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Sustainable lifestyles, eating out habits and the green gap: a study of food waste segments

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ABSTRACT

Despite policy efforts, curbing household food waste remains a challenge. This study uses a survey of 334 respondents and principal component analysis (PCA) to identify different types of consumers. Based on segmentation theory, six lifestyle segments are identified: the freshness lovers, the vegetarian and organic food lovers, the recycle/reuse advocates, the waste-conscious consumers, the label-conscious/sensory consumer and the food waste defenders. Results show that the less well-studied lifestyle variable is an essential determinant of participants' food waste behaviours. Contrary to expectations, waste-conscious consumers waste higher levels of food than other consumers. The results, based on the ordered probit model and marginal effects analysis, demonstrate that affluent consumers, who claim to be waste conscious, who have young children and who frequently eat outside of the home, are more likely to waste food than others, and they lie in the medium waste group. At low levels of food waste, consumers who worry about the cost of food waste and who make an effort to reduce food waste labelled the 'food savers' are less likely to waste food than other consumers. Finally, the study presents segment-specific social marketing tactics that may help reduce food waste.

Graphical abstract

Food waste intensity

	Not wasting (0-5%)	**Light wasting (5-10%)**	**Medium wasting (10-25%)**	**Heavy wasting (25% and above)**
Positive (likely)	Efforts and worry about the cost of food thrown away	Eating out, income, child, and waste consciousness	Eating out, income, child, and waste consciousness	None
Negative (unlikely)	Eating out, income, child and waste consciousness	Worry about the cost of food thrown away	Efforts and worry about the cost of food thrown away	None

Keywords

Food waste; sustainable lifestyles; segmentation; eating out; principal component analysis; marginal effects

1. Introduction

About one-third of all the food produced for human consumption in the world is lost or thrown away (FAO, 2013). It is a significant problem - ethically, socially, environmentally, and economically (Beretta, Stoessel, Baier, & Hellweg, 2013; Fonseca, 2014; Secondi, Principato, & Laureti, 2015; Thyberg & Tonjes, 2016). Wasted food involves a waste of water, energy and other resources that go into its production (Farr-Wharton, Foth, & Choi, 2012). Moreover, as the food is collected, transported to, and degrades in landfill sites (which is increasingly becoming an expensive exercise), it becomes a significant source of methane gas emissions, contributing to climate change (Edwards & Mercer, 2012). Solving the food waste problem is critical given that it is deeply embedded in the United Nations (UN) 2030 Agenda for Sustainable Development "urgent call for action," and food waste is aligned with goal 2 (zero hunger) and goal 12 (sustainable consumption and production) of the 17 Sustainable Development Goals (SDGs).

On the other hand, research on food waste from a consumer behaviour lens is expanding rapidly, but the factors underlying food waste behaviour are still being discussed and are contested (see Papargyropoulou et al., 2016; Secondi et al., 2015). Furthermore, despite the growing literature on food waste, little is known about food waste patterns in households that adopt sustainable lifestyles. Thus, applying general research findings to niche segments is risky. On the one hand, people who hold progressive attitudes toward sustainable consumption might be expected to waste less food than other people.

On the other hand, consumers often behave in an unsustainable manner due to the 'attitudes-behaviour' gap (Newton & Meyer, 2013) or 'intentions-behaviour' gap, due to

uncertainty, decision making biases and sub-optimal heuristics (Setti, Banchelli, Falasconi, Segrè, & Vittuari, 2018). The inconsistencies between attitudes and behaviour, also known as the 'green gap', are explained by multiple factors, such as cost, inconvenience, cynicism, perceived sacrifice and social stigma, which can hamper ethical consumption decisions (Johnson & Tan, 2015). It is posited that researchers, food actors and policymakers should take segment-unique marketing actions and policies to curb food waste (Aschemann-Witzel et al., 2018). Hence, the purpose of this paper is to identify the determinants of food waste behaviour in a less well-studied lifestyle segment, 'green' or sustainable consumers. Although it is recognised that there are 'different shades of green' (Lavell, Rau, & Fahy, 2015), research segmenting the 'green market' on the basis of attitudes towards food waste is scant. According to Lubowiecki-Vikuk et al., (2021, p. 92), "there is a need for a critical review of lifestyles and consumer behaviour patterns in the context of sustainable development, as well as in the relationship between human beings and other elements of the Earth System". Furthermore, what one learns about food waste in a niche segment may hold broader lessons for the management of food waste and lead to a better understanding of how waste levels may change as society changes, for example, the emergence of new food beliefs and trends towards home-cooking, localism, sustainable and mindful eating as a result of the Covid-19 pandemic (Euromonitor International, 2020).

This research is important for three main reasons: firstly, most scholars focus on mainstream consumers and report generalised attitudes towards food waste and typical food-related practices. While the efforts made to profile segments in particular regions (Di Talia, Simeone, & Scarpato, 2019; Annunziata, Agovino, Ferraro, & Mariani, 2020) are helpful, in-depth analysis of sustainability-oriented consumers and their waste patterns are mostly absent from the literature. Secondly, most studies employ descriptive

research designs, and the use of econometric techniques is rare. Thirdly, segment-specific research is critical to shedding light on how to manage the growing food waste problem (Annunziata et al., 2020).

2. Theoretical background

In an attempt to understand the mechanisms underlying food waste, a literature review is undertaken and presented in the next section.

2.1 Definition of food waste, behavioural and socio-demographic determinants of household food waste generation.

Food waste has been studied in many disciplines, such as human health and nutrition, sociology and food marketing. Since research is divided between several disciplines, with different foundations and research methodologies, it is not surprising that a common definition of food waste does not exist (Thyberg & Tonjes, 2016). In this research, food waste is defined as 'avoidable waste' (as opposed to bones, eggshells, vegetable peelings, etc.) and refers to edible food that is fit for human consumption but is still thrown away, as defined by Jörissen, Priefer, & Bräutigam (2015). The focus is on food and beverages wasted within the home and not in away-from-home settings, such as in the catering sector.

A recent review of the literature shows that scholars have focused on socio-demographical, as well as behavioural (e.g., buying, cooking and shopping habits) and attitudinal factors in order to explain levels of food waste (Hebrok & Boks, 2017). However, there is "no clear consensus regarding which socio-demographic factors relate

to more waste" (Thyberg & Tonjes, 2016, p.13). Several studies highlight age (Buzby & Hyman, 2012; Marangon, Tempesta, Troiano, & Vecchiato, 2014; Melbye, Onozaka, & Hansen, 2017; Quested, Marsh, Stunell, & Parry, 2013; Stefan, van Herpen, Tudoran, & Lähteenmäki, 2013), including an earlier Australian study where food waste sharply fell as age increased (Hamilton, Denniss, & Baker, 2005). The over 65 group is a cohort that wastes less food on average than the rest of the population; they view wasting food as wrong, and it is speculated that this attitude may extend to 'wastefulness' in general (Quested et al., 2013).

There are conflicting reports on the role of gender in food waste. Although research has concluded that older females tend to belong to the 'non-waste' segment of consumers (Fonesca, 2013), other studies report that females waste more food than men, probably because they have a tendency to buy more vegetables than men and have an aspiration to cook food themselves, what is not always realised (Silvinoinen et al., 2014; Koivupuro et al., 2012). A study by Koivupuro et al., (2012) established that only a few factors correlate with the amount of avoidable food waste, which were the size of the household, the gender of the person mainly responsible of grocery shopping, the frequency of buying discounted food products, the respondent's own view of the potential to reduce food waste and the influence of purchasing particular food packet sizes. Other scholars conclude that households with children waste more than households without children, due to the unpredictable nature of children's tastes and fussy eating patterns (Cox & Downing, 2007, Hamilton et al., 2005; Parizeau et al., 2015).

Research on the relationship between income and food waste is somewhat conflicting. As income rises, people can afford to waste food because food is relatively inexpensive compared to other household expenses, such as housing (Pearson, Minehan, & Wakefield-Rann, 2013). It is found that that people from higher-income households waste

more, while pensioners waste much less than other groups (Filipová, Mokrejšová, Šulc, & Zeman, 2017). Research (Stefan, van Herpen, Tudoran, & Lähteenmäki, 2013) has found a positive correlation with reported food waste and household income, although the coefficients were relatively low. However, an analysis of low-income consumers found that food waste is a real problem (Porpino, Parente, & Wansink, 2015), and waste arises due to several factors, such as pet ownership, excessive purchasing, over-preparation, unwillingness to consume leftovers and improper food storage. It is noted that low-income parents often buy food that their children like to avoid waste, even if this means compromising on healthy options (Daniel, 2016). According to Koivupuro et al., (2012), the level of food waste in low-income households is not lower compared to that found in high-income families. Some studies (Wenlock, Buss, Derry, & Dixon, 1980) have even found a low, or non-existent, correlation between income and food waste.

Food waste has been explored from a social practice lens. Instead of viewing waste as a conscious act, a growing number of researchers argue for framing of action within the context of interlocking 'practices'. For instance, throwing away edible food is interlinked with food shopping, cooking, storage, consumption habits and left-over routines (Stancu et al., 2016). Other factors linked to food waste or waste reduction are as follows: food literacy and food storage practices (Farr-Wharton et al., 2014); frequency of shopping; impulse buying and price promotions (Fonseca, 2014); having a shopping list (Koivupuro et al., 2012) and testing the freshness of fruit and vegetables when shopping (Principato et al., 2015; Fonseca, 2014).

Numerous studies suggest that food waste is linked to the social and cultural aspects associated with eating, and countries with deep food cultures appear to waste less food (Thyberg & Tonjes, 2016). Scholars draw attention to the culture of abundance and behavioural constraints, such as the 'good provider' mentality, which are challenging to

tackle (Visschers et al., 2016; Graham-Rowe et al., 2014). At the macro level, food waste has been linked to global food supply chains, mass production and demographics (Govindon, 2018), and there are calls for scholars to draw on systems thinking (Carvalho & Mazzon, 2018; Kemper & Ballintine, 2019) in order to solve the growing problem of food waste. This study focuses on the micro-level, household food-wasting behaviour, but recognises that food waste is a systemic problem.

2.2 Food safety concerns and the role of expiry labels

Products with a maximal shelf life of less than two weeks are considered to be perishable products. For most of these products (e.g. meat, fish, dairy) it is obligatory to determine a use-by date and print it on the product packaging. The time between production and the use-by date is called shelf life. Food quality is closely related to food safety, as microorganisms will cause decay and safety hazards (Buisman, Haijema, & Bloemhof-Ruwaard, 2019). For highly perishable products, shelf life is determined by producers and is often set rather conservatively to ensure food safety (Soethoudt, Van der Sluis, Waarts, & Tromp, 2012). According to the *Food Standards Australia New Zealand*, foods that must be eaten before a certain time for health or safety reasons should be marked with a 'use by' date. Most foods have a 'best before' date. Consumers can still eat foods for a while after the best before date as they should be safe, but they may have lost some quality. In addition, it is legal to sell foods that had passed the 'best before' date provided the food is fit for human consumption (Food Standards Australia New Zealand, 2015). Conservative shelf life setting can cause unnecessary waste at retailers and increases when consumers are selective about the use-by dates or if demand varies a lot. A recent study found that discounting, along with the application of dynamic shelf life, is a useful strategy to reduce food waste (Buisman et al., 2019). Several studies show that

lack of knowledge and confusion in relation to food expiry dates leads consumers to throw away food, even though it is safe to eat (Abeliotis et al., 2014; Milne; 2012; Parfitt et al., 2010; Tsiros & Heilman, 2005, WRAP, 2007; 2009; Wilson et al., 2017). It is also noted that consumers tend to select the product with the longest use-by date, which causes the oldest products to be left on retail shelves, thus leading to waste at the retail store (Tromp, Haijema. Rijgersberrg, & van der Vorst, 2016). A recent study demonstrated that the correct understanding of the difference between the best-before date and the use-by date is a good practice minimizing the food waste (Savelli, Fancioni, & Curina, 2020). Therefore, this study examines consumers' perceptions as to whether they can correctly interpret expiry dates and therefore avoid discarding food that is fit for consumption.

2.3 Segmentation studies, sustainable lifestyles and eating out

Market segmentation refers to a process of categorizing the target population into groups based on their shared characteristics which are expected to influence marketing mix decisions (Solomon, Russell-Bennett, & Previte, 2019). Segmentation studies are becoming increasingly common in food waste studies, such as the consumer types based on socio-demographics, awareness of the food waste problem, knowledge of expiry dates and food management practices (Di Talia, Simeone and Scarpato, 2019). Scholars have identified segments such as the 'virtuous', the 'waster' and the 'moderate' segment based on demographics, intentions and food-related behaviours (Romani, Grappi, Bagozzi, & Barone, 2018). Studies have identified the 'non-food waste' consumers (Fonseca, 2014) and people who have a high environmental consciousness (Williams et al., 2012). Scholars have also identified segments of consumers who are unwilling or unable to reduce their food waste to a meaningful level, such as the 'kitchen evaders' (Buckley et al., 2007) or the 'casual' consumers (Mallinson et al., 2016). Spillovers or transfer of

environmental behaviours from one area to another can occur (Thøgersen & Ölander, 2003). For instance, Jörissen et al., (2015) found the food waste decreases when people shop in local markets and grow their food. Delley et al., (2016) describes the 'eco-responsible' consumers as consumers who are aware of the food waste issue, are prudent in their food planning, and shopping behaviours and they tend to have close ties with food production. Batat *et al.* (2017) posit that alternative food consumers have value systems grounded in the notion of social responsibility and sustainability. They are conscientious consumers who are distanced from the globalised and industrialised food system. Alternative food consumers often adopt a lifestyle antithetical to the consumerist society, such as plant-based diets, local and organic food consumption. While aesthetic standards play strong roles in the decisions of consumers to throw away food (Abeliotis et al., 2014; Parfitt et al., 2010; Wilson et al., 2017), alternative food consumers are likely to be sensitive to wasteful practices and may follow trends such as the 'ugly food movement' (Mortimer, 2015). As noted by Kerton and Sinclair (2010), food has become 'a powerful symbol in the struggle to transition to a more sustainable pathway'.

Lifestyle is an important segmentation variable. Plummer (1974, p. 35) defined consumer lifestyle as "a unique style of living based on a wide range of activities, interests, and opinions." Scholars have identified three elements of personal lifestyle, which are related to a healthy lifestyle, namely the unpredictability of food habits, purchasing food to eat healthily and eating out regularly (Roodhuyzen, Luning, Fogliano, & Steenbekkers, 2017). A recent study links a healthy lifestyle and the habit of eating at home with food waste reduction (Savelli, Francioni, & Curina, 2020). Nevertheless, prior studies' findings are often different and even conflicting. For example, Desa, Kadir, & Yusooff (2011) demonstrated that modern lifestyles lead to more acute waste problems. Likewise, authors (Parizeau et al., 2015; Hebrok & Boks, 2017) found a positive

relationship between household lifestyles and food waste production. In contrast, other authors, who specifically focused on the concept of a sustainable lifestyle (Gutiérrez-Barba & Ortega-Rubio, 2013), reveal that sustainable attitudes tend to imply both less consumption and food waste. It would be interesting to see if eating out habits conflict with, or coincide with, sustainable lifestyles. Therefore, the present study focuses on lifestyle, and more specifically on sustainable lifestyles and eating out habits, where the former is associated with food waste reduction and the latter with food waste intensity. Previous research has found a relationship between eating out and food waste intensity (Parizeau et al., 2015; Ponis, Papanikolaou, Katimertzoglou, Ntalla, & Xenos, 2017; Savelli, Francioni, & Curina, 2020). It is speculated that households that have a habit of eating out routinely overestimate and over-purchase the amount of food that their household would consume at home (Parizeau et al., 2015). Likewise, other reports suggest that the more people order take-away or eat out, the less likely they are to possess food-related skills, such as the ability to reuse leftovers or regularly check the food stored at home, which in turn can lead to food waste (Chenhall, 2010). Indeed, eating away-from-home is associated with convenience (Carrigan et al., 2006). It is speculated that people who buy convenience foods are likely to throw them away due to packaging formats (Mallinson, Russell, & Barker, 2016). This is because the standard size of pre-packaged food tends to be too large for single-person households and yet the cost of smaller formats is disproportionately expensive (Aschemann, Witzel et al., 2015; Evans, 2012; Koivupuro et al., 2012).

3. Method

3.1 Research questions, procedure and participants

The research questions are as follow:

(1) Do segments of consumers exist based on sustainable lifestyles, what are their attitudes towards food waste, how often do they eat outside of the home, and are these variables, along with demographics, associated with varying levels of food waste intensity?

(2) What is the impact of a change in an explanatory variable on the predicted probability of wasting food?

Ethical approval was obtained for the study from the authors' university. Respondents were recruited face-to-face at eco-festivals in two regional cities in North Queensland, through a community group dedicated to local and alternative food movements and through the local University. An incentive was used to encourage participation in the survey.

3.2 Instruments and statistical analysis

Questions on expiry dates, eating out habits, attitudes towards food waste and effort made to reduce food waste were investigated which were guided by the literature (Stefan et al., 2013; Lyndhurst, 2007; Principato, Secondi, & Pratesi, 2015; Thyberg &Tonjes, 2016). As it was not possible to observe the actual amount of food wasted, the participants were asked to estimate the amount of food purchased in a week that was wasted (Stefan et al., 2013), noting that people substantially underestimate these amounts (Falasconi et al., 2019). Since the data on food waste amounts are used to compare subsamples, exact quantifications are not needed. Scales to measure sustainable lifestyles were taken from the literature (Lea & Worsley, 2008). A decision was taken to use 5-point Likert scales to avoid ambiguity and make it easy for

respondents to answer questions. Although much research has been conducted on the optimal number of Likert scale items or categories, 5-point scales have high internal reliability (Croasmun & Ostrom, 2011). The dependent variable, food waste intensity, had an eight-level response scale format, capturing the amount of food bought per week that is wasted in percentage terms (ie. “less than 5%”, “5 to 10%”). Although there are many different ways of measuring food waste, this scale was chosen since studies show that in Australia, 20% of food bought, one in five bags of groceries, are wasted (Department of Agriculture, Water and the Environment, n.d). The act of throwing away food is often a habit and people underestimate food waste amounts since they do not like to project themselves as wasteful or do not realise they are wasting food (Stancu et al., 2016; Stefan et al., 2013), hence, the question was designed to be quick and easy to answer, rather than an objective, accurate measure of food waste. One item, effort made to reduce food waste, was dichotomised for statistical analysis. Using a categorical variable, and collapsing categories for analysis, is a standard and established procedure for discriminant analysis (see Grandhi & Singh, 2015).

Data on demographics, such as age, gender, income, education and number of children in the household, was gathered. After data cleaning, a total of 334 usable surveys were analysed with the aid of software, such as Stata, version 14 and IBM SPSS Statistics 20 software.

Table 1: Summary of the scales used and key segments identified

Construct	Question	Segment	Scale
Use-by and best-before dates	***I know the difference in meaning between the 'use by' and 'best before' label.*** ***I only throw away food if the food smells bad or is slightly off.***	***Label conscious/ sensory consumers***	5 point Likert scale, 1= strongly disagree, 5=strongly agree.
Sustainable lifestyles	*Eating locally grown food.* *Eating fruit and vegetables that are in season (e.g. Asian greens in Summertime).* *Avoiding processed food.* **Eating less red meat.** **Eating organic food.** **Eating vegetarian meals.** Recycling paper, plastics, cans and glass. Reusing containers and bottles. Eating free-range eggs. Growing herbs or vegetables.	*Freshness lover* **Vegetarian and organic food lover** Recycle/reuse advocates	5 point scale, 1= not at all important to 5= very important.
Attitudes towards food waste.	***I am worried about the cost of food that I throw away.*** ***I feel guilty /bad when I throw away food because some people don't have enough to eat.*** ***I feel disturbed by the amount of food being wasted since it takes a lot of resources to grow, process, package and transport food.*** *The packaging of food thrown away is a bigger environmental problem that food waste.* *Food waste is not harmful to the environment since it is natural and biodegradable.* *I would probably throw away less food if I had more information on the cost of the food I throw away.* *I think it is better to throw away food than to risk gaining weight.*	***Waste-conscious consumers*** *Food waste defenders*	5 point Likert scale, 1= strongly disagree, 5=strongly agree.
Habit of eating outside of the home	**How often do you eat out?**		5 response categories: 2-3 times per week; once a week; 2-3 times per month; less often; don't know/do not do this.
Food waste intensity	How much of the food and drink that you buy do you throw away in a regular week?		Ordinal scale, 8 response categories, from 'not at all' to '30% or more'.
Effort to avoid food waste	***A good deal of effort is put into reducing food waste.***		Dichotomous. Yes/No.

3.2 Sample profile

The sample had a distinct socio-economic background and was not designed to be representative of the general population. There was a female bias with 74.8% females and 25.2% males. Noting census data in Australia (ABS, 2016a; ABS, 2016b), it was concluded that the sample was relatively affluent and well educated. Respondents came from all age groups, with slightly more (26.2%) aged from 30 to 39 years. Half of the sample (51.8%) was in full-time employment, and others were working part-time (15.8%), retired (10.4%) or studying (12.8%).

3.3 Principal Component Analysis

The sustainable lifestyle statements were analysed and grouped into three distinct segments. Principal Component Analysis (PCA) was used to analyse the survey questions. "PCA is a technique for reducing the dimensionality of such datasets, increasing interpretability but at the same time minimizing information loss. It does so by creating new uncorrelated variables that successively maximize variance" (Jolliffe and Cadima, 2016). The PCA results show that there are three eigenvalues are above 1, which means three groups are significantly different (three fonts are used to differentiate these groups). They are named as follows: the freshness lovers, the vegetarian and organic food lovers and the recycle/reuse advocates.

Likewise, the statements that captured attitudes towards expiry dates and food waste were grouped into three distinct segments. The PCA results of this analysis show that there are three eigenvalues are above 1, which means three groups are significantly different. They are named as follows: the label-conscious/sensory consumers, the waste-conscious consumers and the food waste defenders.

All of the segments were used as additional independent variables that were introduced to the ordered probit model, discussed below.

3.4 Ordered Probit Model

The ordered probit model was selected as it improves on the commonly used t-test, analysis of variance and linear regression models. The probit model and marginal effects have been used before in studies on food waste (Principato et al., 2015). It has its origins in bio-statistics (Aitchison & Silvey, 1957) and is a suitable technique to analyse the effects of multiple, explanatory variables on an ordinal outcome (Chen & Hughes, 2004; Green, 2002). A vital advantage of this technique is that the information contained in the ordering is exploited. A fundamental assumption is the independence of predictor variables, and hence the test for multicollinearity was conducted. Maximum likelihood estimation (MLE) technique is used, for it provides a consistent approach to parameter estimation problems, and has desirable mathematical and optimality properties (Baum, 2006). MLE has some drawbacks, such as the complexity of method (Chen & Hughes, 2004) and small and unbalanced datasets will not give good results. The dependent variable Y in the ordered probit model used here refers to the food waste intensity, i.e. the different percentages of food and drink being wasted in a week.

4. Results

4.1 Food waste intensity

Descriptive analysis shows that a very small percentage of the sample (7.8%) claimed that they did not waste food at all. Around a third (34.3%) of the sample claimed that they

wasted less than 5% of their food. Close to one third (28.8%) of the sample said they wasted less than 10%, 16% said they wasted between 10% and 15% and 13.1% of the sample said they wasted more than 15%.

4.2 Demographic, attitudinal and lifestyle factors contributing to food waste

Table 2 shows the independent variables that were used in the probit regression model, which were demographic variables (income, age, gender and presence of young children in the household), eating out habits, worry about the cost of food throw away, effort and lifestyle segments.

Table 2: Categories and definitions of independent variables used in probit regression models

Demographic category	
Income	Annual household income
Age	Respondent's age
Gender	Dummy variable; 1 if the respondent is a male
Presence of young children	Dummy variable; 1 if the respondent has young children
Consumer habits, food consumption attitudes and lifestyles	
Eatout	Frequency of eating out
Efforts	Dummy variable; 1 if A good deal of effort is put into reducing food waste
Worrycost	Different degrees of worrying about the cost of food I throw away
PC81	Loading of freshness lovers
PC82	Loading of vegetarian and organic food lovers
PC83	Loading of recycle/reuse advocates
PC91	Loading of waste consciousness consumers
PC92	Loading of label-conscious/sensory consumers
PC93	Loading of food waste defenders

Table 3 summarises the results of the ordered probit analysis. Pseudo R^2, the measure of fit, has a value of 0.1445; this figure is low, but there is no benchmark pseudo R^2 value that needs to be achieved before the model can be declared to be successful. The

probability value of 0.000 for the likelihood ratio (>0.05) indicates that the explanatory variables used in the probit model are appropriate and that the model as a whole is statistically significant. The plus sign of the estimated coefficient shows the factors that are positively related to food waste.

Table 3: Estimates of the ordered probit model for food-wasting behaviour

Variables	**Coef.**	**Std. Err.**	**z**	**P>z**
Eatout	.2883	.08546	3.37	0.001**
Efforts	-.6825	.1546	-4.41	0.001**
Worrycost	-.5904	.0768	-7.69	0.002**
Gender (Male:1; Female: 0)	-.1743	.1310	-1.33	0.183
Age	-.0520	.0440	-1.18	0.230
Income	.1053	.0402	2.62	0.009**
Presence of young children	.2854	.0683	4.18	0.000**
PC81	.0304	.0362	0.84	0.401
PC91	.1500	.0520	2.88	0.004**
Number of obs	346			
LR chi2(9)	164.43			
Prob > chi2	0.0000			
Log likelihood	-418.1826			
Pseudo R2	0.1445			

Note: ** indicates 5% significance.

The results show that efforts made to reduce food waste, worry about the cost of food waste, frequency of eating out, demographic variables such as income and presence of young children, along with waste consciousness, are significant at 5% level. Variables such as income, presence of young children, frequency of eating out and waste consciousness are positively related to food waste, while efforts made to reduce food waste and worry about the cost of food waste are negatively related to food waste.

4.3 Food waste intensity and marginal effect analysis

The following table shows the results of the analysis of the marginal effects. Marginal effects are informative since they show the impact of a change in an explanatory variable

on the predicted probabilities. Although many factors were tested, only a few factors explained variances in food waste in a clear and consistent way.

Table 4: Marginal effects of food waste factors

	Not wasting (0-5%)	**Light wasting (5-10%)**	**Medium wasting (10-25%)**	**Heavy wasting (25% and above)**
Positive (likely)	Efforts and worrycost	Eatout, income, child, and PC91	Eatout, income, child, and PC91	None
Negative (unlikely)	Eatout, income, child and PC91	Worrycost	Efforts and worrycost	None

Note: Factors are significate at 5%.

The results show that:

1. Food savers (not wasting) are likely to be those who worry about the cost of food waste and take efforts to reduce food waste. On the contrary, those who have a high income, frequently eat out, have young children, and claim to be waste conscious consumers are unlikely to be in this group.
2. Light wasting consumers are likely to be those who have a high income, frequently eat out, have young children, and claim to be waste conscious consumers. On the contrary, those who worry about the food waste cost are unlikely to be in this group.
3. Medium wasting consumers are likely to be those who have a high income, frequently eat out, have young children, and claim to be waste conscious consumers. On the contrary, those who worry about food waste cost and take efforts to reduce food waste are unlikely to be in this group.
4. No significant factors are found which relate to heavy wasting consumers.

5. Discussion

The aim of this study is to examine the determinants of food waste in households by segmenting consumers on the basis of sustainable lifestyles and investigating eating out habits, attitudes and demographics. Key segments were identified, with some consumers having an appreciation for freshness; others value organic and vegetarian food; others appear to be knowledgeable about expiry dates and claim to make a careful decision before discarding food on the basis of expiry dates alone. Other types, the food waste defenders, do not feel personally responsible for the consequences of their actions and are not aware of the environmental problems linked to food waste. The latter is similar to the 'consumers unware but not wasteful' type identified by Di Talia, Simeone and Scarpato (2019). One segment, the waste-conscious consumer, is similar in some respects to the 'conscious' consumer type (Di Talia et al., 2019). This type of consumer has a high family income, children in the household, is already quite concerned about the problem of domestic food waste and is very sensitive to the consequences of food waste on a global level. Contrary to expectations, the waste-conscious consumer in this study is associated with higher levels of food waste than the food saver segment and therefore does not appear to have adopted the same virtuous behaviour as the type identified by Di Talia et al. (2019). The findings suggest that a move towards a sustainable lifestyle does little to curb food waste, if the consumers have young children, are affluent and regularly eat outside of the home. Paradoxically, even if those consumers are waste conscious, and sensitised to the environmental problems around food waste, they still waste food. This study underscores the importance of the 'green gap' (Johnson & Tan, 2015) and the intentions-behaviour gap (Setti et al., 2018).

Furthermore, this study isolated the factors that contribute to light, medium and low levels of food waste. At light and medium levels of food waste, the presence of young children in the household, eating outside of the home, income, and waste consciousness

are important variables. Hence, this study supports previous research findings, whilst also arguing that the presence of children is, in fact, a stronger influencer than previously recognised. It seems to overtake consumers' sustainable lifestyle priorities. Prior research has found that the number of children in a household (and perceived behavioural control) is a predictor of food waste behaviour (van der Werf, Seabrook, & Gilliland, 2019). Several studies have highlighted the role of young children in household food waste (Terpstra, 2005; WRAP, 2009), as well as the number of younger people in the household (Tucker & Farrelly, 2016). Children are often 'fussy eaters' and have unpredictable eating patterns which may reduce, or even discourage, the room for improvement (Gust, 2004).

The significance of eating outside of the home confirms recent research (Savelli, Francioni, & Curina, 2020) and again, this study suggests that is a much stronger influence on sustainable consumers than previously recognised. Studies suggest that contextual factors, such as busy and unpredictable lifestyles that disrupt everyday food practices are major drivers of food waste in general (Aschemann-Witzel et al., 2015; Evans, 2012; Fonseca, 2013; Ganglbauer et al., 2013; Mallinson et al., 2016; Watson & Meah, 2012).

Concerning socio-demographics, this study confirms the link between income and food waste (Pearson et al., 2013; Stefan et al., 2013; Filipová et al., 2017)), with more affluent consumers being more likely to waste food.

At low levels of food waste, the two factors are found significantly to curb waste, namely, the worry about the cost of the food wasted and efforts made to reduce the waste. Literature reviews (Quested et al., 2013) and qualitative research show that consumers are personally concerned about food waste, i.e., feeling guilty about throwing out food that could be valuable to them or others (Graham-Rowe et al., 2014; Watson & Meah,

2012). A recent study found that reducing the amount of money wasted is ranked highly by survey respondents in a list of motivating factors (van der Werf, Seabrook, & Gilliland, 2019). Our finding of the statistical association between the perception of wasting money and likelihood of wasting less food at home supports empirical research (Grandhi & Appaiah Singh, 2016; Secondi et al., 2015). However, other research reports conflicting findings. A recent study has found that negative emotion was associated with a higher intention to reduce food waste, but higher food waste behaviour, which was paradoxical (Russe, Young, Unsworth, & Robinsor, 2017). Likewise, Stefan et al., (2013) found that moral concern (i.e., concern and guilt about throwing away food) explains intentions, but intentions are not significantly related with reported behaviour. This study suggests that worry over the cost of food wasted is a stronger influence on sustainable consumers than on mainstream consumers.

Although the literature highlights that the misinterpretation of expiry dates is a driver of food waste (Abeliotis et al., 2014; Milne; 2012; Parfitt, Barthel, & Macnaughton, 2010; Tsiros & Heilman, 2005, WRAP, 2007; 2009; Wilson et al., 2017), this factor was not found to be a determinant of food waste. This finding could be attributed to the nature of the sample. The study revealed one segment, the label-conscious/sensory consumer, suggesting that consumer confidence in their ability to read food labels is high amongst this segment, the well-educated, sustainability-oriented consumers.

5.1 Implications for intervention development

This study is valuable since it suggests that interventions and a segment-specific campaign, based on attitudes, demographics (i.e., having children) and lifestyle (sustainability lifestyles, an eating out habit) could be useful. About the food waste defenders, a targeted campaign should highlight the environmental problems associated

with food waste since this segment believes that food waste is natural and no problem for the environment and that packaging waste is a much more severe problem than food waste. A targeted campaign should stress the positive aspects of saving money, given that these consumers state that they might waste less food if they were given information on the cost of the food they throw away.

In relation to the waste-conscious consumers, those who are already aware of the problem of food waste, who are worried about the money they waste and feel guilty about the impacts of waste on the environment, they seem to face constraints leading to the attitudes-behaviour gap. Eating outside of the home is a hot spot for food wastage so interventions could raise awareness of people's unpredictable lifestyles. Interventions could focus on the relationship between buying food for home-cooked foods and consuming meals outside of the home, emphasising how modern lifestyles result in over-provisioning, and in turn waste. Consumers could benefit from tools to help them anticipate eating out patterns (e.g., apps that provide better insight into daily routines and the minimum amount of food needed for home-cooked meals). Educating affluent parents about the 'green gap' and giving them information on how to reduce, share or donate any excess food they might have at home, as a result of eating out regularly, could be helpful. Also, interventions could target children, such as getting them involved in shopping for food, growing vegetables and emphasising the fun and playful aspects of avoiding food waste (using a 'mini bin' intervention where school-children are challenged to reduce their food waste and ensure that any waste generated can fit into a tiny bin). Therefore children could apply "pester power", which is the ability of children to influence parental purchasing (Solomon, Russell-Bennett, & Previte, 2019, p. 371), albeit in a positive way and remind their parents to stop wasting food or prepare more home-cooked meals. Alternatively, a 'grumpy bin' intervention (Altarriba et al., 2017)

could be used, and it is suggested that if an inanimate object such as a school bin is given anthropomorphic traits and children see an unhappy face when they throw away food into a bin, then this could discourage waste. Schools have a role to play in socialising young children and instilling high respect for food. Eco-schools are beginning to attract the attention of scholars (Cincera & Krajhanzl, 2013), and they have a role to play in encouraging a shift to more sustainable lifestyles. Given that it is difficult to modify habits, targeting the 'away-from-home' food consumption segment is recommended. Partnerships with restaurants and other actors are needed to remind consumers of the food left in the fridge at home (i.e., posters) and encourage the use of 'doggy bags'. Research on interventions shows that a brief, visual format, rather than a lengthy, instruction-based format, is quite effective in promoting pro-environmental behaviour (Oniga, 2018). Since eco-conscious consumers tend to grow their own food and eat organic and locally grown food, they could also be reached through farmers' markets, organic restaurants and gardening events, either face-to-face or online. As noted by Quested et al. (2013), there is merit in working with organisations that are focused on other food-related issues, and that can deliver multiple positive outcomes.

For the food-saver segment that is already making an effort to avoid food waste, no specific interventions are needed, but such consumers could be encouraged to share their food waste management practices with others.

5.2 Future research and limitations

Achieving a change in food behaviours in particular households requires an understanding of segmentation variables which should underpin successful intervention programs. Future research would benefit from comparing eco-conscious or 'green' consumers with mainstream consumers, as well as testing the acceptability of various

interventions proposed here. Apart from a few studies (Jörissen et al., 2015; Mallinson et al., 2016; Aschemann-Witzel et al., 2018), there is relatively little scholarly research that focuses on specific segments. Future researchers might ask respondents to weigh in on why they think food waste persists in eco-friendly households, thus taking a phenomenological approach. Ethnographic research should be conducted with other sorts of families, such as 'deep-green' consumers or within anti-consumption cultures, recognising the diversity of sustainability-oriented segments (Martin & Schouten, 2014). Finally, future research could incorporate other variables not considered in this study, such as food-related lifestyles (Grunert et al., 2001; Aschemann-Witzel et al., 2018), healthy lifestyles (Savelli, Francioni, & Curina, 2020), shopping, cooking and storage practices within the household (Parizeau et al., 2015), pro-environmental values, healthy living, thriftiness and level of involvement with food. This study had its limitations, such as the potential for respondents to give socially desirable responses and the reliance on self-reported data.

6. Conclusions

This study illuminates the factors that are associated with food waste patterns, but in a relatively unexplored context, sustainability-oriented lifestyles. The findings of this research are concordant with but extend, previous research. Food waste is a part of everyday life and a reflection of affluence, consumer lifestyles and eating out habits. This study addresses several limitations in the literature. Most studies explore mainstream consumers, generalised attitudes towards food waste and typical food-related practices.

Furthermore, the use of econometric techniques is rare in food waste literature. The findings suggest that certain consumers might appear 'green' and demonstrate a waste

consciousness, but they, nonetheless, behave in an unsustainable way and throw away edible food. A research focus on food waste in niche markets is valuable since scholars will be better equipped to understand the tensions faced by food consumers in their daily lives and develop solutions to the food waste problem.

Author Contributions

Hongbo Liu was in charge of project design and analysis and preparing drafts of the manuscript. Breda McCarthy co-designed the project, collected data and prepared drafts of the manuscript. Both authors contributed equally to this manuscript.

Declaration of interest statement

The authors report no conflict of interest.

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