HOUSEHOLD SOLID WASTE ASSOCIATED WITH FOOD CONSUMPTION ACTIVITIES*

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I. INTRODUCTION

The quantity of solid waste arising from household consumption activities commands considerable public concern. Information about the level and composition of consumption residuals and their relationship to household consumption activities is scarce. Such information is quite basic to a better understanding of solid waste problems and to formulating policies aimed at coping with them.

This paper focuses on linking solid waste from food consumption activities to consumer behavior. The theoretical framework used in conceptualizing the solid waste generation process and its relationship to household consumption behavior is presented in Section II. A four – equation model involving relationships for total household food expenditure, value of food consumed at home, value of meals eaten away-from-home and total household solid waste generated by food consumption activities is set forth in Section III. Data and estimation are discussed in Section IV. The quantities of glass, metal, plastic and paper associated with selected food consumption activities and selected food expenditures, and the statistical estimates of the four-equation model, are analyzed in Section V. Some concluding remarks are given in Section VI.

II. THEORETICAL FRAMEWORK

The traditional theory of consumer behavior has avoided any explicit consideration of consumption residuals. It has implicitly assumed that the act of consumption exhausts all goods that enter directly into a consumer's utility function. However, the last decade witnessed a new approach to consumer demand. Becker [1] suggested that the act of consumption is indeed a production process utilizing physical and nonmarket goods as inputs in order to produce commodities which maximize consumer utility. Becker was interested in analyzing the role of time allocation in relation to household consumption behavior. Lancaster [3] [4] generalized Becker's work, providing a fully integrated theory of consumer choice and demand in which characteristics of goods were taken explicitly into account. His approach was based on the assumption that commodities, per se, do not yield utility to consumer; rather, commodities possess characteristics, and these give rise to utility.

The idea of focusing on characteristics of commodities — as distinct from commodities themselves — is attributed to Hicks [2], although Menger [5] had a similar notion implicit in his view that people demand goods in order to satisfy certain "wants". Lancaster [3] [4] translated the psychological concept of wants into objective characteristics that have universal applications in demand analysis. The traditional demand analysis can be viewed as a special case of Lancaster's approach, where each good has one and only one characteristic.

Solid waste can be traced to the materials

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used as inputs in the consumption process. These materials are an integral part of the commodities and also possess characteristics which yield utility to consumers. Some people, for example, prefer soft drinks in disposable cans to soft drinks in disposable or returnable bottles. Solid waste from food origin is not confined to packaging material. The goods themselves may also generate waste; the level of their waste output depends upon the type and degree of processing of the good.

The cost to households of solid waste management services is fixed in many cases. Households pay a certain amount per year regardless of the waste output they generate. These fixed costs do not affect the consumer's budget allocation among goods. Assessing per-unit costs of managing solid waste may force consumers to alter their budget allocation to achieve maximum utility at a minimum cost of waste disposal.

Using Lancaster's approach, consumer behavior with respect to consumption activities (and associated residuals) can be described as a maximization problem. The objective criterion is utility expressed as a function of goods' characteristics. Constraints on the other hand include: two sets of technological relations linking goods and their characteristics through a collection of consumption activities; and budget constraint, which incorporates any costs of waste disposal associated with the activities.

Lancaster's framework focuses on the individual consumer. Although this framework does not explicitly consider residuals of consumption, modification to encompass such household waste can be formulated. Because of the nature of packaging and other solid waste, a household and not an individual consumer is considered the relevant economic decision-making unit in terms of solid waste generation.[1] Thus, the model will identify a household utility function as a starting point for considering household food expenditures, food consumption, and solid waste generation. This paper does not address itself to drawing inferences about specific individual members of a household. Its concern, rather, is mainly with a household and such attributes that may be germane to explaining the quantity and composition of household solid waste, food expenditures and food consumption.

Consider a household with a utility function over the characteristic space:

$$(1) \qquad U = U(Z_j), \quad j = 1, 2, \cdots s$$

where Z is a vector of s characteristics.

The household is faced with a budget constraint:

$$(2) \qquad P' X \leq k$$

where: X is a vector of n goods
P is a vector of prices of the n goods
k is the household budget or income.

Assuming U is a quadratic[2] function and the constraints are linear, the problem can be expressed in matrix form as the following quadratic program:

$$(3) \qquad \underset{Z}{\text{Max.}}\ U(Z) = a'Z + \tfrac{1}{2} Z' Q Z$$

subject to

$$(4) \qquad \text{(i)} \quad Z = BY, \ Y \geq 0$$

$$\text{(ii)} \quad X = AY$$

$$\text{(iii)} \quad P' X + D' RY \leq k$$

where,

a′ is a row vector of coefficients.
Q is a s x s symmetric negative definite matrix[3] of fixed elements.
Y is a vector of m consumption activities.
B is a s x m matrix whose elements, b_{ij}'s represent the amount of the ith characteristic derived from a unit level of the jth consumption activity.

[1] In recent years Becker [1], Nerlove [7] and others have advanced the notion of a household or family utility function as an appropriate framework for conceptualizing issues involving demand, consumption, value of education, allocation of time, etc. Becker [1] assumed a household utility function which is maximized over a set of commodities that are produced by adding a time input to market goods. Michael [6] and Prochaska and Schrimper [9] used the same type of framework to investigate the opportunity cost in consumption. Richardson and Havlicek [10] used a household utility function to analyze seasonal household waste generation.

[2] The quadratic form of utility yields indifference curves strictly convex to the origin as postulated in the traditional demand theory.

[3] Q here is identical to the Hessian matrix in the traditional analysis, except the characteristics replace goods.

A is a n x m matrix whose elements, a_{kj}'s represent the quantity of the k^{th} good required to carry on the j^{th} consumption activity at a unit level.

D is a vector of r elements corresponding to the total cost of managing r types of solid wastes.

R is a r x m matrix whose elements, r_{wj}'s represent the amount of the w^{th} type of solid waste generated by a unit level of the j^{th} consumption activity.

The matrices A, B, and R are assumed to consist of fixed coefficients. A and B are consumption technology matrices as defined by (i) and (ii). A budget constraint, (iii), includes the costs of disposal related to various types of solid waste. In the absence of a cost associated with level of solid waste output, the term D′ RY vanishes and (iii) collapses to (2). In the case of a flat fee per unit of time irrespective of the quantity of solid waste, the term D′ RY is equal to a constant defined by an institutional constraint. However, for both of the latter two situations solid waste linkage to consumption activities remains effective through the consumption relations defined in (i) and (ii).

The solution to the mathematical programming problem specified in (3) and (4) yields an efficient and optimal consumption activity vector which can be translated into quantities of goods by:

$$(5) \qquad X^* = A\ Y^*$$

The optimal consumption activity level, Y*, defines the level of solid waste associated with it which is:

$$(6) \qquad SW^* = R\ Y^*.$$

From a technical viewpoint, elements of R are considered to be the same per unit of consumption activity for all households choosing it.[4] Household characteristics are hypothesized to affect the type and level of consumption activities chosen by a household and thus the amount and type of solid waste generated.

With fixed prices, household behavior with respect to food expenditure, food consumption and solid waste can be represented by Engel curve types of functions. Total food expenditure (E) may be expressed as the sum of expenditure on food prepared at home, (E_1), and expenditure on away-from-home meals (M),

$$(7) \qquad E = E_1 + M$$

For any given time period, the value of food prepared at home (C) need not equal (E_1). The difference between the two reflects food inventory (I),

$$(8) \qquad I = (E_1 + M) - (C + M) = E - C - M.$$

Thus replacing (E_1) by (C), a three-equation system describing (E), (C), and (M) automatically incorporates the effect of inventory.

From (6) it can be seen that quantities of various types of solid waste depend on a household's choice of consumption activities and technical waste coefficient matrix R. For non-variant prices, these include variables such as household income and attributes of the household and its members. These are the same variables hypothesized to influence a household's behavior concerning food expenditure, food consumption and food inventory.

III. ECONOMIC MODEL AND HYPOTHESES

The empirical model hypothesized to link household food expenditure (Y_1), household food consumption (Y_2), expenditure on away-from-home meals (Y_3), and total food solid waste (Y_4) to household characteristics is:

$$(9) \qquad \begin{aligned} Y_1 &= f(X_1, X_2, X_3, X_4, X_5, X_6) \\ Y_2 &= f(X_2, X_3, X_4, X_5, X_6, X_8) \\ Y_3 &= f(X_1, X_2, X_3, X_5, X_6) \\ Y_4 &= f(X_2, X_3, X_4, X_5, X_6, X_7) \end{aligned}$$

[4]For many consumption residuals, considering elements of R the same for all households choosing particular consumption activities is quite reasonable. This would be true for most packaging waste and various types of newsprint. However, for yard waste, an important component of summer household waste load, and for table scraps as well as other types of putrescibles, respective elements of the R matrix are not necessarily the same for all families. But this does not detract from our subsequent analysis because we don't develop the elements of the R matrix nor use the elements directly in our analyses.

where,

Y_1 = total food expenditure, in dollars per week (E).

Y_2 = food consumed at home, in dollars per week (C).

Y_3 = away-from-home meals, in dollars per week (M).

Y_4 = quantity of solid waste of food origin, in pounds per week (SW).

X_1 = number of person meals eaten away-from-home per week.

X_2 = annual household income before taxes in dollars.

X_3 = a zero-one variable for sex of the head (M = 1, F = O).

X_4 = household size in number of persons.

X_5 = education of the housewife (years of schooling).

X_6 = age of the head in years.

X_7 = a zero-one variable for a gargabe disposal unit (1=with, 0=without).

X_8 = a zero-one variable for a home freezer (1=with, 0=without).

The following hypotheses apply to each of the four equations of the model in which the particular variables appear. Number of away-from-home meals, household income and household size are hypothesized to have positive coefficients. On the average, eating away from home costs more than eating at home. Engel's law indicates that as people's incomes rise, their food expenditure rises but at less than proportionate rate. Larger households spend more on food than smaller-sized households with similar characteristics. characteristics.

Household income as used here represents gross income taken from federal income tax records. For the purpose of this study, gross income as a measure of available household income was the most appropriate data.[5] Although gross income may not be the exact income figure to which households react, it should be highly correlated with other measures of income to which they might be reacting. Income is therefore hypothesized to be positively related to food expenditures, food consumption total household solid waste.

The housewife's education level is included in the model to account for opportunity cost of her time used in activities including meal preparation. The higher the education level the more valuable the housewife's time, thus the greater the purchase of partially prepared foods and convenience foods. Usage of these types of foods generally implies higher household solid waste loads. In terms of household food expenditures, expenditures on away-from-home meals and household food consumption, the effect can be either positive or negative, depending on whether a housewife's education level is viewed as a measure of economic efficiency in consumption. Michael [6] hypothesized[6] that the education elasticity coefficient in household consumption function could be $\gtreqless 0$ depending on whether $\eta_i \gtreqless 1$ (η_i = elasticity of consumption of commodity or group i with respect to income). Since η_i is unknown *a priori,* economic theory provides us with little information about the sign and magnitude of the parameter of housewife education level in terms of food expenditure, cost of away-from-home meals and food consumption.

There is no good basis for specifying hypotheses about effects of age and sex of the head of a household on household food expenditure, expenditures on away-from-home meals, household consumption and household solid waste. They are hypothesized to be a possible source of variation among households and included in the model to account for such variation should it exist.

The availability of a home freezer implies a saving in the cost of food consumed, provided the household is able to benefit from large purchase discounts and sales. This variable is expected to be negatively related with the value of food consumed at home.

Garbage disposal units should have no effect on the total quantity of residuals produced through consumption activities, but they do channel a considerable proportion of food waste into the the sewage system. This reduces the quantity of solid waste channeled into refuse collection which is the quantity being considered here. Thus, this variable is expected to be negatively related to the

[5] Michael [6] and Praise and Houthaker [8] have used total consumption expenditure as a proxy for permanent income.

[6] Michael's analysis is based on the neutrality assumption in the Hicksian sense, i.e. the effect of education on other factors in the household production function (process) is the same and thus induces no factor substitution.

quantity of solid waste of food origin.

IV. DATA AND ESTIMATION

Data required for estimation were secured through survey questionnaires and a panel study conducted in the Lafayette-West Lafayette, Indiana SMSA during May-June of 1973. Participating households were chosen randomly. Date related to consumption and its associated solid waste were obtained by sorting through residential solid waste to determine its composition. Participants were provided with plastic bags to collect their trash and garbage and were instructed to keep containers in a condition that would facilitate identification of the product and its price. Consumption data thus reflect the total food consumed based on prices from various discarded food containers.[7]

Grocery expenditures and expenditures on away-from-home meals were provided by panel members. Households were provided with special forms and cassette tape recorders. They were given the option of filling out the forms or recording their expenditures on tape. About 16 percent chose the latter option.

A total of 93 households cooperated in providing data for the study. An observation consisted of a four-week average for each operating household - data averaging was necessitated by the fact that consumers' shopping habits differ. Some households do their major shopping on a weekly basis, some on a monthly basis and many in between.

A linear stochastic form of the economic model specified in (9) was estimated using ordinary least squares procedures (OSL) and Zellner's [12] method of Seemingly Unrelated Regressions (SUR). In the latter method, two rounds of estimation are carried out. In the first round, OLS is applied to each equation separately. The error terms and their variances and covariances are estimated. In the second round, all equations are treated as one set and re-estimated jointly by applying Aitken's Generalized Least Squares procedure (GLS). The latter makes use of the estimated variance-covariance matrix of the structural disturbances as weights in deriving parameter estimates by the least squares method.

V. EMPIRICAL RESULTS

Information about average weekly per-household expenditures for various types of foods, dollar value of consumption of various types of food, amounts of solid waste associated with various types of foods, and rates of solid waste flow per dollar of expenditure and per dollar of consumption of various types of foods is presented in Table 1. The average weekly expenditure for food prepared at home was \$21.25 per week, about 8.4 percent of total household income before taxes. An additional \$7.22 per week was spent per household on meals away-from-home, thus the total amount spent on food was about 11.3 percent of total household income before taxes. Three-fourths of the expenditure on food prepared at home was for food in plastic and paper packaging materials, while the remaining one-forth was for food and beverages in glass and metal containers.

The average weekly dollar value of consumption of food prepared at home was \$18.61, representing 87.6 percent of the average weekly expenditure for food prepared at home. During the sample period, households were apparently increasing their inventories of food. This was particularly true for foods in plastic and paper packaging materials. On the other hand, the average weekly dollar value of consumption of food and beverages in glass and metal containers exceeded average weekly expenditures for these foods, indicating that some of them came from household inventories (or the expenditures on these foods contain some reporting errors). The largest differences of consumption exceeding expenditures occurred for beer and alcoholic beverages in glass, and soft drinks and beer in metal containers.

[7] A detailed description of data and data methodology can be found in Saleh [11, pp. 159-183].

Table 1. AVERAGE WEEKLY VALUES OF EXPENDITURE (E) $, CONSUMPTION (C) $, AND SOLID WASTE (SW) LBS., SOLID WASTE AS PERCENT OF TOTAL (PCT TSW), SOLID WASTE PER DOLLAR OF EXPENDITURE (SW/E), AND SOLID WASTE PER DOLLAR OF CONSUMPTION (SW/C), BY TYPE OF CONTAINER, FOR HOUSEHOLDS IN THE LAFAYETTE—WEST LAFAYETTE AREA OF INDIANA, MAY-JUNE 1973

Item No.	Description and Type of Container	E ($)	C ($)	SW (LBS)	PCT TSW	SW/E	SW/C
	Glass						
1.	All Food Glass	2.042	2.260	3.067	8.567	1.503	1.357
2.	Soft Drink	.500	.312	1.114	3.111	2.230	3.576
3.	Beer, Alcohol	.239	.847	.470	1.314	1.971	.556
4.	Other Food Glass	1.303	1.101	1.483	4.142	1.138	1.346
	Metal						
5.	All Food Metal	3.090	3.210	1.876	5.216	.607	.584
6.	Vegetables	.320	.354	.306	.854	.957	.863
7.	Fruits	.268	.250	.174	.485	.647	.695
8.	Juice, Drink	.270	.238	.221	.617	.818	.929
9.	Soft Drink	.295	.442	.371	1.037	1.259	.841
10.	Beer	.206	.522	.229	.640	1.110	.439
11.	Soup	.263	.200	.135	.378	.514	.676
12.	Meat, Seafood	.384	.446	.076	.212	.198	.170
13.	Other Food Metal	1.084	.758	.355	.993	.328	.469
	Plastic						
14.	All Food Plastic	9.015	7.089	.417	1.167	.046	.059
15.	Luncheon Meat	.524	.355	.011	.031	.021	.031
16.	Frozen Vegetable	.081	.063	.003	.008	.033	.043
17.	Dehyd. Vegetable	.007	.003	.000	.001	.029	.071
18.	Oth. Food Plastic	8.403	6.668	.403	1.127	.048	.061
	Paper						
19.	All Food Paper	6.920	5.995	1.348	3.764	.195	.225
20.	TV Dinners, etc.	.464	.381	.053	.147	.113	.138
21.	Frozen Cakes, Pies	.063	.043	.012	.034	.196	.285
22.	Frozen Vegetable	.101	.073	.023	.063	.224	.308
23.	Milk	1.321	1.366	.393	1.099	.298	.288
24.	Breakfast Cereal	.423	.411	.171	.477	.404	.416
25.	Snacks, Pot. Chips	.160	.321	.054	.151	.336	.168
26.	Other Food Paper	4.388	3.400	.642	1.793	.146	.189
27.	Other Food Containers	.180	.057	.003	.008	.015	.047
28.	Garbage	--	--	4.626	12.921	--	--
29.	Total Food Prepared at Home	21.247	18.611	11.337	31.643	.534	.609

Total food prepared at home accounts for 11.34 pounds of solid waste per week, about 31.6 percent of the total quantity of weekly solid waste per household. Garbage is the largest single component of food-related household solid waste. About 4.63 pounds of garbage are generated weekly per household, nearly 13 percent of a household's total solid waste load. Foods in glass and metal containers account for nearly 5 pounds of solid waste per household per week, representing 14 percent of the total weekly solid waste load. Soft drinks, beer and alcoholic beverages account for over half of the glass waste and nearly one-third of the metal waste associated with foods consumed at home.

Households, on the average, generate .534 pounds of solid waste for each food dollar spent and .609 pounds for each dollar of food consumed at home. Foods with the lowest rate of solid waste per dollar of expenditure and of consumption are those packaged in plastic, styrofoam, or cellophane. Highest rates are associated with beverages in glass and metal containers. Soft drinks in glass generated 2.23 pounds of solid waste per dollar expenditure and 3.576 pounds per dollar of consumption. The rate of solid waste flow per dollar of expenditure and of consumption on foods in paper are .195 and .225, respectively. Most solid waste classified as food paper is generated by the consumption of milk and breakfast cereals.

The OLS estimates of the parameters of the four equation model specified in (9) are presented in Table 2. The total explained variation of each equation is significant at the .05 level, based on F-tests. Coefficients of determination, corrected for degrees of freedom, range from a low of .43 for total food solid waste to .76 for value of meals away-from-home.

Table 2. ORDINARY LEAST SQUARES REGRESSION COEFFICIENTS, STANDARD ERRORS,[a] ADJUSTED COEFFICIENTS OF DETERMINATION (R^2) AND CALCULATED F-RATIOS FOR TOTAL FOOD EXPENDITURE, VALUE OF FOOD CONSUMED AT HOME, VALUE OF MEALS AWAY FROM HOME, AND TOTAL FOOD SOLID WASTE

Independent Variables	Dependent Variables			
	Total Food Expenditure Y_1	Value of Food Consumed at Home Y_2	Value of Meals Away from Home Y_3	Total Food Solid Waste Y_4
Constant	2.315324	2.924208	-1.441491	4.878537
X_1 Meals Away	1.266342 (.215125)**	N.I.[b/]	1.245954 (.083860)**	N.I.
X_2 Income	.000365 (.000171)**	.000276 (.000112)**	.000245 (.000066)**	-.000033 (.000081)
X_3 Sex of the Head	-6.062378 (3.767962)	-3.514584 (2.321979)	-.835463 (1.473404)	-2.672038 (1.795874)
X_4 Household Size	4.041203 (.651439)**	3.553482 (.410007)**	N.I.	1.671632 (.307905)**
X_5 Housewife's Education	.500229 (.273368)	.403681 (.168339)**	.036636 (.105445)	.495955 (.129743)**

Table 2. Continued

Independent Variables	Dependent Variables: Total Food Expenditure Y_1	Value of Food Consumed at Home Y_2	Value of Meals Away from Home Y_3	Total Food Solid Waste Y_4
X_6 Age of the Head	.071097 (.069626)	.022788 (.042845)	.000201 (.027101)	-.000736 (.032635)
X_7 Garbage Disposal	N.I.	N.I.	N.I.	-3.33619 (1.178496)**
X_8 Home Freezer	N.I.	-1.846253 (1.525876)	N.I.	N.I.
$\bar{R}^2$	.57	.59	.76	.43
F	21.71**	23.01**	59.60**	12.46**

[a] Standard errors appear in parentheses.
[b] N.I.: The variable is not included in the equation.
** Significant at the .05 level
* Significant at the .10 level

The level of total food expenditure is significantly associated with the number of away-from-home meals and household income and size. The coefficients of these variables are significantly greater than zero at the .05 level and have, as hypothesized, positive signs. The estimated coefficient of the number of meals away-from-home is 1.27, indicating that the cost per meal eaten away from home is $1.27. Household food expenditure increases $4.04 per week with each additional household member. A $1000 dollar increase in annual household income results in an increase of 37 cents in total food expenditures per week. Elasticities for these three variables, computed at the mean values of the variables, are .21 for meals away-from-home, .17 for household income and .45 for household size.

Household income, household size and housewife education level are key variables affecting value of food consumed at home. Estimated coefficients have the hypothesized signs and are significantly greater than zero at the .05 level. The estimated coefficients for income (.000276) and household size (3.55) are slightly lower than corresponding ones in the expenditure equation. A 40 cents per week increase in food consumption is associated with each one year increase in housewife education level. Consumption elasticities are .19 with respect to household income, .52 for household size and .28 for housewife education level.

The equation describing expenditures on away-from-home meals is the best-fitting equation of the model's four. About 76 percent of the variation in expenditure on away-from-home meals is accounted for. Income and number of away-from-home meals were the only significant variables at the .05 level. The coefficient of income (.000245) is slightly lower than corresponding ones in the expenditure and consumption equations, but the income elasticity with respect to number of meals outside home(.80). The average price per meal as estimated in this equation is $1.25, close to the $1.27 estimated in the total food expenditure equation.

Variables exhibiting a significant association with level of total food solid waste output include household size, housewife education level and availability of a garbage disposal in the house. Elasticity coefficients of total food solid waste with respect to these variables (evaluated at the means of the variables) are .46 for household size and .56 for housewife education level. No meaningful elasticity figure can be computed for the zero-one variable (representing the availability of a garbage disposal unit). However, availability of such a unit channels 3.337 pounds per household per week into the sewage system, thus reducing the quantity of solid waste collected and handled.

Statistical tests applied to the OLS residual correlation matrix indicated that most off-diagonal elements were different from zero at the .05 level. Diagonal elements of the residual variance-covariance matrix were also hetero-scedastic. Thus, use of the GLS technique results in more efficient estimates. However, there is little difference between the magnitudes of the OLS and SUR estimates. For comparative purposes the SUR estimates are presented in appendix Table 1.

VI. CONCLUDING REMARKS

In this paper, Lancaster's demand framework was modified to explicitly incorporate solid waste residuals from food consumption activities as a secondary output of utility maximization. This framework suggested a four-equation model linking food solid waste to food consumption expenditure behavior.

About 11.3 percent of total household income before taxes was spent on food consumed at home and away from home. The solid waste associated with this food accounts for 31.6 percent of total household solid waste. Soft drinks, beer and alcoholic beverages in glass and metal containers account for 6.1 percent of total waste. These beverages also generate the highest rate of solid waste per dollar of expenditure and per dollar of consumption. The household solid waste load associated with food consumption could be reduced considerably if the quantity of disposable beverage containers were reduced.

From a recycling viewpoint, composition of food-related solid wastes is not very encouraging. Over 70 percent of food related solid waste consists of glass, plastics and garbage. With present resource recovery technology and economic conditions, the potential of recycling these materials economically is questionable.

The number of meals eaten away-from-home, household income, household size and housewife education level are key variables affecting total household food expenditure, value of food consumed at home, value of meals away-from-home and total food solid waste. The number of meals eaten away-from-home is positively related to total food expenditure and value of meals eaten away from home. Rising household income results in increases in total food expenditure, value of food consumed at home and also in the value of meals eaten away from home. Total food expenditure, value of food consumed at home, and total food solid waste vary directly with household size. A housewife's education level significantly affects both value of food consumed at home and quantity of total food solid waste. Both increase as her education level increases, suggesting that as she becomes more highly educated, the opportunity cost of a housewife's time increases. Thus, more convenience and partially-prepared foods are used. Prices of these types of food are generally higher and have relatively larger quantities of solid waste associated with them.

The analysis presented in this paper focused only on a short time period, early summer. Similar analyses need to be performed during different parts of the year to determine if there are seasonal differences in food expenditures, food consumption and associated solid waste.

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Appendix Table 1. EFFICIENT ESTIMATES (SUR) OF REGRESSION COEFFICIENTS AND THEIR STANDARD ERRORS[a] FOR TOTAL FOOD EXPENDITURE, VALUE OF FOOD CONSUMED AT HOME, VALUE OF MEALS AWAY-FROM-HOME, AND TOTAL FOOD SOLID WASTE

Independent Variables	Dependent Variables			
	Total Food Expenditure Y_1	Value of Food Consumed at Home Y_2	Value of Meals Away-from Home Y_3	Total Food Solid Waste Y_4
Constant	.189567	3.423119	-1.430540	4.714545
X_1 Meals Away	1.426794 (.178185)	N.I.	1.242508 (.083062)	N.I.
X_2 Income	.000302 (.000169)	.000243 (.000108)	.000246 (.000066)	-.000036 (.000081)
X_3 Sex of the Head	-6.456295 (3.764492)	-3.606270 (2.320177)	-.821486 (1.473346)	-2.684721 (1.794042)
X_4 Household Size	4.826833 (.607624)	3.380236 (.404321)	N.I.	1.750478 (.306916)
X_5 Housewife's Education	.436242 (.272707)	.413527 (.168308)	.036817 (.105443)	.490068 (.129702)
X_6 Age of the Head	.086877 (.069295)	.016379 (.042634)	.000034 (.027095)	.000084 (.032634)
X_7 Garbage Disposal	N.I.	N.I.	N.I.	-3.388072 (1.079319)
X_8 Home Freezer	N.I.	-.511951 (1.119628)	N.I.	N.I.

[a] Standard errors appear in parentheses.
[b] N. I.: The variable is not included in equation.