Household Food Waste, Food Shopping Behavior, and Time Use

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Introduction

In 2015 the United States (U.S.) set a goal to halve food loss and waste (FLW) by 2030 (Jaglo et al., 2021). While there are no official measures of FLW, studies have estimated that across the entire food supply chain between 161 to 355 billion pounds of food is lost or wasted annually, which translates to approximately 492 to 1,032 pounds per person or 35 percent of the U.S. food supply (Jaglo et al., 2021). This level of FLW is concerning to policy makers both because of the environmental impacts associated with food production and also due to the potential to reallocate foods that will otherwise not be consumed to food insecure households that cannot otherwise afford a sufficient amount of food. As it is believed that roughly half of the FLW in the U.S. occurs at the consumption stage, in either households or in food service, developing an understanding of household level drivers of FLW is necessary to develop policies and programs to effectively modify behavior and reduce FLW (Jaglo et al., 2021).

Household food waste can be generated when consumers purchase, prepare, store, or consume food, therefore models of consumer food waste behavior could consider one or several of these stages of household food behavior. Some of the most recent studies of household food waste from the perspective of consumer behavior have consider food waste in relation to inefficiencies in household production of meals at home (Smith and Landry, 2021; Yu and Jaenicke, 2020), or household demand for food waste (Landry and Smith, 2019). Landry and Smith (2019) found that the demand for food waste was elastic and could be considered a luxury good. They also found demand was decreasing in household size, education, and joint food shopping or meal production. When considering household food production inefficiencies, Smith and Landry (2021) found output efficiency was negatively correlated with larger household, age,

shopping frequency and higher education while Yu and Jaenicke (2020) found household food waste was positively correlated with food security, healthier diets, and higher incomes.

Several of these studies have utilized the Becker model of household production as the economic framework to guide their empirical analysis (Landry and Smith, 2019; Smith and Landry, 2021; Yu and Jaenicke, 2020). While an important feature of the Becker model is the presence of both time and money constraints, the current literature lacks studies that address the influence of time use and the opportunity cost on household food waste behaviors (Landry and Smith, 2019; Smith and Landry, 2021; Yu and Jaenicke, 2020). However, both Smith and Landry (2021) and Yu and Jaenicke (2020) found that longer distance to the household's grocery store was associated with either greater inefficiency or food waste. As distance can serve as a proxy for time use, since greater distances require longer travel times, it suggests that the time use may influence household food behaviors related to food waste.

Prior literature has shown that as an individual's opportunity cost of time increase, they spend more money on food away from (FAFH) and less time in FAH production (Davis, 2014). On the one hand, it is possible that higher opportunity costs of time could result in higher levels of food waste as households spend less time preparing food from purchased ingredients, which results in purchased ingredients being discarded. On the other hand, it is possible that households with higher opportunity cost spend more on FAFH, resulting in more meals away from and less meals at home, which would also reduce time in FAH production but may also decrease food waste. Given these two possible scenarios it is necessary to explore the relationship between time use, meal production, and household food waste empirical.

The purpose of this paper is to incorporate measure of FAH time use and the opportunity cost of time into a model for household food waste demand. The paper will used data collected

from an original online survey administered to nationally representative convenience sample between April and May 2022. Respondents were included in the survey if they were the household's primary food shopper, and asked questions regarding household characteristics, employment status, and past week food behaviors. Food behaviors include trips and expenditures for FAH, trips and expenditures for FAFH, time spent preparing meals, and household food waste. The current analysis provides initial insights into the relationship between time use, FAH production, and household food waste using the respondent's wage rate as a proxy for their opportunity cost of time. Future analysis will also consider estimating the opportunity cost of time for FAH production based on the opportunity cost approach (Davis and Yu, 2010).

Conceptual Framework

In Becker's household production model, households form preferences over commodities that are produced by a household production function subject to time and money constraints (Becker, 1965). Lusk and Ellison (2017) demonstrated how the Becker model could be utilized to conceptualize household food waste as the outcome of an economic process, rather than a mistake or ineficiency and we utilize their model with a minor modification by including FAFH.

In this model, households have utility over two commodities, FAH meals (z_h) and FAFH (z_a), and leisure time (t_l):

$$U = U(z_h, z_a, t_l) \tag{1}$$

Meals are produced by the household using food (x_j) inputs and time (t_j^m) where the subscript j references at home (h) or away from (a) and h is a vector of household charactersitics that effect the producitivty of meal production:

$$z_j = f\left(x_j, t_j^m; h\right) \quad j = h, a \tag{2}$$

Households are also subject to time (3) and money (4) constraints, where w is the wage rate and t_w is time spent at work.:

$$T = t_w + t_l + t_h^m + t_a^m \tag{3}$$

$$x_h p_h + x_a p_a = w t_w \tag{4}$$

Lusk and Ellison (2017) define household food waste (W) as the ratio of demand for raw food to meals consumed ($W = x/z$). Since we are primarily interested in food waste generated in the home we refine this defintion slightly so that household food waste is the ratio of household demand for FAH food inputs over demand for FAH meals ($W = x_h/z_h$).

Demand for food inputs, leisure time, and time spent producing meals is found by maximing utility subject to the meal production function, and money and time constriants:

$$x_h^* = x_h(p, w, T; h); x_a^* = x_a(p, w, T; h)$$

$$t_h^{m*} = t_h^m(p, w, T); t_a^{m*} = t_a^m(p, w, T);\ t_l^* = t_l(p, w, T) \tag{5}$$

Then, optimal food waste can be found by substituting these values into the ratio: $W^* = x_h^*/z_h(x_h^*, t_h^{m*}; h)$. Therefore, optimal food waste is a function of the price of FAH food inputs, wages, the marginal productivities of FAH production, FAH time used in food production, and wages.

Time use and the opportunity cost of time appears several places in the Lusk and Ellison (2017) model for optimal household. First, time use appears directly as an input to the production of both FAH and FAFH meals. Second, wages are often used as proxy measure for the opportunity cost of time since individuals must make choices about how time is allocated between work and leisure. Wages appear in the demand for both goods and time, which indicates they play a role in a household's decision regarding the optimal amount of food purchase or time to spend in home food production and therefore subsequently food waste. Although wages are

often used as a proxy measure of the opportunity cost of time, they may not be the most appropriate measure as it would suggest individuals who are not employed have an opportunity cost of time equal to zero (Davis, 2014). More formally, wages are an appropriate measure of the opportunity cost of time for non-market activities like FAH production for interior solutions (i.e. a positive amount of time allocated to both work and FAH production) (Davis and You, 2010). In the case of corner solutions, an alternative measure can be estimated using the opportunity cost approach (Davis and You, 2010).

Data

Data for this study comes from two online surveys administered by Qualtrics to a national convenience sample with quotas in April and May 2020. Respondents were eligible to participate if they were at least 18 years of age and the primary food shopper for their household. Appropriate human subjects' protocols were followed, and institutional review board approvals were obtained (UTK-IRB-20-06141-XM).

Respondents completed two surveys administered one week apart. In the first survey, respondents were asked question regarding respondent and household characteristics. This included questions related to household size, the presence of children, household income, the respondent's wage, and employment status. Additionally, respondents were asked about their self-assessed cooking abilities, grocery shopping and meal planning habits, and access to food storage (i.e. freezers, refrigerators) resources. Responses to these questions will be used to measure household characteristics that may influence the productivity of household meal production.

In the second survey, respondents were asked about their food behaviors in the past week. This included self-reported time spent grocery shopping, grocery expenditures, restaurant expenditures, and time spent preparing meals. To measure past week household food waste, we utilized the validated *Household Food Waste Questionnaire* survey developed by van Herpen et al. (2019). Prior studies validating this survey instrument found that it was highly correlated with four other methods of collecting household food waste including diaries, photo coding, and kitchen cadies. While the survey resulted in an underestimation of the level of household food waste, the variance across households was similar (van Herpen et al., 2019).

There were 397 respondents that completed both surveys and are included in this analysis. Analysis for this paper will rely on descriptive statistics and simple linear regression to provide initial insight into the relationship between time use for FAH production, food expenditures, and household food waste using the respondent's wage rate as a proxy for their opportunity cost of time. Additional covariates are the same in all regressions and include household income, respondent age, gender and race, presence of children, number of additional adults in the household, census region fixed effects, household characteristics related to FAH production productivity (use of car for grocery shopping, attitudes towards cooking, eating leftovers, and meal planning).

Results

Table 1 contains descriptive statistics for the full sample. Respondents were on average 54.98 years old, 55.05 percent of respondents identified as female, and 53.90 indicated they were married. Approximately 34 percent of the sample identified as white, 3.53 as black, and 50.13 percent as Hispanic. On average, households had one other adult in the home and 28.21percent had at least one child in the home. Most respondents, 53.90 percent, had completed college or a

professional degree and 46.58 percent were currently employed full or part time. Amongst those who were not currently employed most were retired. Respondents who were employed full or part time typically worked on average 37.69 hours per week and indicated their wage rate was $44.75 per hour. Respondents also report the household's income in 2021, which includes the income from all household members. Approximately 39 percent live in a household that earned less than $50,000, 29 percent lived in a household that earned between $50,000 and $100,000, and 33 percent lived in a household that earned more than $100,000.

Table 2 compares several of the household food behavior variables across subsamples based on the respondent's employment status. Since the respondent is the household's primary food shopper, this may give some initial insight into the influence of their opportunity cost of time on household food behaviors. The most common method for traveling to the primary food store was using a car, which included the household's own car, someone else's car or taxi. Employed respondents were slightly more likely to report using a car, while respondents who were not employed were slightly more likely to report using delivery.

When considering attitudes towards different food activities (Table 2), which may influence a household's marginal FAH productivity, households were fairly similar across respondent's employment status. Most household indicated that they enjoyed cooking, but not spending large amounts of time in the kitchen. Less than half of respondents indicated that they do not consume food after the expenditure date, and a majority of respondents indicate they evaluate food to be thrown away based on appearance and smell.

Additionally, Table 2 contains descriptive statistics for the last week food behaviors that will be used as outcome variables in the demand models. On average, households in which the respondent was not employed spent more time grocery shopping (employed=115.28 minutes vs

not employed =137.78 minutes) and cooking (employed =170.58 minutes vs not employed = 202.49 minutes) in the last week. However, on average they also spent less on groceries (employed = $193.05 vs not employed = $132.94). Households with an employed respondent spent more on food at restaurants (employed = $61.70 vs not employed = $57.67) and also had higher levels of food waste (employed = 663.76 grams vs not employed = 423.32 grams).

Finally, Table 3 contains the results from the preliminary linear regressions investigating the influence of wage, the naïve measure of the opportunity cost of time, on several food behavior outcomes. Columns contain results for different dependent variables including time spent grocery shopping, time spent preparing meals at home, grocery expenditures, restaurant expenditures, and household food waste. Increasing wage rates are associated with less time spent preparing meals, and greater food waste, even after controlling for household income. This suggest that the opportunity cost of time may play a role in understanding the household food behaviors that result in different levels of food waste. However, these are very preliminary results and future analysis is needed to develop a better measure of the opportunity cost of time and refined the regression analysis.

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Tables

Table 1: Respondent and Household Characteristics

Respondent Characteristics	Mean (SD)
Age	54.98 (15.62)
Female	55.05 (49.81)
White	34.01 (47.43)
Black	3.53 (18.47)
Hispanic	50.13 (50.06)
Married	53.90 (49.91)
Highschool or less	15.37 (36.11)
Some college or two-year degree	30.73 (46.20)
College, graduate, or professional degree	53.90 (49.91)
Employed full or part time	46.58 (49.95)
Retired	37.22 (48.40)
Stay at home parent	5.57 (22.96)
Not currently working	6.58 (24.83)
Unable to work due to illness/disability	3.04 (17.18)
Student	1.01 (10.02)
Hours per week typically worked amongst individuals employed full or part time	37.69 (9.35)
Hourly wage rate	$44.75 (39.93)
Number additional adults in the home	1.29 (0.92)
Presence of children in household	28.21 (45.06)
Household Characteristics	

Income less than $50,000	38.68 (48.76)
Income between $50,000 and $99,999	28.50 (45.20)
Income at least $100,000	32.82 (47.02)
Midwest	15.87 (36.58)
Northeast	19.14 (39.39)
South	36.27 (48.14)
West	28.72 (45.30)

Table 2: Household Food Behaviors by Employment Status

Mean (SD)	Full Sample	Employed	Not Employed
Method of getting to primary food store			
Car including own, someone else's, or taxi	88.38 (32.08)	91.30 (28.25)	85.71 (35.08)
Walk	6.31 (24.35)	5.98 (23.77)	6.67 (25.00)
Bike	0.51 (7.10)	0.54 (7.37)	0.48 (6.90)
Delivery	2.78 (16.45)	0.54 (7.37)	4.76 (21.35)
Other	0.25 (5.03)	0.54 (7.37)	0.00 (0.00)
Attitudes towards food activities			
Enjoy cooking from scratch	59.85 (49.08)	58.15 (49.47)	61.43 (48.79)
Enjoy spending time in the kitchen	35.77 (47.99)	34.24 (47.58)	36.97 (48.39)
Do not consume food after the expiration date	42.78 (49.54)	44.20 (49.80)	41.46 (49.39)
Not worried that eating leftovers causes illness	47.86 (50.02)	45.65 (49.95)	49.29 (50.11)
Evaluate food to be thrown away by its appearance and small	68.77 (46.40)	66.30 (47.40)	70.62 (45.66)
Before grocery shopping check fridge or pantry to see what is needed	78.09 (41.42)	76.09 (42.77)	79.62 (40.38)
Eat leftovers at least most of the time	55.92 (49.71)	57.07 (49.63)	54.98 (49.87)
Receive help from household members cooking meals most of the time	25.32 (43.54)	28.42 (45.22)	22.38 (41.78)
Last week food behaviors			
Time spent grocery shopping (in minutes)	127.39 (420.65)	115.28 (167.50)	137.78 (559.31)
Time spent cooking meals at home (in minutes)	186.81 (257.82)	170.58 (257.99)	202.49 (257.70)
Grocery expenditures	$160.77 (251.66)	$193.05 (348.36)	$132.94 (108.34)
Restaurant expenditures	$59.40 (208.62)	$61.70 (70.28)	$57.67 (279.06)
Food waste (in grams)	538.97 (789.66)	663.76 (888.46)	423.32 (669.42)

Table 3: Regression Results

Coeff (Std Err)	Grocery shopping time	Time spent preparing meals at home	Grocery Expenditures	Restaurant Expenditures	Household food waste
Wage rate	-0.41 (0.77)	-0.88* (0.45)	0.57 (0.44)	0.22 (0.38)	2.52* (1.36)
Income at least $100,000	-35.45 (58.13)	74.31** (33.61)	32.19 (32.22)	24.05 (27.82)	-201.06** (99.8)7
Age	7.37 (11.31)	-5.71 (6.51)	0.57 (6.21)	1.97 (5.37)	-0.82 (19.28)
Age squared	-0.07 (0.11)	0.06 (0.06)	-0.01 (0.06)	-0.02 (0.05)	0.02 (0.18)
Female	27.61 (49.79)	20.90 (28.76)	-18.79 (27.53)	17.25 (23.78)	-179.87** (85.25)
White	8.00 (52.14)	-5.13 (30.01)	26.33 (28.96)	-42.48* (25.01)	1.43 (89.84)
At least college degree	32.78 (50.29)	43.33 (29.10)	15.20 (27.83)	-15.95 (24.03)	-9.98 (86.42)
Num. additional adults in the house	-25.02 (26.34)	8.25 (15.47)	11.97 (14.72)	-4.14 (12.71)	55.15 (45.71)
Presence of a child	164.74*** (60.87)	41.04 (35.08)	86.74 (33.62)	18.09 (29.04)	378.03*** (104.50)
Midwest	7.12 (75.11)	15.03 (43.03)	-3.18 (41.72)	78.08** (36.03)	66.16 (28.87)
Northeast	20.01 (71.14)	-54.37 (40.79)	3.59 (38.18)	19.37 (32.97)	66.95 (118.76)
South	81.55 (59.31)	-19.31 (34.04)	33.46 (32.69)	3.19 (28.23)	-31.48 (101.28)
Use car to travel to grocery store	35.57 (77.36)	-8.75 (44.02)	1.10 (42.73)	23.68 (36.90)	108.66 (133.07)

Enjoy cooking from scratch	37.52 (57.71)	80.16** (33.18)	27.60 (31.61)	-21.00 (27.30)	-4.59 (98.16)
Enjoy spending time in the kitchen	-59.73 (57.18)	-11.58 (32.56)	39.92 (31.37)	-3.81 (27.09)	95.45 (97.33)
Do not consume food after the expiration date	76.37 (49.90)	-64.70** (28.47)	13.68 (27.38)	-17.93 (23.65)	60.91 (85.06)
Not worried that eating leftovers causes illness	36.06 (51.72)	29.07 (29.84)	29.11 (28.38)	12.09 (24.51)	40.11 (87.96)
Evaluate food to be thrown away by its appearance and small	16.40 (55.79)	23.66 (32.62)	-13.00 (30.88)	-37.98 (26.67)	-37.72 (95.96)
Before grocery shopping check fridge or pantry to see what is needed	46.69 (62.54)	98.12*** (35.27)	8.25 (33.95)	22.59 (29.32)	-88.42 (105.42)
Eat leftovers at least most of the time	31.24 (49.77)	-11.69 (28.67)	-0.01 (27.33)	-33.47 (23.61)	-64.33 (84.83)
Receive help from household members cooking meals most of the time	-17.53 (55.96)	20.83 (32.58)	60.32* (31.30)	-0.98 (27.03)	156.88 (97.41)
Intercept	-246.50 (310.58)	161.07 (181.12)	23.24 (172.68)	10.20 (149.13)	381.84 (536.14)

**=p<0.10; **=p<0.05; ***=p<0.01*