Examining Household Food Waste Decisions: A Vignette Approach

Brenna Ellison and Jayson L. Lusk

Abstract: Although food waste is increasingly recognized as an environmental and food security problem, there remains uncertainty over its primary contributors. Some food waste analyses seem to treat household food waste as a "mistake" or careless decision; however, consumer decisions to waste likely reflect tradeoffs and economic incentives. These issues were explored in large surveys of U.S. food consumers using both within- and between-subject designs, where we study consumers' decisions to discard food in different scenarios that vary safety, price, and opportunity costs. We find that food waste is a function of consumers' demographic characteristics, and that decisions to discard food vary with economic incentives.

Key Words: food waste; consumer waste; vignette methodology; household behavior;

1. Introduction

Food waste is argued to be a problem at virtually every point along the supply chain and is capturing the attention of policymakers worldwide. Gustavsson et al. (2011) estimated that one-third of the food produced for consumption globally is lost or wasted. In the U.S., Buzby, Wells, and Hyman (2014) estimated that 31% of food available at the retail and consumer levels was wasted, translating to a loss of $161.6 billion and 141 trillion calories in 2010.

While many efforts are focused on food waste reduction, the waste decision is rarely framed as an economic decision. However, there are likely instances where the decision to waste (as opposed to the decision to save or keep) may be optimal, depending on one's preferences, incentives, and resource constraints. Becker (1965), for example, suggested that Americans should be more wasteful than people in lower-income countries because Americans' opportunity cost of time is much greater than that in other countries. Daniel (2016) posited a different rationale. She found that low-income households in the U.S. bought fewer fruits and vegetables than higher income consumers because they were more risk averse regarding waste. High-income households were more willing to let food be wasted in hopes that their children would eventually acquire a taste for more healthy foods. As these and other studies suggest, the decision to waste may not be a "mistake" or due to a lack of information, but rather results from legitimate economic incentives and tradeoffs.

None of this is to say that food waste is not a serious issue. There is mounting concern over the loss of scarce natural resources such as land, water, and energy that are inputs in the food production system (Thyberg and Tonjes, 2016; Buzby, Wells, and Hyman, 2014; Gunders, 2012). Gunders (2012) reported that 10% of the total U.S. energy budget, 50% of U.S. land, and 80% of U.S. freshwater consumed is used to move food from farm to fork, yet when food is

wasted, such inputs are considered to be wasted as well. With the global population expected to reach 9.3 billion by 2050, there is also an urgency to reduce food waste in hopes of (1) increasing the amount of food available to consume and (2) decreasing food prices (Buzby, Wells, and Hyman, 2014).

The cost of food waste has driven efforts in both the private and public sectors to reduce food waste along the supply chain. For example, France recently passed a new law requiring supermarkets to donate unsold food to charity. Public policies are likely to be made more effective by a better understanding of the economic forces driving decisions to discard food. At the farmer-producer level, much academic research has been devoted to reducing postharvest losses, particularly in developing countries (see Affognon et al., 2015; Hodges, Buzby, and Bennett, 2011 for discussions). At the foodservice (restaurant) level, food tracking technologies have been introduced that help kitchens track the quantity of food wasted before it reaches consumers' plates. The most prominent example is the LeanPath food waste tracking software (www.leanpath.com). In addition, initiatives have been formed to bring food industry leaders together to share knowledge and identify best practices to reduce food waste in their operations. The Food Waste Reduction Alliance (FWRA) is one such effort that unites three of the food sector's main trade associations: the Grocery Manufacturers Association, the Food Marketing Institute, and the National Restaurant Association (FWRA, 2013). Other initiatives that aim to share best practices for waste reduction and food recovery across the supply chain include the U.S. Food Waste Challenge (USDA, 2013); the Waste and Resources Action Programme (WRAP) in the United Kingdom (WRAP, 2017); and the global SAVE FOOD initiative (FAO, 2016).

Despite these efforts, there has been less attention on food waste at the household level. The U.S. Food Waste Challenge and the SAVE FOOD initiative posit that food waste awareness and knowledge need to increase in households, but fewer efforts have been made to understand how households (and the consumers in them) actually make waste decisions.[1] The academic research to date has primarily been descriptive in nature, gauging consumers' knowledge of and attitudes toward food waste, as well as their performance of waste-promoting or waste-reducing behaviors (Qi and Roe, 2016; Mondéjar-Jiménez et al., 2016; Stancu, Haugaard, and Lähteenmäki, 2016; Neff, Spiker, and Truant, 2015; Parizeau, von Massow, and Martin, 2015; Graham-Rowe, Jessop, and Sparks, 2014; Stefan et al., 2013). However, to our knowledge there has been little empirical work considering economic factors that influence consumers' utility maximizing decisions to throw out food.

The purpose of this research is to examine household (consumer) food waste decisions. Because measurement of food waste is fraught with difficulty, our first contribution is the application of vignette methodology to the issue of food waste. Our second contribution is to systematically determine how decisions to waste food vary with factors such as price, location, cost of replacement, and freshness among other factors. The empirical analysis is concentrated on specific food waste decisions: one focused on leftovers from a fully prepared meal and a second related to a single product (milk). The empirical results show that decisions to discard food are a function of consumers' demographic characteristics and some of the factors experimentally varied in the vignette design.

[1] One notable exception is the WRAP program in the United Kingdom. This research group has undertaken rigorous household food waste audits (to learn more about the methodology used, see Quested, Ingle, and Parry, 2013) and has developed an extensive consumer-facing education campaign, Love Food Hate Waste (for an evaluation of the impact of this campaign on household food waste behavior, see Quested and Ingle, 2013).

2. Background and Literature Review

2.1 Food Waste at the Household (Consumer) Level

The current literature on household food waste is largely descriptive in nature. Researchers have worked to identify and understand several constructs related to food waste including: consumers' knowledge and awareness, attitudes, motivations, and behaviors. Much of this work has taken place in European countries (Lazell, 2016; Mondéjar-Jiménez et al., 2016; Stancu, Haugaard, and Lähteenmäki, 2016; Graham-Rowe, Jessop, and Sparks, 2014; Quested et al., 2013; Stefan et al., 2013; Williams et al., 2012; Refsgaard and Magnussen, 2009), with only a handful of studies to our knowledge examining consumers in the U.S. (Qi and Roe, 2016; Wilson et al., 2016; Neff, Spiker, and Truant, 2015).

In terms of knowledge and awareness, Neff, Spiker, and Truant (2015) found that U.S. consumers considered themselves to be relatively informed on the topic of food waste; 62% of study participants claimed to be at least 'fairly knowledgeable' on how to reduce waste in their own household, and 45% were able to correctly estimate the proportion of food wasted in the U.S. Knowledge on food waste reduction techniques was higher for older consumers and individuals with no children in the home (Neff, Spiker, and Truant, 2015). Stefan et al. (2013) also found that Romanian consumers were aware of food waste, with measures focusing on the awareness of the amount, type, and value of food that is wasted in the individual's household. One study (Parizeau, von Massow, and Martin, 2015) even linked waste awareness to lower food waste production; however, the awareness measurement was not clearly defined.

Attitudes toward food waste have been studied more extensively. Several studies (Mondéjar-Jiménez et al., 2016; Stancu, Haugaard, and Lähteenmäki, 2016; Graham-Rowe, Jessop, and Sparks, 2015; Stefan et al., 2013) have explored food waste behavior using the

Theory of Planned Behavior (TPB; Ajzen, 1991), where attitudes are the central construct. In these studies, consumers exhibited positive attitudes toward reducing food waste. Within the TPB framework, attitudes were positively related to intention not to waste as well as planning routines (Stancu, Haugaard, and Lähteenmäki, 2016; Mondéjar-Jiménez et al., 2016; Graham-Rowe, Jessop, and Sparks, 2015; Stefan et al., 2013). Outside of the TPB framework, Neff, Spiker, and Truant (2015) asked consumers how much it bothered them to throw out food (response options were 'not at all', 'a little' or 'a lot'). They found that 52% of respondents said wasting food bothered them 'a lot', yet this was less bothersome than letting a faucet drip or leaving lights turned on. Qi and Roe (2016) also explored attitudes toward food waste in U.S. consumers and found that attitudes load on to one of three principal components: perceived practical benefits of food waste (e.g., having the freshest foods, avoiding illness), guilt associated with food waste, and ability to reduce food waste. Interestingly, this study found high income households were more likely to agree with the attitude statements on the practical benefits of waste, confirming the intuition of Becker (1965) and qualitative insights of Daniel (2016).

Motivations have been conceptualized in two different ways in the food waste literature: (1) motivations for throwing out food and (2) motivations for reducing food waste. Research has shown that food safety concerns are a key reason U.S. and European consumers throw out food. Namely, consumers are worried about the possibility of food poisoning, which could adversely affect both work and home responsibilities (Qi and Roe, 2016; Wilson et al., 2016; Neff, Spiker, and Truant, 2015; Graham-Rowe, Jessop, and Sparks, 2014; Quested, Ingle, and Parry, 2013). This concern is often tied to confusion over label dates such as "use by", "sell by", or "best by" (Wilson et al., 2016; Newsome et al., 2014; Quested, Ingle, and Parry, 2013; Gunders, 2012). Wilson et al. (2016) found consumers exhibited the highest willingness to waste for foods

carrying the "use by" date language; however, WTW varied widely across products (yogurt, cereal, salad). Alternative motivations for wasting food include: only wanting to eat the freshest foods, household members do not like to eat leftovers, and a lack of concern due to personal time constraints or because the waste can be composted or will break down in the landfill (Qi and Roe, 2016; Neff, Spiker, and Truant, 2015). Through focus groups, Graham-Rowe, Jessop, and Sparks (2014) further identified that some consumers were willing to let food go to waste because they wanted to maintain their identity as a "good provider" and/or they preferred to minimize the number of trips to the store. Relatedly, Quested, Ingle, and Parry (2013) found that 31% of food wasted at the household level was due to over-preparation or over-serving.

A primary motivation for reducing food waste is saving money (Thyberg and Tonjes, 2016; Neff, Spiker, and Truant, 2015; Graham-Rowe, Jessop, and Sparks, 2014; Quested et al., 2013). Setting a good example for children, guilt, worry about hungry people, and environmental concerns have also been identified as motivating factors; however, multiple studies have noted that self-oriented or internal factors like saving money have trumped other-oriented or external factors like saving the environment (Neff, Spiker, and Truant, 2015; Graham-Rowe, Jessop, and Sparks, 2014; Quested et al., 2013).

Though household food waste has been relatively difficult to measure, researchers have identified several waste-promoting and waste-reducing behaviors. These behaviors have been related to both shopping and food preparation. Examples of waste-promoting shopping behaviors are over-purchasing food items that are on sale or in bulk packaging or shopping on an empty stomach; waste-reducing shopping behaviors would be things like taking an inventory of the kitchen before going shopping, making a list, and planning meals in advance (Thyberg and Tonjes, 2016; Stancu, Haugaard, and Lähteenmäki, 2016; Neff, Spiker, and Truant, 2015; Stefan

et al., 2013; Quested et al., 2013; Williams et al., 2012; Gunders, 2012). In terms of food preparation, waste-promoting behaviors would be preparing too much food, throwing away leftovers, and forgetting to use food before it goes bad. Waste-reducing behaviors would be extending product shelf-life through freezing and finding ways to cook with leftovers (Thyberg and Tonjes, 2016; Stancu, Haugaard, and Lähteenmäki, 2016; Neff, Spiker, and Truant, 2015; Quested et al., 2013; Gunders, 2012).

The literature to date has provided an understanding of consumers' knowledge, attitudes, and behaviors related to food waste; however, much of the focus has been broad, asking about food waste more generally. While this approach may offer a baseline estimate of waste in the home, it does not account for differences in waste behavior based on product type, cost, preparation, or other individual-level characteristics. When contemplating throwing food out, a consumer may consider different attributes for a banana than they do for yesterday's leftovers. In the present study, we aim to fill this gap by exploring behaviors for two distinct waste decisions – one for leftovers from a fully prepared meal and one for a carton of milk in a context where waste is clearly defined and where we can experimentally manipulate economic variables of interest. We examine consumers' value of the different factors in each decision context when determining the likelihood of wasting the food in question; further, we explore the potential for heterogeneity in these decisions by interacting each decision factor with a host of sociodemographic variables.

2.2 The Vignette Method

Our empirical research relies on the so-called vignette method. Vignettes are defined as "short descriptions of a person or a social situation which contain precise references to what are thought

to be the most important factors in the decision-making or judgment-making processes of respondents" (Alexander and Becker, 1978, p.94). The vignette methodology has its origins in the field of social psychology (see Alexander and Becker, 1978 for a discussion), where it was used to simulate jury decision-making and assigning responsibility in crimes and/or accidents. However, the use of vignettes has extended to other social science disciplines including management (see Aguinis and Bradley, 2014 for a review) and economics (Kapteyn, Smith, and van Soest, 2007; Epstein, Mason, and Manca, 2008; Kristensen and Johansson, 2008).

It has been argued that, in some cases, survey/interview questions may be too vague or difficult for respondents to answer. In the case of food waste, for example, several studies have asked consumers to estimate the proportion of food thrown out in their household (Stancu, Haugaard, and Lähteenmäki, 2016; Graham-Rowe, Jessop, and Sparks, 2015; Neff, Spiker, and Truant, 2015; Stefan et al., 2013). The question is conceptually straightforward, but it can be challenging for respondents to answer (and for researchers to interpret) because definitions of food waste vary across consumers, meaning responses will reflect each individual's own characterization of food waste. Further, from this question, it is impossible to know which criteria consumers use when deciding whether or not a food should be thrown out. The vignette methodology can help to overcome these limitations by providing a more concrete scenario which accounts for the most likely decision criteria (in the case of food waste, for example, expiration date, smell, cost of replacement, etc.) and holds these criteria constant across respondents, allowing for standardization (Alexander and Becker, 1978).

Aguinis and Bradley (2014) identify two types of vignette studies. The first is a between-subjects vignette design where respondents are randomly assigned different versions of the same basic vignette. The second is a within-subjects vignette design where respondents are presented

with multiple vignette scenarios and asked to make decisions between them. Aguinis and Bradley (2014) note that the between-subject design allows for the examination of explicit decision processes and outcomes while the within-subject design examines the implicit decision processes and outcomes. In the present study, we utilize both between-subject and within-subject vignette approaches.

3. Empirical Study 1: Leftovers Vignette

In the first study, we examined a waste decision related to leftovers from a fully prepared meal. This waste decision may be different for consumers relative to a single-product like juice or milk because this is a value-added product rather than a single-ingredient; therefore, the time cost of preparation may be a factor in the decision – though the importance of this factor could depend on whether or not the consumer is the one actually incurring that cost. Further, Stancu, Haugaard, and Lähteenmäki (2016) note that the reuse of leftovers may be an especially important behavior to target in terms of reducing food waste. The basic vignette shown to respondents is provided below; variables that were experimentally varied across vignettes are in brackets.

> *Imagine you just finished eating dinner [at home; out at a restaurant]. The meal cost about [$8; $25] per person. You're full, but there is still food left on the table – enough for [a whole; half a] lunch tomorrow. Assuming you [don't; already] have meals planned for lunch and dinner tomorrow, what would you do?*

Data collection for Study 1 took place in the fall of 2015 via an online survey. For this study, there were 1,016 participants, with 904 individuals randomly assigned to the between-

subject design and 112 randomly assigned to the within-subject design (see table 1 for participant socio-demographic information).

3.1 Methods: Between-Subject Design

The leftovers vignette had four attributes (preparation location; price; amount left; and future meal plans) varied at two levels each. From the 16 possible vignettes ($2^4 = 16$), we selected a subset of eight vignettes such that each variable was uncorrelated with the other (an orthogonal, fractional factorial design).

Respondents were randomly assigned to evaluate one (and only one) of the eight vignettes, with approximately 113 respondents per scenario. For the vignette presented, respondents were first presented with two response options: "Throw away the remaining dinner" or "Save the leftovers to eat tomorrow". As a follow-up, we asked, "Thinking more precisely about your actions, what would you do?" where respondents could choose one of the following five categories:

> I'd definitely throw away what's left of dinner;
> I'd probably throw away what's left of dinner;
> I'm not sure whether I'd throw away what's left of dinner or save the leftovers to eat tomorrow;
> I'd probably save the leftovers to eat tomorrow; or
> I'd definitely save the leftovers to eat tomorrow.

3.2 Methods: Within-Subject Design

In the within-subject design, each participant was presented with the eight vignettes used in the between-subject design. Rather than evaluating each one individually, however, they were asked to rank each of the eight scenarios from one to eight, where one was the most likely to save the leftovers and eight was the most likely to throw away the remaining dinner. The order of the appearance of the scenarios was randomized across participants. Within this design, it is

important to note that we cannot ascertain the overall propensity for food waste; rather, we can only obtain information on the relative likelihood of wasting in one scenario vs. another.

3.3 Results: Between-Subject Design

Table 2 provides the summary statistics for the between-subject design. For each of the eight vignettes, the percentage who said they would throw out the leftovers (on the dichotomous choice question), the waste score (on the 5-point scale where 1=definitely save and 5=definitely throw out), the attributes of the vignette scenario, and the number of participants who were assigned to the vignette are provided. From the table we see that overall, participants were unlikely to waste the leftovers, with the percent wasting ranging from only 7.1% to 19.5%. Further, the mean likelihood of waste scores were well below the midpoint for all eight vignettes, leaning toward 'definitely save'.

To determine which attributes impacted the waste decision for leftovers, we estimated logistic and OLS regressions for the dichotomous and scale waste questions, respectively (see table 3).[2] The model 1 specifications isolate the effects of the vignette experimental variables. In the logistic regression, there is a negative relationship between cost and waste, such that consumers were less likely to waste more expensive meals. Conversely, in the OLS regression estimates, we found that leftovers for a whole meal were less likely to be wasted than for half a meal. In the model 2 specifications, we add in socio-demographic characteristics. In the logistic results, the negative relationship between cost and waste persists, and in addition the source of the leftovers becomes significant. Leftovers from a meal at home were less likely to be wasted

[2] For the Likert scale waste question, it is also possible to estimate an ordered logit regression as opposed to the OLS regression. We ran both specifications and found the results were largely consistent for the leftovers and milk studies. The ordinal logit estimates, however, cannot be interpreted as marginal effects. For ease of interpretation, we discuss the OLS estimates. Results from the ordered logit estimates are available in the appendix (Table A1 for leftovers results; Table A2 for milk results).

than leftovers from a restaurant. In the model 2 OLS results, however, we no longer observe significant impacts for any of the vignette attributes. Regarding participant characteristics, we find in both the logistic and OLS models that males, younger participants (ages 18-44), SNAP recipients, higher income households, and households with children were significantly more likely to throw out leftovers. Democrats were also more likely to throw out the leftovers than non-democrats – but only in the OLS specification.

The results in table 3 offer evidence of which consumers are more or less likely to throw out the leftovers; however, these models do not account for heterogeneity in preferences for the different vignette attributes. To explore this, we extend the OLS regression model 2 specification to include interactions for each socio-demographic variable with each vignette attribute. These results are shown in table 4.

The table reveals that females were generally less likely to throw out the leftovers than males (intercept column) and meals from home had a lower likelihood of waste than meals from a restaurant. Interestingly, though, is the interaction between age and source of the leftovers. Participants ages 18-24 were significantly more likely to throw out leftovers from home relative to participants ages 65 and older (there was also a significant effect for 45-54 year olds, but at a much smaller magnitude); this result may be due to differences in ability/skill at preparing creating new meals from leftovers. We also observed heterogeneity on the basis of meal cost. Specifically, respondents ages 25-34 and high income participants were less price sensitive (and thus, more likely to throw out the leftovers even when the cost of the meal is high) than those participants in the 65 and older and low income categories, respectively. Participants who receive benefits from the Supplemental Nutrition Assistance Program (SNAP), conversely, are less likely to throw out the leftovers when the meal cost is high relative to non-recipients.

Though there were few differences in waste preferences for the amount of leftovers and future meal plans, our results revealed that individuals with a college degree were less likely to throw out leftovers for a whole meal, and participants ages 55-64 were significantly more likely to waste leftovers even though they had no future meal plans (results compared to people without a college degree and participants 65 years and older, respectively).

3.4 Results: Within-Subject Design

The within-subject design presented each respondent with all eight vignette scenarios, and they were asked to rank the vignettes on a relative waste scale (1=most likely to keep; 8=most likely to throw out). Table 5 presents the mean ranking for each of the eight vignettes, along with a summary of the attributes in each scenario. Here, we see that respondents were most likely to save the leftovers from a meal cooked at home when the meal cost $25 per person, provided enough leftovers for a whole meal, and there were no future meal plans (mean ranking = 2.866); in contrast, respondents were most likely to throw out leftovers from a restaurant meal when the meal cost $8 per person, provided leftovers for only half a meal, and there were future meal plans in place (mean ranking = 6.027).

Turning to table 6, we see that three of the four decision factors significantly impacted the waste/save decision. In particular, respondents were less likely to throw out the leftovers when (1) the meal had a higher cost per person, (2) there were enough leftovers for a whole meal rather than half a meal, and (3) there were no future meal plans in place.[3] Model 1 shows these attributes account for approximately 17% of the variation in the waste/save rankings.

[3] In the model 1 specification, the data is pooled across all subjects, meaning there are eight observations (rankings) per subject for a total of 896 observations. In the model 2 specification, we use each individual's rankings to estimate subject-specific regression models and then report the average the coefficients estimated across all subjects.

By estimating subject-specific regressions, we can then take the coefficients estimated for each individual and then in a second-stage regression model them as a function of socio-demographic variables to account for heterogeneity in preferences. These results are presented in table 7. From the table, we can see in the intercept column that younger participants (ages 18-44) were overall less likely to throw out the leftovers relative to those 65 years and older. This finding seems counterintuitive relative to the between-subject results in table 10 as well as the results from study 1. However, it should be noted that these same younger participants were also significantly less price sensitive compared to their older counterparts, meaning they were more likely to throw out higher-priced leftovers. Based on the range of prices used in this study ($8 - $25), we calculated that participants 65 years and older are more likely to throw out leftovers up to a certain dollar amount ($18.95, $12.49, and $12.65 when compared to 18-24, 25-34, and 35-44 year olds, respectively), yet once the meal cost exceeds this amount, the younger group becomes more likely to throw out the leftovers, all else held constant. We also observed that medium-income households were overall more likely to throw out the leftovers relative to low-income households, but the reverse was true when neither group had future meal plans. Lastly, we found that respondents with children in the home were less likely to throw out higher-priced leftovers but more likely to throw out leftovers when there was enough for a whole meal compared to individuals with no children in the home. Socio-demographics only explained a limited proportion of the variation in the estimated coefficients (r-squared values ranged from 12% for future meal plans to 25% for meal cost per person).

4. Empirical Study 2: Milk Vignette

For the second study, we considered the waste decision process for a single product, milk. We chose milk because it is a commonly purchased product in U.S. households, and it has been identified as a product that is regularly thrown out. Gunders (2012) estimated that 20% of milk is lost along the supply chain, with the largest losses occurring at the household level. The vignette presented was about a carton of milk in the participant's refrigerator. The variables that were experimentally varied are generally comparable to those in the leftovers vignette; however, we replaced the source attribute (home vs. restaurant) with a sensory attribute which indicated whether the milk smelled fine or slightly sour. The basic vignette shown to survey respondents is provided below; variables that varied across vignettes are in brackets.

> *Imagine this evening you go to the refrigerator to pour a glass of milk. While taking out the carton of milk, which is [one quarter; three quarters] full, you notice that it is one day past the expiration date. You open the carton and the milk smells [fine; slightly sour]. [There is another unopened carton of milk in your refrigerator that has not expired; no statement about replacement]. Assuming the price of a half-gallon carton of milk at stores in your area is [$2.50; $5.00], what would you do?*

Data collection for Study 2 took place in the fall of 2015 via an online survey. In total, 1,003 individuals participated; 894 were randomly assigned to the between-subject design, and 109 were randomly assigned to the within-subject design. Participant characteristics are provided in table 8.

4.1 Methods: Between-Subject Design

Like the leftovers vignette, the milk vignette had four attributes (fullness of carton, smell, presence of an unopened carton, and price) varied at two levels each. From the 16 possible vignettes, we selected an orthogonal, fractional factorial design of eight vignettes.

Respondents were randomly assigned to one of the eight vignettes; thus, there were approximately 112 respondents per vignette. For the vignette presented, respondents were first presented with two response options: "Pour the expired milk down the drain" or "Go ahead and drink the expired milk". Following this question, there was a follow-up that asked, "Thinking more precisely about your actions, what would you do?" Respondents could choose between the following five response options:

> I'd definitely pour the expired milk down the drain;
> I'd probably pour the expired milk down the drain;
> I'm not sure whether I'd discard the milk or drink it;
> I'd probably drink the expired milk; or
> I'd definitely drink the expired milk.

4.2 Methods: Within-Subject Design

Each participant in the within-subject design was presented with the eight vignettes used in the between-subject design. They were asked to rank each of the eight scenarios from one to eight, where one was the most likely to drink and eight was the most likely to pour down the drain. The order of the appearance of the scenarios was randomized across participants.

4.3 Results: Between-Subject Design

Table 9 provides the summary statistics for the between-subject design. From these results, it appears that there are at least some scenarios where consumers are much more likely to pour out the milk relative to others. The four vignettes with the highest probability of waste had one attribute in common: milk that smells slightly sour. It should also be noted, though, that the milk

vignettes overall had a higher likelihood of waste relative to the leftovers vignette, suggesting that the expiration date factor likely also contributed to the waste decision.

To further examine which factors are likely to lead consumers to pouring out the milk (i.e., food waste), we estimated a logistic regression for the dichotomous waste variable and an ordinary least squares (OLS) regression for the 5-point likelihood of waste scale (ordered logit results available in Table A2 in the Appendix). Table 10 presents the regression results. Looking at the model 1 specifications (experimental variables only), it is clear that the smell variable drives the waste decision in the case of milk. When milk smells fine (as opposed to slightly sour), consumers were significantly less likely to pour out the milk. The price, fullness, and replacement variables had no statistically significant impact on the waste decision. In the model 2 specifications (experimental variables and socio-demographics), smell remains a highly significant predictor of waste; however, we also observe differences in wasting behavior based on age and SNAP recipient status. Particularly, we observed that younger respondents (ages 18-44) were significantly more likely to pour out the milk relative to respondents who were 65 years and older – a result consistent with past research (Thyberg and Tonjes, 2016; Quested et al., 2013). Interestingly, we found that those participants who received SNAP benefits were more likely to pour out the milk, on average, than those who did not receive benefits. One potential explanation for this is that SNAP recipients are more time constrained relative to non-recipients which could lead to more waste. Indeed, several studies have found that time constraints can often be as problematic for SNAP recipients as monetary constraints, resulting in less time for grocery shopping, food preparation, and eating (Beatty, Nanney, and Tuttle, 2014; Mancino and Guthrie, 2014; Davis and You, 2011). Another possibility could be that many SNAP participants

also received benefits from the Women, Infants, and Children (WIC) program[4]; Darko, Eggett, and Richards (2013) found that WIC recipients often reported having more milk or juice than they could consume, which could result in a higher likelihood of waste.

Table 11 extends the OLS regression results to explore the potential for heterogeneity in preferences for the vignette attributes. In the intercept column, we see that Democrats and obese participants were overall more likely to pour out the milk than their non-Democrat and non-obese counterparts, respectively. The table further reveals these same two groups are more likely to pour out the milk when the carton is fuller. We found that individuals with children in the home, non-democrats, and 45-54 years old were more price-sensitive, such that they were less likely to pour out the milk when the cost of replacement was high. Finally, we found that SNAP recipients were less likely to waste the milk when there was a replacement present compared to non-recipients.

4.4 Results: Within-Subject Design

Table 12 presents the summary statistics for the within-subject design. Similar to table 9, we observe two clusters of means. The cluster that is more likely to drink the milk (rankings closer to 1) all share the characteristic that the milk smells fine, while the other cluster that is more likely to pour out the milk (rankings closer to 8) all share milk that smells slightly sour.

We confirmed the impact of the smell variable on the decision to waste by running an OLS regression on the rankings as a function of the vignette variables. Table 13 shows the two model specifications which ultimately yield the same result – that consumers are significantly less likely to throw out milk that smells fine relative to milk that smells slightly sour.

[4] Geller, Harrington, and Huang (2012) note that 53% of WIC recipients were also SNAP recipients in 2009.

Using the subject-specific regression estimates from model 2 in table 13, we can examine heterogeneity in preferences by interacting each decision factor with our socio-demographic variables (see table 14). The table shows there was significant heterogeneity in the smell attribute. Here, males and younger participants (with the exception of the 45-54 year olds) were more likely to pour out milk when it smells fine relative to females and older participants (ages 65 and up), respectively. Within the replacement category, our results revealed that females and higher income consumers were more likely to pour out the milk when a replacement was readily available. Though there was less variation in preferences based on price and fullness, we found that individuals who were 55-64 years old were less likely to waste when prices were high (relative to those 65 years and older) and that SNAP recipients were less likely to pour out the milk when the carton was fuller (relative to non-recipients). Overall, socio-demographic variables accounted for 13-16% of the variance in the estimated coefficients, with the exception of the smell coefficient which had a higher r-squared value of 0.27.

5. Discussion

Reducing food loss and food waste has become a goal for producers, the food industry, and policymakers alike. While several efforts are underway to reduce food waste along the supply chain, the end of the chain (households and consumers) has received less attention. To date, the literature has examined consumers' knowledge, attitudes, and waste-related behaviors, yet few studies have analyzed food waste as an economic decision. It is stated that food waste should be minimized, yet it is possible that some consumers may derive more utility from throwing out a food than keeping it. Indeed, Becker (1965) suggests that in developed countries like the U.S., the cost of one's time may be higher than the cost of keeping and preparing food, so a decision to

waste may be optimal. Thus, the purpose of this study was to examine the food waste decision process in an economic framework. We empirically examine two specific food waste decisions using a vignette methodology. Through the vignettes, we can assess how different economic variables influence the decision to keep/waste as well as whether heterogeneity exists in food waste behaviors.

In the first vignette, we consider the keep/waste decision for leftovers from a fully prepared meal. Here, we found many of the vignette attributes are important in the keep/waste decision. Depending on the study design (between-subject or within-subject) and the model specification used, each of the attributes could significantly impact the waste decision. Generally, respondents were less likely to waste the leftovers when: the meal cost was high, there were enough leftovers for a whole meal, there were no future meal plans, and the meal was prepared at home. Many of these relationships have a very obvious time component. Leftovers can save individuals time when there is enough for a whole meal and there are no future meal plans; further, when a meal is prepared at home, there is already a time cost for that meal (albeit a sunk cost) that people do not want to discount by throwing the leftovers out.

In the second vignette, we consider a single product, milk. In this case, the decision to waste was heavily impacted by food safety considerations as reflected in the smell of the product. Not surprisingly, milk that smelled slightly sour was more likely to be thrown out than milk that smelled fine – this likely reflects individuals' aversion to consuming a product they believe could make them or their family members ill (Graham-Rowe, Jessop, and Sparks, 2014; Neff, Spiker, and Truant, 2015). However, it should be noted that a subset of consumers opted to throw out the milk even when it smelled fine. This may be explained by the expiration date information provided in the vignette; in all scenarios, the milk was one day past its expiration

date, which may have caused some consumers to throw it out regardless of sensory properties. Research has shown that date label confusion may contribute to food waste (Wilson et al., 2016; Newsome et al., 2014; Quested, Ingle, and Parry, 2013; Gunders, 2012), so this finding provides further support for educational efforts and/or labeling reforms to improve consumers' understanding of date labeling terms.

When we looked at individual-level differences in food waste behavior, some general trends emerged. Consistent with past research (Quested et al., 2013; Thyberg and Tonjes, 2016), we found that younger individuals (18-44 years) were more likely to waste food than older consumers. These consumers were more likely to throw out the milk even when it smelled fine, and were more likely to throw out higher-priced leftovers. In the case of 18-24 year olds, they were also significantly more likely to throw out leftovers from meals prepared at home. One possible explanation for this may be individuals with lower marginal productivities in meal preparation are likely to waste more. It is likely that older individuals have acquired more skill in food preparation, and that retired individuals have more time for such activities. It may also be the case that younger consumers purchase more convenience-oriented items (frozen, microwavable, etc.) that are not well suited for leftovers.

Aside from age differences, we found that females were less likely to waste than males, and higher-income households were more likely to waste than lower-income households. Time use surveys show females spend more time than males cooking (Landefeld, 2009), which likely relates to a higher level of acquired skill in food preparation, which may result in less waste. The income result also follows from Becker's (1965) household production model in that high-income people would have a higher opportunity cost of their time and thus would be expected to waste more. Research by Daniel (2016) and Qi and Roe (2016) further confirms that higher-

income households can tolerate (or may ever prefer) more waste. Understanding the heterogeneity in waste behaviors may enable policymakers or other food waste advocacy groups to better target educational efforts to the households most susceptible for high levels of food waste.

While this study is one of the first to examine the food waste decision in an economic framework, more work is needed to fully understand food waste at the household level. One limitation of the current study is that waste behaviors are self-reported, which may underestimate food waste (Food Loss and Waste Protocol, 2016). However, as long as the self-report bias is constant across treatments, we can still identify the marginal effects of our decision attributes even if our overall estimated level of waste is underestimated. Future studies should work to replicate these findings where behaviors are non-hypothetical and do not rely on self-reported waste data. In addition, future research should more explicitly account for time costs in the decision making process, including time spent shopping for and preparing food, to quantify the trade-offs households are willing to make between time and food waste. It may also be important to consider how the appearance of the food impacts the waste decision. In the case of produce and/or meat, the visual appearance may be one heuristic that consumers rely on when making the keep/waste decision. Neff, Spiker, and Truant (2015) asked consumers about the amount of brown they were willing to tolerate on bananas, but this attribute was isolated. The study did not consider the cost of replacement, whether a readily-available replacement existed, and so on, so one cannot draw a conclusion as to how appearance ranks in the decision process relative to other attributes.

This study revealed that the keep/waste decision is not always a straightforward one. It is an economic decision, with both costs and benefits; the outcome depends on several contextual

factors as well as individual-level characteristics. For waste reduction efforts to be effective, it is critical to understand the household decision process as well as the potential heterogeneities that exist across households.

References

Affognon, Hippolyte, Christopher Mutungi, Pascal Sanginga, and Christian Borgemeister. 2015. "Unpacking Postharvest Losses in Sub-Saharan Africa: A Meta-Analysis." *World Development*, 66:49-68.

Ajzen, Icek. 1991. "The Theory of Planned Behavior." *Organizational Behavior and Human Decision Processes*, 50(2):179-211.

Alexander, Cheryl S., and Henry Jay Becker. 1978. "The Use of Vignettes in Survey Research." *Public Opinion Quarterly*, 42(1):93-104.

Beatty, Timothy K.N., M. Susie Nanney, and Charlotte Tuttle. 2014. "Time to Eat? The Relationship between Food Security and Food-Related Time Use." *Public Health Nutrition*, 17(1):66-72.

Becker, Gary S. 1965. "A Theory on the Allocation of Time." *The Economic Journal*, 75(299):493-517.

Buzby, Jean C., Hodan F. Wells, and Jeffrey Hyman. 2014. "The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States." USDA Economic Research Service, Washington, DC, USA.

Cooke, L. 2007. "The Importance of Exposure for Healthy Eating in Childhood: A Review." *Journal of Human Nutrition and Dietetics*, 20(4):294-301.

Daniel, Caitlin. 2016. "Economic Constraints on Taste Formation and the True Cost of Healthy Eating." *Social Science & Medicine*, 148:34-41.

Darko, Janice, Dennis L. Eggett, and Rickelle Richards. 2013. "Shopping Behaviors of Low-Income Families During a 1-Month Period of Time." *Journal of Nutrition Education and Behavior*, 45(1):20-29.

Davis, George C., and Wen You. 2011. "Not Enough Money or Not Enough Time to Satisfy the Thrifty Food Plan? A Cost Difference Approach for Estimating a Money-Time Threshold." *Food Policy*, 36(2):101-107.

Epstein, David, Anne Mason, and Andrea Manca. 2008. "The Hospital Costs of Care for Stroke in Nine European Countries." *Health Economics*, 17(S1):S21-S31.

Food and Agriculture Organization of the United Nations (FAO). 2016. "FAO and Messe Düsseldorf lead the SAVE FOOD – Global Initiative on Food Loss and Waste Reduction." Available online at: http://www.fao.org/save-food/background/en/.

Food Loss and Waste Protocol. 2016. "Food Loss and Waste Accounting and Reporting Standard: Version 1.0." Available online at: http://www.wri.org/sites/default/files/FLW_Standard_final_2016.pdf.

Food Waste Reduction Alliance (FWRA). 2013. "About the Food Waste Reduction Alliance." Available online at: http://www.foodwastealliance.org/about-us-page-2/.

Geller, Daniel M., Marcia Harrington, and Gary Huang. 2012. "National Survey of WIC Participants II: Volume 1: Participant Characteristics (Final Report)." United States Department of Agriculture and Food and Nutrition Service Special Nutrition Programs Report No. CN-10-NSWP2-R2. Available online at: http://www.fns.usda.gov/sites/default/files/NSWP-II.pdf.

Graham-Rowe, Ella, Donna C. Jessop, and Paul Sparks. 2014. "Identifying Motivations and Barriers to Minimising Household Food Waste." *Resources, Conservation and Recycling*, 84:15-23.

Graham-Rowe, Ella, Donna C. Jessop, and Paul Sparks. 2015. "Predicting Household Food Waste Reduction Using an Extended Theory of Planned Behavior." *Resources, Conservation and Recycling*, 101:194-202.

Gunders, Dana. 2012. "Wasted: How America is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill." Natural Resources Defense Council (NRDC) Issue Paper:12-06-B, Available online at: http://www.indianasna.org/content/indianasna/documents/NRDC_Wasted_Food_Report.pdf.

Gustavsson, Jenny, Christel Cederberg, Ulf Sonesson, Robert van Otterdijk, and Alexandre Meybeck. 2011. "Global Food Losses and Food Waste: Extent, Causes and Prevention." Food and Agricultural Organization, Rome, Italy.

Hodges, R. J., J. C. Buzby, and B. Bennett. 2011. "Postharvest Losses and Waste in Developed and Less Developed Countries: Opportunities to Improve Resource Use." *Journal of Agricultural Science*, 149:37-45.

Kapteyn, Arie, James P. Smith, and Arthur van Soest. 2007. "Vignettes and Self-Reports of Work Disability in the United States and the Netherlands." *The American Economic Review*, 97(1):461-473.

Kristensen, Nicolai, and Edvard Johansson. 2008. "New Evidence on Cross-Country Differences in Job Satisfaction Using Anchoring Vignettes." *Labour Economics*, 15(1):96-117.

Landefeld, J. Steven, Barbara M. Fraumeni, and Cindy M. Vojtech. 2009. "Accounting for Household Production: A Prototype Satellite Account Using the American Time Use Survey." *Review of Income and Wealth* 55(2):205-225.

Lazell, Jordan. 2016. "Consumer Food Waste Behaviour in Universities: Sharing as a Means of Prevention." *Journal of Consumer Behavior*, in press.

Mancino, Lisa, and Joanne Guthrie. 2014. "SNAP Households Must Balance Multiple Priorities to Achieve a Healthful Diet." *Amber Waves*, Available online at: http://www.ers.usda.gov/amber-waves/2014-november/snap-households-must-balance-multiple-priorities-to-achieve-a-healthful-diet.aspx#.VxbvhEfpjT8.

Mondéjar-Jiménez, Juan-Antonio, Guido Ferrari, Luca Secondi, and Ludovica Principato. 2016. "From the Table to Waste: An Exploratory Study on Behavior Towards Food Waste of Spanish and Italian Youths." *Journal of Cleaner Production*, in press.

Neff, Roni A., Marie L. Spiker, and Patricia L. Truant. 2015. "Wasted Food: U.S. Consumers' Reported Awareness, Attitudes, and Behaviors." *PLoS ONE*, 10(6): e0127881.

Newsome, Rosetta, Chris G. Balestrini, Mitzi D. Baum, Joseph Corby, William Fisher, Kaarin Goodburn, Theodore P. Labuza, Gale Prince, Hillary S. Thesmar, and Frank Yiannas. 2014. "Applications and Perceptions of Date Labeling of Food." *Comprehensive Reviews in Food Science and Food Safety*, 13(4):745-769.

Parizeau, Kate, Mike von Massow, and Ralph Martin. 2015. "Household-level Dynamics of Food Waste Production and Related Beliefs, Attitudes, and Behaviors in Guelph, Ontario." *Waste Management*, 35:207-217.

Qi, Danyi, and Brian E. Roe. 2016. "Household Food Waste: Multivariate Regression and Principal Components Analyses of Awareness and Attitudes among U.S. Consumers." *PLoS ONE*, 11(7): e0159250.

Quested, Tom, and Robert Ingle. 2013. "West London Food Waste Prevention Campaign Evaluation Report." WRAP Research Report, Project Code: CFP104-030. Available online at:

http://www.wrap.org.uk/sites/files/wrap/West%20London%20Food%20Waste%20Campaign%20Evaluation%20Report_1.pdf.

Quested, Tom, Robert Ingle, and Andrew Parry. 2013. "Household Food and Drink Waste in the United Kingdom 2012." WRAP Research Report, Project Code: CFP102. Available online at: http://www.wrap.org.uk/sites/files/wrap/hhfdw-2012-main.pdf.pdf.

Quested, T. E., E. Marsh, D. Stunell, and A. D. Parry. 2013. "Spaghetti Soup: The Complex World of Food Waste Behaviors." *Resources, Conservation and Recycling*, 79:43-51.

Refsgaard, Karen, and Kristin Magnussen. 2009. "Household Behaviour and Attitudes with Respect to Recycling Food Waste – Experiences from Focus Groups." *Journal of Environmental Management*, 90:760-771.

Stancu, Violeta, Pernille Haugaard, and Liisa Lähteenmäki. 2016. "Determinants of Consumer Food Waste Behavior: Two Routes to Food Waste." *Appetite,* 96:7-17.

Stefan, Violeta, Erica van Herpen, Ana Alina Tudoran, and Liisa Lähteenmäki. 2013. "Avoiding Food Waste by Romanian Consumers: The Importance of Planning and Shopping Routines." *Food Quality and Preference*, 28:375-381.

Thyberg, Krista L., and David J. Tonjes. 2016. "Drivers of Food Waste and their Implications for Sustainable Policy Development." *Resources, Conservation and Recycling*, 106:110-123.

United States Department of Agriculture (USDA). 2013. "USDA and EPA Launch U.S. Food Waste Challenge." USDA Press Release Number 0112.13, Available online at: http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=2013/06/0112.xml.

Waste and Resources Action Programme (WRAP). 2017. "Food Waste Reduction." Available online at: http://www.wrap.org.uk/food-waste-reduction.

Williams, Helén, Fredrik Wikström, Tobias Otterbring, Martin Löfgren, and Anders Gustafsson. 2012. "Reasons for Household Food Waste with Special Attention to Packaging." *Journal of Cleaner Production*, 24:141-148.

Wilson, Norbert L.W., Bradley J. Rickard, Rachel Saputo, and Shuay-Tsyr Ho. 2016. "Food Waste: The Role of Date Labels, Package Size, and Product Category." *Food Quality and Preference*, in press.

Table 1. Socio-Demographic Variables and Definitions for Study 1 (*N*=1016)

Variable	Definition	Sample Proportion
Female	1 if female; 0 if male	0.535
Age 18-24	1 if 18-24 years old; 0 otherwise	0.115
Age 25-34	1 if 25-34 years old; 0 otherwise	0.228
Age 35-44	1 if 35-44 years old; 0 otherwise	0.189
Age 45-54	1 if 45-54 years old; 0 otherwise	0.157
Age 55-64	1 if 55-64 years old; 0 otherwise	0.152
Age 65 and older	1 if 65 years or older; 0 otherwise	0.158
SNAP	1 if current SNAP recipient; 0 otherwise	0.143
College degree	1 if obtained college degree; 0 otherwise	0.495
Democrat	1 if identifies as a Democrat; 0 for all other parties	0.440
Obese	1 if BMI $\geq$ 30; 0 otherwise	0.279
Kids in household	1 if children under age 12 living in the household; 0 otherwise	0.325
Low Income	1 if annual income is less than $40,000; 0 otherwise	0.263
Medium Income	1 if annual income is $40,000-$99,999; 0 otherwise	0.459
High Income	1 if annual income is $100,000 or more; 0 otherwise	0.279

Table 2. Summary Statistics for Study 1, Between-Subject Design

Treatment	% Wasting[a]	Likelihood of Waste[b]	Location	Cost per Person	Amount of Meal Leftover	Future Meal Plans	Number of Obs.
1	14.90%	1.667	restaurant	$8	whole	no	114
2	19.50%	1.973	restaurant	$8	half	yes	113
3	8.00%	1.545	restaurant	$25	whole	yes	112
4	11.70%	1.721	restaurant	$25	half	no	111
5	12.30%	1.623	home	$8	whole	yes	114
6	12.30%	1.930	home	$8	half	no	114
7	7.10%	1.752	home	$25	whole	no	113
8	8.80%	1.602	home	$25	half	yes	113

[a] Based on dichotomous choice question with options "Throw out the leftovers" or "Save the leftovers"
[b] Based on 5-point scale response where 1="Definitely save" and 5="Definitely throw out"

Table 3. Regression Results for Study 1, Between-Subject Design

	Logistic Regression Estimates (*1=Waste; 0=Save*)		*OLS Regression Estimates* (*1=Save; 5=Waste*)	
Variable	Model 1	Model 2	Model 1	Model 2
Intercept	-1.186* (0.268)[†]	-3.429* (0.631)	1.904* (0.102)	1.299* (0.153)
Home vs. Restaurant	-0.332 (0.209)	-0.471* (0.230)	0.001 (0.074)	-0.028 (0.069)
Cost per Person	-0.034* (0.013)	-0.033* (0.014)	-0.008 (0.004)	-0.007 (0.004)
Whole vs. Half Meal Leftover	-0.241 (0.208)	-0.188 (0.227)	-0.160* (0.074)	-0.132 (0.069)
No Future Meal Plans vs. Plans	-0.061 (0.207)	-0.027 (0.225)	0.082 (0.074)	0.075 (0.069)
Female vs. Male	---	-0.796* (0.235)	---	-0.379* (0.070)
Age 18-24 vs. 65 and older	---	1.759* (0.562)	---	0.577* (0.136)
Age 25-34 vs. 65 and older	---	1.333* (0.528)	---	0.527* (0.120)
Age 35-44 vs. 65 and older	---	1.154* (0.549)	---	0.379* (0.129)
Age 45-54 vs. 65 and older	---	0.239 (0.603)	---	0.092 (0.123)
Age 55-64 vs. 65 and older	---	0.302 (0.612)	---	0.035 (0.123)
SNAP vs. Non-SNAP	---	0.717* (0.313)	---	0.515* (0.106)
College degree vs. No degree	---	0.318 (0.280)	---	0.122 (0.081)
Democrat vs. Other parties	---	0.413 (0.230)	---	0.207* (0.070)
Obese vs. Non-obese	---	-0.162 (0.275)	---	0.005 (0.078)
Kids in household vs. No kids	---	0.927* (0.262)	---	0.200* (0.086)
Medium vs. Low income	---	0.800* (0.359)	---	0.234* (0.094)
High vs. Low income	---	1.258* (0.405)	---	0.402* (0.110)
Number of Observations	904	904	904	904
R-Squared			0.17	0.16

*Denotes significance at the 5% level
[†]Standard errors are in parentheses

Table 4. OLS Regression Results with Socio-Demographic*Vignette Attribute Interactions (Study 1, Between-Subject Design)

Interaction with …	Intercept	Home vs. Restaurant	Cost per Person	Whole vs. Half Meal Leftover	No Future Meal Plans vs. Plans
n/a	1.556* (0.356)[†]	-0.503* (0.247)	0.005 (0.015)	-0.304 (0.247)	-0.140 (0.247)
Female vs. Male	-0.405* (0.196)	0.086 (0.383)	0.523 (0.352)	0.293 (0.381)	0.058 (0.355)
Age 18-24 vs. 65 and older	-0.201 (0.378)	1.251* (0.307)	0.293 (0.223)	-0.040 (0.193)	-0.147 (0.211)
Age 25-34 vs. 65 and older	-0.226 (0.239)	0.105 (0.255)	0.612* (0.297)	-0.069 (0.143)	0.245 (0.273)
Age 35-44 vs. 65 and older	0.264 (0.242)	0.081 (0.258)	-0.003 (0.247)	0.153 (0.248)	0.105 (0.219)
Age 45-54 vs. 65 and older	-0.183 (0.163)	0.386* (0.143)	0.117 (0.157)	-0.216 (0.174)	0.451* (0.190)
Age 55-64 vs. 65 and older	0.372 (0.222)	0.002 (0.008)	0.004 (0.016)	0.006 (0.014)	-0.004 (0.015)
SNAP vs. Non-SNAP	0.016 (0.015)	0.011 (0.015)	-0.060* (0.013)	-0.006 (0.010)	-0.001 (0.008)
College degree vs. No degree	-0.003 (0.009)	0.009 (0.010)	-0.003 (0.011)	-0.027* (0.013)	0.138 (0.143)
Democrat vs. Other parties	0.197 (0.273)	-0.209 (0.243)	0.094 (0.260)	-0.162 (0.249)	0.069 (0.250)
Obese vs. Non-obese	0.067 (0.214)	0.068 (0.163)	-0.059 (0.143)	0.166 (0.157)	0.294 (0.175)
Kids in household vs. No kids	0.005 (0.192)	-0.165 (0.224)	-0.085 (0.142)	0.397 (0.275)	-0.258 (0.243)
Medium vs. Low income	0.043 (0.261)	-0.189 (0.249)	-0.123 (0.248)	0.238 (0.215)	-0.023 (0.163)
High vs. Low income	0.136 (0.142)	0.058 (0.157)	0.572* (0.175)	-0.086 (0.191)	0.153 (0.224)
Number of Observations	904				
R-Squared	0.24				

*Denotes significance at the 5% level
[†]Standard errors are in parentheses

Table 5. Summary Statistics for Study 1, Within-Subject Design

Treatment	Mean Ranking[a] (std. dev.)	Location	Cost per Person	Amount of Meal Leftover	Future Meal Plans	Number of Observations
1	4.696 (2.044)	restaurant	$8	whole	no	112
2	6.027 (2.252)	restaurant	$8	half	yes	112
3	3.902 (2.135)	restaurant	$25	whole	yes	112
4	3.643 (2.008)	restaurant	$25	half	no	112
5	5.491 (2.110)	home	$8	whole	yes	112
6	4.964 (2.079)	home	$8	half	no	112
7	2.866 (2.064)	home	$25	whole	no	112
8	4.411 (2.025)	home	$25	half	yes	112

[a] Vignettes were ranked such that 1=most likely to save; 8=most likely to throw out (waste)

Table 6. OLS Regression Estimates for Study 1, Within-Subject Design

Variable	Model 1: Data Pooled Across All Subjects	Model 2: Average Coefficients Across Subject-Specific Models
Intercept	6.828* (0.194)†	6.828* (0.256)
Home vs. Restaurant	-0.134 (0.140)	-0.134 (0.141)
Cost per Person	-0.093* (0.008)	-0.093* (0.132)
Whole vs. Half Meal Leftover	-0.522* (0.140)	-0.522* (0.149)
No Future Meal Plans vs. Plans	-0.915* (0.140)	-0.915* (0.155)
Number of Observations	896	112
R-Squared	0.17	n/a

*Denotes significance at the 5% level
†Standard errors are in parentheses

Table 7. Subject-Specific Regression Results with Socio-Demographic*Vignette Attribute Interactions (Study 1, Within-Subject Design)

Interaction with …	Intercept	Home vs. Restaurant	Cost per Person	Whole vs. Half Meal Leftover	No Future Meal Plans vs. Plans
n/a	7.180* (1.079)	0.872 (0.630)	-0.181* (0.052)	0.016 (0.666)	-0.283 (0.696)
Female vs. Male	0.058 (0.489)	-0.498 (0.285)	0.019 (0.024)	-0.244 (0.302)	-0.016 (0.315)
Age 18-24 vs. 65 and older	-2.501* (1.056)	0.338 (0.616)	0.132* (0.051)	0.047 (0.651)	0.271 (0.681)
Age 25-34 vs. 65 and older	-1.774 (0.949)	-0.612 (0.554)	0.142* (0.046)	-0.399 (0.585)	-0.115 (0.612)
Age 35-44 vs. 65 and older	-2.062* (0.935)	-0.649 (0.546)	0.163* (0.045)	-0.593 (0.577)	0.002 (0.603)
Age 45-54 vs. 65 and older	-0.177 (1.002)	-0.909 (0.585)	0.050 (0.048)	-0.184 (0.618)	-0.189 (0.646)
Age 55-64 vs. 65 and older	-0.806 (0.954)	-0.571 (0.557)	0.086 (0.046)	-0.280 (0.589)	-0.364 (0.615)
SNAP vs. Non-SNAP	-0.865 (0.760)	-0.582 (0.444)	0.071 (0.037)	0.306 (0.469)	-0.327 (0.490)
College degree vs. No degree	-0.124 (0.562)	0.108 (0.328)	0.008 (0.027)	-0.110 (0.347)	-0.018 (0.363)
Democrat vs. Other parties	-0.444 (0.555)	-0.510 (0.324)	0.035 (0.027)	-0.043 (0.342)	0.282 (0.358)
Obese vs. Non-obese	0.503 (0.551)	-0.303 (0.321)	-0.014 (0.027)	-0.133 (0.340)	-0.114 (0.355)
Kids in household vs. No kids	0.237 (0.622)	0.173 (0.363)	-0.066* (0.030)	1.119* (0.384)	0.425 (0.401)
Medium vs. Low income	1.431* (0.631)	0.164 (0.368)	-0.046 (0.030)	-0.472 (0.389)	-1.027* (0.407)
High vs. Low income	1.508 (0.807)	-0.263 (0.471)	-0.039 (0.039)	-0.611 (0.498)	-0.842 (0.520)
Number of Observations	112	112	112	112	112
R-Squared	0.23	0.14	0.25	0.13	0.12

*Denotes significance at the 5% level
†Standard errors are in parentheses

Table 8. Socio-Demographic Variables and Definitions for Study 2 (*N*=1003)

Variable	Definition	Sample Proportion
Female	1 if female; 0 if male	0.500
Age 18-24	1 if 18-24 years old; 0 otherwise	0.125
Age 25-34	1 if 25-34 years old; 0 otherwise	0.227
Age 35-44	1 if 35-44 years old; 0 otherwise	0.199
Age 45-54	1 if 45-54 years old; 0 otherwise	0.154
Age 55-64	1 if 55-64 years old; 0 otherwise	0.171
Age 65 and older	1 if 65 years or older; 0 otherwise	0.124
SNAP	1 if current SNAP recipient; 0 otherwise	0.168
College degree	1 if obtained college degree; 0 otherwise	0.507
Democrat	1 if identifies as a Democrat; 0 for all other parties	0.466
Obese	1 if BMI $\geq$ 30; 0 otherwise	0.244
Kids in household	1 if children under age 12 living in the household; 0 otherwise	0.362
Low Income	1 if annual income is less than $40,000; 0 otherwise	0.281
Medium Income	1 if annual income is $$40,000 to $99,999; 0 otherwise	0.471
High Income	1 if annual income is $100,000 or more; 0 otherwise	0.248

Table 9. Summary Statistics for Study 2, Between-Subject Design

Treatment	% Wasting[a]	Likelihood of Waste[b]	Price	Fullness	Smell	Replacement	Number of Obs.
1	50.50%	2.838	$2.50	one-quarter	sour	absent	111
2	15.30%	1.622	$2.50	one-quarter	fine	present	111
3	51.80%	2.857	$2.50	three-quarters	sour	present	112
4	14.20%	1.646	$2.50	three-quarters	fine	absent	113
5	52.70%	2.857	$5.00	one-quarter	sour	present	112
6	14.30%	1.598	$5.00	one-quarter	fine	absent	112
7	58.90%	3.009	$5.00	three-quarters	sour	absent	112
8	16.20%	1.793	$5.00	three-quarters	fine	present	111

[a] Based on dichotomous choice question with options “Pour out the milk” or “Drink the milk”
[b] Based on 5-point scale response where 1=“Definitely drink” and 5=“Definitely pour out”

Table 10. Regression Results for Study 2, Between-Subject Design

	Logistic Regression Estimates (1=Waste; 0=Drink)		*OLS Regression Estimates (1=Drink; 5=Waste)*	
Variable	Model 1	Model 2	Model 1	Model 2
Intercept	1.990* (0.291)[†]	0.987* (0.430)	4.500* (0.162)	3.788* (0.237)
Price	-0.056 (0.062)	-0.027 (0.065)	-0.030 (0.036)	-0.004 (0.035)
¾ full vs. ¼ full	-0.112 (0.154)	-0.092 (0.163)	-0.098 (0.090)	-0.085 (0.088)
Smells fine vs. Slightly sour	-1.877* (0.163)	-2.049* (0.176)	-1.226* (0.090)	-1.221* (0.088)
Replacement present vs. Absent	0.027 (0.154)	0.041 (0.163)	-0.009 (0.090)	0.006 (0.088)
Female vs. Male	---	-0.035 (0.173)	---	0.084 (0.094)
Age 18-24 vs. 65 and older	---	1.594* (0.347)	---	0.755* (0.185)
Age 25-34 vs. 65 and older	---	0.962* (0.313)	---	0.387* (0.173)
Age 35-44 vs. 65 and older	---	0.959* (0.317)	---	0.374* (0.175)
Age 45-54 vs. 65 and older	---	0.276 (0.297)	---	0.201 (0.170)
Age 55-64 vs. 65 and older	---	-0.098 (0.287)	---	-0.126 (0.164)
SNAP vs. Non-SNAP	---	0.654* (0.259)	---	0.282* (0.125)
College degree vs. No degree	---	0.033 (0.188)	---	0.004 (0.103)
Democrat vs. Other parties	---	0.277 (0.166)	---	0.155 (0.089)
Obese vs. Non-obese	---	-0.010 (0.193)	---	0.003 (0.104)
Kids in household vs. No kids	---	0.232 (0.208)	---	0.186 (0.111)
Medium vs. Low income	---	0.105 (0.211)	---	0.153 (0.114)
High vs. Low income	---	0.183 (0.258)	---	0.137 (0.140)
Number of Observations	894	894	894	894
R-Squared			0.17	0.23

*Denotes significance at the 5% level
[†]Standard errors are in parentheses

Table 11. OLS Regression Results with Socio-Demographic*Vignette Attribute Interactions (Study 2, Between-Subject Design)

Interaction with …	Intercept	Price	¾ full vs. ¼ full	Smells fine vs. Slightly sour	Replacement present vs. absent
n/a	4.073* (0.626)[†]	0.019 (0.137)	-0.057 (0.346)	-1.822* (0.345)	-0.219 (0.344)
Female vs. Male	0.064 (0.341)	0.154 (0.641)	0.072 (0.624)	-0.433 (0.630)	0.197 (0.610)
Age 18-24 vs. 65 and older	-0.203 (0.607)	-0.013 (0.440)	-0.175 (0.374)	0.580 (0.320)	0.531 (0.387)
Age 25-34 vs. 65 and older	0.514 (0.399)	-0.366 (0.414)	0.329 (0.518)	-0.034 (0.075)	0.096 (0.148)
Age 35-44 vs. 65 and older	0.041 (0.138)	0.138 (0.139)	-0.018 (0.135)	0.094 (0.132)	0.009 (0.101)
Age 45-54 vs. 65 and older	0.030 (0.082)	-0.144* (0.071)	-0.156 (0.084)	-0.088 (0.088)	0.071 (0.091)
Age 55-64 vs. 65 and older	-0.005 (0.112)	0.288 (0.187)	-0.288 (0.367)	-0.309 (0.344)	-0.202 (0.346)
SNAP vs. Non-SNAP	-0.139 (0.339)	0.007 (0.328)	-0.054 (0.251)	0.120 (0.205)	-0.409* (0.178)
College degree vs. No degree	0.213 (0.209)	-0.101 (0.220)	0.336 (0.227)	-0.057 (0.280)	-0.265 (0.186)
Democrat vs. Other parties	1.038* (0.371)	0.828* (0.345)	0.971* (0.347)	0.329 (0.340)	-0.306 (0.330)
Obese vs. Non-obese	0.531* (0.254)	0.120 (0.206)	0.444* (0.179)	0.036 (0.207)	0.052 (0.220)
Kids in household vs. No kids	-0.038 (0.226)	-0.561* (0.278)	0.252 (0.187)	-0.297 (0.368)	-0.116 (0.345)
Medium vs. Low income	-0.255 (0.347)	-0.068 (0.339)	-0.233 (0.330)	0.263 (0.254)	-0.077 (0.206)
High vs. Low income	0.179 (0.177)	-0.103 (0.209)	0.017 (0.220)	0.197 (0.227)	0.314 (0.280)
Number of Observations	894				
R-Squared	0.32				

*Denotes significance at the 5% level
[†]Standard errors are in parentheses

Table 12. Summary Statistics for Study 2, Within-Subject Design

Treatment	Mean Ranking[a] (std. dev.)	Price	Fullness	Smell	Replacement	Number of Observations
1	5.486 (2.234)	$2.50	one-quarter	sour	absent	109
2	3.688 (2.044)	$2.50	one-quarter	fine	present	109
3	5.450 (1.808)	$2.50	three-quarters	sour	present	109
4	3.422 (2.070)	$2.50	three-quarters	fine	absent	109
5	5.229 (2.058)	$5.00	one-quarter	sour	present	109
6	3.495 (2.154)	$5.00	one-quarter	fine	absent	109
7	5.431 (2.303)	$5.00	three-quarters	sour	absent	109
8	3.798 (2.198)	$5.00	three-quarters	fine	present	109

[a] Vignettes were ranked such that 1=most likely to drink; 8=most likely to pour out (waste)

Table 13. OLS Regression Estimates for Study 2, Within-Subject Design

Variable	Model 1: Data Pooled Across All Subjects	Model 2: Average Coefficients Across Subject-Specific Models
Intercept	5.431* (0.258)[†]	5.431* (0.279)
Price	0.009 (0.057)	0.009 (0.058)
¾ full vs. ¼ full	-0.050 (0.143)	-0.050 (0.126)
Smells fine vs. Slightly sour	-1.798* (0.143)	-1.798* (0.221)
Replacement present vs. absent	-0.083 (0.143)	-0.083 (0.139)
Number of Observations	872	109
R-Squared	0.15	n/a

*Denotes significance at the 5% level
[†]Standard errors are in parentheses

Table 14. Subject-Specific Regression Results with Socio-Demographic*Vignette Attribute Interactions (Study 2, Within-Subject Design)

Interaction with …	Intercept	Price	¾ full vs. ¼ full	Smells fine vs. Slightly sour	Replacement present vs. absent
n/a	4.739* (1.105)	0.293 (0.231)	-0.238 (0.505)	-2.167* (0.813)	-0.270 (0.549)
Female vs. Male	0.878 (0.605)	-0.079 (0.126)	-0.019 (0.276)	-1.893* (0.445)	0.745* (0.301)
Age 18-24 vs. 65 and older	-0.484 (1.252)	-0.093 (0.261)	0.024 (0.572)	1.845* (0.921)	-0.206 (0.623)
Age 25-34 vs. 65 and older	-1.774 (1.033)	0.166 (0.216)	0.572 (0.472)	2.091* (0.760)	-0.361 (0.514)
Age 35-44 vs. 65 and older	0.341 (1.119)	-0.173 (0.233)	-0.200 (0.511)	1.792* (0.823)	-0.978 (0.556)
Age 45-54 vs. 65 and older	0.736 (1.078)	-0.173 (0.225)	-0.055 (0.493)	0.875 (0.793)	-0.996 (0.536)
Age 55-64 vs. 65 and older	1.185 (1.064)	-0.525* (0.222)	-0.148 (0.487)	2.327* (0.783)	-0.609 (0.529)
SNAP vs. Non-SNAP	1.418 (0.828)	-0.324 (0.173)	-0.896* (0.378)	-0.019 (0.609)	0.512 (0.412)
College degree vs. No degree	0.558 (0.618)	-0.039 (0.129)	-0.249 (0.282)	-0.568 (0.454)	-0.009 (0.307)
Democrat vs. Other parties	0.134 (0.581)	-0.047 (0.121)	0.162 (0.266)	0.061 (0.428)	-0.139 (0.289)
Obese vs. Non-obese	0.749 (0.791)	-0.180 (0.165)	0.194 (0.362)	-0.070 (0.582)	-0.273 (0.393)
Kids in household vs. No kids	0.146 (0.764)	0.002 (0.159)	0.326 (0.349)	-0.254 (0.562)	-0.376 (0.380)
Medium vs. Low income	-0.291 (0.765)	-0.049 (0.160)	0.173 (0.350)	0.057 (0.562)	0.717 (0.380)
High vs. Low income	-0.655 (0.831)	-0.011 (0.173)	0.190 (0.380)	0.373 (0.611)	0.825* (0.413)
Number of Observations	109	109	109	109	109
R-Squared	0.16	0.14	0.13	0.27	0.15

*Denotes significance at the 5% level
†Standard errors are in parentheses

APPENDIX

Table A1. Ordered Logit Regression Results for Study 1, Between-Subject Design

	Regression Estimates (1=Save; 5=Waste)	
Variable	Model 1	Model 2
Intercept	---	---
Threshold 5	-2.808* (0.236)	-1.320* (0.367)
Threshold 4	-1.804* (0.199)	-3.237* (0.341)
Threshold 3	-1.131* (0.188)	-2.485* (0.332)
Threshold 2	-0.056 (0.183)	-1.278 (0.323)
Home vs. Restaurant	-0.051 (0.132)	-0.115 (0.138)
Cost per Person	-0.013 (0.008)	-0.013 (0.008)
Whole vs. Half Meal Leftover	-0.324* (0.132)	-0.385* (0.137)
No Future Meal Plans vs. Plans	0.084 (0.132)	0.112 (0.137)
Female vs. Male	---	-0.721* (0.140)
Age 18-24 vs. 65 and older	---	1.439* (0.287)
Age 25-34 vs. 65 and older	---	1.141* (0.257)
Age 35-44 vs. 65 and older	---	0.991* (0.274)
Age 45-54 vs. 65 and older	---	0.397 (0.274)
Age 55-64 vs. 65 and older	---	0.263 (0.280)
SNAP vs. Non-SNAP	---	0.843* (0.202)
College degree vs. No degree	---	0.400* (0.166)
Democrat vs. Other parties	---	0.334* (0.139)
Obese vs. Non-obese	---	0.027 (0.158)
Kids in household vs. No kids	---	0.337* (0.164)
Medium vs. Low income	---	0.251 (0.193)
High vs. Low income	---	0.552* (0.224)
Number of Observations	904	904

Table A2. Ordered Logit Regression Results for Study 2, Between-Subject Design

	Regression Estimates (1=Drink; 5=Waste)	
Variable	Model 1	Model 2
Intercept	---	---
Threshold 5	0.892* (0.233)	-0.076 (0.345)
Threshold 4	1.648* (0.238)	0.714* (0.346)
Threshold 3	2.057* (0.242)	1.153* (0.347)
Threshold 2	3.329* (0.258)	2.503* (0.356)
Price	-0.045 (0.051)	-0.009 (0.052)
¾ full vs. ¼ full	-0.159 (0.127)	-0.135 (0.129)
Smells fine vs. Slightly sour	-1.575* (0.133)	-1.652* (0.136)
Replacement present vs. Absent	0.007 (0.127)	0.008 (0.129)
Female vs. Male	---	0.179 (0.138)
Age 18-24 vs. 65 and older	---	0.896* (0.274)
Age 25-34 vs. 65 and older	---	0.299 (0.250)
Age 35-44 vs. 65 and older	---	0.440 (0.254)
Age 45-54 vs. 65 and older	---	0.239 (0.243)
Age 55-64 vs. 65 and older	---	-0.184 (0.232)
SNAP vs. Non-SNAP	---	0.526* (0.196)
College degree vs. No degree	---	-0.036 (0.150)
Democrat vs. Other parties	---	0.249 (0.131)
Obese vs. Non-obese	---	0.035 (0.153)
Kids in household vs. No kids	---	0.328* (0.165)
Medium vs. Low income	---	0.264 (0.168)
High vs. Low income	---	0.183 (0.204)
Number of Observations	894	894