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Consumers' preferences and willingness to pay for improved environmental standards: insights from cane sugar in the Great Barrier Reef region*

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Reducing nutrient runoff from sugarcane production into the Great Barrier Reef (GBR) has become a major policy focus for the Queensland and Australian Governments. This study explores consumer willingness to pay (WTP) to achieve higher environmental standards for sugar originating from the GBR catchments, through the use of a GBR-safe ecolabel. A Best-Worst Scaling (BWS) and a Contingent Valuation (CV) experiment are conducted on a random sample of 1,100 Australian residents. The BWS experiment reveals that personal health considerations are more important than sustainability and environmental factors, including impacts on the GBR. Results of the CV experiment show that respondents are more likely to pay a premium to support Reef-friendly sugar if they are living in urban areas, plan to visit the GBR in the future, think that the GBR condition has declined, and are generally concerned about keeping a healthy diet. We estimate that the average WTP is $24.5/year/household, which only represents 0.34 per cent of the average weekly grocery bill of Australian households. This small contribution through increased sugar prices could conservatively raise $46.9M/year in support of sugar producers to improve water quality in the GBR. Based on these results, we recommend policy-makers consider instruments that further involve sugar consumers.

Key words: commodity food, ecolabel, environmental standard, green consumerism, product differentiation, sugar, sustainability, water quality.

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1. Introduction

Issues of poor water quality have been identified as key pressures on the Great Barrier Reef (hereafter GBR), along with climate change and increased cyclonic pressure (MacNeil *et al.* 2019; Commonwealth of Australia 2021). Nitrogen, phosphorus and fine sediment run-off from agricultural lands in areas adjacent to the GBR has become a major policy focus for the Queensland and Australian Governments, particularly in the sugarcane and grazing industries that account for over 70 per cent of the land use in GBR catchments (GBRMPA 2019). A large range of policy instruments have been applied to encourage adoption of more sustainable farming and land management practices so as to reduce pollutant loads, including suasion, extension, direct incentives and regulation, underpinned by substantial funding support from the Australian and Queensland Governments (Waterhouse *et al.* 2017; Queensland Government 2021). Despite these various initiatives, progress to achieving water quality improvements has been slow, as shown in recent report cards (State of Queensland 2016, 2019).

Another potential mechanism to drive adoption of more sustainable farming and land management practices is to have higher production standards incorporated into food labelling and supply chains (also know 'ecolabelling') so that consumers have more power to choose foods that are produced at higher standards, even though prices are higher (Loureiro and Lotade 2005). Price premiums can pass through supply chains to provide positive incentives for farmers, linking farmers more closely with consumer demands and providing the financial incentive for uptake of higher standard practices (Stavins 2003). Ecolabelling alone may, however, be insufficient to correct for the negative externalities associated with sugar production if consumers continue to purchase the standard product despite the label (Golan *et al.* 2001). This is because of the misalignment between private consumption choices and socially optimal choices; that is, even the best, most intuitive ecolabel does not warrant consumers will not choose to buy other products for various personal – and possibly irrational – reasons. Nevertheless, when used in combination with appropriate systems of certification, accreditation and audited labelling, ecolabels can create an effective solution to promote eco-friendly farming practices through an improved chain of trust and credibility between producers and consumers (Grolleau and Caswell 2006).

While ecolabelling is an adequate mechanism to transfer information and capture price premiums for some particular products, such as fair trade coffee, it might be less suitable for commodity foods such as sugar. One reason is that commodity foods are often modified or combined with other ingredients to create higher-value goods, making it virtually impossible for consumers to verify the sustainability claims of the ecolabel; a problem known as information asymmetry between producers and consumers (Caswell and Padberg 1992; Loureiro and McCluskey 2000). However, consumers may be willing to pay for broad improvements in environmental

standards that reduce impacts at an industry level (rather than item by item or farm by farm). Rather than creating a niche market for eco-friendly products that would only appeal to a limited number of consumers, multi-stakeholder initiatives that raise the baseline for an entire commodity food supply chain are more desirable and could be more profitable long-term strategies (Smith 2008).

For sugar, the Bonsucro program (a production standard for sustainable sugar production) is one example of a voluntary international certification system to promote more sustainable farming practices that link to customer requirements. Bonsucro (www.bonsucro.com) is a global non-governmental organisation devoted to promoting sustainable sugarcane production worldwide, with membership from a diversity of stakeholders, including food and beverage companies (e.g. Coca-Cola, Unilever), commodity traders (e.g. Cargill), non-governmental organisations (e.g. WWF), producer associations (e.g. UNICA) and oil companies (e.g. Shell, BP). While Bonsucro certification gives Australian sugarcane producers the assurance of a quality standard that is recognised by a large number of customers worldwide, take-up of the Bonsucro standard by growers has been very limited. On average, only 12.7 per cent of sugarcane land was managed using best practice systems in 2019 (State of Queensland 2019), and a much smaller fraction of these were Bonsucro-accredited.

So, on the production side, some efforts are being made for cane sugar grown in the GBR to be produced at minimal impact on the environment. However, progress towards agricultural land management practice adoption targets and water quality improvement targets set by the Australian and Queensland Governments is slow (State of Queensland 2019). Currently, the demands for higher environmental standards in agricultural systems in GBR catchments are driven by voters through governments, and are transmitted through government funding programs, policy mechanisms and regulatory standards (State of Queensland 2016). An alternative pathway would be initiating a process for Australian consumers to demand food produced at higher environmental standards, with corresponding price premiums transmitted to growers in return.

This study analyses consumer demands and support for setting higher environmental standards for sugarcane production, a question left largely unanswered in the literature (Ruggeri and Corsi 2019). To do this, a random sample of Australian consumers were surveyed so that the proportion willing to pay higher prices and the premiums to improve water quality into the GBR could be estimated with reference to the following research questions:

- RQ1: What aspects of sugar production and consumption are consumers most sensitive about? This question is being investigated through a best–worst scaling experiment.

- RQ2: Are consumers willing to pay a universal price premium on sugar for changes in environmental standards? This question is being answered via a contingent valuation experiment.

The remainder of this paper is organised as follows. Section 2 presents a literature review about the use of environmental standards and ecolabels in food production, their general perception by the public, and the challenges they may represent to address environmental issues related to the production of commodity foods. Section 3 introduces the two techniques applied in this study: best–worst scaling and contingent valuation. Next, Section 4 presents all the results of our analysis. A discussion of these results follows in Section 5, together with a summary of the main findings and policy recommendations.

2. Background

Sustainability has become a central societal concern that businesses can no longer afford to neglect. To remain competitive, businesses need to adopt practices that are more respectful of the environment because regulatory pressures and changing expectations by consumers are starting to affect access to markets and capital (Rein 2011). In this context, environmental standards have become important tools, for they allow businesses to obtain compliance certifications that inform consumers that they have made the necessary adjustments and innovations to their production processes to reduce their impact on the environment. Those businesses can then inform consumers that they respect certain environmental standards by applying the corresponding ecolabel onto their product.

Ecolabel Index, a global directory of ecolabels, is listing 455 ecolabels currently in use in 199 countries and across 25 industry sectors (Big Room Inc. 2021). Of these, 57 ecolabels are used in Australia through a diverse spectrum of products (e.g. fish, coffee, cotton), product characteristics (e.g. organic, compostable) and industries (e.g. electronics, transportation). Bonsucro is the standard ecolabel specific to the sugarcane industry. Established in 2005 as a multi-stakeholder organisation aiming to create a global performance standard for the sugarcane industry, Bonsucro launched its own certification scheme in 2011 and further evolved to become the global change platform for sugarcane.

Considering the large and increasing number of sustainability standards and ecolabels available in the market, one may question their level of comprehension and support from the public, and whether they correctly address a genuine consumer need. Prior studies conducted worldwide have shown that consumers are supportive of improved social and environmental responsibility standards for various products (Olesen *et al.* 2010; Li *et al.* 2017; Steiner *et al.* 2017). Miller *et al.* (2017) found that fruit and vegetable consumers in the UK, Japan, India and Indonesia were willing to

pay a 16 to 30 per cent (median) increase to go from minimum to improved standards, and a 6 to 26 per cent (median) increase from improved to high standards. Tait *et al.* (2015) compared British and Japanese fruit consumers and observed that sustainability attributes – reduced carbon emissions, especially – significantly influenced fruit purchase decisions. Moser *et al.* (2011) investigated which credence attributes (i.e. attributes that surround how the product was produced rather than its physical properties) were most important to fruit and vegetable consumers across multiple countries. For Australian consumers, they found that the most strongly determinant attributes were (in decreasing order of importance): personal health, visual aspect and smell, environmental impact, absence of pesticides, locally produced, supporting farmers and quality.

Ecolabels *per se* also seem to hold the power to influence consumers. For instance, Sörqvist *et al.* (2013) found that people preferred the taste of, and were willing to pay more for, eco-friendly labelled coffee, in spite of any sensory difference from regular coffee. Eriksson (2004) advocated that educational campaigns targeting the less eco-conscious consumers would homogenise preferences for greener products and increase their adoption by the masses, especially if in combination with production subsidies to involve both producers and consumers. Likewise, Rex and Baumann (2007) recommended green marketing going beyond the simple use of ecolabels, and using new strategies to attract other types of consumers.

Consumers' preferences for sustainability labels are, however, subject to a number of factors that still impair their effectiveness as an incentivisation tool. First, stamping ecolabels onto products does not guarantee that consumers will necessarily pay attention to them at the time of purchase (Caswell 1998; Ruggeri *et al.* 2021). Second, the sustainability concept itself and the message conveyed by the ecolabel might not be correctly understood (Grunert *et al.* 2014). Third, there might be a gap between consumers' general awareness of sustainability issues, and actual purchase behaviour, which may be primarily motivated by socio-economic constraints such as financial budget (Grunert 2011) and fear of social judgement (Kimura *et al.* 2012). Fourth, intrinsic differences in individuals' demographic, attitudinal and behavioural characteristics make it difficult to appeal to all consumers at once; hence, there may be segmentation of the market (D'Souza *et al.* 2006; Vanhonacker *et al.* 2013). For instance, Brécard *et al.* (2009) observed that well-informed and well-educated consumers were more likely to consume 'green' products in priority.

Another critique of ecolabels found in the literature is that it may not be the most effective instrument to correct for environmental externalities or other forms of spillovers related to food production and consumption (Golan *et al.* 2001). Mandatory food labels are well suited to alleviating issues having to do with information asymmetry between sellers and buyers (Loureiro and McCluskey 2000; van Amstel *et al.* 2008), but voluntary ecolabels are often not efficient to address credence attributes because of their ambiguity about

which environmental issues they address. McCluskey (2000) recommends going through third-party certification bodies for such attributes.

Voluntary ecolabels are thus at the centre of a debate about whether they are sufficiently effective at influencing consumption behaviours on their own or whether they might need to be combined with other policy instruments. The environmental issue at stake, consumer attitudes and awareness of the issue, the type of good, the level of commitment by government and the socio-economic context seem to combine to make it a case-by-case matter. Sugar is a complex good as it is a commodity food that is rarely purchased raw by consumers (except for specific usages such as baking) but is more generally embedded in other products where it represents a small proportion of the overall product and costs. This makes it difficult and impractical to apply voluntary ecolabels for the sugar content.

An alternative to consider is more universal environmental standards and labels that are more akin to food safety standards in that they represent an underlying demand from the consumer and help to build consumer trust in the product. This is the model that is being tested in this research, where the goal is to test whether there is a market for higher environmental standards for sugar produced in GBR catchments. If consumer demands for higher standards can be estimated and valued, their transmission to sugar producers can help drive the adoption of improved land management practices and deliver subsequent water quality improvements to the GBR. Another, broader research goal is to fill an important knowledge gap in the literature: Can environmental standards for commodity foods be effective tools to involve consumers in tackling environmental issues?

3. Methods

In this study, the best–worst scaling (BWS) and contingent valuation method (CVM) experiments were integrated into an online survey that also contained questions about people's sugar consumption habits, perception of food labels, familiarity with the GBR and socio-economic profiling questions. The full questionnaire is available in Appendix S1. Data from a total of 1100 Australian households were collected in November–December 2020. A representative sample of participants over 18 and from across Australia were recruited via an Internet panel from a third-party provider,[1] and the survey was conducted under human ethics approval (Ref.: 0000022617).

The two different methods used to assess people's preferences for environmental standards for sugar produced in GBR catchments – BWS and CVM – are described in this section.

[1] FortySix Research Pty. Ltd.

3.1 Best–worst scaling – profile case

The first goal was to evaluate how important consumers considered environmental factors relative to other issues for sugar production and consumption. The BWS Case 2 method is adequate for this purpose, as it is a stated preference method based on random utility theory (Flynn *et al.* 2007; Louviere *et al.* 2015), and it is extensively used in ranking attributes of composite goods. It operates by identifying a number of statements relevant to the issue or commodity of interest, asking respondents in a survey format to identify from groups of statements that they most and least support, and then evaluating from a pool of responses the varying levels of support for each statement.

3.1.1 Experimental design

Respondents were presented four times with four different statements about sugar production and consumption in Australia. These statements were based on a review of literature around agriculture and the GBR and from conversations with stakeholders, including from the Queensland Government, Department of Environment and Science. Each time respondents were asked: '*select which statement you agree the MOST with and which statement you agree the LEAST with'* (see Figure 1). By drawing the statements from a set group, and asking each respondent to consider repeated groups, enough data could be generated for statistical analysis. Respondents received the four sets of attributes in combinations that were set by an experimental design.

The statements presented in each BWS card were drawn from four different groups: (1) Health, (2) Sustainability and Environment, (3) Quality and Price, and (4) Information and Trust. There were four statements within each group (levels), so 16 statements in total (Table 1). These statements were shown to respondents in four cards (four groups of four), with one statement drawn from each group in each exercise (Figure 1). An orthogonal experimental

Agree LEAST	Statement	Agree MOST
○	I have health concerns about too much sugar in soft drinks.	○
○	I prefer to buy sugar that has been produced in sustainable systems.	○
○	I try to only consume soft drinks that have lower sugar content.	○
○	I prefer to buy processed foods with detailed labelling about sugar content.	○

Figure 1 Example of BWS card presented to each respondent. [Colour figure can be viewed at wileyonlinelibrary.com]

Table 1 Statements used in the BWS experiment

Attribute	Level	Statement	Label
Health	Soft drinks	I have health concerns about too much sugar in soft drinks.	SoftDrink
	Processed foods	I have health concerns about too much sugar in processed foods.	ProcFood
	General	Sugar is an essential part of a healthy diet.	General
	Children	Many children eat too much sugar.	Children
Sustainability and Environment	Land and water sustainability	I am concerned about the environmental impact on land and water of the sugar that I consume.	LandWater
	Natural production	I prefer to buy sugar that has been produced in sustainable systems.	NaturalProd
	GHG emissions	I am concerned about the carbon footprint (CO2 emissions) of the sugar that I consume.	GHG
	Great Barrier Reef	I am concerned about the impact of sugar production on the health of the Great Barrier Reef.	GBR
Quality and Price	Quality – processed foods	Processed foods that have lower sugar content are of better quality.	Quality
	Taste	Processed foods and soft drinks that have higher sugar content taste better.	Taste
	Price – soft drinks	Price is very important in my decision to buy soft drinks.	PriceSD
	Price – processed foods	Price is very important in my decision to buy processed foods.	PricePF
Information and Trust	Sugar content labelling	I prefer to buy processed foods with detailed labelling about sugar content.	ContentLa
	Location and traceability	Information that shows where food was produced and is traceable is important.	Location
	Health labelling	I prefer to buy foods where it is clearly labelled how healthy they are.	HealthL
	Organic	Organic certification is very important when I buy raw sugar.	Organic

design generated using the Ngene software package was used to assign the statements to a set of 24 profiles, which were grouped into six blocks of four sets each. The experimental design ensured that one statement from each category was drawn for every profile to provide some level of balance. Each statement was included six times in the design, but not always in each block. So, each best–worst score had to be corrected by the number of times the statement was presented (Eqn 2). On average, there were 12.33 separate statements in each block of 16 statements. All participants completed the BWS exercise and were randomly assigned to one of the six blocks (the number of respondents completing blocks 1 to 6 was 182, 203, 182, 175, 183 and 175, respectively).

3.1.2 Best–worst count report approach

The simplest form of analysis of BWS data involves a count report (Merlino *et al.* 2018). The number of times level i is selected as best (B_i) and the number of times level i is selected as worst (W_i) are calculated. Then, the combined best and worst (BW) score for individual n can be calculated:

$$BW_{in} = B_{in} - W_{in}, \tag{1}$$

which can be standardised as follows:

$$std.BW_{in} = \frac{BW_{in}}{f_i}, \tag{2}$$

where f_i is the total number of times the i^{th} statement appeared in the experiment.

3.1.3 Modelling approach

A BWS profile case (Case 2) can be estimated in two different ways: paired model or marginal model (Flynn *et al.* 2007). The model assumes that the utility for the level selected as worst (j) is negative, best (i) is positive and zero otherwise ($j \neq i$). Respondents select level i and j from $L * (K-1)$ possible pairs to derive the utility. K is the number of attributes of L level. For choice set C, the paired model can be expressed as follows (Aizaki and Sato 2020):

$$Pr(Best = i, Worst = j) = exp(v_i - v_j) / \sum_{p,q \in C, p \neq q} exp(v_p - v_q), \tag{3}$$

where v_i is the systematic component of the utility selection i. Then, the systematic component can be estimated as follows:

$$\begin{aligned} v_i = {} & \beta_1 A_1 + \beta_2 A_2 + \beta_3 A_3 + \beta_4 A_4 + \beta_5 B_1 + \beta_6 B_2 + \beta_7 B_3 + \beta_8 B_4 + \beta_9 C_1 \\ & + \beta_{10} C_2 + \beta_{11} C_3 + \beta_{12} C_4 + \beta_{13} D_1 + \beta_{14} D_2 + \beta_{15} D_3 + \beta_{16} D_4 \end{aligned} \tag{4}$$

where A, B, C and D represent the groups, and letter subscripts indicate the statements in each group (in the analysis, one statement needs to be omitted to act as a base; see Section 4.1.2). βs are coefficients to be estimated. Attribute levels are effects-coded, meaning that if an attribute level is selected as 'best' in a possible pair, it takes a value of 1; if an attribute level is selected as 'worst' in a possible pair, it takes a value of −1. Unselected attribute levels take a value of 0. All possible pairs of levels are extracted from each choice set for the analysis. The model was estimated in open software R (R Core Team 2021) using the 'support.BWS2' (Aizaki and Fogarty 2019; Aizaki 2021) and 'survival' (Therneau *et al.* 2022) packages.

3.2 Contingent valuation

3.2.1 Theoretical background

The CVM is a stated preference technique that is widely used in environmental economics and other fields to estimate the economic value of environmental goods or services that are not traded in regular markets (Mitchell and Carson 1989; Pearce and Turner 1990; Hanley and Barbier 2009). The technique can assess use values and non-use values (Plottu and Plottu 2007). Use values imply either a direct consumption of goods or services, which can be extractive (e.g. fishing) or non-extractive (e.g. wildlife tourism), indirect consumption (e.g. pollination) or an option value, that is a possibly delayed/unidentified consumption (e.g. nature conservation). Non-use values refer to more intangible values, such as the value environmental assets hold just by existing (existence value), the value they hold for meeting future generations' needs (bequest value) and the value one can place on them for meeting other people's needs (altruistic value) (OECD 2006). Non-use values are important when the good in question has few substitutes, which is the case for many biological resources (Pearce and Turner 1990).

In a CVM experiment, a hypothetical market situation is presented to respondents in a survey. The environmental good is described, as well as its policy context and the way it would be financed. Then, respondents are asked to express their willingness to pay (WTP) for the hypothetical policy to be applied to the good. A range of elicitation methods exist to express WTP in a CVM setting, including open-ended questions, dichotomous choices, double-bounded dichotomous choices, bidding games and payment cards (Perman *et al.* 2011). However, the hypothetical element of the process means that responses from individuals may be biased in several ways, leading to concerns about validity and reliability (McFadden and Train 2017). A number of research protocols have been developed to guide application of the method so as to minimise these issues (Johnston *et al.* 2017).

3.2.2 CVM experiment

In this study, the CVM was selected to estimate WTP for higher environmental standards because no suitable market data were available where values could be inferred from market data. The CVM experiment was applied with a payment card, a state-of-the-art format both simple to design and not prone to anchoring effects with initial bid amounts (Johnston *et al.* 2017). Respondents were shown a card with different hypothetical amounts and were then asked to select the maximum amount they would be ready to pay for the proposed policy scenario. Prior to filling the payment card, respondents were given some information about the situation of sugarcane production standards in Australia, the environmental benefits of improved management practices, and the possible impacts on the price of foods that contain sugar produced in GBR catchments (see Appendix S1).

The experiment was framed as a ten-year program that would help increase the rate at which sugarcane growers could meet best management practices to achieve the water quality targets set in the Reef 2050 Long-Term Sustainability Plan (Commonwealth of Australia 2021). To help sugarcane growers meet the extra costs that more stringent management practices would require, an extra charge on sugar used in Australian foods could be levied over the next ten years (2021–30). This payment mechanism of higher consumer prices would be applied to all sugar used for consumption, including the following:

- Sugar consumed directly,
- Sugar in cooking and processed foods,
- Sugar in drinks and alcoholic beverages, and
- Sugar in takeaway foods and restaurant meals.

The impact on consumers would be that prices for sugar, foods and drinks would rise slightly, leading to higher grocery bills over a year. Respondents were then shown a CVM card containing 24 possible hypothetical values ranging from $0 (no change) up to $20 a week (Figure 2). Respondents were asked to pick the maximum premium that their household would be ready to pay so that the sugar in their food would be produced with best management practices to meet the nutrient reduction targets required in the Reef 2050 Plan (State of Queensland 2021). Premiums were expressed in both weekly and yearly terms to ease their interpretation.

Additional questions were also included that controlled for the presence of protest bidders and identified respondents having alternative preferences about sugar-related labelling and environmental standards (see Section 4.2). Protest bidders are respondents who object to pay for ethical or ideological reasons rather than financial reasons (Halstead *et al.* 1992; Strazzera *et al.* 2003). They are to be differentiated from genuine zero bidders who pick the '$0' option due to budget constraints.

3.2.3 Descriptive statistics

The survey contained a number of questions to gauge respondents' level of familiarity with the GBR (see questionnaire in Appendix S1). The survey questions were tested as variables in the econometric model, and only the significant ones were kept:

- *Do you live in an urban area?* Most respondents (72.1 per cent) were living in inner cities, in urban areas or near urban areas. A dummy variable was created taking the value 1 in that case, and zero if respondents resided in regional cities, regional towns, rural areas or other places.
- *How likely are you to visit the GBR in future?* Responses to this question were fairly split, but 55 per cent stated that they would likely visit the GBR in future. A new dummy variable was created taking the value 1 in

Increase in annual food costs	The highest amount you would pay (Tick one)
$0 (no increase)	
$5 ($0.10 per week)	
$10 ($0.20 per week)	
$25 ($0.50 per week)	
$50 ($1.00 per week)	
$75 ($1.50 per week)	
$100 ($2.00 per week)	
$125 ($2.50 per week)	
$150 ($3.00 per week)	
$175 ($3.50 per week)	
$200 ($4.00 per week)	
$225 ($4.50 per week)	
$250 ($5.00 per week)	
$275 ($5.50 per week)	
$300 ($6.00 per week)	
$350 ($7.00 per week)	
$400 ($8.00 per week)	
$450 ($9.00 per week)	
$500 ($10.00 per week)	
$600 ($12.00 per week)	
$700 ($14.00 per week)	
$800 ($16.00 per week)	
$900 ($18.00 per week)	
$1,000 ($20.00 per week)	

Figure 2 Contingent valuation bidding card. [Colour figure can be viewed at wileyonlinelibrary.com]

that case, and zero if respondents were unlikely to visit the GBR. That new variable was included in the model.

- *How has the GBR changed over the past 10 years?* Most respondents (52.3 per cent) replied that the state of the GBR had deteriorated over the past 10 years, 17.4 per cent thought it had stayed the same, 14.4 per cent stated that it had improved, and 16 per cent did not know. Here again, a new dummy variable was created for the model, giving a value of 1 to respondents who thought the GBR had declined and a zero to everyone else.
- *How important is it for you to keep a healthy diet?* Respondents were presented a 5-level Likert scale ranging from 'very important' to 'not at

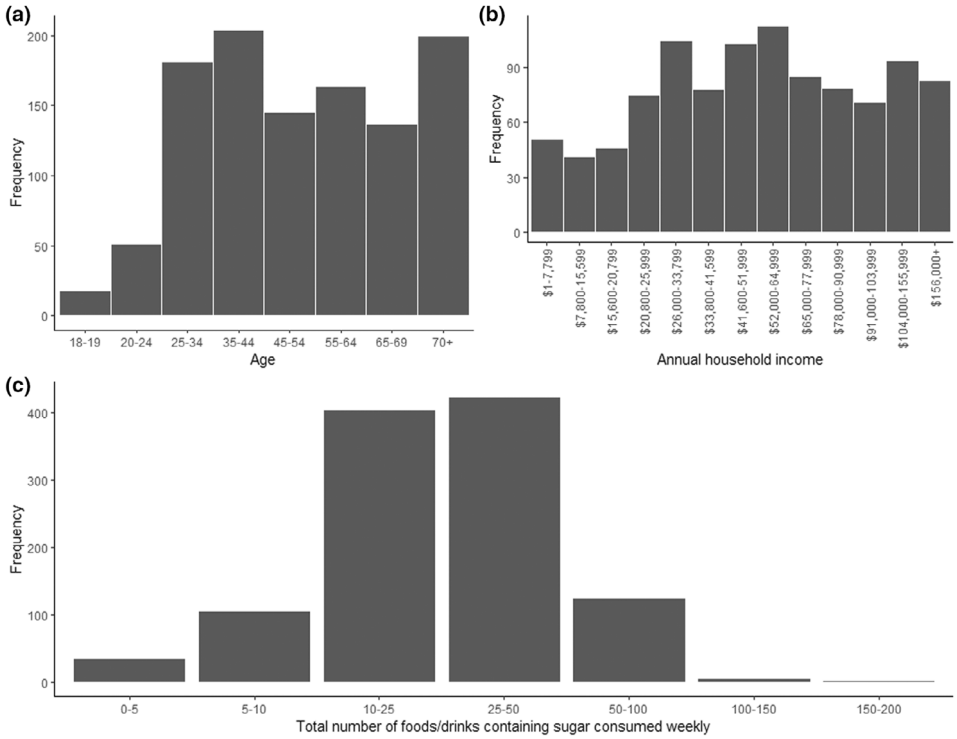

Figure 3 Socio-demographic characteristics of the survey respondents: (a) Age categories, (b) annual household income and (c). total number of foods/drinks containing sugar consumed each week.

all important'. For the model, an index variable was constructed based on responses to that question by allocating values from zero for 'not at all important' (2.1 per cent) to one for 'very important' (31.3 per cent) with the other levels in between coded at 0.25 ('not important') (13.3 per cent), 0.50 ('somewhat important') (17.4 per cent) and 0.75 ('important') (36 per cent).

A number of socio-economic and behavioural characteristics of the respondents were also collected during the survey. Among the ones that were tested, three of them were kept in our econometric model because they showed significance: age, income and level of sugar consumption (Figure 3). The age variable (Figure 3a) does not exactly follow a normal distribution due to an over-representation of respondents in the 70+ category, and the absence of respondents under 18. However, the 70+ category is open-ended unlike the other ones, suggesting that this over-representation is most likely an artefact of the wider age category. It should be noted that categories are not of the exact same size, which can therefore give the impression of a misrepresentation of certain categories. The most frequent age group was the 35–44 one, with 18.5 per cent, followed by the 70+ age group (18.2 per cent) and the 25–34 age group (16.5 per cent). Respondents were 50 years old on average (SD: 16.3).

Table 2 BW scores of all statements

Attributes	Levels	Best	Worst	BW	BW score
Health	Children	604	174	430	0.388
	ProcFood	532	172	360	0.330
	SoftDrink	498	194	304	0.271
	General	220	477	−257	−0.238
Information and Trust	HealthL	300	163	137	0.125
	Location	279	161	118	0.107
	ContentLa	220	193	27	0.025
	Organic	119	356	−237	−0.215
Sustainability and Environment	NaturalProd	227	183	44	0.041
	LandWater	229	225	4	0.004
	GBR	228	229	−1	−0.001
	GHG	175	347	−172	−0.153
Quality and Price	PricePF	242	339	−97	−0.086
	Quality	172	365	−193	−0.174
	Taste	169	403	−234	−0.214
	PriceSD	186	419	−233	−0.218

Note: Total number of respondents = 1100.

In terms of gross annual household income, respondents earned on average $64,087/year and the median income was of $58,500/year (Figure 3b). The largest category was the $52,000-64,999/year (10.3 per cent), followed by the $26,000-33,799/year (9.5 per cent) and the $41,600-51,999/year (9.4 per cent). Seventy-six respondents (6.9 per cent) preferred not to answer that question, so were recoded using the mean income of the sample (mean imputation) to maintain them in the analysis and prevent further sample attrition (Kalton 1982).

One survey question asked about the amount of sugar-rich food and beverages that respondents consumed on a weekly basis. These included 11 broad categories: soft drinks, cordials, juices/smoothies, sweets/chocolate, ice cream, hot drinks with sugar, jams/spreads, fresh fruits, biscuits, cakes/pastries and alcohol. Frequencies were 'never' (i.e. '0'), 'occasionally' (i.e. '0.5') and then each number from 1 to 14 (note: '>14' was the last category but was approximated to 14). The variable included in the model was created by summing up all self-reported frequencies for the 11 categories of foods/drinks for each respondent (Figure 3c).

4. Results

4.1 Best–worst scaling results

4.1.1 Best–worst count report

The purpose of the BWS experiment was to explore the broad context of issues relevant for sugar consumers so that the relative importance of water quality improvements in production systems could be assessed. In the first

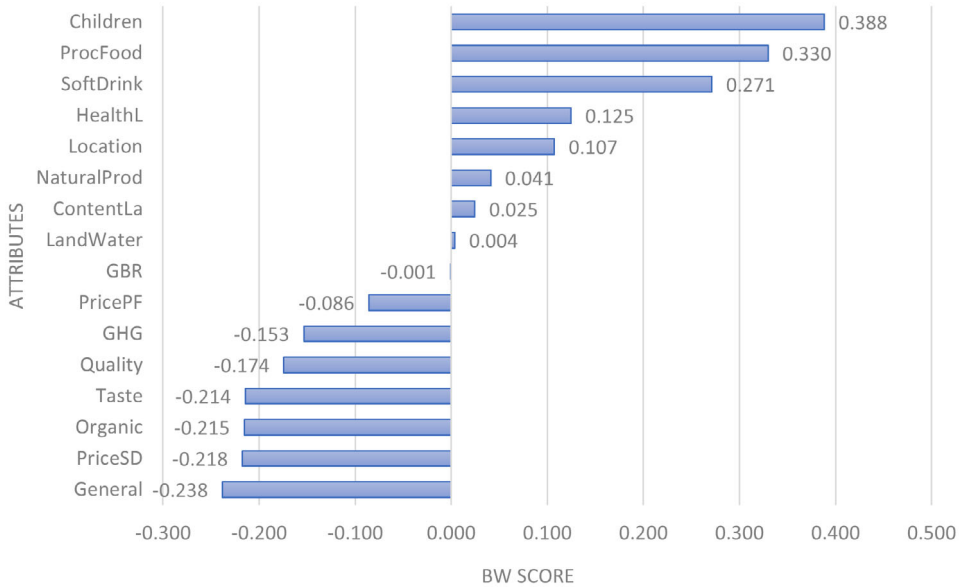

Figure 4 BW scores by attributes. [Colour figure can be viewed at wileyonlinelibrary.com]

stage of analysis, the BW scores were computed by considering the number of times each attribute/statement level was selected as most and least important, a process that can be referred to as BW count report (Merlino *et al.* 2018). BW scores consist of positive and negative values, in which the attributes can be arranged in descending order (Table 2). The negative value does not necessarily indicate that the attribute is not important but rather that it is relatively less important than other attributes based on respondents' evaluation. It is notable that all statements were selected at least 119 times as 'best' statement, indicating that all of them were viewed as important. BW scores were calculated to rank the importance of each statement, as illustrated in Figure 4.

Among the four main attribute categories, 'Health' appears to be the most important in sugar buying decisions, followed by 'Information and Trust'. One possible explanation is that sugar consumption and health problems are frequently associated topics and consequently top-of-mind concerns for most consumers. Generating on average the lowest BW scores, 'Quality and Price' has been identified as the least important attribute category. One possible explanation is that Australian consumers already trust the quality of sugar produced within the country and that price does not represent a big share of consumers' budget. 'Sustainability and Environment' is the third most important family of attributes in sugar buying decision. These findings corroborate those of Moser *et al.* (2011) through the high importance of personal health and the relatively lower importance of quality-related attributes.

Table 3 Conditional logit model estimation results (paired model)

	Coefficient	Standard error	Z-value
Children	0.879***	0.0614	14.31
ProcFood	0.6652***	0.0662	10.05
SoftDrink	0.6027***	0.0612	9.85
HealthL	0.3908***	0.0601	6.50
Location	0.3041***	0.0642	4.74
ContentLa	0.1469**	0.0616	2.38
NaturalProd	0.142**	0.0652	2.18
LandWater	0.1263**	0.0602	2.10
GBR	0.1225**	0.0601	2.04
GHG	−0.0145	0.0608	−0.24
Quality	−0.1003	0.063	−1.59
PriceSD	−0.1708**	0.0652	−2.62
Organic	−0.2301***	0.0607	−3.79
Taste	−0.2822***	0.0648	−4.35
General	−0.3999***	0.0605	−6.61
No. of observations	52,800		
No. of respondents	1100		
Likelihood ratio	1151 ($P < 0.000$)		

Note: *** and ** indicate significance levels at 1% and 5%, respectively.

Among the different statements of the 'Health' category, respondents' concerns were strongest about many children eating too much sugar and too much sugar content in processed food and soft drinks (*Children*, BW score = 0.388; *ProcFood*, BW score = 0.330; *SoftDrink*, BW score = 0.271), consistent with the results of scientific research conducted in Australia (Louie *et al.* 2016). These results confirm respondents' health-related concerns. Consistent with these health perceptions, the 'General' attribute (i.e. '*Sugar is an essential part of a healthy diet*') was recognised as the least important statement (*General* BW score = −0.238).

In the 'Sustainability and Environment' attribute category, respondents had highest support for sugar being produced in sustainable natural systems (*NaturalProd*, BW score = 0.041). The impact of sugar production on the 'GBR' and 'land and water' was valued equally by respondents (BW scores equal to −0.001 and 0.004, respectively). However, the statement about the carbon footprint generated a negative BW score (−0.153), suggesting that sustainability-related credence attributes remain a secondary priority for Australian sugar consumers. Attributes from the 'Quality and Price' category received less attention, generating the lowest scores of all categories on average. In particular, respondents seemed to disagree the most with the statements '*Processed foods and soft drinks that have higher sugar content taste better*' (*Quality*, BW score = −0.174) and '*Price is very important in my decision to buy soft drinks*' (*PriceSD*, BW score = −0.218). This may be consistent with sugar being treated as a staple commodity.

4.1.2 Paired model

In the second stage of analysis for the BWS data, a paired model was estimated to identify the relative importance of the 16 statements, treating the levels selected as 'best' to have positive utility, 'worst' to have negative utility and zero otherwise (Aizaki and Sato 2020). The results of the estimated conditional logit model are presented in Table 3. In this analysis, the price of processed food (*PricePF*) was chosen as the base attribute, in which the coefficient is assumed to be zero and acts as a reference point for the other coefficient values. In line with the BW score findings, 13 levels (statements) out of 16 are significant. Positive coefficients indicate statements that are more important than the price of processed food, while negative coefficients indicate less important statements.

The paired model generates similar priority rankings to the BW scores, but relative scores are higher for the factors related to health and, to a lesser extent, information. There is also slightly more importance placed on statements relating to sustainability, including reducing impacts on the GBR.

4.2 Contingent valuation results

The aim of the CVM experiment was to assess consumer willingness to pay for water quality improvements in sugar production systems in GBR catchments. Combined with the BWS experiment, it allows the identification of the aspects of sugar production and consumption that are most important to consumers, which will be relevant to the sugar industry and policymakers.

Of 1100 respondents, 737 did pick a value superior to zero in the CVM exercise, indicating that 67 per cent of respondents were ready to pay a premium to reduce the impact of sugar production on water quality in the GBR. The 363 remaining responses were examined to identify whether they were protest bidders or genuine zero bidders (Question C2, p.11 in the questionnaire – see Appendix S1). Seventy-two (19.8 per cent) of these respondents picked '*I support environmental improvements but can't afford to pay for it'* and were therefore kept as genuine zero bidders. Another 32 (8.8 per cent) respondents picked '*Making environmental improvements is not important'* and were also kept as genuine zeros. Discarded responses treated as protest bids were the following ones: '*I support environmental improvements but object to paying extra for it'* (30 per cent), '*I support environmental improvements but think Government should pay for it'* (12.9 per cent), '*I support environmental improvements but think growers should pay for it'* (7.2 per cent) and '*Other reason'* (7.7 per cent). Respondents who picked '*I did not really understand the choice'* (13.5 per cent) were not kept either. As a result, the total number of respondents kept for the CVM analysis was 841 (=737 + 104), that is 76.5 per cent of the total sample (Appendix A).

Table 4 Two-stage selection model for the CVM experiment

	Using annual payment	
	Coefficient	Std. error
Stage 1: Probit selection model to predict positive bid		
Constant	0.176	0.207
Live in an urban area	0.224*	0.125
Plan to visit GBR	0.510***	0.116
Think condition has declined	0.250**	0.115
Healthy diet is important	0.097**	0.038
Model statistics		
No. of observations	841	
Log likelihood	−295.7	
AIC/N	0.715	
McFadden R-sqd	0.060	
Chi-squared	37.9	
Stage 2: Regression model to predict LN of bid value		
Constant	3.477***	0.247
Age	−0.018***	0.003
Household income ($,000)	0.006***	0.002
Total no. of sugar consumed per week	0.011***	0.003
Lambda	3.477	0.247
Model statistics		
No. of observations	737	
R-sqd	0.078	
Mean bid/year	$24.47	
95% Confidence interval	$18.71 – $31.38	

Note: ***, ** and * indicate significance levels at 1%, 5% and 10%, respectively. Lambda represents the error term in the first stage model.

4.2.1 Empirical model

To handle the relatively large number of zero bidders, a two-stage modelling process was followed to model people's WTP from the CVM (Table 4). Analyses were conducted using the LIMDEP software package. First, a probit model was applied that predicts participation into a non-zero bid based on different characteristics. That is, the dependent variable is a 0–1 dummy variable depending on whether the respondent gave a zero response or not. The responses given to four questions about the GBR in the survey were used to create four explanatory variables. A normal distribution of the error terms was selected over other options based on the AIC statistic.

Second, an ordinary least square (OLS) regression model was applied to predict the bid value. The annual bid that respondents would be willing to pay is the dependent variable in this case. Two socio-economic variables – age and annual household income – and one behavioural variable – the total number of food and drinks containing sugar consumed each week, were included as predictors. The bid values were then estimated from the regression model by multiplying the coefficient for each factor by its mean

value from the sample, summing these together with the constant term, and then taking the exponential value (because the bid values were in log form).

The probit model shows that respondents living in urban areas were more likely to bid (*P*-value = 0.074), consistent with a tendency that young, well-educated and affluent urban citizens are generally the primary constituents of the environmentally conscious public (Arbuthnot 1977; Weigel 1977). Respondents who stated that they were planning to visit the GBR in future were significantly more likely to express a positive bid (*P*-value = 1.06e-05, 1 per cent significance level). This result demonstrates that respondents who see direct utility in preserving water quality in the GBR for recreational purposes are willing to pay for it.

Respondents who thought that the condition of the GBR had declined over the past 10 years also showed that they were significantly more likely to express a positive bid (*P*-value = 0.030, 5 per cent significance level). Here again, this result shows that respondents who appear to be more aware of the state of degradation of the GBR are also willing to pay to preserve it through supporting best management practices in the local sugarcane industry.

Finally, respondents who were the most concerned about keeping a healthy diet also showed that they were significantly more likely to bid (*P*-value = 0.010, 5 per cent significance level). Consumers willing to pay extra for eco-friendly products may be willing to be more selective about their consumption of sugar, favouring pricier products but that respect multiple credence attributes (e.g. pesticides-free, fair trade, sustainable). Consumers jointly concerned about health and environmental aspects of their food might be the most supportive of a transition towards novel and sustainable production methods (Macdiarmid *et al.* 2011; Johnston *et al.* 2014).

The proportion of the non-protest sample likely to pay extra for the protection scenario can be estimated from the probit model. This is done by summing the constant coefficient with the product of each variable coefficient by its sample mean, and then applying the sum as a Z-score in a probability table. The calculated Z-score of 1.226 generates a probability that 89 per cent of non-protest respondents are willing to pay a price premium. When the shares are allocated between explanatory factors, 36.1 per cent of support aligns with health interests, 35.9 per cent with interests in the GBR, and 27.9 per cent with urban populations and the constant term. Equal reallocation of these latter factors generates 50.1 per cent support for health and 49.9 per cent support for the GBR.

The linear regression shows that WTP for the proposed environmental standards can be predicted by socio-economic factors such as age, income and current levels of sugar consumption. Older people were significantly less inclined to support environmental standards than younger respondents (*P*-value = 2.11e-07, 1 per cent significance level). This finding contradicts the trend observed in the literature that older generations might actually be more prone to purchase sustainable products (Vecchio and Annunziata 2015;

Siegrist and Hartmann 2019), but is consistent with younger consumers being more environmentally conscious.

Income is also a determining factor, with respondents from higher household incomes more likely to place a higher bid (*P*-value = 0.005, 1 per cent significance level). Finally, the total amount of sugar consumed by respondents in a week is also a positive and significant factor (*P*-value = 5.69e-05, 1 per cent significance level). Generally, it would be expected that households with higher consumption would favour lower rates to minimise payment burdens, but the use of a total payment mechanism in this experiment may have disguised this effect. The result indicates that households with higher sugar consumption are more prepared to pay a higher premium.

4.2.2 Extrapolating values to the Australian population

The mean WTP is estimated at $24.47/year per household, with a 95 per cent confidence interval ranging between $18.71 and $31.38. If a premium of that kind were extrapolated across all independent 9.4 million Australian households estimated in 2021 at a conservative 76.5 per cent (non-protest) participation rate like in our survey, this could potentially yield total value estimates of $176 M/year. However, the bid results show that not all households would pay the average increase. Of 1100 respondents to the survey, only 377 gave bid values higher than the estimated mean of $24.47/year from 841 respondents entering a bid value, with a further 259 responses identified as protests. This implies that only 34.3 per cent of households were prepared to pay the higher prices. The median WTP is identified at $10 per household, which if extrapolated to all non-group households gives a total WTP of $94 M per annum. However, if value increases are limited to the 49.9 per cent with concerns for the GBR, that total WTP reduces to $46.9 M per year.

Some indirect support for the value estimates comes from consideration of the relatively small contribution from household budgets that the values represent. The mean WTP that has been estimated only represents 0.038 per cent of respondents' gross total income, and about 0.34 per cent of Australians' weekly grocery bill ($140, Canstar Blue Pty Ltd. 2020). As such, it appears easily absorbable by most consumers as part of the household's recurring expenses.

The advantages of using the more conservative estimate of $46.9 M are that it is based on the statistical modelling of the CVM data, and it limits the estimates to a subgroup of Australian households that are more actively interested in the GBR. It is possible that the gap between the extrapolation of the median bid ($94 M) and the group interested in the GBR ($46.9 M) represents those who are more interested in using higher prices to address health and other factors.

5. Discussion and conclusion

This study examined consumer demands and feasibility of environmental standards for sugar originating from the GBR area in an attempt to gauge consumers' interest in contributing to alleviating the issue of water quality degradation from agriculture in that region. Consumers' WTP for sustainable food products remains largely understudied in Australia compared with other developed countries. Li and Kallas (2021) reported only two Australian studies in their recent meta-analysis (Ogbeide *et al.* 2015; Mugera *et al.* 2017), with Oceania showing the lowest WTP (17.2 per cent premium for sustainable food products) of all four studied continents. Nevertheless, Garcez de Oliveira Padilha *et al.* (2021) reported that the environmental dimension of sustainability was most important to Australian meat consumers. We note that our study is one of the first attempts in the literature to explore this matter in the context of sugar as a commodity food (Ruggeri *et al.* 2021).

Our findings show that even a small contribution of $24.5/year from Australian consumers could potentially raise $46.9 M/year to address the issue of water quality degradation from the sugar industry in the GBR, and would represent a small proportion of weekly grocery bills. We note that this potential premium from consumers could be an effective mechanism to fund a large part of the water quality improvement actions in the GBR. It would also be very difficult for consumers to avoid it as 95 per cent of all sugar grown in Australia originates from the GBR area (Australian Government 2020).

We caution, though, that actual consumer behaviour may not match the level of interest in sustainability reported by other researchers (e.g. Garcez de Oliveira Padilha *et al.*, 2021). Closer inspection of the detail reveals the challenges in introducing ecolabel mechanisms into private markets. While there is widespread support for price premiums, three major issues can be identified. The first is that there is a substantial group that protests against or does not understand this type of mechanism, estimated in our sample at 23.5 per cent, almost a quarter of respondents. A second issue is that while most respondents might support price premiums, they involve very different motivations such as health and environmental concerns so that no single concern may necessarily have majority support. This supports Hoek *et al.* (2017), who reported that consumers' familiarity and liking of the sustainable alternatives to a product largely determine the success of actions visible at point of purchase. The third issue is that estimates of mean WTP are misleading for private goods, because respondents who indicated lower bid levels are unlikely to participate in a market mechanism where prices are higher. In this case study, the median bid of $10 is likely to be a more realistic indicator of consumer support than the mean WTP of $24.5 per year. Market design will be further complicated by the need to track and label higher standard products through the supply chain, and to optimise the potential revenue against the market and supply chain costs involved.

We must acknowledge some caveats with the analysis. There is some potential for biases in CVM experiments, where respondents' answers to the

constructed choice task do not necessarily match what they might do in more complex shopping situations in real life. As the payment mechanism used in this study is not coercive, incentive compatibility is limited, which could bias our WTP estimates (Carson and Groves 2007). Uehleke (2017) advises to use a referendum format to solve this issue. However, there are other issues with the referendum format, such as yea-saying, that limit its appropriateness to scenarios that do not involve pure public goods (Johnston *et al.* 2017). Bearing in mind the importance to keep the survey consequential, we opted for a payment card format instead because water quality improvement is a quasi-private good with a price increase payment mechanism linked to multiple goods (sugar products), a scenario not suited to a referendum format. Nevertheless, this is a familiar trade-off to shoppers, and health of the GBR is a familiar issue as well to Australian consumers, so the scenarios are likely to be realistic and compelling.

We also note some divergence between the results of the BWS and CVM experiments, where the BWS suggests that the environmental condition of the GBR is not a major issue, but the CVM results indicate that it is important to a subset of consumers. An additional caveat to mention is that respondents may have multiple drivers for supporting higher prices for sugar (particularly health). While the extrapolation has been limited to only the subset willing to pay higher prices for the GBR, it is still possible that some of their values may be for multiple outcomes. Therefore, the estimates presented in this study should be treated with caution and considered as upper bounds for payment and support.

Based on the results of the present study, we recommend policymakers to consider instruments that would further involve sugar consumers. Our experiments demonstrated that there was definite interest and support from the majority of consumers to choose ecolabelled sugar products, confirming a trend observed in the literature (Li and Kallas 2021). An important challenge that remains to be addressed effectively relates to brand awareness and the need to develop a credible label that consumers become familiar with in order to capture market premium (Mugera *et al.* 2017). The results of this study show that higher environmental standards with price premiums transferred back to producers to support practice change offer a potential solution that would better link producers to consumer demands in the case of commodity foods. While sustainable production certification systems such as Bonsucro already exist for sugar production, stronger links to consumer demands through price differentiation would help to create further drivers for agricultural management changes.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available online as Supporting Documents to this article.

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Appendix

Table A1 Number of respondents who selected each bid value

Bid values	Number of respondents
$0 (no increase)	363
$5 ($0.10 per week)	223
$10 ($0.20 per week)	137
$25 ($0.50 per week)	77
$50 ($1.00 per week)	98
$75 ($1.50 per week)	25
$100 ($2.00 per week)	46
$125 ($2.50 per week)	8
$150 ($3.00 per week)	22
$175 ($3.50 per week)	3
$200 ($4.00 per week)	14
$225 ($4.50 per week)	2
$250 ($5.00 per week)	25
$275 ($5.50 per week)	2
$300 ($6.00 per week)	6
$350 ($7.00 per week)	3
$400 ($8.00 per week)	6
$450 ($9.00 per week)	0
$500 ($10.00 per week)	8
$600 ($12.00 per week)	5
$700 ($14.00 per week)	5
$800 ($16.00 per week)	1
$900 ($18.00 per week)	4
$1000 ($20.00 per week)	17
Total	1100

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Survey questionnaire.