Consumer Behavior and Environmental Policy: Applications to Issues in Food Waste and Organics Recycling

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Dedication

– To my dear mother, Sangeeta Ramphul

&

the love of my life, Dominique Rolando –

Abstract

A large proportion of the food produced in the United States is wasted throughout the supply chain, with households accounting for the highest proportion. In Chapter 1, building on the existing literature, this paper develops a structural model to determine the economic relationship between household food waste reduction efforts, organics recycling efforts, and the opportunity cost of time in a public goods framework. In Chapter 2, we classify consumers in distinct classes dictated by their food related routines such as grocery shopping and kitchen management. We then investigate the roles of products attributes, especially cosmetic appearance and expiration dates, on food waste tendencies across these different classes of consumers. We examine whether underlying risk preferences and stated risk perceptions have an impact on those food waste propensities. In addition to prevention strategies that curb the negative impacts of food waste, recycling presents an opportunity to convert environmentally harmful materials into valuable economic downstream products such as compost. In chapter 3, we conduct a randomized control trial to examine the impact on information on organics recycling behavior and food waste generation tendencies in a local community.

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Chapter 1. Introduction, Overview, and Contributions

Food waste is a problem with grave environmental, social, and economic consequences. To help mitigate the problem, public policy has focused on increasing residential access to curbside food and organics recycling, which has doubled in the past five years. Further, various policies are in place to encourage households to minimize food waste at home through prevention activities.

Presently, household compliance to source separation remains very poor causing ambitious residential organics recycling programs to fail at meeting their waste diversion goals. Food scraps continue to be the largest category of materials that are landfilled, substantially contributing to the emission of methane gas and a host of other economic and environmental problems. One hypothesis is that engaging in activities to reduce food waste generated at home or dedicating efforts towards meticulous source separation of food scraps and organics may impose significant time costs to households. The first essay develops a conceptual framework model to determine the economic relationship between household food waste reduction efforts, organics recycling efforts, and the opportunity cost of time in a public goods framework. The paper uses data from a nationally representative survey fielded in 2018 and gathers regional variables from multiple sources to gauge food waste reduction and recycling regulations as well as the median Air Quality Index (AQI). The paper then uses two-stage least squares to estimate the relationships and address the endogeneity of the opportunity cost of time variable structurally. Empirical results show that people's opportunity cost of time may negatively impact their willingness to participate in both food waste reduction activities as well as organics recycling endeavors. Findings suggest that public policy should focus on making food waste reduction at home a more convenient activity for people by reducing time costs. Further, while it may be desirable to consider how to improve residential organics programs that have proven to be largely expensive and inefficient thus far, it may be more useful to think of other alternatives as potential solutions. Particularly, there may be benefit in taking the burden off the hand of private individuals and focusing on new and innovative technologies that can allow central source separation to meet public policy goals more effectively.

The second essay characterizes household behaviors and habits that may be associated with higher levels of food waste. Further, while the literature on food waste continues to grow, little is known about how underlying risk preferences and perceptions impact household food waste behavior. We administered an interactive survey at the Minnesota State Fair *(N=333)* to collect key details on relevant food purchasing behaviors, shopping routines, and kitchen management and cooking skills, amongst others. Using a factor analysis, followed by a latent model, our sample was categorized into two, highly distinct classes: Planners and Extemporaneous Consumers. While various product attributes have been identified as drivers of food waste in peer-reviewed literature, less attention has been given to food cosmetic appearance, which we address in this paper. We determine the relative importance of cosmetic deterioration, in fresh ground beef and bagged spinach, together with other product attributes such as expiration dates and product size, in simulated food waste decisions. The implications are empirically examined using survey responses gauging how individuals perceive food items are fit for consumption as a proxy for likelihood to waste food. While effects for other product attributes such as price, size, and expiration date were relatively modest, food cosmetic appearance played a key role. As products displayed cosmetic imperfections in terms of wilting, browning, or bruising, consumers showed higher likelihood to discard the products. Thus, even though food products were merely cosmetically deteriorated and remained edible, consumers were still likely to reject foods that had flawed appearance. Consumers who are closer to the Extemporaneous profile appear more prone to waste food due to food cosmetic appearance. Finally, some products may be more vulnerable to getting discarded due to their appearance, as it was the case with ground beef in this study compared to spinach. Controlling for demographics and food product attributes, OLS regressions are also used to determine the effects of risk preferences and perceptions on the food waste tendencies of the study subjects.

The final chapter investigates the role of information in determining people's behavior when it comes to organics recycling and food waste generation activities. In this paper, we examine the results from a randomized control study in the City of Maplewood, Minnesota. A total of 121 households participated in this research. The participants were randomly assigned to a group: Control Group, Treatment Group 1, and Treatment Group 2. Treatment Group 1 received similar information to current municipal food scrap collection programs. This information outlined the basics of organics source separation at home. The guideline for organics recycling for this study was adopted from well-established municipal programs. Treatment Group 2 received more detailed information focusing on the environmental benefits of recycling from a resource-recovery lens. All groups received information on food waste prevention. First, we determine households' food scraps discarding behavior following their adoption of a new waste collection routine in terms of quantity and quality. Quality in this context reflects household compliance in source separating their food scraps and avoiding contamination of other wastes such as plastic or cardboard. We then examine the changes in households' food scraps in terms of quantity and quality, in response to different levels of information about use of their food scraps. We also determine the presence of an "information rebound effect," which would deter food waste reduction efforts at the household level. Finally, we identify socioeconomic, cultural, behavioral, and attitudinal factors on food discarding and recycling tendencies.

Chapter 2. Household Food Waste Reduction and Organics Recycling Activities: Too Time Consuming or for the Better Good?

2.1. Introduction

In the U.S., households currently generate the highest proportion of food waste in the food supply chain, accounting for almost half of the total food waste landfilled (ReFED, 2016). Food scraps alone is estimated to account for 22% of material that goes to landfills by weight, making food the largest single category of landfill waste. The decomposition of this uneaten food generates 23% of all methane emissions in the U.S. (Gunders, 2012), a greenhouse gas that is 25-fold more potent than carbon dioxide (Hall et al., 2009). While prevention and reduction are essential, recovery and re-utilization of food scraps and organics constitute attractive, complementary strategies for curbing the environment consequences of food waste. Residential organics recycling, hence, is an important opportunity to convert environmentally harmful materials into resources, such as compost, animal feed, and biofuel. Such large-scale solutions to minimize and divert food waste present an opportunity to alleviate this burden for more sustainable agricultural, environmental, and social outcomes.

There is a growing literature on what drives people to generate or prevent food waste. Little is known however, about household behavior in relation to food scraps and organics recycling. From a practical perspective, there has been increasing interest to reduce, re-use and recycle organic materials throughout the supply chain. This is demonstrated by an increasing number of policies aiming at source reduction, recycling, and composting at the state and local levels. Recent statistics indicate that 326 communities, spanning 20 states, provide variations of curbside collection of food scraps (Streeter & Platt, 2017). About 4% of U.S. households have access to organics curbside collection programs (Streeter & Platt, 2017). This represents a significant growth from 1.9% in 2014 (Yepsen, 2015).

Granted that organics collection programs offer access to household food scraps, it is uncertain whether households can meaningfully contribute high quality organics for downstream processing by maintaining their compliance with instructions. This skepticism is substantiated by the concern that current enthusiasm outweighs the quantifiable progress in residential food scraps collection (Yepsen, 2015). First, contamination levels in the composting stream remain an issue for multiple municipalities (Sloan, 2018). Second, a majority of food and organics still end up in the trash even when households participate in organics recycling programs. For instance, in New York City, the expansion of a comprehensive residential organics recycling program had to be terminated. The recycling efforts were only able to divert a small fraction of organic materials with the rest winding up in people's trash and going to the landfill (Amiri, 2018).

As more communities move towards food waste diversion strategies, understanding the behavior of households becomes essential. Diversion of food from the landfill through both prevention and recycling activities contributes to higher environmental quality, a public good. Utility gained from higher environmental quality may encourage households to engage in conscious food waste prevention activities and careful recycling towards downstream resources. Utility effects from feelings of warm glow à la Andreoni (1990) or bettering one's self-image (Brekke, Kverndokk, and Nyborg, 2003) may also incentivize households to dedicate efforts towards these activities. However, households have to weigh the benefits against their costs, especially their time costs.

In this study, I investigate the link between the opportunity cost of time and willingness to participate in food waste reduction and organics recycling efforts. Alongside, I also explore the roles of other factors such as views on environment and moral norms on the effort levels. The study uses a nationally representative survey to examine these relationships empirically. Findings show that an increase in the opportunity cost of time reduces people's willingness to participate in food and organics recycling programs as well as food waste reduction activities. Views on the environment and norms are also associated with individuals' willingness to participate in these environmentally sustainable activities at home.

This paper provides three significant contributions to the literature. The first is to build on Halvorsen's (2008) and Brekke et al.'s (2003) theoretical and empirical modeling of household choice to recycle in a public goods framework. While these existing models only regard increases in the recycling effort as a public good, this model explicitly considers not only recycling efforts, but also how food waste prevention efforts at home increase environmental quality. It reframes how we view the issue of waste management as one that not only recycles materials from the municipal stream, but also reduces the volume of materials that gets generated in the first place. Second, the empirical model, drawing from the conceptual framework, brings together key state-level variables collected from various reports and governmental sources that capture current food waste reduction efforts, recycling endeavors, and the overall air quality (the environmental good). This study also uses an instrumental-variable framework (Halvorsen, 2008), which establishes a causal link between the opportunity cost of time and related food waste reduction and organics recycling efforts at home. Third, I compare the results from the structurally motivated definitions of the opportunity cost of time, which are stated willingness-to-pay values, to more standard measures, namely household income and an inferred wage rate.

Thinking through all the results comprehensively, this paper proposes policy strategies to incentivize food waste reduction at home and divert food and organics from landfills through recycling. Specifically, given that there are time costs associated with reducing food waste or engaging in organics recycling, it critical to evaluate how to best meet waste diversion goals. This is especially true when outcomes rely heavily on private individuals at home. Public policy should make it more convenient and time efficient for people to reduce their food waste at home. Particularly households could be provided with tools that can help them manage their routine activities that are prone to generate more food waste. Promotion of affordable meal-kits or educational programs could be some of many ways to reach this goal. If it is a critical policy goal to keep food and organics out of the landfill, it may be more valuable to actually take the burden off the hands of private individuals altogether. For example, policy can invest in, and focus on implementing new innovative central source separation of household organics through technology. A look at the struggling residential organics programs all over the nation would support this conclusion.

The rest of the article proceeds as follows. Section 2.2 provides a background on the food waste situation in the U.S, drawing on current prevention and recycling trends. It also provides a review of the relevant literature to clarify a clear connection between food waste reduction and organics recycling activities as contributors to higher environmental quality. Section 2.3 establishes the conceptual framework of household choice for food waste prevention and recycling efforts in a public good approach. The section also provides a detailed overview of the different measures of the opportunity cost of time. I present the empirical models in Section 2.4. Section 2.5 contains details on the data and the design of the consumer survey. Section 2.6 illustrates the results drawn from the empirical approaches. Section 2.7 provides a discussion of the results, concluding remarks, and policy implications.

2.2. Background

2.2.1. Food waste as an environmental problem

Food waste has serious environmental consequences. Accounting for over a quarter of freshwater supply and millions of barrels of oil (Hall et al., 2009), this presents a deep burden on the total food supply. Garnett (2008) argues that emissions embedded in the movement of food through the supply chain, including stages such as production, processing, retailing, and transport, generate a significant amount of greenhouse gases. Life-cycle studies illuminate the grave impacts of food waste on climate change. A recent study finds that almost 29% of annual food production, representing 55 million metric tonnes per year, is avoidable food waste (Venkat, 2011). Contributing to 2% of annual carbon emissions, this costs the U.S. over $198 billion. Further, decomposing food in landfills generates methane, carbon dioxide and other greenhouse gases, all by-products of landfilling solid wastes (Melikoglu, Lin, and Webb, 2013).

The Environmental Protection Agency (EPA) prioritizes food waste disposal activities through the Food Recovery Hierarchy. Namely, in the order of preference, efforts should be allocated to (i) reduce food waste, (ii) donate food to hunger relief agencies, (iii) recycle for feeding animals, (iv) recover energy through conversion, (v) compost, and lastly (vi) landfill or incinerate. Specifically, the EPA has set a goal to reduce food waste by 50% by 2030 (EPA, 2016a).

These priorities however do not reflect current practices. In 2014, of the 38 million pounds of municipal food disposed in the U.S., only 5.1% was composted, 18.6% was used in combustion for energy recovery, and the remaining 76.3% was landfilled (EPA, 2016b). In contrast, the European Union (EU) legislation requires landfill disposal of food waste. In the UK, this is about 48% of food waste that needs to be phased out (House of Lords, 2014). Further, many European countries have adopted plans to become circular economies by minimizing the amount of municipal waste that is landfilled and increasing their recycling and preparation of solid waste for the most efficient re-use. The European Commission adopted a legislative proposal to recycle and reuse waste up to 70% by 2030 (Sahimaa et al., 2015). Since wasted food places a burden on society in multiple ways, recent trends suggest that waste management strategies in the U.S. will likely follow suit.

There is a robust, growing trend toward ensuring proper avenues for diversion and re-use employing advanced technologies. Diversion and reuse objectives involve finding suitable strategies to prevent the waste from going to landfills and instead being converted into productive, high-value resources (Lin et al., 2013; Levis et al., 2010). Existing food waste diversion efforts are mostly concentrated in combustion for energy generation. However, environmental stresses still persist when organics are combusted with other municipal wastes for energy generation (Kiran et al., 2014). To a lesser extent, some organics are currently converted into composting for fertilizer. Given the high-moisture content and physical structure of food waste, composting is yet another possibility for resource efficiency (Chang and Hsu, 2008). An estimated 1.94 million tons of postconsumer food was diverted through composting in 2014 (EPA, 2015). Composting technologies vary in sophistication and have been widely researched and applied (Lemus and Lau, 2002; Seo et al., 2004; Chang, Tsai, and Wu, 2006). Mounting landfill costs and high market prices make composting a promising and economically sustainable food waste diversion solution; however, current inefficiencies in hauling and collection as well as lack of adequate infrastructure pose challenges to realize higher composting potential (ReFED, 2016).

To date, most food waste are dumped in unregulated landfills where generated methane, instead of being potentially harvested for biogas, is emitted in the atmosphere

(Themelis and Ulloa, 2007). Presently, less than 10% of the methane in landfills is captured and used for renewable energy. When unharvested and allowed to escape into the atmosphere, these gases contribute to global warming. Given the extent of the environmental consequences of food waste, there is an urgent need to adopt sustainable food production and consumption practices to ease the burden on the food system. Minimizing avoidable food waste through prevention efforts and unavoidable food waste through recycling can help reach these goals, especially at the household level.

Consumers throw away over 25% of food and beverages they purchase (Bloom, 2011). Buzby and Hyman (2012) translated this food loss to almost 10% of the average amount spent on food or equivalently consumer-level losses of 0.7 pounds of food per capita valued at $1.07 per day. A report by ReFED (2016) estimates that households' food waste accounts for 42% of 63 million tons of food wasted in the U.S., followed by restaurants at 22%. Further, this makes up 51% of the total food that is landfilled.

Various factors may dictate people's efforts towards food waste reduction and organics recycling activities at home. The role of the household cost of time on recycling efforts, especially for items such as paper or plastic, has been previously documented (Halvorsen, 2008; Tiller, Jakus, & Park, 1997; Hong, Adams, & Love, 1993). Reducing food waste at home requires making a host of changes in household routines which may be time consuming. This includes planning meals in advance, sticking to meal plans, cooking all the meals intended for at home, and so on. In a recent study, Ellison and Lusk (2016 highlighted the roles of trade-offs and economic incentives in food waste decisions.

A brief look at the intricacies of separating organics for recycling would also substantiate why it may be challenging to keep up with the tasks required. Municipalities throughout the U.S. are experiencing difficulties with their organics recycling programs. For instance, Alameda County in California, where organics recycling is mandatory, saw an alarming rise in the amount of food scraps that the residents put in their garbage instead of collection bins. Examples include cities of Oakland and Berkeley, where the amount of food in garbage bins rose from about 15% to 39% between 2013 and 2014 (StopWaste Benchmark Service, 2015). In New York, the city had to pause the expansion of a residential composting program after noting that only 10.6% of organic waste was being collected through the effort with the rest ending up in the landfills with other trash (Amiri, 2018). Another issue is that of contamination, as seen in [the City of] Madison, Wisconsin. Various non-organic materials tend to get disposed through the composting stream which negatively impacts the conversion process (Sloan, 2018). However, many households, albeit a small proportion, may still be motivated to voluntarily contribute towards food waste reduction and organics recycling daily. It remains a question whether a concerted effort at the household level could achieve the resolute goal of keeping food and organics out of the landfills.

2.2.2. Environmental quality as a public good

Samuelson (1954) described a public good as one that is consumed in equal amounts by all. Environmental quality is a public good in its role as a supplier of public-consumption goods such as landscape, clean air, and other types of life-supporting systems (Siebert and Siebert, 1981). To date, many have used a public-goods approach to study the role of individuals in environmental problems. Individuals make choices for contributing to the public good by weighing incentives, private benefits, motivations, and existing policy (Halvorsen, 2008; Brekke et al., 2003; Andreoni, 1990).

Particularly relevant is the literature on household recycling of plastic, paper, glass from the public goods perspective. Brekke et al. (2003) develop a model of motivation to show that individuals, viewing themselves as socially responsible individuals, make voluntary contributions to the public good. Applying the model to recycling behavior, the authors show that individuals dedicate effort, in the form of time, and use a household production function to generate morally ideal levels of contributions to the public good. In their survey data, they find that public policies providing economic incentives affecting budget, time and relative prices may result in negative effects for voluntary contributions. This would happen if those incentives reduce morally driven contributions resulting in a "crowding-out" effect. Similar outcomes had been noted in the previous recycling literature (Thøgersen, 1994). Additional information effects, such as an understanding that recycling is good for the environment, is found to increase people's self-reported likelihood to dedicate more effort towards recycling.

Halvorsen (2008) extends and develops a similar public good model to include other social and moral norms such as self-respect in community, self-respect for oneself, and warm-glow. Empirically, the author finds that household recycling effort decreases when there is an increased opportunity cost of time. However, other indicators, such as social and moral norms, increase recycling efforts. In contrast to Brekke et al. (2003), the author does not find strong evidence of "crowding-out" in the presence of economic incentives to increase recycling.

Parallels can be drawn between the non-food material recycling and the organic recycling activities. Increases in both recycling activities contribute to higher levels of environmental quality, a public good. Both types of recycling can be costly and time-consuming to households suggesting trade-offs that affect levels of contributions to the public good. Further, similar moral norms may be at play in both types of decisions. Similar likes can be deduced when thinking about food waste reduction activities which also contribute to the larger public good.

2.3. Opportunity Cost of Time Model

The goal of this study is to investigate the role of the opportunity cost of time in decisions to participate in household food waste reduction and organics recycling activities at home. I approach this inquiry using two different definitions of the opportunity cost of time. The first method uses household income as well as a wage rate inferred from the household income as measures of the opportunity cost of time (Hong, Adams, & Love, 1993; Jakus, Tiller, & Park, 1996). It can be argued that the wage rate or household income are good proxies for the opportunity cost of time. However, studies have shown that those who are likely to recycle or be engaged in environmentally sustainable activities at home tend to be individuals with higher income levels and socio-economic status (Sidique, Lupi, & Joshi, 2010; Berger, 1997; Oskamp et al., 1991). The same inference can be drawn for food waste reduction activities.

Thus, I anticipate this traditional definition of the opportunity cost of time to be problematic in this context. Household income or the wage rate may not be a realistic reflection of how people view their actual opportunity cost when making environmentally sustainable decisions relating to food waste reduction and organics recycling. That is, it may not accurately represent what individuals *really* give up to do participate in those environmentally-friendly endeavors. For completeness, however, I use a reduced form approach to estimate the relationship between the household income/wage rate and household choices to engage in food waste reduction and organics recycling efforts.

The second definition of the opportunity cost of time follows from a structural framework that links moral norms, household production functions, and household choices to participate in food waste reduction and organics recycling efforts. Assume that the household, i, gains utility ($\mathcal{U}_i$) from meals (F_i), other private goods excluding meals (x_i), leisure ($t_{L,i}$), environmental quality as the public good (G), and self-image (I_i). Brekke et al. (2003) describe I_i as a moral behavior that would serve as private interest for the individual i to contribute to the public good G. For simplicity, the utility function, assumed to be increasing and strictly quasi-concave, is given by

(1) $$\mathcal{U}_i = \mathcal{U}_i\left(x_i, F_i, t_{L,i}, G, I_i\right)$$

This framework is comparable to previous work by Halvorsen (2008) who modeled recycling behavior in Norway. However, I do not assume that consumers make only one type of contribution towards the public good, for instance, discarding food scraps as recyclables. It would not make sense that households simply purchasing a large volume of food and recycling a big share would count as a contribution toward higher environmental quality. The reality is a little more nuanced. Instead, I explicitly model two types of contributions: tangible ($g_{R,i}$) and intangible ($g_{A,i}$) contributions. Higher environmental quality can be achieved when individuals contribute a higher food waste share towards recycling ($g_{R,i}$) as well as when they engage in activities that minimize the generation of discarded food in the first place ($g_{A,i}$). Ideally, avoidable food waste is mitigated through $g_{A,i}$ and unavoidable food waste is curbed through $g_{R,i}$, both contributing to the public good. The total amount of the public good depends on the private provisions of the contributions $G_i(g_{R,i}, g_{A,i})$ and provisions from other households $G_{-i}\left(g_{R,-i}, g_{A,-i}\right)$. The total public good can be defined as:

(2) $$G = G(G_i\left(g_{R,i}, g_{A,i}\right) + G_{-i}\left(g_{R,-i}, g_{A,-i}\right))$$

The recycled share $g_{R,i}$ and intangible contribution $g_{A,i}$ are generated as functions of the efforts dedicated towards the respective activities: $g_R(e_{R,i})$and $g_A(e_{A,i})$. The person's effort, $e_{R,i}$, is measured in units of time and contributes to an increased supply of the public good through recycling efforts. Thus, we have $\frac{\partial g_{R,i}}{\partial e_{R,i}} > 0$; that is, increases in recycling efforts raises contributions to the public good in the form of higher levels of food scraps as recyclables, $g_{R,i}$. Contribution, $g_{A.i}$, is a function of effort, also measured in units of time $e_{A,i}$ dedicated towards activities such as meal planning, disciplined shopping, meal preparation, cooking and so on. Ideally, engaging in these activities lead to improved use of food inputs, hence preventing larger amounts of avoidable food disposed. Spending time in these household food production related activities is assumed to be equivalent to engaging in food waste prevention activities which increases the public good; that is, $\frac{\partial g_{A,i}}{\partial e_{A,i}} > 0$.

The household production function approach introduced by Becker (1995) has been used to explain material recycling behavior (Morris and Holthausen, 1994) and more recently, food waste decisions (Landry and Smith, 2017; Ellison and Lusk, 2016). Households combine purchased food inputs z_i and time spent in cooking and preparation $e_{A,i}$ to convert them into meals, $F_i = f(z_i, e_{A,i})$. Waste proportion can then be defined as $W_i = \sum_{j=1}^{J} z_{ji} / F_i$, for J inputs.

Accordingly, the individual's self-image is a function of both types of contributions towards the public good, $I_i(g_{R,i}, g_{A,i})$. The individual maximizes utility given standard time and budget constraints given by (*3*) and (*4*):

(3) $$T_i = t_{L,i} + e_{A,i} + e_{R,i}$$

(4) $$\sum_{j=1}^{J} p_j z_{ji} + \sum_{n=1}^{N} p_n x_{ni} = Y_i$$

Labor supply decisions are assumed to be long-term and given for the period. As such, income Y_i is also given. Further, I also assume that total time available, excess of work, also consist of some "non-negotiable" hours spent on activities that are necessary and less flexible for the household. This may include time in child care or adult care activities. Behaviorally, people would be less likely to substitute these "non-negotiable" hours for other household production activities. Total time endowment T_i is hence excess of work hours and other non-negotiable hours. This time can be spent on leisure ($t_{L,i}$), food-related household production and waste prevention activities ($e_{A,i}$), and food recycling activities ($e_{R,i}$). Household income, Y_i, is spent on raw food input z_j at price p_j and other private goods x_n at price p_n. Individual i maximizes utility with respect to consumption of private non-food goods (x_i), food inputs (z_i), time in leisure ($t_{L,i}$), effort to dedicate towards her recycled share of food and organics ($e_{R,i}$), and efforts towards food waste prevention ($e_{A,i}$). Denoting λ_i as the Lagrange multiplier on money budget and μ_i as the Lagrange Multiplier on the time budget, the Lagrangian of the household's problem is:

(5)
$$\mathcal{L} = \mathcal{U}_i(x_i, F_i, t_{L,i}, G, I_i) + \lambda_i \left\{Y_i - \sum_{j=1}^{J} p_j z_{ji} - \sum_{n=1}^{N} p_n x_{ni}\right\} + \mu_i \{T_i - t_{L,i} - e_{A,i} - e_{R,i}\}.$$

Recall that the utility function can be expressed as:

(6)
$$\mathcal{U}_i(x_i, F_i, t_{L,i}, G, I_i) = \mathcal{U}_i\left(x_i, f(z_i, e_{A,i}), t_{L,i}, G_i\left(g_R(e_{R,i}), g_A(e_{A,i})\right) + G_{-i}(g_{R,-i}, g_{A,-i}), I_i(g_R(e_{R,i}), g_A(e_{A,i}))\right)$$

In the optimum the time and money budget will bind and the first-order conditions for the problem are expressed as:

(7)
$$\frac{\partial \mathcal{L}}{\partial x_{ni}} = \frac{\partial \mathcal{U}_i}{\partial x_{ni}} - \lambda_i p_n = 0$$

(8)
$$\frac{\partial \mathcal{L}}{\partial z_{ji}} = \frac{\partial \mathcal{U}_i}{\partial f} . \frac{\partial f}{\partial z_{ji}} - \lambda_i p_j = 0$$

(9)
$$\frac{\partial \mathcal{L}}{\partial t_{L,i}} = \frac{\partial \mathcal{U}_i}{\partial t_{L,i}} - \mu_i = 0$$

(10)
$$\frac{\partial \mathcal{L}}{\partial e_{R,i}} = \frac{\partial \mathcal{U}_i}{\partial G_i} . \frac{\partial G_i}{\partial g_R} . \frac{\partial g_R}{\partial e_{R,i}} + \frac{\partial \mathcal{U}_i}{\partial I_i} . \frac{\partial I_i}{\partial g_A} . \frac{\partial g_R}{\partial e_{R,i}} - \mu_i = 0$$

(11)
$$\frac{\partial \mathcal{L}}{\partial e_{A,i}} = \frac{\partial \mathcal{U}_i}{\partial f} . \frac{\partial f}{\partial e_{A,i}} + \frac{\partial \mathcal{U}_i}{\partial G_i} . \frac{\partial G_i}{\partial g_A} . \frac{\partial g_A}{\partial e_{A,i}} + \frac{\partial \mathcal{U}_i}{\partial I_i} . \frac{\partial I_i}{\partial g_A} . \frac{\partial g_A}{\partial e_{A,i}} - \mu_i = 0$$

Equation (9) tells us that the Lagrange Multiplier for the time budget (μ_i) is equal to the marginal utility of excess leisure time. When choosing recycling efforts ($e_{R,i}$), equation (10) shows that the household assesses the marginal utility gained from increased environmental quality (non-negative) as well as increased self-image (non-negative). When making choices about how much time to dedicate towards food production and food waste reduction efforts ($e_{A,i}$), the household not only evaluates the effects from the marginal utility of time spent in the production of meals but also the marginal utility from the increase in environmental quality and the feeling of positive self-image through I_i. All three terms making up (11) are non-negative implying that there are additional effects to spending more time in $e_{A,i}$ than simply the marginal utility of meal production.

In solving all first order conditions, the arguments of the utility function can be expressed in terms of the exogenous factors which include total time available (T), prices (P_j and P_n), income (Y_i), total recycling and food waste prevention contributions by other households (G_{-i}). I thus obtain the respective demands: x_{ni}^*, $t_{L,i}^*$, z_{ji}^*, $e_{R,i}^*$, and $e_{A,i}^*$. Plugging the demands in the utility function gives the indirect utility, which is a function of time, income, prices, and optimal efforts. For simplicity, I normalize and leave out non-food prices:

(12) $$V_i = V_i(t_{L,i}^* + e_{A,i}^* + e_{R,i}^*, Y_i, P_j, G(g_R(e_{R,i}^*), g_A(e_{A,i}^*)), I_i(g_R(e_{R,i}^*), g_A(e_{A,i}^*))$$

To determine the opportunity costs of time, I seek estimates of the household' compensating variation (CV), that is, the change in income required to maintain utility at a given level when the household engages in environmentally sustainable household activities compared to when they leave them to others. Contextually, it is equivalent to the willingness-to-pay to leave food waste reduction and organics recycling activities to a third party. This would leave the households indifferent between doing the activities themselves or leaving them for others to do in exchange of a payment. This is similar to the willingness-to-pay measure elicited by Halvorsen (2008). In this case, however, even if the household leaves food waste reduction efforts to others, it is intuitive to see that there is a minimum of food-related activities, $(\bar{e}_{A,i})$, they have to do at home. Thus, $g_A(\bar{e}_{A,i}) = 0$ when the household does not engage in food waste reduction activities at home. On the other hand, when the household does not engage in any source separation of their food and organics, $e_{R,i} = 0$ and $g_R(0) = 0$. The CV (CV) is given as the following difference:

$$(13) \qquad V_i\left(t_{L,i}^* + e_{A,i}^* + e_{R,i}^*, \boldsymbol{Y_i}, P_j, G\left(g_R\left(e_{R,i}^*\right), g_A\left(e_{A,i}^*\right)\right), I_i\left(g_R\left(e_{R,i}^*\right), g_A\left(e_{A,i}^*\right)\right)\right) - V_i\left(T_i - \bar{e}_{A,i}, \boldsymbol{Y_i} - \boldsymbol{CV}, P_j, \bar{\bar{G}}, 0\right) = 0$$

When leaving food waste reduction and recycling efforts to others, the household is still ensured an environmental public provision of $\bar{\bar{G}}$ without making any personal contributions. All available time is spent on leisure and a minimum level of effort towards food-related activities at home $(T_i - \bar{e}_{A,i})$. Self-image is also assumed to be 0 as $I_i(g_R(0), (g_A(\bar{e}_{A,i})) = 0$. Solving the difference in the indirect utilities gives the compensation variation as a function of leisure time, household income, food price level, the given environmental quality, and others' contribution towards the public good:

$$(14) \qquad CV = CV\ (T_i - \bar{e}_{A,i}, Y_i, P_j, \bar{\bar{G}})$$

CV is positive for households who would leave the activities to a third party and negative for those who would rather undertake the activities themselves. I use the household's stated willingness-to-pay to leave the activities to others as a proxy for *CV*, which is the reduction in income required to maintain the public good. This willingness-to-pay amount represents a valuation of their own time, thus is a proxy for the opportunity cost of time.

2.4. Empirical Models

In this first section, I first propose empirical models drawing from the conceptual framework with the alternate, and most preferred, definitions of the opportunity cost of time. In the next section, I establish the reduced form approach using the household income/wage rate as the opportunity cost of time. In both cases, I estimate household recycling efforts $(e_{R,i})$ and food waste reduction efforts $(e_{A,i})$ as two separate models.

2.4.1. Structurally motivated empirical approach

Following the conceptual model, the household recycling efforts ($e_{R,i}$) is estimated as a function of the regional food price index (P_j), the household income (Y_i), the opportunity cost of time used for organics recycling ($OP_{R,i}$), m individual motivations towards organics recycling ($I_{m,i}$), h household demographics ($H_{h,i}$), and a state-level variable capturing organics recycling exposure ($S_{R,i}$). This consists of a variable capturing whether the state where the respondent resides has broad food waste disposal accessible to its residents in equation *(15)*. Thus recycling effort is approximated using the following equation with ε_i as the error term:

(15)
$$e_{R,i} = \beta_{0R} + \beta_{PR}P_j + \beta_{YR}Y_i + \beta_{RR}OP_{R,i} + \sum_{m=1}^{M} \ell_{1m}I_{m,i} + \sum_{h=1}^{H} \ell_{2h}H_{h,i} + \ell_s S_{R,i} + \varepsilon_i$$

The willingness-to-pay value of leaving recycling to others is used as the opportunity cost of time ($OP_{R,i}$). Given that willingness-to-pay measures suffer from issues of endogeneity, it needs to be instrumented. Following the theoretical framework, the opportunity cost, which is approximated by CV, is given by the following equation:

(16)
$$OP_{R,i} = \theta_0 + \theta_P P_j + \theta_{\ Y}Y_i + \theta_h WH_i + \theta_o NG_i + \theta_A A_i + \sum_{st=1}^{ST} \delta_s S_{st,i} + v_i$$

Thus, household CV ($OP_{R,i}$) is a function of food prices (P_j), household income (Y_i), work hours (WH_i), non-negotiable household hours (NG_i), individuals' age (A_i) as a control, and the state-level variables related to recycling and food waste reduction programs ($S_{st,i}$) to gauge what efforts others may be undertaking. This includes the number of food waste composting facilities per capita to determine widespread food recycling action (US Compositing Council, 2018; EPA, 2016a; NatureWorks LLC, 2007). As a proxy for the prevalence of food waste reduction activities, I use the state-wide per capita reported participation in the EPA's and United States Department of Agriculture's (USDA) food recovery challenge (USDA, 2017). These participants, which include schools, farmers, and local communities, join this effort by sharing their food waste reduction activities and working with EPA experts to measure and reduce their food waste. Finally, I construct a measure for environmental quality at the state level by using the annual median Air Quality Index (AQI) available at county level (EPA, 2018b) and include the number of active landfills by state. See Appendix A more details.

I estimate a similar equation to approximate household food waste reduction efforts. However, this model includes additional variables specific to food to capture the marginal utility of meals and food prices more accurately:

(17)
$$e_{A,i} = \beta_{0A} + \beta_{PA}P_j + \beta_{YA}Y_i + \beta_{RA}OP_{R,i} + \beta_s SHOP_i + \beta_F FOOD_i + \sum_{m=1}^{M} \varphi_m I_{m,i} + \sum_{h=1}^{H} \varphi_h H_{h,i} + \varphi_s S_{A,i} + \epsilon_i$$

Namely, I include details about the primary shopping location ($SHOP_i$) in conjunction with the food price index (P_j) to better account for price differences which may matter in food waste reduction decisions (Ellison and Lusk, 2016). I also include a relative measure of individual satisfaction from consuming meals ($FOOD_i$): the marginal utility from food in the theoretical framework ($\frac{\partial u_i}{\partial f}$). To capture state wide exposure to food waste information that may influence household choices in reducing food waste, I use a variable determining coverage of food waste news ($S_{A,i}$). See Appendix A for more details on the state-wide news coverage of food waste issues. The CV/opportunity cost of time equation is estimated similarly as above in equation *(16)* using the willingness-to-pay measure for leaving food waste reduction activities to others as the dependent variable ($OP_{A,i}$). Any simultaneity issues connecting the effort levels and the CV/opportunity cost of time should further be addressed through the IV method (Biørn and Krishnakumar, 2008).

2.4.2. Reduced form approach

Using the next approach, household recycling efforts ($e_{R,i}$) and food waste reduction efforts ($e_{A,i}$) are estimated as follows with ρ_i and κ_i as the error terms respectively :

(18) $$e_{R,i} = \beta_{01} + \beta_{R1}OP_{W,i} + \beta_{P1}P_j + \sum_{m=1}^{M} \partial_{1m}I_{m,i} + \sum_{h=1}^{H} \partial_{2h}H_{h,i} + \partial_s S_{R,i} + \rho_i$$

(19) $$e_{A,i} = \beta_{02} + \beta_{R2}OP_{W,i} + \beta_{P2}P_j + \beta_{S2}SHOP_i + \beta_{SF}FOOD_i + \sum_{m=1}^{M} \tau_{1m}I_{m,i} + \sum_{h=1}^{H} \tau_{2h}H_{h,i} + \tau_s S_{s,i} + \kappa_i$$

Household recycling efforts ($e_{R,i}$) is estimated as a function of the opportunity cost of time measure ($OP_{W,i}$), which is the household income or the inferred wage rate. To keep things consistent and the results comparable across the models and equations, I include similar additional regressors in equations *(18)* and *(19)* as *(15)* and *(17)* respectively. That is, regional food prices (P_j), individual motivations ($I_{m,i}$), demographics ($H_{h,i}$), and the state-level variables are all included in both equations. I also include the additional variables from equation *(17)* in equation *(19)*, that is, $SHOP_i$ and $FOOD_i$. While these variables present in equations *(15)* and *(17)* are dictated by the theoretical approach, in the reduced form model, they are used as controls. In these models, income or the wage rate ($OP_{W,i}$), not the proxy for the CV ($OP_{R,i}$ or $OP_{A,i}$), is the main explanatory variable of interest.

In this reduced form method, there is worry that the income variable may be endogenous. In this light, an instrument may be appropriate to yield appropriate estimates (Card, 2001; Angrist, Imbens, & Rubin, 1996; Angrist and Krueger, 1991). In the previous model, I use variables that dictate the CV from the theoretical framework as the instruments for the opportunity cost of time. In this case, I have to identify an appropriate instrument or set of instruments. I use the total expenditure on food and beverages in a given week as the instrument. Total food and beverage expenditure is expected to be strongly correlated with the endogenous variable, household income or the wage rate, as well as meet the exclusion restriction requirement. This implies that total food and beverage expenditure has no direct effect on food waste reduction or organics recycling efforts, except through income/wage rate. In other words, higher income/wage rate is expected to correlate with higher levels of food and beverage expenditure. However, food and beverage expenditure should not affect efforts to reduce food waste or engage in organics recycling directly and explicitly. Thus, the instrument can be excluded from the causal model (Angrist and Pischke, 2008). This leads to the following equation:

$$OP_{W,i} = \phi_0 + \phi_{1,i} FOODEXP + \zeta_i \quad (20)$$

The opportunity cost of time ($OP_{W,i}$) defined as either the household income or the inferred wage rate is a function of the total food and beverage expenditure, with ζ_i as the error term.

2.5. Data and Survey Design

A U.S. nationally representative survey was fielded through the Qualtrics platform in August 2018. The nationally representative survey was designed to collect data on willingness to participate in food waste reduction and recycling efforts as well as key variables pertinent to the conceptual framework including the willingness-to-pay (CV) measures. Recruitment specified desired demographic characteristics of the sample to match that of the United States. Only those who were (1) over the age of 18, (2) responsible for a significant portion of food-related activities at home, including purchasing, preparation, and disposal, as well as (3) those who resided in single family homes or duplexes were eligible to participate in the survey. The last eligibility criterion was in place, since most organics curbside collection programs are targeted towards this population versus those who reside in apartments, for instance. The sample included 865 respondents after accounting for questionable or incomplete records.[1]

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[1]*Since only those who resided in single family homes or duplexes were invited to participate, I exclude all unreasonable responses for household size. Eight respondents reported household sizes over 20 and were*

2.5.1. Demographic composition

Table 2-1 reports the descriptive statistics for the socio-demographic characteristics of the respondents. Nearly two-thirds (65.6%) of the sample is White, followed by Black or African American respondents at 12.4%. These statistics are quite comparable to the U.S. population. Similar to the U.S., just under 6% of the sample is Asian. Only about 10% of the sample consists of Hispanic individuals, implying an underrepresentation of this group. There is a higher proportion of female respondents with women and other (those who chose not to identify as male nor female) making up about 73% of the sample. Almost 55% of the sample has less than a Bachelor's or Associate's degree, which compares to the U.S. population. There is an underrepresentation of people with Associate's degree since only about 9% of the sample falls in that category compared to 25% in the United States. Approximately a quarter (23%) of the sample has a bachelor degree and another 12.8% has a Master degree or higher. Thus, the sample consists of more individuals who have an advanced degree compared to the U.S. population.

Table 2-1 Demographic characteristics of the sample compared to the U.S

Demographic Variables	Sample	U.S. Census
Race (%)		
Asian	5.8	5.8
Black or African American	12.4	13.4
Hispanic	9.6	18.1
White	65.6	60.7
Other	6.7	2
Gender (%)		
Male	27.1	48.7
Female or other	73.0	51.3

discarded. Although the survey had the "Force Response" feature in all questions, due to technical issues, twenty-four respondents did not have complete records, missing responses sporadically throughout the survey. Their responses were omitted. About twenty individuals reported willingness-to-pay values over $100 per month, up to $150,000, which is unreasonable and signals some lack of genuineness when taking the survey. Their responses are also omitted.

Demographic Variables	Sample	U.S. Census
Educational attainment (%)		
Less than Bachelor's or Associate's	55.4	52
Associate's degree	8.9	25.1
Bachelor's degree	22.9	14.5
Master's degree or higher	12.8	8.8
Age (%)		
18-24	8.4	12.2
25-34	20.0	17.8
35-44	17.7	16.3
45-54	20.1	16.8
55-64	19.9	16.7
65 or above	13.9	20.1
Region (%)		
Midwest	23.9	20.9
Northeast	20.1	17.1
South	39.5	38.1
West	16.4	23.8
Household size	2.76	2.6
N	*865*	

U.S data from Census Bureau and the American Community Survey 2017-2018. Statistics reported are for population 18 and over, not total population.

The age and geographic distribution of the sample compared quite closely to that of the U.S. with a few minor discrepancies. Under 10% of the sample is aged between 18-24, while just about 12% of the U.S population falls in that category. There is a concentration of respondents in the 25-34 and 45-54 age groups. Thus, there is a slight overrepresentation in these age groups in the study sample. With 13.9% of the sample aged 65 and above, there is an underrepresentation of this particular age group compared to the U.S. (20.1%). Similar to the U.S., the largest proportion of the sample resides in the South. Finally, the mean household size in the sample is 2.76, which is slightly higher than the average of 2.6 for the U.S.

2.5.2. Household recycling and food waste reduction efforts

Since only a small proportion of U.S households currently participate in organics recycling programs, this survey elicits *willingness to participate* in given food waste reduction and recycling efforts instead of *actual* efforts. This is similar to previous work by Aadland and Caplan (2003) who elicited willingness to participate in a curbside recycling program in Utah. Although it is uncertain how closely hypothetical reponses reflect potential real actions, the survey includes cheap talk, which has been documented in the literature to help mitigate possible hypothetical bias (Cummings & Taylor, 1999; Aadland & Caplan, 2003). In the survey, respondents reported their willingness to participate in nine different activities that could reduce food waste at home on a five-point scale (1 = "Very Unlikely" to 5 = "Very Likely"). I draw those activities from the the EPA's "Reducing Wasted Food at Home" guideline (EPA, 2018a). The question was posed as follows:

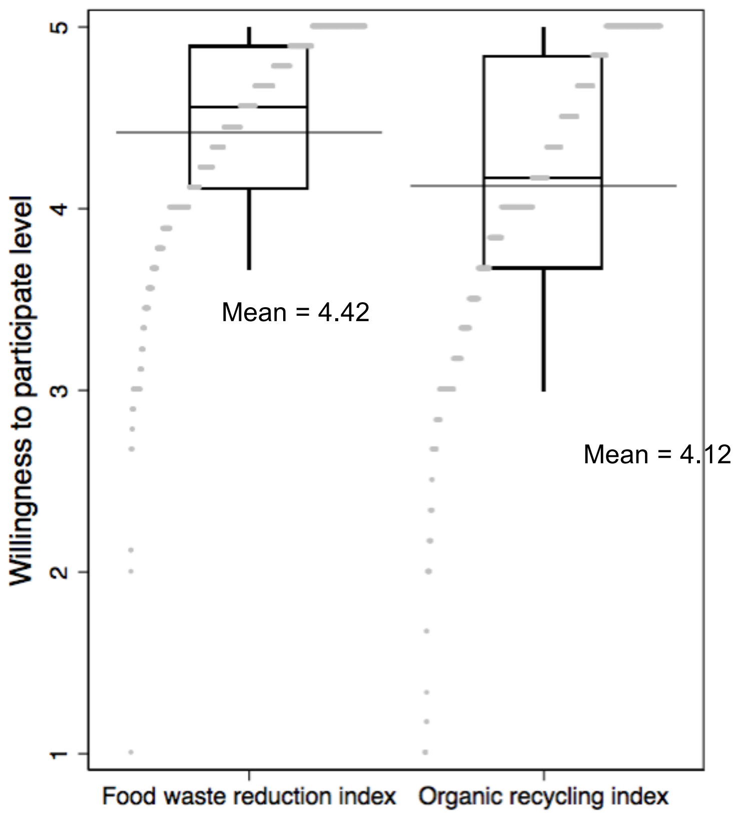
> *Thinking about your own household, if you are proposed to engage in the following food waste reduction efforts at your home, realistically how likely are you participate in these activities?*
>
> *(1) Planning your weekly meals, (2) Making a shopping list and checking your kitchen inventories before food shopping, (3) Buying only what you need at the store, (4) Storing your fruits and vegetables so they stay fresh longer, (5) Cooking and preparing perishable items before they spoil, (6) Learning about expiration dates of foods, (7) Cooking only what will be eaten, (8) Re-using leftovers, (9) Preparing and eating all planned meals.*

Using the same scale, the survey asks respondents to state their willingness to participate in food and organics recycling activities at home in six distinct activities. The question asks:

> *Thinking about your household, if you are invited to engage in the following food and organics recycling efforts, realistically how likely are you be to participate in these activities?*
>
> *(1) Separating all food scraps from your regular trash, (2) Separating all paper products from your regular trash, (3) Separating any trapped organics (such as leftover food in a Styrofoam container) from your regular trash, (4) Separating any coffee filters and coffee bean grounds, and other organic materials from your regular trash, (5) Preventing any non-organic materials (such as Styrofoam or plastic wraps) from your organic waste, (6) Avoiding any food or other organics from getting disposed in your regular trash bin.*

Figures A.1 and A.2 in the Appendix show the details of the individual responses for the willingness to participate measures for food waste reduction and organics recycling activities, respectively. I derive a representative measure of organics recycling efforts (*organics recycling index*) by taking the average of the reported likelihood to participate in the five individual related activities. The same method is applied to obtain a measure for food waste reduction efforts (*food waste reduction index*). Figure 2-1 shows the cumulative distribution of the responses for both measures as well as the boxplot summarizing the first quartile, median, third quartile, and the mean responses.

Figure 2-1. Boxplot of willingness to participate in (1) Food waste reduction activities and (2) Organics recycling activities



Food waste reduction and organics recycling indices obtained by taking the mean of the individual responses gauging the likelihood to participate in those activities respectively (see Figures A.4 and A.5 in the Appendix). Food waste reduction index obtained from nine individual responses. Organics recycling index derived from five individual responses. Horizontal lines on boxplots depict mean responses.

On average, respondents were enthusiastic and reported high willingness to participate in food waste reduction and organics recycling activities. These high values may suggest some element of optimism for these environmentally sustainable activities. For instance, on a scale of 1 (“Very Unlikely”) to 5 (“Very Likely”), the mean for likelihood to participate in organics recycling program was 4.12 and for food waste reduction efforts the average was approximately 4.42.

2.5.3. Willingness-to-pay measures

According to the theoretical framework, the compensating variation (CV) is a proxy for the opportunity cost of time as it aggregates all the utility effects of participating in organics recycling or engaging in food waste reduction activities. The CV/opportunity cost measures can be captured through willingness-to-pay measures. Accordingly, the respondents were asked whether they would be willing to leave recycling activities or food waste reduction activities to others. Those who said they were agreeable were asked to report their willingness-to-pay for leaving recycling or food waste reduction activities to a third party in a set of open-ended contingent valuation questions (OE-CVM) and similar dichotomous contingent valuation questions (DC-CVM). About 70% of the sample reported a value for willingness-to-pay for food waste recycling and another 60.3% for the food waste reduction. It makes intuitive sense that a lower number of respondents were willing to leave their food waste reduction activities to a third party. Making lists for grocery shopping, buying food for meals, checking kitchen inventories, and cooking meals are highly personal routines.

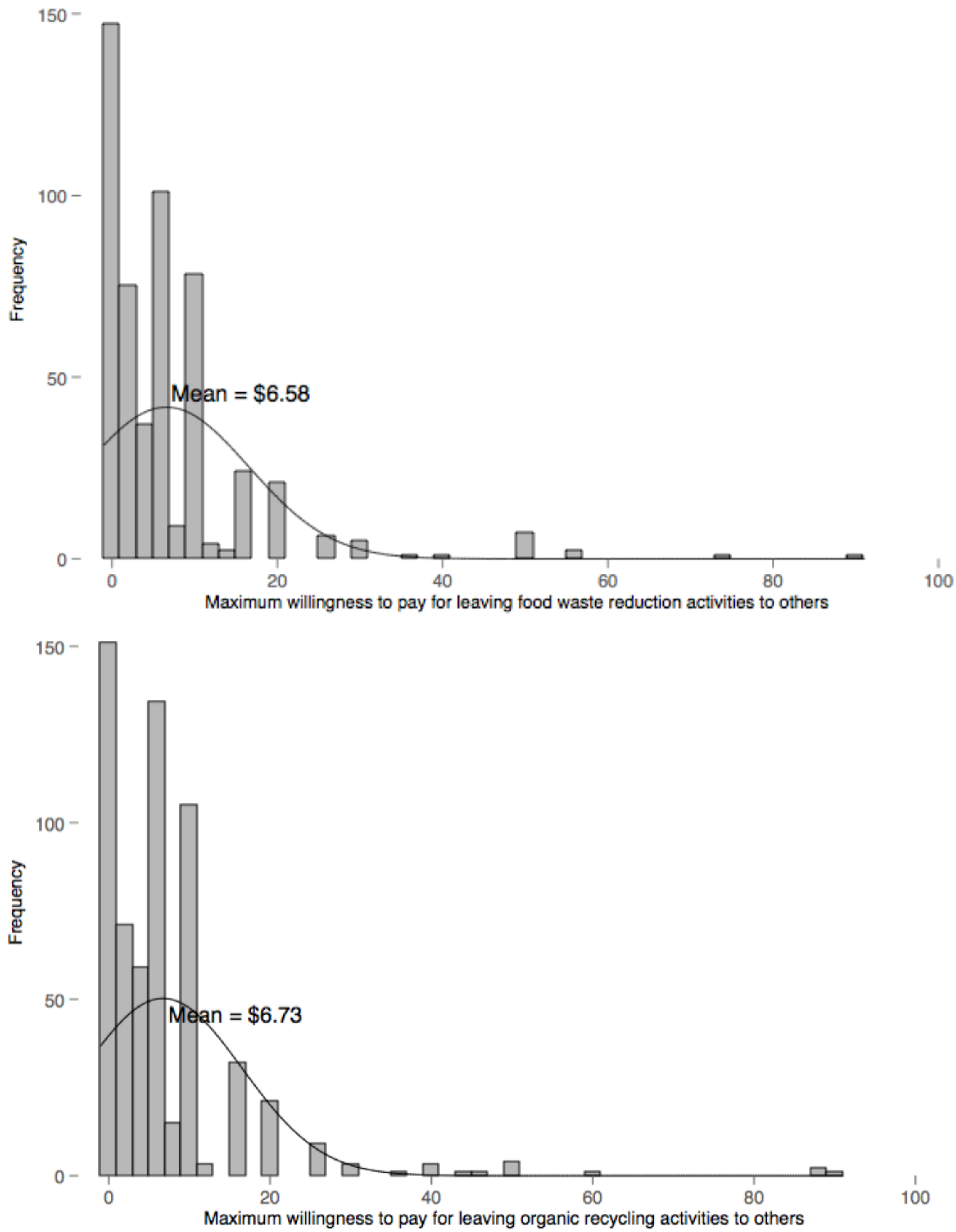
Figure 2-2 shows the responses to the DC-CVM questions. For food waste reduction, the respondents were asked: "Imagine it costs you a monthly fee for the company to help you make the decisions to buy and prepare only the amounts of food that your household needs. Would you be willing to pay this monthly fee: $\$x$?" In the case of organics recycling, the respondents were asked: "Imagine it costs you a monthly fee for the company to do the central source separation for you. Would you be willing to pay this monthly fee: $\$y$?" The amounts x and y ($3, $6, and $9) were randomly shown to the respondents in each case. The respondents could choose "Yes" or "No" in each scenario. Overall, about 45% of the sample reported that they are willing to pay the cost to leave food waste reduction activities to a third party. Up to 54% of the sample were willing to do so when it came to organics recycling activities. In general, respondents were more agreeable to leaving the activities to a third party when prices were lower. For instance, 71% of the respondents who saw the $3 price tag were ready to pay that cost to leave organics recycling activities to others. However, only 35.8% of respondents were ready to pay a monthly price tag of $9 to do so.

Figure 2-2. Willingness-to-pay to leave (1) Food waste reduction activities and (2) Organics recycling activities to others (DC-CVM responses)

The graph depicts responses from the DC-CVM questions. Respondents reported their willingness-to-pay the respective monthly amounts to leave (1) food waste reduction activities and (2) organics recycling activities to a third party. Prices are reported in $/month. All differences are statistically significant at the 5% level.

Figure 2-3 shows the distribution of responses from the OE-CVM questions. The top panel reports responses related to food waste reduction and the bottom panel is concerned with organics recycling. Close to 28% of the sample reported that they would pay a maximum of $0 to leave food waste reduction activities to others. Similarly, almost 25% of the sample reported that they were not willing to pay any monthly amount to leave organics recycling activities for a third party to conduct the central separation of their materials. On average, respondents were ready to pay an average of $6.58 per month to leave food waste reduction activities to others and about $6.73 per month for central source separation of their organic materials.

Figure 2-3. Willingness-to-pay to leave (1) Food waste reduction activities and (2) Organics recycling activities to others (OE-CVM responses)



Respondents reported their maximum willingness-to-pay amount ($/month) to leave the environmentally sustainable activities for a third party to do for them. Respondents completed this section after the respective DC-CVM question.

2.5.4. Moral motivations and norms

The survey instrument also tried to gauge respondents' moral norms and motivations to participate in food waste reduction and organics recycling activities at home. Table 2-2 reports key food waste reduction and organics recycling related characteristics as well as the regional variables gathered from multiple sources. First, respondents reported their valuation of environmental quality as it relates to these activities. The empirical challenges of gauging people's valuation of public goods, especially environmental quality, is extensively discussed in the literature. Particularly, although environmental quality is an important exogenous factor that determines willingness-to-pay, respondents are known to hold heterogeneous subjective information and existing knowledge about quality of the good (Whitehead, 2006). Some survey instruments include extensive descriptions of the environmental good but also tend to be expensive, or worse run the risk of fatiguing and tuning off their respondents (Berrens et al., 2002). Standardizing the information on the environmental good has been identified as a possible solution to the problem.

Hence, the survey provides comprehensive, yet concise, facts on the impact of food waste and organics recycling on the environment. See *Supplemental Materials* in Appendix A for more information. Respondents were then asked the following five-point scale question (1 = "Definitely No" to 5 = "Definitely Yes"): Do you think food waste reduction [food scraps and organics recycling contribute] to a better environment? Overall, respondents were likely to believe that participating in both sustainable activities contributes to a better environment.

In order to gauge other moral motivations, the survey asks the respondents whether they would partake in those environmentally sustainable activities for the following reasons: (1) I want to consider myself as a responsible person; (2) I want others to consider me as a responsible person; (3) Recycling of food scraps and organics [engaging in food waste reduction at home] would be a pleasant activity. All these variables were on a scale of 1 through 5 (1 = "Definitely No" to 5 = "Definitely Yes"). In all these cases, respondents were likely to respond favorably; that is, they were mostly in agreement that they participate in these activities for the given reasons.

Table 2-2. Moral norms, food-related routines, and state-level variables

VARIABLES	Means
Food waste reduction (average reported unless otherwise stated)	
Believes reducing FW contributes to better envir. (5 point scale)	4.5
Consider themselves a responsible person (5 point scale)	4.5
Want others to consider them a responsible person (5 point scale)	4.1
FW reduction is a pleasant activity (5 point scale)	3.9
Beliefs about other households' participation (3 point scale)	1.7
Recycling organics (average reported unless otherwise stated)	
Believes food recycling contribute to a better envir. (5 point scale)	4.5
Consider themselves a responsible person (5 point scale)	4.5
Want others to consider them a responsible person (5 point scale)	4.1
Organics recycling is a pleasant activity (5 point scale)	3.8
Beliefs about other households' participation (3 point scale)	1.8
Average food CPI	101.01
State level variables [1]	
Average food waste disposal program present in state	0.1
Average number of active landfills	13.0
Average number of news articles on food waste	11028.9
Average number of food waste disposal facilities	7.6
Average number of food waste reduction programs	36.2
Average of Median Air Quality Index (AQI)	35.9
Primary shopping location (%)	
Grocery stores	26.5
Supermarkets	63.6
Warehouse	7.3
Other	2.7
Household hours (weekly)	
Work hours	38.6
Minimum number of hours in food-related activities	16.75
Non-negotiable hours	18.59

VARIABLES	Means
Mean weekly food expenditure ($)	285.6
Mean food satisfaction (5 point scale)	4.4
N	*865*

[1] These averages are reported at the state level (47 states represented)

I also ask respondents to report what percentage of households would participate in food waste reduction and recycling programs if were widely available ("beliefs about other households' participation"). This question tries to get at possible crowding out or reinforcing effects. For instance, if people think that many other people would participate, they may be motivated to increase their effort. On the other hand, they may feel laxer and reduce their own efforts. This question was posed on three point scale (1 = "Less than 25% of households would participate," 2 = "About 50% of households would participate," and 3 = "More than 75% of households would participate").

I also gather several regional and state-wide variables. At the regional level, I include the food current price index (CPI) collected from the Bureau of Labor Statistics which averages at 101.01. The median Air Quality Index (AQI) is available in varying geographic areas within a state. The AQI consists of five major air pollutants regulated by the Clean Air Act which includes ground-level ozone, particle pollution, carbon monoxide, sulfur dioxide, and nitrogen dioxide. An air quality index of 50 or lower is considered "Good." See Appendix Figure A.3 for more information on the construction of this variable. The average median AQI was 35.9 with only three states with higher than 50 AQI (Hawaii, Nevada, and Arizona).

Other state-level variables account for household's exposure to environmentally sustainable activities. For instance, only about 10% of states have a comprehensive food waste disposal program present, with an average of seven food composting/disposal facilities per state. I also gather information on the number of active landfills in the U.S. (Figure A.4). There is an average of 13 active landfills per state, with a maximum of 67 in California and 0 in Hawaii. The study also includes the number of food waste related news articles to assess potential commonness of the issues (Figure A.5). This value is obtained from searching "[state name]" and "food waste" in the news section of google search.

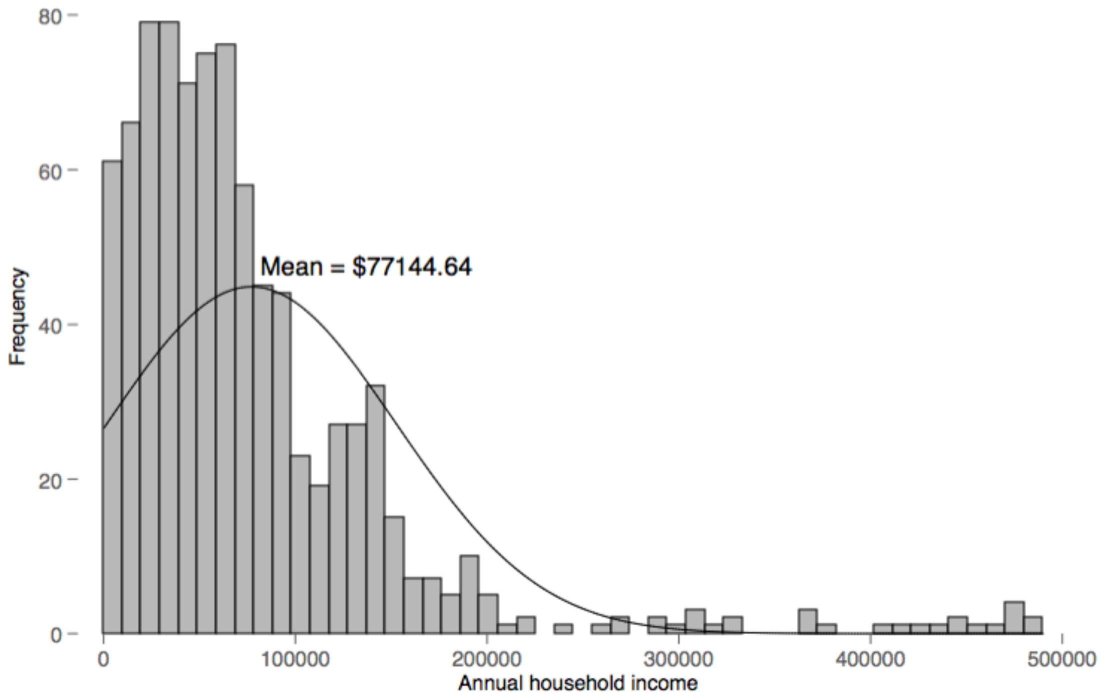
While there are no limits on the dates of these articles, most news articles are recent (2014 or later). This is representative of the recent surge of interest on issues of food waste in the media. I note an average state-level coverage of almost 11,000 articles per state. Finally, I include the number of participants in EPA's and USDA's food recovery challenge to determine widespread action on the food waste issue by state. States had about 36 participants on average, which could include schools, farmers, and local communities.

I also collect people's primary shopping store locations, the total weekly food and beverage expenditures, and other household related time use variables. Most people in this survey shop at grocery stores or supermarkets and only about 2.5% of the sample shop at other locations such as ethnic stores and specialty markets. The average number of household hours worked is about 39 hours. Respondents report that an average of 18.59 hours is non-negotiable per week and is spent on activities that are not flexible such as adult or child care. At a minimum, about 16.75 hours are spent on food-related activities at home per week. The average household also spends just about $285.60 on food and beverages (at home and away from home) per week. The survey also includes routine questions on respondents' satisfaction from meals to determine their marginal utility from meal consumption. On a scale of 1 to 5 (1 = "Very Dissatisfied" to 5 = "Very Satisfied"), respondents reported an average of 4.4 for their meal satisfaction.

2.5.5. Income and wage rate inferred

The survey asked respondents to report their income through a set of categorical choices. In order to infer a wage rate, I first assign a uniformly distributed random number over the self-reported interval of income. For instance, a respondent who reported an income between the range $75,000 - $99,999 was randomly assigned a value of $75,104 while another individual picking the same range was assigned a random value of $96,763. Figure 2-4 shows the distribution of the income variable from generated continuous income variable. Another option would be to assign the median value of the range to all respondents. However, that would cluster all the observations within a given interval around the same value. Mean household income in the sample is approximately $77,145 per year, which is slightly lower than the U.S. mean income of $81,283 for 2017.

Figure 2-4. Distribution of continuous income variable



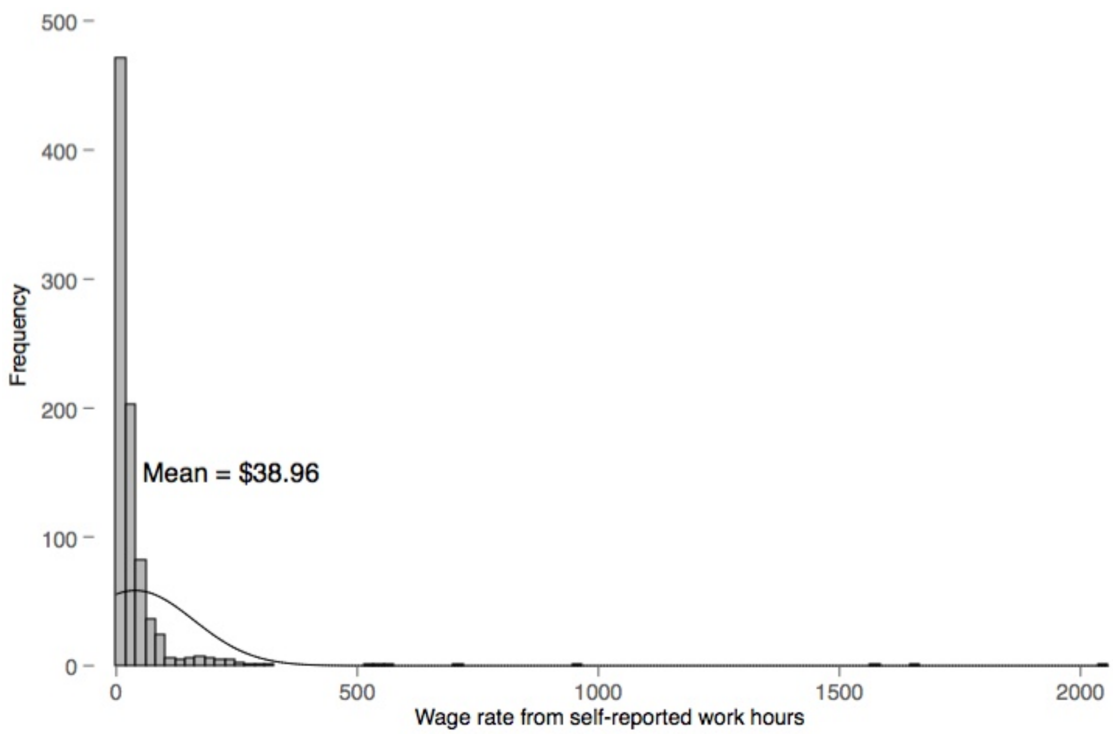
I use two different approaches to infer a wage rate from the continuous household income generated. I first divide the continuous household income by the self-reported number of hours worked per week extrapolated for the full year (52 weeks) to calculate the wage rate. More than one member may be employed and contributing to the household income. I thus account for the self-reported number of hours worked by a second main adult in the house. In some cases, individuals report very few hours worked per week with high levels of household income. For these individuals, the wage rates are very steep, up to almost $2000 per hour. In other cases, individuals report working up to 168 hours per week. For these respondents, the wage rate is exceedingly low. The wage rate obtained from this measure is less reliable and problematic. It may be that weekly hours reported in the survey may not be representative of hours worked in a typical year. The median worker in the U.S made an average wage rate of $21.42 in 2017. The mean wage rate using this methodology is about $38.96 per hour (Figure 2-5, top panel).

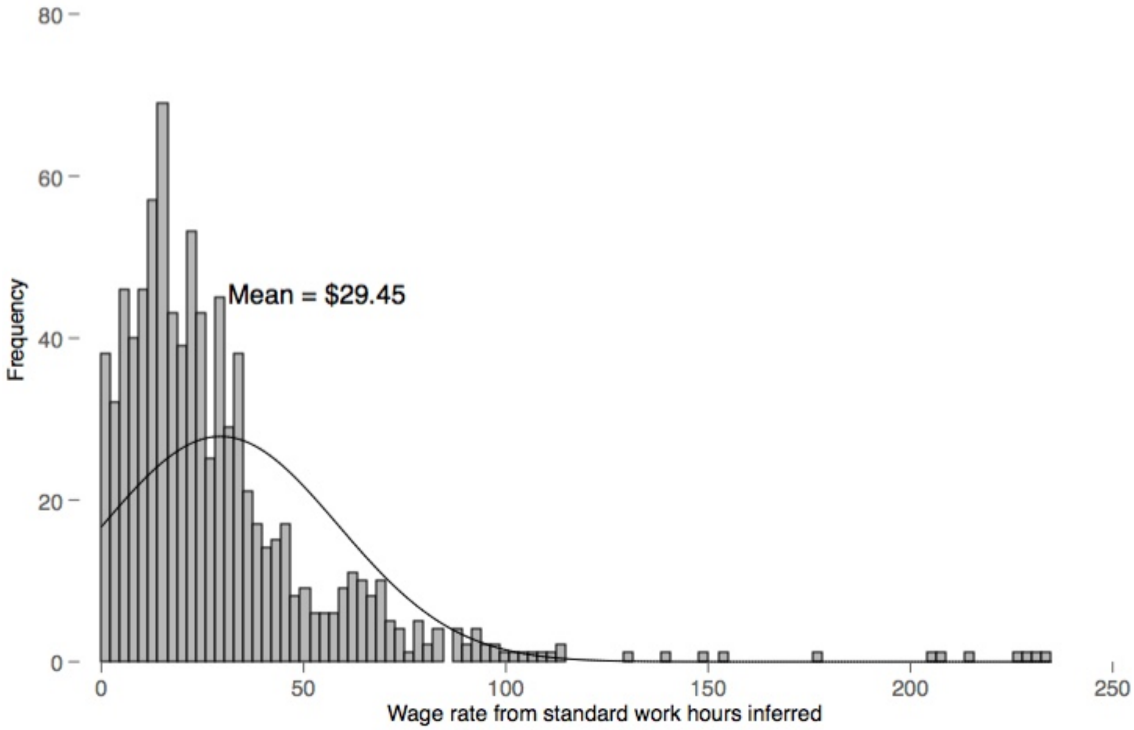
To obtain another estimate, I use a more standard measure and divide the household income by 2,087 hours to extrapolate a wage rate (United States Office of Personnel

Management, 2019). I adjust the measure by weighing the number of hours worked to account for two adults, if work hours are reported for a second adult. That is, I divide the household income by 4,174 if there are more than two adults working (2,087 hours x 2 adults). Using this method yields a more even distribution of wage rates across the sample as per the bottom panel of Figure 2-5. The average wage rate is $29.45 with a maximum wage rate of about $230. This measure of the wage rate is preferred and more dependable.

In both cases, if more than two members contribute to the household income, the wage rate would be overestimated. This is because instead of dividing by the exact number of contributing members, I would be dividing by two. If the household income is divided by the number of all adults present, some adults may be dependents. In sum, the wage rate may be more imprecise for households with more than two adults present and working. Overall, 77.6% of the sample consist of households with two adults, another 15.1% have three adults present, and just about 7% have more than three adults in the household. Thus, the likelihood of this overestimation is relatively low. Figure 2-5 (top and bottom panels) shows the distribution of the wage rate using both methods.

Figure 2-5. Distribution of wage rates inferred





2.6. Results

I first show the results from the two-stage least squares process using the CV equation *(16)* and efforts models (Equations *15* and *17)*. These results are presented in sections 2*.6.1*. Subsequently I illustrate the results from the reduced form approach using household income and the inferred wage rates as the opportunity cost of time (Equations *18* and *19*). I present the ordinary least squares estimates, then the two-stage least squares estimates which use total food and beverage expenditures as an instrument (Equation *20*). In all cases, I estimate two separate models to evaluate the impact of the opportunity cost of time on (1) organics recycling efforts and (2) food waste reduction efforts.

2.6.1. Structurally motivated empirical results

Table 2-3 shows the results of the second stage regressions using the willingness-to-pay measures as the opportunity costs of time. I use Stata's "ivregress" function to estimate the models. This function uses all the exogenous variables as instruments to ensure maximum efficiency and unbiased estimates if the willingness-to-pay measure is deemed to be endogenous (Wiggins, 2015; Baltagi, 2011). Even if the stage-by-stage model is more appropriate, as guided by the theoretical framework, the "ivregress" results should remain consistent (Wiggins, 2015). Since there may be some theoretical rationale for the two step computation of instrumental variable models (Sanchez, 2011), I also report the corresponding stage-by-stage results in the Appendix.

The models also control for the DC-CVM response. First, I control for the monthly cost of leaving environmentally sustainable activities to others. This is the amount that the respondent saw ($3, $6, or $9). I include this variable to control for possible anchoring effects since respondents saw the DC-CVM question prior to answering the OE-CVM question. The hypothesis is that higher amounts in the DC-CVM question may incentivize higher values reported in the OE-CVM question. Simple tabulations show that, for example, those who saw a proposed monthly cost of $3 to leave food waste reduction activities to a third party on the DC-CVM question, reported an average maximum willingness-to-pay value of $5.41. However, those who saw a cost of $6 had an average of $6.43 and those who saw $9 reported a mean of $7.58. The model also includes an interaction of this variable with the response of whether the individual replied "yes" or "no" to the respective proposed amounts, that is, whether they would be willing to pay that monthly cost or not.

Columns 1 and 2 display results that apply only to those respondents for whom I have a reported willingness-to-pay value, that is, those who responded positively to the question of whether they would be willing to leave organics recycling or food waste reduction efforts to a third party. I find a significant negative effect of the opportunity cost of time on food and organics recycling effort as well as food waste reduction endeavors at the 5% significance level. A one-unit increase in the opportunity cost variable for recycling results in a 0.0161-unit decrease in the willingness to participate index for organics recycling. Similarly, a one-unit increase in the opportunity cost variable (which is approximated by the dollar value of the OE-CVM question) results in a 0.0081-unit reduction in the willingness to participate in food waste reduction activities index. These values are similar to the magnitude of the coefficient obtained by Halvorsen (2008) although the estimation procedures are different and hence, not directly comparable. However, it may be worthwhile to note that Halvorsen finds that a one-unit increase in the opportunity cost of time (measured in Norwegian Krone which is equivalent to 0.12 U.S dollars in the present and 0.16 U.S dollars in 2008), resulted in a 0.0009-unit reduction in the total recycling efforts.

Given that most households reported relatively high likelihood to be engaged in both efforts to begin with, the significant effects of time cost on these environmentally sustainable efforts are especially notable. Those who are likely to find organics recycling or food waste reduction activities to be pleasant report higher propensities to dedicate time towards those efforts. Thus, people's perception about whether these activities are pleasant or a troublesome may make a difference in their efforts at home. Unsurprisingly, acknowledging that food waste reduction and organics recycling contributes to a better environment highly increases willingness to participate in the environmentally sustainable activities. This may suggest that if people had better knowledge about the negative environmental impact of food waste, they might be more likely to dedicate efforts towards mitigation activities at home.

Table 2-3. Second stage least squares estimates of household organics recycling (OREC) and food waste (FW) reduction efforts using willingness-to-pay measures

	(1)	(2)	(3)	(4)
	Limited Sample		Full Sample	
	OREC	*FW*	*OREC*	*FW*
Opportunity cost [a]	-0.018*	-0.008*	-0.025***	-0.022***
	(0.009)	(0.004)	(0.008)	(0.005)
Recycling/Food waste reduction				
Pleasant activity	0.230***	0.173***	0.258***	0.182***
	(0.031)	(0.026)	(0.026)	(0.022)
Better environment [b]	0.343***	0.204***	0.332***	0.167***
	(0.045)	(0.035)	(0.035)	(0.028)
Other's participation	0.027	0.014	0.050	-0.010
	(0.036)	(0.025)	(0.029)	(0.021)
Moral motivations				
Responsible person [c]	0.321***	0.122***	0.282***	0.134***
	(0.048)	(0.037)	(0.040)	(0.032)
Others [d]	-0.010	0.023	-0.003	0.024
	(0.034)	(0.027)	(0.028)	(0.021)
State level variables				

	(1)	(2)	(3)	(4)
	Limited Sample		Full Sample	
Recycling programs present [e]	0.156		0.122	
	(0.088)		(0.075)	
Food waste related news		-0.000*		-0.000
		(0.000)		(0.000)
Shopping location (Grocery omitted)				
Supermarkets		-0.014		0.019
		(0.044)		(0.038)
Warehouse clubs		-0.057		-0.097
		(0.079)		(0.068)
Other		-0.117		-0.100
		(0.122)		(0.104)
Household time variables				
Non-negotiable hours	-0.001	-0.001	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.000)
Minimum food activities [f]	0.000	-0.000	0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Food satisfaction		0.309***		0.274***
		(0.036)		(0.032)
Constant	0.265	0.898***	0.332	1.167***
	(0.226)	(0.211)	(0.176)	(0.170)
N	617	522	865	865

[a] *Opportunity cost of time/Willingness-to-pay*
[b] *Contributes to better environment*
[c] *Consider myself a responsible person*
[d] *Others to consider me responsible*
[e] *Food recycling programs present in the respondent's state*
[f] *Minimum time in food-related activities*
*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
All regressions control for demographic characteristics including race, education, income, household size, and gender.

Results also show that respondents who consider themselves to be personally responsible are more willing to be engaged in organics recycling and food waste reduction activities. Whether others view them as responsible is not deemed important in their choices. Finally, being satisfied with one's meal habits (at home and away from home) has a significant positive effect on willingness to be engaged in food waste reduction activities. It is not hard to see that people who enjoy making meals or, generally, their meal intakes may have a much more positive relationship with their food-related routines. Included state-level variables as well as demographic variables were generally not significant in both sets of results.

By assumption, the respondents who do not want to leave organics recycling or food waste reduction activities to others would have reported a value of zero for the willingness-to-pay measures. Those who did report a value of zero for the willingness-to-pay have weighed their options and reported that value. These individuals would then be responsible to do these environmentally sustainable activities on their own, with no help from third parties. It is expected that assigning a value of zero for the willingness-to-pay measures to the respondents that did not report a value would yield similar results as in the limited sample case.

For a next set of results (Columns 3 and 4), I assign a value of zero for the willingness-to-pay measures to all those who reported that they would either not be prepared to leave organics recycling activities or food waste reduction efforts to a third party. As expected, in this case as well, I note that higher time costs are associated with lower willingness to participate in both food waste reduction and organics recycling activities at home. The coefficients on the other variables are also similar to the main results from the limited sample.

2.6.2. Household income as the opportunity cost

Table 2-4 displays the results of the model using household income as the opportunity cost of time. Columns 1 and 2 show the results from the OLS regressions whereas columns 3 and 4 show the results from the 2SLS models with total food and beverage expenditure as the instrument. Stage-by-stage IV results are available in the Appendix.

Table 2-4. Second stage least squares estimates of household organics recycling (OREC) and food waste (FW) reduction efforts using household income as the opportunity cost

	(1)	(2)	(3)	(4)
	OLS Results		IV Results	
	OREC	*FW*	*OREC*	*FW*
Opportunity cost [a]	-0.000	-0.000	-0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Recycling/Food waste reduction				

	(1)	(2)	(3)	(4)
	OLS Results		IV Results	
Pleasant activity	0.253***	0.158***	0.255***	0.152***
	(0.024)	(0.022)	(0.025)	(0.041)
Better environment [b]	0.295***	0.137***	0.291***	0.178***
	(0.032)	(0.032)	(0.034)	(0.054)
Other's participation	0.047	-0.008	0.049	-0.026
	(0.027)	(0.010)	(0.029)	(0.040)
Moral motivations				
Responsible person [c]	0.280***	0.160***	0.265***	0.065
	(0.038)	(0.036)	(0.042)	(0.069)
Others [d]	-0.005	0.002	0.004	0.053
	(0.026)	(0.021)	(0.029)	(0.043)
State level variables				
Recycling programs present [e]	0.110		0.226	
	(0.070)		(0.133)	
Food waste related news		-0.00		0.000*
		(0.000)		(0.000)
Shopping location (Grocery omitted)				
Supermarkets		0.015		-0.109
		(0.036)		(0.084)
Warehouse clubs		-0.134		0.008
		(0.071)		(0.139)
Other		-0.156		-0.335
		(0.104)		(0.209)
Household time variables				
Non-negotiable hours	0.000	0.000	-0.000	0.000
	(0.001)	(0.000)	(0.001)	(0.001)
Minimum food activities [f]	-0.002	-0.000	-0.000	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Food satisfaction		0.280***		0.288***
		(0.038)		(0.061)
Constant	0.465**	1.279***	0.652**	1.899***
	(0.162)	(0.209)	(0.247)	(0.388)
N	865	865	865	865

[a] Opportunity cost of time/Willingness-to-pay
[b] Contributes to better environment
[c] Consider myself a responsible person
[d] Others to consider me responsible
[e] Food recycling programs present in the respondent's state
[f] Minimum time in food-related activities
*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
All regressions control for demographic characteristics including race, education, income, household size, and gender.

OLS results show relationships of almost zero magnitudes between household income and efforts towards food waste reduction and organics recycling activities. The same applies for the IV results. As hypothesized earlier, I am not able to detect an impact of economic significance of household income (as the opportunity cost of time) on these environmentally sustainable activities. Correlations between the other included variables and the effort levels remain similar to the main results.

2.6.3. Wage rate inferred as the opportunity cost

The next set of results in Table 2-5 show the model using the wage rate inferred from the continuous income variable as the opportunity cost of time. Results from the OLS regressions are reported in Columns 1 and 2. Columns 3 and 4 show the results from the 2SLS models with total food and beverage expenditures as the instrument. Stage-by-stage IV regression results are available in the Appendix. I present the results using the standard and more dependable measure of wage rate, which divides the household income by a standard number of hours worked per year. Other wage results are available in the Appendix. While the coefficient on the opportunity cost of time variable (wage rate) are in the hypothesized direction (negative in all models), the results are all non-significant. Thus, there is not a significant relationship between the inferred wage rate and efforts towards food waste reduction and organics recycling activities. IV results show coefficients that are more negative and larger in magnitude (in absolute value), but they also remain non-significant. Similar to the income model, there may not be a relationship of economic significance between the inferred wage rate, as the opportunity cost of time, and these environmentally sustainable activities at home.

Table 2-5. Second stage least squares estimates of household organics recycling (OREC) and food waste (FW) reduction efforts using inferred wage rate as the opportunity cost

	(1)	(2)	(3)	(4)
	OLS Results		IV Results	
	OREC	*FW*	*OREC*	*FW*
Opportunity cost [a]	-0.000	-0.000	-0.010	-0.008
	(0.001)	(0.001)	(0.010)	(0.009)
Recycling/Food waste reduction				

	(1)	(2)	(3)	(4)
	OLS Results		IV Results	
Pleasant activity	0.253***	0.159***	0.265***	0.219***
	(0.028)	(0.022)	(0.029)	(0.031)
Better environment [b]	0.295***	0.136***	0.296***	0.264***
	(0.040)	(0.032)	(0.034)	(0.042)
Other's participation	0.047*	-0.007	0.049	0.043
	(0.022)	(0.019)	(0.030)	(0.030)
Moral motivations				
Responsible person [c]	0.280***	0.162***	0.254***	0.223***
	(0.046)	(0.036)	(0.049)	(0.053)
Others [d]	-0.006	0.000	0.007	0.019
	(0.026)	(0.021)	(0.031)	(0.031)
State level variables				
Recycling programs present [e]	0.108		0.243	
	(0.075)		(0.152)	
Food waste related news		-0.000		0.000
		(0.000)		(0.000)
Shopping location (Grocery omitted)				
Supermarkets		0.018		0.041
		(0.036)		(0.062)
Warehouse clubs		-0.137		0.097
		(0.072)		(0.105)
Other		-0.152		-0.150
		(0.105)		(0.158)
Household time variables				
Non-negotiable hours	-0.000	0.000	-0.001	-0.000
	(0.000)	(0.000)	(0.001)	(0.001)
Minimum food activities [f]	0.000	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Food satisfaction		0.280***		0.115*
		(0.038)		(0.050)
Constant	0.461*	1.263***	0.696*	0.446
	(0.180)	(0.211)	(0.287)	(0.279)
N	865	865	865	865

[a] *Opportunity cost of time/Willingness-to-pay*
[b] *Contributes to better environment*
[c] *Consider myself a responsible person*
[d] *Others to consider me responsible*
[e] *Food recycling programs present*
[f] *Minimum food-related activities*
*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
All regressions control for demographic characteristics including race, education, income, household size, and gender.

2.7. Discussion, Conclusions, & Policy Implications

This study proposes a public goods approach to evaluate food waste reduction and organics recycling efforts at home. The theoretical framework uses both food waste reduction at the source and organics recycling activities as contributions towards the public good (i.e. environmental quality). This reframes how one views the issue of waste management as one that diverts but also explicitly reduces waste to meet public policy and environmental goals. The model builds on the existing literature to bring together household effort levels towards these environmentally sustainable activities, construct a proxy to measure the opportunity cost of time, and combine social norms, moral motivations, and environmental quality.

I hypothesize that time costs may reduce people's willingness to participate in these environmentally sustainable food-related activities at home. The conceptual framework calls for willingness-to-pay measures to be used as the opportunity cost of time (i.e. how much people are willing to pay to leave environmentally-friendly activities to a third party). However, more standard approaches usually use the wage rate as the opportunity cost of time. I argue that the latter may not be representative of the actual opportunity cost of time given the vast evidence showing that those with higher income or socio-economic status are more likely to be engaged in environmental activities at home. Nevertheless, I present results using multiple measures of the opportunity cost of time: (1) the willingness-to-pay measures, (2) household income, and (3) wage rates inferred from the income variable.

Data are collected from a nationally representative survey fielded in 2018. I also include other variables gathered at the state and regional level. Using total food and beverage expenditure as an instrument, I find no linkages between household income/wage rate and the propensities to be engaged in food waste reduction and organics recycling activities. This evidence reinforces the idea that household income or the wage rate may not be good proxies for the opportunity cost of time in this context. Based on the results from the two-stage least square models using the willingness-to-pay measures, I find that an increase in the opportunity cost of time reduces people's willingness to participate in food and organics recycling programs as well as food waste reduction efforts.

Additionally, the results suggest that those who agree with the fact that reducing food waste or increasing organics recycling contributes to better environmental quality were more willing to participate in the activities. Thus, policy would benefit by increasing awareness of food waste and its impact on the environment. However, simply providing information may not be sufficient. For instance, survey respondents in this study had the opportunity to be exposed to various facts about food waste and organics recycling. Still, many respondents reported that they believed that reducing food waste or increasing organics recycling does not necessarily contribute to a better environment.

If people perceived being engaged in environmentally sustainable activities as pleasant, then they stated higher likelihood to participate in them. Checking kitchen inventories, making food shopping lists, meticulously storing produce, or carefully separating organics can be viewed as bothersome activities to undertake. It may be useful to make these activities less inconvenient to people through technology (such as promoting the use and availability of meal kits and affordable smart fridges) or outreach and education to increase people’s efficiency in the kitchen. Respondents who believed it was their personal responsibility to reduce their food waste reported being more likely to be engaged in food waste reduction efforts.

Given that food waste reduction programs and organics recycling efforts are poised to rise across the nation, this paper contributes to the literature by shedding light on what factors may dictate people’s willingness to participate in those activities. Given the hypothetical nature of this study, it was expected that people may feel optimistic about their willingness to participate in these activities, which we note. However, in reality, although sometimes not apparent, these household routines can be quite time consuming. This may explain why throughout the nation residential food waste levels are still high, various organics recycling programs are seeing record amounts of contaminants in the organics that people set out, or people are simply not separating their organics adequately, which then end up with the trash in landfills or get incinerated with regular trash.

Food waste reduction campaigns as well as comprehensive food and organics recycling programs are costly to implement and sustain. These subpar outcomes are undesirable from an economic standpoint. Worse, if the majority of food and organic materials still ends up in landfills, the negative burden on the food system and the environment remains. Since enjoying participating in food waste reduction activities was correlated with higher reported willingness to participate in those activities, public policy may implement nudges to increase awareness, provide tools to make food waste reduction a convenient activity at home, and give guidance on how people can reduce food waste through better meal preparation and food management skills. Meal-kits are currently on the rise and may be a way to encourage households to be efficient with their meal purchase and preparation to minimize food waste.

However, when it comes to food and organics recycling, the recommendation is quite the opposite. Currently, even people with the best intentions are unable to comply with instructions to source separate effectively. The survey results clearly show that higher opportunity costs of time reduce the willingness to participate in environmentally sustainable activities, such as organics recycling and food waste reduction. It is not naïve to hypothesize that even the respondents who anticipate being highly likely to partake in organics source separation activities may not be able to keep up in reality. We do not often expect people to clean their local parks, or maintain their public roads personally. There may be some merit in making current and future organics recycling program more efficient through education and outreach. However, I argue that it may be more valuable to think outside the box.

Instead of adamantly trying to make these organics recycling programs work nationwide, it may be worth it to invest effort in creating technologies to conduct central source separation of organics. The 2016 Food Recovery Summit convened by the EPA and the USDA brought together stakeholders from across the food supply chain. The first key activity identified in the Summit was for businesses, individuals, and organizations to use the Food Recovery Hierarchy to maximize economic gains while increasing social and environmental benefits. They identified food waste diversion and recovery using new technologies and innovation as a critical action to capitalize on key economic opportunities in the broader food management system. Central source separation would effectively take the burden off households and re-focus the attention on public infrastructure. If diversion of food waste and organics are important public policy goals, and people have high opportunity costs in dedicating time to these environmentally sustainable activities at home, this may be a serious alternate solution for policy makers to consider.

Chapter 3. Food Waste, Risk Preferences, and Risk Perceptions: Consumer Behavioral Responses to Cosmetic Deterioration of Food

3.1. Introduction

Food waste has garnered much attention in the arena of food and agricultural policies, as research continues to highlight its negative impacts on the environment. Evidence shows that wasted food places a huge burden on society in multiple ways, including opportunity costs of resources such as fresh water, cropland and energy used to produce the food (Kummu et al., 2012; Hall et al., 2009) and methane emissions generated from accumulated food in landfills (Bajželj et al., 2014). Currently, food scraps contribute to about 22% of the weight of material that goes to landfills (Dovetail Partners, 2014), making food the single largest category of landfill waste. Decomposition of uneaten food alone accounts for 23% of all methane emissions in the U.S. (Gunders, 2012), a gas that is 25-fold more potent with global warming potential than carbon dioxide (Hall et al., 2009).

Consumers discard a significant portion of food constituting a substantial share of their household food expenses. Buzby and Hyman (2012) translate this food loss to 1% of household disposable income or equivalently consumer-level losses of food valued at $1.07 per day. Consumers, by far, generate the largest proportion of food currently wasted in developed nations (ReFED, 2016; Buzby et al., 2014). A deeper analysis of food waste generation at home may shed further light on *why* food gets discarded at this striking rate and, more intriguingly, *who* is rejecting the food. In the present analysis, we first study the roles of two anecdotally important contributors to food waste by consumers – appearance of food and food product date labeling – in household food waste. We examine these effects through an interactive survey instrument collecting individual responses on how they view food items are fit for consumption.[2] This elicitation is accomplished through a carefully-designed conjoint task, simulating food handling scenarios at home. Additionally, we measure the extent to which underlying risk preferences, and risk perception may be associated with food waste propensities. We thus collect key details on household food-related routines as well as risk preferences (Lusk and Coble, 2005; Holt and Laury, 2002. The survey was administered at the 2016 Minnesota State Fair, and 333 subjects participated.

Our paper contributes to the behavioral economics literature centering on food choices—in our case, food handling and discarding decisions at home. First, we focus on the question of *who* wastes food, which at its core is a behavioral inquiry. To this end, we uncover patterns relating to household routines such as shopping, planning, waste sorting and other "home economics" skills in order to characterize our subjects. Second, focusing on appearance and date labels, which have been identified as two possible key factors of food waste[3], we consider how much these factors potentially contribute to the *why* of food going to waste in the household. Foremost, we ask: how much do people reject foods with cosmetic deterioration such as shrinkage, wilting, or browning even though they are perfectly fit to consume? Concurrently, we focus on how subjects react to different presentations of expiration dates which are also known to cause confusion among consumers (Wilson et al., 2017; Lieb et al., 2016). We selected two products (ground beef and bagged spinach) which are likely to have both an appearance component and an expiration date element when food decisions are made.

A novel component to our study is the inclusion of a key hypothesis drawing on the economic literature. In a consumer survey, Qi and Roe (2016) found that for a majority of households, efforts to enhance meal safety may sometimes require wasting some food. If consumers consider cosmetic deterioration or expiration dates as indicators for food safety

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[2] One major part of the research design involved working closely with food experts to capture appearance of food products at different stages of cosmetic deterioration. We provide more details in section 3.3.

[3] Wilson et al. (2017) and Lieb et al. (2016) find that consumers use date labels to make decisions to discard food. Qi and Roe (2016) show that consumers value meal freshness and quality which may result in food waste.

risks, they can be expected to reject these products because of those *risk perceptions*. On the other hand, underlying risk aversion may also impact how individuals behave when it comes to decisions relating to food waste. Hence, underlying *risk preferences* and *risk perceptions* may be important determinants of food waste decisions.[4] We thus ask: Are risk preferences and perceptions associated with food waste behavior and if so, how much?

A growing literature suggests that for households, food waste results from complex interactions between food purchase and management.[5] In their theoretical modeling of household food waste to determine social-optimal disposal tax, Katare et al. (2017) define creation of food waste as a function of food purchases as well as knowledge about food and its preservation. Various studies based mostly in European nations emphasize the intersect of socio-demographical, behavioral and attitudinal factors as drivers of food waste. Stancu et al. (2016) find that household routines such as planning, shopping, and reuse of leftovers contribute to most of the household food waste in Danish households. For Romanian consumers, similar shopping and planning routines explain most of the food waste consequences (Stefan et al., 2013). UK-based study conducted by WRAP (2007) find that buying or making too much food or having poor "home economics" skills are strong contributors to household waste. A recent U.S. based study on consumer food waste found that concern about foodborne illness and a desire to eat only the freshest food were important drivers for discarding food (Neff et al., 2015). Thus, awareness, attitudes and behaviors conventionally related to food waste are both broad and varied.

While there is a flourishing literature on food waste quantification and behaviors that characterize food waste tendencies (Porpino, 2016), there is a negligible literature on the impact of underlying risk preferences and risk perception on food waste, whether actual, self-reported, or alternately, proxies. Findings from this study are expected to contribute to a better understanding of behavioral tendencies that are linked to higher

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[4] *Lusk and Coble (2005) find that risk preferences elicited through context-less lottery choices in a laboratory setting seem to be related to the same risk preferences that impact other individual decisions such as food choices.*

[5] *See for example Evans (2011) who argues that food waste is a consequence of the social and material contexts in which food practices are organized at home.*

potential household food waste propensities besides those that have been typically considered. Overall, we believe that carefully understanding and addressing food loss and waste at the consumer level is an opportunity to mitigate this issue.

Our results can be summarized in two main parts getting at the *who* and *why* questions. A latent class model revealed that respondents fall into two, somewhat clichéd, classes: *Planners* and *Extemporaneous Consumers*. Making up 57% percent of the respondents, the *Planners* class is characterized by people who reported having strong pre-shopping planning routines, disciplined in-store behavior, steady waste sorting practices, and good cooking and food management skills. The respondents in the second class stand in stark contrast. *Extemporaneous Consumers* tend to have poor meal planning routines and are more likely, for instance, to buy products on an impulse in the store. Compared to their counterparts, they also recycle or compost less regularly and are generally less savvy in the kitchen.

To measure the tradeoffs individuals are willing to make for foods with various date labels and cosmetic flaws, we examine responses to the conjoint task portion with attributes and levels that mimic realistic food handling decisions at home.[6] Our regression analyses suggest that as appearance deteriorates people were likely to eat less spinach and substantially less of ground beef. As expected, the effects were different for the two classes. Overall, *Extemporaneous Consumers* had higher tendencies to reject the foods based on cosmetic appearance. Effects from other attributes such as date labeling or size of the products were somewhat modest but noteworthy.

Further analyses incorporate economic parameters for risk aversion and risk perception. We find that those who report higher levels of perceived risk regarding cosmetic appearance and date labeling have higher rates of food discarding tendencies, especially those who fall under the *Extemporaneous Consumers* group. We note that there

[6] *We are not the first to elicit proxies for food waste tendencies. For example, Wilson et al. (2017) use a laboratory experiment to examine the effects of different date labels on anticipated food waste, which is assumed to reflect the actual level of food waste. For each food item in their study, subjects were asked to place a bid and indicate the percentage of the item that they expect that their household will consume.*

may be gains from informing consumers about edibility of food given cosmetic deterioration to decrease perceived risks and mitigate food waste propensities.

The remainder of the article proceeds as follows. In section 3.2, we give a review of the literature and background of relevant topics in relation to this study. We present the design of the survey, focusing on the conjoint task as well as the risk elicitation method in Section 3.3. Section 3.3 also details our empirical strategy. We illustrate the results drawn from the empirical approach and econometric analysis in Section 3.4. The study limitations are discussed in Section 3.5. Section 3.7 includes a discussion of our findings together with concluding remarks.

3.2. Background and Literature Review

3.2.1. Food waste

Although food waste estimation is highly sensitive to methodologies employed (Dusoruth, Peterson, and Schmitt, 2018), the literature finds that essentially 30% to 40% of the food produced in the U.S. is wasted throughout the supply chain. For instance, in their mathematical model of human energy expenditure, Hall et al. (2009) puts this estimate at 40%. Buzby et al. (2014) find that 31% of the 430 billion pounds of the available food supply at the retail and consumer levels went uneaten in 2010. This food waste is valued at almost 162 billion dollars. In 2014, 38 million pounds of municipal food waste was generated in the U.S of which only 5.1% was composted, 18.6% was used in combustion for energy recovery, and the remaining 76.3% was landfilled (U.S. Environmental Protection Agency, 2016a).

Research shows that food waste poses a serious threat to the already constrained food and agricultural system. In the U.S., and other developed countries, households currently generate the highest proportion of food discarded in the food supply chain making food waste at this stage of particular interest. Kummu et al. (2012) estimate that wasted food crops accounts for 24% of freshwater resources used in global food crop production, 23% of cropland area, and 23% of fertilizer use. In the U.S, Hall et al. (2009) find that food waste accounts for one quarter of the freshwater consumption and 300 million barrels of oil per year. Projections indicate that by 2050 cropland and pasture-based food production will see a 60% increase.

To meet global food security and essential emissions reductions, Bajželj et al. (2014) argue for both demand-side improvements such as changing diets and decreasing food waste and supply-side mitigation strategies including the increase of crop yields. In light of rising global food demand which is projected to further increase, food waste is a challenge to meet the global food security (Irani and Sharif, 2016; Bajželj et al., 2014; Fonseca, 2013; Kummu et al., 2012). Even if the private costs of food waste would not seem to entirely incentivize food waste curbing incentives, the larger negative externalities call for pressing actions. These environmental and social issues are central to why food waste prevention and recycling have become important policy objectives throughout the country (Schneider, 2013).

3.2.2. Household food waste drivers

Food waste is generated along the entire food supply chain, starting from farmers to individual consumers. In the U.S. and other developed countries, households currently generate the highest proportion of food discarded in the food supply chain making food waste at this stage of particular interest. Consumers throw away over 25% of food and beverages they purchase (Bloom, 2011). A report by ReFED (2016) estimates that household food waste accounts for 42% of 63 million tons of food wasted in the U.S, followed by restaurants at 22%. Further, this makes up 51% of the total food waste that is landfilled. Secondi et al. (2015) finds that individuals do not appear to be fully aware of the environmental, economic and social consequences of the uneaten food they throw away. Gauging the issue at the household level has the ability to design behavioral nudges which may reduce individuals' food waste levels.

Consequently, understanding contributors to food discarding habits has been a critical goal of a handful of consumer food waste research to date. The main focus has been on food choices and food-related activities. Cox and Downing (2007) started the pioneering work of exploring household food waste behavior as well as triggers that can reduce waste in the UK through household surveys and diaries. Concurrently, an emerging body of research have highlighted the socio-economic, cultural, attitudinal, and behavioral determinants in context of household food waste generation. For instance, activities such as food shopping routines, meal planning, and food handling skills have been recognized as important contributors to food waste (Stancu, et al., 2016; Stefan et al., 2013; Gunders, 2012; Parfitt, et al., 2010). Chandon and Wansink (2006) find that biased estimates of household inventory lead to over-stocking and eventual spoilage of foods. Thus, intentionally checking inventory can help minimize this bias leading to more accurate purchases and stocking of food items.[7] From food acquisition, to storing, preparing, cooking, eating, and finally disposing food, individuals make multiple, implicit and explicit, interrelated choices, which dictate how much of what is acquired is consumed or wasted. Table 3-1 summarizes a set of questions and related details that gauge habits, attitudes, barriers and demographic characteristics that recent studies have considered in relation to food waste behavior.[8]

Table 3-1. Select questions relating to food waste habits, attitudes, behaviors and socio-demographic characteristics from the literature.

Behavioral and routines

Self-reported food waste habits [abcd]

- How much is thrown away in your household of what you buy and/or grow, in a regular week?
  - Could be fruits, meats, dairy, etc. (Hardly Any, Less than 10%, between 10% and 25%, etc.)

Shopping habits, shopping frequency.

- How do you purchase your everyday commodities? [bce]
  - We buy most of our food on one big weekly shopping occasion. (Strongly Disagree…Strongly Agree)
  - We make several purchases a week (Strongly Disagree…Strongly Agree)
  - We look around and decide a lot based on price/kg. (Strongly Disagree…Strongly Agree)

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[7] *Planning routines such as keeping a regular shopping schedule or checking inventories have been linked with lower food waste amounts in Romanian households (Stefan et al., 2013).*

[8] *Note that only a select number of questions from the relevant studies are included.*

Behavioral and routines (cont.)

- We often purchase food items with discount coupons. (Strongly Disagree…Strongly Agree)
- We often prepare and purchase food items momentarily. (Strongly Disagree…Strongly Agree)
- We often buy unintended food products when shopping (Strongly Disagree…Strongly Agree)
- We often buy food in packages that are too big for our household's needs (Strongly Disagree…Strongly Agree)
- We usually buy higher amounts of food when they offer good value for money (Strongly Disagree…Strongly Agree)

- Frequency at type of grocery store: Co-op, Farmer's Market, etc.[d]
- Planning routines [abc]
  - The shopping trips are usually planned in advance - shopping lists are made, inventories are checked, etc. - (Strongly Disagree…Strongly Agree)
  - The home meals are usually planned for a couple of days ahead (Strongly Disagree…Strongly Agree)

Household habits. [bc]

- Thinking about the activities related to food within your home, how would you rate your household's skills, in terms of
  - Buying the right food in right amounts to prepare the meals (Very poor to Very good)
  - Cooking/preparing the food (Very poor to Very good)
  - Storing and reusing leftover food (Very poor to Very good)
- Main way of going to the grocery store[d]
  - Mode: By car, bike, foot or public transport
  - Distance: within 5 minutes, within 10 minutes, within 20 minutes, etc
- Food preparation and eating habits (e.g. frequencies of cooking at home, eating out and eating ready meals).
- Food behaviors before/after meals [e]
  - We prepared too much (Strongly Disagree…Strongly Agree)
  - We made a mistake while preparing (Strongly Disagree…Strongly Agree)
  - There is an accident (Strongly Disagree…Strongly Agree)
  - We save leftovers not used in time (Strongly Disagree…Strongly Agree)
- Leftovers reuse routines [abce]
  - The leftovers are usually eaten as such or just reheated when used again (Strongly Disagree…Strongly Agree)
  - The leftovers are usually transformed into a different dish by adding some ingredients before eating them (Strongly Disagree…Strongly Agree)
  - The leftovers are stored in appropriate conditions so they will last (Strongly Disagree…Strongly Agree)

- Waste sorting habits (e.g. organic waste, other waste) [d]
- Habits of feeding pets (e.g. use of leftovers in feeding) [d]

Attitudinal

Perception on the quantity of food normally wasted and potential to reduce food waste in one's household. [d]

- View of the effect of purchasing too big package sizes on the generation of food waste
- View of the possibility to reduce food waste by buying food in smaller packages

Intention not to waste food. [bc]

- Thinking about the near future (e.g. next one/two weeks) and your household:
  - I intend not to throw food away (Strongly Disagree…Strongly Agree)
  - My goal is not to throw food away (Strongly Disagree…Strongly Agree)
  - I will try not to throw food away (Strongly Disagree…Strongly Agree)

Moral norms. [bc]

- Wasting food would:
  - Make me feel guilty about people who do not have enough food (Strongly Disagree…Strongly Agree)
  - Make me feel guilty about the environment (Strongly Disagree…Strongly Agree)
  - Give me a bad conscience (Strongly Disagree…Strongly Agree)

Perceived control [bc]

- In my opinion wasting food is: (Avoidable… Unavoidable)
- In my opinion loading the environment with my household's food waste is: (Avoidable… Unavoidable)
- Not to throw food away would be easy…difficult (by product category)

Subjective norms [bc]

- Most people important to me disapprove of me cooking/preparing more than enough food (Strongly Disagree…Strongly Agree)
- Most people important to me disapprove of me throwing out some food (Strongly Disagree…Strongly Agree)

Injunctive norms. 'One should …' [bc]

- Never waste any food (Strongly Disagree…Strongly Agree)
- Reuse leftovers (Strongly Disagree…Strongly Agree)
- Recycle the food waste generated, e.g. composting (Strongly Disagree…Strongly Agree)
- Not load the environment with food waste (Strongly Disagree…Strongly Agree)

Socio-demographical [df]

- Age of the oldest person in the household
- Size of the household (number of occupants)
- Type of the household (single, adult household without children, family with children)
- Families with children (e.g. households with children of different age groups)

- Area of residence (center of larger city, suburb of a larger city, small city or town, smaller population center, country side)
- Distance between the place of residence and grocery store)
- Form of residence (owner occupied/rental)
- Type of residence (flat/detached house/row house)
- Educational level of the adults
- Work (e.g. income class and type of employment of adults (full-time job, part-time job, unemployed etc.)
- Pets in the household

Others [g]

Motivations to minimizing waste

- Money waste concerns
- Doing the right thing, as in an ethical stance or out of environmental concern

Barriers to minimizing waste (Motivations)

- Being a good provider – providing abundance to be perceived as healthy and nourishing
- Minimizing inconvenience - stock up on food, food safety, not taking risk with dates or products that do not look fresh

Barriers to minimizing waste (lack of social pressure)

- Lack of priority, no engagement to issues surrounding food waste "food rot down, right?"
- Exemption from responsibility – responsibility lies with food industry and supermarkets

[a] *Cox and Downing (2007)*
[b] *Stancu et al. (2016)*
[c] *Stefan et al. (2013)*
[d] *Koivupuru et al. (2012)*
[e] *Williams et al. (2012)*
[f] *Neff et al. (2015)*
[g] *Graham-Rowe et al. (2014)*

Cox and Downing (2007), Koivupuru et al. (2012), Neff et al. (2015) have highlighted demographic characteristics which may be linked to household food waste tendencies. For instance, Neff et al. (2015) report significant associations between food waste knowledge and demographics. Mainly, those who were aged 65 years or older reported greater knowledge of food waste than their counterparts. Further, households with children under 18 years of age expressed having less knowledge of food waste than other households. They also find that older respondents reported discarding lower amounts of food. Using results from a household survey and food waste diaries, Koivupuru et al. (2012) uncover that in their Finnish sample, size of the household mattered. Particularly, households with fewer residents wasted less food. Moreover, they find that households with women mainly responsible for grocery shopping created more avoidable food waste.

Factors and questions included in these studies often gauge the amount of food waste in the households, prevalently asking the subjects to self-report amounts of food discarded. Cox and Downing (2007) find that among uncooked food, fruit, vegetables and salad are often cited as being wasted more frequently. Stefan et al. (2013) and Stancu et al. (2016) use the self-reported amounts of food waste for five food categories as a proxy for household food waste behavior. Planning and shopping routines are found to be important predictors of such food waste behaviors in both studies. Leftover reuse routines were also important (Stancu et al., 2016) and other factors such as moral attitudes such as feelings of guilt were significant drivers of food waste behavior (Stefan et al., 2013). In contrast, Koivupuru et al. (2012) did not find clear and consistent correlation between the amount of avoidable food waste and shopping behaviors.

Multiple studies have considered the effect of cooking and food management skills. Graham-Rowe et al. (2014) find that respondents who claimed to have cooking skills and food storage knowledge were more likely to report being in control of their food waste. This is consistent with research by Cox and Downing (2007) who found that those who have poor cooking and food management skills reported higher levels of food waste.

Product attributes such as packaging size and price have also conventionally been linked to food waste behavior. For example, Williams et al. (2012) note that packages that were too big or difficult to empty were identified as causes for food waste. They further find food wastage due to products passing their "best before date." Using results from a laboratory experiment, Wilson et al. (2017) expand on this matter and show that "Use by" dates, which may be suggestive of safety, yielded higher willingness of waste for products than "Sell by" or "Best if Used by" dates. Overall, different date labels prompted differences in the amounts of potential waste.

There are different motivations and barriers to minimize food waste. Graham-Rowe et al. (2014), for example, find that parents may purchase variety of healthy and nourishing foods and frequently over-purchase to be "good" providers for the family. Further, preparing meals in amounts beyond the estimated consumption ("over-preparation") was also identified as reasons for food going to waste. This finding is consistent with other research (Stancu et al., 2016; Stefan et al., 2013; Cox and Downing, 2007).

Overall, except for a few minor differences, the current literature agrees on many routines, habits, awareness, and attitudes that may be drivers of food waste behavior. Socio-demographic characteristics such as age and household size were found to be important. Other routines related to food shopping such as checking inventories and making a list have mostly been linked to food waste behavior. Other factors such as cooking skills and food storage and management also have been related to food waste tendencies.

3.2.3. Risk, food waste, and elicitation methods

When investigating consumer stated preferences for genetically-modified food, Lusk and Coble (2005) find that risk *preferences* and *perceptions* impact individual food choices to eat, purchase and accept genetically-modified products. Qi and Roe (2016) find that more than two-thirds of their sample demonstrated strong agreement to throwing away food past expiration dates to reduce odds of foodborne illness. Thus, our hypothesis relating food waste and risk is based on intuition and past studies cueing the potential relationship.

It is known that food date labels are often only intended as the manufacturers' best guess of peak optimality of quality attributes such as flavor, taste, and freshness. For consumers, however, this date may signal a degree of safety depending on the type of food. Similarly, cosmetically deteriorated food, while conceivably indicates a reduction in freshness and quality, can be perceived as no longer safe to consume. Overall, consumers may perceive cosmetic defects or expiration dates as indicators for food safety. Thus, individuals with higher perceived risk from food because of cosmetic deterioration or expiration dates would be expected to reject products with more likelihood than their counterparts. Thus far, it seems that higher *perceived risk* from consumption of products would result in greater food waste.

It can be argued that risk preferences may play out in the same fashion. That is, more risk averse individuals would be more likely to discard food as they inherently want to minimize uncertainty from the negative effects of consuming certain food products. On the other hand, risk aversion may materialize differently in behavior. When exposed to uncertainty about the condition of the food, either in terms of freshness or safety, risk averse individuals may choose to lower that uncertainty by consuming more of the food in the present. This implies that they are wary about leaving the food in the fridge facing the risk of it becoming less fresh or unsafe over time. Thus, risk averse individuals could potentially waste less food than their counterparts.

There are various methodological approaches to measuring individual-specific attitudes toward risk, including hypothetical gambles, actual behaviors and self-reported valuations. For example, Eckel and Grossman (2008) develop a simple gamble choice task to measure risk attitudes amongst male and female university students. Barsky et al. (1997) and Arrondel (2002) use survey responses to hypothetical situations to construct underlying parameters for risk tolerance. Kapteyn and Teppa (2002) find that self-reported ad-hoc measures have better explanatory power for total assets and for financial assets portfolio decisions. Actual behaviors, such as smoking status (Hakes & Viscusi, 2007) or seat-belt use (Viscusi, 2001) can also be used to proxy risk preferences.

3.3. Study design and methods

3.3.1. Survey overview

In order to maximize the opportunity to explain the questions, the survey was administered in an interactive setting for a period of 5 days at the 2016 Minnesota State Fair at a building of the University of Minnesota dedicated to the use of interactive research with visitors. Subjects were recruited for 30 minutes of their time in exchange for a drawstring backpack with the University of Minnesota logo, which have been a popular give-away item for human subject research projects conducted at the State Fair. Recruitment did not mention food waste to minimize self-selection bias in the study. The surveys were completed on electronic tablets.

We asked over 100 questions relating to (i) eating habits, (ii) food shopping routines, (iii) food purchasing behavior, (iv) reasons for discarding food at home, (v) self-reported amounts of waste for different types of food products, (vi) food risks perceptions, (vii) waste sorting practices, (viii) food management and cooking skills, (ix) environmental stances, (x) risk preferences, and finally the (xi) conjoint task to elicit a measure for our food waste proxy. Our project staff worked closely with each respondent, especially for the more involved parts of the survey eliciting risk prefences and food waste proxies. They explained the tasks at hand and answered any clarifying questions. The presence of our staff helped with making the survey interactive to ensure credible responses from engaged respondents.

3.3.2. Elicitation of food waste proxy

The food waste proxy for the study was constructed by eliciting the likelihood to eat selected food products and subtracting it from 100, assuming that the lower the likelihood of products eaten, the higher the amounts potentially discarded. The respondents were presented food products with varying attribute profile and asked to indicate the percentage of the presented food product they would likely consume as they are preparing meals, ranging from eating none to eating all. For each product profile, the question was posed as follows:

"Imagine you are in your kitchen to do some meal preparation using <food product>. The <food product> you took out is Product X. Thinking of all possible ways you are likely to eat <food product>, what percentage of this product are you and/or your household likely to eat?"

Answer: 0 % – 100 % (sliding scale)

We developed the food product profiles in consultation with food science experts to simulate realistic food handling decisions at home. Of food product attributes that have been associated with waste tendencies, five were selected for the study: cosmetic deterioration, expiration date type, days to expiration date, package size, and price purchased. We selected two products, packaged fresh spinach and ground beef, which are both sold with an expiration date and deteriorate visibly over time even if their nutritional properties are intact.

Perception about the appearance of a food product is related to individual sensory attributes (flavor anticipation, size, color, texture, shape, consistency) which in turn affects the total view of the visual appearance of the food product (Hutchings, 1977). Thus, cosmetic deterioration was categorized into the three distinct levels using photographic images. The *appearance level* of 1 suggests that the product was free from any cosmetic flaws. As the level progresses to level 3, there are multiple flaws in the form of browning in the case of beef and blemishes, spots, or wilting in the case of spinach. Respondents saw various angles of the products. Deterioration was merely in appearance and products remained edible. Figure 3-1 displays the three levels of cosmetic deterioration for the products, using one of the visual dimension that respondents saw. Complete visuals are available upon request.

Figure 3-1. Cosmetic deterioration of spinach and ground beef

Products	Appearance 1	Appearance 2	Appearance 3
Spinach			
Ground Beef			

Three types of expiration dates were considered: *Best by*, *Use by*, and *Best if used by*. These particular date types have been emphasized in the recent food waste literature and "*Best if used by*" is currently proposed as the preferred food date label (United States Department of Agriculture, 2016). The other attributes were specified distinctly for spinach and ground beef. For days to expiration date, a *near, middle* and *far* expiration date for spinach implied 1, 3 and 7 days away respectively; for ground beef, however, that implied 1, 2, and 3 days away. For package size, a large spinach product weighed 10 ounces and the small 5 ounces. The large ground beef weighed 2 lbs. and small size was 1 lbs. Price paid varied between $1.99 to $5.99 for spinach and between $4.79 and $15.99 for ground beef. These sizes and prices were selected to ensure familiarity with attributes at regular grocery outlets.

For each product, we used a fractional factorial method to develop twelve profiles for each product using orthogonal designs. To minimize response fatigue, each subject saw eight profiles to complete the task. The profiles were grouped into three sets of four profiles, and each subject was presented with two randomly selected sets of four profiles, one for each product, and both for spinach if they indicated that they did not eat meat. The task was interrupted with a different set of questions between the series. Table 3-2 summarizes the properties of the twelve product profiles.

Table 3-2. Properties of product profiles included in the study

Profile	Expiration date	Date type	Size	Appearance level	Price paid
1	Far	Best by	Large	2	Low
2	Near	Best by	Large	1	High
3	Near	Use by	Large	2	Middle
4	Far	Use by	Small	1	High
5	Far	Best by	Small	3	Middle
6	Near	Best if Used by	Small	1	Low
7	Middle	Best if Used by	Large	3	High
8	Middle	Best if Used by	Small	2	High
9	Far	Best if Used by	Large	1	Middle
10	Middle	Use by	Large	1	Low
11	Near	Use by	Small	3	Low
12	Middle	Best by	Small	1	Middle

3.3.3. Elicitation of risk parameters

Following similar methods outlined by Holt and Laury (2002) as well as Lusk and Coble (2005), subjects are tasked with choosing between a proposed Lottery A or Lottery B. Lottery A paid either $10 or $8 and lottery B paid either $19 or $1; both with differing probabilities on the higher payoff. Table 3-3 summarizes the lottery choices. In any given choice, Lottery A is the “safe choice” and B the “risky choice” since A has less variability in payoffs. In decisions 1 through 4, Lottery A yields a higher expected payoff than Lottery

B ($E[A] > E[B]$). In decisions 5 through 10, Lottery B has the higher expected payoff, that is, $E[B] > E[A]$.

Table 3-3. Lottery choice experiment and expected payoffs

Lottery A	Lottery B	$E[A]$	$E[B]$	$E[A] - E[B]$
10% chance of $10, 90% chance of $8	10% chance of $19, 90% chance of $1	8.2	2.8	5.4
20% chance of $10, 80% chance of $8	20% chance of $19, 80% chance of $1	8.4	4.6	3.8
30% chance of $10, 70% chance of $8	30% chance of $19, 70% chance of $1	8.6	6.4	2.2
40% chance of $10, 60% chance of $8	40% chance of $19, 60% chance of $1	8.8	8.2	0.6
50% chance of $10, 50% chance of $8	50% chance of $19, 50% chance of $1	9	10	-1
60% chance of $10, 40% chance of $8	60% chance of $19, 40% chance of $1	9.2	11.8	-2.6
70% chance of $10, 30% chance of $8	70% chance of $19, 30% chance of $1	9.4	13.6	-4.2
80% chance of $10, 20% chance of $8	80% chance of $19, 20% chance of $1	9.6	15.4	-5.8
90% chance of $10, 10% chance of $8	90% chance of $19, 10% chance of $1	9.8	17.2	-7.4
100% chance of $10, 0% chance of $8	100% chance of $19, 0% chance of $1	10	19	-9

Employing a widely-used "multiple price list" design whereby subjects are presented with ten lottery choices to make, we determine lower and upper bounds of their coefficient of absolute risk aversion and coefficient of relative risk aversion. This method has the advantage of being simple to implement and context-free.

In this choice experiment, subjects usually start by choosing the safe option A then switch to the risky option B for chances of higher hypothetical payoff. Assuming a functional form for utility, the lower and upper bounds of the subject's risk aversion parameter can be computed. Given that we use the same payoffs as Lusk and Coble (2005), ranges for the risk parameters are identically specified. For instance, assume that utility is given by: $U(x) = x^{1-rr}/_{1-rr}$ where rr is the coefficient of relative risk aversion and x

is the payoff. For illustration purposes, we present calculations of risk parameters for a person who chooses safe option A in choices 1 through 3 and switches to risky option B in subsequent choices. The lower bound can be calculated as follows:

(1)

$$0.3\ \frac{10^{1-rr}}{1-rr} + 0.7\ \frac{8^{1-rr}}{1-rr} = \ 0.3\ \frac{19^{1-rr}}{1-rr} + 0.7\ \frac{1^{1-rr}}{1-rr}$$

$$\therefore rr \equiv -0.49$$

Similarly, the lower upper is given by:

(2)

$$0.4\ \frac{10^{1-rr}}{1-rr} + 0.6\ \frac{8^{1-rr}}{1-rr} = \ 0.4\ \frac{19^{1-rr}}{1-rr} + 0.6\ \frac{1^{1-rr}}{1-rr}$$

$$\therefore rr \equiv -0.12$$

For this person, the range for the coefficient of relative risk aversion is $-0.49 < rr < -0.12$. A similar exercise yields the bounds for absolute risk aversion parameters.

3.3.4. Factor analysis and latent model

The survey gathered numerous highly correlated measurements of habits and skills relating to shopping, purchasing, cooking and other related household routines. We use factor analysis, a data reduction technique, to generate low dimensional and informative aggregates that capture a range of household skills and behaviors. Applying factor analysis to 34 measurements related to shopping, purchasing, cooking and other food-related routines, we generated six aggregated variables that captured a range of relevant skills and behaviors. A minimum factor loading of 0.40 was considered in this analysis (Rohde et al., 2001; Conners et al., 1998). Factor loadings are the weights and correlations between each variable and the grouping pre-defined by researcher. The higher the load the more relevant the variable in defining the factor's dimensionality (Alarcón and Sánchez, 2015; Torres-Reyna, 2010).

Further, we evaluated the reliability and internal consistency of extracted factors through the Cronbach α, which is a lower-bound estimate of the reliability of the multiple measures of a construct (Tavakol and Dennick, 2011). This parameter can be viewed as the expected correlation among variables that measure the same concept. A score of 0.75

usually indicates high reliability and a score of 0.5 and above indicates moderate reliability (Hinton et al., 2004). These factors and other data from the survey are then used in a latent class analysis.

We presume that relationships among observed habits, behaviors and attitudes relating to food handling and discarding tendencies can be characterized into distinct consumer profiles which are unobservable to the researcher. A latent class analysis identifies such categorical latent variable through analyzing the structure of the statistical relationships among observed categorical variables (McCutcheon, 1987; Formann, 1985). This type of modeling is a popular technique used to identify unobserved heterogeneity in a population (Nylund et al., 2007). For instance, using a latent class analysis, Fonseca (2013) categorizes a Portuguese sample of 542 subjects into non-food waste and food waste citizens. We conduct a similar exercise focusing on factors that were deemed most relevant from the literature collected from our survey.

Assume a heterogeneous population made up of S groups ($s = 1, 2, \ldots, S$), which are the latent classes. The latent model is described by variable Y for S latent classes through analyzing the structure of relationship among observed variables $X_1, X_2, \ldots, X_g$ that respectively comprise of I ($i = 1, 2, \ldots I$), J ($j = 1, 2, \ldots, J$), $\ldots, K$ ($k = 1, 2, \ldots, K$) categories. Denote $\lambda_{ij\ldots ks}^{X_1 X_2 \ldots X_g Y}$ as the joint probability that an observation is in category i of variable X_1, category j of variable X_2, category k of variable X_g, and so on. Further, that observation is in class s of the variable Y. Let $\lambda_{is}^{\bar{X}_1 s}$ be the conditional probability that an observation is in category i of variable X_1, given that the observation is in class s of variable Y. Similarly, let $\lambda_{js}^{\bar{X}_2 s}$ be the conditional probability that an observation is in category j of variable X_2, given that the observation is in class s of variable Y. Thus, there are $\lambda_{is}^{\bar{X}_1 s}, \lambda_{js}^{\bar{X}_2 s} \ldots \lambda_{ks}^{\bar{X}_g s}$ such conditional probabilities. Finally, let λ_s^Y be the probability that an observation is in class s of variable Y. The latent class model can then be expressed as:

$$\lambda_{ij\ldots ks}^{X_1 X_2 \ldots X_g Y} = \lambda_s^Y \lambda_{is}^{\bar{X}_1 s} \, \lambda_{js}^{\bar{X}_2 s} \ldots \lambda_{ks}^{\bar{X}_g s} \quad (3)$$

for $i = 1, 2, \ldots I$; $j = 1, 2, \ldots, J \ldots$; $k = 1, 2, \ldots, K$ and $s = 1, 2, \ldots, S$

These probabilities determine the individuals' class membership and the relative size of the latent classes. The standard latent model computes the probability of the response patterns of the included measurements and uses a chi-square test to compare the sets of response patterns that were observed with the set of response patterns expected under the model (Bartholomew et al., 2011). The Bayesian Information Criterion (BIC) derived by factoring in the log likelihood of the model, the number of estimated model parameters, and the total number of observations, is used to evaluate the latent model fit in terms of the number of classes (Schwartz, 1978). The model with the lowest BIC is selected (Dziak et al., 2012).

Individuals are assigned to classes based on the estimated conditional response probabilities based on the selected model, applying a modal classification rule, also defined as the highest posteriori probability rule (Lazarsfeld and Henry, 1968; Hagenaars and McCutcheon, 2002). These conditional response probabilities represent the probabilities that for each combination of latent class, observed variable, and response level for that item, that a randomly selected member of that class will make that response to that variable (Uebersax, 2006). For instance, a conditional response probability parameter might be the probability that a member of Latent Class 1 answers "Strongly Agree" to the questions on pre-shopping routines (represented by a single factor variable). The central idea is that class membership describes the composition of unobserved subgroups and defines different types of people based on their respective food-related behavioral patterns and attitudes.

3.3.5. Regression analyses

To examine the relative roles of product attributes, especially appearance level and date labeling, we estimate the following regression equation:

$$y_i = \beta_0 + \sum_{j=1}^{J} \beta_{1j} z_j + \sum_{k=1}^{K} \beta_{2k} x_{ik} + \varepsilon_i \qquad (4)$$

where the dependent variable y_i captures the likelihood of the product being discarded by individual i. Thus, it is the percentage of the product that the subjects report they would not consume in the conjoint task. Let **z** be a vector of J product attributes which consists of categorical variables measuring the levels of cosmetic deterioration (appearance level), expiration date type (best by, best if used by, use by), days to expiration, package size (large or small), and the price of product purchased. Denote $\mathbf{x}$ as the vector of k demographic characteristics including age, gender, income, household size, presence of children in the household and urban/rural indicator. β's are parameters and ε_i is the error term for the model. We first run the model on the full sample, that is, for both products, spinach and ground beef, and all classes (*N=333*). We then run the same specification (4) for the individual products within a given class. We thus report h regression outputs, where $h = 2c + 2$, and c is the number of latent classes.

To further test the relative roles of risk preferences and perceptions, we estimate another regression:

$$(5)\ y_i = \alpha_0 + \sum_{j=1}^{J} \alpha_{1j} z_j + \sum_{k=1}^{K} \alpha_{2k} x_{ik} + I_4 D_j + \alpha_{3i} rr_i + \alpha_{4i} rp_i + \alpha_{5i} (rr_i\ x\ rp_i) + \omega_i$$

We pool the sample in the second equation *(5)* across the (j) products (ground beef and bagged spinach) for two reasons. First, from a theoretical standpoint, these risk-related variables capture inherent behavior which should not differ from product to product. Second, we do this for convenience given small sample issues. To capture product effects, we include a dummy variable D equal to 1 if the product is beef and 0 otherwise.

Demographics variables x and product attributes z are included as controls. The variable rr_i is the continuous coefficient of relative risk aversion from the context-less risk elicitation exercise. This variable is normalized with mean 0 and standard deviation 1 to ease interpretation. Further, rp_i is the self-reported risk perception vis-a-vis expiration dates and cosmetic deterioration. Higher levels of perceived risk are associated with higher values of this variable. We are also interested in measuring any interaction between risk perceptions and risk preferences. We thus include a two-way interaction between the continuous variables rr_i and the variable rp_i.

3.4. Results

3.4.1. Sample demographics

We begin by describing the overall demographic composition of the sample compared to the U.S population. Table 3-4 summarizes the characteristics of the 333 respondents. Most discrepancies are reasonable based on the study design. The subjects were considered eligible only if they were responsible for at least half of the food shopping for the household—which explains a higher proportion of female participants. In this case, female respondents make up about 66% of the sample compared to the U.S average of 51%. The subjects were recruited to participate in a research study at the University of Minnesota during their visits to the Minnesota State Fair at the end of August to early September at Saint Paul, Minnesota. Those with higher education were more likely willing to participate in a study to support scholarly work at the local university. For example, the sample consists of only 9.0% of respondents with a high school degree or less while the U.S averages at 41.5%. Similarly, a larger proportion of the sample have a bachelor degree or higher in our sample.

The weather and outdoor nature of the Fair explain the smaller portion of individuals who are of age 75 and above, and the location of the Fair explains below the national average racial diversity and higher than average proportion of urban residency among the subjects. Particularly, we have a larger representation of white respondents, at 85.9%. While Black or African Americans make up 13.3% of the U.S population, our sample consists of 3% of individuals from this race category. The fact that subjects were asked to interrupt their Fair activities to participate in the study explains the reason why proportionally fewer people with children opted to do so. The income distribution is similar across most income levels except for the lowest range. It is possible that university students disproportionately participated explaining why almost one quarter of the participants fell in the less than $25,000 income category.

Table 3-4. Summary statistics of demographic variables

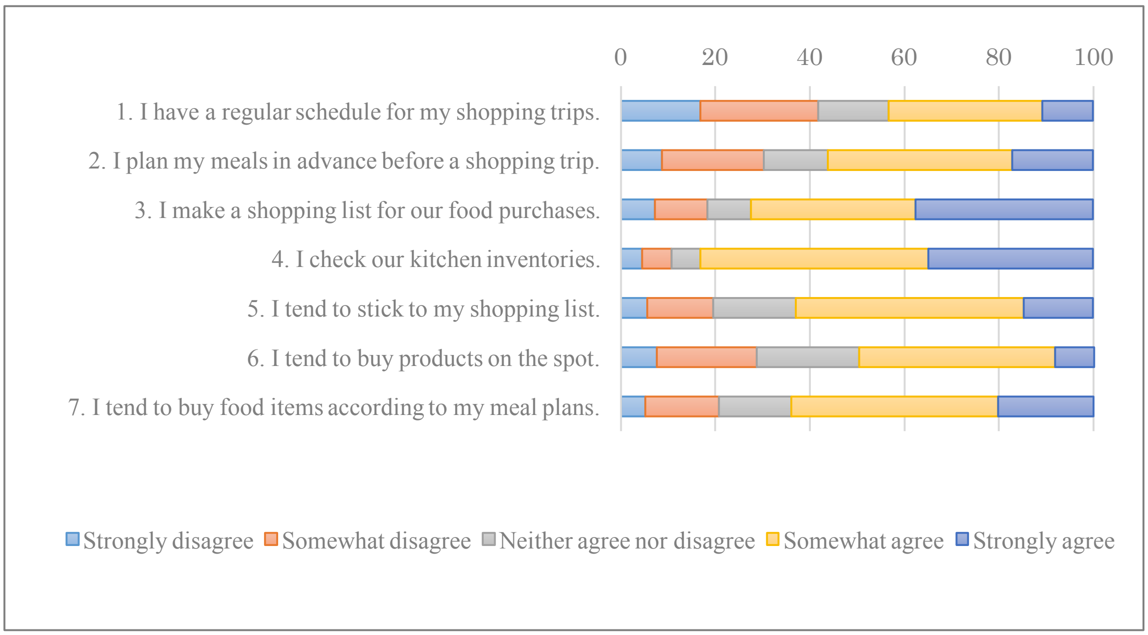
	Survey participants (N = 333)	U.S. Census
Gender		
Female	66.1%	50.8%
Male	32.7%	49.2%
Other	1.2%	
Age		
18–24	12.6%	12.9%
25-34	17.1%	17.7%
35-44	17.4%	16.8%
45-54	20.1%	18.1%
55-64	21.3%	16.2%
65-74	9.6%	10.3%
75 and over	1.8%	8.0%
Education		
Some college, no degree	33.3%	72.8%
Bachelor's degree or higher	66.6%	27.2%
Race		
Non-White	14.11%	23.10%
White	85.90%	76.90%
Household income		
Less than $25,000	23.0%	10.8%
$25,000 to $34,999	10.1%	6.6%
$35,000 to $49,999	13.4%	12.9%
$50,000 to $74,999	17.8%	19.5%
$75,000 to $99,999	12.1%	15.6%
$100,000 to $149,999	13.1%	19.2%
$150,000 to $199,999	5.1%	8.1%
$200,000 or more	5.3%	7.2%
Children less than 18 present	24.0%	32.0%
Residency in an urban area	86.4%	80.7%
Household size (mean)	2.64	2.53

U.S data from Census Bureau and the American Community Survey 2016
Age and education percentages are for population 18 and over, not total population

3.4.2. Household food handling behaviors

The survey included questions relating to food choices and food-related activities such as shopping routines, meal planning, and food handling skills, mainly drawn from the literature reviewed in the previous section. This segment provides a summary of relevant household food handling behaviors included in the study. Building on previous work, we consider four measures of planning routines and three measures of shopping routines.[9] Statements 1– 4 in Figure 3-2 show the questions getting at planning habits and statements 5-7 relate to shopping routines.

Figure 3-2. Agreement with statements related to household shopping and planning routines



A larger proportion of the sample report having disciplined shopping and planning routines. An overwhelming 83% of the respondents report checking their kitchen inventories before their shopping trips. Almost two thirds (64%) of the sample claim they buy food items in amounts according to their meal plans. Forty-three percent of the sample agree with having a regular schedule for shopping trips while 41% disagree. Most subjects (73%) report that they make a shopping list for their food purchases. Half of the

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[9] *Subjects illustrated agreement or disagreement on a five point Likert scale (strongly agree, agree, neutral, disagree, strongly disagree). Responses to these statements were recoded from 1 to 5 with larger numbers indicating stronger agreement.*

respondents state that they tend to buy products on the spot at the store while about 28% do not.

A next set of questions examine the respondents' self-awareness of why food goes to waste in their households.[10] The rationale behind these questions was twofold. First, we wanted households to carefully consider and reflect on a variety of motivations behind food going to waste. Some reasons could be classified as mostly beyond the individual's control. For instance, packaging being too large or food not turning out well are sensibly unintentional reasons. Other causes such as buying and preparing too much or purposefully not wanting to save leftovers are more premeditated. Second, the next set of statements related to the amount of food that respondents thought went to waste at home. Exposing the respondents to the reasons first then asking about the amounts later arguably could lead to better awareness and reported approximation. Figure 3-3 show the likely reasons that the household stated that food went uneaten.

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[10] Subjects were also able to choose a "not applicable" option if food was not wasted in their households for the given reasons.

Figure 3-3. Agreement with statements related to reasons for food going to waste

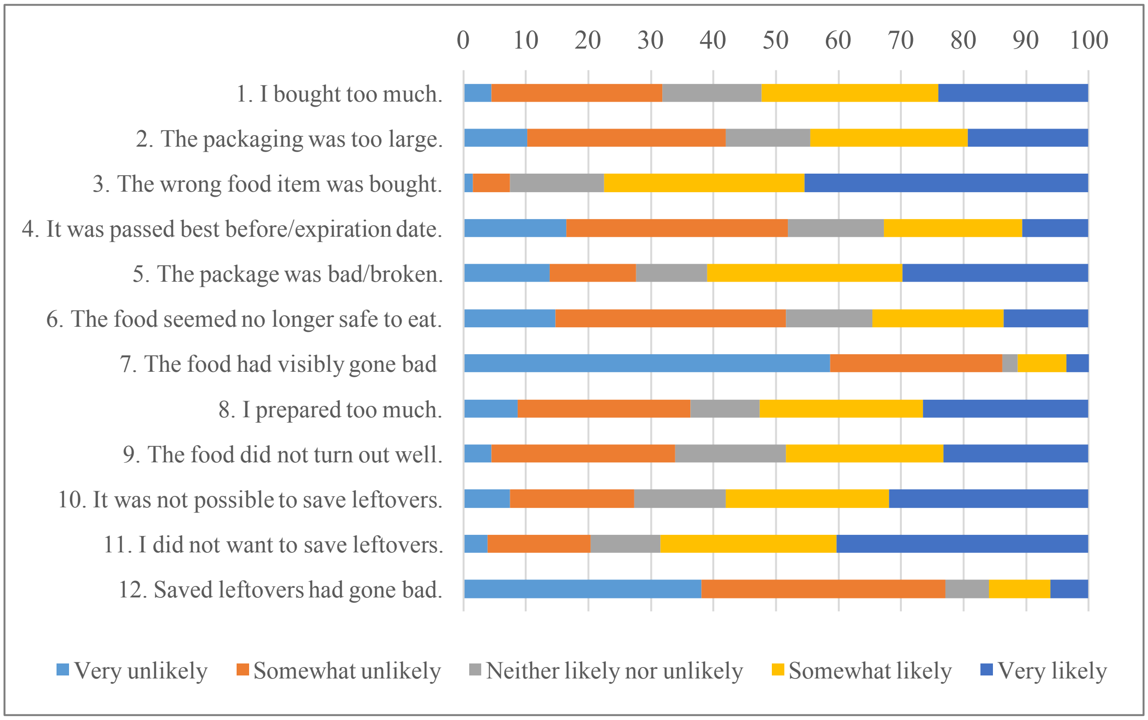
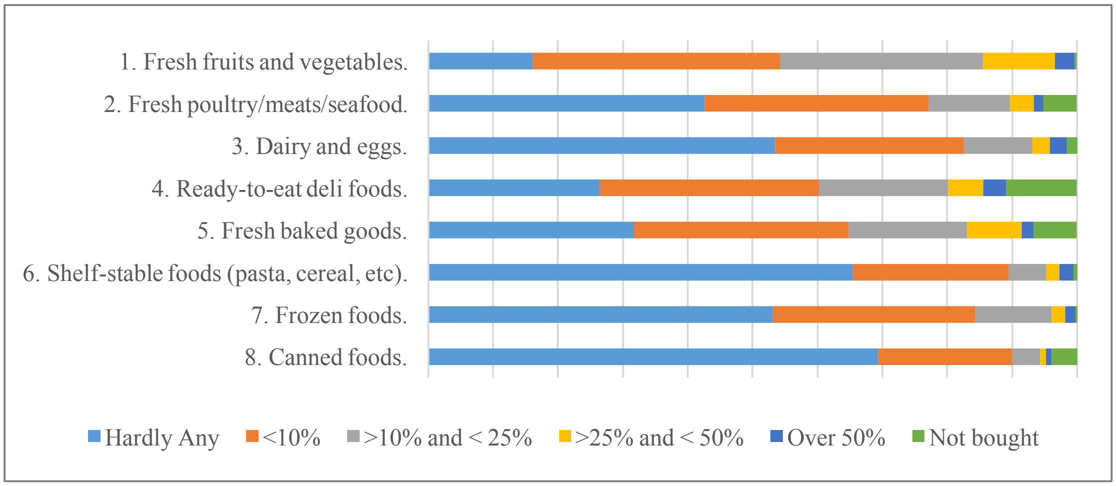


Figure 3-4 illustrates the self-reported percentage of food that the respondent reported discarding. For perishables, we ask subjects to estimate the amount that gets thrown away in a typical week. For items with longer shelf-life such as frozen foods, the timeline is for 6 months. Unsurprisingly, a majority of respondents, almost 70%, report hardly tossing any canned foods. Over 30% of the sample report throwing away between 10-25% of fresh fruits and vegetables in a usual week. Few people report throwing away more than half of any of the food items. For instance, less than 4% of the sample report discarding over 50% of the ready-to-eat deli foods that they purchase. Consistently, fresh fruits and vegetables are the highest percentage of what gets discarded. About 45% of the sample report trashing at least more than 10% of the fruits and vegetables bought. All products with longer shelf-life are reported to be discarded at a lower rate. This is consistent with previous research that shows that fruits and vegetables are highly likely to get discarded (Gunders, 2012; Buzby et al., 2011).

Figure 3-4. Self-reported percentage of food items that gets thrown away



Following studies that highlighted a strong relationship between "home economics" skills and food waste tendencies (Stancu et al., 2016; Cox and Downing, 2007), three questions gauging cooking skills and three questions regarding food management skills were included in this study (Figure 3-5). Tendencies to cook, prepare or buy too much food have also been associated with higher levels of food waste in Swedish households (Williams et al., 2012). We find that 53% of the sample agree that they prefer buying too much food than to run out and 67% report preparing more food than needed than running out.

Figure 3-5. Cooking and food management skills

A final set of questions consider the recycling habits of the respondents. People who recycle both food and non-food items may be more aware of environmental aspects of food waste. In this sample, 56% of people report being likely to always recycle materials such as paper, plastic and glass, while 11% report composting their food.

3.4.3. Risk related results

In their risk elicitation task, Holt and Laury (2002) find that between 6 to 13 percent of respondents switched back from B to A in the experiments and about one-fourth of them switched more than once. Lusk and Coble (2005) have only 3 instances of such inconsistencies in their sample of 50. In both studies, the authors find clear clusters of A and B responses suggesting few mistakes on the respondents' end. Hence, the subjects remain in the respective studies. In our sample, 23% of the sample (N=78) switched back and forth from B to A, of which 28 had only one switch back. To be conservative, we keep only those subjects who had one switch back, omitting those who switched back and forth more than once. The size of final sample with consistent risk parameters is 283 respondents, that is, 85% of the original sample.

Ranges of rr and ar corresponding to decisions in the experiment are given in Table 3.5. Our sample consists of a larger proportion of risk loving respondents compared the other two studies. About 30% of the sample is risk loving whereas only 8% are in Holt and Laury (2002) and 12% are in Lusk and Coble (2005).[11] Approximately 17% of the sample is risk neutral and the remaining 52% are risk averse.[12] As with the previous studies, we also use the midpoint of the range for the first and second switch for those who switched more than once.

Table 3-5. Risk aversion classification of the sample based on lottery choices

# of safe choices	Obs. [a]	Range of relative risk aversion $U(x) = x^{1-rr}/1-rr$	Range of absolute risk aversion $U(x) = -\exp(-ar \text{ x } x)$	Risk level classification
0,1	8.83%	rr < -0.97	ar < -0.11	highly risk loving
2	3.18%	-0.97 < rr < -0.49	-0.11 < ar < -0.06	very risk loving
3	18.02%	-0.49 < rr < -0.12	-0.06 < ar < -0.02	risk loving
4	17.67%	-0.12 < rr < 0.19	-0.02 < ar < 0.03	risk neutral
5	13.07%	0.19 < rr < 0.49	0.03 < ar < 0.07	slightly risk averse
6	12.37%	0.49 < rr < 0.79	0.07 < ar < 0.11	risk averse
7	5.30%	0.79 < rr < 1.13	0.11 < ar < 0.17	very risk averse
8	6.01%	1.13 < rr < 1.61	0.17 < ar < 0.25	highly risk averse
9,10	15.55%	1.61 < rr	0.25 < ar	stay in bed
Number of observations				283

[a] *Number of respondents/observations.*

Table 3-6 shows a measure of risk perception in consuming foods with certain cosmetic defects or past expiration dates collected for four items. A higher value denotes larger perceived risk. On average, respondents display higher levels of perceived risk associated with expiration dates. For instance, almost 70% of the respondents report checking date labels on their food items most of the times. This is captured in the higher average value (3.78) on the response scale in the sample. Further, over 50% of the sample believe that eating food past the expiration dates will pose some risks. Perceived risks from

[11] *This may be limitation of the hypothetical nature of the experiment whereby respondents afford to be riskier than they would conventionally be. It is reasonable to assume that the direction of the bias would be the same for all respondents, hence, the risk parameters should still be suitable measures.*

[12] *Compare to 64% of the Lusk and Coble (2005) sample who were risk averse and 66% in the Holt and Laury (2002) study.*

eating foods with cosmetic defects was slightly lower but still present. In order to get an index of risk perception, we aggregate and average the responses for the four variables.

Table 3-6. Perception of risk in foods with cosmetic defects or past their dates labels: Response to Scale Questions (1 = Strongly Disagree, 5 = Strongly Agree)

	Questions	Mean
Item 1	Eating food that has cosmetic defects will not pose risks to my family and me.	2.42
		(1.28)
Item 2	Eating food that has passed its expiration date will not pose risks to my family and me.	2.90
		(1.14)
Item 3	My family and I could be exposed to risks from eating food that has cosmetic defects.	2.46
		(1.24)
Item 4	I pay attention to date labels on food items, such as "use by," "best by"?	3.78
		(1.10)

Items 1 and 2 are reverse coded
Cronbach alpha = 0.60

3.4.4. Factor analysis

The factor analysis of 34 items formed the six variables gauging (i) pre-shopping routines, (ii) purchasing behaviors, (iii) reasons to discard food, (iv) self-reported amounts of food discarded, (v) cooking and food management skills, and (vi) tendencies to buy or prepare too much food to provide for the family. Table 3-7 displays the factor variables, the loadings on each construct, the related Cronbach α, and mean scores of individual items in parentheses. For instance, both the high factor loadings (>0.4) and the Cronbach α (0.72) for *Variable 1* suggest that the four measures of pre-shopping routines illustrate the essence of a person's activities before grocery shopping. Making a list food purchases has a high loading of 0.80 implying that such a behavior is highly relevant in defining the pre-shopping routines factor's dimensionality.

Table 3-7. Means, factor variables, loadings and Cronbach α (alpha). [a]

VARIABLES	***Factor Loadings*** [b]
Variable 1	
Pre-shopping routines	
I make a shopping list for our food purchases (3.85)	0.8
I check our kitchen inventories before our shopping trips (4.03)	0.77
I plan my meals in advance before a shopping trip (3.34)	0.74
I have a regular schedule for my shopping trips (2.96)	0.65
Cronbach α	0.72
Variable 2	
Purchasing behaviors	
I tend to stick to my shopping list (3.52)	0.82
I tend to buy products on the spot (3.21) [c]	0.7
I tend to buy food items in amounts according to my meal plans (3.58)	0.61
Cronbach α	0.52
Variable 3	
Reasons for throwing away food	
before meal prep	
The wrong food item was bought (4.13)	0.63
It was passed best before/expiration date (2.75)	0.57
The food looked ok but seemed no longer safe to eat (2.82)	0.55
I bought too much or we already had item at home (3.40)	0.53
The packaging was too large and contained more than I needed (3.11)	0.52
The package was bad/broken (3.49)	0.47
The food had visibly gone bad - rotten, sour, moldy, etc. (1.70)	0.46
after meal prep	
The food did not turn out well (3.33)	0.63
I did not want to save leftovers (3.84)	0.62
I prepared too much (3.34)	0.58
It was not possible to save leftovers (3.55)	0.56
Saved leftovers had gone bad (2.06)	0.45
Cronbach α	0.79
Variable 4	
Amount of food discarded	
fresh foods (1 week)	
Fresh poultry/meats/seafood (1.71)	0.73
Dairy and eggs (1.68)	0.66

VARIABLES	*Factor Loadings* [b]
Fresh fruits and vegetables (2.46)	0.62
Ready-to-eat deli (1.93)	0.57
Fresh baked goods (1.97)	0.55
shelf-stable foods (6 months)	
Frozen foods (1.67)	0.75
Shelf-stable foods - pasta, cereal, etc. (1.50)	0.69
Canned foods (1.32)	0.66
Cronbach α	0.8
Variable 5	
Cooking and food management skills	
cooking skills	
Preparing foods from raw/fresh ingredients (4.13)	0.7
Cooking with leftovers/random ingredients to make a meal (3.79)	0.7
Avoiding food getting burnt/ruined during cooking/preparation (4.06)	0.64
food management skills	
Correctly resealing/repackaging opened products so they stay fresh (4.27)	0.75
Knowing how to store different types of food products purchased (4.11)	0.75
Eating foods that need to be eaten first (4.05)	0.67
Cronbach α	0.79
Variable 6	
Providing for the family	
I would prefer to buy more food than to run out (3.42)	0.88
I would prefer to prepare more food than to run out (3.71)	0.88
Cronbach α	0.7

[a] *Variable means reported in parentheses (five point Likert scale)*

[b] *Factor loadings are the weights and correlations between each variable and the factor.*

[c] *Items were reverse coded*

While the Cronbach α of 0.52 suggests moderate reliability, the factor loadings for *Variable 2* are high implying that the measures are able to capture the factor's dimensionality, particularly for sticking to the shopping list. It should be noted that pre-shopping and in-store purchasing are presented as separate latent variables. When combined together (for a total of 7 variables), they did not produce Cronbach α or factor loadings that met the minimum requirements.

On the other hand, the Cronbach α score of 0.79 shows that rationales for discarding food whether *before* or *after* meal (*Variable 3*) are internally consistent and reliable for the construct capturing activities and routines linked to food discarding. For example, amongst others, tendencies for buying the wrong item, not being able to save leftovers, or a package being broken leading to throwing away food are correlated and measure the same concept with good reliability. Self-reported amounts of food discarded are also closely related across all the different products (*Variable 4*), with an alpha of 0.80 indicating high reliability. Variable 5 captures a construct of food management and cooking skills which performs well according to the respective alpha and factor loadings. Finally, measures capturing agreement to preferring buying and preparing more food than running out are well correlated, explaining the Cronbach α score of 0.70.

3.4.5. Latent class analysis

Using the six variables from the factor analysis in addition to two other variables that represent composting and recycling frequencies, the latent class model tests whether a group of unobserved classes (latent) validates the association among the included variables. Table 3-8 displays a summary of the Bayesian Information Criterion (BIC) with 1 to 4 classes.

Table 3-8. Latent class models and Bayesian Information Criterion

Number of classes	Bayesian Information Criterion
1	1914.44
2	**1906.97**
3	2001.01
4	2095.28

The relative model fit is evaluated by comparing the BIC implies that the respondents fall into two classes (BIC = 1906.97). Fifty-three percent of the sample make up, what we denote as, the *Planners* class. We call the other class, the *Extemporaneous Consumers*.

Table 3-9. Conditional response probabilities to response items and class membership

	(1)		(2)		(3)	
	Probability		P-Value		Class Membership	
	Pl.[a]	Ext.[b]	Pl.[a]	Ext.[b]	Pl.[a]	Ext.[b]
Variable 1						
Pre-shopping routines						
Strongly disagree	0.01	0.09	0.23	0.00		×
Somewhat disagree	0.04	0.24	0.04	0.00		×
Neutral	0.13	0.29	0.00	0.00		×
Somewhat agree	0.38	0.38	0.00	0.00	×	
Strongly agree	0.45	0.00	0.00	0.73	×	
Variable 2						
Purchasing behaviors						
Strongly disagree	0.00	0.1	0.89	0.00		×
Somewhat disagree	0.03	0.26	0.16	0.00		×
Neutral	0.33	0.56	0.00	0.00		×
Somewhat agree	0.43	0.08	0.00	0.03	×	
Strongly agree	0.21	0.00	0.00	0.81	×	
Variable 3						
Reasons for throwing away food						
Strongly disagree	0.02	0.03	0.08	0.06		
Somewhat disagree	0.18	0.24	0.00	0.00		×
Neutral	0.39	0.54	0.00	0.00		×
Somewhat agree	0.29	0.18	0.00	0.00	×	
Strongly agree	0.12	0.01	0.00	0.39	×	
Variable 4						
Amount of food discarded						
Little	0.71	0.36	0.00	0.00	×	
Some	0.24	0.49	0.00	0.00		×
Average	0.03	0.12	0.04	0.00		×
Quite a bit	0.02	0.01	0.05	0.31		
A lot	0.01	0.01	0.32	0.32		
Variable 5						
Cooking and food management skills						
Quite poor	0	0.01	0.96	0.16		
Somewhat poor	0.04	0.26	0.01	0.00		×
Average	0.43	0.55	0.00	0.00		×
Somewhat good	0.53	0.18	0.00	0.00	×	
Variable 6						
Providing for the family						
Strongly disagree	0.04	0.04	0.01	0.02		×
Somewhat disagree	0.12	0.15	0.00	0.00		×
Neutral	0.17	0.2	0.00	0.00		×
Somewhat agree	0.44	0.38	0.00	0.00	×	
Strongly agree	0.24	0.22	0.00	0.00	×	

	Probability		P-Value		Class Membership	
	Pl.[a]	Ext.[b]	Pl.[a]	Ext.[b]	Pl.[a]	Ext.[b]
Variable 7						
Composting habits						
< 1/2 of the time	0.71	0.89	0.00	0.00		×
Most of the time	0.29	0.11	0.00	0.01	×	
Variable 8						
Recycling habits						
< 1/2 of the time	0.06	0.17	0.00	0.00		×
Most of the time	0.94	0.83	0.00	0.00	×	

[a] *Planners Class*
[b] *Extemporaneous Consumers Class*

Table 3-9 shows the conditional response probabilities for each response item (1) together with the related p-value (2). We compare these conditional probabilities in each case to assign a class membership for that specific response (3). Most probabilities are significant at the 5% level with the exception of a handful which are not used for interpretation for class membership.

The results show that respondents who tend to either "Strongly Disagree," "Disagree" or are "Neutral" about their pre-shopping routines such as making lists, checking the inventories and so on, mostly fall into the *Extemporaneous Consumers* class. Those who tend to mostly agree with these routines fall into the *Planners* class. Similar trends are noted for in-store or during shopping behaviors. Those who are in agreement with having less impulses in the store or sticking to their shopping lists fall into the *Planners* class.

When asked about reasons for food going to waste in the household, *Extemporaneous Consumers* report that they disagree with or are neutral about those. That is, on average, they do not throw away food because the package was bad/broken or too much food was prepared, for example. On the other hand, *Planners* tend to agree with throwing away food for various reasons such as being unable to save leftovers or buying the wrong item. The trend is reversed when it comes to amounts of food wasted, which include both perishables such as fruits, vegetables and meats as well as shelf-stable items such as frozen or canned goods. *Planners* report throwing away little amounts of food while *Extemporaneous Consumers* throw away an average amount. The p-value of the responses for "Quite a bit" or "A lot" of food thrown away were not significant at the 5% implying that they do not inform class membership.

Planners report that they do end up buying or preparing more food than needed to provide for their families while *Extemporaneous Consumers* mostly disagree with those statements. When it comes to food management and cooking skills such as re-using leftovers or knowing how to store food items in the kitchen, Extemporaneous consumers report either "Somewhat Poor" or "Average skills. On the other hand, Planners report being somewhat good with these home-economics skills. Finally, *Planners* report steady composting and recycling tendencies compared to their counterparts in the other class who do so less than half of the time.

3.4.6. Regression analyses

We regress the likelihood to eat the respective food product on product attributes and demographic factors for the entire example and for each of the classes, *Planners* and *Extemporaneous Consumers*. Tables 3-10 and 3-11 report the OLS regression coefficients for the product attributes. For each product, the first column is for the entire sample, the middle column (columns 2) is for the *Planners* class, and the last column is for the *Extemporaneous Consumers* class.

Table 3-10. Regression results: Propensity to waste bagged spinach by products attributes and demographics

	Bagged spinach		
	(1)	(2)	(3)
VARIABLES	All Sample	Planners	Ext. Consumers
Appearance			
Level 2	2.376**	2.880**	1.261
	(0.791)	(1.020)	(0.999)
Level 3	5.513***	4.731*	7.454***
	(1.190)	(1.895)	(1.037)
Date type (Best if Used By omitted)			
Best by	-2.946*	-2.222	-3.175**
	(1.238)	(1.920)	(1.080)
Use by	1.322*	0.350	2.694**
	(0.531)	(1.287)	(0.907)
Days to expiration	-1.589***	-1.671***	-1.576***
	(0.141)	(0.235)	(0.194)
Price paid	0.883	1.533*	-0.240
	(0.538)	(0.743)	(0.686)
Package size	2.773*	1.508	4.936**
	(1.280)	(1.552)	(1.586)
Vegetarian indicator	-2.320	-3.375	2.770
	(2.270)	(2.901)	(3.173)
Demographics			
Age	-0.186**	-0.144	-0.227**
	(0.068)	(0.081)	(0.077)
Gender: (Female omitted)	7.617***	13.778***	-0.450
	(1.791)	(2.607)	(2.528)
Race: (White omitted)	4.970	1.847	8.920**
	(2.829)	(2.907)	(3.409)
Income (Less than $25,000 omitted)			
$25,000 to $34,999	15.894***	11.100**	25.617***
	(3.203)	(3.798)	(6.049)
$35,000 to $49,999	-2.209	-0.986	-0.618
	(2.185)	(2.679)	(4.860)
$50,000 to $74,999	-1.012	2.217	-0.537
	(3.456)	(4.275)	(6.162)
$75,000 to $99,999	0.424	3.865	2.860
	(3.239)	(3.948)	(6.622)
$100,000 to $149,999	-1.688	-7.091*	7.342
	(2.395)	(3.356)	(5.812)
$150,000 to $199,999	-1.856	-1.909	5.368
	(3.529)	(4.343)	(6.130)
$200,000 or more	-0.521	-11.154**	15.843*
	(3.456)	(4.260)	(6.677)

VARIABLES	(1) All Sample	Bagged spinach (2) Planners	(3) Ext. Consumers
Urban Population	-1.836	4.569	-5.565
	(3.538)	(3.396)	(6.475)
Household Size	-2.543***	-2.107*	-3.272***
	(0.727)	(1.002)	(0.845)
Child Presence	2.384	4.641	-0.657
	(1.675)	(2.888)	(3.177)
Constant	44.041***	28.750**	57.005***
	(3.880)	(9.735)	(6.778)
Number of individuals	333	189	144
Observations	1,482	851	631

Robust standard errors in parentheses
**** p<0.001, ** p<0.01, *p<0.05*

Table 3-11. Regression results: Propensity to waste ground beef by products attributes and demographics

VARIABLES	(1) All Sample	Ground Beef (2) Planners	(3) Ext. Consumers
Appearance			
Level 2	7.846***	8.245***	8.031**
	(1.370)	(1.066)	(2.459)
Level 3	26.519***	25.599***	28.299***
	(1.039)	(1.542)	(1.068)
Date type (Best if Used By omitted)			
Best by	1.432	1.373	1.759
	(1.088)	(1.285)	(1.537)
Use by	2.592	0.282	5.823***
	(1.345)	(1.508)	(1.762)
Days to expiration	-0.233	-0.249	-0.725
	(0.556)	(0.708)	(0.719)
Price paid	0.438*	0.357	0.490
	(0.204)	(0.203)	(0.378)
Package size	2.699	3.523*	1.234
	(1.459)	(1.383)	(3.396)
Demographics			
Age	-0.107	-0.134	-0.028
	(0.058)	(0.081)	(0.083)

VARIABLES	Ground Beef (1) All Sample	 (2) Planners	 (3) Ext. Consumers
Gender: (Female omitted)	0.394	-1.462	2.188
	(2.410)	(3.512)	(1.782)
Race: (White omitted)	-4.869*	-1.158	-6.434
	(2.400)	(2.967)	(4.929)
Income (Less than $25,000 omitted)			
$25,000 to $34,999	5.791	-4.523	18.678**
	(4.219)	(4.479)	(6.257)
$35,000 to $49,999	-9.561*	-13.201**	-8.002
	(4.027)	(4.198)	(6.222)
$50,000 to $74,999	-9.843*	-13.305*	-5.383
	(4.761)	(5.207)	(8.205)
$75,000 to $99,999	-5.004	-7.311	-1.868
	(3.658)	(3.809)	(8.022)
$100,000 to $149,999	-6.820*	-13.513***	0.753
	(3.068)	(2.577)	(6.883)
$150,000 to $199,999	-17.573***	-19.443***	-18.259
	(4.291)	(4.361)	(9.513)
$200,000 or more	-8.874	-15.913**	-4.618
	(4.966)	(4.889)	(8.791)
Urban Population	-2.261	7.638*	-14.200**
	(2.840)	(3.000)	(5.056)
Household Size	1.235	0.972	1.366
	(0.747)	(1.000)	(1.347)
Child Presence	8.452***	7.492	7.245
	(2.550)	(4.045)	(4.130)
Constant	24.553***	18.150**	30.090**
	(4.553)	(6.804)	(9.440)
Number of individuals	333	189	144
Observations	1,178	659	519

Robust standard errors in parentheses
**** p<0.001, ** p<0.01, *p<0.05*

As cosmetic appearance deteriorates, we see a general trend in increased likelihood to discard the products, particularly for ground beef. As bagged spinach products' appearance deteriorates from level 1 to level 2, consumers report an increased likelihood to discard by 2.88 percentage points for *Planners* and 2.376 percentage points for the entire sample, holding all other factors constant. The result for *Extemporaneous Consumers* is not significant at the 5% level but in the hypothesized direction. However, as the appearance deteriorates from level 1 to level 3, likelihood to discard bagged spinach goes up to 4.731 and 7.454 percentage points for *Planners* and *Extemporaneous Consumers*, respectively. The results for ground beef are significant at both levels 2 and 3 compared to level 1 and far more substantial. *Planners* report increased likelihood to discard ground beef up to 25.599 percentage points at level 3 compared to level 1. The results for *Extemporaneous Consumers* are more pronounced, with a coefficient of 28.299.

The likelihood to discard edible food products among *Planners* seemed to be unaffected to expiration date types, while *Extemporaneous Consumers* responded differently to different date terms applied to different food products. For bagged spinach, *Extemporaneous Consumers* were less likely to waste products with "*Best by*" dates and more likely with those with "*Use by*" dates, compared to a *"Best if used by"* date. For ground beef products, the likelihood to waste was higher for those with the *"Use by"* dates by nearly 5.823 percentage points, compared to "*Best if used by*" dates. This indicates that different types of expiration dates may be interpreted differently for different product types. However, "*Use by*" dates were associated with higher likelihood to waste the products steadily. This is consistent with recent findings that associate "*Use by*" dates with higher predicted waste generated (Wilson et al., 2017). Leib et al. (2016) also find that "*Use by*" dates are more likely to be interpreted as safety indicators which may explain the finding in this case.

As the expiration dates are further away, consumers report decreased likelihood to discard the spinach products only. For a 1-day increase to expiration, *Planners* report a 1.671 percentage point decrease in likelihood to waste and *Extemporaneous Consumers* a decrease of 1.576 percentage points. Thus, having more time until expiration is associated with reduced wastage propensities. The effects of prices paid on decision to eat of discard the product were in general minimal, supporting the sunk cost concept. We note small positive coefficients on price in two instances; however, they are not significant at the 5% level. This would imply that the higher the price, the higher the wastage, which is counterintuitive.

The results suggest higher wastage tendencies are associated with larger product sizes. This is also consistent with findings by Wilson et al. (2017) and Williams et al. (2012) who find that larger packaging play a role in higher food wastage. In the full sample and for *Extemporaneous Consumers*, we see about 3-5 percentage point increase in likelihood to discard bagged spinach when the size is a large, that is 10 ounces compared to 5 ounces. Further, for *Planners*, we see an increase in likelihood to discard beef when the size is a large, that is 1 lbs. compared to 2 lbs.

A second set of regression results address the hypotheses that underlying consumer risk preferences and perceptions have an impact on this likelihood to discard the products. Our main inquiry is: do elicited risk preferences and stated risk perceptions relate to possible food discarding propensities and decisions? Table 3-12 report the main coefficients of interest from the regression equations estimated using OLS. These results pool all the products together (bagged spinach and ground beef). Product-specific results are available in Appendix B. In terms of product attributes and demographics, we note robust results consistent with the previous regression.

Table 3-12. Risk coefficients from regression results (Pooled)

Risk Variables	All sample	Planners	Extemporaneous. Consumers
rr/CRRA	4.458	11.067***	5.047
	(2.599)	(3.353)	(4.522)
Risk Perception	7.305***	6.869***	8.082***
	(0.872)	(1.139)	(1.417)
rr/ CRRA x Risk Perception	-1.904*	-3.681**	-2.174
	(0.858)	(1.132)	(1.460)
Number of individuals	283	160	123
Observations	2,261	1,279	982

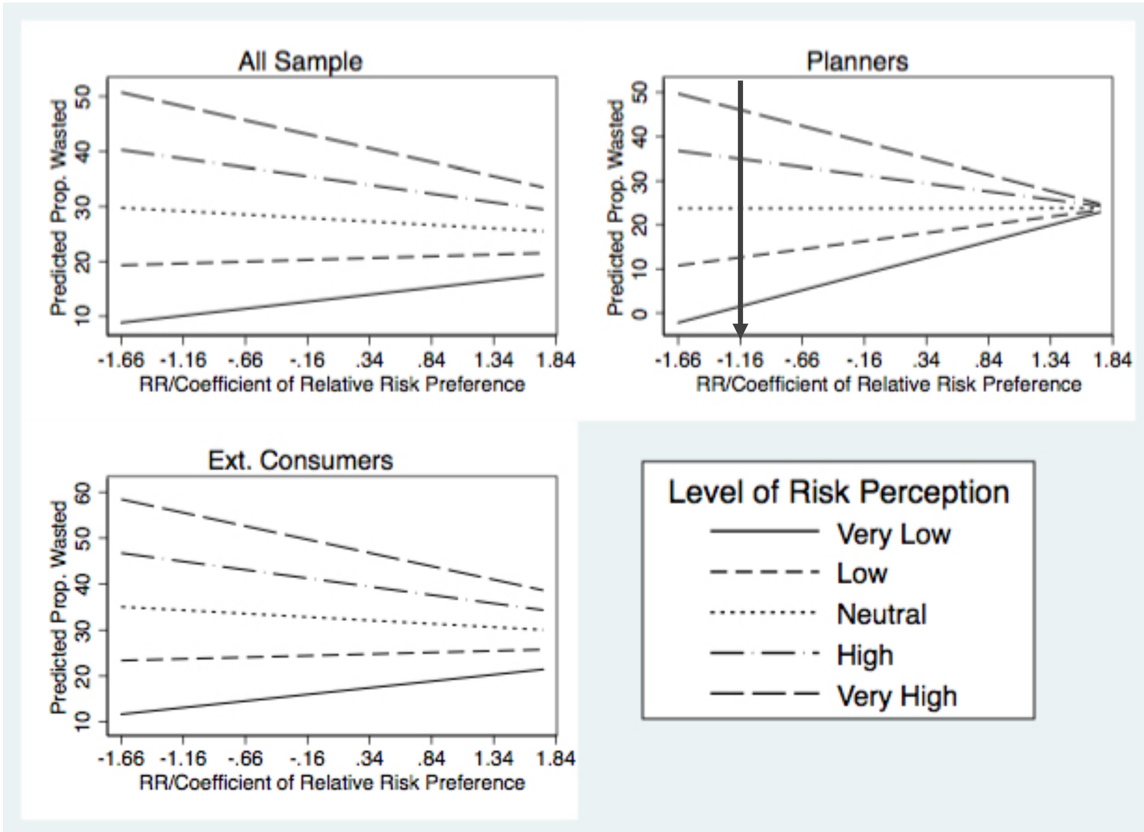
All Model controls for product attributes and demographic variables
Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

First, the results for the full sample show that as a person becomes more risk averse, the amounts of products she is likely to discard increases, implying a higher tendency to generate waste. These results are consistent with our hypotheses. Mainly, a one-standard deviation increase in the coefficient, which is equivalent to a 0.75-unit increase, decreases the likelihood to consume the products by about 11 percentage points for *Planners*. This one-standard deviation increase is equivalent to moving from risk-neutral to moderately risk averse.

The underlying risk effect is statistically significant only for *Planners* compared to *Extemporaneous Consumers*. Additionally, having a higher perceived risk also increases food waste likelihood by about 8 to 10 percentage points overall, with the effect being stronger for the *Extemporaneous Consumers*. In fact, on average, for *Extemporaneous Consumers*, only the risk perception seems to impact food waste propensities, not the underlying risk preferences. Throughout, we note the negative coefficients on the interaction terms. Because of the interactions, we cannot interpret the standalone coefficients on our variables of interest. In order to interpret and visualize these results, we calculate average marginal effects for the interaction between the risk preference and perception variables after the fitting the model.

Figure 3-6 depicts the relationship between the risk variables. It shows the predicted food waste propensities for the two classes of consumers and the full sample. The y-axis shows the percentage of food predicted likely to be discarded and the x-axis displays the coefficient of relative risk aversion, rr. The lines depict the impact of risk preferences on propensity to discard the products at different levels of risk perceptions. Notably, for *Planners*, food waste decisions are variable across risk perceptions when individuals are highly risk loving. As *Planners* become more risk averse, irrespective of their risk perceptions, food waste tendencies are starkly similar. On the other hand, although deviations get smaller as the individual gets more risk averse, we see more variation in food waste propensities at all levels of risk aversion for *Extemporaneous Consumers*.

Figure 3-6. Food waste prediction by risk preferences and risk perception



Note: All the marginal effects are significant at the 5% level.

Another point to note is that those who have neutral risk perceptions tend to have similar food wastage tendencies at all levels of risk aversion. For a given level of inherent risk aversion (rr), those with higher risk perceptions have higher food waste tendencies. This is especially true for all groups, except for those at the extreme spectrum of risk aversion in the *Planners* group. For example, at risk aversion of -1.66 for Planners (see arrow on Figure 3-6), those with high risk perception are predicted to waste up to 45 percentage points of their food products, while those with low risk perception are at less than 5 percentage points.

3.5. Limitations

The interactive survey tool was administered at the Minnesota State Fair implying that results from our consumer survey are subject to potential biases such as sample selection bias and measurement error (Berk, 1983; Bound et al., 2001). To avoid sample selection biases, recruited respondents were told that the survey deals with food and food-related choices without mentioning food waste. Further, respondents knew little about the contents of the survey they were about to take which should minimize issues arising from topic-specific self-selection. But the study still is subject to the general bias of subjects with tendency to participate in a university-led research project. One key measurement error arises from the fact that the surveyed population is not fully representative of the U.S. This challenges the external validity of the results. For instance, we have an underrepresentation of African Americans and Black respondents in the survey. Future research should aim to balance socio-demographic characteristics between the surveyed and target population.

Given the mixed results regarding the importance of socio-demographic characteristics in food waste behaviors (Neff et al., 2015; Koivupuru et al. 2012; Cox and Downing, 2007), the hope is that the different distribution of characteristics in the survey, while undesirable, should have minimal to moderate impact on the generalizability of the results. Given that the study took place in a specific location, these results should be generalized with caution when it comes to demographic characteristics. However, we suspect that similar classes of consumers would be found at the U.S level.

When collecting self-reported details about food and food-related behaviors such as shopping habits, amounts of food that potentially goes to waste in the household and so on, there may be information bias, and more particularly recall bias (Tarrant et al., 1993; Hassan, 2006). This may arise from respondents imperfectly remembering events and activities from the past. To reduce this type of bias, questions were carefully pre-tested and worded to ensure that respondents were able to recollect the intended events as accurately as possible. Pre-testing aimed to reduce cognitive issues related to wording of questions and aid understanding (Bertrand and Mullainathan, 2001). Further, respondents were allowed plenty of time to reflect and think through the questions as they answered. Measures such as cooking skills and shopping routines are frequent enough that respondents do not have to think too far back in time which should also minimize recall biases.

There is a worry that respondents may misreport or misrepresent measures such as amounts of food discarded in the household which would be a form of measurement error (Bertrand and Mullainathan, 2001). For instance, people may understate their amounts of food discarded if they place social value on that tendency. Overall, we expect that this should bias these self-reported amounts of food discarded downwards for all respondents.

3.6. Discussion and conclusions

We use an interactive survey fielded at the Minnesota State fair to collect individual responses on how they view food items are fit for consumption. Through this elicitation from a carefully-designed conjoint task, we simulate food handling decisions at home and obtain a proxy for how much of the products the respondents are likely to consume and by inference, discard. We posit that behaviors captured in these hypothetical scenarios are indicative of food waste decisions at the household level. We vary the product profiles for ground beef and bagged spinach in the study by five attributes level including the price of product purchased, size (large or small), expiration date type (best by, best if used by, use by), days to expiration, and a categorical variable measuring the level of cosmetic deterioration (appearance level).

Further, we measure the extent to which underlying risk preferences and risk perception may be associated with food waste propensities. We thus collect key details on household food-related routines, risk preferences, and risk perceptions. We have 333 subjects in the full sample measuring the roles of product attributes and demographics and 283 subjects in the sample examining the effects of risk preferences and perceptions.

A latent class analysis of the respondents' food and food-related routines and behaviors showed that they fell into two quite stereotypical subgroups. Fifty-seven percent of the respondents were in the *Planners* class which was characterized by people who reported having strong pre-shopping planning routines and disciplined in-store behavior. For example, they are people who make a shopping list, check their kitchen inventories and stick to their list when in store. These people have higher tendencies to recycle and compost.

In terms of food management and cooking skills, they report being quite savvy in the kitchen. They are aware of what foods need to be eaten first, are good about avoiding food getting spoiled when preparing meals and have good knowledge about storing and packaging their food products. The individuals identify many reasons why food go to waste in their household, for example, they buy or prepare too much, but compared to the other class, they report throwing out less amount of food. The respondents in the second class making up the remaining 43% of the sample were vastly different. *Extemporaneous Consumers* tend to have poor meal planning routines and are more likely, for instance, to buy products on an impulse in the store. They report being poor cooks and struggle with food management in the kitchen. Compared to their counterparts, they also recycle or compost less regularly.

Our regression models showed that even though food products are merely cosmetically deteriorated and remain edible, consumers were still likely to reject foods that had flawed appearance. *Planners* were likely to reject a modest amount of bagged spinach and *Extemporaneous Consumers* just slightly more. However, respondents were quite sensitive to cosmetic deterioration when it came to ground beef. *Extemporaneous consumers* were likely to discard over a quarter of ground beef bought. This may signal higher risks associated with ground beef compared to bagged spinach.

Factoring in risk preferences and risk perception provides a few more insights. Particularly, there is strong evidence for the effect of self-reported risk perception as they relate to food cosmetic appearance and date labeling for all respondents, but especially for *Extemporaneous Consumers*. For example, individuals in this class who reported higher levels of perceived risk were apt to reject about 10 percentage points more of the food products. Given the evidence of the role of risk perceptions, it may be valuable to provide consumers with information about risk related to food. Especially, consumer education related to the edibility of food with cosmetic defects or nearing expiration dates may be valuable. For *Planners*, the role of risk preferences stands out. Generally, *Planners* who are more risk averse tend to have the propensity to waste similar amounts of food products, irrespective of their risk perceptions.

Thus, it may be more difficult to nudge these individuals through changing their risk perceptions. However, there are major variations in food waste tendencies for risk loving individuals. Those who have higher perceived risks are more likely to discard food products. There may be gains targeting these individuals to change their risk perceptions through policy. The caveat remains that underlying risk preferences are not easily observed characteristics, which would make targeting problematic.

The results highlight the gains from incorporating constructs such as risk preferences and risk perceptions to explain food-related behaviors and especially food waste decisions. Besides evaluating the explanatory roles of direct product attributes and demographic characteristics, incorporating these underlying risk constructs may also be valuable. Given the importance of the direct product attributes such as appearance level as well as risk tendencies, policy makers may employ efforts to nudge behavior. Especially, there are gains from informing consumers about edibility of food given cosmetic deterioration to decrease perceived risks and mitigate food waste propensities.

Chapter 4. Role of Information in Household Source Separation: Evidence from a Curbside Organics Recycling Simulation

4.1. Introduction

Food waste is an issue that embeds significant economic, social, and environmental consequences, imposing a profound burden on the food system. With alarming figures estimating that more than one third of what is produced for human consumption goes uneaten (ReFED, 2016; Gustavsson et al., 2011), various efforts to mitigate food waste have transpired across the nation. In addition to prevention and recovery strategies that curb the negative impacts of food waste, recycling presents an opportunity to convert environmentally harmful food waste materials into valuable economic resources such as animal feed, biogas, or compost (Galanakis, 2015; Kiran et al., 2014; EPA, 2016a). Bellemare et al. (2017) contended that the food not ending up in the landfill should not be regarded as food waste.

Although promoting and developing resources from organics recycling directly contribute toward mitigating food waste and loss, almost 95% of food waste is still landfilled or incinerated in the U.S. (EPA, 2016b), making it the largest category of disposed materials. Households currently account for the highest proportion of food discarded and landfilled in the U.S. (ReFED, 2016). There has been increasing interest among practitioners to reduce, re-use, and recycle discarded food throughout the supply chain. Recent statistics indicate over 5.1 million households have access to curbside collection of food scraps (Streeter & Pratt, 2017). This represents a doubling of residential organics recycling efforts since 2014 (Yepsen, 2015).

The success, efficacy and long-term sustainability of these discarded food recycling programs depend critically on households' commitment and source separating efforts. Yet, many questions remain regarding behavioral factors that impact food discarding and recycling efforts. For instance, food scrap collection programs would amass household food materials for additional processing. However, households need to comply to strict instructions on source separation to contribute effectively. For instance, major organics recycling programs throughout the nation are facing struggles in their efforts. In New York, an organics recycling program expansion was halted after the city was only able to gather 10.6% of the total organics disposed (Amira, 2018). Other cities are also facing high rates of organics in the regular trash in spite of offering organics recycling services. Another issue is that of contamination when non-organic materials get mixed in the composting stream making conversion problematic.

It also remains a question whether the availability and presence of organics recycling programs would deter individuals in their food waste reduction efforts. According to a recent experiment in a dine-out situation, knowledge of food discard recycling seemed to undermine personal food waste reduction (Qi & Roe, 2016). Specifically, diners who received information on the negative effects of landfilling produced significantly less amounts of food waste compared to the control group that received no information. However, those who were also told that their food will be composted generated significantly higher levels of food waste than those with the food waste reduction information only. The authors labeled this occurrence as an "information rebound effect." Whether or not a similar effect is likely for individuals at home is unknown and addressed in this study.

The overall objective of this study is to examine households' food waste generation and discarding behaviors. To this end, this study combines consumer surveys and a waste sort in a randomized control trial setting that simulates a local curbside collection program. The research team partnered with Ramsey County, the City of Maplewood, and Republic Hauling Services to conduct this study with following specific set of objectives. First, we examine the changes in households' food scraps discard in terms of quantity and quality, in response to different levels of information about use of their food scraps. We also aim to determine whether "information rebound effect" is a problem that deters food waste reduction efforts at the household level. Finally, we identify socioeconomic, cultural, behavioral, and attitudinal factors on food discarding and recycling tendencies.

In collaboration with organics recycling professionals and scientists, awareness and training informational videos tailored for each study group were developed and used as a primary method to deliver the information to the households. Households were also provided supplementary reading materials as well. The project took place in Ramsey County, Minnesota in the City of Maplewood. This city was chosen because of various reasons. First, its proximity to the Ramsey County head offices minimized transportation of study-related materials to participants. Second, the Environment/Code Specialist at the City of Maplewood showed enthusiasm to participate in the study and offer advice. Third, the hauling company for the neighborhood (Republic Services) also showed willingness to participate in the study by providing their services in exchange of remuneration. In sum, the location choice facilitated the implementation and management of the study.

Treatment interventions educated households on how their food scraps would be used or recycled and provided instructions on source separation efforts needed for composting. All materials (trash, food, other organics) with the exception of recycling were picked up from all households. The materials were all identified through a unique number assigned to individual households. Further, we simulated an organics collection program to collect materials from treatment households. A total of 124 resident households were recruited by community partners to participate in a 6-week food scrap curbside pickup program and assigned to treatment or control status randomly. Of this recruited group, 121 households completed all study components and are hence included in this study. Week one was a trial period and is omitted from analysis.

The results show that differential information in the treatment groups did not impact compliance to source separation efforts. Levels of contamination remained similar across the treatment groups irrespective of the depth of information they received. However, we find evidence of a "rebound effect" where those who did not compost (control group) discarded lower amounts of food waste weekly compared to the households who recycled. Recognizing that their organics material will be recycled and productively reused, treatment households may have experienced a reduced moral burden and become laxer in their food waste prevention activities at home, resulting in increased food waste generation.

In this paper, Section 4.2 provides a brief background on food waste and organics recycling in the United States. We elaborate on the recruitment procedures in Section 4.3 and the study procedures in Section 4.4. Section 4.5 outlines the empirical model. We present some descriptive results in Section 4.6 and the regression results in 4.7. Section 4.8 concludes the essay.

4.2. Background

Wasted food includes opportunity costs of scarce resources used to produce the food and unprecedented amounts of methane emissions generated from accumulated food in landfills. Current policy objectives mainly aim at reducing overall amounts of food discarded through prevention measures (Schneider, 2013). Food waste, because of its complex biological composition, poses both challenges and opportunities for efficient re-use and valuation. The nutrient content in food waste makes it a potentially good animal feed (Westendorf, 2000). Given the high-moisture content and physical structure of food waste, composting is yet another possibility for resource efficiency (Chang and Hsu, 2008). An estimated 1.94 million tons of postconsumer food was diverted through composting in 2014 (EPA, 2015). Composting technologies vary in sophistication and have been widely researched and applied (Lemus and Lau, 2002; Seo et al., 2004; Chang, Tsai, and Wu, 2006).

Mounting landfill costs make composting a promising and economically sustainable food waste diversion solution; however, current inefficiencies in hauling and collection as well as lack of adequate infrastructure pose challenges to realize higher composting potential (ReFED, 2016). Other technological advances in digestion and fermentation processes allow food waste to be converted into biogas, hydrogen, ethanol, and biodiesel, as well as other key renewable energy sources as final products with improved valorization (Kiran et al., 2014). The manufacturing, retail, wholesale and restaurant industries combined process less than 5% of their food waste through anaerobic digestion (AD) which yields biogas for energy (EPA, 2015). Thus, conversions of food scraps into animal feed, incineration, fertilizer and composting, biogas energy, and other reusable by-products have been identified as potential approaches to capture valuable compounds (Galanakis, 2015).

As research exploring utilization of household food scraps is sought, behavior of food scraps recycling remains little understood. Mainly, it is unknown whether or not the same factors, identified in the literature, are at play in food scraps discarding as it relates to its recycling. These questions have been extensively researched on non-organic recyclables such as plastic or paper. For instance, Berger (1997) found that the size of residential area, type of housing, education, and income were significant determinants of whether recycling services were utilized. In a national survey of over 2,000 households, Saphores and Nixon (2014) found that the most important determinants of household recycling were people's attitudes. There was less evidence for the role of socio-economic variables, but knowledge and moral norms were found to be important predictors of recycling. Other studies highlight factors such as information, habits or perceptions (Thomas and Sharp, 2013; Schultz, Oskamp, and Mainieri, 1995). Whether the same motivations are at play in food scraps discarding and recycling is an inquiry with increasing significance as more communities move towards waste reduction and diversion strategies, including organics drop-off or curbside pickup programs for consumers.

Experiments, while imperfect, are suitable to address public policy issues. RCT's have been historically used to determine the impact of nudges on consumer behavior. For instance, in a UK-based study, feedback postcard cards with smiley or frown faces, were sent to households in treatment groups informing them on their performance on food waste recycling compared to the average in their neighborhoods (John et al., 2013). They found that households in the treatment groups raised their recycling rates by 3 percentage points compared to the control groups with no feedback in the short-run. Timlett and Williams (2008) also encouraged recycling through feedback and found less contamination from non-targeted materials in recyclables in treated households.

It has however been argued that interventions based on what others are doing may not be as sustainable as those based on personal involvement and self-identity (Castro et al., 2009). There may be gains from using strategies, such as providing information, that would encourage behavioral change at a personal level (Dilling and Lemos, 2011; Lee et al., 2015). However, simply giving information and environmental appeals may really not be effective interventions to promote pro-environmental consumer behavior (Fernandes and Schubert, 2016). Instead, message framing, incentivizing, removing barriers and structurally facilitating pro-environmental activities have been recognized as effective solutions to drive behavioral change (Frederiks, Stenner, and Hobman, 2015; Fernandes and Schubert, 2016).

Given the behavioral nature of household recycling, it is no surprise that various FW mitigation efforts in other countries have framed the waste issue as an economic resource opportunity (Stenmarck et al., 2016). Early efforts in Canada addressing the overall solid waste problem emphasized the critical need to frame the issue as an economic resource opportunity versus a landfill crisis or public health threat (Wagner, 2007). A paradigm shift in their waste management strategies showed that certain efficiencies and economies of scale could be realized through collaborative efforts at regional levels. There is reason to believe that from a behavioral standpoint, households are likely to act differently based on their perception of how their FW will be utilized in the downstream processes. In the US, the plateauing trend in non-organic recycling and decreased compliance in organics recycling (Yepsen, 2015) may be due to households being uninformed of the economic value of their contribution to a sustainable food and environmental system.

This study contributes to the literature by clarifying the missing connection between household food discarding and recycling behaviors, and the role that policy nudges may play in mitigating the problem. Findings from the study have the capacity to offer a critical understanding of household responses to messaging around recycling and inform interventions to ensure both successful food waste prevention and recycling outcomes from a policy perspective.

4.3. Recruitment

Recruitment was conducted in three separate waves and was approved by the Institutional Review Board at the University of Minnesota. Table 4-1 provides a summary of the recruitment phases. A first set of invitations were sent to 770 households residing in the 55109-zipcode neighborhood in the City of Maplewood. These invitations were sent out in early June and were followed by reminders and post card mailings. A total of 63 households responded to the first sets of invitations. A second round of recruitment was conducted door-to-door in July targeting a second separate set of households (700 households). From these rounds, a total of 140 households responded to the invitation and 108 were eligible to participate. Another round of invitations went out to another set of 700 households in early August via mail. From these separate rounds, a total of 193 households responded to the invitation and 144 total were eligible. Although 144 households indicated interest, a total of 126 participants completed consent forms online. Two people dropped out of the study for personal reasons. Another three households either did not complete the exit survey or send in their materials for sorting regularly, and were hence excluded from the study. Thus, a total of 121 households completed all components of the study.

Table 4-1. Summary of recruitment processes

Wave	Methods	Time period	Targeted *Not Cumulative*	Registered *Cumulative*	Eligible *Cumulative*
1	- Flyers (long form) [a] - Reminder flyers - Post card	June 2018	770	63	52
2	- Door to door - Post card	July 2018	700	140	108
3	- Flyers (shortened) [a] - Post card	August 2018	700	193	144
Summary			2,170	193	144
Final participation: 121 households [b]					

[a] *The long form flyer provided detailed information about the study, including the timeline, eligibility, and compensation. The shortened version provided a succinct amount of information on the study and provided a link that participants could access to find the full version of the flyer.*

[b] *Of the 144 eligible participants, 126 completed consent forms. A total of 121 completed all study components.*

A combination of flyers, postcards, and a door-to-door were used as recruitment methods to ensure adequate enrollment numbers and demographics. The literature has shown that door-to-door recruitment with flyers have higher success of recruiting a diverse population, decreasing distrust in research, as well as creating an opportunity for potential participants to ask pertinent questions if they have them (Williams et al., 2017; Willman, 2015; Perez et al., 2013; Ejiogu et al., 2011). We also posted the study details on the

NextDoor platform to inform households that the research team will be in their community during a period of time. Past studies at the University of Minnesota have used this platform to advertise studies and/or provide information on studies conducted in certain communities.

4.4. Study Procedures

Prior to the beginning of the study, participants had to complete an enrollment form online. Eligible participants were invited to join the study by completing a consent form online. To avoid any confounding effects, only households that did not currently participate in any private organics pick-up program or backyard composting were eligible. At the time of recruitment, in order to minimize bias, all subjects were told that the study is interested in examining their food discarding behavior.

The study required the corresponding member of the participating household to be at least 18 years old, be responsible for a significant portion of household related food decisions, and not be engaged in composting activities. These individuals were asked to complete a baseline survey, participate in the 6-week pilot as either control or treatment groups, and be willing to respond to a follow-up post-study exit survey at the end, for which they received $100 for their time and effort. While it is likely obvious from the amount of compensation, it was communicated to the households that the intent was not to pay them for putting out the food scraps or trash. The study timeline is summarized in Table 4-2. Recruitment materials and the baseline and post-study survey questionnaires are available upon request.

Table 4-2. Timeline of study procedures

Dates/Timeframe	Description of study procedures/activities
June – August 2018	<u>Recruitment period</u> This included the three waves of recruitment in collaboration with Ramsey County. Please see more details in Table 4-1 above. Households indicated interest by filling out a questionnaire online which also determined their eligibility to participate in the study.
August – Early September	<u>Consent Process</u> Eligible households completed a consent form to indicate whether they understood and accepted the terms of the study.
Week 1 of September	<u>Baseline Survey</u> An eligible representative from the participating household completed a **30-minute baseline survey**. Participants had 5 days to complete the survey which covered food-related topics such as their food shopping routines, time spent on selected activities at home, and food disposal tendencies, among others. The online survey was designed to be completed on a computer or tablet with Internet access.
Week 2 of September	<u>Intervention</u> Households were randomly assigned into treatment and control groups (see Table 4-3 for more information). After completing the baseline survey, household members watched a **5-6 minutes long informational video** on topics that relate to food waste and organics recycling (for treatment households). Participants had 5 days to view the video and complete a **short quiz**. The short quiz contained a few questions on the video they watched to make sure they understood the content. Research staff then dropped off necessary equipment/materials for the participants at their residence upon completion of watching the assigned video. Thus, participants were provided all the necessary items needed, such as trash liners, compostable bags (if applicable), and compost bins (if applicable) to dispose of their materials.
September 19^{th} – October 24^{th} *(6 weeks)*	<u>Collection of materials</u> For a period of 6 weeks, the participating household was asked to engage in certain **food handling and disposal activities at home**. This information was provided in the informational video.

Dates/Timeframe	Description of study procedures/activities
	Households were given instructions (via the informational video) on **how to dispose of their trash and organic materials at home over the course of the 6 weeks**. Their trash and organics was picked up by a licensed hauler identified by the research team and brought in for sorting at the University of Minnesota.
Early November	Final steps and Exit survey At the end of the 6th week, collection of trash/organic materials as part of the study ended. Households' regular garbage service resumed. The household representative completed a **post-study survey** that took an average of 5-10 minutes. Individuals had about one week to complete the post-study survey. Extensions were granted on case by case. After the post-study survey was completed, an **electronic payment card with $100** was mailed to households.

The households were randomly assigned to one of three groups: two (the experimental or treatment groups) received the intervention being tested, and the other (the comparison group) received only part of the intervention. Households were assigned a number using a random number generator. The first third was assigned to the first treatment group, the next third to the second treatment group, and the final third as the control group. Table 4-3 outlines the three groups in the study.

Table 4-3. Study group descriptions

Study Group	Description
Treatment Group 1	1) Received food waste information. 2) Obtained regular organics recycling information. 3) Saw some filler materials on the U of M. [a]
Treatment Group 2	1) Received food waste information. 2) Obtained information on organics recycling in a resource efficiency lens. 3) No filler information included.
Control Group	1) Received food waste information. 2) No information on organics recycling. [b] 3) Full filler materials on the U of M.

[a] *Filler information included details and facts about the University of Minnesota.*

[b] *The households were told that their materials will be picked up for waste characterization.*

One of the treatment groups obtained similar information to current municipal food scrap collection programs, which outline the basics of what can or cannot be recycled. The guideline for organic recycling for this study was adopted from those available from organizations such as the Penn State's Sustainability Institute and Hennepin County, Minnesota. The other treatment group received more detailed information defined in a resource efficiency framework, focusing on the environmental benefits from a resource recovery lens.

Treatment interventions educated households on how their food waste would be recycled and dictated source separation efforts for proper conversion into composting. Treatment households received instructions and information about food scrap recycling. To ensure that households understood that no action will be required on the participant's end to stop or resume their trash hauling, the information was communicated to them in the recruitment flyer, the consent process, and well via a specific email. Finally, all households received the same food waste reduction information at the beginning of the study.

The individuals in the control group were told that the study is only interested in sorting their materials and characterizing their organic materials. This is identical to other food waste characterization or composition studies that examine the types of food that are more likely to go uneaten. Control households thus receive no further information on recycling but to account for cognitive efforts for information processing, they were given “filler” information on the University of Minnesota. Participants in this group could discard their trash, food, and other organics in one single stream as usual.

All households were asked to view a 5-6 minutes long video designed to communicate the negative economic, environmental and social impact of throwing away food scraps. The videos were available privately by direct link and hosted on Youtube (Appendix D). The video included a quiz to confirm participants’ understanding of the video. Each group received a different quiz. The quiz took only about two minutes to complete. Individuals were allowed to complete this part only if they input all correct answers to the questions on the quiz. Hence, they were prompted to correct their answers if they got it wrong. Households could tune to the video prior to the beginning of the collection program.

This staging allowed us to identify and compare the behaviors linked to understanding the importance of food waste reduction as well as information on food scraps recycling into resources on the treatment households. We are able to isolate the impact of understanding the importance of food waste reduction only using data from the control group. This also allowed for the detection of any “rebound effect” on food waste reduction behaviors. Irrespective of what households were told, all organics obtained were weighed and eventually composted. It would not have been environmentally viable to landfill the organics for the control groups. Further, regular trash was disposed through a regular stream. While the sorting team aimed to separate all recyclable materials (unsoiled paper, cardboard, glass, metal), it was not set as a priority during the process due to time constraints. While we did not weigh them, the recyclable items made up a significant portion of disposed materials. Thus, a bulk of household trash consisted of recyclable materials that was not properly disposed through the regular recycling stream.

In the absence of this staging, households may have changed their behavior. That is, if they knew the nature of how their food scraps will be actually converted, they may have behaved differently. For instance, we needed households in the control groups to believe that their food scraps will be sent to the incinerator to mimic the status quo of what usually happens to food scraps in the absence of organics recycling. This helps evaluate behavior as close as possible to reality. This staging was harmless for both the participants and the environment. At the end of the study, a debrief statement was communicated to the households to inform them of the staging, what happened to the organic materials, and the study goals. We also shared the regular Ramsey County's website information on their organics drop off services in case households were interested in keeping participating in an organics recycling drop-off program.

Simulating a curbside pickup program, participating treatment households received two buckets (one kitchen-counter size and a larger one) and compostable bags with unique household identifiers. The buckets and compostable bags were dropped off at the residences by staff at Ramsey County at the beginning of the study. Households in these groups collected their food scraps and other organic materials in the kitchen counter bucket lined with the compostable bags; the second bucket (also lined with provided larger compostable and identified bags) was used to deposit the compostable bags as they got full. Households in the control group continued disposing of food scraps with regular trash in their trash can.

All households were asked to line their regular trash cart. This allowed us to identify the contents by household. On a weekly 'collection day,' all materials were picked up by the regular licensed hauler (Republic Services) on a dedicated route for the study. The hauler emptied the materials into their collection truck, securing the identified bags. The trash collected was brought to the University of Minnesota for sorting by staff.

The food scraps remained identified by household through the sorting process. The process was repeated for 6 weeks, allowing us to obtain (1) quantities and (2) qualities of food scraps by household. Table 4-4 provides a summary of the main outcomes of interest including other terminologies used in this study. Please see Appendix C for more detailed information and examples of these terminologies.

Table 4-4. Key variable definitions in the study

Variable/Terminology	Definition [a]
Edible food waste	These are food items that could be safely eaten and are intended for human consumption. Examples include cooked or uncooked meat, bread, fruits. and so on. Although some food items may have become rotten, wilted, or are spoiled, they are still included under "edible food waste" as they were once edible. [b]
Inedible food waste	Inedible food items are those that are conventionally not intended for human consumption. This includes egg shells, banana peels, bones, pits, herbs, and so on. Examples of inedible food could be radish leaves, cauliflower stalks, apple cores, and kale stems.
Total food waste	Total food waste is the sum of all edible and inedible food waste as defined above.
Other organics	"Other organics" includes food soiled paper, certified compostable items (plates, napkins, bowls), and other household compostable items such as coffee grounds, houseplants, certain tea bags, and nail clippings.
Total organics	Total organics is the sum of edible food waste, inedible food waste, and other organics as defined above.
Contamination [c]	Contamination (quantity) refers to the total weight of materials that cannot be viably composted which are included in the composting stream (mistakenly separated for organics recycling). This would comprise of, for example, yard waste, pet waste, Styrofoam or other recyclable items including cartons, glass, metal, paper, and plastic which are conventionally not compostable. In this study, this consisted of the total of non-organic materials that was disposed by the [treatment] households in the certified compostable bags that they were provided with.
Food/organics in liner [c]	This definition is specific to the study. It denotes the total amount of food and other organics that the [treatment] households disposed in their trash (lined with a liner) instead of recycling them in the compostable bags they were provided with.
Misclassification [c]	Misclassification rate is amount of contamination and food/organics in liner as a proportion of total materials disposed by the household. It is calculated as the sum of contamination and food/organics in liner, divided by the weight of total collected materials in the liner.

[a] *These definitions have been adapted from the Natural Resource Defense Council (Hoover, 2017).*
[b] *It should be noted however that a large proportion of the edible food in the study were unspoiled and seemed edible at the time of the sort. This includes fruits free of blemishes, unspoiled bread in packaging, or fresh vegetables free of imperfections.*
[c] *These variables/terminologies are applicable for treatment households only.*

4.5. Empirical Strategy

Let y_{Rit} denote the amount of discarded materials, measured in pounds, recycled by household i at time t. For discarded materials, we consider (i) the total amounts of food waste generated (*total food waste*), (ii) the total edible amounts of food waste (*edible food waste*), and (iii) the total organic materials generated (*total organics*). These are our main dependent variables of interest. Thus, as a first step, we consider the differences in the generation of these materials across the different study groups. We estimate these effects using the following specification for each week and all weeks combined:

(1) $$y_{Rit} = \beta_0 + \beta_1 T1_{it} + \beta_2 T2_{it} + \sum_{k=1}^{K} \delta_k X_{it} + \epsilon_{it}$$

$T1_{it}$ is a dummy variable indicating that the household is in Treatment Group 1 and $T2_{it}$ indicates that the household is in Treatment Group 2. X_{it} consists of household or individual characteristics such as age, income, education level, gender, presence of children, household size, number of meals eaten at home, hours worked, environmental beliefs, and other food-related attributes. These attributes include, for instance, the respondents' efficiency in food preparation or meal planning which may impact amounts of food waste generated.

Second, let y_{Cit} be quantities or the percentage of materials deemed inappropriate for downstream processing for composting or misclassified as compostable. We run a similar model as above:

(2) $$y_{Cit} = \alpha_0 + \alpha_1 INFO_{it} + \sum_{k=1}^{K} M_k X_{it} + \mu_{it}$$

Thus, we first we look at the amount of contamination in the biobags (c*ontamination*). Then, we also consider the amounts of food that got disposed in the trash instead of being composted (*food/organics in liner*). Finally, we examine the percentage of organics materials either disposed with the trash or contaminations set out in the compost stream (*misclassification*). Let $INFO_{it}$ represent dummy variable equal 1 for those in Treatment Group 2 and 0 for those in Treatment Group 1.

4.6. Descriptive Results

4.6.1. Demographic description of participants

Table 4-5 shows the demographic distribution of the corresponding individuals from the participating households.

Table 4-5. Demographic characteristics of study participants compared to the U.S

Demographics	Sample	U.S Census [a]
Race (%) [b]		
Asian	2.5	5.8
Black or African American	1.4	13.4
Hispanic	0.9	18.1
White	90.8	60.7
Other	4.4	2.0
Gender (%)		
Male	28.9	48.7
Female or other	71.1	51.3
Educational attainment (%)		
Less than Bachelor's or Associate's	22.3	52
Associate's degree	9.9	25.1
Bachelor's degree	40.5	14.5
Master's degree or higher	27.3	8.8
Age (%)		
18-24	n/a	12.2
25-34	19.0	17.8
35-44	16.5	16.3
45-54	20.7	16.8
55-64	23.1	16.7
65 or above	20.6	20.1

Demographics	Sample	U.S Census [a]
Mean income ($)	121,379.5	81,283
Household size	2.9	2.6
N	121	

[a] *U.S data from Census Bureau and the American Community Survey 2017-2018. Statistics reported are for population 18 and over, not total population.*

[b] *The remaining analysis in this paper combines the households in "White" and "Non-White" groups due to small cells in the different race groups.*

The demographic distribution varies from that of the United States. For instance, we have a larger representation of White households and an underrepresentation of all other races including Asian, Black or African American, Hispanic, or other. We also have more females in the study, comprising almost 71% of the sample. The sample is more educated compared to national averages. For example, about 27.3% hold a Master's degree or higher, while only under 9% do in the U.S. There are no corresponding individuals aged between 18-24. Otherwise, age distribution is fairly similar to the U.S with a slight overrepresentation in the 55-64 age group. The average household income is also about $121,000 while the mean household income in the U.S is consequentially less around $81,000 in 2018. The average household size in the sample is 2.9 which is slightly higher than the U.S average of 2.6.

4.6.2. Participation in curbside collection

About 77.7% of the households sent in their materials all five weeks. Just under 15% sent in their materials four times during the study. Another nine households (7.4%) sent in their materials three times and only one household did twice. There are various reasons for a household not being able to send in their materials all weeks including travel, being absent from their home in a given week, or not producing enough trash/materials to put out. Finally, randomly, a few households' materials went unidentified when the trash bag tore during hauling. About one to five of these cases happened weekly.

Table 4-6 shows the number of materials we received over the 5-week period. Note that we received 105 bagged materials in week 1 which is not included in the analysis. In any given week, we received a maximum of 115 bagged materials and a minimum of 111 bags (in week 6). The average participation over the course of the study was 94.3%. Average participation amongst treated groups was about 95% and amongst control households was almost 91%.

Table 4-6. Participation counts and rates by week [a]

Week	Number of households who sent their materials [b]	Treatment Groups [c]	Control Group [d]
2	113	78	35
	(93.4%)	(94.0%)	(92.1%)
3	113	76	37
	(93.4%)	(91.6%)	(97.4%)
4	115	79	36
	(95.0%)	(95.2%)	(94.7%)
5	115	81	34
	(95.0%)	(97.6%)	(89.5%)
6	111	76	35
	(91.7%)	(91.6%)	(92.1%)
All weeks	567 bags received in total (94.3%)		

[a] *Week 1 is omitted from analysis*

[b] *The maximum number of materials that could be received per week was 121.*

[c] *Total number of treatment households was 83.*

[d] *Total number of control households was 38.*

4.6.3. Materials sorted

During the five weeks, a total of 11,879 lbs. of materials was sorted. Table 4-7 shows the total of materials sorted by category in all groups. For instance, a total of almost 2,560 lbs. of materials was processed in week 4. This represents the upper end of materials processed compared to about 2,272 lbs. sorted in week 2. This table does not break down the totals by the different groups in the study. A total of 2,783.7 lbs. of materials were recovered from the biobags over the course of the study. Contamination made up about 4.8% of weight of the materials with a maximum of 6.5% in week 4 and a minimum of 3.2% in week 3. Note that there was one instance of non-identifiable materials present in the biobags (7.4 lbs. in week 2) which is omitted from the tables.

Table 4-7. Materials (in lbs.) processed by week

Full liner -including biobags- (567 bags)					
Week	Liner	Edible	Inedible	Other organics	
2	2,272.5	132.6	74.6	115.9	
3	2,310.2	138.2	66.1	113.0	
4	2,559.7	169.3	84.0	116.6	
5	2,396.8	113.7	65.5	106.1	
6	2,339.6	137.2	48.1	88.8	
Biobag details (378 bags)					
		Edible	Inedible	Other organics	Contamination
2		234.6	230.1	92.8	33.8 (5.7%)
3		269.8	217.0	81.4	18.9 (3.2%)
4		273.3	193.5	85.5	38.4 (6.5%)
5		245.4	199.5	86.0	27.7 (5.0%)
6		305.4	188.4	80.9	21.9 (3.7%)

Table 4-8 provides a breakdown of the materials in the main liner by category for the different groups, excluding biobags. It can be noted that although Treatment Groups 1 (194 bags) and 2 (196 bags) had access to organics recycling, a large amount of food and organics still was found in the regular trash. For instance, in week 4, households in the treatment group 1 had about 44.5 lbs. of edible food, 31.5 lbs. of inedible food, and about 25 lbs. other organics in their regular trash. Overall, of the 8,517.4 lbs. of materials generated by the treatment households, about 7.6% was food and organics. Figure 4-1 shows the trends visually. Control groups account for 177 bags total during the study period.

Table 4-8. Materials (in lbs.) by study groups by week in the main liner (excl. biobags)

	Groups	Liner weight	Edible food	Inedible food	Other organics
Week 2	Treatment 1	821.9	32.5	17.7	34.0
	Treatment 2	787.8	21.1	7.3	28.9
	Control	662.8	78.9	49.6	52.9
Week 3	Treatment 1	863.6	28.1	12.5	31.4
	Treatment 2	782.0	21.2	9.5	33.3
	Control	664.6	88.8	44.1	48.3
Week 4	Treatment 1	940.8	44.5	31.5	25.0
	Treatment 2	784.7	12.8	6.9	29.8
	Control	834.2	112.0	45.6	61.7
Week 5	Treatment 1	813.9	17.3	5.4	26.6
	Treatment 2	1,012.5	28.8	6.4	40.3
	Control	570.4	67.6	53.7	39.2
Week 6	Treatment 1	797.6	11.4	8.6	22.5
	Treatment 2	912.6	23.2	4.4	20.8
	Control	629.4	102.5	35.1	45.5

Figure 4-1. Materials (in lbs.) by study groups by week in the main liner (excl. biobags)

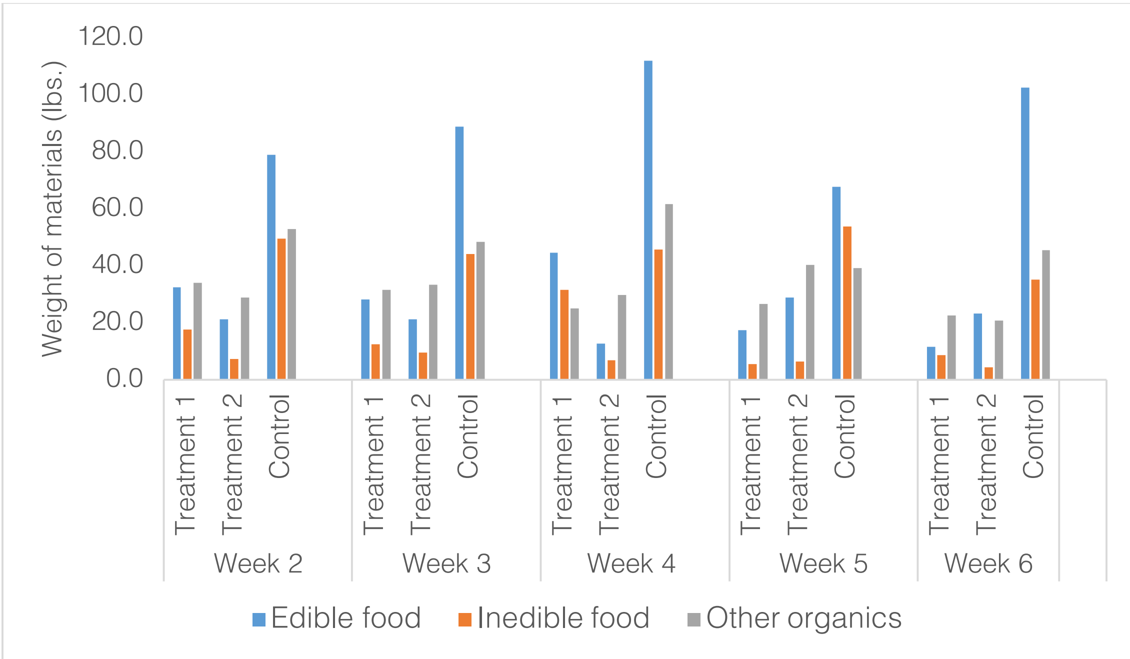


Table 4-9 displays the amount of materials for all the study groups. For the control group this includes the totals in the liner. For the Treatment Groups 1 and 2, this includes the totals from the liner and the biobags as well.

Table 4-9. Organic materials (in lbs.) by study group in liners and biobags

	Groups	Edible food	Inedible food	Other organics	Total organics
Week 2	Treatment 1	157.8	140.6	72.1	370.5
	Treatment 2	129.9	114.2	84.0	328.1
	Control	79.2	79.2	53.4	211.9
Week 3	Treatment 1	169.3	98.3	72.0	339.6
	Treatment 2	150.5	140.8	74.0	365.2
	Control	89.2	85.2	48.5	222.8

	Groups	Edible food	Inedible food	Other organics	Total organics
Week 4	Treatment 1	153.7	121.1	65.3	340.1
	Treatment 2	177.0	110.5	74.5	362.0
	Control	112.1	113.1	61.7	286.8
Week 5	Treatment 1	113.2	93.3	62.6	269.0
	Treatment 2	179.3	119.2	91.6	390.1
	Control	67.6	67.6	38.9	174.2
Week 6	Treatment 1	161.9	95.1	64.4	321.4
	Treatment 2	178.7	106.9	59.9	345.5
	Control	102.3	100.0	45.4	247.7

These totals represent 194 bags for Treatment Group 1 households, 196 bags for Treatment Group 2 households, and 177 bags for control households. The trend shows that the control group generated less total organics, and the same trend holds even when the amounts were adjusted for the number of bags received. Figures 4-2 and 4-3 display these trends visually. Figure 4-2 depicts the totals and Figure 4-3 show the totals adjusted for the number of bags received per group. It can be noted that, on average, control groups generated less organics (adjusted for number of bags). For instance, over the period of the study, Treatment 1 households sent in about 8.46 lbs. of organics per bag, Treatment 2 participants about 9.14 lbs./bag, and finally Control households about 6.46 lbs./bag.

Figure 4-2. Organic materials (in lbs.) by study group in liners and biobags

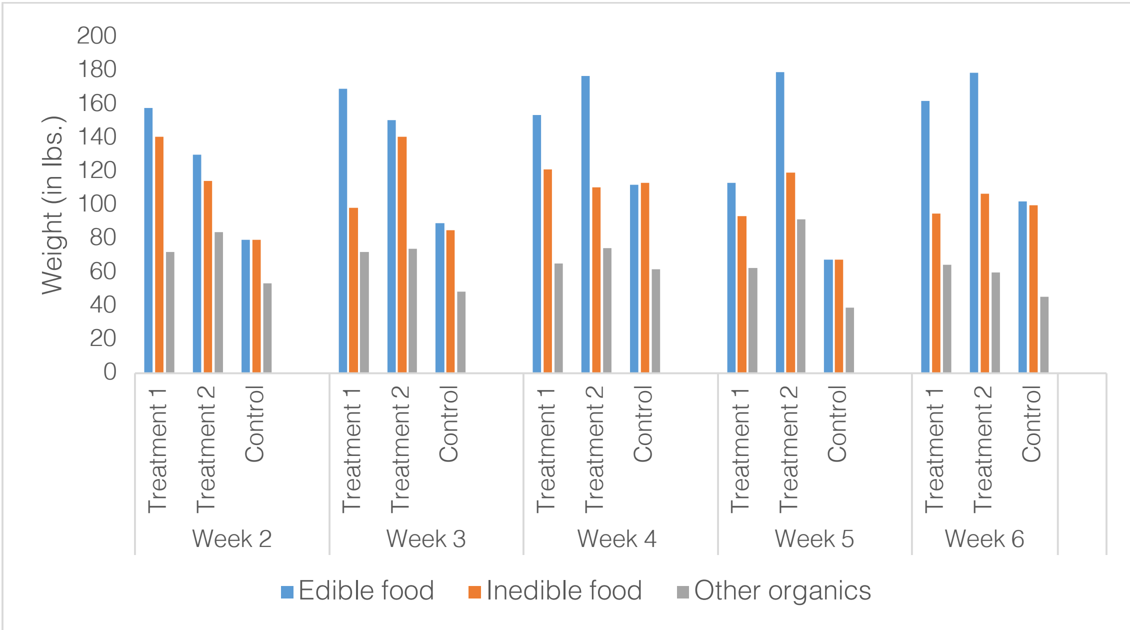
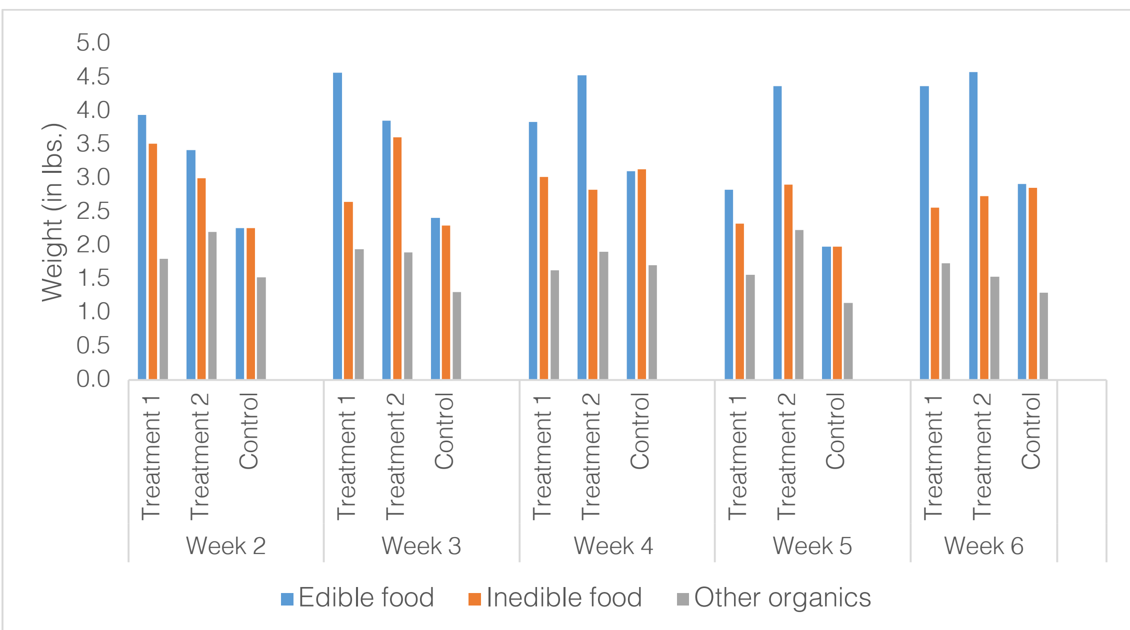


Figure 4-3. Average organic materials (in lbs.) per bag by study group in liners and biobags



Many of the biobags contained contaminants for the treatment groups. Recurring contaminants that were non-organic or non-compostable items included the following: plastic bags, aluminum foil, coupons, other plastic materials (containers, plates, cutlery), popcorn bags, to-go containers, cardboard, dryer lint, deli wrappers, fast food wrappers, boxed/lined containers (e.g., packaging for half and half or broth), plastic lids, regular recyclables, rubber bands, plastic teabags, waxed paper, K-cups, Ziplock bags, diapers, gum, and various other packaging materials. While the different types of contaminants were not weighed individually due to their nature (i.e., usually very light material), packaging involving "trapped organics" was a major occurrence. People discarded various foods in their packaging in their organic bins which had to be manually separated and weighed.

Households in Treatment 1 generated an average of 0.19 lbs. of contaminants per week (186 observations) whereas households in Treatment 2 generated an average of 0.53 lbs. per week (192 observations) over the course of the study. This difference of 0.33 lbs. is statistically different for the groups.[13] Note that most of this difference arises from a single household who generated a significant portion of contamination weekly. If this household is omitted, then the average for treatment households is 0.28 lbs. and the difference between the two groups became no longer significant.[14] In this analysis, we pay particular attention to this household since its behavior is not representative of the group. Specifically, it is possible that this household misunderstood the instruction provided on source separation. Overall, up to 85% of this household's disposed materials ended up in the biobags.

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[13] *The p-value of this difference is 0.0218.*
[14] *The p-value of this difference is 0.1691.*

Table 4-10 shows descriptive statistics on the main outcomes of interest in the study. For instance, on average households generated a total of 5.96 lbs. of food waste. Edible food waste made up on average 3.55 lbs. and the total amount of organic materials disposed averaged 7.66 lbs. Overall, control group discarded less of food waste, edible food waste, and total organics than their counterparts in the treatment groups. The Natural Resource Defense Council [NRDC] reports that households in their kitchen diary and bin dig study discarded about 7.5 to 9.6 lbs. of food waste per week (Hoover, 2017). Their numbers are higher than ours, but closer to the statistics of the treatment groups. Their reported edible food waste averaged 6.0 lbs. per week at the household level, which also exceeds the averages of any of the groups in this study.

Table 4-10. Descriptive statistics of outcome variables

(in lbs. unless otherwise specified)	All households (n = 121)				Control Group (n = 38)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Food waste	5.96	5	0	40.1	3.83	3.1	0	19.2
Edible food	3.55	4	0	27.5	2.54	2.8	0	18.5
Total organics	7.66	5.4	0	41.9	5.23	3.8	0	22.5
Contamination [a]	0.37	1.4	0	18.2				
Food in liner	1.64	2.7	0	23.9				
Misclassification [a]	10.3%	11.7%	0%	85.1%				

	Treatment Group 1 (n = 42)				Treatment Group 2 (n = 41)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Food waste	6.69	5.5	0	40.1	7.16	5.4	0	33.7
Edible food	3.88	4.4	0	27.5	4.15	4.4	0	22.6
Total organics	8.41	5.7	0	41.9	9.11	5.6	0	33.7
Contamination [a]	0.2	0.4	0	4.1	0.53	1.9	0	18.2
Food in liner	1.79	3.1	0	23.9	1.49	2.2	0	17.5
Misclassification [a]	10.1%	11.1%	0%	61.1%	10.5%	12.3%	0%	85.1%

a *These statistics only apply to the Treatment Groups.*

The EPA (2017) suggests that in 2015, U.S households generated and discarded a total of 39,730 tons of food waste. Accounting for 124.59 million households at that time, this statistic represents an average of 12.26 lbs. of food waste per week. Thus, these figures also exceed our data. Figures 4-4 through 4-7 show the distributions of the weekly amounts of food waste generated for the full sample and for respective study groups. As noted, in all cases the distribution is positively skewed with few observations on the higher side of the scale.

Figure 4-4. Distribution of total food waste generated per week (All participating households)

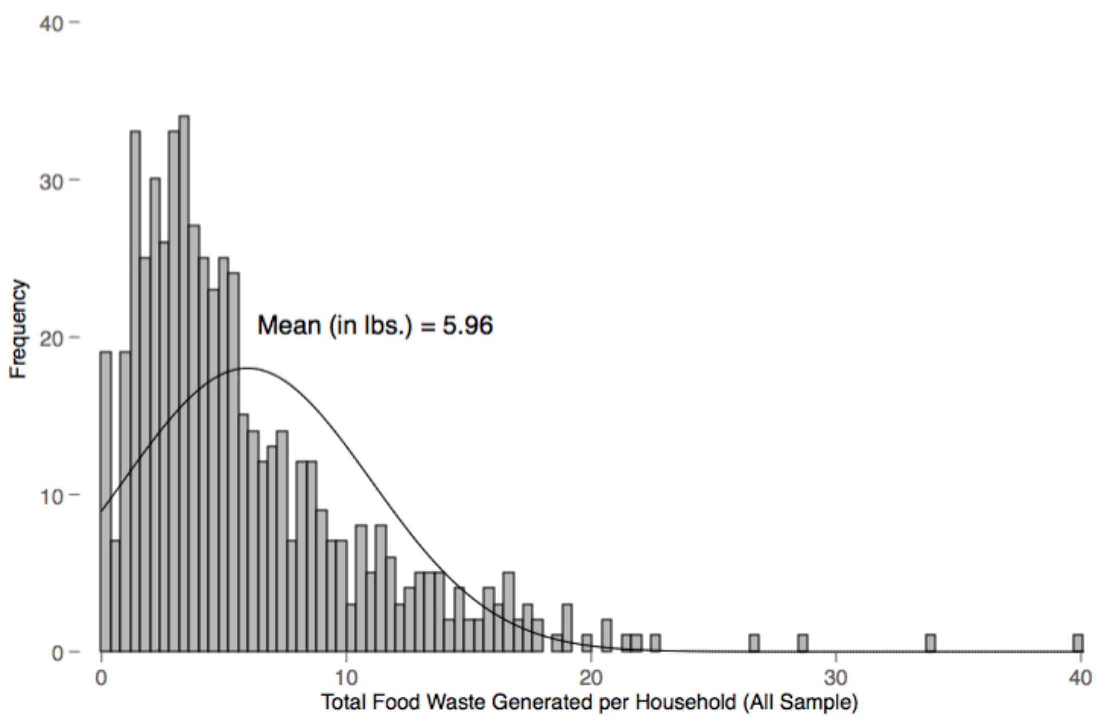


Figure 4-5. Distribution of total food waste generated per week (All Control households)

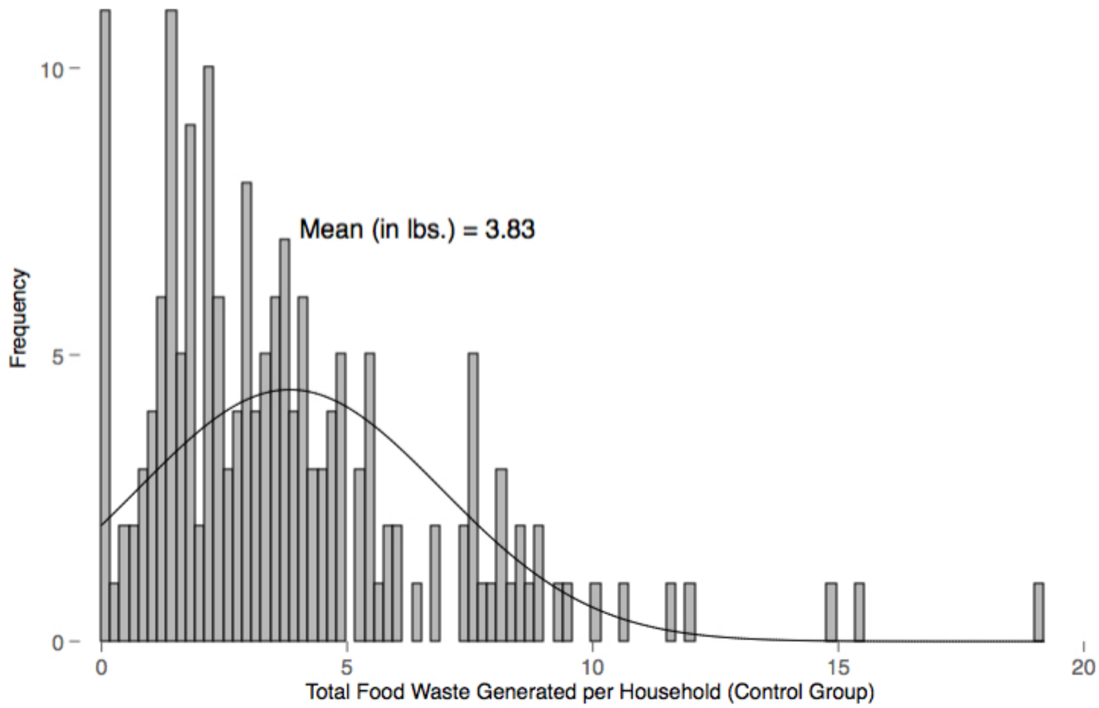


Figure 4-6. Distribution of total food waste generated per week (Treatment Group 1)

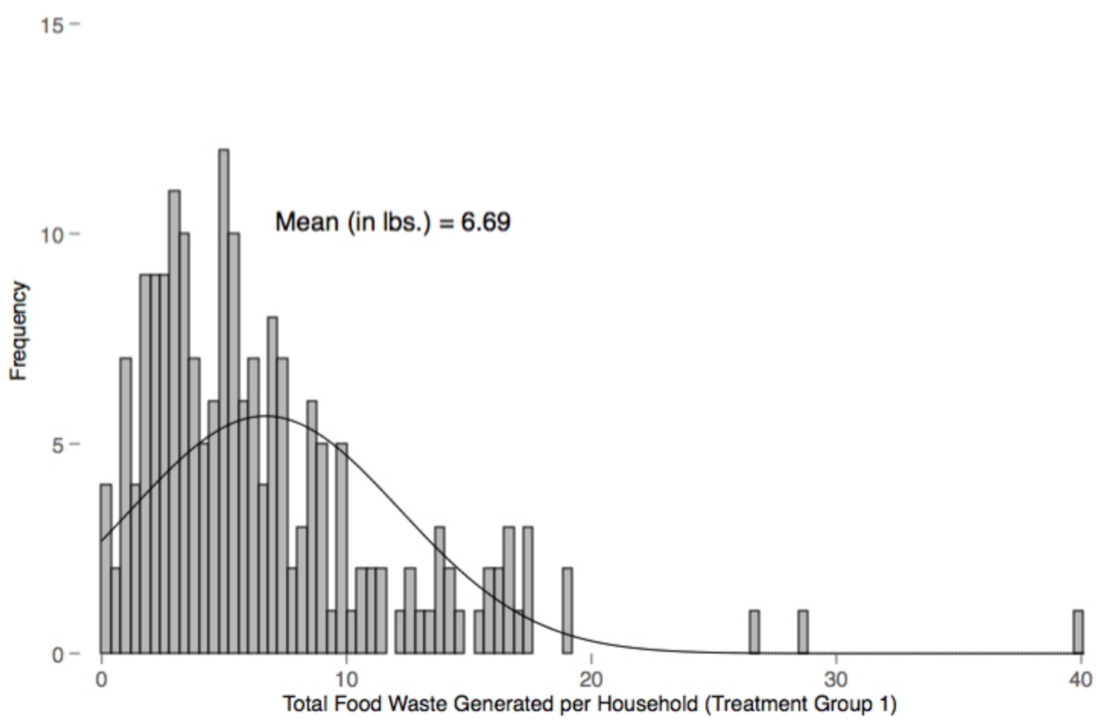
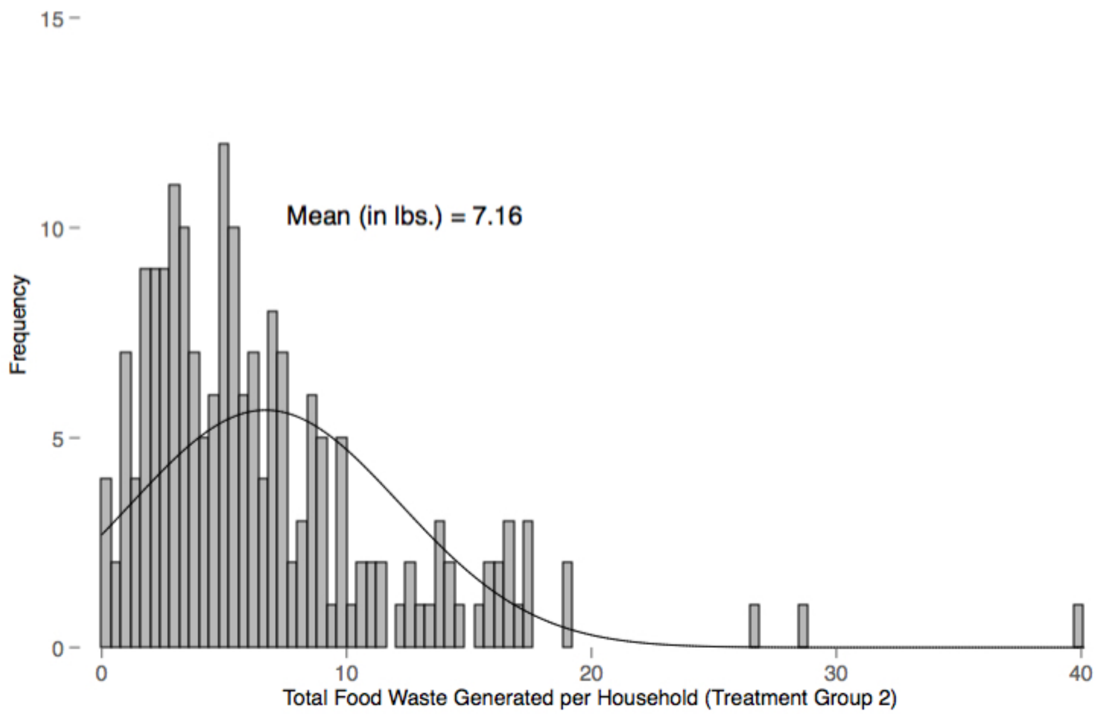


Figure 4-7. Distribution of total food waste generated per week (Treatment Group 2)



4.6.4. Willingness to participate

Prior to the collection of materials through the curbside collection, households reported willingness to participate in various efforts that could help (1) reduce their food waste at home and (2) improve their organic recycling outcomes should they participate in a program. Note that organics recycling is abbreviated as OREC and food waste reduction as FW. These questions were posed in the baseline survey prior to them watching the intervention videos. The questions were presented as follows respectively on a scale of 1 through 5 (1 = “Definitely Not” through 5 = “Definitely Yes”):

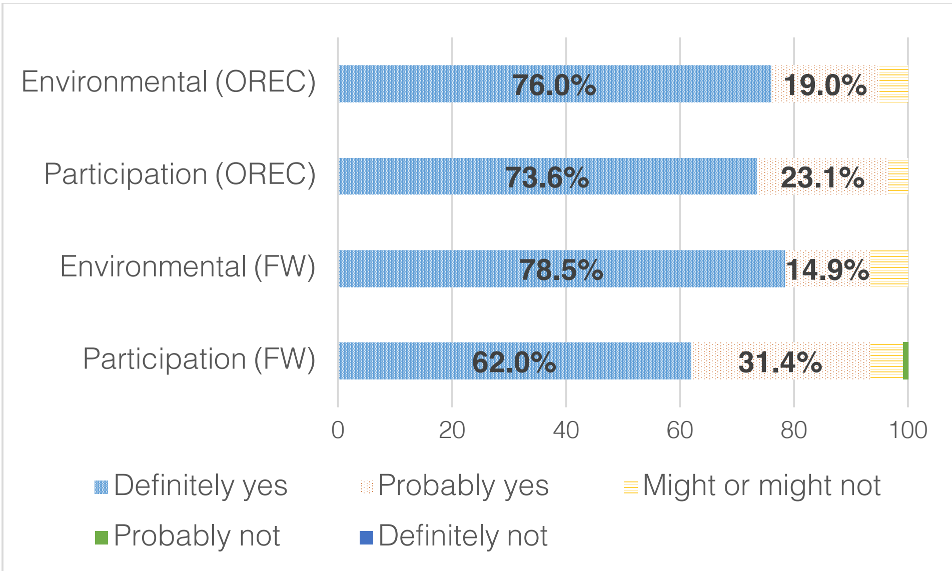
— [Participation (OREC)] Assume that your municipality arranges for food scraps and organics curbside collection and recycling. Food scraps recycling is voluntary and the service is free of charge. Would you consider participating?

— [Participation (FW)] Would you be willing to be engaged in household activities that would reduce the amounts of food waste (food that goes uneaten and is discarded) in your household?

After answering these questions, on the same answer scale, the household were asked to indicate whether they believed that food scraps and organics recycling [reducing the amount of food waste] contributes to a better environment.

The answers to these four questions are shown in Figure 4-8. As shown, in all cases, the majority of the respondents showed enthusiasm and willingness to reduce their food waste and/or participate in organic recycling activities should the municipality offer the service free of charge. For example, almost three out of four respondents (73%) reported that they would participate in an organics recycling program. Another 23.1% reported that they would probably participate. Three percent were undecided. On the 1 through 5 scale, the average response was 4.70. On this scale, the willingness to participate in food waste reduction activities was about 4.55. A similar trend can be noted when it comes to self-reporting of whether the respondent believed that participating in these activities contributes to a better environment. For instance, 76.0% of the sample strongly believed that being engaged in organics recycling would contribute to a better environment.

Figure 4-8. Willingness to participate and environmental perceptions



Notes: Abbreviation used: OREC (Organics recycling) | FW (Food waste reduction)
"Environmental" report the perception of whether the respondent thought the activities would contribute to a better environment.
"Participation" report the respondents' likelihood to participate in the given environmentally sustainable activities.

4.6.5. Other motivations and food habits

Other activities and routines may impact resulting food waste discarding or organics recycling behavior. This section outlines some of the main variables of interest that are included as part of the analysis. As shown in Table 4-11, the average frequency of meals consumed at home by adults is somewhere between daily and 4-6 times per week for adults. Generally, the sample reported above average efficiency in the kitchen with a mean score of 3.71 on a scale of 1 (Excellent) to 5 (Terrible). About half of the sample uses a garbage disposal with just under one-fifth of food scraps disposed through that method.

Table 4-11. Household routines and food-related variables

Variables	Mean	Std. Dev	Mean[1]	Std. Dev[1]
Frequency of meals eaten at home [1]				
Adults	3.34	0.77		
Children[2]	3.43	0.59		
Efficiency [3]				
Food planning and shopping	3.71	0.84		
Food prep, cooking, and disposal	3.65	0.83		
Garbage Disposal				
Usage [4]	0.58	0.49		
Amount disposed (%) [2,5]	27.98	25.89		

[1] *This question was posed as follows: In a typical week, how often do the following adults/children in your family eat meals prepared at home? [Answers: Daily (4), 4-6 times a week (3), 2-3 times a week (2), Once a week (1), never (0)]*

[2] *These items did not applicable to all respondents. For instance, households without children would not report a value for the frequency of meals eaten by children in their home. These statistics are computed for households that responded to the items.*

[3] *Respondents were asked: Rate how efficient you are with your time when doing the listed activities on a scale of 1 to 5 (Scale: Excellent (5) Good (4) Average (3) Poor (2) Terrible (1)]*

[4] *People responded to: Do you use a garbage disposal, usually installed in sinks, for discarding food scraps? [Yes = 1/No=0]*

[5] *This question gets at amount of food normally disposed through garbage disposal prior to the experiment. The question was asked as follows: Of the leftovers on your plates/pans discarded, typically how much is scraped in the garbage disposal? [Sliding scale between 100% (All) and 0 (Hardly Any)]*

4.7. Regression Results and Discussion

This section presents the main results of this analysis using OLS regressions. The sections separate the different types of materials discarded including total amounts of food waste, edible food waste, total organics materials, as well as contamination and misclassification levels.

4.7.1. Total food waste generated

Table 4-12 shows the regression results of the amount of food waste discarded (in total including the food disposed in the biobags) over the course of the 5 weeks.

Table 4-12. Total food waste discarded (in lbs.) over study period

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Control						
Treatment Group 1	3.64***	2.85***	2.32*	1.95**	2.51**	2.64***
	(1.19)	(0.97)	(1.35)	(0.95)	(1.24)	(0.50)
Treatment Group 2	2.82**	3.43***	2.36**	3.51***	2.57**	2.97***
	(1.14)	(1.20)	(1.14)	(1.09)	(1.22)	(0.50)
Age (Base: 25-34)						
35 - 44	-0.53	2.61	-0.36	0.49	-0.80	0.30
	(1.85)	(1.73)	(2.32)	(1.79)	(1.75)	(0.79)
45 - 54	0.44	3.76**	0.45	0.36	0.80	1.04
	(1.45)	(1.50)	(2.34)	(1.57)	(2.12)	(0.77)
55- 64	0.77	1.23	-1.65	-1.06	-2.55	-0.71
	(1.39)	(1.42)	(2.32)	(1.53)	(1.76)	(0.71)
65 and older	2.05	3.54**	-0.86	0.20	2.71	1.50*
	(1.70)	(1.58)	(2.32)	(1.69)	(2.10)	(0.80)
Education (Base: High School or less)						
Associate's Degree	-0.65	-1.77	-0.54	-1.76	-0.83	-1.02
	(1.67)	(1.53)	(1.86)	(1.21)	(1.59)	(0.64)
Bachelor's	-0.20	0.04	0.84	0.38	0.66	0.38
	(1.18)	(1.24)	(1.41)	(1.15)	(1.45)	(0.55)
Master's or more	-1.72	-0.92	-0.52	-1.26	0.03	-0.77
	(1.35)	(1.31)	(1.36)	(1.22)	(1.47)	(0.58)
Female	-0.76	0.72	-0.23	-1.18	0.44	-0.20
	(0.95)	(1.06)	(1.13)	(0.95)	(1.61)	(0.52)
White	-2.74	-3.27	-1.26	-0.30	-3.18	-2.18**
	(2.02)	(2.05)	(2.47)	(1.87)	(2.10)	(0.92)
Income	0.00	-0.00	-0.00	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	0.85	0.85*	1.15	0.74	0.63	0.84***
	(0.63)	(0.46)	(0.79)	(0.61)	(0.61)	(0.27)
Children present	6.20	3.94	3.86	-2.31	0.46	2.27
	(6.21)	(5.53)	(7.32)	(4.36)	(5.53)	(2.56)
Meals at home (adults)	0.24	0.27	-0.55	0.29	-0.19	-0.04
	(0.60)	(0.65)	(0.82)	(0.69)	(0.81)	(0.32)
Meals at home (children)	-1.40	-0.94	-1.12	0.67	-0.70	-0.65
	(1.62)	(1.52)	(1.87)	(1.23)	(1.53)	(0.68)
Household work hours	0.02	0.03**	0.02	-0.01	0.02	0.02***

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Efficient in planning	-0.18	-0.39	0.35	-1.02	-1.48	-0.52
	(0.75)	(0.83)	(1.09)	(0.87)	(0.90)	(0.38)
Efficient at food prep	0.48	0.29	0.25	1.29	1.52	0.79**
	(0.87)	(0.75)	(1.01)	(0.92)	(0.96)	(0.38)
Engaged in FW efforts	-1.47	-0.76	0.50	-0.06	0.42	-0.23
	(0.90)	(0.72)	(1.35)	(0.61)	(0.70)	(0.41)
Engaged in OREC efforts	1.60*	1.06	-0.53	0.85	1.24	0.84**
	(0.86)	(0.93)	(1.13)	(0.87)	(1.14)	(0.42)
Environmental beliefs						
FW	-1.15	0.78	0.77	0.52	0.11	0.23
	(1.46)	(1.05)	(2.09)	(1.25)	(1.44)	(0.67)
OREC	1.11	-0.42	-0.14	-1.20	-0.14	-0.20
	(1.41)	(1.16)	(2.11)	(1.38)	(1.77)	(0.70)
Garbage disposal						
Usage (Yes)	0.81	0.48	-0.33	2.07*	2.53	1.05*
	(1.10)	(1.24)	(1.44)	(1.19)	(1.52)	(0.55)
Amounts disposed	-0.00	-0.02	0.01	-0.03	-0.07**	-0.02*
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.01)
Constant	-0.76	-2.34	-0.13	-0.60	-3.80	-1.45
	(5.12)	(6.51)	(9.35)	(5.96)	(7.76)	(3.05)
N	113	113	115	115	111	567

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

It is noted that the coefficients on the treatment indicators are all positive and significant. This implies that treatment households generated more food waste on average compared to the control households. This is in accordance to the “rebound effect” hypothesis, which postulated that households who recycled would have the tendency to generate more food waste since they knew their materials would be composted. On average, treatment households in Treatment Group 1 generated 2.6 lbs. of food waste more than control groups and households in Treatment Group 2, just about 3.0 lbs. of food waste more. This trend is sustained in respective weeks as well.

Socio-demographic variables, environmental beliefs, as well as food-related household habits were generally not associated with levels of food waste generated at the household level with a few exceptions. Noteworthy correlations to the levels of food waste include age, race, household size, self-reported efficiency in the kitchen, and willingness to engage in recycling efforts. For instance, those who are 65 and older produced about 1.5 lbs. more food waste per week than their younger counterparts aged 25-34 over the course of the study. Households who identified as "White" produced on average 2.18 lbs. less food waste than their non-white counterparts. Larger households produced more food waste, all else equal. For instance, an additional household member is associated with 0.84 lbs. more food waste per week over the course of the study.

Surprisingly, those who stated that they are more efficient at food preparation generally discarded about 0.79 lbs. more food waste, all else constant. It is possible that those who report being more efficient are also faster in the kitchen, hence resulting in higher waste while preparing food. Respondents who reported higher willingness to participate in food scraps and organics curbside collection (Engaged in OREC efforts) generated more food waste as well. Usage of a garbage disposal was also associated with 1.05 lbs. more of food waste generated over the course of the study. We note some very small significant effects on hours worked and self-reported amounts of food disposed through garbage disposal. For instance, a one-unit increase in hours worked is associated with about 0.02 lbs. of more food waste generated

While the study only lasted 5 weeks, one inquiry relates to whether food waste behavior changed over the course of the period. There is reason to believe that households may be more engaged at the beginning and as weeks go by, their potential "actual" behavior may be revealed as the novelty of the study fades. However, further inquiry into the weekly amount of food waste generated did not reveal any glaring or clear changes in discarding behavior over the study period.[15] This could imply two possible things. First, it may be that the study period is too short to capture any stabilizing behavior after the novelty of the food waste reduction/recycling activities have set in. On the other hand, it is likely that the behavior noted during the study is representative of actual steady behavior should the

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[15] *This exercise included testing whether there were significant differences in the amounts of food waste generated across the study groups over the individual weeks.*

program have been implemented in the long run. It is difficult to hypothesize which is more probable in this case.

4.7.2. Edible food waste generated

Table 4-13 shows the results of the amount of edible food waste generated over the course of the study. On average, Treatment Group 1 generated about 3.88 lbs. of edible food waste, Treatment Group 2 about 4.17 lbs., and finally the Control Group about 2.54 lbs. From the regression results, it can be noted that both treatment groups generated about 1 lbs. of food waste more than their control counterparts over the course of the study, with households in Treatment Group 1 generating slightly more, on average. However, the differences are not significant in all weeks. For instance, mostly weeks 2 and 5 are driving these findings. During weeks 3, 4, and 6, the amount of edible food waste generated was not significantly different across the groups.

In this case, in terms of socio-demographic characteristics, we find some differences across age group, education, race, household size, presence of children, meal eating habits, garbage disposal usage, and efficiency in the food planning and shopping. Particularly, those who are aged 55-64 overall produced less edible food waste than the younger counterparts aged 25-34. Compared to those with a high school degree, people who held an Associate's degree were likely to generated about 1.16 lbs. less food waste during the study. Individuals who identified as White generated about 1.97 lbs. less food waste, so did those who reported higher frequency of meals eaten at home. Both larger household size and presence of children lead to higher levels of edible food waste, all else constant. Similar trends can be noted when it comes to garbage disposal usage and amounts of food self-reported to be disposed as general food waste amounts (see table 4-8).

Table 4-13. Total edible food waste (in lbs.) discarded over study period

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Control						
Treatment Group 1	1.71*	1.20	0.58	0.96	0.91	1.06**
	(0.96)	(0.82)	(1.11)	(0.82)	(1.06)	(0.42)
Treatment Group 2	1.08	0.43	0.73	1.76*	0.95	1.00**
	(0.90)	(0.87)	(1.07)	(0.92)	(1.09)	(0.43)
Age (Base: 25-34)						
35 - 44	-0.75	0.69	-1.16	-1.50	-0.95	-0.71
	(1.39)	(1.12)	(2.19)	(1.42)	(1.38)	(0.66)
45 - 54	0.60	2.97**	0.51	-1.13	0.38	0.59
	(1.06)	(1.30)	(2.19)	(1.44)	(1.58)	(0.66)
55- 64	0.05	0.78	-2.23	-2.19*	-2.12	-1.16**
	(0.97)	(0.99)	(1.90)	(1.23)	(1.52)	(0.56)
65 and older	0.93	2.18*	-1.43	-1.31	2.24	0.52
	(1.09)	(1.23)	(2.02)	(1.38)	(1.94)	(0.66)
Education (Base: High School or less)						
Associate's Degree	-1.74*	-1.41	-0.73	-1.65	-0.43	-1.16**
	(1.00)	(1.21)	(1.60)	(1.13)	(1.36)	(0.50)
Bachelor's	-0.82	-0.48	0.54	-0.92	-0.01	-0.37
	(0.92)	(0.90)	(1.15)	(0.93)	(1.22)	(0.42)
Master's or more	-1.93**	-0.78	-0.42	-1.16	0.22	-0.76
	(0.88)	(1.03)	(1.21)	(1.10)	(1.47)	(0.51)
Female	-0.85	0.98	0.31	-0.63	0.62	0.10
	(0.69)	(0.90)	(0.84)	(0.82)	(1.25)	(0.43)
White	-2.53	-3.09*	-0.05	-1.07	-3.34*	-1.97***
	(1.93)	(1.59)	(1.50)	(1.50)	(1.77)	(0.75)
Income	0.00	0.00	-0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	0.49	0.64	0.64	0.58	0.48	0.55**
	(0.51)	(0.42)	(0.49)	(0.60)	(0.54)	(0.23)
Children present	11.34*	6.79	7.34	-0.53	-1.05	4.46*
	(5.84)	(4.66)	(6.70)	(3.91)	(4.52)	(2.33)
Meals at home (adults)	0.28	-0.26	-0.39	-0.15	-0.24	-0.21
	(0.55)	(0.49)	(0.74)	(0.66)	(0.76)	(0.29)
Meals at home (children)	-3.03**	-1.90	-2.19	0.07	-0.24	-1.38**
	(1.45)	(1.29)	(1.70)	(1.12)	(1.26)	(0.61)
Household work hours	0.01	0.02**	0.01	-0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Efficient in planning	-0.42	-0.75	0.03	-0.81	-0.95	-0.58*
	(0.60)	(0.53)	(0.98)	(0.72)	(0.74)	(0.31)
Efficient at food prep	0.57	-0.05	-0.23	0.92	0.70	0.40
	(0.72)	(0.52)	(0.98)	(0.74)	(0.85)	(0.34)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Engaged in FW efforts	-0.98	0.04	1.22	0.32	0.69	0.31
	(0.64)	(0.52)	(0.96)	(0.47)	(0.64)	(0.29)
Engaged in OREC efforts	1.55**	0.76	-0.48	-0.07	0.75	0.51
	(0.63)	(0.68)	(0.91)	(0.73)	(0.99)	(0.34)
Environmental beliefs						
FW	-1.57	-0.23	-0.52	-0.08	0.02	-0.48
	(1.12)	(0.77)	(1.44)	(1.15)	(1.22)	(0.50)
OREC	1.40	0.37	0.70	-0.57	-0.00	0.35
	(1.11)	(0.89)	(1.39)	(1.30)	(1.39)	(0.53)
Garbage disposal						
Usage (Yes)	1.45*	0.84	-0.65	2.48**	2.67**	1.31***
	(0.82)	(0.89)	(1.30)	(0.98)	(1.21)	(0.47)
Amounts disposed	-0.02	-0.03	0.00	-0.03	-0.05**	-0.02***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Constant	-1.01	0.78	0.68	5.07	-1.87	0.87
	(4.20)	(4.96)	(6.68)	(5.23)	(7.32)	(2.54)
N	113	113	115	115	111	567

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

4.7.3. Total organics generated

Table 4-14 displays the results on the total amounts of organic materials generated across the different groups. Generally, both treatment groups generated a larger amount of total organics than control households. This includes edible food, inedible food, and other organic materials such as coffee grounds, house plants, and compostable kitchen goods. Socio-demographic effects are more or less similar to the results above (see tables 4-12 and 4-13).

Table 4-14. Total edible food waste (in lbs.) discarded over study period

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Control						
Treatment Group 1	4.38***	3.61***	2.17	2.37**	2.98**	3.04***
	(1.21)	(1.11)	(1.48)	(1.04)	(1.41)	(0.55)
Treatment Group 2	4.19***	3.81***	2.67**	4.72***	2.97**	3.62***
	(1.20)	(1.25)	(1.21)	(1.19)	(1.32)	(0.54)
Age (Base: 25-34)						
35 - 44	-0.97	2.63	-0.28	1.71	-2.17	0.19
	(1.86)	(1.83)	(2.39)	(1.92)	(2.08)	(0.86)
45 - 54	0.28	4.10***	0.10	1.63	-0.18	1.09
	(1.55)	(1.53)	(2.46)	(1.70)	(2.36)	(0.83)
55- 64	1.46	1.31	-1.79	-0.11	-2.55	-0.38
	(1.43)	(1.58)	(2.46)	(1.61)	(1.86)	(0.75)
65 and older	3.51**	2.94*	-0.84	1.62	1.78	1.78**
	(1.73)	(1.71)	(2.47)	(1.79)	(2.23)	(0.85)
Education (Base: High School or less)						
Associate's Degree	-0.60	-3.00*	-1.20	-2.17	-1.07	-1.55**
	(1.77)	(1.76)	(2.21)	(1.33)	(1.69)	(0.73)
Bachelor's	0.55	-0.74	0.73	0.96	-0.01	0.29
	(1.29)	(1.31)	(1.55)	(1.24)	(1.61)	(0.59)
Master's or more	-1.64	-2.04	-1.24	-1.74	-0.50	-1.34**
	(1.51)	(1.34)	(1.36)	(1.32)	(1.56)	(0.61)
Female	-0.71	0.48	-0.55	-0.84	0.39	-0.26
	(1.07)	(1.20)	(1.18)	(1.06)	(1.72)	(0.54)
White	-2.48	-2.83	-1.06	0.67	-2.66	-1.73*
	(1.94)	(2.34)	(2.64)	(2.29)	(2.12)	(1.00)
Income	0.00	-0.00	-0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	0.38	0.84	1.11	1.00	0.38	0.74**
	(0.62)	(0.54)	(0.84)	(0.66)	(0.68)	(0.29)
Children present	9.85	5.10	3.85	-0.47	3.51	4.27
	(6.33)	(6.29)	(7.37)	(5.16)	(6.34)	(2.78)
Meals at home (adults)	0.64	0.55	-0.51	0.59	0.27	0.27
	(0.64)	(0.70)	(0.83)	(0.68)	(0.86)	(0.33)
Meals at home (children)	-2.03	-1.19	-1.11	-0.09	-1.35	-1.13
	(1.66)	(1.74)	(1.86)	(1.42)	(1.70)	(0.73)
Household work hours	0.04**	0.03	0.03*	0.00	0.03	0.03***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)
Efficient in planning	-0.13	-0.01	0.50	-0.70	-1.49	-0.33
	(0.76)	(0.84)	(1.13)	(0.89)	(0.97)	(0.39)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Efficient at food prep	0.55	0.17	0.12	1.13	1.34	0.64
	(0.91)	(0.79)	(1.10)	(0.93)	(1.07)	(0.40)
Engaged in FW efforts	-1.73*	-0.70	0.84	-0.28	0.68	-0.17
	(0.90)	(0.76)	(1.45)	(0.63)	(0.76)	(0.42)
Engaged in OREC efforts	1.57	1.00	0.04	1.94**	1.15	1.15**
	(1.10)	(1.05)	(1.19)	(0.94)	(1.36)	(0.48)
Environmental beliefs						
FW	-1.05	1.30	0.33	0.14	-0.50	0.06
	(1.53)	(1.19)	(2.19)	(1.25)	(1.66)	(0.70)
OREC	1.16	-0.87	0.23	-0.81	0.50	-0.02
	(1.49)	(1.35)	(2.22)	(1.45)	(1.98)	(0.75)
Garbage disposal						
Usage (Yes)	1.08	0.36	-0.50	2.07	2.20	1.01*
	(1.19)	(1.28)	(1.45)	(1.29)	(1.64)	(0.58)
Amounts disposed	0.00	-0.03	0.01	-0.05**	-0.07**	-0.03**
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.01)
Constant	-1.54	-2.96	-2.64	-8.24	-3.16	-3.57
	(5.77)	(6.82)	(9.69)	(6.79)	(8.76)	(3.33)
N	113	113	115	115	111	567

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

4.7.4. Contamination in biobags

In this section, we present the results on the amount of contamination present in the composting stream. This section of the results only applies to treatment households who were asked to separate their food waste and organic materials from their regular trash. Table 4-15 displays the results using all households in the treatment groups. On average, households in Treatment Group 2 generated higher levels of contamination compared to those in Treatment Group 1. Yet, the significant difference (at the 10% level) of about 0.22 lbs. over the course of the study disappears when the one household who produced an extensive amounts of contamination is omitted (Table 4-16). This result is further not sustained throughout the weeks. Thus, results show no evidence of additional information provided to Treatment Group 2 affecting the amounts of contamination. A few demographic variables stood out in this set of results. For instance, households with respondents who identified as female generated higher levels of contamination. Those who were 55-64 also had higher contamination than their younger counterparts in the 25-34 age group. While the presence of children implied higher levels of contamination, larger household size correlated with lower contamination. Intriguingly, those who reported being more likely to be engaged in food waste reduction and organics recycling generated higher levels of contamination.

Table 4-15. Contamination (in lbs.) in biobags (all treatment households)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Group 1						
Treatment Group 2	0.43	0.06	0.17	0.31	0.17	0.22*
	(0.41)	(0.15)	(0.44)	(0.30)	(0.23)	(0.12)
Age (Base: 25-34)						
35 - 44	0.19	-0.18	0.12	0.06	-0.01	0.03
	(0.53)	(0.15)	(0.49)	(0.33)	(0.26)	(0.13)
45 - 54	0.48	0.12	0.40	0.08	0.19	0.23
	(0.58)	(0.19)	(0.47)	(0.39)	(0.26)	(0.16)
55- 64	0.90	0.06	1.03	0.61	0.50	0.60***
	(0.71)	(0.21)	(0.63)	(0.48)	(0.30)	(0.19)
65 and older	0.58	0.06	0.06	-0.35	0.01	0.02
	(0.80)	(0.22)	(0.65)	(0.53)	(0.33)	(0.19)
Education (Base: High School or less)						
Associate's Degree	0.88	0.16	0.14	0.00	0.18	0.24
	(1.02)	(0.24)	(0.96)	(0.65)	(0.49)	(0.28)
Bachelor's	0.62	0.30**	0.62	0.21	0.30	0.36
	(0.79)	(0.13)	(0.80)	(0.60)	(0.32)	(0.23)
Master's or more	0.34	0.09	0.20	-0.08	0.12	0.07
	(0.67)	(0.12)	(0.63)	(0.43)	(0.25)	(0.16)
Female	0.79	0.04	0.62	0.29	0.32	0.38**
	(0.69)	(0.14)	(0.58)	(0.38)	(0.27)	(0.18)
White	-0.17	-0.04	0.05	0.08	0.18	0.00
	(0.51)	(0.12)	(0.37)	(0.39)	(0.36)	(0.12)
Income	-0.00	0.00	-0.00	-0.00	-0.00	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	-0.26	-0.06	-0.23	-0.20	-0.13	-0.17***
	(0.21)	(0.05)	(0.22)	(0.19)	(0.11)	(0.06)
Children present	5.15	0.13	4.43	2.34	2.47	2.95***
	(3.84)	(0.56)	(3.10)	(1.75)	(1.53)	(1.06)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Meals at home (adults)	-0.05	-0.01	-0.08	-0.07	-0.03	-0.04
	(0.22)	(0.08)	(0.24)	(0.18)	(0.11)	(0.06)
Meals at home (children)	-1.09	0.01	-0.88	-0.45	-0.51	-0.61**
	(0.89)	(0.14)	(0.72)	(0.40)	(0.35)	(0.24)
Household work hours	-0.01	-0.00	-0.01	-0.01	-0.00	-0.01***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Efficient in planning	-0.23	0.04	0.17	0.13	-0.04	0.02
	(0.38)	(0.12)	(0.40)	(0.31)	(0.21)	(0.12)
Efficient at food prep	0.07	-0.02	-0.28	-0.11	-0.05	-0.07
	(0.36)	(0.11)	(0.42)	(0.32)	(0.18)	(0.12)
Engaged in FW efforts	0.91	0.09	0.97	0.53	0.53	0.62***
	(0.71)	(0.17)	(0.60)	(0.33)	(0.33)	(0.20)
Engaged in OREC efforts	0.37	-0.05	0.28	0.26	0.21	0.23*
	(0.48)	(0.12)	(0.51)	(0.30)	(0.23)	(0.14)
Environmental beliefs						
FW	0.03	-0.08	-0.37	-0.11	-0.35	-0.23
	(0.54)	(0.24)	(0.54)	(0.32)	(0.32)	(0.16)
OREC	-1.65	-0.07	-1.07	-0.77	-0.46	-0.78**
	(1.34)	(0.21)	(1.07)	(0.68)	(0.52)	(0.37)
Garbage disposal						
Usage (Yes)	-0.82	-0.03	-1.03	-0.46	-0.74*	-0.64**
	(0.77)	(0.18)	(0.75)	(0.59)	(0.44)	(0.27)
Amounts disposed	0.02	0.00	0.02	0.01	0.01	0.01**
	(0.02)	(0.00)	(0.02)	(0.01)	(0.01)	(0.01)
Constant	2.97	0.65	2.47	1.62	1.22	1.84**
	(3.25)	(0.74)	(2.97)	(1.71)	(1.28)	(0.88)
N	76	76	75	76	75	378

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

Table 4-16. Contamination (in lbs.) in biobags (omitting outlier household)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Group 1						
Treatment Group 2	0.09	0.05	-0.07	0.09	-0.04	0.04
	(0.10)	(0.15)	(0.24)	(0.17)	(0.09)	(0.06)
Age (Base: 25-34)						
35 - 44	0.02	-0.20	-0.16	-0.17	-0.12	-0.11**
	(0.10)	(0.15)	(0.20)	(0.17)	(0.12)	(0.06)
45 - 54	-0.02	0.09	-0.00	-0.18	0.10	-0.03
	(0.16)	(0.18)	(0.24)	(0.24)	(0.14)	(0.09)
55- 64	0.34**	0.01	0.56	0.27	0.25*	0.28***
	(0.16)	(0.20)	(0.35)	(0.32)	(0.14)	(0.10)
65 and older	0.11	0.06	-0.18	-0.37	-0.01	-0.07
	(0.23)	(0.21)	(0.46)	(0.39)	(0.17)	(0.13)
Education (Base: High School or less)						
Associate's Degree	-0.08	0.13	-0.60	-0.43	-0.27*	-0.25*
	(0.26)	(0.22)	(0.45)	(0.42)	(0.15)	(0.13)
Bachelor's	-0.20	0.26**	-0.07	-0.23	0.03	-0.06
	(0.27)	(0.13)	(0.51)	(0.47)	(0.18)	(0.14)
Master's or more	-0.28	0.08	-0.23	-0.25	-0.06	-0.16
	(0.23)	(0.12)	(0.42)	(0.36)	(0.14)	(0.11)
Female	-0.06	-0.01	-0.04	-0.13	-0.01	-0.05
	(0.09)	(0.14)	(0.21)	(0.21)	(0.08)	(0.05)
White	-0.02	-0.03	0.18	-0.02	0.04	0.04
	(0.10)	(0.12)	(0.21)	(0.26)	(0.21)	(0.06)
Income	0.00	0.00	0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	-0.06	-0.05	-0.05	-0.11	-0.05	-0.06*
	(0.06)	(0.05)	(0.11)	(0.15)	(0.06)	(0.03)
Children present	0.36	-0.29	0.71	0.25	0.60	0.29
	(0.42)	(0.50)	(0.79)	(0.66)	(0.44)	(0.22)
Meals at home (adults)	-0.03	-0.01	-0.07	-0.02	-0.01	-0.04
	(0.08)	(0.08)	(0.17)	(0.13)	(0.07)	(0.04)
Meals at home (children)	-0.05	0.10	-0.08	-0.01	-0.10	-0.03
	(0.11)	(0.13)	(0.21)	(0.17)	(0.11)	(0.05)
Household work hours	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Efficient in planning	0.14	0.06	0.45	0.33	0.17*	0.22***
	(0.12)	(0.13)	(0.27)	(0.24)	(0.10)	(0.08)
Efficient at food prep	-0.24*	-0.05	-0.52*	-0.31	-0.19*	-0.26***

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
	(0.13)	(0.11)	(0.29)	(0.25)	(0.10)	(0.08)
Engaged in FW efforts	0.07	0.01	0.38	0.19	0.15	0.17**
	(0.10)	(0.16)	(0.28)	(0.12)	(0.12)	(0.07)
Engaged in OREC efforts	0.04	-0.07	-0.06	0.01	-0.03	-0.00
	(0.14)	(0.12)	(0.32)	(0.18)	(0.10)	(0.07)
Environmental beliefs						
FW	-0.05	-0.05	-0.37	-0.14	-0.24**	-0.17*
	(0.12)	(0.23)	(0.29)	(0.16)	(0.11)	(0.09)
OREC	0.11	0.07	0.31	0.13	0.22*	0.16**
	(0.11)	(0.19)	(0.27)	(0.16)	(0.11)	(0.08)
Garbage disposal						
Usage (Yes)	0.14	0.08	-0.17	0.17	-0.16	0.01
	(0.15)	(0.17)	(0.30)	(0.35)	(0.14)	(0.09)
Amounts disposed	-0.00	-0.00	-0.00	-0.01	-0.00	-0.00*
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Constant	0.04	0.32	-0.17	0.12	0.04	0.05
	(0.64)	(0.67)	(1.04)	(0.78)	(0.51)	(0.29)
N	75	75	74	75	74	373

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

4.7.5. Food/organics in liner

Another issue is that of food and organic materials ending up in the trash instead of the organic/composting stream. This section of the results looks at the amounts of food and organics that treatment households had in their regular trash. Treatment Group 1 discarded an average of 1.79 lbs. of organics whereas Treatment Group 2 disposed an average of 1.49 lbs. in their trash instead of their compost bins. However, this difference of about 0.29 lbs. is not statistically significant.[16] This result is maintained in the regression analysis controlling for other household variables. There are no significant differences between the

[16] *The p-value of this difference is 0.2771 implying the difference is not statistically significant.*

two treatment groups (see Table 4-17). One notable result is that higher levels of organics ending up with the trash is associated with higher number of meals consumed at home and household work hours.

Table 4-17. Total organics (in lbs.) in liner (all treatment household)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Group 1						
Treatment Group 2	-0.32	0.03	-1.25	0.75	-0.05	-0.21
	(0.50)	(0.71)	(1.03)	(0.62)	(0.54)	(0.31)
Age (Base: 25-34)						
35 - 44	-1.72*	0.69	-2.92	1.16	-0.92	-0.79
	(0.90)	(0.97)	(2.33)	(1.20)	(0.87)	(0.62)
45 - 54	-0.24	-0.15	-3.05	0.06	-0.15	-0.74
	(0.94)	(1.08)	(2.03)	(0.95)	(0.81)	(0.54)
55- 64	0.07	-0.52	-3.76*	-1.36	-0.70	-1.28**
	(0.85)	(0.99)	(2.02)	(0.82)	(0.95)	(0.51)
65 and older	2.72**	-1.28	-2.90	1.09	-0.66	-0.15
	(1.27)	(1.04)	(2.04)	(0.96)	(0.88)	(0.58)
Education (Base: High School or less)						
Associate's Degree	0.57	0.39	-0.61	-0.74	-0.49	-0.03
	(0.80)	(1.48)	(1.19)	(0.80)	(0.81)	(0.44)
Bachelor's	-0.42	-0.24	0.08	-0.91	-0.75	-0.38
	(0.70)	(0.89)	(1.37)	(0.71)	(0.54)	(0.39)
Master's or more	0.07	-1.12	0.25	-1.67*	-0.70	-0.55
	(0.98)	(0.97)	(0.81)	(0.87)	(0.57)	(0.35)
Female	0.36	0.83	-0.13	0.48	0.68	0.41
	(0.68)	(0.85)	(1.03)	(0.82)	(0.55)	(0.37)
White	-1.87	-0.53	-1.21	0.42	-0.18	-0.84
	(1.39)	(1.03)	(1.58)	(1.26)	(0.53)	(0.55)
Income	0.00	-0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	-0.10	0.01	0.71	0.54	0.05	0.25
	(0.35)	(0.35)	(0.59)	(0.32)	(0.21)	(0.17)
Children present	6.76	-0.21	1.28	-2.10	0.80	1.00
	(4.33)	(2.70)	(6.29)	(2.13)	(1.60)	(1.74)
Meals at home (adults)	0.88*	0.79*	0.44	0.49	0.63*	0.66***
	(0.47)	(0.42)	(0.51)	(0.36)	(0.34)	(0.17)
Meals at home (children)	-1.56	-0.03	-0.18	-0.10	-0.32	-0.36
	(1.06)	(0.71)	(1.43)	(0.63)	(0.48)	(0.41)
Household work hours	0.03***	0.00	0.00	0.01	0.01	0.01***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Efficient in planning	0.21	0.77	-0.34	0.41	-0.08	0.18
	(0.46)	(0.54)	(0.99)	(0.38)	(0.26)	(0.24)
Efficient at food prep	0.04	-0.13	0.27	0.51	-0.28	0.13
	(0.50)	(0.42)	(0.67)	(0.58)	(0.37)	(0.20)
Engaged in FW efforts	-0.37	-0.84	0.23	-0.45	0.54*	-0.24
	(0.49)	(0.64)	(1.66)	(0.54)	(0.32)	(0.43)
Engaged in OREC efforts	-0.42	0.01	-1.18	0.63	-0.64	-0.32
	(0.76)	(0.58)	(0.99)	(0.60)	(0.48)	(0.30)
Environmental beliefs						
FW	-0.06	1.49	0.37	-0.60	-0.71	0.10
	(0.84)	(0.94)	(1.46)	(0.63)	(0.48)	(0.42)
OREC	0.58	-0.49	-0.46	0.69	0.66	0.17
	(0.75)	(0.77)	(1.27)	(0.74)	(0.61)	(0.38)
Garbage disposal						
Usage (Yes)	0.67	1.01	-1.08	0.32	-0.01	0.26
	(0.75)	(0.77)	(1.19)	(1.06)	(0.59)	(0.41)
Amounts disposed	-0.01	0.01	0.00	-0.02*	-0.01	-0.01
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Constant	-1.31	-3.55	7.21	-6.98	1.42	-0.26
	(3.99)	(4.10)	(7.92)	(6.39)	(2.70)	(2.54)
N	78	76	79	81	76	390

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

4.7.6. Misclassification (treatment groups only)

A final regression analysis looks at the proportion of misclassification of materials for the treatment households during source separation (tables 4-18 and 4-19). The total proportion of materials misclassified during source separation includes the total of organic materials present in the liner and the amount of contamination in the biobags as a proportion of the total materials disposed by the household. To avoid putting too much weight on the outlier household, we present two sets of results, one including all households and a second excluding the outlier. The average proportion of misclassification was about 10.3% with a minimum of 0% and a maximum of 85.1%. Omitting the outlier household, the average misclassification is 9.70% with a minimum of 0% and a maximum of 61.1%. The table below shows the average of misclassification across the treatment groups with and without the outlier for the entire study period. In both cases, the differences are not statistically different between the groups.

Table 4-18. Mean misclassification across treatment groups

Groups	All households	Excluding outlier
	10.20%	9.70%
Treatment 1	10.05%	10.05%
Treatment 2	10.51%	9.34%
p-value [1]	0.7114	0.4997

[1] *This is the p-value on the test of differences in mean*

Regression results (Table 4-19) show that there was not a significant difference in misclassification by treatment groups. This is the case whether the outlier is included or not. Those who prepared and ate more meals at home had a higher misclassification rate. Specifically, a one-unit increment in meals eaten at home, on a scale of 1 (Never) – 5 (Daily) by adults is associated with about two percentage points more misclassification. The same effect is not found when children eat more at home. Having stronger environmental beliefs was also associated with lower rates of misclassification. This may display more attention to the source separation process due to moral norms.

Table 4-19*. Total proportion of misclassified materials from source separation, in %, (all treatment households)*

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Group 1	-0.62	0.37	-3.61	0.89	0.78	-0.35
Treatment Group 2	(3.38)	(3.46)	(4.06)	(2.74)	(2.97)	(1.34)
Age (Base: 25-34)						
35 - 44	-1.19	-1.05	-8.11	2.05	-4.38	-2.48
	(4.60)	(4.65)	(6.76)	(4.20)	(4.42)	(2.21)
45 - 54	6.96	0.37	-3.68	5.12	2.42	2.05

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
	(5.28)	(4.53)	(5.76)	(4.20)	(4.54)	(2.23)
55- 64	5.19	-4.46	-3.65	0.18	1.05	-0.77
	(5.39)	(5.14)	(6.25)	(4.45)	(5.25)	(2.31)
65 and older	16.70**	-6.23	-3.02	-0.73	-4.16	0.34
	(8.01)	(5.73)	(6.25)	(5.71)	(4.81)	(2.88)
Education (Base: High School or less)						
Associate's Degree	6.75	-1.81	-1.43	-0.72	-2.02	0.77
	(7.11)	(5.39)	(6.28)	(5.26)	(4.22)	(2.21)
Bachelor's	2.93	3.22	6.61	1.86	3.21	3.49*
	(5.13)	(3.37)	(5.72)	(4.02)	(2.66)	(1.80)
Master's or more	2.45	-4.78	5.48	-0.41	1.86	0.97
	(5.36)	(3.75)	(4.69)	(3.56)	(2.69)	(1.61)
Female	2.52	3.45	4.57	3.85	4.21	3.16**
	(4.44)	(3.09)	(4.64)	(3.44)	(3.07)	(1.59)
White	-4.51	0.06	0.02	-2.21	1.02	-1.36
	(4.82)	(4.05)	(4.37)	(6.87)	(3.18)	(1.99)
Income	-0.00	0.00	0.00	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	-1.47	-0.96	0.69	0.96	-1.50	-0.35
	(1.79)	(1.47)	(1.82)	(1.69)	(1.12)	(0.72)
Children present	45.91**	5.50	28.28	-1.95	21.60*	19.86***
	(20.10)	(11.6)	(21.11)	(14.44)	(11.40)	(7.38)
Meals at home (adults)	3.15	3.38*	1.79	-0.56	1.92	2.12**
	(2.26)	(1.80)	(2.22)	(1.95)	(2.04)	(0.83)
Meals at home (children)	-11.50**	-2.58	-5.90	-1.63	-5.21*	-5.62***
	(4.94)	(3.05)	(5.12)	(3.46)	(2.97)	(1.78)
Household work hours	0.09*	-0.00	-0.04	-0.02	-0.00	0.01
	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.02)
Efficient in planning	-1.77	4.88*	-1.96	3.83*	1.69	1.16
	(2.74)	(2.63)	(3.43)	(2.23)	(1.90)	(1.11)
Efficient at food prep	0.59	-2.79	0.05	-1.92	-3.00	-1.05
	(2.70)	(2.37)	(3.10)	(2.61)	(2.16)	(1.05)
Engaged in FW efforts	4.38	0.31	7.19	-0.36	6.75***	3.43**
	(4.19)	(3.54)	(5.47)	(3.50)	(2.28)	(1.71)
Engaged in OREC efforts	0.14	-2.17	-0.67	2.88	-4.19*	-0.74
	(4.07)	(3.16)	(4.11)	(3.55)	(2.38)	(1.39)
Environmental beliefs						
FW	-1.56	-0.58	-4.05	-4.78	-7.25**	-3.66**
	(4.67)	(4.57)	(5.26)	(3.85)	(3.26)	(1.80)
OREC	-4.81	2.98	-6.71	1.85	1.17	-1.16
	(6.76)	(3.66)	(6.84)	(5.54)	(3.89)	(2.32)
Garbage disposal						
Usage (Yes)	-6.56	1.96	-9.24	-0.92	-5.91	-3.88**
	(4.83)	(3.80)	(5.57)	(4.59)	(3.56)	(1.91)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Amounts disposed	0.07	0.03	0.09	-0.03	0.10	0.05
	(0.12)	(0.07)	(0.11)	(0.09)	(0.07)	(0.04)
Constant	10.77	-8.10	30.91	7.65	25.83	13.77
	(24.32)	(18.1)	(29.72)	(25.59)	(15.52)	(9.84)
N	76	76	75	76	75	378

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

Table 4-20. Total proportion of misclassified materials from source separation, in %, (omitting outlier household)

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
Base: Group 1						
Treatment Group 2	-2.41	0.31	-4.90	-0.62	-0.22	-1.32
	(2.42)	(3.46)	(3.49)	(2.41)	(2.77)	(1.22)
Age (Base: 25-34)						
35 - 44	-2.35	-1.13	-9.31	0.29	-4.96	-3.24
	(3.79)	(4.63)	(6.32)	(3.62)	(4.13)	(2.11)
45 - 54	4.99	0.10	-5.87	3.44	2.00	0.69
	(4.72)	(4.55)	(5.52)	(3.67)	(4.64)	(2.16)
55- 64	2.70	-4.81	-5.94	-2.13	-0.11	-2.46
	(4.00)	(5.23)	(5.42)	(3.95)	(5.09)	(2.14)
65 and older	14.80*	-6.23	-4.26	-0.95	-4.25	-0.12
	(7.67)	(5.82)	(5.69)	(4.92)	(4.61)	(2.78)
Education (Base: High School or less)						
Associate's Degree	1.96	-2.05	-5.16	-3.09	-4.26	-1.77
	(5.13)	(5.38)	(4.36)	(4.25)	(3.44)	(1.79)
Bachelor's	-0.76	2.85	3.00	-0.90	2.00	1.30
	(4.03)	(3.41)	(4.64)	(3.13)	(2.52)	(1.57)
Master's or more	-0.36	-4.88	3.33	-1.40	1.06	-0.23
	(4.87)	(3.78)	(3.98)	(3.41)	(2.79)	(1.54)
Female	-1.41	3.04	1.30	1.04	2.69	0.90
	(3.02)	(3.08)	(3.53)	(2.68)	(2.77)	(1.31)
White	-3.10	0.06	0.26	-2.95	0.49	-1.17
	(4.53)	(4.16)	(4.13)	(6.66)	(2.88)	(1.99)
Income	0.00	0.00	0.00*	0.00	0.00	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household size	-0.49	-0.87	1.59	1.47	-1.06	0.23
	(1.65)	(1.52)	(1.61)	(1.63)	(1.14)	(0.71)
Children present	24.61**	2.44	9.16	-15.19	12.67	5.98

	(1) Week 2	(2) Week 3	(3) Week 4	(4) Week 5	(5) Week 6	(6) All weeks
	(9.42)	(11.76)	(16.56)	(10.75)	(9.78)	(5.66)
Meals at home (adults)	3.41	3.40*	1.79	-0.22	2.01	2.14***
	(2.05)	(1.82)	(2.04)	(1.74)	(1.98)	(0.79)
Meals at home (children)	-6.93**	-1.90	-1.74	1.20	-3.31	-2.58*
	(2.65)	(3.02)	(3.97)	(2.56)	(2.72)	(1.40)
Household work hours	0.13***	-0.00	-0.01	0.01	0.01	0.03*
	(0.04)	(0.05)	(0.03)	(0.05)	(0.04)	(0.02)
Efficient in planning	-0.02	5.03*	-0.42	4.97**	2.68	2.22**
	(2.23)	(2.65)	(3.11)	(2.15)	(1.79)	(1.04)
Efficient at food prep	-0.92	-3.02	-1.38	-3.05	-3.55*	-1.99**
	(2.15)	(2.40)	(2.70)	(2.36)	(2.05)	(0.96)
Engaged in FW efforts	0.53	-0.28	4.31	-2.51	4.91**	1.06
	(2.38)	(3.64)	(4.75)	(3.18)	(1.93)	(1.45)
Engaged in OREC efforts	-1.38	-2.35	-2.37	1.06	-5.27**	-1.96
	(4.07)	(3.26)	(3.77)	(3.05)	(2.45)	(1.33)
Environmental beliefs						
FW	-1.54	-0.37	-4.31	-5.12	-6.64**	-3.33**
	(3.78)	(4.53)	(4.36)	(3.21)	(2.86)	(1.59)
OREC	3.06	3.95	0.50	7.80**	4.21	3.73**
	(3.62)	(3.89)	(4.31)	(3.54)	(3.40)	(1.57)
Garbage disposal						
Usage (Yes)	-2.06	2.67	-5.05	3.40	-3.18	-0.48
	(3.34)	(4.04)	(4.51)	(3.46)	(3.03)	(1.50)
Amounts disposed	-0.05	0.01	-0.02	-0.14**	0.04	-0.04
	(0.08)	(0.08)	(0.06)	(0.06)	(0.06)	(0.03)
Constant	-4.54	-10.20	17.91	-1.60	20.07	4.38
	(20.52)	(18.04)	(24.71)	(23.08)	(14.99)	(8.91)
N	75	75	74	75	74	373

*Notes: * P < 0.1, ** P < 0.05, *** P < 0.01*

Abbreviations in table: OREC: Organics recycling | FW: Food waste

Results in Column 6 do not include dummy variables for the different weeks. Results are similar with added dummy variables for the weeks. All week dummy variables are insignificant at the 5% level.

4.8. Conclusions and recommendations

Food waste reduction and organics recycling are issues of growing importance for policy makers. This study combines surveys and a curbside collection pilot to determine food waste and organics recycling habits for a sample of households in the City of Maplewood. This project was conducted in collaboration with the University of Minnesota, Ramsey County, the City of Maplewood, and Republic Services (hauling service). A total of 121 households participated in the pilot and completed all study components. Weekly participation rate in the garbage/organics was about 94.3%. There were three groups in the study: Treatment Group 1, Treatment Group 2, and a Control Group. All groups received information to reduce their food waste. Control households were asked to dispose of their materials as usual and were told that their materials would be sorted for waste characterization. The treatment households were asked to source separate their food and organics from their regular trash. They were provided with bio-bags that were co-collected with their regular trash. The researchers received all trash and organics, whether separated or not, identified by household in large bags. Treatment Group 1 received information that is in accordance with the status quo, that is, similar to what current municipalities give to their residents on organics recycling. Treatment Group 2 received more intensive information outlined in a resource efficiency framework. The information was communicated via 5-6 minutes long videos and other reading materials.

A total of 11,879 lbs. of materials was processed during five weeks, with week 1 being a trial. Materials were sorted into edible food, inedible food, and other organic materials. All non-organic materials in biobags were tagged as contamination. Although treatment households had access to organics recycling, a proportion of food and organics was still found in the trash. For instance, 7.56% of the trash disposed by households in the treatment groups comprised of organic materials. From a policy standpoint, there needs to be a strong feedback system to encourage households participating in organics recycling to conduct source separation carefully. This could be similar to energy usage feedback that households receive comparing their usage to similar neighbors.

While contamination in the biobags was not too extreme, it still persevered throughout the weeks. Packaging was one of the most common contaminant in the green biobags. Given the importance of packing as a barrier to properly recycle, manufacturers should be encouraged to minimize packaging, make them compostable, or have packaging be easier to separate from food. For instance, various packaged meats took a lot of effort to separate from their package during sorting.

In the analysis, we found evidence of what can be described as a "rebound effect." That is, households who were asked to participate in organics recycling generally created more food waste. This effect is noted weekly and throughout the study period. Particularly, households in treatment groups produced nearly 3 lbs. more food waste than control households. A similar trend in noted when it comes to edible food waste as well. Thus, there may be some disincentive to reduce food waste when participating in organics recycling as households may feel laxer. Our conversations and interactions with the study participants showed that many chose to "purge" their refrigerators as they were participating in the recycling program. Hence, they felt it was opportunity to clean out their fridge and discard their unwanted food items in an environmentally friendly way. However, while we noted a large amount of frozen meats and other items that were probably tossed as part of a fridge cleaning, a higher proportion of sorted food were food items that were not. These items included fresh fruits and vegetables, bread that was recently purchased, and so on. Thus, the rebound effect may not be only a short-lived phenomenon but a sustained trend for those who might participate in organics recycling programs.

To minimize the impact of the rebound effect, city/county environmental policy makers should consider the disincentive effect on food waste reduction when organics curbside collection programs are available. Particularly, this finding should not necessarily discourage the implementation of possibly helpful organics recycling programs, but should illuminate on potential negative effects. This tendency could be elaborated in awareness programs for residents.

Overall, socio-demographic variables (age, education, race, moral motivations) were not consistently associated with levels of food waste or contamination. However, there were some noteworthy results. For instance, it is noted that often larger households produce more food waste and households where children are present produce more edible food waste. For instance, households with children were associated with on average 4.46 lbs. more edible food waste generated than the counterparts with no children, on average. Some targeted awareness could be done for households with children when providing organics recycling programs or when implementing food waste reduction campaigns. Especially, households may benefit from understanding and being cognizant of the general tendency of households like theirs in discarding larger amounts of edible food.

There were other socio-demographic variables that were associated with levels of food waste generated in certain results. This includes variables such as race, age, education level, household size, and moral norms around the connection between the environment and these environmentally sustainable activities. It should be noted that these are only correlations and results ought to be treated with care.

The purpose of the differential information treatments was to explore ways to reduce the incidence of misclassification of materials during source separation. That is, (1) reduce contamination in the biobags and (2) reduce the amount of food/organics that get discarded with regular trash. In order to make the information effect as effective as possible, we provided tailored, user-friendly, and engaging videos available through the Youtube platform. Participants also had access to supplementary reading materials as well. To ensure comprehension of the information, households were asked to complete a quick 2-minute quiz to test their understanding of the information and instructions.

Unfortunately, there were no significant differences in misclassification between these two groups. Whether households were in Treatment Group 1 or Treatment Group 2, they generated similar levels of contaminants during source separation. Thus, providing more information, even interactively, may not be an effective policy tool to encourage proper source separation to reduce contamination levels in the composting stream and minimize the amount of organics discarded with regular trash. Households prioritize their regular routines and may not factor in additional information they receive when making their source separation decisions. Policy may find it helpful to explore alternative ways to encourage proper source separation. More importantly, municipalities may find it valuable to think outside the box and imagine ways to conduct central source separation of materials on behalf of households.

This final recommendation is especially important. If contamination levels continue to be a problem and households discard significant portion of their organic materials with their trash, then policy goals of keeping food out of the landfill and converting organics into economic resources (animal feed, compost, energy) cannot be effectively realized. This trend can be noted throughout the nation where organics recycling programs are performing poorly. Thus, in the future, more sophisticated and technology forward solutions that take the source separation burden out of the hands of the private individuals could be particularly helpful.

Chapter 5. Conclusions

This dissertation investigates consumer behaviors pertaining to food waste generation and organics recycling at home. The findings in these different chapters highlight the roles of policy nudges, consumer heterogeneity, and unintended consequences of environmental programs.

In the first chapter, I examine the role of people's opportunity cost of time in determining their willingness to participate in food waste reduction activities and organics recycling. Drawing from the existing literature, I propose a theoretical framework that connects people's willingness to dedicate efforts towards food waste prevention, organics recycling, and their opportunity cost of time. The results show that people's opportunity cost of time may negatively impact their willingness to participate in both food waste reduction activities as well as organics recycling endeavors. Thus, time costs are important when household make these environmentally sustainable decisions at home. Current public policy is focusing on improving residential organics programs to improve efficiency. Largely, the goals are to reduce the amount of organics that get mistakenly disposed with regular trash and to minimize the level of contamination in the composting stream. However, given the role of time costs, it may be more useful to think of other alternatives as potential solutions. There may be a need to invest in innovative technologies that could be scaled up which would in turn allow for central source separation to meet public policy goals more effectively.

In the second essay, I use factor analysis, a latent class model, and OLS regressions to characterize household behaviors and habits that may be associated with food waste. I also investigate whether underlying risk preferences and perceptions impact household food waste behavior. This study draws from an interactive survey which was administered at the Minnesota State Fair (N=333) in 2015. This survey collected details on relevant food purchasing behaviors, shopping routines, and kitchen management and cooking skills, amongst others. As a first step, our sample was categorized into two, highly distinct classes: *Planners* and *Extemporaneous Consumers*. For these classes of consumers, we examine the relative importance of cosmetic deterioration, in fresh ground beef and bagged spinach, together with other product attributes such as expiration dates and product size, in simulated food waste decisions. We find that while the effects for other product attributes such as price, size, and expiration date were quite modest, food cosmetic appearance played an important role. Food products, which appearance progressively deteriorated, although they remained edible, were increasingly more likely to get rejected by consumers. Both higher levels of risk perceptions and risk aversion increased people's tendency to discard food products. Higher levels of risk loving behavior was associated with larger variations in food waste tendencies across individuals. This paper highlights the role that public policy may play in shifting people's behavior. Especially, there may be gain in increasing awareness around cosmetic appearance and edibility of food products. Educating consumers to reassess risk perceptions of foods with cosmetic flaws may reduce the amount of food waste generated.

The last chapter investigates the role of information in determining people's behavior when it comes to organics recycling and food waste generation activities. This study draws from a randomized control trial in the City of Maplewood, Minnesota. A total of 121 participants were randomly assigned a group: Control Group, Treatment Group 1, and Treatment Group 2. Treatment Group 1 received similar information to current municipal food scrap collection programs, whereas Treatment Group 2 received more detailed information in a resource recovery lens. The Control Group were asked to discard their trash, food, and organic materials as they would normally. All groups obtained information on food waste prevention. We find evidence of a rebound effect; that is, those who were asked to recycle produced higher amounts of food waste and organics materials compared to those in the Control Group. These households may have felt laxer as they knew that their disposed materials would be recycled. Although the two treatment groups received different information on source separation, they generated similar levels of contamination and misclassification when it came to their disposed materials. Thus, information alone may not incentivize people to recycle more efficiently. Thus, other forms of education or awareness, such as in-person training in community groups may be more fruitful.

Both Chapters 2 and 4 emphasize the consequences of time costs. Chapter 4 especially highlights how time costs elicited in a survey may manifest in real life. As people face limited time at home, they may be more likely to discard their materials in the most convenient way for themselves. Thus, contamination and misclassification may be an expected consequence of time costs, even more so than lack of awareness/information. Particularly, people in the experiment (Chapter 4) discarded large amounts of packaged foods in their regular trash or in their composting stream (rather than separate and recycle them).

Sophisticated packaging emerged as a response to rising demand for convenience and evolved historically as people's opportunity cost of time rose. However, the large amounts of packaging in which our food come are becoming to threaten environmental sustainability. More recently, a gradual evolution in food packaging can be observed. Increasingly more food items are sold in bulk, free of packaging, or in compostable linings. These strategies effectively minimize the burden on households to carefully source separate and should be a priority for policy and the manufacturing industry. This is especially important to reduce contamination levels and encourage lower misclassification rates.

We also saw large amounts of food waste and edible food waste in the experiment conducted. This relates to the findings in Chapter 3. Often times people may discard food items with few blemishes, imperfections, and those that are closer to their expiration dates. Thus, awareness around the appearance of food and expiration dates may be important. Further, we noted a range in the amounts of materials that get discarded across participating households in Chapter 4. Risk preferences, perceptions, and heterogeneity may explain some of these large ranges for the food waste and organics materials discarded.

Overall, this dissertation highlights nudges that could be in place to reduce food waste at home, especially through mitigation of risk perception and awareness towards key product attributes such as cosmetic appearance. Further, Chapters 2 and 4 enlighten on the role of public policy when it comes to organics recycling. Currently, municipalities across the nation are trying to improve the efficacy of their residential organics programs. However, time costs and other barriers may prevent households from meaningfully contributing to better source separation. One key conclusion is to perhaps ease the burden by removing this organics recycling responsibility from households. To achieve large scale efficiencies, central source separation may be key.

Nevertheless, policy should also consider potential unintended consequences of providing such conveniences. Particularly, this would not resolve the rebound effect that we note. It may in fact exacerbate the amounts of food waste and organic materials that households generate as they may feel laxer. This detail underlines two main points. First, there is a necessity to simultaneously pursue both food waste prevention at home and organics recycling. Second, policy should critically evaluate the relative importance and cost of reducing food waste at home and keeping food out of the landfill for environmental benefits.

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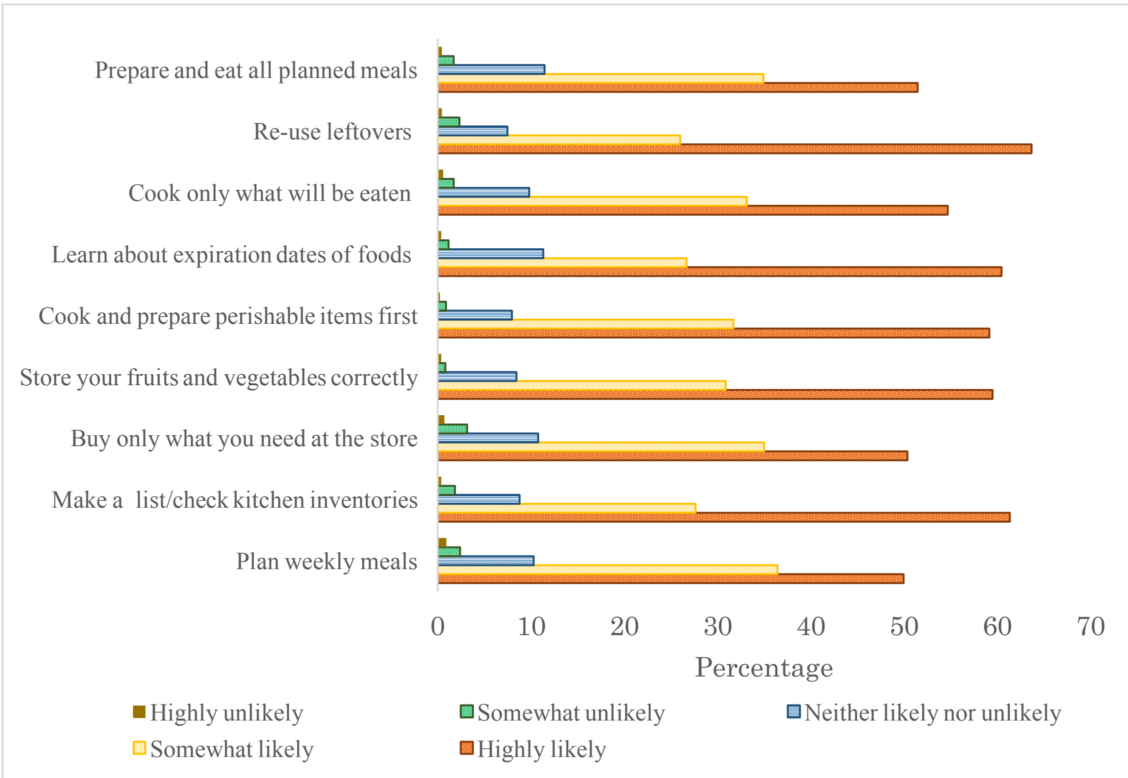
Appendix

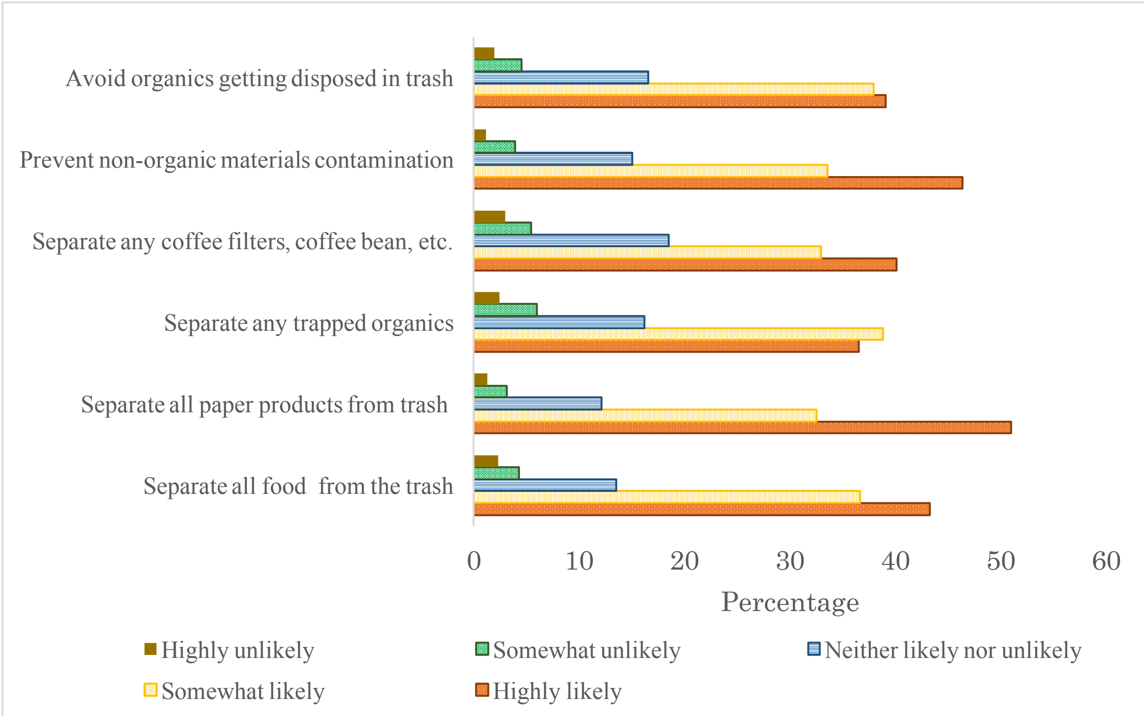
Appendix A

Figure A.1. Item-specific responses to willingness to participate questions (Food waste reduction)



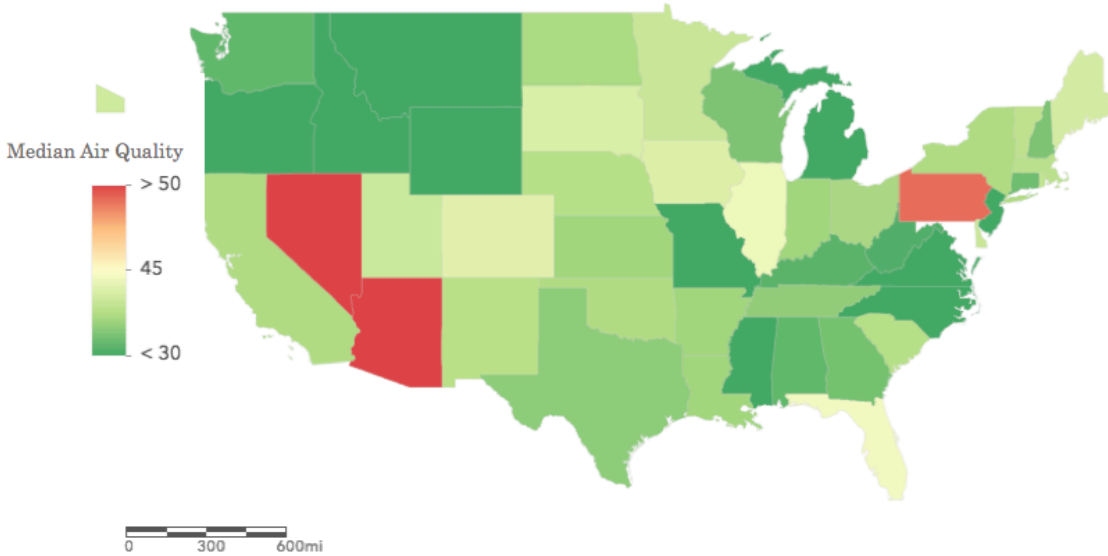
The chart shows the individual responses for the willingness to participate in nine separate activities that could reduce the amount of food waste at home.

Figure A.2. Item-specific responses to willingness to participate questions (Food and organics recycling)



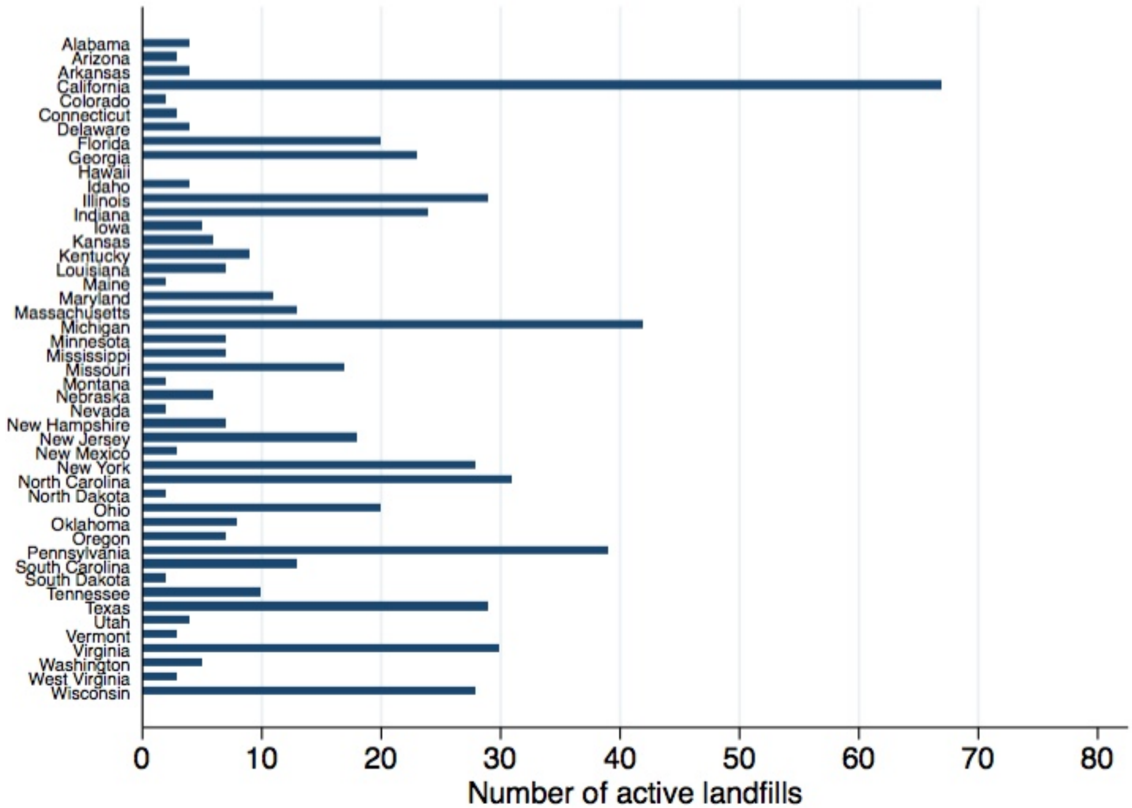
The chart shows the individual responses for the willingness to participate in six separate activities that could help with efficient recycling of food and organic materials.

Figure A.3. Median Air Quality Index (AQI) in the United States



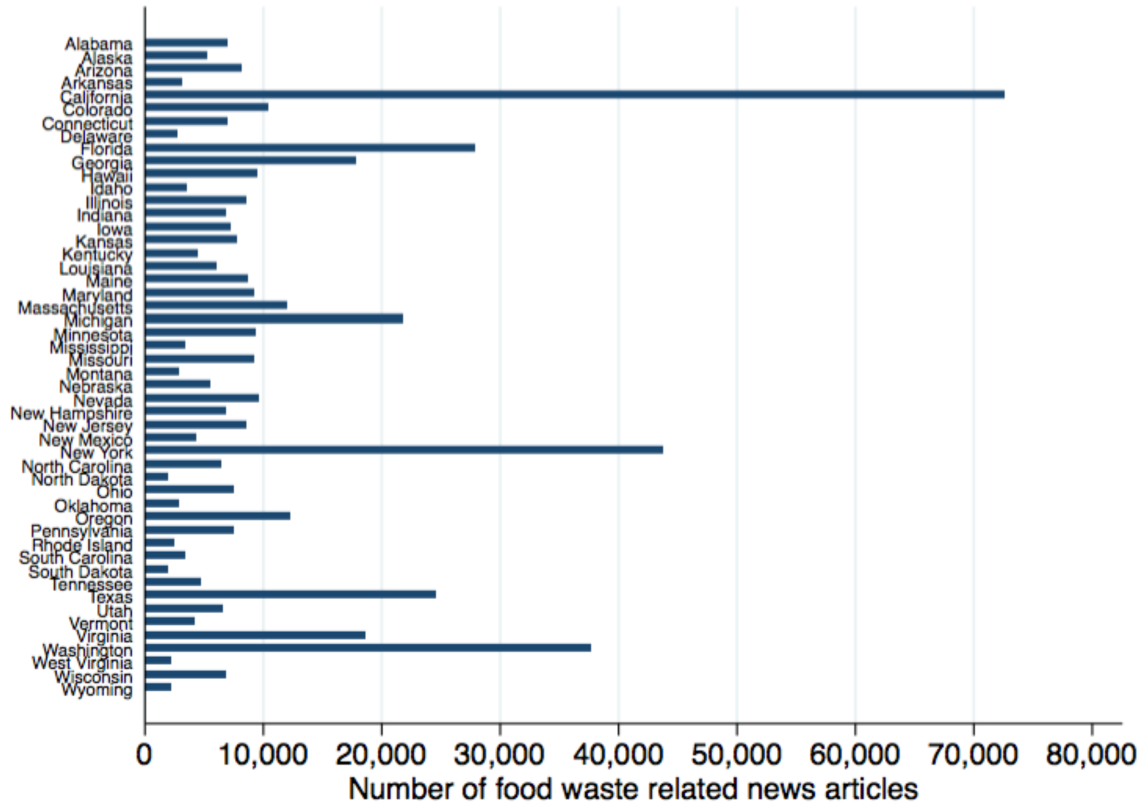
Notes: Data from the United States Environmental Protection Agency. The AQI consists of five major air pollutants regulated by the Clean Air Act which includes ground-level ozone, particle pollution, carbon monoxide, sulfur dioxide, and nitrogen dioxide. An air quality index of 50 or lower is considered "Good." Thus, all areas with hues of green have low level of health concern, with darker green showing very low levels of air pollutants. The median air quality is only available in certain regions within a state. To obtain a state-level median air quality index, I use the population weighted median air quality calculated at the state level using all the available observations at the regional level. Not pictured are the states of Hawaii (median air quality, 50) and Alaska (median air quality, 16.2). The median air quality index was not available for six states including Kansas, Vermont, South Dakota, Missouri, Oregon, and Alaska. For those states, I use the current air quality index (as of February 2019) to obtain a proxy for the median air quality index.

Figure A.4. Number of landfills by U.S state



Notes: The graph depicts the number of active landfills by state. Data from EPA (2018).

Figure A.5. Number of food waste related news by U.S state



Notes: The graph depicts the number of food waste related news available online by state. The value reported is obtained from searching "[state name]" and "food waste" in the news section of google search. While there are no limits on the dates of these articles, most news articles are recent (2014 or later). This is representative of the recent surge of interest on issues of food waste in the media.

Table A.1. First stage results for willingness-to-pay models (stage by stage)

	(1)	(2)	(3)	(4)
	Limited sample		Full sample	
	FW	*OREC*	*FW*	*OREC*
Income	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
State variables				
FW reduction programs	30071.3	86505.6	25333.9	17680.5
	(75309.5)	(75069.9)	(23583.4)	(28850.6)
Food disposal facilities	389543.4	600915.8	131685.9	323494.3
	(450636.5)	(453182.1)	(211566.5)	(256983.8)
Number of landfills	0.003	0.002	0.008	0.003
	(0.022)	(0.023)	(0.0163)	(0.017)
Air quality	-0.025	-0.056	-0.020	-0.029
	(0.047)	(0.061)	(0.033)	(0.048)
Household time variables				
Non-negotiable hours	-0.014	0.001	-0.011*	-0.006
	(0.007)	(0.008)	(0.004)	(0.005)
Minimum food activities	0.010	0.0256	0.013	0.022*
	(0.007)	(0.014)	(0.001)	(0.010)
Workhours	-0.012	-0.024	-0.004	-0.004
	(0.009)	(0.014)	(0.006)	(0.008)
Food price index	-0.434	0.040	-0.176	-0.071
	(0.934)	(0.957)	(0.684)	(0.733)
Constant	47.81	0.914	20.85	11.05
	(94.73)	(96.58)	(69.35)	(73.82)
N	522	617	865	865
F-Statistic	19.36	5.78	13.57	10.95

*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
This table reports the first stage results corresponding to Appendix Table A.2. Regressions include additional controls for age, and the dichotomous price (DC-CVM) that the respondents saw prior to reporting their maximum willingness-to-pay amount. Columns (3) and (4) only include the DC-CVM question price value seen and to avoid missing variables, a price equal to 0 is assigned for those who did not answer the contingent valuation questions.

Table A.2 Second stage least squares estimates of household organics recycling (OREC) and food waste (FW) reduction efforts using willingness-to-pay measures using stage-by-stage IV method.

	(1)	(2)	(3)	(4)
	Limited Sample		Full Sample	
	FW	*OREC*	*FW*	*OREC*
Opportunity cost [a]	-0.008*	-0.016*	-0.022***	-0.027**
	(0.007)	(0.008)	(0.005)	(0.009)
Recycling/Food waste reduction				
Pleasant activity	0.163***	0.222***	0.158***	0.252***
	(0.028)	(0.036)	(0.033)	(0.031)
Better environment [b]	0.199***	0.317***	0.153***	0.295***
	(0.042)	(0.055)	(0.033)	(0.043)
Other's participation	0.011	0.012	-0.008	0.043
	(0.023)	(0.029)	(0.020)	(0.025)
Moral motivations				
Responsible person [c]	0.124**	0.314***	0.144***	0.271***
	(0.045)	(0.057)	(0.038)	(0.047)
Others [d]	0.021	-0.007	0.0143	0.000
	(0.029)	(0.032)	(0.022)	(0.028)
State level variables				
Recycling programs present		0.139		0.103
		(0.094)		(0.084)
Food waste related news	-0.000		-0.000	
	(0.000)		(0.000)	
Shopping location (Grocery omitted)				
Supermarkets	-0.013		0.014	
	(0.044)		(0.038)	
Warehouse clubs	-0.061		-0.121	
	(0.077)		(0.076)	
Other	-0.157		-0.172	
	(0.116)		(0.111)	
Household time variables				
Non-negotiable hours	-0.001	-0.001	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.001)
Minimum food activities	-0.000	0.0004	-0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Food satisfaction	0.304***		0.269***	
	(0.046)		(0.040)	
Constant	0.972***	0.422	1.330***	0.564**
	(0.228)	(0.253)	(0.222)	(0.195)
N	522	617	865	865

[a] *Opportunity cost of time/Willingness-to-pay*

[b] *Contributes to better environment*
[c] *Consider myself a responsible person*
[d] *Others to consider me responsible*
[e] *Food recycling programs present*
[f] *Minimum food-related activities*
*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
All regressions control for demographic characteristics including race, education, income, household size, and gender.

Table A.3 Second stage least squares estimates of household organics recycling (OREC) and food waste (FW) reduction efforts using household income as the opportunity cost using stage-by-stage IV method.

	(1)	(2)
	IV Results	
	FW	*OREC*
Opportunity cost [a]	-0.000**	-0.000
	(0.000)	(0.000)
Recycling/Food waste reduction		
Pleasant activity	0.163***	0.255***
	(0.038)	(0.029)
Better environment [b]	0.133*	0.295***
	(0.053)	(0.041)
Other's participation	0.006	0.050**
	(0.030)	(0.023)
Moral motivations		
Responsible person [c]	0.149*	0.276***
	(0.059)	(0.027)
Others [d]	0.015	-0.002
	(0.034)	(0.027)
State level variables		
Recycling programs present		0.109
		(0.076)
Food waste related news	0.000	
	(0.000)	
Shopping location (Grocery omitted)		
Supermarkets	0.034	
	(0.060)	
Warehouse clubs	-0.108	
	(0.117)	
Other	-0.151	
	(0.164)	
Household time variables		
Non-negotiable hours	0.000	-0.000
	(0.001)	(0.000)
Minimum food activities	-0.000	0.000
	(0.001)	(0.001)

	(1)	(2)
	IV Results	
Food satisfaction	0.279***	
	(0.062)	
Constant	1.752***	0.586**
	(0.383)	(0.215)
N	865	865

[a] Opportunity cost of time/Willingness-to-pay
[b] Contributes to better environment
[c] Consider myself a responsible person
[d] Others to consider me responsible
[e] Food recycling programs present
[f] Minimum food-related activities
*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
All regressions control for demographic characteristics including race, education, income, household size, and gender.

Table A.4 Second stage least squares estimates of household organics recycling (OREC) and food waste (FW) reduction efforts using inferred wage rate as the opportunity cost measures using stage-by-stage IV method.

	(1)	(2)
	IV Results	
	FW	*OREC*
Opportunity cost [a]	-0.023	-0.006
	(0.089)	(0.016)
Recycling/Food waste reduction		
Pleasant activity	0.163	0.255*
	(0.424)	(0.102)
Better environment [b]	0.133	0.295*
	(0.590)	(0.142)
Other’s participation	0.006	0.050
	(0.338)	(0.082)
Moral motivations		
Responsible person [c]	0.149	0.276
	(0.662)	(0.158)
Others [d]	0.016	-0.002
	(0.382)	(0.093)
State level variables		
Recycling programs present		0.109
		(0.265)
Food waste related news	-0.000	
	(0.007)	

Shopping location (Grocery omitted)		
Supermarkets	0.034	
	(1.837)	
Warehouse clubs	-0.108	
	(1.310)	
Other	-0.150	
	(1.837)	
Household time variables		
Non-negotiable hours	-0.000	-0.000
	(0.008)	(0.002)
Minimum food activities	-0.000	0.000
	(0.013)	(.0025)
Food satisfaction	0.279	
	(0.690)	
Constant	1.866	0.615
	(4.490)	(0.798)
N	865	865

[a] Opportunity cost of time/Willingness-to-pay
[b] Contributes to better environment
[c] Consider myself a responsible person
[d] Others to consider me responsible
[e] Food recycling programs present
[f] Minimum food-related activities
*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
All regressions control for demographic characteristics including race, education, income, household size, and gender.

Table A.5 OLS and Second stage results (Wage rate – self-reported measure – inferred as opportunity cost of time)

	(1)	(2)	(3)	(4)
	OLS Results		IV Results	
	FW	*OREC*	*FW*	*OREC*
Opportunity cost [a]	0.000	-0.000	-0.006	-0.001
	(0.002)	(0.000)	(0.005)	(0.001)
Recycling/Food waste reduction				
Pleasant activity	0.159***	0.253***	0.163	0.255***
	(0.022)	(0.028)	(0.097)	(0.036)
Better environment [b]	0.136***	0.295***	0.133	0.295***
	(0.032)	(0.039)	(0.135)	(0.050)

	(1)	(2)	(3)	(4)
	OLS Results		IV Results	
Other's participation	-0.007	0.0476*	-0.007	0.050
	(0.019)	(0.022)	(0.078)	(0.029)
Moral motivations				
Responsible person [c]	0.163***	0.281***	0.149	0.276***
	(0.036)	(0.043)	(0.152)	(0.056)
Others [d]	-0.000	-0.005	0.0155	-0.002
	(0.021)	(0.025)	(0.088)	(0.033)
State level variables				
Recycling programs present [e]		0.110		0.109
		(0.076)		(0.093)
Food waste related news	-0.000		-0.000	
	(0.000)		(0.000)	
Shopping location (Grocery omitted)				
Supermarkets	0.019		0.034	
	(0.036)		(0.154)	
Warehouse clubs	-0.138		-0.108	
	(0.072)		(0.300)	
Other	-0.150		-0.150	
	(0.105)		(0.421)	
Household time variables				
Non-negotiable hours	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.002)	(0.001)
Minimum food activities [f]	-0.000	0.000	-0.0004	0.000
	(0.001)	(0.001)	(0.0029)	(0.001)
Food satisfaction	0.280***		0.279	
	(0.038)		(0.158)	
Constant	1.255***	0.462**	1.428	0.504*
	(0.209)	(0.176)	(0.899)	(0.232)
N	865	865	865	865

[a] *Opportunity cost of time/Willingness-to-pay*
[b] *Contributes to better environment*
[c] *Consider myself a responsible person*
[d] *Others to consider me responsible*
[e] *Food recycling programs present*
[f] *Minimum food-related activities*
*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
All regressions control for demographic characteristics including race, education, income, household size, and gender.

Table A.6. First stage results (Reduced form models)

	(1)	(2)	(3)
	Income	*Wage Rate 1*	*Wage Rate 2*
Total food/beverage expenditures	55.66***	0.0747*	0.0177***
	(12.93)	(0.0300)	(0.0046)
Constant	61246.7***	23.93***	24.39***
	(3784.8)	(5.975)	(1.465)
N	865	865	865
F-statistic	18.53	6.19	15.17

*Notes: * P < 0.05, ** P < 0.01, *** P < 0.001.*
Column 1 corresponds to the first stage results from Appendix Table A.3.
Column 2 corresponds to the first stage results from Appendix Table A.4. Note that the F-statistic is 6.19, which does not meet the minimum of 10. This may be related to the problematic measure of this wage rate variable.
Column 3 corresponds to the first stage results from Appendix Table A.5.

A.1 Supplemental Materials

Box 1. Current facts about food waste in the U.S.

1. Over 30-40% of food produced is wasted every year.
2. Food waste generates 23% of all methane emissions from landfills.
3. Food waste accounts for 25% of losses in resources such as water, land and energy used to produce the food.
4. It's costly to dispose food that we discard even to landfills.
5. Food wasted is worth over $162 billion.
6. Consumers at home generate about 51% of total food waste landfilled.
7. Reducing food waste could save an average family of four up to $1,500 a year.

Box 2. Current facts about organics recycling in the U.S.

8. Food scraps make up about 22% of the weight of material that goes to landfills.
9. Recycling of discarded food presents an opportunity to divert the waste towards other productive uses.
10. Food scraps obtained from recycling programs can be used for production of energy, compost, or animal feed.
11. Recycling food scraps can help save costs of waste disposal.
12. About 4% of U.S households have access to food recycling programs.

Above are the facts on food waste (Box 1) and organics recycling (Box 2) that were shown to respondents in the survey. Respondents saw these informational facts prior to providing their willingness to participate in food waste reduction activities (organics recycling activities), their willingness-to-pay values, as well as the environmental valuation. The individuals were also quizzed to check their understanding. This exercise was implemented to mitigate subjective biases when it comes to environmental valuation (Whitehead, 2006; Berrens et al., 2002).

Appendix B

Table B.1 Risk coefficients from regression results (Spinach)

Risk Variables	All sample	Planners	Extemporaneous. Consumers
rr/CRRA	5.626	9.924*	7.424
	(3.607)	(4.747)	(5.932)
Risk Perception	6.627***	3.558*	10.619***
	(1.195)	(1.582)	(1.870)
CRRA/rr Risk Perception	-2.239	-3.703*	-2.676
	(1.175)	(1.590)	(1.883)
Number of individuals	283	160	123
Observations	1,270	731	539

All Model controls for product attributes and demographic variables
Robust standard errors in parentheses

Table B.2. Risk coefficients from regression results (Beef)

Risk Variables	All sample	Planners	Extemporaneous. Consumers
rr/CRRA	2.783	11.232*	3.886
	(3.576)	(4.391)	(6.920)
Risk Perception	7.681***	10.172***	4.520*
	(1.219)	(1.537)	(2.137)
CRRA/rr Risk Perception	-1.484	-3.324*	-2.231
	(1.204)	(1.499)	(2.303)
Number of individuals	248	137	111
Observations	991	548	443

All Model controls for product attributes and demographic variables
Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Appendix C

FOOD-RELATED DEFINITIONS:[17]

FOOD WASTE: all edible and inedible parts of food that is discarded

INEDIBLE PARTS: components associated with food which are not typically consumed in the United States and/or for which significant skill or effort would be required to render edible.

EDIBLE:

1. QUESTIONABLY EDIBLE FOOD: food items which can be safely eaten, but may not be considered edible by a portion of the population due to culture or preference.
2. TYPICALLY, EDIBLE FOOD: food items which are intended for human consumption and are not generally considered inedible.

Inedible Items not intended for human consumption (small amounts of edible material associated with the inedible material are permitted to be included)

- *Egg shells, banana peels, pits/ seeds, bones*

Typically, Edible –

- Meat & Fish: Uncooked or cooked meat (with mostly edible components) unmixed with other types of food
  - *Boneless chicken breast, salmon fillet*

- Dairy & Eggs: Solid dairy or egg products unmixed with other food types or in original form
  - *Cheese, yogurt, fried egg*

- Vegetables & Fruits: Solid uncooked or cooked vegetables and fruits (with mostly edible components) unmixed with other types of food
  - *Potatoes, spinach, berries, salad with only vegetables*

- Baked Goods: Baked goods and bread-like products unmixed with other food types or in original form, including pastries
  - *Bread, tortillas, pastries*
- Dry Foods: Cooked or uncooked grains, pastas, legumes, nuts, or cereals unmixed with other food types or in original form

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[17] *These food-related definitions have been adapted from the NRDC report (Hoover, 2017)*

- *Rice, cereal, pasta*

- Snacks, Condiments, & Other: Includes confections, processed snacks, condiments, and other miscellaneous items
  - *Condiments, candy, granola bars, sauces, jellies*

- Liquids/Oils/Grease: Items that are liquid, including beverages and sodas
  Milk, oil, juice

- Cooked/Prepared Items/ Leftovers: Items that have many food types mixed together as part of cooking or preparation
- *Lasagna, sandwiches, leftovers*

Questionably Edible

- *Apple (skin and cores), Potato (peels), Carrot (peels and tops/greens), Broccoli (stalks), Cauliflower (stalks), Lettuce (outer leaves and cores), Asparagus (stems), Chicken (skin, giblets), Tomato (cores), Cucumber (skins), Kale (stems), Radish (leaves), Herbs (stems), Leek (tops), Celery (tops)*

Unidentifiable Food (Used only if necessary)

ORGANICS DEFINITIONS

The following are organics:

- All Food (<u>see above</u>)
  - *Fruits and vegetables; Meat, fish and bones; Dairy products; Eggs and egg shell; Pasta, beans and rice; Bread and cereal; Nuts and shells*

- Food soiled paper
  - Pizza boxes from delivery; Napkins and paper towels; Paper egg cartons

- Certified compostable materials
  - *Compostable paper and plastic cups, plates, bowls, utensils and containers*

  **Look for the BPI or Cedar Grove logos or the term "compostable" on certified products*

- Other compostable household items
  - *Coffee grounds and filters; Hair and nail clippings; Cotton balls and swabs with paper stems; Houseplants and flowers; Tea bags (tricky one!); Wooden items such as chopsticks, popsicle sticks and toothpicks*

NOT ACCEPTABLE:

- *Yard waste, diapers and sanitary products, animal and pet waste, litter or bedding, cleaning or baby wipes, grease or oil, Styrofoam™, dryer lint and dryer sheets, recyclable items (cartons, glass, metal, paper, plastic), frozen food boxes, microwave popcorn bags, gum, fast food wrappers, products labeled "biodegradable"*

Other recyclables: aluminum foil, glass, plastics, and metals

Appendix D

Expose D.1. Youtube Videos Screenshots and URLs

The following shows a screenshot of the videos that the participants saw and the URL to the videos. Scripts are available upon request.

Control Group
https://www.youtube.com/watch?v=VTV8-skhD7o&feature=youtu.be

Treatment Group 1

https://www.youtube.com/watch?v=gxTzBHsH1cE&t=120s

Treatment Group 2

https://www.youtube.com/watch?v=pDM8JV0-Tz4&feature=youtu.be