Examining Household Food Waste Decisions: A Vignette Approach

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Abstract: Although food waste is increasingly recognized as an environmental and food security problem, there remains uncertainty over its primary contributors. Analyses of food waste often fail to treat the problem as an economic phenomenon, where consumers' utility maximizing decisions result in discarded food. This paper presents a conceptual model of household food waste, showing that decisions to discard food depend on food prices and wage and non-wage income. The results of two empirical studies are presented, 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.

"Americans are supposed to be much more wasteful of food and other goods than persons in poorer countries…because the market value of time is higher relative to the price of goods there than elsewhere."

--*Gary Becker* (*1965*)

Introduction

Food waste is 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 387 billion calories in 2010.

Despite growing concern about food waste, there is no consensus on the causes of the phenomenon or solutions to reduce waste. In fact, many analyses of food waste seem to conceptualize food waste as a mistake or inefficiency, and in some popular writing a sinful behavior, rather than an economic phenomenon that arises from preferences, incentives, and constraints. In reality consumers and producers have time and other resource constraints which implies that it simply will not be worth it to rescue ever last morsel of food in every instance, nor should it be expected that consumers with different opportunity costs of time or risk preferences will arrive at the same decisions on whether to discard food (Daniel, 2016).

None of this is to say that food waste might not be 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 Hodges, Buzby, and Bennett, 2011; Affognon et al., 2015 for discussions). At the foodservice (restaurant) level, food tracking technologies[1] have been introduced that help kitchens track the quantity of food wasted before it reaches consumers' plates. 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). The U.S. Department of Agriculture (USDA) and Environmental Protection Agency (EPA) launched the U.S. Food Waste Challenge in 2013 which also provides a forum for organizations across the food supply chain to share best practices on how to reduce, recover, and recycle food waste (USDA, 2013). Globally, the SAVE FOOD initiative exists to bring together all global stakeholders in an effort to combat food waste and food loss (FAO, 2016).

[1] The most prominent example is the LeanPath food waste tracking software (www.leanpath.com).

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. 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 (Neff, Spiker, and Truant, 2015; Stancu, Haugaard, and Lähteenmäki, 2016; Stefan et al., 2013; Parizeau, von Massow, and Martin, 2015; Graham-Rowe, Jessop, and Sparks, 2014), rather than understanding why consumers may discard food in the first place. However, to our knowledge there has been little work considering economic factors that influence consumers' utility maximizing decisions to throw out food.

The purpose of this research is to examine the household food waste decision from an economic perspective. First we consider how Becker's (1965) household production model may be used to help explain household food waste behavior. From these insights, we utilize the vignette method to examine two specific food waste decisions: one related to a single product (milk) and a second focused on leftovers from a fully prepared meal. We consider both the impact of decision factors (e.g., cost of replacement, smell of milk, whether the meal was prepared at home or in a restaurant) as well as socio-demographic factors on consumers' waste decisions. 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.

Background and Literature Review

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. The majority of this work has taken place in European countries (Graham-Rowe, Jessop, and Sparks, 2014; Quested et al., 2013; Stancu, Haugaard, and Lähteenmäki, 2016; Stefan et al., 2013; Williams et al., 2012; Refsgaard and Magnussen, 2009), with only two studies to our knowledge examining consumers in North American countries (Neff, Spiker, and Truant (2015) studied U.S. consumers while Parizeau, von Massow, and Martin (2015) examined Canadian households).

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 (Stancu, Haugaard, and Lähteenmäki, 2016; Stefan et al., 2013; Graham-Rowe, Jessop, and Sparks, 2015) 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; Stefan et al., 2013; Graham-Rowe, Jessop, and Sparks, 2015). 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.

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 (Graham-Rowe, Jessop, and Sparks, 2014; Neff, Spiker, and Truant, 2015). This concern is often tied to confusion over label dates such as "use by" or "sell by" (Gunders, 2012). 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 because the waste can be composted or will break down in the landfill (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.

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, the focus has been quite broad, asking about food waste 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 a carton of milk and one for leftovers from a fully prepared meal 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.

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. Because the vignettes correspond to a very specific waste situation, we conduct two different studies utilizing different vignettes to determine the robustness and generalizability of results.

A Conceptual Model of Food Waste

One approach for understanding the economic factors influencing consumer-derived food waste is the household production model introduced by Becker (1965). Almost in passing, Becker (1965) noted that the framework might be used to explain the supposed paradox that Americans are seemingly more wasteful while simultaneously being more time conscious than people in other countries. Becker's explanation for the paradox is that Americans have higher opportunity costs of time. Variations on Becker's model have been used to help explain recycling behavior

(Morris and Holthausen, 1994) and waste (Hojgard, Jansson, and Rabinowicz, 2013), and more generally have been used in a variety of contexts to study time use and expenditures related to food (e.g., see Huffman, 2011 for a review).

Rather than deriving utility directly from purchased goods, it is assumed that consumers combine purchased goods with time to produce commodities that provide the ultimate source of utility. To simplify matters, consider a model where consumers derive utility from only two commodities, meals and leisure. In particular, consumers maximize $U(z, t_l)$, where z is meals consumed and t_l time spent in leisure. Rather than purchasing z directly, the consumer combines raw food inputs, x, and time, t_f, to convert food into meals via a production function, $z = f(x, t_f)$.

The household production function framework provides one means of conceptualizing waste via the productivity of time. The amount of waste, W, or the volume of raw food ingredients present in a final meal is given by the ratio $W = x/z$. A household that produces more meals using less raw food inputs has lower W, and this can be accomplished either by using more time, t_f, or by a household having a higher marginal productivity of time, $\partial z/\partial t_f$ or food inputs $\partial z/\partial x$.[2]

The consumer maximizes utility $U\big(f(t_f, x), t_l\big)$ subject to the budget constraint $xp = M + wt_w$, where p is the market price of x, M is non-wage income, t_w time spent at work, and w is the wage rate. Let T be the total time endowment, $T = t_w + t_l + t_f$, such that time spent at work is given by $t_w = T - t_l - t_f$. Substituting this into the budget constraint yields $xp = M +$

[2] Our approach differs from Hojgard, Jansson, and Rabinowicz (2013) and Morris and Holthausen (1994) who conceptualize waste as a byproduct of production (i.e., waste is an increasing function of the amount of raw food input used). In their approaches, there is a production function for waste that, in the case of Morris and Holthausen (1994) also indirectly enters the utility function via recycling (which is defined as the amount of waste less that conventionally disposed).

$w(T - t_l - t_f)$, or after re-arranging, $xp + wt_f + wt_l = M + wT$. The consumer chooses x, t_f, and t_l to maximize the Lagrangian function

$\mathcal{L} = U\big(f(t_f, x), t_l\big) + \lambda(M + wT - xp - wt_f - wt_l)$.

The first order conditions are:

1) $\frac{\partial \mathcal{L}}{\partial x} = \frac{\partial U}{\partial f}\frac{\partial f}{\partial x} - \lambda p = 0$,

2) $\frac{\partial \mathcal{L}}{\partial t_f} = \frac{\partial U}{\partial f}\frac{\partial f}{\partial t_f} - \lambda w = 0$,

3) $\frac{\partial \mathcal{L}}{\partial t_l} = \frac{\partial U}{\partial t_l} - \lambda w = 0$, and

4) $\frac{\partial \mathcal{L}}{\partial \lambda} = M + wT - xp - wt_f - wt_l = 0$.

Equations 1 and 2 imply that the ratio of the marginal utility of the use of raw food inputs *x*, $U_x = \frac{\partial U}{\partial f}\frac{\partial f}{\partial x}$, to the marginal utility of the use of time spent in meal preparation, $U_{t_f} = \frac{\partial U}{\partial f}\frac{\partial f}{\partial t_f}$ must equal the ratio the price of raw food inputs to the wage rate, i.e., $\frac{U_x}{U_{t_f}} = \frac{p}{w}$. As such, raw food purchases and time spent in meal preparation are driven by relative prices of food and wage rates. Generally, the solutions to equations 1 through 4 yield demands for raw food, time spent in meal preparation, and time spent in leisure:

5) $x^* = x(p, w, M, T)$,

6) ${t_f}^* = t_f(p, w, M, T)$, and

7) ${t_l}^* = t_l(p, w, M, T)$.

Recall that waste was previously defined as $W = x/z$. Thus, in optimum, waste is

8) $W^* = x(p, w, M, T)/z(x(p, w, M, T), t_f(p, w, M, T))$.

Equation 8 reveals that the volume of food waste is a function of economic variables like *p*, *w*, and *M* in addition to the overall time constraint, *T*, and marginal productivities of raw food and time use in producing meals. Differences in market prices for raw food ingredients, *p*, or across food consumers in the opportunity cost of their time, *w*, might thus explain differences in food waste. It is also possible that education, background, or cooking ability can lead to different marginal productivities of time used in meal preparation. These basic insights lead us to consider how waste might vary with food prices, opportunity cost of time, and income.

While it was not an explicit part of the model above, the household production model is sufficiently general to include other household outputs (i.e., additional *z*'s), such as human capital or health. Modifying the utility function to include health as an output produced via the use of time and market goods would make the function in equation (8) depend on time spent promoting health and on the relationship between meal production and health. Thus, if consumption of a meal lowers health (e.g., by consuming a spoiled, raw ingredient), a larger amount of waste might be optimal.

Because the economic forces driving food waste have received such scant attention, it might be useful to further elucidate the insights by determining model outcomes for some specific functional forms. Let a consumer's utility function take on the Cobb-Douglass form, $U = z^{\alpha} {t_l}^{1-\alpha}$. In addition, let the meal production function take on the simple form, $z = \beta t_f x$. Given this production function, one unit of time, t_f, yields βx meals; or, for every unit of raw food input, *x*, there are βt_f meals produced. The amount of waste is given by $W = x/z = 1/\beta t_f$. Higher amounts of time used in meal preparation, t_f, lead to less food waste as does a higher productivity of time/food inputs, β. Maximizing the Lagrangian and solving the first order conditions produces the optimal use of time in meal preparation and by further substitution, optimal waste:

9) $t_f{}^* = \frac{\alpha(M+wT)}{(1+\alpha)w}$ and $W^* = \frac{(1+\alpha)w}{\beta\alpha(M+wT)}$.

These equations do not depend on the price of raw food inputs, p, because of the assumption of Cobb-Douglass preferences, but they do show how optimal waste varies with the wage rate, non-wage income, time constraint, the marginal utility of meal consumption, and the marginal productivity of time spent in meal preparation. For example, an individual facing a higher wage rate would be expected to have more food waste: $\frac{\partial W^*}{\partial w} = \frac{M(1+\alpha)}{\beta\alpha(M+wT)^2} > 0$. By contrast, an individual with higher non-wage income would be expected to have less food waste: $\frac{\partial W^*}{\partial M} = \frac{-w(1+\alpha)}{\beta\alpha(M+wT)^2} < 0$. An individual with greater talents/ability/education at turning raw food inputs and time into meals will waste less: $\frac{\partial W^*}{\partial \beta} = \frac{-1}{\beta^2 {t_f}^*} < 0$. An individual with a higher marginal utility for meals relative to leisure will have less food waste $\frac{\partial W^*}{\partial \alpha} = \frac{-w}{\beta\alpha^2(M+wT)} < 0$ if they have more non-wage income than wT, otherwise the reverse is true.

The empirical studies that follow attempt to utilize some of the insights derived from the general modeling framework. In particular, we study how decisions to discard food vary with the price of food and with opportunity costs for replacing the food. In one study, we consider how food quality and safety considerations affect food waste. Additionally, we investigate how decisions to waste food vary with consumers' incomes and education, which the modeling framework suggests might play a role in food waste decisions.

Empirical Study 1: Milk Vignette

For the first 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 basic vignette shown to survey respondents is provided below; variables that were experimentally 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 1 took place in September, 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 1.

Methods: Between-Subject Design

Based on the vignette design, there were four attributes (fullness of carton, smell, presence of an unopened carton, and price) varied at two levels each. Thus, there were $2^4 = 16$ possible vignettes that could be created. From the full factorial, we selected a subset of eight vignettes such that each variable was uncorrelated with the other (an orthogonal, fractional factorial design) and where the interaction effects associated with the presence/absence of the unopened carton were also uncorrelated with other variables.

Respondents were randomly assigned to evaluate one (and only 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.

Methods: Within-Subject Design

In the within-subject design, each participant was presented with all 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 drink and eight was the most likely to pour down the drain. The order of the appearance of the scenarios was randomized across participants. With 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.

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 milk (on the dichotomous choice question), the waste score (on the 5-point scale where 1=definitely drink and 5=definitely pour out), the attributes of the vignette scenario, and the number of participants who were assigned to the vignette are provided. From these results, it appears that consumers are apt to throw out milk past the expiration date. The lowest proportion of consumers wasting in any of the eight scenarios is only 41% and the highest is 86%. All scale value averages, except one, are above the midpoint. The four vignettes with the highest probability of waste had one attribute in common: milk that smells slightly sour.

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. For each dependent variable, we estimated two model specifications. In model 1, we only utilize the variables experimentally varied across the vignette scenarios: price, fullness, smell, and replacement. In the second specification, we build on model 1 by including a host of socio-demographic variables.

Table 3 presents the regression results. Looking at the model 1 specifications in table 3, 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, 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 (Quested et al., 2013; Thyberg and Tonjes, 2016). 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. While the household production framework would suggest this group would waste less because they have higher non-wage income (in the form of SNAP benefits), research on the relationship between income and waste behavior has been mixed (see Thyberg and Tonjes, 2016 for a discussion). 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).

The results in table 3 offer evidence of which consumers are more or less likely to pour the milk down the drain; 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. 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.

Results: Within-Subject Design

The within-subject design presented each respondents with all eight vignette scenarios, and they were asked asked to rank the vignettes on a relative waste scale (1=most likely to drink; 8=most likely to pour out). Table 5 presents the mean ranking for each of the eight vignettes, along with a summary of the attributes in each scenario. Similar to table 2, we observe two clusters of means. The higher ranking vignettes all share the characteristic that the milk smells fine, while the lower ranking vignettes 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 (the dependent variable was reverse coded so that a higher number is a higher likelihood of wasting). Table 6 shows 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. In the first model specification, the data is pooled across all subjects, meaning there are eight observations (rankings) per subject for a total of 872 observations. In the model 2 specification, we use each individual's rankings to estimate subject-specific regression models and then 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 observe 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.

Empirical Study 2: Leftovers Vignette

In the second study, we examined a waste decision related to leftovers from a fully prepared meal. This waste decision may be different for consumers relative to the milk waste decision because this is a value-added product rather than a single-ingredient; therefore, the time cost of preparation may also 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. For this vignette, the general variables experimentally varied are comparable to those in the milk vignette; however, we replaced the smell attribute with a location attribute that identified the source of the leftovers (home or restaurant). The basic vignette shown to respondents is provided below; variables that 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 2 took place in October, 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 8 for participant socio-demographic information).

Methods: Between-Subject Design

Like the milk vignette, the leftovers vignette had four attributes (location; price; amount left; and future meal plans) varied at two levels each. From the 16 possible vignettes ($2^4 = 16$), we selected an orthogonal, fractional factorial design of eight vignettes.

Respondents were randomly assigned to 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.

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 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.

Results: Between-Subject Design

Table 9 provides the summary statistics for the between-subject design. Relative to the milk vignette, participants were much less likely to waste the leftovers overall, with the percent wasting ranging from only 7.1% to 19.5% (the range was 41% to 86% for milk). 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 10). 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 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.

Table 11 extends the OLS regression results to explore the potential for heterogeneity in preferences for the vignette attributes. 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. SNAP recipients, 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).

Results: Within-Subject Design

Table 12 presents the summary statistics for the within-subject design. Compared to study 1, we see more dispersion in the mean ranking values. 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 13, 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. Model 1 shows these attributes account for approximately 15% of the variation in the waste/save rankings.

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). From table 14, 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. 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. Similar to study 1, sociodemographics 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).

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 is to examine the food waste decision process in an economic framework. We explore how the food waste decision may fit into Becker's (1965) household production model and 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.

Applying the household production model to food waste, we find that, in optimum, food waste is a function of the price of raw food inputs, the wage rate, non-wage income, the overall time constraint, and the marginal productivities of raw food and time in producing meals. Differences in market prices of inputs and/or the wage rate (opportunity cost of time) could lead to differences in the keep/waste decision. For instance, an individual with a high wage rate would be expected to waste more whereas a person with a higher non-wage income would be expected to waste less. Further, individual-level characteristics like education or cooking ability may also impact this decision in that they differentially affect the marginal productivities of food and time. An individual who is more adept at preparing meals, for example, would be expected to waste less than an individual with lower cooking ability/knowledge.

To examine this framework in an actual decision context, we conducted two vignette studies with two different samples of U.S. consumers. In the first vignette, we consider a single product, milk. Here, 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); a result that can also be reconciled with a household production model that includes health.

In the second vignette, we consider the keep/waste decision for leftovers from a fully prepared meal. Where milk is primarily a raw input, a fully prepared meal has a time cost of preparation associated with it. Depending on the source of the meal, an individual may not be the one incurring that time cost (e.g., if the leftovers are from a restaurant meal), but it is likely accounted for in the price of that meal. In the case of leftovers, 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, we found that 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 don't want to discount by throwing the leftovers out.

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) tend to be more wasteful 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. A possible explanation relates to the conceptual model: 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 according to our model will 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. A recent study by Daniel (2016) further confirmed that higher-income households can tolerate more waste, which can ultimately impact children's eating habits and preferences. Through qualitative interviews and shopping observations, Daniel (2016) found that lower-income households could not afford to purchase foods (e.g., fruits and vegetables) that may go uneaten in their households. Research suggests it takes several exposures to an unfamiliar food to increase liking and consumption (see Cooke, 2007 for a review), yet this is a luxury that only higher-income households can afford. For low-income households, this often means purchasing more calorie-dense, nutrient-poor foods that they know their children will eat over healthier alternatives (Daniel, 2016).

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. In the case of the milk vignette, for example, one attribute which may interact with smell is the product expiration date. For the purposes of this study, we held the expiration date constant across vignette scenarios (all milk was stated to be one day past the expiration date); however, future studies may want to vary the number of days past the expiration date. For at least a segment of consumers, it is likely that there is a maximum number of days past the expiration date that can be tolerated – once a product has reached that point, it could be thrown out regardless of smell. A second attribute which was not considered in the present study but may also be an important determinant of waste in some product categories is the appearance of the food. 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. The conceptual model also draws an important distinction between the effects of wage and non-wage income on food waste; however, our surveys did not differentiate between these two types of income. We leave these issues to future research.

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Table 1. Socio-Demographic Variables and Definitions for Study 1 (*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
Foodstamps	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 2. Summary Statistics for Study 1, Between-Subject Design

Treatment	% Wasting[a]	Likelihood of Waste[b]	Price	Fullness	Smell	Replacement	Number of Obs.
1	49.55%	3.162	$2.50	one-quarter	fine	absent	111
2	84.68%	4.378	$2.50	one-quarter	sour	present	111
3	48.21%	3.143	$2.50	three-quarters	fine	present	112
4	85.84%	4.354	$2.50	three-quarters	sour	absent	113
5	47.32%	3.143	$5.00	one-quarter	fine	present	112
6	85.71%	4.402	$5.00	one-quarter	sour	absent	112
7	41.07%	2.991	$5.00	three-quarters	fine	absent	112
8	83.78%	4.207	$5.00	three-quarters	sour	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 3. Regression Results for Study 1, 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)
Foodstamps vs. No foodstamps	---	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 4. OLS Regression Results with Socio-Demographic*Vignette Attribute Interactions (Study 1, 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)
Foodstamps vs. No foodstamps	-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 5. Summary Statistics for Study 1, 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	fine	absent	109
2	3.688 (2.044)	$2.50	one-quarter	sour	present	109
3	5.450 (1.808)	$2.50	three-quarters	fine	present	109
4	3.422 (2.070)	$2.50	three-quarters	sour	absent	109
5	5.229 (2.058)	$5.00	one-quarter	fine	present	109
6	3.495 (2.154)	$5.00	one-quarter	sour	absent	109
7	5.431 (2.303)	$5.00	three-quarters	fine	absent	109
8	3.798 (2.198)	$5.00	three-quarters	sour	present	109

[a] Vignettes were ranked such that 1=most likely to drink; 8=most likely to pour 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	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 7. Subject-Specific Regression Results with Socio-Demographic*Vignette Attribute Interactions (Study 1, 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)
Foodstamps vs. No foodstamps	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	0.16	0.14	0.13	0.27	0.15
R-Squared	109	109	109	109	109

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

Table 8. Socio-Demographic Variables and Definitions for Study 2 (*N*=1016)

Variable	Definition	Sample Proportion
Female	1 if female; 0 if male	0.499
Age 18-24	1 if 18-24 years old; 0 otherwise	0.319
Age 25-34	1 if 25-34 years old; 0 otherwise	0.420
Age 35-44	1 if 35-44 years old; 0 otherwise	0.392
Age 45-54	1 if 45-54 years old; 0 otherwise	0.364
Age 55-64	1 if 55-64 years old; 0 otherwise	0.359
Age 65 and older	1 if 65 years or older; 0 otherwise	0.365
Foodstamps	1 if current SNAP recipient; 0 otherwise	0.350
College degree	1 if obtained college degree; 0 otherwise	0.500
Democrat	1 if identifies as a Democrat; 0 for all other parties	0.497
Obese	1 if BMI ≥ 30; 0 otherwise	0.449
Kids in household	1 if children under age 12 living in the household; 0 otherwise	0.469
Low Income	1 if annual income is less than $40,000; 0 otherwise	0.440
Medium Income	1 if annual income is $40,000-$99,999; 0 otherwise	0.499
High Income	1 if annual income is $100,000 or more; 0 otherwise	0.449

Table 9. Summary Statistics for Study 2, 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 10. Regression Results for Study 2, 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)
Foodstamps vs. No foodstamps	---	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 11. OLS Regression Results with Socio-Demographic*Vignette Attribute Interactions (Study 2, 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)
Foodstamps vs. No foodstamps	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 12. Summary Statistics for Study 2, 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 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	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	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	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)
Foodstamps vs. No foodstamps	-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	0.23	0.14	0.25	0.13	0.12
R-Squared	112	112	112	112	112

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