Agribusiness & Economics Research Unit
LINCOLN UNIVERSITY

California apple consumer consumption behaviours and product preferences: A Latent Class Analysis

Peter Tait
Caroline Saunders
Paul Dalziel
Paul Rutherford
Timothy Driver
Meike Guenther

Research Report No. 366
March 2021

Research to improve decisions and outcomes in business, resource and environmental issues.

The Agribusiness and Economics Research Unit (AERU) operates at Lincoln University, providing research expertise for a wide range of international, national, and local organisations. AERU research focuses on business, resource, and environmental issues.

The Agribusiness and Economics Research Unit (AERU) has four main areas of focus. These areas are wellbeing economics, trade and the environment, economic development, and non-market valuations.

Research clients include Government agencies, both within New Zealand and from other countries, other international agencies, New Zealand enterprises in the private sector, and community groups.

AERU MISSION
To exercise leadership in research for sustainable well-being.

AERU VISION
The AERU is a cheerful and vibrant workplace where senior and emerging researchers are working together to produce and deliver new knowledge that promotes sustainable well-being.

AERU STRATEGIC AIMS

- To be recognised by our peers and end-users as research leaders for sustainable well-being.
- To mentor emerging researchers and provide advanced education to postgraduate students.
- To maintain strong networks to guide AERU research efforts and to help disseminate its research findings.
- To contribute to the University's financial targets as agreed in the AERU business model.

DISCLAIMER
While every effort has been made to ensure that the information herein is accurate, the AERU does not accept any liability for error of fact or opinion that may be present, nor for the consequences of any decision based on this information.

Summaries of AERU Research Reports are available at www.lincoln.ac.nz/aeru. Printed copies of AERU Research Reports can be requested from the AERU Administrator.

Suggested citation for this report:

Tait, Peter, Caroline Saunders, Paul Dalziel, Paul Rutherford, Timothy Driver and Meike Guenther (2021). *California apple consumer consumption behaviours and product preferences: A Latent Class Analysis.* AERU Research Report No. 366, prepared for Unlocking Export Prosperity Research Programme. Lincoln University: Agribusiness and Economics Research Unit.

California apple consumer consumption behaviour and product preferences: A Latent Class Analysis

Peter Tait
Caroline Saunders
Paul Dalziel
Paul Rutherford
Timothy Driver
Meike Guenther

Research Report No. 366

March 2021

Agribusiness and Economics Research Unit
PO Box 85084
Lincoln University
Lincoln 7647
Canterbury
New Zealand

P: (64) (3) 423 0372
www.lincoln.ac.nz/AERU

ISSN 1170-7682 (Print)
ISSN 2230-3197 (Online)
ISBN 978-1-877519-96-3 (Print)
ISBN 978-1-877519-97-0 (Online

Acknowledgements

This Client Report has been prepared as part of the research programme *Unlocking Export Prosperity*, funded by the Ministry of Business, Innovation and Employment (LINX1701).

Contents

List of Tables

List of Figures

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 apples by consumers in California, 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 California residents in December 2020 using a research panel. The survey process achieved 1003 responses with a suitable representation of key population demographics.
- As well as WTP values, this survey reports on:
    - Consumption frequency and behaviour by apple colour
    - Prices paid
    - Purchase frequency by country-of-origin
    - Country-of-origin quality ranking
    - Apple varieties purchased and understanding of country-of-origin
    - Purchase behaviour of "ugly" fruit and vegetables
    - Importance of attributes of apples and personal value statements
- Over two-thirds of respondents consumed apples at least *fortnightly*, with *red apples* the most frequently consumed. One-third of respondents ranked New Zealand in the top three producers of apples for quality, following the USA and Fiji. Almost one-quarter reported buying New Zealand apples at least sometimes.
- Respondents were mostly unaware of the country that the apple varieties they consumed were grown or developed in, reporting they did not know or possibly assumed that it was grown or developed in the USA.
- Over a quarter of respondents said that they have bought "ugly" apples (that were unusual, blemished or misshapen) however 60 per cent said that they have only bought "perfect" apples.
- The survey included a choice experiment to assess the Willingness to Pay by consumers for different attributes associated with apples. Consumers were then segmented using a latent class model into three classes, each with different characteristics and preferences.
- The results showed that Group Three (56 per cent of the sample) had the highest willingness to pay for organic apples at almost double the average price, for a reduction in greenhouse gas emissions, at 75 per cent, and also for social responsibility labels at 71 per cent to support local communities and 95 per cent to support farmers, but they required even larger discounts for buying blemished or misshapen apples. This group was younger than the other groups and more likely to have children. They reported buying and consuming more apples and more varieties of apples than other groups and also reported paying more for apples overall.
- Group Two (27 per cent of the sample) required the least discount for blemished or misshapen fruit but would pay relatively less than the other groups for other attributes such as reduced greenhouse gas emissions or social responsibility. This group tended to be older than Group Three and low price was more important than the other groups.

- Group One (17 per cent of the sample) were the only group to not value the reduction of greenhouse gases and were only willing to pay 28 per cent more for organic production and 16 per cent more to support farmers. This group tended to be older than Group Three and Group Two and agreed least with the statements on supporting local producers, minimising harm to the environment and on Climate change.
- Considering apple appearance, Group Three reported that were the group most open to buying "ugly" apples but the Choice Experiment showed that they expected a large discount to do so. Group Two was more willing to buy moderately blemished apples with no discount at all.

- The respondents' average percentage willingness-to-pay (WTP) was:

Apple attributes	Group One (17%)	Group Two (27%)	Group Three (56%)
Blemished, Moderately	-21%		-111%
Blemished, Significantly	-49%	-12%	-204%
Misshapen, Moderately	-24%	-7%	-106%
Misshapen, Significantly	-71%	-23%	-158%
15% less GHG			
30% less GHG		11%	58%
Organic	22%	13%	76%
Care for workers		8%	45%
Contribute to local communities		17%	55%
Support Farmers	12%		73%

Mean WTP per pound apples (95 per cent Confidence Interval). Percentage calculated using the average price respondents usually paid for apples ($2.45/lb).

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. 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 Californian apple 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 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
Apple Survey Method

To understand how consumers value NZ credence attributes, this study used a structured self-administered online survey that included a Choice Experiment, conducted in California in December 2020. The survey was administered through Qualtrics™, a web-based survey system, and had a sample size of 1,003 apple consumers.

The survey was developed by the research team drawing from a literature review on consumer trends for apples, results from previous surveys examining consumer attitudes in overseas markets, a scoping survey of 199 Washington apple consumers (December 2019), survey pre-testing with recruited testers, and consultation with industry partners and stakeholders, especially those on the 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 apples 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 and beverage 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 apples are described by appearance, production practices 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 American consumers considered distinctive of NZ apples.

Table 2.1: Apple attribute descriptions used in the choice experiment

Apple attributes	Attribute descriptions
Appearance	Apples may have some blemishing such as coloring or spotting, or may be misshapen. Apples that are not perfect in appearance are still safe to eat and taste the same. However they are often considered as not saleable and therefore do not make it onto supermarket shelves. These apples are typically wasted and reduction in this food waste has the potential to improve sustainability
Social Responsibility	The apple may be labeled as being produced by growers that are socially responsible, with programs that actively care for workers, contribute to local communities, or support farmers
Organic Production	Apples grown organically avoid the use of synthetic pesticides and fertilizers, or genetic engineering
Reduction in Greenhouse gas emissions	Reduction in Greenhouse gas (GHG) emissions could be achieved through changes in production systems. Reduction in GHG, such as carbon and methane, is an important tool for reducing global warming and climate change
Genetic Engineering	Genetic engineering can be used to increase growing productivity and enhance the financial sustainability of the apple industry. It can also be used to improve disease resistance and reduce the use of agrichemicals
Price	Price per pound of apples

Changes in apple attributes are described using the labels in Table 2.2. Price levels were determined by market prices, and from what scoping survey respondents said that they usually paid. The different levels of apple appearance were expressed using images without description, these images are also included in Table 2.2.

An example of alternative product offerings presented to respondents is shown in Figure 2.1. Each set of offerings comprises four options, of which respondents chose their preferred one. Three options present alternative apples, while the fourth is a 'none of these' option. Each respondent answered ten choice sets, generating 4,012 completed choice sets over the total sample.

Table 2.2: Apple attribute levels used in the choice experiment

Apple attributes	Attribute levels				
Appearance	 Perfect	 Moderately blemished	 Significantly blemished	 Moderately misshapen	 Significantly misshapen
GHG reduction	No Label	15% less GHG	30% less GHG		
Genetic engineering	No Label	GE-free			
Organic production	No label	Organic			
Social Responsibility	No label	Care for workers	Contribute to local communities	Support farmers	
Price	$1.50 / lb	$3 / lb	$4.50 / lb		

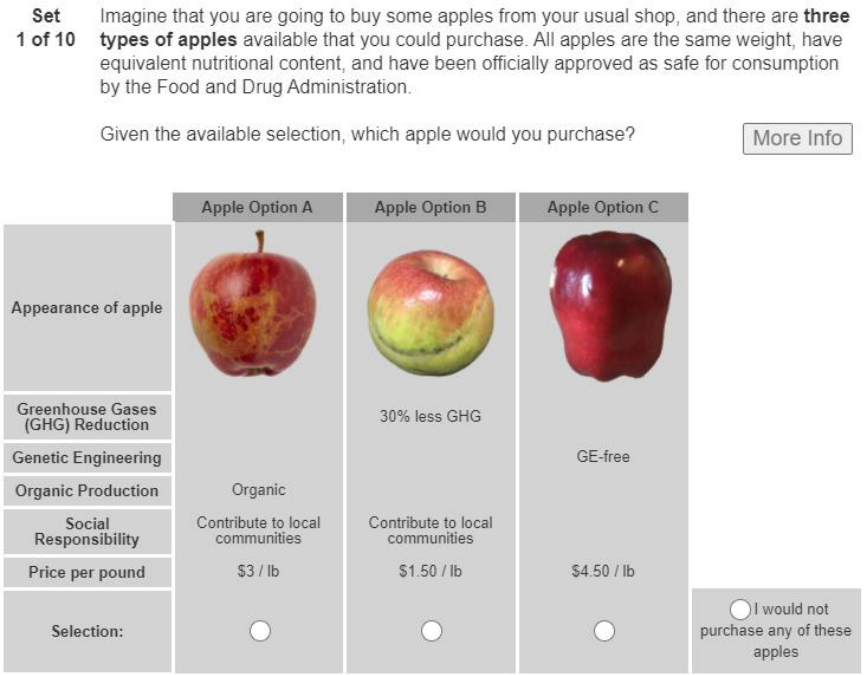


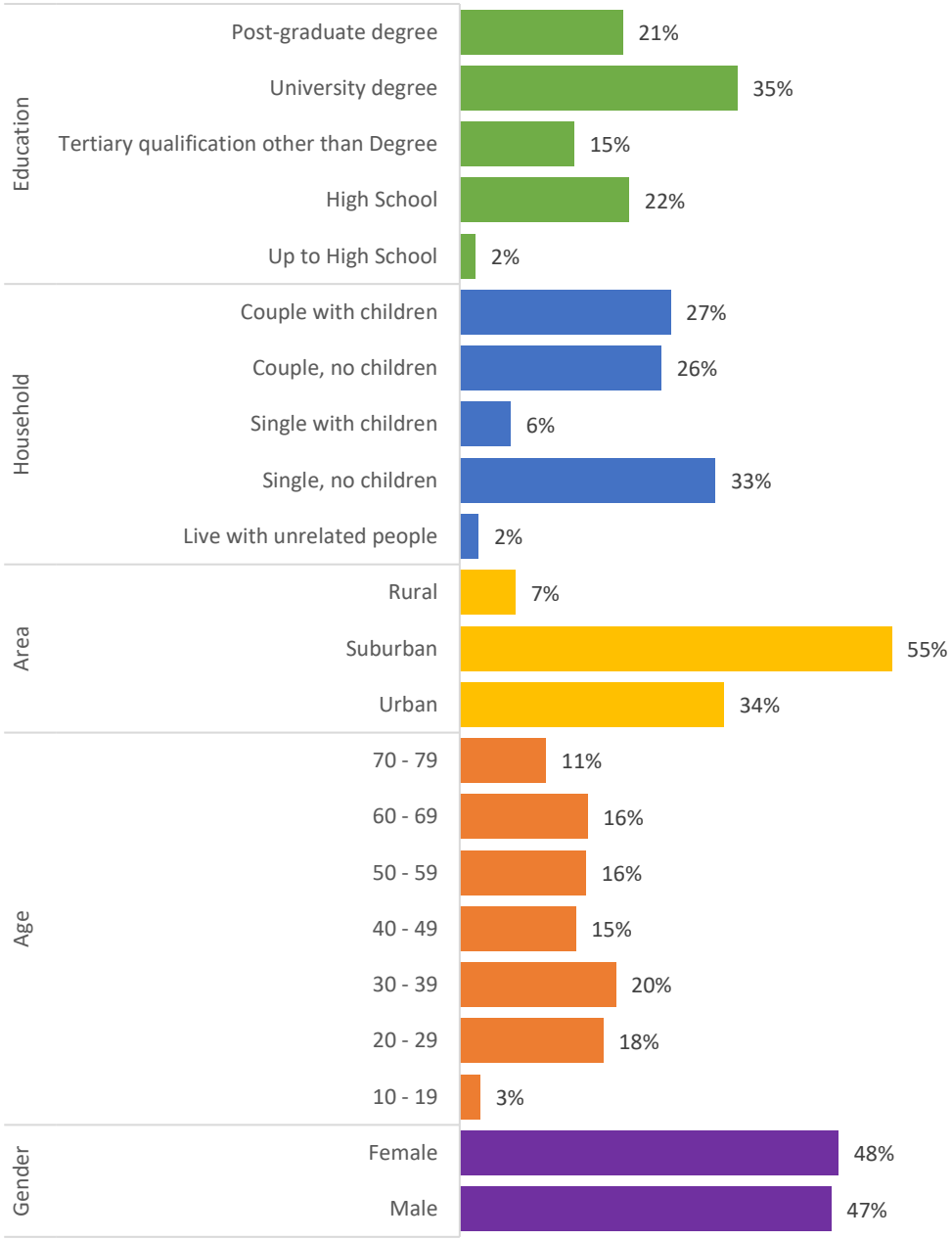
Figure 2.1: Example of a choice experiment question shown to respondents

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 Californian population, but rather those that purchase apples at least monthly.



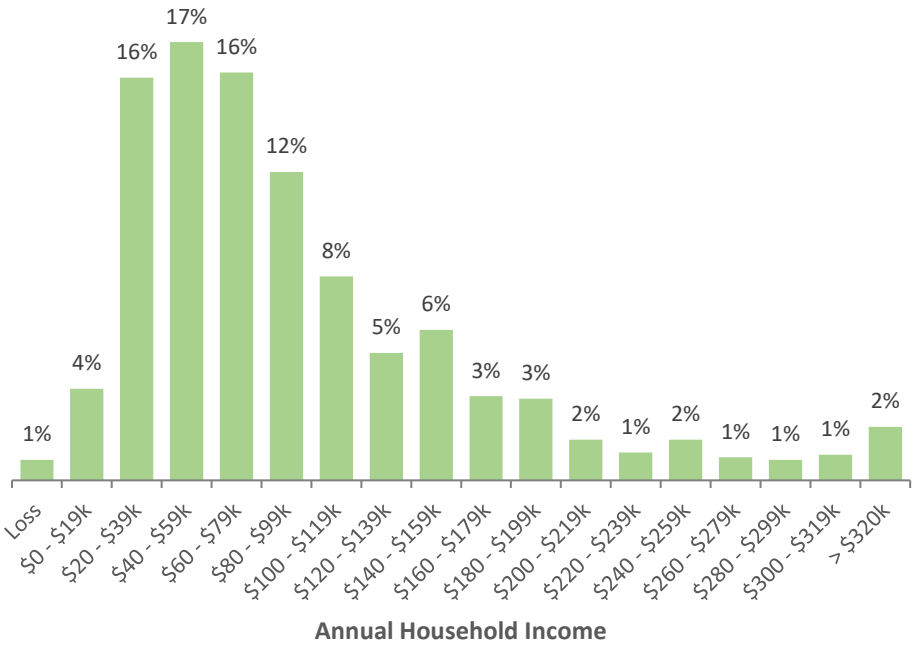


Figure 3.1: Sample demographics

3.2 Purchase and consumption behaviour

- 69 per cent of respondents consumed apples at least fortnightly, with red apples the most frequently consumed (Figure 3.2).

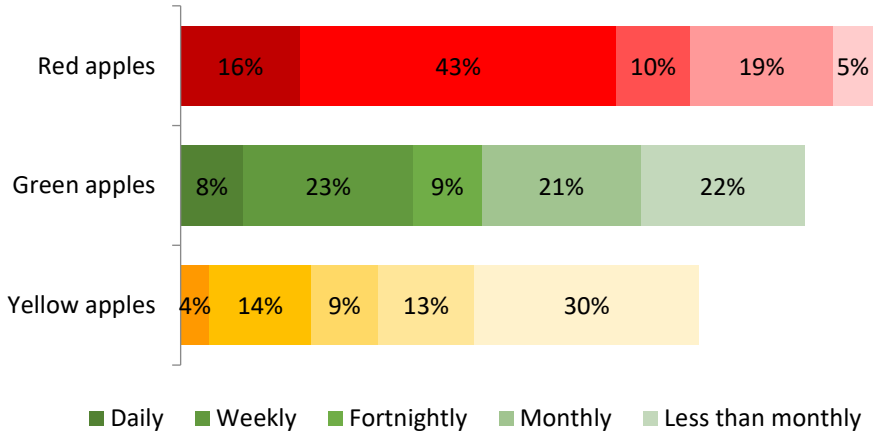


Figure 3.2: Apple consumption by colour

- Most respondents reported eating apples *whole* or as *slices*, up to a quarter used apples for *cooking* and up to 11 per cent used apples for *juicing* (Figure 3.3).

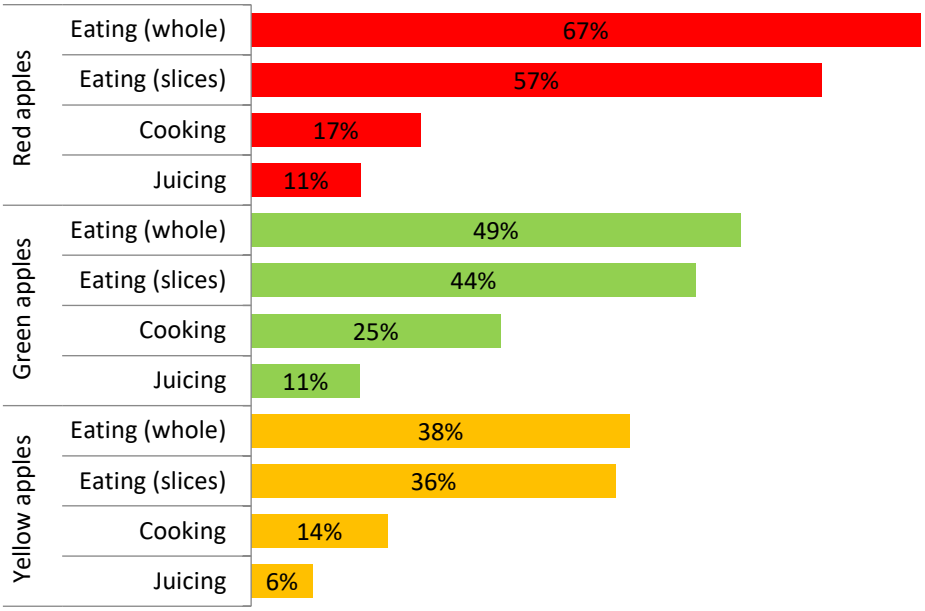


Figure 3.3: Use of apples by colour

- Almost half of respondents ate apples *whole* or as *slices* at least *once a week*, while consumption by juicing or use in cooking was less frequent (Figure 3.4).

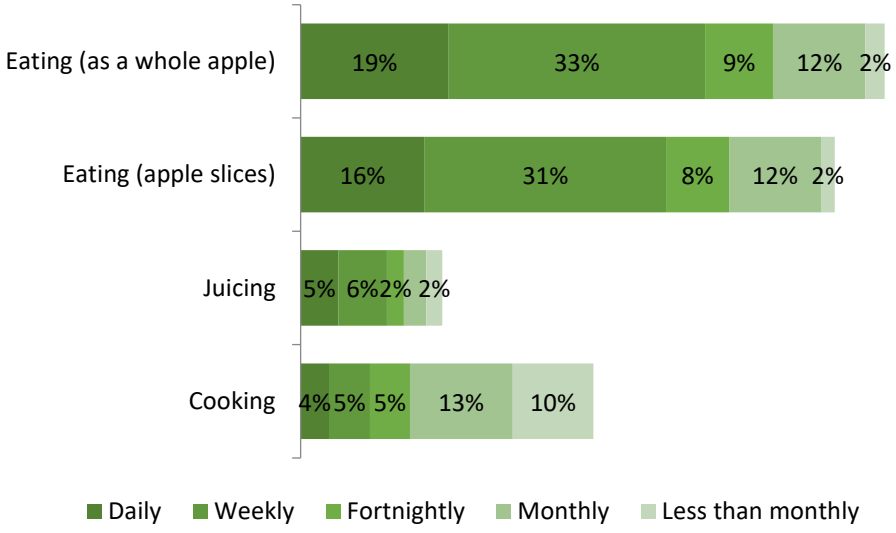


Figure 3.4: Frequency of use of apples

- The most common price point usually paid for apples was $1.9 / lb (Figure 3.5). The average price usually paid is $2.45/lb.

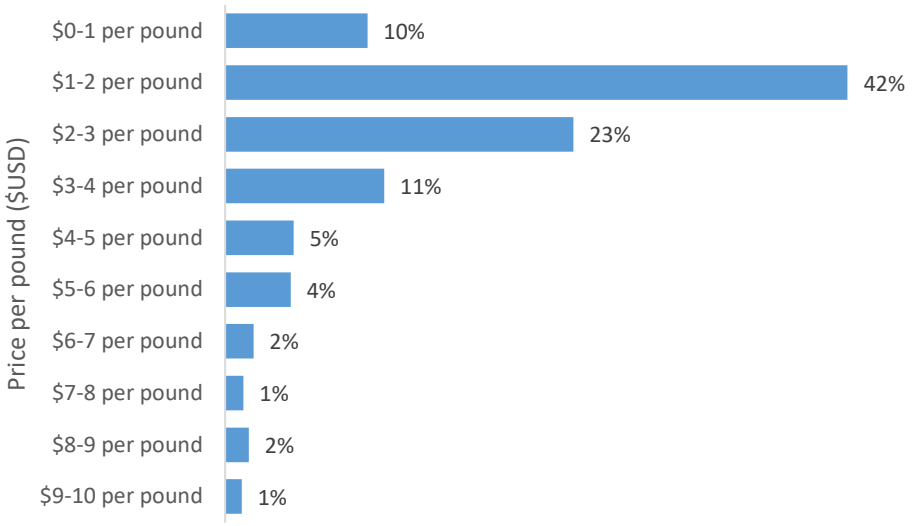


Figure 3.5: Usual price paid per pound for apples

- Apples were mostly purchased for *personal consumption* or *family members* (Figure 3.6).

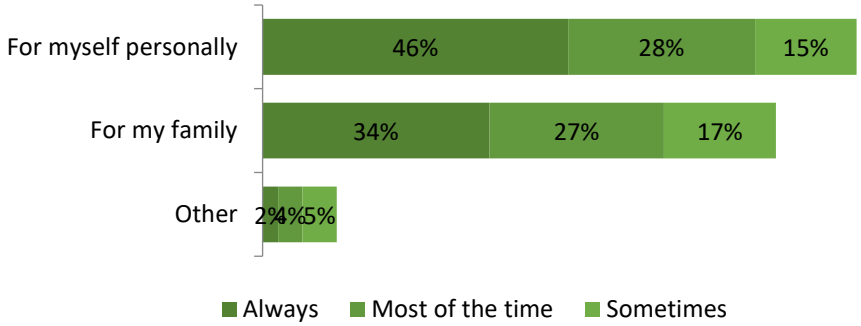


Figure 3.6: Who apples were purchased for

- Of respondents who knew where the apples they bought were grown, New Zealand was the fourth-highest country-of-origin purchase frequency (Figure 3.7).

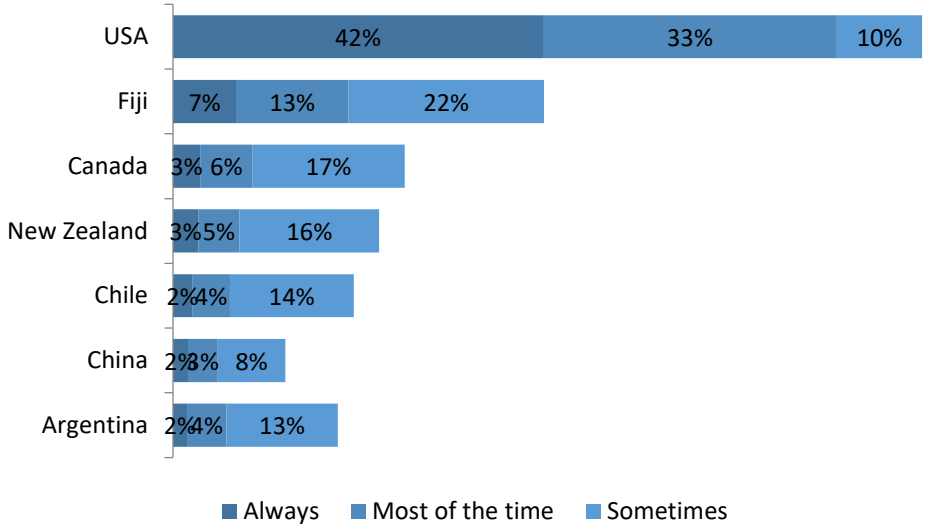


Figure 3.7: Country-of-origin purchase frequency

- When asked which countries produced the best quality apples, 33 per cent ranked New Zealand in the top 3 apple producers and overall ranked New Zealand third, following the USA (72 per cent) and Fiji (42 per cent).

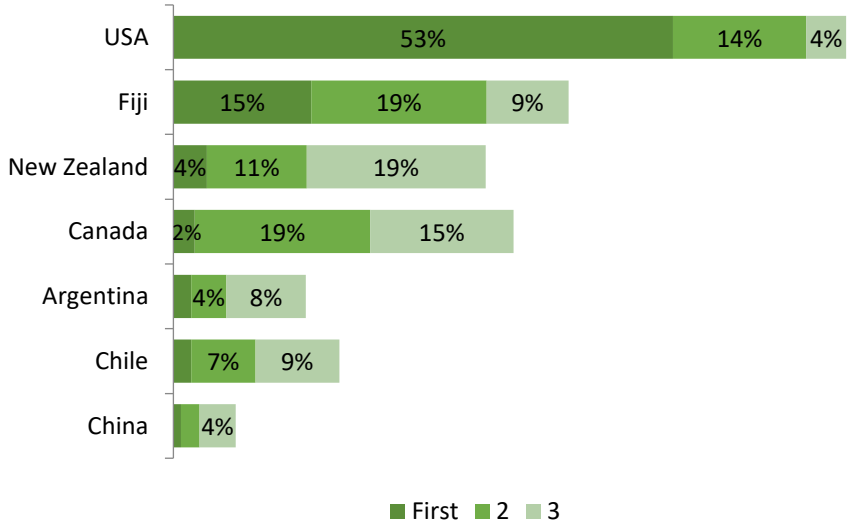


Figure 3.8: Ranking of countries by apple production quality, showing the top three ranks only

- The most frequently purchased apple varieties were *Fuji*, *Granny Smith*, *Red Delicious* and *Gala* (Figure 3.9)

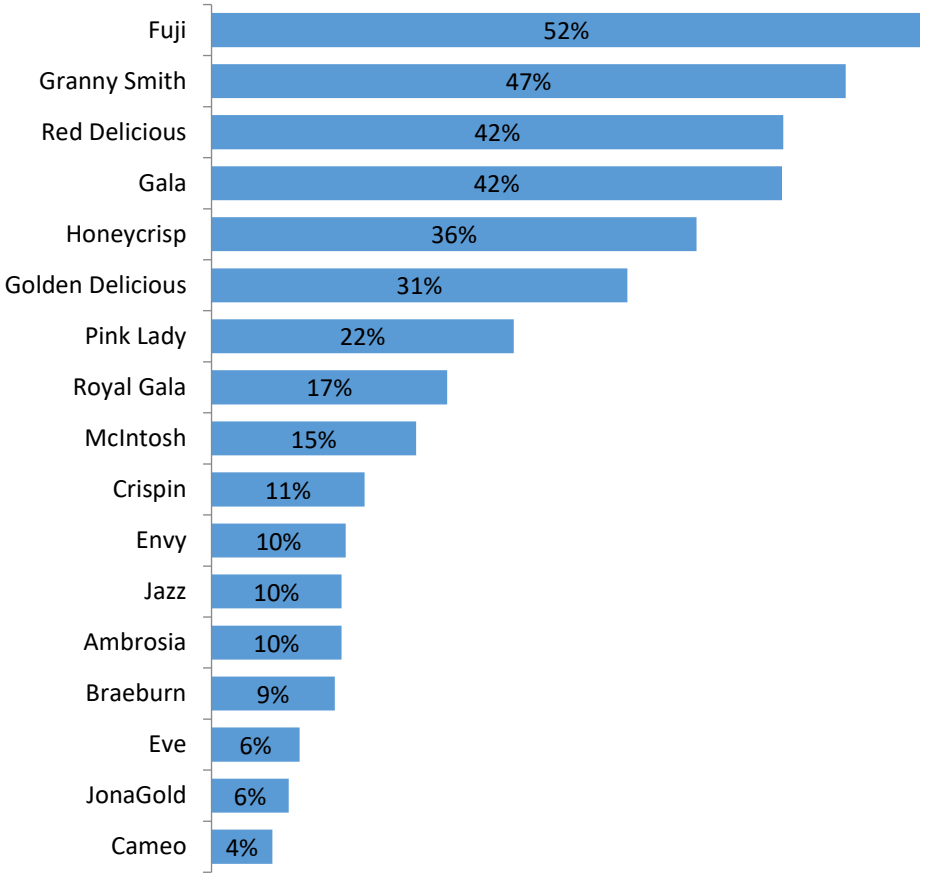


Figure 3.9: Varieties of apples purchased in the previous month

- Most respondents thought the apples they consumed were grown in the USA and, as the USA produces a number of varieties of apples, that could have been correct most of the time. Almost 20-30 per cent didn't know where their apples were grown, and few knew where the Australasian varietals (*Braeburn*, *Eve*) were grown (Figure 3.11).

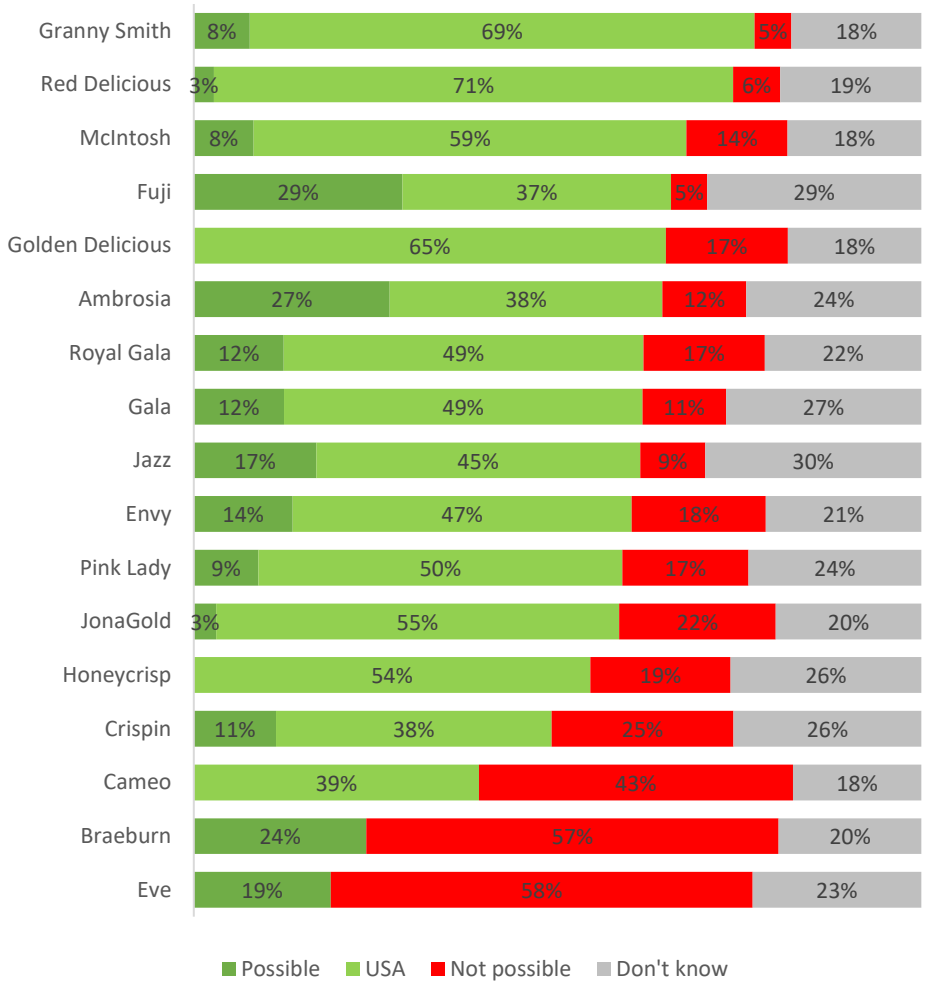


Figure 3.10: Identification of country where apples were grown, by possibility of selection being correct

- Most respondents were unaware of the country that the apple varieties they consumed were developed in, reporting they did not know or possibly assumed that it was USA-developed (Figure 3.11).

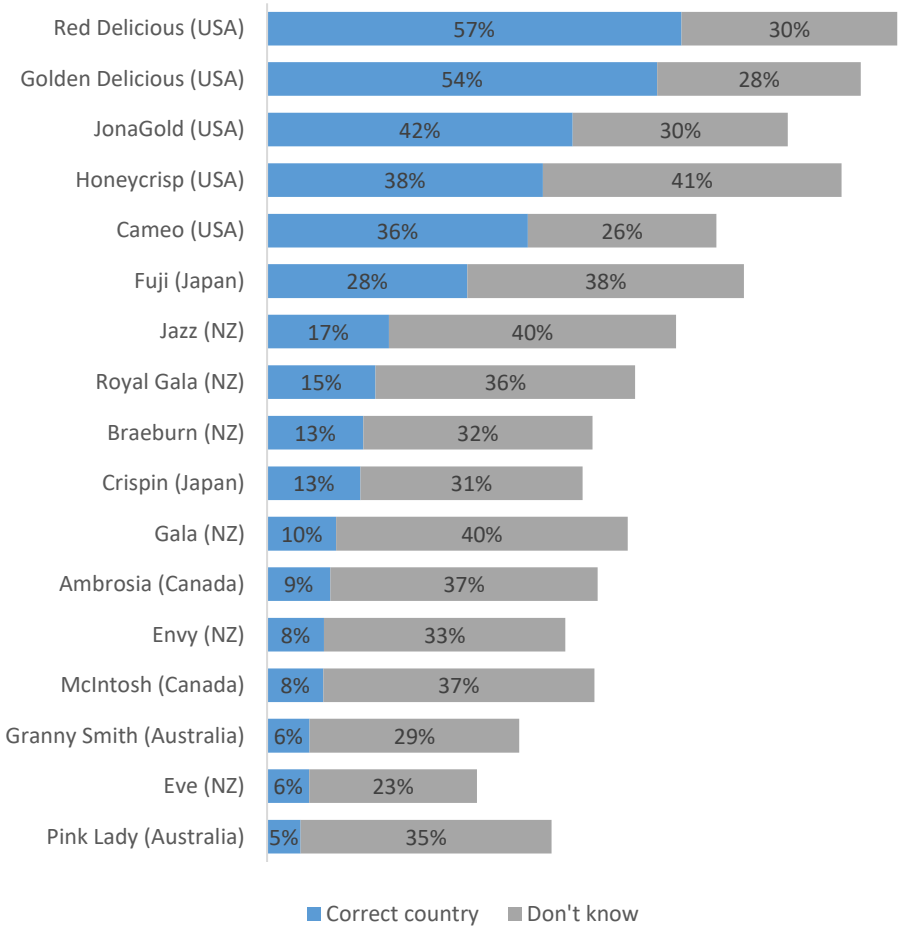


Figure 3.11: Identification of country that apple varieties were developed in (country of development in brackets)

3.3 Perceptions, preferences and attitudes

- Over a quarter of respondents said that they have bought “ugly” apples (that were unusual, blemished or misshapen) however 60% said that they have only bought “perfect” apples (Figure 3.12).

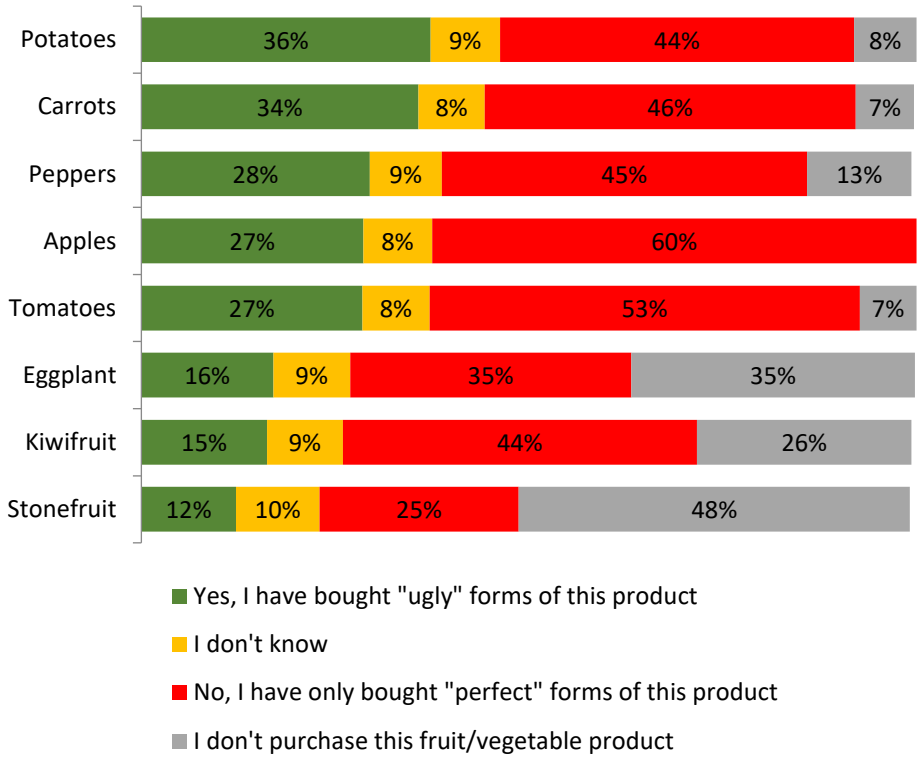


Figure 3.12: Purchase of “ugly” fruit and vegetables

- *Freshness*, *high quality* and *crispness* were the most important attributes respondents reported considering when purchasing apples (Figure 3.13).

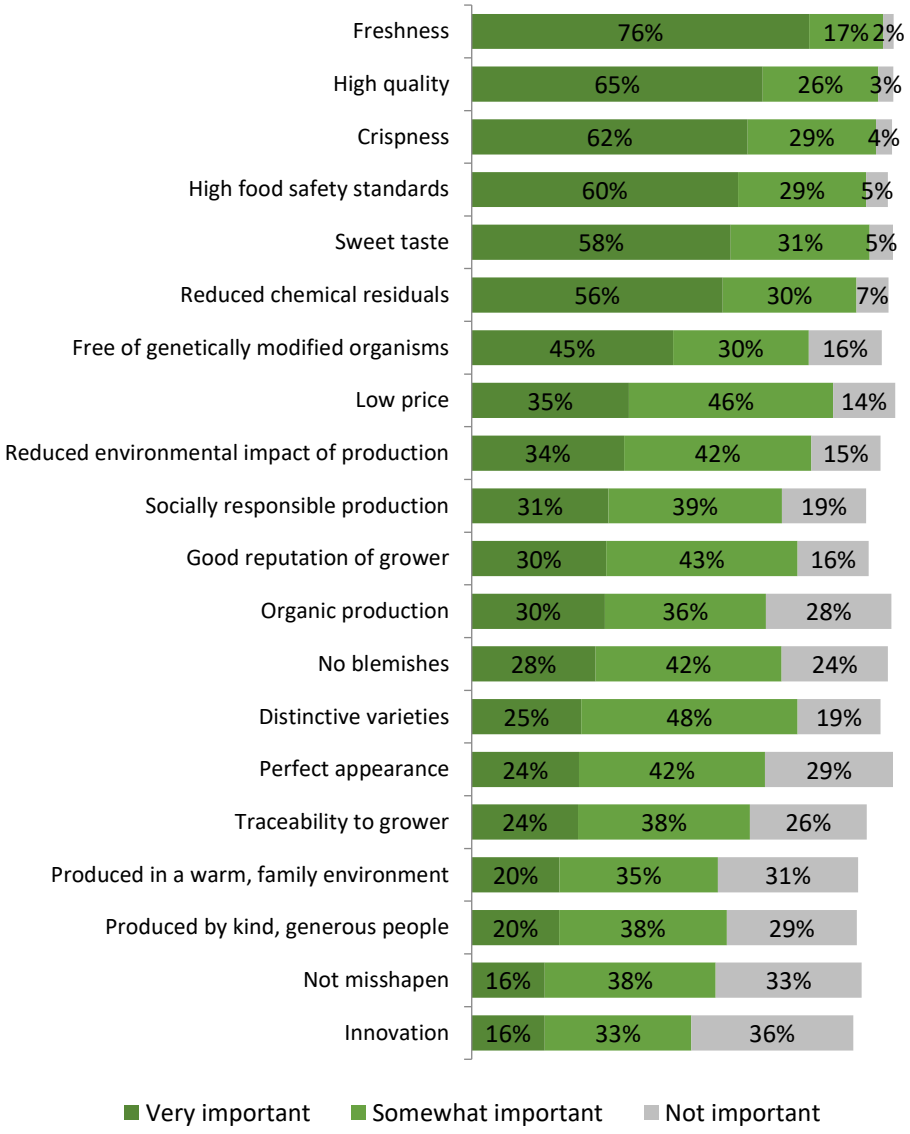


Figure 3.13: Importance of attributes when purchasing apples

- Considering the appearance of apples, 28 per cent said that having no blemishes was *very important* and 24 per cent said that perfect appearance was *very important*. Considering the shape of apples, 16 per cent said not being misshapen was *very important* compared to 36 per cent saying it was *not important* (Figure 3.13).

- Respondents who reported they had bought NZ apples were asked about the importance of attributes for purchasing NZ apples. Again here, *freshness*, *high quality* and *crispness* were the most important attributes (Figure 3.14).

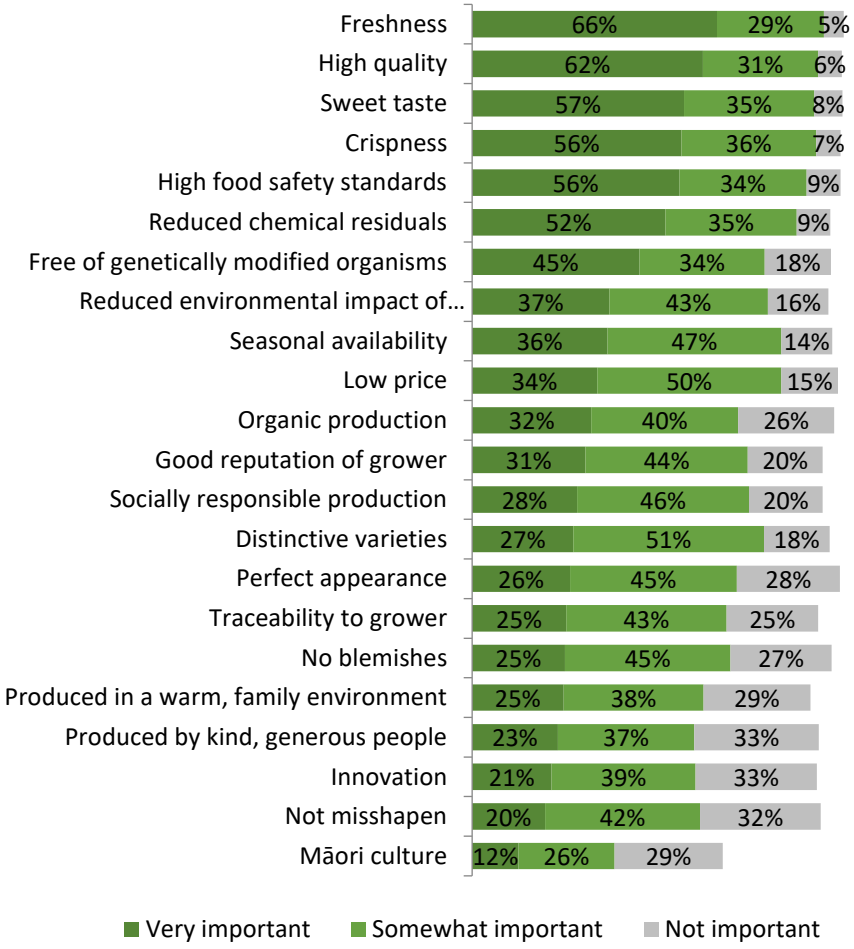


Figure 3.14: Importance of attributes for purchasing New Zealand grown apples

- Perhaps unsurprisingly for fruit consumers, health outcomes were important to 85 per cent of respondents (Figure 3.15).

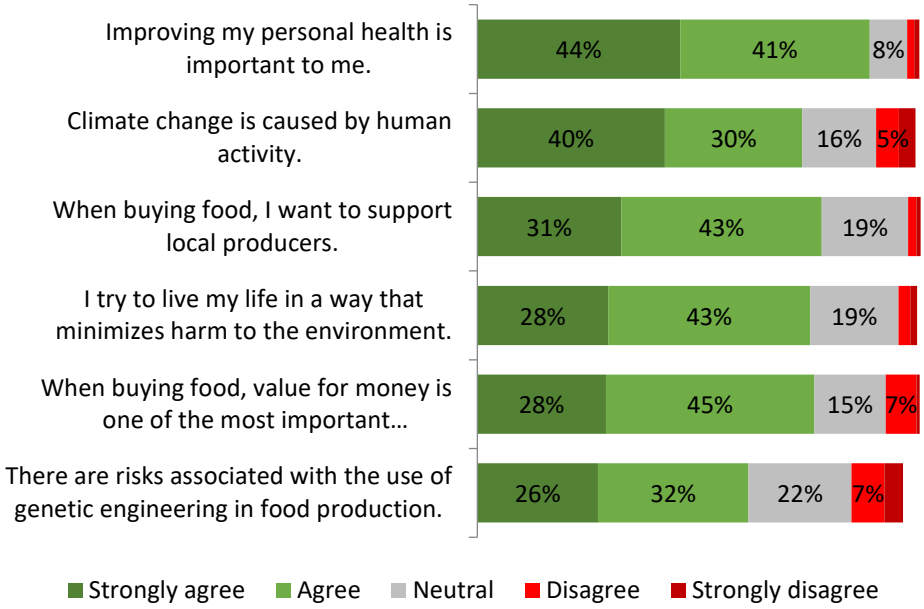


Figure 3.15: Personal value statements

3.4 Choice Experiment analysis of apple choices

In this section we present findings of the Choice Experiment. Our aim is to identify which apple attributes drive product choices, 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 high, and most respondents felt certain that their responses reflected real-world choices if these apples were available (Figure 3.30).

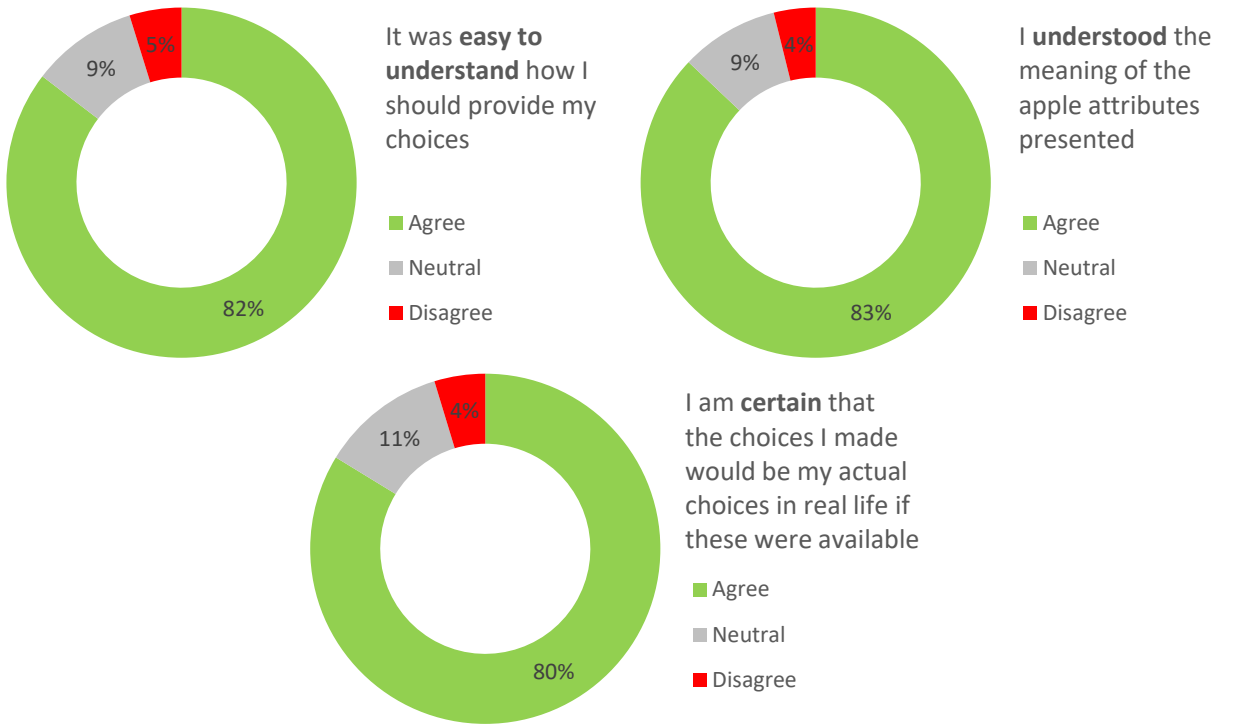


Figure 3.16: Choice experiment debriefing questions: task understanding, attribute understanding, certainty of choices made

Estimates of WTP tell us how much more the average consumer is willing to pay per pound for apples with a particular attribute, over one that does not have this attribute (Table 3.1), (Figure 3.31). For example, members of Group Three are willing to pay, on average, $1.85 more per pound for apples that were produced organically over apples that are not. 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.

Group Three also preferred apples produced with 30% less emissions of greenhouse gases (+$1.42) and with social responsibility attributes, however they were strongly against misshapen (moderately misshapen at -$2.59/lb) and blemished apples (moderately misshapen at -$2.72/lb).

Group Two were the least against blemished (no discount required for moderately blemished) and misshapen apples (-$0.16/lb for moderately misshapen) and would pay modest amounts more for 30 per cent greenhouse gas emissions (+$0.26).

Table 3.1 presents the results for the three distinct consumer groups – the first group has an estimated size of 17 per cent of the total sample, the second group's size is 27 per cent and the third is 56 per cent. These group sizes tell us the probability that a randomly selected Californian apple purchaser belongs to that consumer group.

Table 3.1: Apple attribute willingness-to-pay (WTP) by consumer group

Apple attributes	Group One (17%)	Group Two (27%)	Group Three (56%)
Blemished, Moderately	-$0.51 (-0.85,-0.17)		-$2.72 (-3.33,-2.1)
Blemished, Significantly	-$1.19 (-1.56,-0.83)	-$0.29 (-0.48,-0.09)	-$4.99 (-5.86,-4.13)
Misshapen, Moderately	-$0.59 (-0.99,-0.18)	-$0.16 (-0.33,0.01)	-$2.59 (-3.22,-1.96)
Misshapen, Significantly	-$1.75 (-2.33,-1.17)	-$0.56 (-0.74,-0.37)	-$3.88 (-4.74,-3.01)
15% less GHG			
30% less GHG		$0.26 (0.1,0.41)	$1.42 (1.01,1.83)
Organic	$0.54 (0.05,1.02)	$0.32 (0.19,0.45)	$1.85 (1.39,2.31)
Care for workers		$0.20 (0.03,0.38)	$1.11 (0.59,1.63)
Contribute to local communities		$0.41 (0.27,0.55)	$1.35 (0.88,1.83)
Support Farmers	$0.30 (0.06,0.54)		$1.80 (1.35,2.24)

Mean WTP per pound apples (95 per cent Confidence Interval). $US 2020.

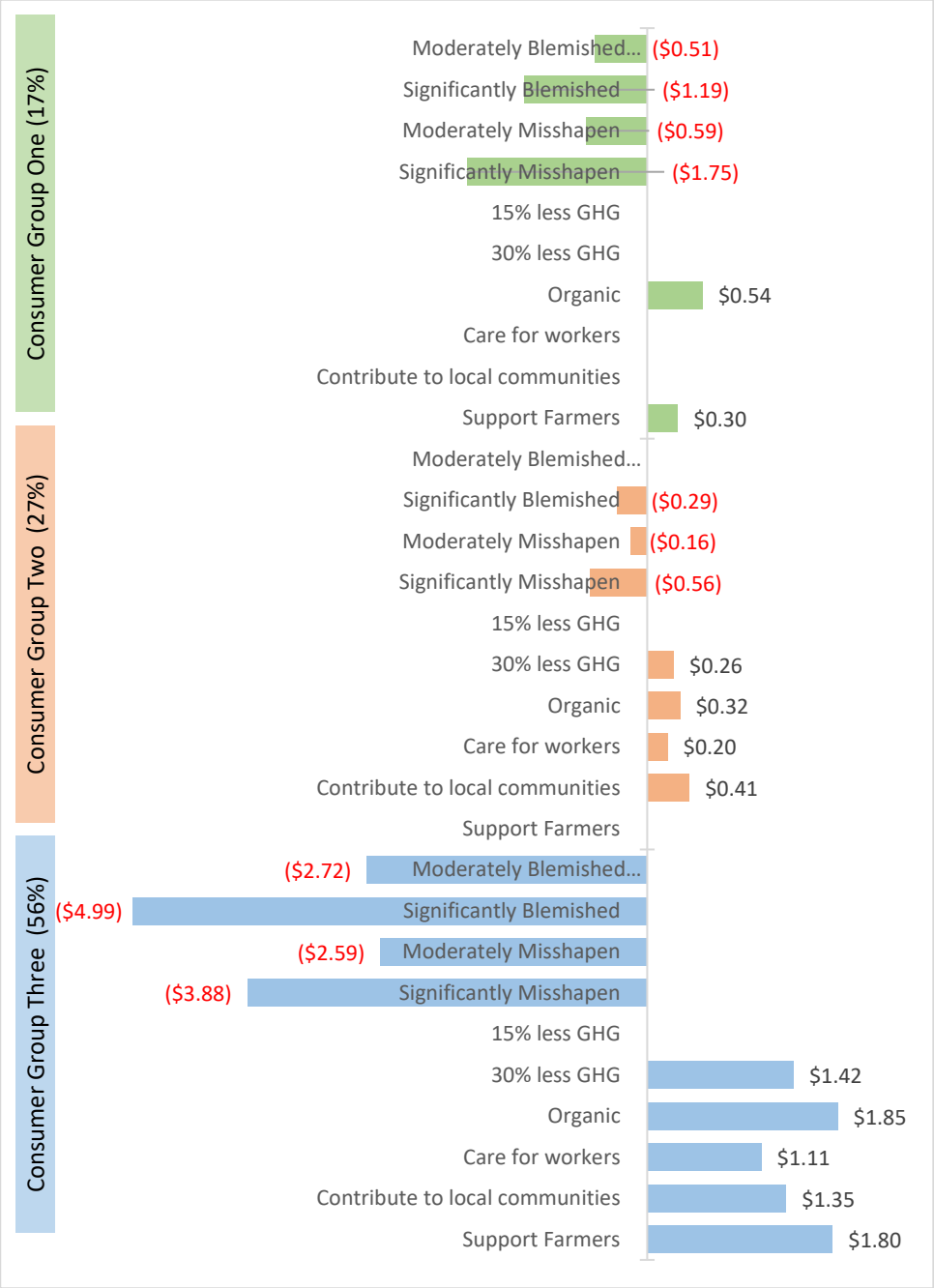


Figure 3.17. Apple attribute willingness-to-pay by consumer group ($ per pound, $US 2020)

Of the attributes considered, consumer groups value apples that are not blemished or misshapen the most overall. Preferences for lower greenhouse gas emissions and socially responsible practices were also strong in Group Three (Figure 3.17).

- Consumers in Group One are willing to pay for organic production and to support farmers.
- They are the only group to not value the reduction of greenhouse gases.

- Consumer Group Two have the least negative preferences for apples that are blemished or misshapen and are willing to accept apples with moderate blemishes at no discount.
- These consumers also valued Organic production, reductions of greenhouse gas emissions of at least 30 per cent, and social responsibility attributes, but at a less value than Consumer Group Three.

- Consumers in Group Three generally have stronger preferences and WTP overall of the three groups.
- They are willing to pay more for Organic production, reductions of greenhouse gas emissions of at least 30 per cent, and social responsibility attributes.
- However they require high discounts for apples that are blemished or misshapen.

3.5 Consumer group descriptions

This section describes each of the three consumer groups identified in the statistical analysis, using the same questions 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. 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.

- Group One consumers are more likely to be older, while Group Three consumers are more likely to be younger and live with children (Table 3.2).

Table 3.2. Describing consumer groups: Demographics

Demographics	Group One	Group Two	Group Three
Female	50%	47%	53%
< 44 years old	26%	30%	64%
> 65 years old	33%	27%	11%
Rural	5%	8%	7%
Have children	25%	29%	41%
University degree	63%	64%	54%
Income of Upper quartile	$100,000	$120,000	$100,000
Median income	$60,000	$60,000	$60,000
Income of lower quartile	$40,000	$40,000	$40,000

- Group Two consumers agree the most strongly with the importance of improving personal health and value for money, while Group One agrees less with statements on minimising harm to the environment and that climate change is caused by human activity (Table 3.3).

Table 3.3: Describing consumer groups: Personal statements

Agree:	Group One	Group Two	Group Three
Improving my personal health is important to me.	88%	92%	86%
When buying food, value for money is one of the most important considerations.	75%	81%	74%
When buying food, I want to support local producers.	64%	79%	81%
I try to live my life in a way that minimizes harm to the environment.	63%	76%	78%
Climate change is caused by human activity.	60%	76%	76%
There are risks associated with the use of genetic engineering in food production.	57%	57%	65%

- Group Three consumers reported that they have bought "ugly" forms of fruit and vegetables before, while Group One reported this behaviour the least (Table 3.4).

Table 3.4: Describing consumer groups: Purchase of "Ugly" forms of fruit and vegetables

I have bought:	Group One	Group Two	Group Three
"Ugly" forms of Potatoes	22%	38%	42%
"Ugly" forms of Carrots	23%	36%	40%
"Ugly" forms of Peppers	16%	28%	34%
"Ugly" forms of Apples	17%	27%	31%
"Ugly" forms of Tomatoes	18%	29%	31%
"Ugly" forms of Eggplant	8%	16%	20%
"Ugly" forms of Kiwifruit	6%	15%	19%
"Ugly" forms of Stonefruit	6%	10%	16%

- Group Three consumers are more likely to place importance on reduced environmental impact, organic production and socially responsible production, while Group One and Group Two consumers place more importance on low price (Table 3.5).

Table 3.5: Describing consumer groups: Importance of attributes

Very Important	Group One	Group Two	Group Three
Reduced environmental impact of production	20%	27%	44%
Organic production	21%	18%	40%
Socially responsible production	19%	23%	40%
Produced by kind, generous people	9%	13%	27%
Produced in a warm, family environment	11%	11%	27%
Good reputation of grower	22%	24%	38%
Traceability to grower	18%	16%	31%
Innovation	9%	8%	24%
Free of GMO	43%	39%	52%
Low price	40%	43%	32%
Reduced chemical residuals	51%	58%	61%

- Group Three consumers placed the most importance on perfect appearance and apples not having blemishes, while Group Two was more accepting of imperfections (Table 3.6). Misshapen apples were more acceptable than blemished apples.

Table 3.6: Describing consumer groups: Importance of appearance

Very Important	Group One	Group Two	Group Three
Perfect appearance	20%	13%	32%
No blemishes	30%	19%	34%
Not misshapen	17%	8%	22%

Chapter 4
Conclusions

This report presents the results of a survey of apple consumption in California. The survey was of just over 1,000 respondents who were selected as purchasing apples at least once a month.

The survey assessed purchase behaviour and the reasons for purchasing apples by appearance and country of origin. Over two-thirds of respondents consumed apples at least *fortnightly*, with *red apples* the most frequently consumed. One-third of respondents ranked New Zealand in the top three producers of apples for quality, following the USA and Fiji. Respondents were mostly unaware of the country that the apple varieties they consumed were grown or developed in, reporting they did not know or possibly assumed that it was grown or developed in the USA.

Over a quarter of respondents said that they have bought "ugly" apples (that were unusual, blemished or misshapen), however 60 per cent said that they have only bought "perfect" apples.

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

The results showed that Group Three (56 per cent of the sample) had the highest willingness to pay organic apples, for a reduction in greenhouse gas emissions and also for social responsibility labels, but they required even larger discounts for buying blemished or misshapen apples. This group was younger than the other groups and more likely to have children. They reported buying and consuming more apples and more varieties of apples than other groups and also reported paying more for apples overall.

Group Two (27 per cent of the sample) required the least discount for blemished or misshapen fruit but would pay less for other attributes such as reduced greenhouse gas emissions or social responsibility. This group tended to be older than Group Three and low price was more important than the other groups.

Group One (17 per cent of the sample) were the only group to not value the reduction of greenhouse gases and were only willing to pay more for organic production and to support farmers. This group tended to be older than Group Three and Group Two and agreed least with the statements on supporting local producers, minimising harm to the environment and on Climate change.

Considering apple appearance, Group Three reported that were the group most open to buying "ugly" apples but the Choice Experiment showed that they expected a large discount to do so. Group Two was more willing to buy blemished apples with no discount at all.

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:

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

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 β_{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 Apple choices

Table B.1 Californian Apple choice Latent Class model

Utility parameters[1]	Class 1	Class 2	Class 3
Moderately Blemished	-0.59*** (0.16)	-0.16 (0.19)	-0.58*** (0.06)
Significantly Blemished	-1.37*** (0.21)	-0.58*** (0.21)	-1.06*** (0.07)
Moderately Misshapen	-0.68*** (0.17)	-0.32* (0.18)	-0.55*** (0.06)
Significantly Misshapen	-2.01*** (0.28)	-1.12*** (0.21)	-0.83*** (0.06)
15% less GHG	0.11 (0.16)	0.14 (0.14)	0.07 (0.05)
30% less GHG	0.06 (0.18)	0.52*** (0.16)	0.30*** (0.05)
Organic	0.62*** (0.21)	0.65*** (0.14)	0.40*** (0.05)
Care for workers	-0.27 (0.22)	0.41** (0.19)	0.24*** (0.06)
Contribute to local communities	-0.02 (0.15)	0.82*** (0.15)	0.29*** (0.05)
Support Farmers	0.34*** (0.13)	0.27 (0.17)	0.38*** (0.05)
Price apples /lb	-1.15*** (0.19)	-2.02*** (0.12)	-0.21*** (0.02)
Class Membership			
Has bought “ugly” apples	-0.54* (0.30)	0.02 (0.19)	
Age	0.05*** (0.01)	0.04*** (0.01)	
Has children	-0.54** (0.24)	-0.37** (0.18)	
Average class probability	0.17	0.27	0.56
Model Fit Statistics			
Log Likelihood function	-10192		
Log Likelihood chi^2 stat (70 d.f.)	7423***		
McFadden Pseudo R^2	0.27		
Number of observations	10,030		
Number of respondents	1003		

***, **,* 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