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Japanese Kiwifruit consumer consumption behaviours and product preferences: A Latent Class Analysis

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Key Points

- The Agribusiness and Economics Research Unit (AERU) at Lincoln University with the support of research partners under the *Unlocking Export Prosperity from the Agri-food Values of Aotearoa New Zealand* research programme has estimated willingness-to-pay (WTP) values for selected credence attributes of kiwifruit by Japanese consumers, with a focus on identifying preferences for attributes considered *distinctively New Zealand.*
- Preferences for many of the credence attributes considered here are not readily observable from market prices and so the non-market valuation method of Choice Experiments was used. This involved an online survey of Japanese residents in December 2019, using a research panel. The survey process achieved 995 responses with suitable representation of key population demographics.
- As well as WTP values, this survey reports on:
    - Purchase frequency by kiwifruit type, and by country-of-origin
    - Prices paid by kiwifruit type
    - Country-of-origin quality ranking
    - Brand purchase frequency
    - Kiwifruit attribute importance
- New Zealand kiwifruit was by far the most purchased by country of origin. With 47 per cent purchasing them often compared with 21 per cent for Japanese kiwifruit. New Zealand was ranked the highest of the countries included for quality by 60 per cent of respondents compared to 20 per cent for Japanese kiwifruit. These qualities included taste, freshness and value for money.
- The survey included a choice experiment to assess the Willingness to Pay by consumers for different attributes associated with kiwifruit. The consumers were then segmented, using a latent class model, into 3 classes each with different characteristics and preferences.
- The results showed that consumer group two (the group at 43 per cent of the sample) were willing to pay the most for kiwifruit from New Zealand, with a premium of 168 per cent. However, this was less than premium for Japanese kiwifruit at 176 per cent but higher than kiwifruit grown in Italy at 146 per cent. This group were mostly male, had a higher income, were older, university educated and paid the highest prices.
- Therefore group two would seem to be the target for New Zealand exporters.
- Group one (27 per cent of the sample) had the lowest number of attributes that they were willing to pay a premium for and they were not willing to pay for country origin. They were willing to pay a premium for the balance of acidic and sweet, sweet taste and water quality protection at 96, 46 and 67 per cent respectively
- Group three (30 per cent of the sample) were willing to pay premium for New Zealand fruit at 74 per cent but again as with group two this was less than the premium for Japanese fruit at 88 per cent. They were the only group willing to pay a premium for Chilean fruit of 44 per

cent. They also were willing to pay a premium for sweet taste at 51 per cent and balance of acidic and sweet at 49 per cent.

- The average respondents willingness-to-pay (WTP) as a percentage of the large gold kiwifruit purchase price was:

Kiwifruit Attribute	Group One 27% of consumers	Group Two 43% of consumers	Group Three 30% of consumers
Sweet Taste	46	0	51
Balance of Acidic and Sweet	96	0	49
Carbon Neutral	0	155	0
Water Quality Protection	67	0	10
Organic	25	32	22
Enhanced Food Safety	27	0	8
Social Responsibility	0	44	9
Large Size	0	88	18
Increased Fibre	0	0	16
Increased Vitamin C	0	74	15
Grown in Japan	0	176	88
Grown in New Zealand	0	168	74
Grown in Italy	0	146	26
Grown in Chile	0	0	44

Chapter 1
Introduction

This study is part of a research programme entitled *Unlocking Export Prosperity from the Agri-food Values of Aotearoa New Zealand*. It is funded by the Ministry of Business, Innovation and Employment (MBIE) Endeavour Fund for science research programmes.

The research aims to provide new knowledge on how local enterprises can achieve higher returns by ensuring global consumers understand the distinctive qualities of the physical, credence and cultural attributes of agri-food products that are "Made in New Zealand".

Agricultural exports are an important contributor to the New Zealand (NZ) economy. While NZ historically relied on key markets such as the United Kingdom for export trade, NZ has more recently significantly expanded its export markets and Japan has become established as an important kiwifruit destination. It is critically important for NZ exporters to understand export markets and the different cultures and preferences of those consumers to safeguard market access, and for realising potential premiums.

This report describes the application of a survey of Japanese kiwifruit consumers that is designed to examine consumption behaviour and consumer Willingness-to-Pay (WTP) for credence attributes. While search attributes such as price or colour can be observed directly, and experience attributes such as flavour or texture can be assessed when consumed, credence attributes such as environmental sustainability cannot be immediately seen or experienced at the point of sale. For products promoting credence attributes, the role of verification including labelling is of significant importance.

Our approach is to apply a Choice Experiment economic valuation method, analysed using a statistical approach called Latent Class Modelling that describes profiles for different consumer segments identified in the data and provides estimates of attribute WTP across these segments.

Chapter 2
Kiwifruit Survey Method

To understand how consumers value NZ credence attributes this study used a structured self-administered online survey that included the Choice Experiment, conducted in Japan in December 2019. The survey was administered through Qualtrics™, a web-based survey system, and had a sample size of 995 kiwifruit consumers.

The survey was developed by the research team drawing from a literature review on consumer trends for fruit products, results from previous surveys examining consumer attitudes in overseas markets, a scoping survey of 200 Japanese kiwifruit consumers (November 2019) and consultation with industry partners and stakeholders, especially those on the AERU advisory board.

Sampling involved recruiting participants from an online consumer panel database provided by an international market research company (dynata.com). Panel members are recruited by online marketing across a range of channels and panels are profiled to ensure adequate representativeness. Panels are frequently refreshed, with the participation history of members reviewed regularly. Respondents for each survey are compensated with a retail voucher for completing a survey. Potential respondents were recruited by e-mail and were screened out if they purchased kiwifruit less than monthly.

2.1 Using Choice Experiments to examine consumer preferences

Choice Experiments are a survey based valuation approach that have been widely used to value consumer preferences for food product attributes. They are particularly useful for examining the role of new attributes, and attributes that that are not easily observable in market prices, such as the attributes explored in the current report. The ability of this method to identify which individual attributes are more important in consumer choices, and to estimate consumers WTP for these, has seen this approach to valuation become increasingly favoured by researchers.

Designing a Choice Experiment survey involves deciding which product attributes are of interest, combining these into different product offerings, and asking consumers to pick which offering they prefer from a range of alternatives. In this study, alternative kiwifruit products are described by the size, taste, nutrition, production practices, country of origin and price (Table 2.1). Attribute selection was primarily informed by the scoping survey that used a combination of open text and structured questions to identify which attributes Japanese consumers considered distinctive of NZ kiwifruit.

Table 2.1 Kiwifruit attribute descriptions used in the choice experiment

Kiwifruit attributes	Attribute descriptions
Country-of-origin	The kiwifruit may be labeled with the country where the kiwifruit was grown.
Organic Production	The kiwifruit may be labelled as being grown 100% organically which is GE free and without using synthetic fertilisers or pesticides.
Environmental Sustainability	The kiwifruit may be labeled as being certified by an Environmental Agency who guarantees that the production of the kiwifruit employs a management system that is either Carbon Neutral, Enhances Biodiversity, or Protects Water Quality.
Nutritional Content	Kiwifruit is a good source of nutritional value such as vitamins and fibre. There are natural ways to grow and distribute kiwifruit that is high in vitamins, such as selecting varieties that have higher levels of vitamins or reducing loss during storage.
Taste	The taste of kiwifruit is described as being either sweeter, more acidic, or having balanced sweetness and acidity.
Social Responsibility	The kiwifruit may be labeled as being produced by growers that are socially responsible and actively include public interest into their decision making.
Enhanced Food Safety	The kiwifruit may be labelled as being certified by a Food Safety Agency who guarantees that the production of this kiwifruit employs a management system that is of a higher safety standard than the minimum required.
Size	The kiwifruit is either a small or large size.
Price ¥/kiwifruit	Price per individual kiwifruit

Changes in kiwifruit attributes are described using the levels in (Table 2.2). Price levels were determined by market prices, and from what scoping survey respondents said that they usually paid. Countries of origin were selected based on volumes of sales in Japan for 2019.

Table 2.2 Kiwifruit attribute levels used in the choice experiment

Kiwifruit attributes	Attribute levels				
Enhanced Food Safety	No Label	Certified			
Social Responsibility	No Label	Certified			
Organic Production	No Label	Certified			
Size	Small	Large			
Nutritional Content	No change	Increased Fibre	Increased Vitamin C		
Taste	No Label	More acidic than sweet	More sweet than acidic	Balance of sweet and acidic	
Environmental Sustainability	No Label	Carbon Neutral	Biodiversity Enhancement	Water Quality Protection	
Country of Origin	No Label	Japan	NZ	Italy	Chile
Price ¥ per kiwifruit	¥60	¥100	¥160	¥200	

An example of alternative product offerings presented to respondents is shown in Figure 2.1. Each set of offerings comprises three options, of which respondents chose their preferred one. Two options present alternative kiwifruit, while the third is a 'none of these' option. Each respondent answered ten choice sets, generating 9,950 completed choice sets over the total sample.

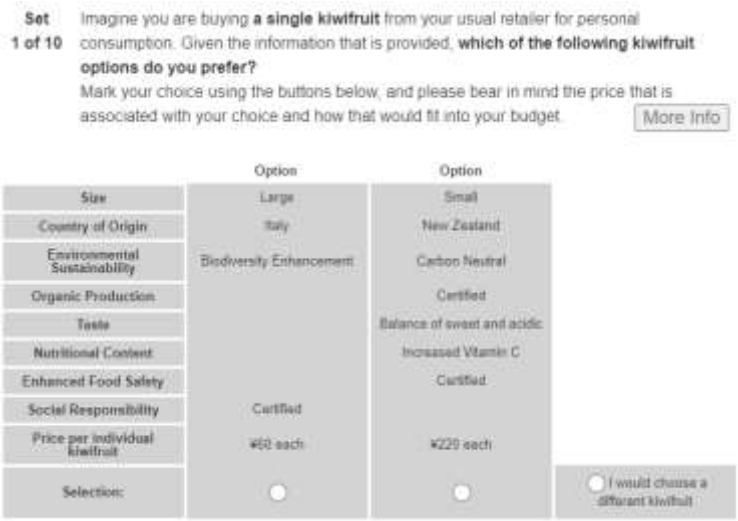


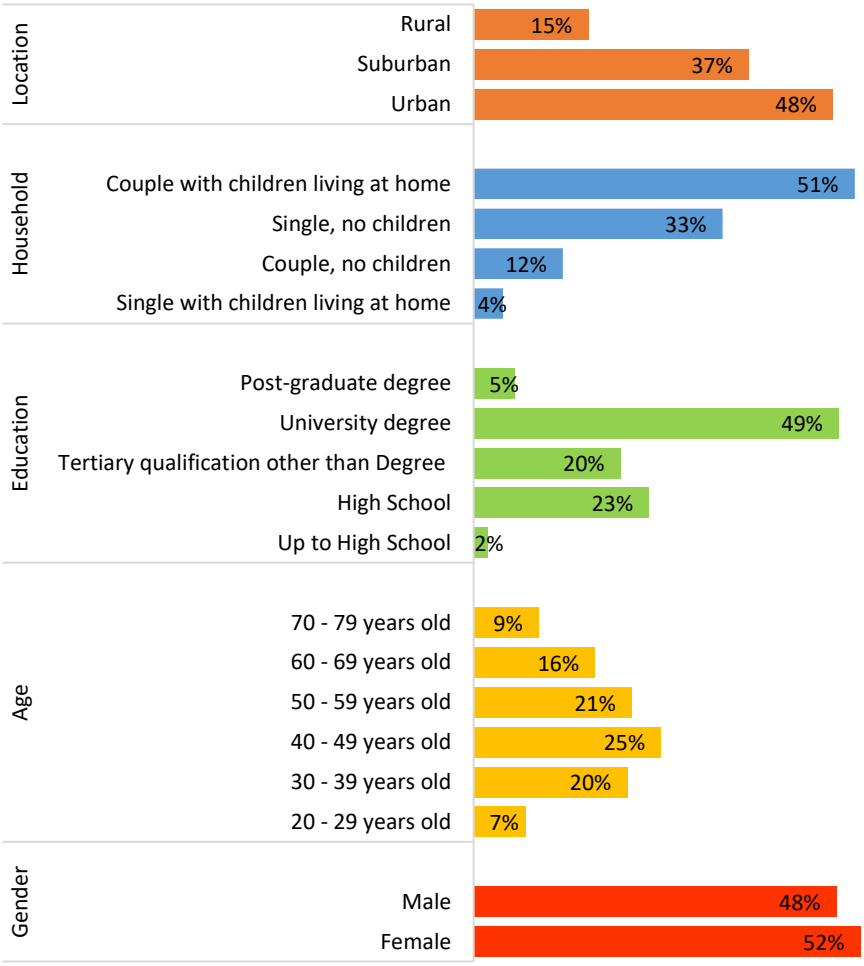
Figure 2.1 Example of a choice experiment question shown to respondents

Product choices are statistically analysed, and consumers WTP for each attribute is estimated. A more detailed presentation of the theoretical foundation and statistical procedure can be found in Appendix A.

Chapter 3
Survey Results

3.1 Sample demographic description

- The sample comprised a wide range of demographics, which is important to ensure that the sampling process has broadly canvased the relevant population (Figure 3.1).
- It is important to note that we are not attempting to represent the overall Japanese population, but rather those that purchase kiwifruit at least monthly.



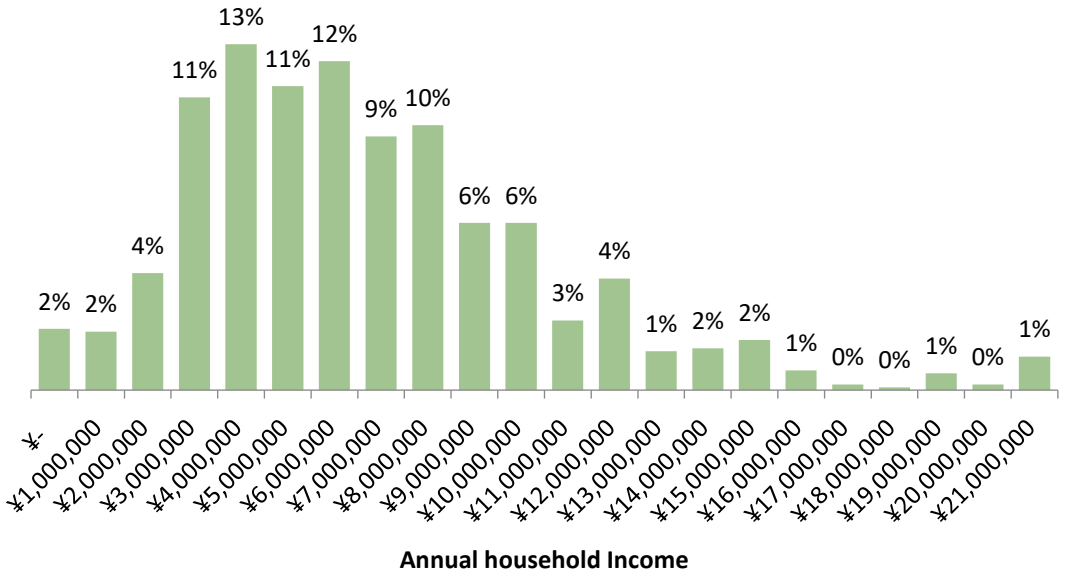


Figure 3.1 Sample demographics

- Perhaps unsurprisingly for fruit consumers, health outcomes are important to almost 90 per cent of respondents (Figure 3.2).

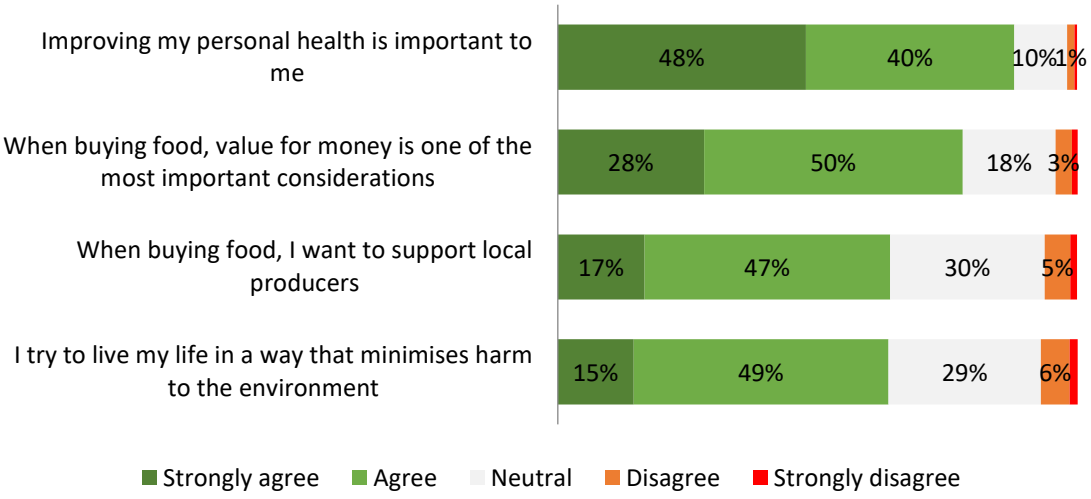


Figure 3.2 Personal value statements

- Over 60 per cent of the sample purchase kiwifruit at least weekly (Figure 3.3).

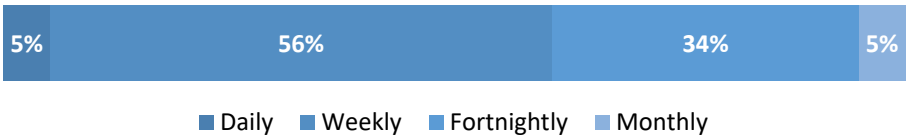


Figure 3.3 Kiwifruit purchase frequency

- Gold is the most frequently purchased variety, while Red variety is the least frequently purchased (Figure 3.4).
- Within a variety, the large size has higher purchase frequency.
- The average consumer usually purchased three varieties.

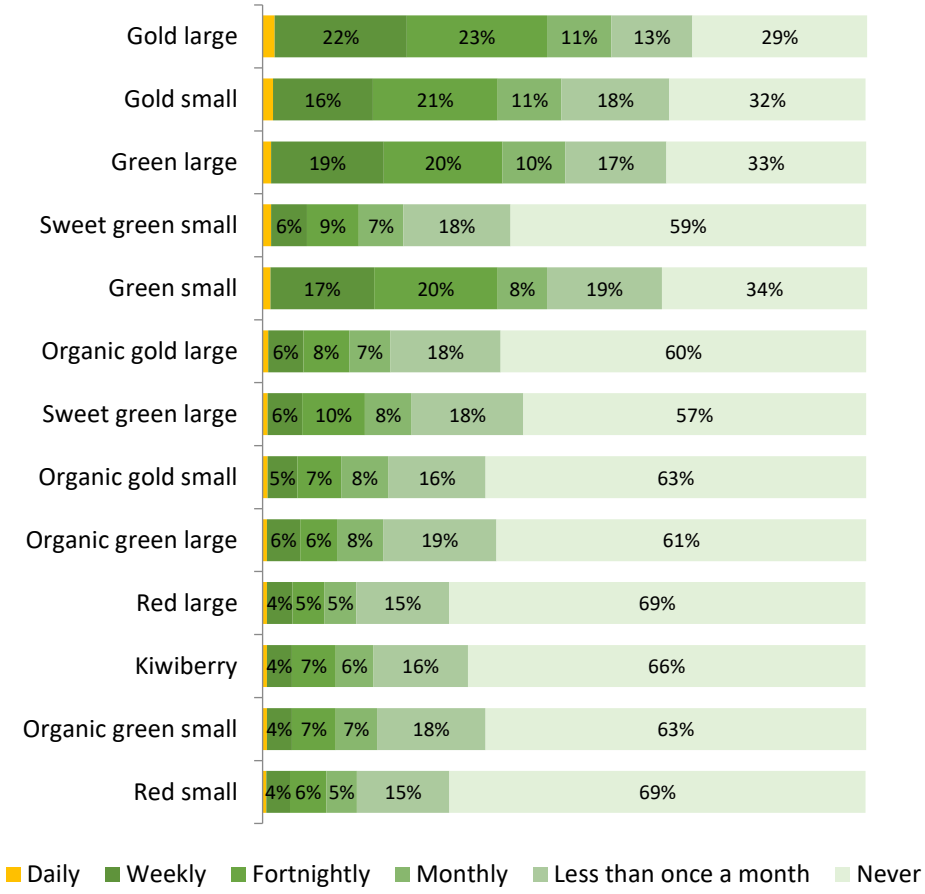


Figure 3.4 Purchase frequency by kiwifruit variety

- Considering the price per kiwifruit that respondents usually paid, overall the most frequent price was between ¥101 and ¥125/kiwifruit (Figure 3.5).
- The highest prices were paid for Organic kiwifruit, with the lowest for small Green (Figure 3.6).

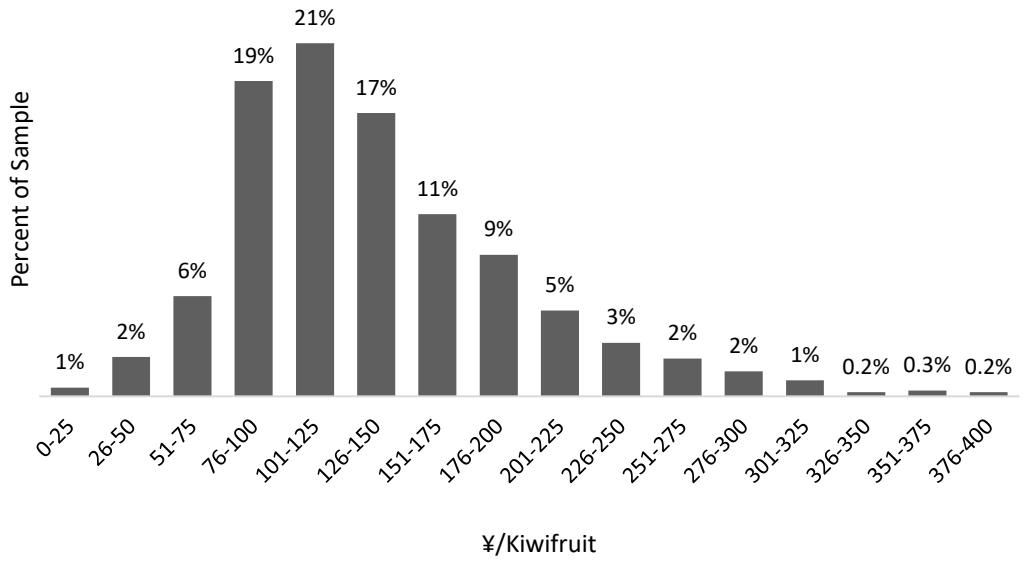


Figure 3.5 Range of prices usually paid

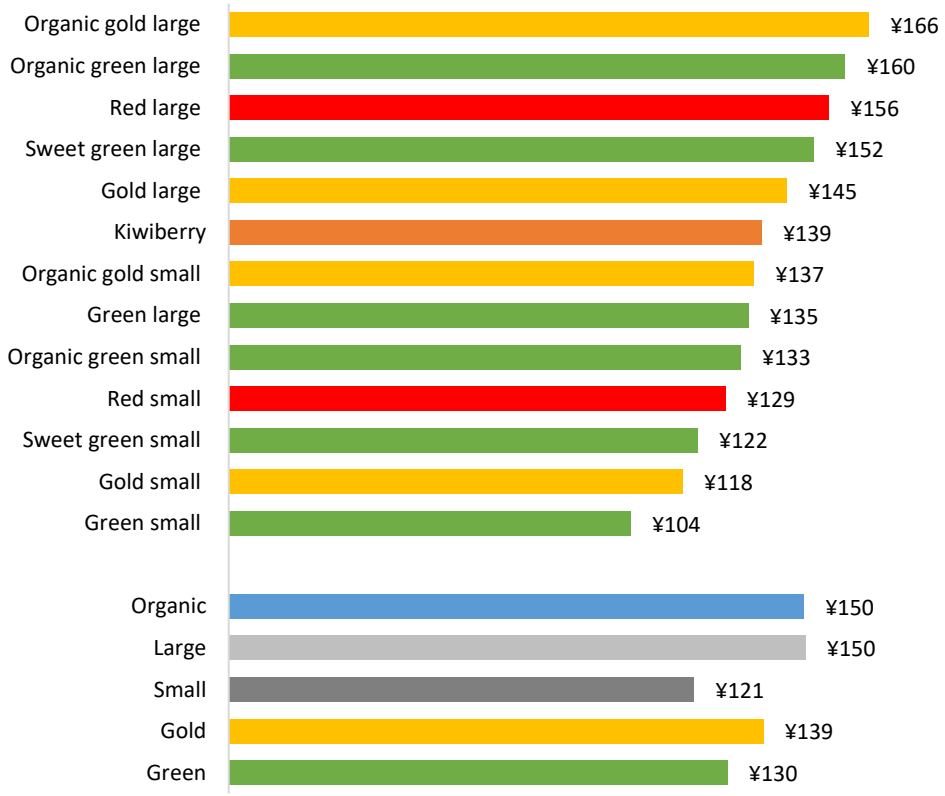


Figure 3.6 Average price usually paid by variety

- The main reason for buying Organic kiwifruit was personal health benefits (Figure 3.7).

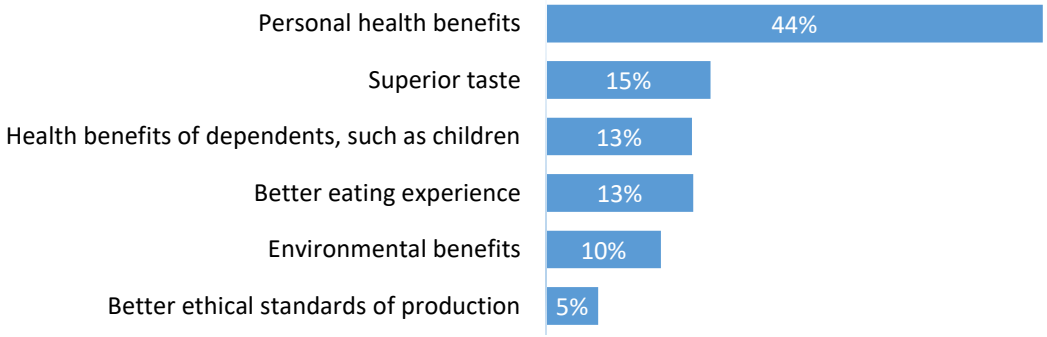


Figure 3.7 Main reasons for buying Organic kiwifruit

- Zespri is the most frequently purchased kiwifruit brand, with just 9% of respondents having never purchased Zespri kiwifruit (Figure 3.8).

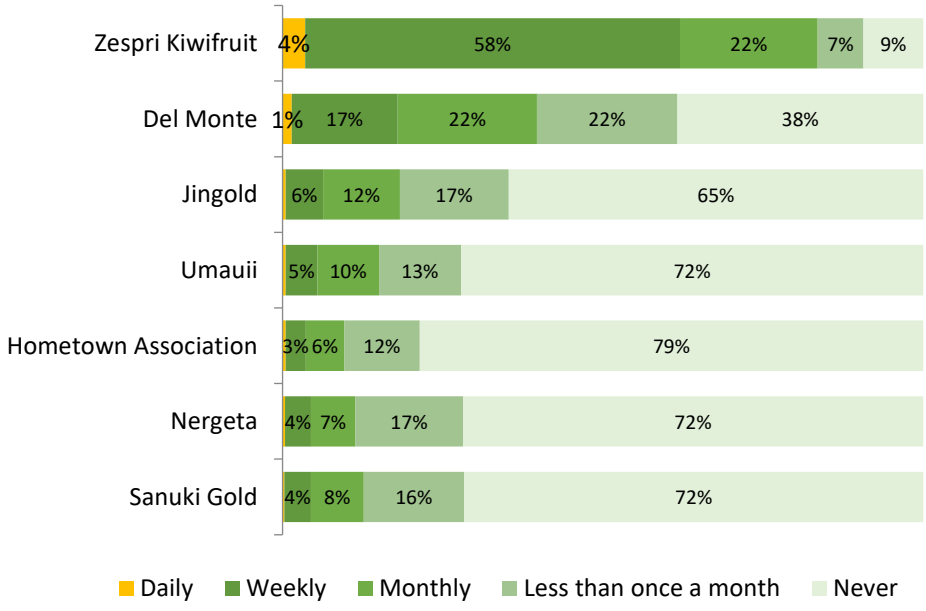


Figure 3.8 Kiwifruit brand purchase frequency

- Consistent with brand, NZ has the highest country-of-origin purchase frequency (Figure 3.9).

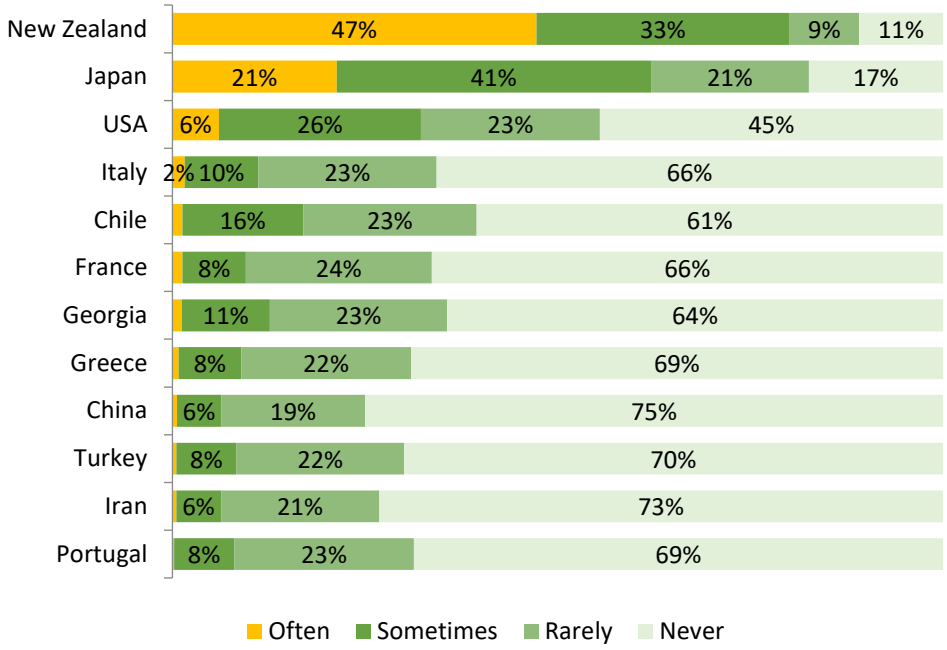


Figure 3.9 Country-of-origin purchase frequency

- Considering how respondents rank the quality of kiwifruit from each country, we see that NZ is ranked first by almost 60 per cent of respondents (Figure 3.10).

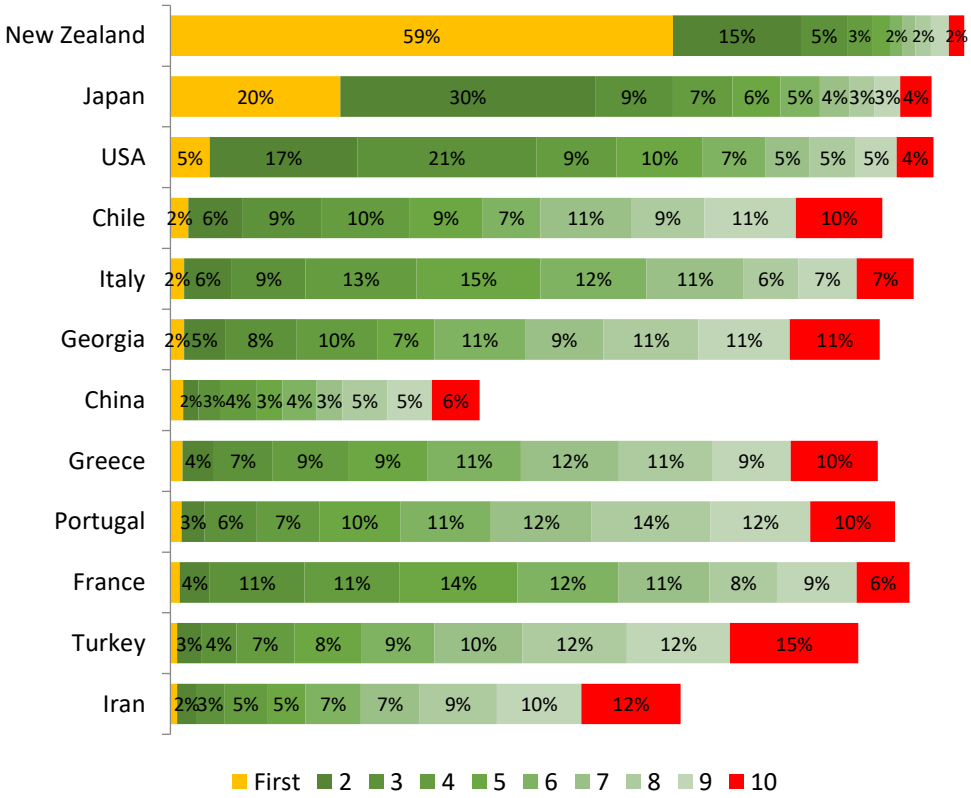


Figure 3.10 Country-of-origin quality ranking

- Overall, it is most important to consumers that kiwifruit taste good, are fresh, affordable, and safe to eat (Figure 3.11).

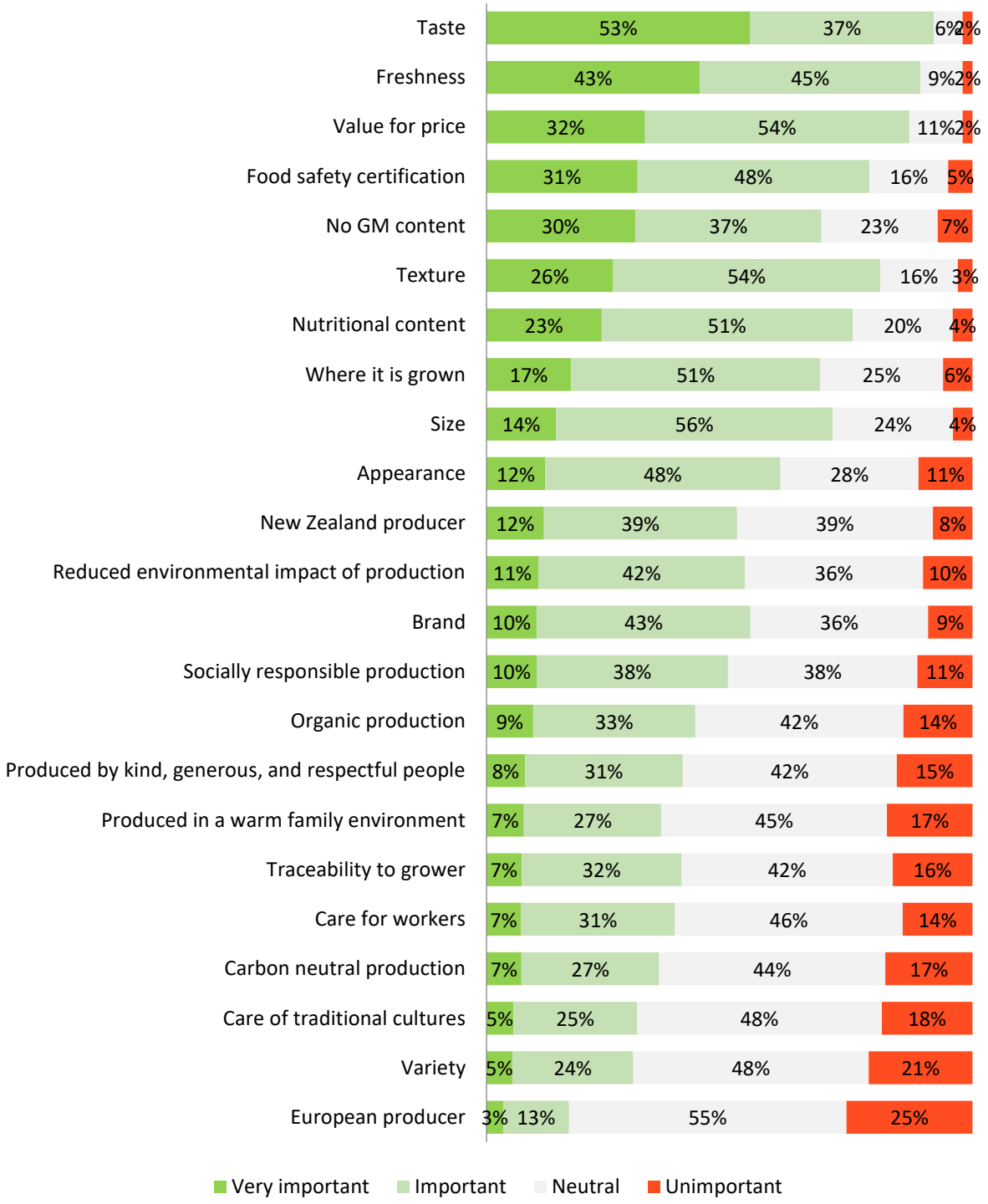


Figure 3.11 Importance of kiwifruit product attributes when purchasing

3.2 Choice Experiment analysis of kiwifruit choices

In this section we present findings of the Choice Experiment. Our aim is to identify which kiwifruit attributes drive kiwifruit choice, by how much, and by who. We do this by segmenting the sample of consumers into groups based on which product offerings they preferred Appendix B.

Choice Experiments can be somewhat more difficult to answer compared with the usual question formats that people have typically seen before, so it is important to check whether respondents have been able to complete the exercise reliably. Overall, task and attribute understanding was relatively high, and most respondents felt certain that their responses reflected real-world choices if these kiwifruit were available (Figure 3.12).

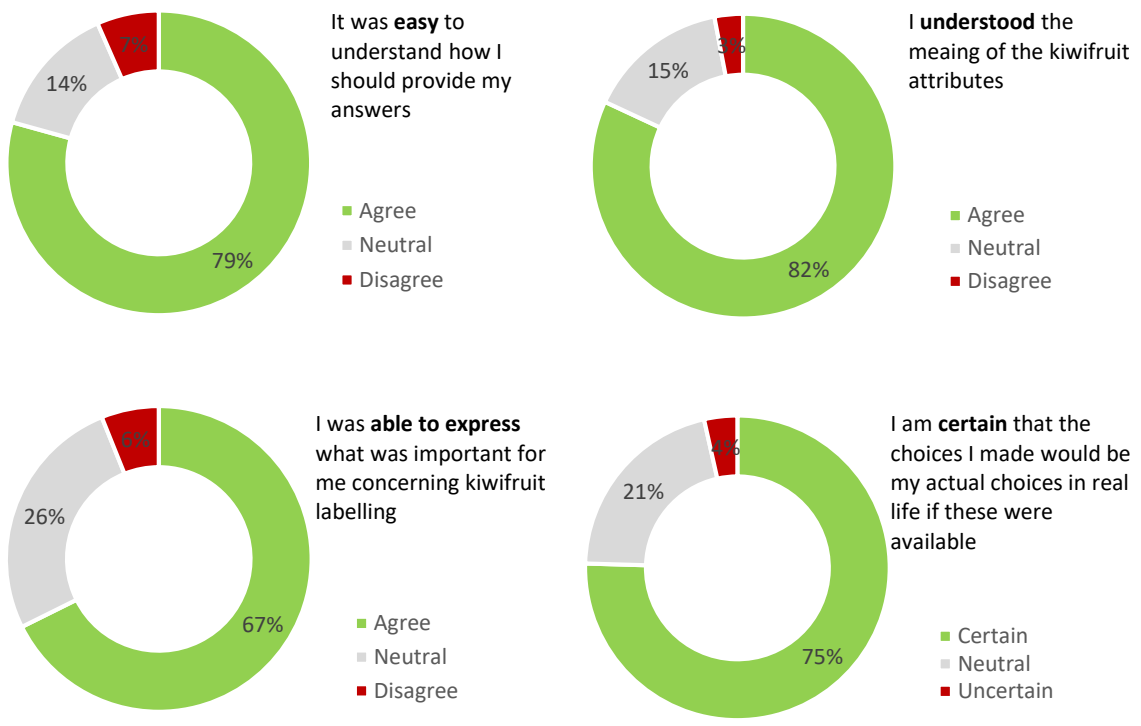


Figure 3.12 Choice experiment debriefing questions: task understanding, attribute understanding, ability to express preferences, certainty of choices made

Estimates of WTP tell us how much more the average consumer is willing to pay for a kiwifruit with a particular attribute, over a kiwifruit that does not have this attribute (Table 3.1). For example, members of Groups One and Three are willing to pay, on average, ¥66 more for a sweet tasting kiwifruit over one that does not have this taste profile. There is some uncertainty in WTP estimates, and the Confidence Intervals reported in Table 3.1 indicate that we can be 95 per cent sure that the true WTP falls within this interval.

In regard to country of origin group two were willing to pay the most from New Zealand sourced kiwifruit at 168 per cent of the average price paid for gold. However, this was less than the 176 per cent they were willing to pay for Japanese kiwifruit but above the 146 per cent premium for Italian kiwifruit.

Group two were also willing to pay a premium for carbon neutral fruit at 155 per cent and 74 per cent for increased vitamin C. Group one was willing to pay a premium for taste at 46 per cent, balance of acid and sweet 96 per cent, water quality protection at 67 per cent and organic 25 per cent but preference for country of origin. Group three were willing to pay a premium of 88 per cent for fruit produced in Japan, 74 per cent for New Zealand fruit and 44 per cent for fruit grown in Chile. They were also willing to pay a premium for fruit with sweet taste and balance of acid and sweet at 51 and 49 per cent respectively.

In Table 3.1 this is reported under each group's column heading. We can see that three distinct consumer groups have been identified, the first group has an estimated size of 27 per cent, the second group's size is 43% and the third is 30 per cent. These group sizes tell us the probability that a randomly selected Japanese kiwifruit purchaser belongs to that consumer group.

Table 3.1 Japan Kiwifruit willingness-to-pay by consumer group

Kiwifruit Attribute	Group One 27%	Group Two 43%	Group Three 30%
Sweet Taste	¥66 (24, 128)		¥66 (51, 81)
Balance of Acidic and Sweet	¥136 (106, 166)		¥63 (48, 78)
Carbon Neutral		¥244 (77, 411)	
Water Quality Protection	¥95 (75, 115)		¥13 (-2, 29)
Organic	¥36 (19, 53)	¥51 (16, 86)	¥28 (18, 38)
Enhanced Food Safety	¥39 (24, 53)		¥10 (2, 19)
Social Responsibility		¥69 (31, 106)	¥12 (4, 20)
Large Size		¥138 (68, 208)	¥23 (15, 32)
Increased Fibre			¥20 (8, 33)
Increased Vitamin C		¥116 (68, 164)	¥19 (7, 31)
Grown in Japan		¥276 (124, 428)	¥113 (97, 129)
Grown in New Zealand		¥263 (133, 392)	¥96 (82, 111)
Grown in Italy		¥230 (119, 324)	¥33 (12, 54)
Grown in Chile			¥57 (32, 82)

Average WTP per single kiwifruit (95% Confidence Interval)

Consumers' WTP is also reported relative to the average price usually paid for a single kiwifruit of ¥137 (Figure 3.13).

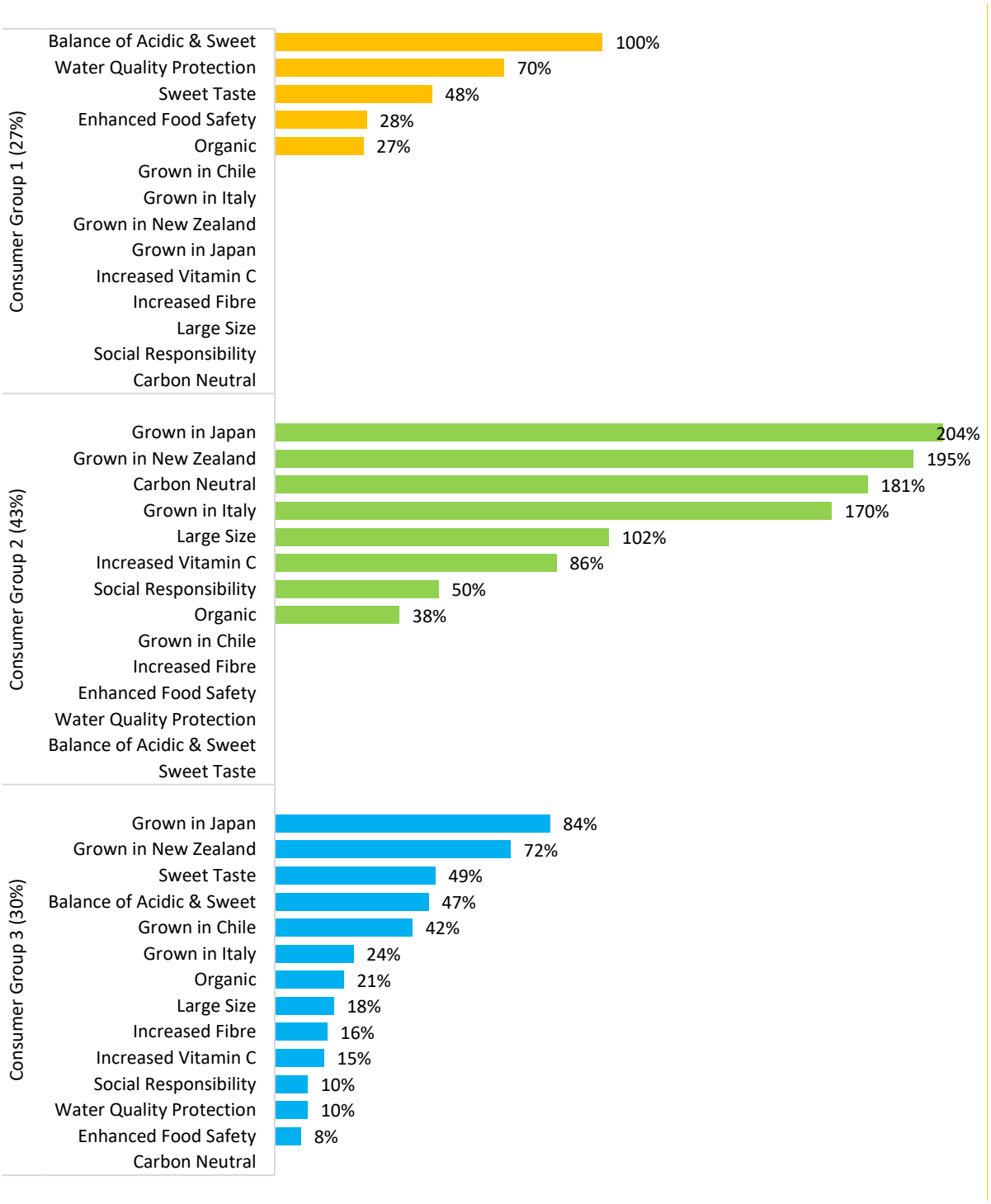


Figure 3.13 Kiwifruit attribute willingness-to-pay as percentage of average price

- Consumers in Group One have the narrowest set of attribute preferences of the three groups, with the smallest number of attributes that are significant in their product choice (Figure 3.13).
- Taste profile is the most important attribute to this group. Water quality protection is valued next highest with Organic and food safety also significantly valued, which can be considered as complementary measures in safeguarding against adverse human health effects.
- Of note is the absence of a preferred country-of-origin attribute.

- Consumers in Group Two have strong country-of-origin preferences with the highest WTP for domestic kiwifruit of the three groups (Figure 3.13).
- Group Two members are the only consumers with significant WTP for Carbon Neutral production.
- They also have the highest WTP of the three groups for large size, vitamin C, Organic, and socially responsible production.

- Consumers in Group Three have the broadest set of preferences, exhibiting positive WTP for all attributes other than Carbon Neutral production (Figure 3.13).
- These consumers are the only group with significant WTP for kiwifruit from Chile.
- They are also the only group with significant WTP for increased fibre content.

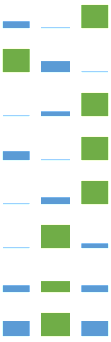
3.3 Consumer group descriptions

This section describes each of the three consumer groups identified in the statistical analysis, using the same questions we presented above. The objective is to highlight the differences and similarities between groups that can be useful in identifying the types of consumers who are willing-to-pay for attributes relevant to an organisation's objectives. For example, an organisation interested in developing into the Carbon Neutral space will be able to use the information below to describe the members of consumer Group Two, who are the group willing-to-pay for this attribute. As we go through the comparisons, the small bar charts on the right hand side will highlight the group with the largest values with a green bar.

- Consumer Group Three are more likely to be female, older, and from a rural location. While Group Two are more likely to be male, with a university degree, and from a higher income household (Table 3.2).

Table 3.2 Describing consumer groups: Demographics

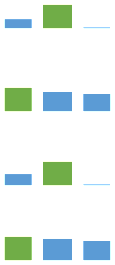
Demographics	Group One	Group Two	Group Three
Female	50%	44%	64%
< 44 years old	11%	7%	3%
> 65 years old	12%	14%	20%
Rural	15%	12%	20%
Have children	53%	54%	57%
University degree	47%	63%	51%
Median income	¥6,000,000	¥7,000,000	¥6,000,000
Income of upper quartile	¥8,000,000	¥10,000,000	¥8,000,000



- Improving personal health is important to all groups. Supporting local producers and minimising environmental harm are particularly important to consumers in Group Two (Table 3.3).

Table 3.3 Describing consumer groups: Personal values

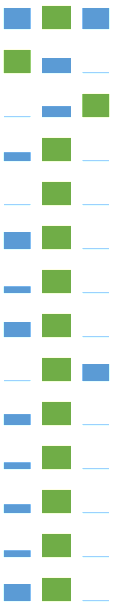
Statements with **strong agreement**	Group One	Group Two	Group Three
When buying food, I want to support local producers	16%	19%	13%
Improving my personal health is important to me	51%	47%	46%
I try to live my life in a way that minimises harm to the environment	14%	17%	11%
When buying food, value for money is one of the most important considerations	30%	28%	27%



- Large size kiwifruit are purchased more often across all three consumer groups, with large gold and large green varieties purchased the most. Members of Group Two have the highest weekly purchase frequencies overall (Table 3.4).

Table 3.4 Describing consumer groups: Purchase frequencies

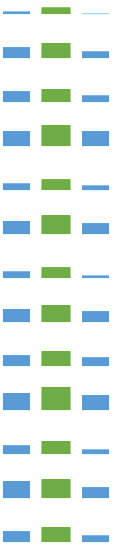
Purchase at least weekly	Group One	Group Two	Group Three
All types	58%	63%	59%
Green Small	20%	19%	16%
Green Large	16%	20%	24%
Org Green Small	4%	6%	3%
Org Green Large	5%	8%	5%
Sweet Green Small	8%	9%	4%
Sweet Green Large	5%	9%	4%
Gold Small	19%	20%	15%
Gold Large	20%	26%	24%
Org Gold Small	5%	7%	3%
Org Gold Large	6%	8%	5%
Red Small	4%	7%	2%
Red Large	4%	8%	2%
Kiwiberry	5%	7%	2%



- Members of consumer Group Two are more likely to usually pay the highest prices across all kiwifruit varieties. Members of Group Three are more likely to usually pay the lowest prices (Table 3.5).

Table 3.5 Describing consumer groups: Prices usually paid

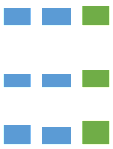
Average usual price paid (¥/fruit)	Group One	Group Two	Group Three
Green Small	¥104	¥116	¥87
Green Large	¥135	¥148	¥115
Org Green Small	¥129	¥140	¥117
Org Green Large	¥149	¥173	¥144
Sweet Green Small	¥116	¥130	¥108
Sweet Green Large	¥141	¥165	¥135
Gold Small	¥115	¥129	¥103
Gold Large	¥142	¥157	¥129
Org Gold Small	¥131	¥144	¥122
Org Gold Large	¥157	¥178	¥148
Red Small	¥125	¥137	¥111
Red Large	¥154	¥165	¥129
Kiwiberry	¥133	¥148	¥117



- While consumers in all groups have the highest brand purchase frequency for Zespri kiwifruit, Group Three consumers are more likely to have the highest purchase frequency, and to rank NZ kiwifruit as better than kiwifruit from other countries (Table 3.6).

Table 3.6 Describing consumer groups: New Zealand purchasing

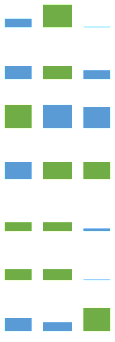
	Group One	Group Two	Group Three
Buy Zespri kiwifruit at least weekly	61%	60%	66%
NZ produces the best kiwifruit	56%	57%	66%
Rank NZ in top three best kiwifruit	79%	77%	85%



- Consumers in Group Two are more likely to purchase Organic kiwifruit often (Table 3.7).

Table 3.7 Describing consumer groups: Organic purchasing

	Group One	Group Two	Group Three
Purchase Organic kiwi often	9%	13%	7%
Purchase Organic kiwi at least sometimes	53%	54%	40%
% of Benefits to myself	45%	44%	42%
% of Benefits to family	34%	36%	36%
% of Benefits to public locally	7%	7%	6%
% of Benefits to public globally	6%	6%	5%
% of Benefits to plant and animals	8%	7%	10%



- Table 3.8 presents a significant amount of information. One interesting point includes that Group Two consumers demonstrate higher levels of import for social responsibility attributes. Almost 40 per cent of this group state that care of traditional cultures is important to them, they also having the highest import for socially responsible production, care for workers, and reduced environmental impacts (Table 3.8).

Table 3.8 Describing consumer groups: Product characteristics considered important

Characteristic considered **important**	Group One	Group Two	Group Three
Reduced environmental impact	53%	57%	45%
Food safety certification	79%	80%	77%
Socially responsible production	47%	52%	44%
No GM content	64%	69%	68%
Taste	92%	89%	91%
High level of sweetness	85%	81%	79%
High level of acidity	44%	50%	32%
Balance of sweetness & acidity	85%	82%	86%
Texture	79%	82%	79%
Appearance	60%	61%	57%
European producer	15%	22%	9%
Traceability to grower	41%	43%	31%
Organic production	43%	49%	32%
New Zealand producer	46%	56%	46%
Carbon neutral production	31%	41%	26%
Care of traditional cultures	29%	37%	20%
Freshness	90%	85%	90%
Variety	35%	34%	19%
Nutritional content	74%	75%	72%
Shape	47%	54%	43%
Size	74%	72%	65%
Where it is grown	65%	71%	65%
Brand	49%	60%	49%
Value for price	86%	83%	91%
Care for workers	36%	43%	32%
Produced in a warm family environment	38%	42%	22%
Produced by kind, generous, respectful people	36%	44%	34%

Chapter 4
Conclusions

This report presents the results of a survey of kiwifruit consumption in Japan. The survey was of just under 1,000 respondents who were selected as purchasing kiwifruit at least once a month.

The survey assessed purchase behaviour and the reasons for purchasing kiwifruit by country of Origin. New Zealand kiwifruit was by far the most purchased by country of origin. With 47 per cent purchasing them often compared with 21 per cent for Japanese kiwifruit. New Zealand was ranked the highest of the countries included for quality by 60 per cent of respondents compared to 20 per cent for Japanese kiwifruit. These qualities included taste, freshness and value for money.

The survey included a choice experiment to assess the Willingness to Pay by consumers for different attributes associated with kiwifruit. The consumers were then segmented, using a latent class model, into 3 classes each with different characteristics and preferences.

The results showed that consumer group two (the group at 43 per cent of the sample) were willing to pay the most for kiwifruit from New Zealand, with a premium of 168 per cent. However, this was less than premium for Japanese kiwifruit at 176 per cent but higher than kiwifruit grown in Italy at 146 per cent. This group were mostly male, had a higher income, were older, university educated and paid the highest prices.

Group one (27 per cent of the sample) had the lowest number of attributes that they were willing to pay a premium for and they were not willing to pay for country origin. They were willing to pay a premium for the balance of acidic and sweet, sweet taste and water quality protection at 96, 46 and 67 respectively

Group three (30 per cent of the sample) were willing to pay premium for New Zealand fruit at 74 per cent but again as with group two this was less than the premium for Japanese fruit at 88 per cent. They were the only group willing to pay a premium for Chilean fruit of 44 per cent. They also were willing to pay a premium for sweet taste at 51 per cent and balance of acidic and sweet at 49 per cent.

Appendix A
Statistical Method

This appendix provides technical details of statistical analysis of choice data. The appendix includes a brief description of the theoretical foundations of choice analysis followed by statistical probability estimation approaches, focusing on contemporary models applied in this report. Lastly, the method used in generating monetary estimates is described.

A.1 Conceptual Framework

In Choice Experiments (CEs), researchers are interested of what influences, on average, the survey respondents' decisions to choose one alternative over others. These influences are driven by people's preferences towards the attributes but also the individual circumstances such as their demographics or perceptions of the choice task (e.g., the level of difficulty or understanding) (Hensher et al. 2015).

Each alternative in a choice set is described by attributes that differ in their levels, both across the alternatives and across the choice sets. The levels can be measured either qualitatively (e.g., poor and good) or quantitatively (e.g., kilometres). This concept is based on the characteristics theory of value (Lancaster 1966) stating that these attributes, when combined, provide people a level of utility[1] *U* hence providing a starting point for measuring preferences in CE (Hanley et al. 2013; Hensher et al. 2015). The alternative chosen, by assumption, is the one that maximises people's utility[2] providing the behavioural rule underlying choice analysis:

$$U_j > U_i \tag{0.1}$$

where the individual *n* chooses the alternative *j* if this provides higher utility than alternative *i*. A cornerstone of this framework is Random Utility Theory, dated back to early research on choice making (e.g., Thurstone 1927) and related probability estimation. This theory postulates that utility can be decomposed into systematic (explainable or observed) utility *V* and a stochastic (unobserved) utility ε (Hensher et al. 2015; Lancsar and Savage 2004).

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{0.2}$$

where *j* belongs to a set of J alternatives. The importance of this decomposition is the concept of utility only partly being observable to the researcher, and remaining unobserved sources of utility can be treated as random (Hensher et al. 2015). The observed component includes information of the attributes as a linear function of them and their preference weights (coefficient estimates).

$$V_{nsj} = \sum_{k=1}^{K} \beta_k x_{nsjk} \tag{0.3}$$

with *k* attributes in vector x for a choice set s. Essentially, the estimated parameter β shows "the effect on utility of a change in the level of each attribute" (Hanley et al. 2013, p. 65). This change can be specified as linear across the attribute levels, or as non-linear using either dummy coding or effect coding

[1]Related terminology used in psychology discipline is *the level of satisfaction* (Hensher et al. 2015).
[2]In choice analysis, utility is considered as *ordinal utility* where the relative values of utility are measured (Hensher et al. 2015).

approaches. The latter coding approach has a benefit of not confounding with an alternative specific constant (ASC) when included in the model (Hensher et al. 2015).

A.2 Statistical Modelling of Choice Probabilities

The statistical analysis aims to explain as much as possible of the observed utility using the data obtained from the CE and other relevant survey data. In order to do so, the behavioural rule (eq. 1.1) and the utility function (eq. 1.2) are combined (Hensher et al. 2015; Lancsar and Savage 2004) to estimate the probability of selecting an alternative *j*:

$$\Pr_{nsj} = \Pr\left(U_{nsj} > U_{nsi}\right) = \Pr\left(V_{nsj} + \varepsilon_{nsj} > V_{nsi} + \varepsilon_{nsi}\right) = \Pr\left(\varepsilon_{nsi} - \varepsilon_{nsj} < V_{nsj} - V_{nsi}\right) \forall j \neq i \quad (0.4)$$

where the probability of selecting alternative *j* states that differences in the random part of utility are smaller than differences in the observed part. A standard approach to estimate this probability is a conditional logit, or multinomial logit (MNL) model (McFadden 1974). This model can be derived from the above equations (1.2 and 1.3) by assuming that the unobserved component is independently and identically distributed (IID) following the Extreme Value type 1 distribution (see e.g. Hensher et al. 2015; Train, 2003). Although the MNL model provides a "workhorse" approach in CE, it includes a range of major limitations (see e.g. Fiebig et al. 2010; Greene and Hensher 2007; Hensher et al. 2015):

- Restrictive assumption of the IID error components
- Systematic, or homogenous, preferences allowing no heterogeneity across the sample
- Restrictive substitution patterns, namely the existence of independence of irrelevant alternatives property where introduction (or reduction) of a new alternative would not impact on the relativity of the other alternatives
- The fixed scale parameter obscures potential source of variation

Some or all of these assumptions are often not realised in collected data. These restrictive limitations can be relaxed in contemporary choice models. In particular, the random parameter logit (RPL) model (aka, the mixed logit model) has emerged in empirical application allowing preference estimates to vary across respondents (Fiebig, et al. 2010; Hensher et al. 2015; Revelt and Train, 1998). This is done by specifying a known distribution of variation to be parameter means. The RPL model probability of choosing alternative *j* can be written as:

$$\Pr_{nsj} = \frac{\exp(\beta_n' x_{nsj})}{\sum_J \exp(\beta_n' x_{nsj})} \quad (0.5)$$

where, in the basic specification, $\beta_n = \beta + \eta_n$ with η being a specific variation around the mean for *k* attributes in vector *x* (Fiebig, et al. 2010; Hensher et al. 2015). Typical distributional assumptions for the random parameters include normal, triangular and lognormal distributions, amongst others. The normal distribution captures both positive and negative preferences (i.e., *utility* and *disutility*) (Revelt and Train, 1998). The lognormal function can be used in cases where the researcher wants to ensure the parameter has a certain sign (positive or negative), a disadvantage is the resultant long tail of estimate distributions (Hensher et al. 2015). The triangular distribution provides an alternative functional form, where the spread can be constrained (i.e., the mean parameter is free whereas spread is fixed equal to mean) to ensure behaviourally plausible signs in estimation (Hensher et al. 2015). Further specifications used in modelling include parameters associated with individual specific characteristics (e.g, income) that can

influence the heterogeneity around the mean, or allowing correlation across the random parameters. The heterogeneity in mean, for example, captures whether individual specific characteristics influence the location of an observation on the random distribution (Hensher et al. 2015). In this study, the frequency of visits to rivers, streams and lakes was used to explain such variance.

Another way to write this probability function (in eq. 1.4) (Hensher et al. 2015) involves an integral of the estimated likelihood over the population:

$$L_{njs} = \int_{\beta} \Pr_{nsj}(\beta) f\left(\beta|\theta\right) d\beta \tag{0.6}$$

In this specification, the parameter θ is now the probability density function conditional to the distributional assumption of β. As this integral has no closed form solution, the approximation of the probabilities requires a simulation process (Hensher et al. 2015; Train, 2003). In this process for data *X*, *R* number of draws are taken from the random distributions (i.e. the assumption made by the researcher) followed by averaging probabilities from these draws; furthermore these simulated draws are used to compute the expected likelihood functions:

$$L_{nsj} = E(\Pr_{nsj}) \approx \frac{1}{R} \sum_{R} f(\beta^{(r)}|X) \tag{0.7}$$

where the $E(\Pr_{nsj})$ is maximised through Maximum Likelihood Estimation. This specification (in eq. 1.6) can be found in Hensher et al. (2015). In practice, a popular simulation method is the Halton sequence which is considered a systematic method to draw parameters from distributions compared to for example, pseudo-random type approaches (Hensher et al. 2015).

A.3 Econometric Extensions

Common variations of the RPL model include specification of an additional error component (EC) in the unobserved part of the model. This EC extension captures the unobserved variance that is alternative-specific (Greene and Hensher 2007) hence relating to substitution patterns between the alternatives (Hensher et al. 2015). Empirically, one way to explain significant EC in a model is SQ-bias depicted in the stochastic part of utility if the EC is defined to capture correlation between the non-SQ alternatives (Scarpa et al., 2005).

Another extension which has gained increasing attention in recent CE literature, is the Generalized Mixed Logit (GMXL) model (Czajkowski et al. 2014; Hensher et al. 2015; Juutinen et al. 2012; Kragt 2013; Phillips 2014). This model aims to capture remaining unobserved components in utility as a source of choice variability by allowing estimation of the scale heterogeneity alongside the preference heterogeneity (Fiebig et al. 2010; Hensher et al. 2015). This scale parameter is (inversely) related to the error variance, and in convenient applications such as MNL or RPL, this is normalised to one to allow identification (Fiebig et al. 2010; Louviere and Eagle 2006). However, it is possible that the level of error variance differs between or within individuals, due to reasons such as behavioural outcomes, individual characteristics or contextual factors (Louviere and Eagle 2006).

Recent GMXL application builds on model specifications presented in Fiebig et al. (2010), stating that β_n (in eq. 1.4) becomes:

$$\beta_n = \sigma_n \beta + \gamma \eta_n + (1-\gamma)\sigma_n \eta_n \tag{0.8}$$

where σ is the scale factor (typically = 1) and $\gamma \in \{0,1\}$ is a weighting parameter indicating variance in the residual component. In the case the scale factor equals 1, this reduces to the RPL model. The importance of the weighting parameter is the impact on the scaling effect on the overall utility function (population means) versus the individual preference weights (individual means): when *γ* parameter approaches zero the scale heterogeneity affects both means, whereas when this approaches one the scale heterogeneity affects only the population means (Hensher et al. 2015; Juutinen et al. 2015). Interpretation of these parameters includes

- If *γ* is close to zero, and statistically significant, this supports the model specification with the variance of residual taste heterogeneity increases with scale (Juutinen et al. 2012); and
- If *γ* is not statistically significant from one, this suggests that the unobserved residual taste heterogeneity is independent of the scale effect, that is the individual-level parameter estimates differ in means but not variances around the mean (Kragt, 2013)

The scale factor specification (eq. 1.7) can also be extended to respondent specific characteristics associated with the unobserved scale heterogeneity (Hensher et al. 2015; Juutinen et al. 2015):

$$\sigma_n = \exp\{\bar{\sigma} + \tau\omega_n\} \tag{0.9}$$

where $\bar{\sigma}$ *is* the mean parameter in the error variance; and ω is unobserved scale heterogeneity (normally distributed) captured with coefficient *τ* (Hensher et al. 2015; Juutinen et al. 2015; Kragt, 2013). Juutinen et al. (2012), for example, in context of natural park management found that respondents' education level and the time spent in the park explained the scale heterogeneity ($\tau > 0$, p-value < 0.01). In this study, the respondents indicated levels of choice task understanding and difficulty were used to explain scale heterogeneity.

A.4 Estimation of Monetary Values

Typically the final step of interest in the CE application is the estimation of monetary values of respondent preferences for the attributes considered in utility functions. These are commonly referred to as marginal willingness-to-pay (WTP). WTP estimation is based on the marginal rate of substitution expressed in dollar terms providing a trade-off between some attribute k and the cost involved (Hensher et al. 2015) and is calculated using the ratio of an attribute parameter and the cost parameter. WTP can take into account interaction effects, if statistically significant, such as with the respondent demographics. WTP of attribute *j* by respondent *i* is calculated as the ratio of the estimated model parameters accommodating the influence of the random component (Cicia et al. 2013) as:

$$WTP_i^j = -\left(\frac{\beta_j + \varepsilon_{ij}}{\beta_{price} + \varepsilon_{ip}}\right) \tag{0.10}$$

The estimated mode parameters can also be used to estimate compensating surplus (CS) as a result of policy or quality change in a combination of attributes, using (Hanemann, 1984):

$$\mathbf{CS} = \frac{-1}{\beta cost}\left[\ln\sum_{j=1}^{J}\exp\left\{V_j^0\right\} - \ln\sum_{j=1}^{J}\exp\left\{V_j^1\right\}\right] \tag{0.11}$$

which calculates the difference in utilities before the policy or quality change (V_0) and after the policy or quality change (V_1) (Hanley et al. 2013; Lancsar and Savage 2004). Similar to WTP, the monetary estimation of this change is possible by using the estimate for the monetary attribute $\beta_{cost.}$. Lastly, there are some challenges associated with the empirical estimation of the WTP in the RPL based models. One approach is to use a fixed cost, which simplifies the WTP estimation (Daly et al. 2012) but which may not be as behaviourally a plausible consideration as allowing heterogeneous preferences towards the cost attribute (Bliemer and Rose, 2013; Daziano and Achtnicht, 2014). Conceptually, the estimated cost parameter is a proxy for the marginal utility of income for respondents and economic theory suggests individuals will respondent differently to varying income levels. The use of a random cost parameter however, presents complications in deriving population distribution moments from the ratio of two random parameters.

Appendix B
Latent Class Model of Kiwifruit Choices

Table B.1 Japanese Kiwifruit choice Latent Class model

Utility parameters[1]	Class 1	Class 2	Class 3
Acidic Taste	0.64 (0.63)	- 0.70***(0.23)	0.17 (0.15)
Sweet Taste	0.99* (0.56)	- 0.17 (0.22)	1.11***(0.16)
Balance of Acidic and Sweet	2.05***(0.40)	- 0.44***(0.14)	1.06***(0.17)
Carbon Neutral	- 1.34***(0.43)	0.73***(0.18)	0.11 (0.13)
Biodiversity Enhancement	0.31 (0.48)	- 0.14 (0.18)	0.15 (0.13)
Water Quality Protection	1.44***(0.29)	- 0.27** (0.11)	0.23* (0.14)
Organic	0.55***(0.16)	0.15***(0.05)	0.48***(0.08)
Enhanced Food Safety	0.58***(0.15)	- 0.04 (0.06)	0.18** (0.08)
Social Responsibility	- 0.02 (0.13)	0.21***(0.05)	0.21***(0.07)
Large Size	-0.32** (0.13)	0.41***(0.06)	0.40***(0.08)
Increased Fibre	0.52 (0.59)	0.32 (0.31)	0.35***(0.11)
Increased Vitamin C	- 0.95***(0.22)	0.34***(0.08)	0.32***(0.11)
Grown in Japan	- 0.01 (0.31)	0.83***(0.14)	1.91***(0.15)
Grown in New Zealand	- 0.81** (0.36)	0.79***(0.15)	1.62***(0.16)
Grown in Italy	- 1.52***(0.41)	0.68***(0.18)	0.56***(0.20)
Grown in Chile	- 0.66 (0.57)	- 0.23 (0.24)	0.96***(0.26)
Price/individual kiwifruit	- 0.02***(0.00)	- 0.03***(0.00)	- 0.02***(0.00)
Class Membership			
Purchase Frequency	- 0.48** (0.21)	- 0.50***(0.19)	
Environment Important	0.90** (0.39)	0.88** (0.36)	
Age	-0.03***(0.01)	- 0.03***(0.01)	
Male	0.83***(0.21)	0.02***(0.19)	
Average class probability	0.27	0.43	0.30
Model Fit Statistics			
Log Likelihood function	- 7,375		
Log Likelihood chi^2 stat (70 d.f.)	7,154***		
McFadden Pseudo R^2	0.33		
Number of observations	9,950		
Number of respondents	995		

***, **,* denote statistical significance at the 1%, 5% and 10% levels respectively for the null hypothesis that a parameter estimate is not significantly different from zero.

Standard errors in brackets.

[1] Parameter mean estimates indicates the estimated average value in the model for each different parameter