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Valuing Preferences for Environmental Sustainability in Fruit Production by United Kingdom and Japanese Consumers

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Abstract

Reduction of carbon intensity of high volume grocery products is potentially a major contributor in meeting climate targets. In a choice experiment concerning fruit purchase decisions in the United Kingdom and Japan, this study estimates consumer willingness to pay for sustainability attributes of production alongside vitamin content, including water use efficiency, waste and packaging, and carbon emissions. Results indicate that sustainability attributes significantly influence consumers' fruit purchase decisions. Preferences are found to be very similar between countries, with reduction of carbon emissions the most valued sustainability attribute by both UK and Japanese consumers and increased vitamin content the least. This study's findings provide implications for carbon emission labeling development in the context of international food supply chains, and primary sector strategy encouraging initiatives to improve environmental performance domestically.

Keywords: carbon labelling, food sustainability, choice experiment, willingness to pay, cross-country comparison

1. Introduction

Changes in consumer demands in many primary sector markets are constantly driving changes in the value chains that primary industries participate in. There is an increasing expectation that products have environmental sustainability credentials in production (Guenther, Saunders, & Tait, 2012) such as information about climate change impacts (Rousseau & Vranken, 2013). Groceries account for about a third of total environmental impact and emissions arising from European Union countries, making reduction of carbon intensity of high volume grocery products a potential major contributor in meeting climate targets (Upham, Dendlar, & Bleda, 2011). Understanding the importance of carbon labelling in consumer choices and how it relates to other environmental attributes is crucial to determining potential efficacy of contributing to reductions. The potential for carbon labelling of food products to change consumer behaviour has been recognised (Vanclay et al., 2011; Cohen & Vandenbergh, 2012) and the practice of carbon labelling is likely to grow in importance (Roos & Tjarnemo, 2011). While some attention has been focused on estimating monetary values of consumer preferences for changes in carbon emissions levels of food products (Caputo Nayga & Scarpa, 2013) including fruit (Aoki & Akai, 2013; Onozaka & McFadden, 2011) meat products (Koistinen et al., 2013) and non-food products including flowers (Michaud, Llerena, & Joly, 2013; and air travel (Mackerron, Egerton, Gaskell, Parpia, & Mourato, 2009) the literature is scarce relative to that for other credence attributes such as organics or food safety. This study is motivated by a need to improve understanding of the relative importance of multiple environmental sustainability attributes of primary sector fruit production including carbon emissions reductions. The primary objective is to analyse the potential role of carbon labelling of fruit in consumers purchase behaviour as a tool in the formation of effective climate change strategies. Identifying consumer demand could contribute to incentivising adoption of carbon reduction strategies. Current strategies include adaptation of traditional processes (van Rikxoort, Schroth, Läderach, & Rodríguez-Sánchez, 2014) organic systems (Aguilera, Guzmán, & Alonso, 2014) localisation of consumption (Cleveland et al., 2011) and reduction in waste (Svanes & Aronsson, 2013).

This study estimates consumer values for carbon labelling of fruit in both the United Kingdom (UK) and Japan, where carbon labelling schemes are currently applied to food products. While carbon labelling schemes have been launched in several countries (Guenther et al., 2012) we chose the UK and Japan as representing early

adopters of carbon labelling schemes, having culturally diverse populations, and with significant demand for fruit products. Consumer demand for carbon labelling in the UK has been found to be relatively strong (Gadema & Oglethorpe, 2012). The UK Carbon Trust introduced one of the world's first carbon labels, the Carbon Reduction Label, in 2006 with the proviso that products bearing the label have to reduce emissions associated with producing the product by 20% over two years following certification otherwise they risk losing the right of use the label. In Japan, consumer demand for carbon labelling has also been recognised (Aoki & Akai, 2013). Japan introduced a carbon labelling scheme in 2008 with retailers voluntarily attaching a Carbon Footprint Label to their products providing detailed breakdowns of each products carbon footprint (Ministry of Economy Trade and Industry [METI], 2010). There is a recognition that consumers from different countries may respond differently to the same environmental attribute with willingness to pay (WTP), especially for socially responsible and origin-based food products, dependent in part on the culture and traditions of countries' consumers (McCluskey & Loureiro, 2003). Considering the possible implications for collaborative climate mitigation policy, and specialization of export strategies, there is surprisingly scant literature providing direct cross-country comparisons of consumer preferences for sustainability attributes of food products (Basu & Hicks, 2008; Tonsor, Schroeder, Pennings, & Mintert, 2009).

The economic valuation literature contains many applications of symbol and icon type eco-labelled products that signal attainment of a certain level of environmental performance, such as the often cited exemplar of the Nordic Swan (Bjorner, Hansen & Russell, 2004). Typical symbol and icon-type labels are defined by a generally simple presentation format intended to communicate single criteria (Jaffry, Pickering, Ghulam, Whitmarsh, & Wattage, 2004; McCluskey & Loureiro, 2003). Despite their popularity, there is growing recognition of the limitations of symbol and icon type eco-label formats. Due to their inherent simplicity they could be considered inadequate in addressing the complex information requirements of emerging consumer preferences (Czamezki, 2011). Problems can emerge concerning the divergence of simplicity in presentation with the complexity of preferences. A significant dispute concerns the risk that overly simplistic labelling schemes may lead to potentially misleading environmental evaluations by consumers, in a consequence known as the halo effect (Andrews, Burton, & Kees, 2011). This means that consumers may generalise that the product is more favourable on other environmental elements not explicitly identified. The implication for environmental sustainability labelling suggests the use of a multiattribute labelling format rather than an overly simplistic symbol or icon type format. Multiattribute labels would allow consumers to identify and express preferences over individual environmental outcomes previously aggregated into a single metric. Moreover, valuation studies employing icon-based label designs to estimate consumer WTP are not able to determine the value of preferences for changes in individual component measures of an eco-label standard.

The paper has two main objectives. The first is to advance understanding of the relative importance to individual consumers of minimising carbon emissions compared with other environmental sustainability attributes, water use efficiency, and reduction of waste and packaging. The second is to provide a direct cross-country comparison extending understanding of similarities and differences in consumer preferences for credence attributes in culturally diverse countries. By employing a choice experiment approach comprising of multiple environmental sustainability measures of food presented simultaneously, this study is able to provide more detailed information estimating consumer WTP and trade-offs over a range of environmental measures. There is some evidence suggesting that consumers' food purchase decisions may be primarily driven by private benefits such as enhanced health outcomes, rather than from public benefits typically associated with environmental goods (Rousseau & Vranken, 2013). With this in mind we include vitamin content as a fruit attribute in the choice experiment. This allows for investigation of the relative importance placed by consumers on private versus public benefits.

The paper proceeds by presenting next the choice experiment method employed to estimate consumers WTP. Section 3 then details survey development and implementation. Model estimation results are presented and WTP is calculated and discussed in Section 4. The paper concludes with implications.

2. Choice Modelling Method

Consumer markets that would allow for identification of relative importance between environmental attributes such as carbon emissions and water use efficiency are absent. This analysis employs the stated preference method of survey based choice experiments to collect information on consumers' fruit preferences. There is an established literature of application to food in Japan (Aizaki, Nanseki, & Zhou, 2013; Hu, Chen, & Yoshida, 2006; Iwamoto, Yamamoto, Sato & Sawada, 2003; Managi, Tamamoto, Iwamoto, & Masuda, 2008) and the UK (Bitzios, Fraser, & Haddock-Fraser, 2011; Balcombe, Fraser, & Di Falco, 2010; Jaffrey et al., 2004). In this study, alternative fruit options are described by the environmental impacts of production, vitamin content and price.

Consumers are asked to indicate their preferred alternative in each scenario. The observed choice and associated attribute levels of each alternative are modelled in a probabilistic econometric framework using Random Utility Models (RUM) underpinned by the theory of choice behaviour known as Random Utility Theory (McFadden, 1974; Ben-Akiva & Lerman, 1985). In this way, choice experiments provide a utility theoretic measure of preferences over various product characteristics.

The RUM can be made operational by formulising the relationship of an individual's utility function as follows:

$$U_{ni} = \beta_{0,n} + \sum \beta_k x_{ni} + \varepsilon_{ni} \quad (1)$$

Where, U_{ni} is the measure of utility from alternative i for individual n and it is a function of constant variable β_0, the sum of the utilities for each k attribute where β_k is the utility weight to be estimated and x is a vector of observed parameters, and ε_{ni} is an unobserved error term which is randomly distributed. The random component allows analysts to express consumer choice in probabilistic terms that enables the underlying preferences for attributes to be extracted.

$$P_{(ni|A)} = \Pr(U_{ni} > U_{nj}) \qquad i, j \in A \text{ and } i \neq j \quad (2)$$

Where the probability of choosing alternative i in choice set A ($P_{(ni|A)}$) is commensurate with the probability that the utility U_{ni} is greater than the utility of the other alternatives U_{nj} in A. Assuming that the error term is distributed independently and identically (IID) with extreme value type I, results in the multinomial logit (MNL) model (McFadden, 1974). A more flexible alternative is the Random Parameter Logit (RPL) model which represents a full relaxation of the IID assumption, accommodates correlations among panel observations and accounts for uncontrolled heterogeneity in tastes across respondents (Train, 2009). Preference heterogeneity is introduced in the individual specific random parameters for attributes (Greene & Hensher, 2007; Train, 2009). The parameter vector can now be expressed as the population mean β and the individual specific deviation η_n from a specified continuous distribution (Train, 2009). Hence the utility function can be rewritten as:

$$U_n = \beta X_n + \eta_n X_n + \varepsilon_n \quad (3)$$

The stochastic part of utility may now be correlated among alternatives and across the sequence of choices via the common influence of η_n (Hensher & Greene, 2003). The choice probability resulting from this specification does not have a closed form solution and requires estimation by simulated Maximum Likelihood (ML). The ML algorithm searches for a solution by simulating draws from distributions with given means and standard deviations. Probabilities can then be calculated by integrating the joint simulated distribution (the mixture distribution of the IID distribution of ε_n and the specified distribution for η_n). The preferred model specifications used here assume all randomly specified parameters are normally distributed allowing for both positive and negative preferences. WTP of fruit attribute j by consumer i is calculated as the ratio of the estimated model parameters accommodating the influence of the random component (Cicia, Cembalo, Del Giudice, & Scarpa, 2013) as:

$$WTP_i^j = -\left(\frac{\beta_j + \varepsilon_{ij}}{\beta_{price} + \varepsilon_{ip}} \right) \quad (4)$$

3. Survey Development

In order to explore possible attributes to be valued in the choice experiment, literature review was accompanied by focus groups with the general public, and interviews with key fruit industry stakeholders. Two focus groups consisting of 12 participants each were recruited by a professional marketing research company. Focus group participants were chosen based on their prominent role in household shopping and were selected from middle and upper income levels, semi-professionals, and as individuals who stated they were concerned about health and environmental issues. The latter views were collected from their response to screening questions. The first group were primarily single and a mixture of gender up to 30 years old. The second group were older, with or without children, but otherwise shared the same demographic characteristics. Each participant was remunerated $60 for their ninety minutes participation. The focus groups were an important method in trying to understand consumer views and attitudes towards environmental sustainability and how they relate to agricultural production, and particularly of carbon footprint labelling. Both focus group meetings followed a similar format including discussion of individual products and awareness and perceptions of environmental sustainability.

Overall, the awareness of sustainability issues was similar across both groups, and it was made clear by participants that sustainability is important, even though it may not be the primary driver of their purchase decisions.

To stimulate discussion of carbon labelling, participants were presented with three types of carbon labels to assess their preferences and user interpretation. The first label referred to the absolute level of carbon dioxide contained in a product, the second showed that an emissions standard had been met, while the third indicated that a percentage reduction of emissions had been achieved relative to a regular product. Although both groups understood the intent of the labels, there was no clear distinction in which label overcame all concerns expressed by the majority of participants. Participants were concerned about how a standard was set and how it would be measured, suggesting that significant effort would be required to gain enough information from secondary sources so as to gauge the strength of the standard. A weakness perceived in using a percentage reduction was the bass level of emissions was unknown, but participants agreed that if all products displayed such labels it would be useful for food product comparison. Participants were also concerned about how an absolute carbon measure was set, and were missing reference point and background information that made interpretation of an absolute value difficult. This finding is consistent with criticism of the absolute carbon measure approach as being cognitively difficult for respondents to ascertain meaning from as significant knowledge is required to be able to use information on absolute quantities, and that consumers are more likely to be able to comprehend relative changes (Upham et al., 2011). Taken as a whole, these considerations informed the decision to use a relative measure of carbon emissions change expressed as a percentage change from current levels.

Table 1. Choice experiment attribute descriptions and levels

Price	This attribute compares the price for the fruit in the survey to the price you currently pay for the fruit you normally buy. The fruit in the survey may cost more or may cost less than you currently pay.			
	- 10%	No change	+ 10%	+ 20%
Carbon emissions reduction	This attribute concerns the amount of carbon dioxide (CO_2) equivalents emitted during production and distribution of the fruit. For many of the options in the survey, emissions have been reduced. Most scientists believe that greenhouse gas emissions, often expressed as CO_2-equivalents, are causing global climate change or global warming.			
	- 30%	- 20%	- 10%	No change
Water efficiency	This attribute focuses on the use of water in production and distribution. Greater efficiency means that less water is used to grow the fruit and get it to the consumer.			
	+ 60%	+ 40%	+ 20%	No change
Vitamins	Fruit is a good source of vitamins. There are natural ways to grow and distribute fruit that is high in vitamins, such as selecting varieties that have higher levels of vitamins or reducing vitamin loss during storage. These changes are reflected in the higher vitamin content of some of the options in the survey.			
	+ 100%	+ 66%	+ 33%	No change
Waste/ packaging reduction	This attribute indicates that the product is produced and distributed in ways that reduce waste and packaging. Reducing waste and packaging means less use of natural resources.			
	- 60%	- 40%	- 20%	No change

Alongside carbon emissions, interviews with industry stakeholders revealed a strong indication that participants were predominantly concerned about ongoing issues around water scarcity and quality. To reflect this concern an attribute measuring the degree of water efficiency was developed and included in the model. The next sustainability attribute to be incorporated into the model was reductions in product waste/packaging. This is a theme that has significant policy traction in Japan, but less so in the UK, and a comparison of WTP could therefore aid in indicating the impact of differing policy environments on consumer preferences. Fruit is considered a healthy food option and increased consumption is often proffered on this basis, and so changes in vitamin levels were also included as an attribute important to consumers. The inclusion of vitamins also helps to

indicate the relative preferences for attributes with private benefits versus those with public good benefits such as carbon reduction. The above discussion determined the final attributes selected for the choice experiment in this study and are described in Table 1, which also shows the information presented to respondents in the survey. The chosen levels reflect possible achievable changes in the attributes that were identified with consultation from major primary industry stakeholders including food scientists.

The final questionnaire included twelve choice sets each made up of a paired comparison of two alternatives employing a D-efficient fractional factorial experimental design, and included the ability of respondents to opt-out of making a choice. Surveys of fruit consumers were implemented online in each country recruited from an online panel database maintained by the research company Research Now™ during October 2011. To improve reliability respondents had to have bought fruit in the previous month. The sampling process employed a pre-stratification approach to enhance representativeness of each countries age and household income population distributions.

4. Results and Discussion

Respondent demographics are given in Table 2. Statistical analysis was conducted employing econometric software Limdep v.9™. Alternative model specifications including an attribute non-attendance model yielded no qualitative improvement over parameter estimates presented (Table 3).

Table 2. Sample demographics

		United Kingdom (%)	Japan (%)
Male		45	50
Age	19-29	6	19
	30-49	21	30
	50-59	17	18
	60+	56	33
Location	Urban	23	48
	Suburban	46	44
	Rural	31	7
Education	High School	44	32
	Junior College	1	19
	Tertiary qualification	44	43
	Postgraduate qualification	7	4
Income (GB£)	< 15 000	19	12
	15 001 – 40 000	42	42
	40 001 – 60 000	17	22
	> 60 001	11	18

Consistent across countries, all attribute parameters are highly statistically significant and of the expected signs. Consumers are more likely to select a fruit option with higher levels of carbon emissions reduction, water use efficiency, vitamin content, or waste / packaging reductions; and are less likely to choose fruit options with a higher price. Significant taste heterogeneity is observed around the means of all random parameters in both the UK and Japan models, with reductions in carbon emissions subject to the greatest respondent taste variation in both countries.

Table 3. Random Parameter Model estimates

	United Kingdom	Japan
Random parameters in utility functions		
Carbon	5.89 (0.88)***	3.11 (0.49)***
Water	2.58 (0.38)***	1.45 (0.24)***
Waste	3.75 (0.57)***	0.68 (0.24)***
Vitamins	0.94 (0.28)***	0.59 (0.14)***
Price	-16.74 (1.68)***	-9.72 (0.85)***
Nonrandom parameters in utility functions		
ASC	-0.19 (0.11)*	0.18 (0.07)**
Distributions of standard deviations of random parameters		
Carbon	8.94 (2.76)***	3.44 (1.12)***
Water	3.34 (1.25)***	2.11 (0.56)***
Waste	4.82 (1.33)***	2.06 (0.41)*
Vitamins	3.95 (0.79)***	1.12 (0.22)***
Price	-16.74 (1.68)***	-9.72 (2.21)***
McFadden Pseudo-R^2	0.39	0.25
Number of observations	2 280	2 448

Notes. ***, **, * denotes statistical significance at 1%, 5%, and 10% level respectively. Standard Errors in brackets.

We simulate the unconditional distributions of WTP for fruit attributes and report the medians, lower and upper quartiles (Table 4.) As both the price and non-price attribute levels are defined as percentage changes the interpretation of WTP is the percentage change in the price of fruit for a percentage change in the level of an attribute (Snowball & Willis, 2006). Ranking the WTP estimates reveals an important finding that both countries value carbon emissions reductions the highest, at over twice the value of the next ranked attribute. While increased vitamin content is valued the least in both countries by a substantial margin, with the lower quartile of UK respondents indicating negative preferences for increases in vitamin content. Strikingly, the estimates are very similar across countries. The single statistically significant difference is in preferences for reductions in waste and packaging, valued by UK respondents at over twice that of Japanese (Poe, Giraud, & Loomis, 2005).

Table 4. Consumer Willingness to pay estimates

	United Kingdom	Japan
Carbon	22% (17%, 26%)	23% (18%, 26%)
Water	10% (8%, 12%)	11% (8%, 12%)
Waste	11% (7%, 15%)	5% (4%, 6%)
Vitamins	2% (-1%, 3%)	4% (3%, 5%)

Note. Median of unconditional simulated distribution (lower quartile, upper quartile).

Our results are consistent with Michaud et al. (2013) who found lowering the carbon footprint of roses was valued more than applying a composite standard that comprised of energy efficiency, waste management, fertiliser use and social requirements. Conversely, Onozaka et al. (2011) found that United States consumers valued reductions in the carbon footprint of tomatoes less than organic certification, and placed no value on carbon footprint reductions for apples. Similarly, Koistinen et al. (2013) found lowering carbon footprint in mincemeat production was not an attribute that consumers were willing to pay much for, and was the least valued of all attributes considered. This difference may in part be explained by the lack of a stand-alone carbon

labelling scheme in these studies locations. Whereas Japans' carbon labelling system has been in place since 2008 covering over 460 products and services, and the UK system was launched in 2008 covering around 4,000 products and services (Guenther et al., 2012). This disparity may result in differing levels of consumers' awareness of the connection between food products and carbon emissions, resulting in less developed preferences for this attribute. There is also the possibility that the divergent values observed may be specific to the differing food products considered.

Comparing WTP estimated here within a Japanese context, the experiment economics approach used by Aoki and Akai (2013) estimated that high environmentally conscious Japanese consumers are willing to pay ¥0.851 more per Satsuma mandarin per one gram reduction in carbon. The authors employ a range of observed market prices in their laboratory experiment and likewise a range of observed carbon levels. Using the averages of these series, ¥35 cost for a mandarin and 30 grams of carbon per mandarin, facilitates a comparison with values estimated in the present paper. Therefore, for a 10% reduction in carbon emissions, high environmentally conscious Japanese consumers are willing to pay about 7% more for a mandarin. This is significantly lower than the 23% value estimated here, even when considering the lower end of the WTP distribution. There are several possible reasons for this including the hypothetical nature of the choice experiment. Another possibility relates to the sample composition obtained by Aoki and Akai. Their sample recruitment approach resulted in over 40% students from the authors' university, and the remaining located adjacent to the university. It may be reasonable to expect the sample on average to be younger and have lower incomes relative to the general population and therefore a lower relative ability to pay, leading to a lower WTP estimate. The ability to pay is in part ameliorated by the design of the experiment that initially endows participants with money with which to purchase the mandarins. However the tighter relative budget constraint facing the typical student could reasonably be expected to incentivise the amount spent to be minimised, as any monies remaining are retained by participants. This would lead to lower WTP estimates.

The assertion that preferences over food attributes are likely to be differentiated by culturally diverse consumer groups across international borders (McCluskey & Loureiro, 2003) has been supported within the limited number of direct cross-country comparisons of preference valuation available. A study on consumer preferences for environmentally-friendly seafood in the US and Norway found differences in consumer preferences across countries (Johnson, Wessells, Donath, & Asche, 2001). Lusk, Roosen and Fox (2003) found differences across France, Germany, the UK, and the United States for preferences over beef fed GM corn. Some studies have found totally opposing preferences, for example Chinese consumers were found to be willing to pay a premium for GM soybean and rice, while Japanese consumers required a price discount (Li, Curtis, McCluskey, & Wah, 2003). Another GM valuation study (Tonsor, Schroeder, Fox, & Biere, 2005) found that French and German consumers have a higher WTP to avoid genetically modified feed than British consumers. While German and British consumers would pay more for growth hormone-free beef and French and German consumers are willing to pay for farm-specific source verification. Other studies finding disparities include preferences for food safety in beef steaks across Canada, Japan, Mexico and the US (Tonsor et al., 2009); meat traceability in the US, Canada, the UK and Japan (Dickinson & Bailey, 2005); Fair Trade coffee in Germany and the US (Basu & Hicks, 2008); Farm animal welfare in France, Germany, Spain, Italy and the UK (Nocella, Hubbard, & Scarpa, 2010).

When looking at which differences in consumer WTP exist between Japan and the UK, this study finds that WTP for reductions in waste and packaging is the only statistically significant difference. This suggests that preferences for environmentally sustainable production outcomes focused on carbon reduction and water use efficiency are relatively consistent across UK and Japanese consumers, at least for fruit. This implies that primary sector environmental policies applied domestically may be more readily aligned internationally than previous cross-country comparisons would indicate. UK consumers value reductions in production waste and packaging over two times greater than their Japanese counterparts. This finding may be a reflection of the already relatively high level of recycling activity in Japan compared to the UK. Only 16 per cent of total municipal waste is landfilled in Japan compared to 49% in the UK (European Environmental Agency [EEA], 2013). This cultural difference may lead Japanese consumers to not consider recycling a distinct product attribute as it is already strongly embedded within product design and part of expected behaviour in line with established social norms.

5. Conclusions

This study was motivated by a need to improve understanding of the relative importance of multiple environmental sustainability attributes of primary sector fruit production. An important finding is that improved carbon emissions reduction is valued most of all attributes, across both countries and by over twice as much as the next valued environmental attribute. The implication for the primary sectors of both countries is that

consumers foremost prefer environmental policy focused at climate targets, and are WTP for products that deliver this benefit. The finding of consistent preferences across cultural and country borders has implications for international supply chains. This result suggests that development of carbon labelling schemes within a domestic context may be more readily transferable to international supply chains than typically assumed. The ability to maintain uniformity in labelling scheme designs for products consumed domestically, as well as being exported, could be achieved without significant loss of generality of the effect on consumer behaviour. This is a useful finding considering that international coordination is required for effective climate mitigation policy. Facilitating this coordination is made simpler if consumers react to labels in a similar manner.

Future research extending the range of products and countries analysed is needed to establish whether the findings of relatively consistent preferences for environmentally sustainable production across countries may be more widespread than suggested here. In addition, the development of comparable revealed preference studies to form external validity remains as ground for future research.

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