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MEASUREMENT OF HOUSEHOLD TIME VALUE
AND ITS IMPACT ON THE DEMAND FOR BEEF AWAY-FROM-HOME

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ABSTRACT

Demand equations derived from household production theory stress the importance of time in household decisions. Value of time was quantified using a method that corrects for selection bias. This study concludes that household time value, income, size and composition, and other environmental variables significantly influence beef consumption away-from-home.

MEASUREMENT OF HOUSEHOLD TIME VALUE AND ITS IMPACT ON THE DEMAND FOR BEEF AWAY-FROM-HOME

One general extension of traditional economic theory integrates the theory of the consumer with that of the firm, and appropriately has become known as "household production theory" (Gorman; Lancaster; Michael; Pollak and Wachter). The theory of the firm is especially relevant to that aspect of household decision making which is concerned with efficient use of market goods, time, and human capital as inputs into the production of utility yielding non-market goods (Deaton and Muellbauer). Viewing consumer behavior from this perspective suggests why consumer behavior varies across households for reasons other than income and "tastes and preferences." Households differ in size and composition (hence are at different stages in the life cycle), in the age and education levels of members (hence are at different productivity levels), and with respect to employment status (hence have different constraints on their time). The traditional model would attribute the effect of these factors to differences in tastes and preferences, but the household production model attempts to account for these factors explicitly.

This model leads to household derived demand market equations which are analogous to derived demand equations for factor inputs in traditional production theory (e.g., see the works of Ghez and Becker; Michael; or Fletcher). The relationship that is derived expresses the j<u>th</u> household's demand for the i<u>th</u> market good (X_{ij}) as a function of its total market expenditure or income (Y_j), the effective shadow price of time or opportunity cost of non-market time (W_j^*), environmental factors (E_j), and the prices of the n market goods (P_j). These equations stress the interrelationships between human capital, the allocation of time in the household market and non-market activities, and the environment within which these activities occur.

The main objective of this study was to quantify the impacts of selected economic and demographic factors on household demand for beef away-from-home (AFH). The household production approach stresses the importance of the value of household time on food demand through its effect on the real price of a commodity. Accordingly the outline of the remainder of this paper is as follows. Approaches which have been suggested to estimate the value of time are briefly reviewed, and its quantification in the present study is discussed. Finally, the results of using these value of time estimates in a model of beef consumption AFH are presented.

Approaches to Measuring the Value of Household Time

One potential measure of the value of household time is the wages or earnings that an individual in the household receives for market work. These are observable only for individuals who are active labor force participants (LFP's) and hence there is a problem of estimating wages for non-labor force participants (NLFP's). Early studies estimated labor supply models over samples of LFP's either restricting the analysis exclusively to LFP's or imputing a wage or earnings to non-workers from a wage or earnings equation estimated over a sample of workers. Both approaches result in biased labor supply estimates because of the non-random nature of the assignment of individuals to the LFP and NLFP groups. That is, individuals select to be or not to be in the labor force. Recent work has focused on methods of estimating wage and labor supply functions which are free of this sample selection or censoring bias.

Relevant here is Heckman's work (1974) which integrated into a consistent framework decisions regarding wages, hours, and labor force participation. In addition, Heckman (1976; 1979; and 1980) made a contribution to the econometric literature by characterizing the problem of sample selection or censoring bias within the conventional specification error framework of Griliches and Theil. Heckman developed a relatively simple two-step procedure to estimate models free of selection bias which has been used in recent studies to estimate the value of time for women not in the labor force.

The procedure involves constructing a selection bias correction factor (a ratio of the ordinate of a standard normal density to the tail area of the distribution) from a first-stage Probit of the probability of labor force participation of an individual. Then at the second-stage, this instrumental variable is included as an independent variable in a wage or earnings equation, estimated over the group of LFP's.

A stochastic censoring model was used in this study to estimate the value of the household's time. The model consists of two conceivably related behavioral equations: a potential market earnings equation and a reservation earnings equation. Observed market earnings can be used to measure potential earnings of LFP's. However, potential earnings are not easily observable for NLFP's. Because of the non-random assignment of individuals to these two groups, the final component of the model is the sample selection rule which determines whether or not an individual participates in the labor market and thus has observed market earnings. An individual is assumed to participate if the utility or benefit derived from participation (potential earnings) is greater than that derived from not participating (reservation earnings). Note that reservation earnings are not observed for any portion of the sample, but information about reservation earnings is provided by the observed labor force participation decision.

The interest here is in the potential earnings equation for the group of NLFP's. Aside from efficiency considerations, estimation of the potential earnings equation (for the LFP group) alone is not desirable because of the sample selection problem. Both the method of maximum likelihood (ML) (based on the nonlinear optimization method proposed by Berndt, et. al.) and the less complex two-step procedures were used to estimate the model. The ML procedure provides correct asymptotic standard errors for the estimated coefficients (those from the two-step are only approximate) and does not assume a two-step decision process in the labor force participation decision and wage determination which is implicit in the two-step estimates. ML is theoretically preferred but is more difficult and costly to implement. Use of the two-step procedure in practice has been met with mixed success.

Results: Estimation of Value of Time

The data used to estimate the value of household time and demand for FAFH are from the spring quarter of the 1977-78 USDA Nationwide Food Consumption Survey. The survey provides detailed socio-economic, demographic, and food consumption information for households, and identifies a male and/or female head in each household. There is reason to believe that males and females as well as single-household heads and dual-household heads are faced with different wage offers and are characterized by different LFP decisions and hence separate models were estimated for each of these groups (Roos).

Specification of the potential market earnings and reservation earnings functions are as follows. Potential market earnings are measured by reported market earnings for LFP's, and are not observed for NLFP's. Reservation earnings are not observed for either group. The independent variables for the potential and/or reservation earnings functions include educational attainment, age, region, urbanity, the household's non-earned income, the spouse's earnings, and age and presence of children in the household.

ML and two-step coefficient estimates for the potential and reservation earnings (hence labor force participation) equations used in this study for females and males from dual-headed households are presented in Tables 1 and 2, respectively. (Results for females and males from single-headed households are available upon request.) The OLS estimates are included as a basis for comparison.

The alternative procedures yielded estimates for all equations which were generally of the same sign and relative magnitude. In terms of the two-step results, the overall model was statistically significant for both the female and male dual-headed households, with R^2 values of .18 and .26, respectively (Tables 1 and 2). The greater explanatory power for males relative to females was expected because the dependent variable was annual earnings rather than hourly wages. Inasmuch as degree of commitment to the labor force differed between groups (females were more likely to be working only part-time and probably for a wage rather than a salary), there was more variation observed in market earnings for females which could not be attributed to the specified factors. Many of these factors (except age and some region variables) were not significant, at least for the ML method.

Participation in the labor force for females and males was largely affected by similar factors--age, education, labor earnings of spouse, and household income excluding asset income and that individual's labor earnings. The presence of young children decreased the probability that females work outside of the household, but was not an important factor for male heads.

In the two-step procedure, the coefficient on the selection bias correction factor ($\hat{\lambda}$) measures the correlation between the error terms in the potential earnings and labor force participation equations. For females, the coefficient was not statistically different from zero, indicating either the absence of selection bias or that if bias was present the two-step procedure did not adequately correct for it. The latter appears to be the case, based on the ML results that indicate a sizeable negative correlation of -.66 between the errors of the potential earnings and labor force participation equations. However, the two-step procedure appeared to be appropriate for males. This apparent failure of the two-step procedure to model the female head's labor decision process is important since this procedure is commonly used to impute wages for female homemakers (e.g., see the works of Anderson; Ferber and Green, 1983, 1985; Fligstein and Wolf; and Leuthold).

These results indicate the inappropriateness of OLS to estimate potential earnings equations using groups of LFP's only. By adjusting for LFP selection bias, the two-step and ML procedures provide improvements over OLS. Superiority of the ML estimates is not guaranteed and the dollar cost of ML estimation was large relative to two-step estimation (due to the large number of iterations required). It is unclear whether the gains from the ML procedure outweighed the costs. The two-step procedure did appear to perform poorly for the group of female heads and it is for this group that the procedure is typically used.

Results: Estimation of Demand for FAFH

The interest in quantifying the value of household time stemmed from its hypothesized effect on the consumption of beef AFH. The typical approach to quantify the value of household time in demand models has been to either differentiate (typically via the dummy variable approach) between

TABLE 1
LABOR MODEL COEFFICIENT ESTIMATES FOR GROUP (1), FEMALE HEADS IN DUAL-HEADED HOUSEHOLDS

	(1) Potential Earnings (ln $/year)[a]			(2) Reservation Earnings (ln $/year)[b]	(3) Labor Force Participation
Variables/Procedure	Maximum Likelihood	Two-Step	OLS	Maximum Likelihood	Two-Step (Probit)
Intercept	-4.722	3.243	2.245	0.262	-2.292
	(-0.68)[c]	(1.09)	(0.08)	(0.04)	(-1.55)
Age (years)	0.217	0.023	0.034	0.038	0.113
	(1.67)	(0.36)	(0.54)	(0.32)	(2.44)
$(Age)^2$	-0.003	-0.001	-0.001	-0.001	-0.001
	(-3.13)	(-0.96)	(-1.20)	(-0.96)	(-3.14)
Education (years)	0.883	0.646	0.699	0.524	0.154
	(1.16)	(2.06)	(2.25)	(0.78)	(1.71)
$(Education)^2$	-0.030	-0.025	-0.026	-0.021	-0.001
	(-1.32)	(-2.56)	(-2.68)	(-1.07)	(-1.33)
Age*Education	0.002	0.003	0.002	0.004	-0.002
	(0.29)	(0.79)	(0.71)	(0.65)	(-1.00)
Race	0.636	0.503	0.525	0.687	0.160
	(1.13)	(1.90)	(1.99)	(1.28)	(0.73)
Age of Other Head	--	--	--	-0.007	0.001
	--	--	--	(-0.37)	(0.11)
Wage of Other Head (ln $/year)	--	--	--	-0.025	0.041
	--	--	--	(-0.86)	(2.30)
Income, other (ln $/year)[d]	--	--	--	0.177	-0.133
	--	--	--	(2.82)	(-3.56)
Home-Ownership	--	--	--	-0.048	-0.091
	--	--	--	(-0.18)	(-0.51)
Asset income (ln $/year)	--	--	--	0.010	0.004
	--	--	--	(0.34)	(0.18)
Household Composition Dummies:					
Child < 3 years	--	--	--	-0.030	-0.509
	--	--	--	(-0.10)	(-2.15)
Child 3-5 years	--	--	--	0.467	-0.522
	--	--	--	(1.59)	(-2.56)
Child 6-12 years	--	--	--	0.070	-0.085
	--	--	--	(0.29)	(-0.52)
Child > 12 years	--	--	--	0.069	0.169
	--	--	--	(0.28)	(1.04)
Household Size	--	--	--	-0.033	-0.033
	--	--	--	(-0.51)	(-0.07)
Region:[e]					
North Central	0.515	-0.204	-0.139	--	0.286
	(2.05)	(-0.88)	(-0.62)	--	(1.71)
South	-0.093	0.097	0.078	--	-0.084
	(-0.32)	(0.39)	(0.31)	--	(-0.47)
West	0.129	0.192	0.274	--	0.285
	(0.40)	(0.74)	(1.10)	--	(1.43)
Urbanity:[f]					
Central City	0.169	-0.181	-0.157	--	0.132
	(0.59)	(-0.86)	(-0.74)	--	(0.75)
Nonmetropolitan	-0.181	-0.270	-0.25	--	-0.060
	(-0.81)	(-1.38)	(-1.31)	--	(-0.41)

TABLE 1
CONTINUED

Variables/Procedure	(1) Potential Earnings (ln $/year)[a] Maximum Likelihood	Two-Step	OLS	(2) Reservation Earnings (ln $/year)[b] Maximum Likelihood	(3) Labor Force Participation Two-Step (Probit)
Selection Bias Correction Factor (λ)[g]	--	-0.414	--	--	--
	--	(-1.20)	--	--	--
log L/R^2 [h]	-351.47	0.18	0.17	--	--
	--	(3.00)	(3.13)	--	--

[a]The estimates presented in this table correspond to a sample of size 500, 175 of whom were labor force participants.

[b]The reservation earnings equation is not explicitly estimated in the two-step procedure.

[c]The numbers presented in parentheses are t-values. Those from the ML procedure are asymptotic values and from the two-step are approximate values (due to the heteroscedasticity introduced by the estimated selection bias correction factor).

[d]Other income is household income excluding the specified individuals labor earnings and household asset earnings.

[e]Omitted region category: Northeast.

[f]Omitted urbanity category: Metropolitan.

[g] $\hat{\lambda}$, the inverse of Mills ratio, is the estimated sample selection bias correction factor suggested by Heckman [17]. It is calculated as $\lambda = \phi(z)/[1-\Phi(z)]$, where ϕ and Φ are the standard normal density and distribution function, respectively, and z is an index of labor force participation based on the first-step probit equation.

[h]The logarithm likelihood function value (log L) at the optimum is presented for the ML procedure and R^2 (and the F-value) is given for the two-step and OLS procedures.

TABLE 2

LABOR MODEL COEFFICIENT ESTIMATES FOR GROUP (2), MALE HEADS IN DUAL-HEADED HOUSEHOLDS

Variables/Procedure	(1) Potential Earnings (ln $/year)[a]			(2) Reservation Earnings (ln $/year)[b]	(3) Labor Force Participation
	Maximum Likelihood	Two-Step	OLS	Maximum Likelihood	Two-Step (Probit)
Intercept	9.571[c]	9.001	9.094	10.551	-1.531
	(8.24)	(7.12)	(7.08)	(5.70)	(-0.81)
Age (years)	0.111	0.079	0.075	0.023	0.103
	(2.73)	(2.61)	(2.44)	(0.49)	(1.89)
$(Age)^2$	-0.003	-0.001	-0.001	-0.002	-0.002
	(-6.74)	(-5.01)	(-5.52)	(-3.51)	(-2.92)
Education (years)	-0.431	-0.223	-0.231	-0.446	0.235
	(-8.59)	(-1.84)	(-1.87)	(-2.59)	(2.32)
$(Education)^2$	0.004	0.006	0.006	0.003	-0.001
	(13.95)	(1.58)	(1.57)	(0.58)	(-2.48)
Age*Education	0.010	0.003	0.003	0.009	-0.002
	(15.26)	(2.17)	(2.49)	(6.36)	(-1.31)
Race	-0.309	-0.415	-0.346	-0.474	0.377
	(-1.19)	(3.13)	(-2.60)	(-1.61)	(1.15)
Age of Other Head	--	--	--	-0.002	-0.001
	--	--		(-0.17)	(-0.07)
Wage of Other Head (ln $/year)	--	--	--	-0.013	0.045
	--	--	--	(-0.80)	(2.25)
Income, other (ln $/year)[d]	--	--	--	0.095	-0.156
	--	--	--	(3.29)	(-5.15)
Home-Ownership	--	--		-0.039	-0.121
	--	--		(-0.24)	(-0.47)
Asset income (ln $/year)	--	--	--	0.018	-0.030
	--	--	--	(0.75)	(-1.03)
Household Composition					
Child <3 years	--	--	--	0.035	-0.129
	--	--	--	(0.13)	(-0.31)
Child 3-5 years	--	--	--	0.057	-0.211
	--	--	--	(0.02)	(-0.66)
Child 6-12 years	--	--	--	0.076	-0.078
	--	--	--	(0.34)	(-0.26)
Child >12 years	--	--	--	0.231	-0.183
	--	--	--	(1.16)	(-0.71)
Household Size	--	--	--	-0.093	0.171
	--	--	--	(-0.99)	(1.70)
Region:[e]					
North Central	0.119	0.073	0.144	--	0.115
	(0.83)	(0.66)	(1.02)	--	(0.51)
South	0.139	-0.077	-0.054	--	0.234
	(0.85)	(-0.66)	(-0.46)	--	(0.96)
West	0.217	0.095	0.144	--	0.111
	(1.18)	(0.75)	(0.89)	--	(0.40)
Urbanity:[f]					
Central City	-0.194	-0.087	-0.135	--	-0.412
	(-1.16)	(-0.80)	(-1.22)	--	(-1.67)
Nonmetropolitan	-0.103	-0.177	-0.179	--	-0.127
	(-0.80)	(-1.91)	(-1.91)	--	(-0.64)
Selection Bias Correct Factor (λ)[g]	--	-0.327	--	--	--
	--	(-3.35)	--	--	--
log L/R^2 [h]	-1227.13	0.26	0.23	--	--
	--	(9.14)	(8.67)	--	--

[a]The estimates presented in this table correspond to a sample of size 500, 332 of whom were labor force participants.

[b-h]Same as in Table 1.

households with and without the female head in the labor force (e.g., Redman, and Kinsey) or estimate (using OLS) a potential wage for non-employed female heads using wage information for employed females (e.g., Prochaska and Schrimper). However the former procedure is a rather ad hoc method of measuring time value while the latter procedure will result in biased wage estimates (due to the sample selection problem). The procedures of the potential wage equation (which correct for selection bias) were used to estimate the value of time of the food manager in each household.

The estimates of the value of time along with other household variables were used in beef demand models in the AFH market. The dependent variables were binary variables indicating whether the household consumed beef AFH, at all facilities and by type of food facility--restaurant, fast food, and other commercial facilities. Probit estimates indicate that retirement, membership in other than white race, and observation during the week all had negative effects on the probability of consuming beef AFH (at all sources). Consistent with prior expectations, increases in income were associated with increases in the probability of consumption. The value of household time was positively related to the probability of beef consumption, consistent with the hypothesis that households with high time values eat out rather than at home to save time. There were also differences in the probability of consumption by households of varying size and age composition.

The results suggest that beef demand is not identical across eating facilities. The probability of consuming beef at restaurants was more affected by economic factors (income and value of time) rather than by demographic factors, while consumption at fast food and other commercial facilities was affected by a mix of these factors. The impact of income on the probability of consuming beef was significant (and sizeable) for restaurants

TABLE 3

PROBIT REGRESSION RESULTS FOR BEEF CONSUMPTION AWAY-FROM-HOME, TOTAL AND BY TYPE OF FOOD FACILITY[a]

Independent Variables	All Food Facilities	Restaurants	Fast Food Facilities	Other Commercial Facilities
Intercept	-0.5128*[b]	-0.4078*	-0.3111*	-0.1944*
Retired (1=yes)	-0.0672*	-0.0311	-0.0169	-0.0352*
Education (years)	0.0057	0.0074*	0.0097	-0.0018
Income ($'000/year)	0.0032*	0.0023*	0.0001	-0.0005
Value of Time (ln $/year)	0.0170*	0.0070*	0.0074*	0.0065*
Region:				
North Central	0.0435*	0.0106	0.0236*	-0.0006
South	0.0348	0.0126	0.0368*	-0.0018
West	0.0281	0.0287	0.0050	-0.0173
Urbanity:				
Central City	-0.0093	-0.0114	-0.0035	-0.0010
Nonmetropolitan	-0.0360	-0.0089	-0.0173*	-0.0208*
Race (1=nonwhite)	-0.1206*	-0.0920*	-0.0427*	-0.0295*
$[\text{Household Size}]^2$	-0.0006	-0.0001	-0.0013	0.0003
Household Composition:				
Males > 40 (number)	0.0479*	0.0054	0.0245*	0.0244*
Females > 40	-0.0002	0.0125	0.0108	-0.0100
Males 21-40	0.0657*	0.0250	0.0489*	0.0184*
Females 21-40	0.0678*	0.0346	0.0501*	-0.0043
Males 15-20	0.0677*	0.0335*	0.0476*	0.0084
Females 15-20	0.0304	0.0163	0.0270*	0.0058
Children 7-14	0.0264	0.0078	0.0213*	0.0013
Children 3-6	-0.0212	-0.0253	0.0080	0.0054
Infants < 2	-0.0234	-0.0228	0.0079	-0.0071
Day (1=weekday interview)	-0.0317*	-0.0315	-0.0130	-0.0175*
-2 log likelihood ratio[c]	246.98	152.33	144.71	70.97
Percent Households Consuming	23.5	13.9	7.8	5.3

[a] The absolute size of a parameter estimate is meaningless due to the normalization made in the estimation procedure. However, the derivative of the probability function with respect to each independent variable provides a direct measure of the change in probability of consuming for a given change in that independent variable (Maddala). Hence the measures presented in this table are changes in probability, evaluated at the sample mean values of all variables.

[b] An asterisk (*) indicates statistical significance at the 90 percent level, according to a classical two-tailed hypothesis test.

[c] -2 log likelihood ratio is [-2.0* log (the likelihood function value when all parameters other than the constant are set equal to zero minus its unrestricted maximum value)].

but not for other facilities AFH. However, value of time had a positive, significant effect on beef consumption at all facilities. Other differences by type of food facility are noted in the table (e.g., household composition and residency).

Summary and Conclusions

The overall goal of the study was to analyze beef consumption AFH. An economic model of demand was developed, which stresses the importance of human capital, the allocation of time in market and non-market activities, and the environment within which these activities occur. A naive approach has typically been taken to account for the value of time in household food demand models. The importance of correcting for a sample selection or censoring bias problem which exists in using observed earnings by LFP's to impute potential earnings for NLFP's was emphasized. Accordingly, a model which accounts for selection bias was developed and estimated separately for males and females from single- and dual-headed households, using the method of ML and the (Heckman) two-step procedure. The results indicated the importance of accounting for selection bias but the superiority of either the ML or less complex two-step procedure is less clear. However, the two-step procedure appeared to perform poorly for dual-headed household females, for whom it may be most frequently used.

The ML estimates were ultimately used to construct a measure of the value of household time to analyze beef consumption AFH. In general, the value of time, income, household size and composition, and other environmental variables affected the probability of consuming beef AFH. As expected, the value of time had positive impacts on the probability of consuming beef at all establishments. However, income was only a significant explanatory variable for beef consumption at restaurants.

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