries sales volume x option B	−0.121**	–
	(0.058)	
Percentage of sweet cherries sales volume x option A	0.016	–
	(0.012)	
Percentage of sweet cherries sales volume x option B	0.026**	–
	(0.013)	
Rating of importance of own experience x option A	0.692	–
	(0.532)	
Rating of importance of own experience x option B	0.511	–
	(0.444)	
Rating of importance of experience of peer firms x option A	−1.151**	–
	(0.575)	
Rating of importance of experience of peer firms x option B	−0.568	–
	(0.574)	
Rating of importance of consumers' preference x option A	−0.814**	–
	(0.378)	

(*Continued*)

TABLE 5. Continued

Quality traits and firm characteristics	Fresh sweet cherry Mixed logit	Processed tart cherry Conditional logit
Rating of importance of consumers' preference x option B	−0.885**	–
	(0.437)	
Facility sold fruit to wholesalers x option A	4.403*	–
	(2.459)	
Facility sold fruit to wholesalers x option B	5.632**	–
	(2.839)	
Facility sold fruit to distributors x option A	−1.904**	–
	(0.924)	
Facility sold fruit to distributors x option B	−0.714	–
	(0.708)	
Facility sold fruit to grocery retailers x option A	−7.247**	–
	(2.877)	
Facility sold fruit to grocery retailers x option B	−7.297**	–
	(3.080)	
Facility used own brand label x option A	1.421	–
	(1.191)	
Facility used own brand label x option B	1.878	–
	(1.267)	
Number of employees x option A	–	−0.007*
		(0.004)
Number of employees x option B	–	−0.011**
		(0.005)
Percent. total sales vol. fac. perform as processor x option A	–	0.049*
		(0.029)
Percent. total sales vol. fac. perform as processor x option B	–	0.052
		(0.037)
Rating of importance of packers/shippers' preference x option A	–	−0.168
		(0.355)
Rating of importance of packers/shippers' preference x option B	–	0.029
		(0.448)
Facility sold fruit to brokers x option A	–	−2.482**
		(1.179)
Facility sold fruit to brokers x option B	–	0.858
		(1.423)
Facility sold fruit directly to consumers x option A	–	−4.233***
		(1.407)
Facility sold fruit directly to consumers x option B	–	−4.854***
		(1.833)
Number of observations	741.000	195.000
Log likelihood	−151.873	−28.427

[a]Numbers in parenthesis are standard errors.
[b]Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 0.1, 0.05 and 0.01 levels.

Tronstad et al., 1992; Kajikawa, 1998; Jesionkowska et al., 2006). Results are comparable to previous WTP estimates from consumers' studies[2]: \$0.26/lb premium for apples with a firmness

[2]Results are comparable if considering the marketing spread between producers' and consumers' prices. For example, the US Department of Agriculture, reports a marketing spread of 75% for apples (US Department of Agriculture, 2013), if 75% is added to the WTP estimate for firmness estimated in this study (\$0.13/lb), it becomes \$0.22/lb, which is comparable to \$0.26/lb reported by McCluskey et al. (2007) and falls within the range for WTP estimates for firmness \$0.58-\$0.04/lbf reported by McCluskey at al. (2013).

TABLE 6. Parameter Estimates for Market Intermediaries' Preferences for Fresh Strawberry Quality Traits and Firm Characteristics

Quality traits and firm characteristics	Fresh strawberry Conditional logit
External color	0.445
	(0.359)[a]
Size	0.643**[b]
	(0.308)
Internal color	0.369
	(0.309)
Flavor	1.588***
	(0.477)
Firmness	0.988*
	(0.563)
Shelf life at retail	0.286
	(0.312)
Cost of production/handling/storage	−6.659***
	(2.168)
Number of employees x option A	−0.021*
	(0.011)
Number of employees x option B	−0.07**
	(0.028)
Percent. total sales vol. fac. perform as shipper x option A	0.012
	(0.007)
Percent. total sales vol. fac. perform as shipper x option B	0.018*
	(0.010)
Percent. total sales vol. fac. perform as broker x option A	0.015
	(0.010)
Percent. total sales vol. fac. perform as broker x option B	0.006
	(0.013)
Rating of importance of wholesaler's preference x option A	0.401*
	(0.236)
Rating of importance of wholesaler's preference x option B	0.482
	(0.290)
Rating of importance of shipper/packer's preference x option A	−0.295**
	(0.148)
Rating of importance of shipper/packer's preference x option B	−0.354*
	(0.214)
Facility sold fruit to supercenters (e.g., Wal-Mart) x option A	1.183**
	(0.550)
Facility sold fruit to supercenters (e.g., Wal-Mart) x option B	0.972
	(0.700)
Facility used own brand label x option A	−6.457∗
	(3.488)
Facility used own brand label x option B	−6.261*
	(3.419)
Number of observations	474.000
Log likelihood	−119.690

[a]Numbers in parenthesis are standard errors.
[b]Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 0.1, 0.05 and 0.01 levels.

of at least 14 lbs. and sweetness of at least 13.5 °Brix (McCluskey et al., 2007); and \$0.58/lbf and- \$0.04/lbf premium for an improvement in "Red Delicious" and "Gala" apple firmness, respectively (McCluskey et al., 20013). Furthermore, the results show that apple breeding programs' target priorities are consistent with market intermediaries preferences, as crispness and shelf life were two quality attributes with a probability higher than 87% of being selected by breeders in new cultivar development (Yue et al., 2012; Gallardo et al., 2012).

TABLE 7. Marketing Intermediaries' Willingness-to-Pay for Improvements[a] in Targeted Fruit Quality Traits for Selected Rosacea Crops

	WTP ($/lb)[b]						
Quality traits	Fresh apples	Processed apples	Fresh peaches (California)	Fresh peaches (not California)	Fresh sweet cherries	Processed tart cherries	Fresh strawberries
External appearance	−0.123 (0.135)[c]	–	0.041 (1.739)	0.061 (1.315)	–	−0.022 (0.051)	–
External color	–[d]	–	0.076 (1.244)	0.099 (1.842)	0.259 (1.451)	0.110 (0.064)	0.067 (0.048)
Size	0.129 (0.093)	0.001 (3.837)	0.017 (1.189)	0.243 (4.284)	0.180 (3.690)	0.047 (0.050)	0.096 (0.065)
Internal defects	–	0.028 (14.051)	–	–	–	–	–
Internal color	–	–	–	–	–	–	0.055 (0.046)
Aroma	–	0.006 (12.972)	–	–	–	–	–
Flavor	0.009 (0.100)	–	-0.066 (2.242)	0.049 (2.550)	0.310 (1.287)	–	0.238 (0.043)
Sweetness	–	0.027 (11.176)	0.162 (1.947)	0.166 (3.200)	0.344 (1.809)	–	–
Tartness (Acidity)	–	0.003 (13.247)	–	–	–	–	–
Firmness	0.128 (0.134)	0.021 (10.113)	0.098 (1.969)	0.205 (3.873)	0.170 (3.541)	–	0.148 (0.070)
Crispness	0.002 (0.117)	–	–	–	–	–	–
Pit removal	–	–	–	–	–	0.101 (0.073)	–
Shelf life at retail	0.134 (0.124)	–	–	–	0.359 (1.850)	–	0.043 (0.067)

[a]Improvements are different for each fruit crop. See Table 2 for a detailed description of improvements.
[b]The willingness to pay units for each crop was different. For example, for fresh apples the unit was dollars per 42-lbs carton, for processed apples, dollars per ton; for fresh peaches in California and not in California, dollars per 25-lbs carton; for fresh sweet cherries, dollars per pound; for processed tart cherries, dollars per ton; and for fresh strawberries, dollars per 25-lbs carton. To enable comparisons we converted the WTP units to dollars per pound.
[c]Numbers in brackets are standard deviations.
[d]Means that the fruit quality trait does not apply to the fruit type listed, thus no estimate is reported.

For fresh peaches, there were differences in WTP between operations in California and operations not in California. For fresh market peaches in California, market intermediaries were willing to pay $0.16/lb for an increase in SSC from less to more than 11 °Brix, and $0.10/lb for an improvement in firmness from less to more than 10 lbs. This aligns with observations by Reighard (2013) in that California peaches are typically harvested when fruit is not physiologically ripe to minimize damage while handling thus lacks of full flavor profile. Not surprisingly, sweetness and firmness are of the most importance to intermediaries. Also, the results are consistent with previous studies on consumers' preferences signaling sweetness as a highly preferred attribute (Ravaglia et al., 1966; Parker et al., 1991; Kader, 1994; and Predieri, 2006).

For fresh peaches not in California, intermediaries were willing to pay $0.24/lb for an improvement in size (from 2.25–2.50 to 2.75–3.00 inches diameter). They were willing to pay $0.21/lb for an improvement in firmness from less to more than 10 lbs., $0.17/lb for an

improvement in SSC from less to more than 11 °Brix, and \$0.10/lb for an improvement in external color from not desirable (lack of skin blush color) to desirable (cream/yellow background with a red blush color). These results signal that the WTP by market intermediaries is aligned with the US standards for grades of peaches (US Department of Agriculture, 2004) where size, firmness and color are included in the criteria to set grades. Also the results are consistent with findings in consumer studies by Jordan et al. (1986) and Parker et al. (1991), who found that size and desirable external color were positively correlated with US fresh peach prices. Ravaglia et al. (1966), Parker et al. (1991), Kader (1994), and Predieri (2006) also found peach sweetness was highly preferred by consumers. In general, the results indicate that US peach breeding program targets are consistent with market intermediaries' values as fruit firmness and fruit size were two quality attributes likely (probability higher than 87%) to be included in breeding programs (Yue et al., 2012; Gallardo et al., 2012).

Fresh sweet cherry market intermediaries were willing to pay \$0.34/lb for an increase in SSC from less to more than 18 °Brix. This WTP is lower than the consumers' WTP value of \$0.87/lb for an extra °Brix reported by Hu (2007).[3] Market intermediaries for sweet cherries were willing to pay \$0.31/lb for an improvement in flavor from weak/mild to full/intense, \$0.26/lb for an improvement in external color from light to dark red, and \$0.18/lb for an increase in size from less to more than 1-inch diameter. Intermediaries were also willing to pay \$0.17/lb for an improvement in firmness from less than to more than 300 g/mm (17 lbs.). This is lower than the consumers' WTP value of \$0.35/lb for an extra unit of firmness reported by Hu (2007). Aside from sweetness and flavor, external color, size, and firmness are attributes included in the US standards for grades of sweet cherries (US Department of Agriculture, 2005), which impacts market prices. Even under good postharvest storage conditions, sweet cherries deteriorate rapidly due to moisture loss, color change, softening, surface pitting, stem browning, and loss of acidity (Serrano et al., 2005). Thus, sweet cherries have a short marketing window with low lengths of storability (one to two weeks) and limited shelf life (one week). Results also signal that sweet cherry breeders are aligned with market intermediaries' values. Fruit size and firmness were of the highest probability to be included in selections (100% probability) for new cultivar development (Yue et al., 2012; Gallardo et al., 2012).

For fresh strawberries, market intermediaries were willing to pay \$0.24/lb more to improve flavor from weak/mild to full/intense, \$0.15/lb for an improvement in firmness from soft to firm, and \$0.10/lb for an increase in size from less to more than 25 g/fruit. Firmness and size are both attributes considered in the US standards for grades of strawberries, which commands markets prices and thus impacts intermediaries' profitability (US Department of Agriculture, 2006). The WTP results are consistent with findings in previous studies where flavor, sweetness, size, and firmness were found to positively impact consumers' preferences for strawberries (Ford et al., 1996; Safley et al., 1999; Keutgen & Pawelzik, 2007; Lado et al., 2010; and Colquhoun et al., 2012). US strawberry breeders' current breeding targets are consistent with market intermediaries' values, as flavor and size were two quality attributes likely (probability higher than 89%) to be included in the selections for a new cultivar development (Yue et al., 2012; Gallardo et al., 2012).

Among processed fruit crops, preferences for quality traits were aligned with the specific end-use of the fruit. Processors were willing to pay \$0.03/lb for an increase in SSC (an indicator of sweetness levels) from less to more than 12 °Brix, \$0.03/lb for an improvement in internal defects

[3]With data from the WA Growers Clearing House Association (2013) and the US Department of Labor (2013), we estimated differences across WA producers and US consumers' sweet cherry prices. On average for the 2013 season, there was a 35% spread between prices. When comparing WTP estimates from this study and Hu (2007), one observes a difference larger than100% between intermediaries and consumers' WTP for firmness and sweetness. The difference estimated for the 2013 season was obtained considering prices received by Washington State producers and the US consumer price index for sweet cherries. While the Hu (2007) study elicited WTP from individuals shopping at the Portland Saturday farmers' market. The population segment in the Hu (2007) study might not be representative of the average US sweet cherry consumer, thus the differences in the stated WTP.

from more to less than 3% per lot, and slightly less, $0.02, for an increase in firmness from less to more than 14 lbs. End-use possibilities for apples include juice and applesauce. Higher sweetness levels improve the juice-making process, and higher firmness levels improve applesauce making (Stokes, 2010). Tart cherry processors were willing to pay $0.11/lb for an improvement in external color from poor to characteristic red color, $0.10/lb for an improvement in ease of pit removal, and $0.05/lb for an improvement in size from nonuniform to uniform. End market uses include frozen cherries, pie filling, and juice (Korson, 2010). For frozen tart cherries, characteristic external color, ease of pit removal, and uniform size are traits that improve the processing efficiency (Iezzoni, 2010; Korson, 2010).

7. CONCLUSIONS

This study fills a gap in the agricultural economics literature through eliciting values from rosaceous crop market intermediaries for a number of fruits (apples, peaches, sweet and tart cherries, and strawberries) of significant economic and human nutritional importance. We used a popular methodology—hypothetical discrete choice models—and focused on fruits for both the fresh and processing markets. We used the econometric specification that best fit the data to estimate parameters (conditional logit model, HEV, mixed logit, and multinomial probit).

Market intermediaries valued fruit quality traits differently depending on the fruit, the end use, and the region where the operation was located. In general, market intermediaries assigned greater values to fruit quality traits that would enhance profits for their operations by more closely meeting consumers' preferences, expanding the marketing time window, or facilitating processing. For example, for fruit for the fresh market, respondents valued the consumer-related traits of flavor, sweetness, and firmness. They also valued traits that directly impact grades and firms' profitability such as size and external appearance. Depending on the storability of the fruit (for example, apples exhibit the longest storability times compared to the other crops in this study), market intermediaries valued increased shelf life, consistent with the need to reduce shrinkage and hence losses during shipping and handling through the point of sale. Differences in fruit trait valuation were found by locations from which the fruit was shipped, for example, between fresh peach operations in California and those in other states due to production (weather, soil conditions, scale of operations) and transport (proximity to key markets) reasons. In general, WTP values elicited from market intermediaries were within the bounds with WTP elicited from consumers in previous studies. For processed fruit, greater values were assigned to traits facilitating processing operations.

In addition this study sought to help inform breeders about the fruit quality attributes of highest value to the supply chain. Market intermediaries' and fruit breeders', in general, place higher values on consumer related fruit quality attributes, such as fruit crispness for apples, fruit firmness and fruit size for peaches and sweet cherries, and fruit flavor and fruit size for strawberries. Finally, our hope is that knowledge from this study in conjunction with other studies being conducted as part of the RosBREED project will provide an empirical basis to ensure that breeding efforts are focused, relevant to the industry, and consumers' needs and desires.

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