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Direct Estimates of Food and Eating Production Function Parameters for 2004–12 Using an ATUS/CE Synthetic Dataset

by

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Abstract

This paper evaluates the presence of heterogeneity, by household type, in the elasticity of substitution between food expenditures and time and in the goods intensity parameter in the household food and eating production functions. We use a synthetic dataset constructed by statistically matching the American Time Use Survey and the Consumer Expenditure Survey. We establish the presence of heterogeneity in the elasticity of substitution and in the intensity parameter. We find that the elasticity of substitution is low for all household types.

Keywords: Consumption Expenditures; Elasticity of Substitution; Food Production; Household Production; Statistical Matching; Time Use

JEL Classifications: C14, D13, J22

1. INTRODUCTION

Studies estimating the elasticity of substitution between monetary food expenditures and time in the household food production function in the United States place its value between 0.22 and 0.75 (Hamermesh 2008; Baral et al. 2011; Davis and You 2013). This finding suggests that time is not easily substitutable with monetary expenditures in the household food production, which in turn implies that monetary compensation-based policies aimed at promoting household well-being vis-à-vis food production at home may have only partial success at achieving their goal.

This paper's contribution is twofold. First, we investigate whether the low average elasticity of substitution masks variation by household type, with a particular focus on the presence and age of children, given that the implications of promoting healthy eating habits are particularly relevant for households with children. To that end, we assess the elasticity of substitution in single-headed and married-couple households with and without children of different age groups. We further supplement the analysis by evaluating the variation in the goods intensity parameter of the production function. Second, we construct a synthetic dataset by statistically matching the American Time Use Survey (ATUS) and the Consumer Expenditure Survey (CE). The dataset can be used for evaluating the elasticity of substitution between market expenditures and time in other household production processes, as well.

2. DATA

The synthetic dataset linking time use and consumption expenditure data is created by statistically matching the ATUS data with the diary survey of the CE from 2004–12 using the March supplement (Annual Social and Economic Supplement, or ASEC) of the Current Population Survey (CPS) as a link.[1] The CE is a household/consumer-unit level survey, while the ATUS captures the time use of one individual 15 years or older in each household. Therefore, the statistical matching process is implemented in two parallel steps. In the first step, we use the data from the ATUS and the March CPS and apply a statistical matching technique to create a synthetic dataset, in which each member of the household in the March CPS (recipient) is linked with the data from the ATUS (donor). In the second parallel step, we use the

[1] We use age, race, relation to the household head, education, labor force status, household size, household income, home ownership, and presence of children and adults by age group as strata variables in the matching process.

March CPS household level data and match it using the CE data. After these two steps are performed, the data from the ATUS and the CE are matched into a single synthetic dataset with March CPS data being our link file. The synthetic dataset contains individual characteristics, household-level consumption expenditure data, and individual time use data of each member of the household that can then be aggregated to form household-level time use information used in the analysis. Our proposed method of statistical matching is similar to the propensity score-based statistical matching approach described in Kum and Masterson (2010).

Our measure of "eating" activity follows Hamermesh (2008) and includes eating and drinking, food preparation and clean-up, purchasing of groceries and other food shopping, and travel for food shopping. In addition, it includes travel related to eating and drinking.[2] The "food production" activity excludes the eating and drinking time and the travel time related to eating and drinking. We standardize the time use to weekly hours spent on these activities. The food expenditures correspond to the expenditures incurred during the survey week. Hence, the ratio of market expenditures to time can be interpreted in terms of dollars of food expenditures per weekly hour of cooking and preparation. Nominal wages and expenditures are converted into real values by using the consumer price index (CPI) for all urban consumers (CPI-U) 1982–84=100.

We evaluate single-headed households separately from married-couple households. This allows us to place our results in the context of Hamermesh (2008) for married-couple households and Baral et al. (2011) for single-headed households. We exclude households with adult members (15+) other than the single head or the married couple. For single-headed households, household time use includes only the head's time. For married-couple households, it includes the joint time of the husband and wife. We limit the sample to households in which the head (for single-headed households) or both husband and wife (for married-couple households) are 18–64 years old and include only households with positive eating and food production time and positive food expenditures[3] (Baral et al. 2011). These constraints limit the sample to 172,396 married-couple households and 86,226 single-headed households.

[2] Hamermesh (2008) does not include travel related to eating and drinking in order to maintain the comparability of ATUS03 and TUS85 data.
[3] We also drop observations with hourly wages above $1,000 an hour.

Table 1 Proportions of Households, by the Presence and Age of Children

	Single headed	Married couple
No children	.7887	.4777
Children, 0-5 years old	.0963	.3275
Children, 6-14 years old	.1607	.3376
Children, both age groups	.0458	.1428

Notes: weighted proportions.

3. ESTIMATION

Our empirical approach is closely related to that of Hamermesh (2008) and Baral et al. (2011). We assume a constant elasticity of substitution function for "food production" (*F*) and "eating" (*E*) of the form $Y_i = A_i(\beta_i X^{\gamma_i} + (1-\beta_i)T_i^{\gamma_i})^{\frac{1}{\gamma_i}}$, where $i = F, E$; X is food expenditures; T_i is the time input; A_i is the efficiency parameter; β_i is the goods intensity parameter, and $\sigma_i = \frac{1}{1-\gamma_i}$ is the elasticity of substitution between food expenditures and time. Suppressing the subscripts T and F, the relative demand function for *X* and *T* can be written as

$$\ln\left(\frac{X}{T}\right) = \alpha + \sigma ln\text{w} \tag{1}$$

The price of food expenditures is normalized to 1 and the price of time is the wage rate *w*. In the case of single-headed households, *w* is the household head's hourly wage; and in the case of married-couple households, *w* is the weighted average of the respondent's and (imputed) spousal wage.

We further note that $\alpha = \sigma ln\frac{\beta}{1-\beta}$ and therefore (1) can be rewritten as:

$$\ln\left(\frac{X}{T}\right) = \alpha + \sigma ln\text{w} = \sigma(ln\frac{\beta}{1-\beta} + ln\text{w}) \tag{2}$$

Our main interest lies in investigating the variation in the elasticity of substitution and the food intensity parameter by the presence and age of children.[4] Similar to Davis and You (2013), we model this variation using a linear specification. Then the relative demand function accounting for heterogeneity can be written as:

$$\ln\left(\frac{X}{T}\right) = (Z\sigma)\left(ln\frac{Z\beta}{1-Z\beta} + ln\text{w}\right) \tag{3}$$

[4] Hamermesh (2008) and Baral et al. (2011) include the number of children by age as control variables in (1), which is equivalent to accounting for the intercept effects. Our approach examines the intercept and the slope effects.

where Z is a matrix including a constant and the presence of children by age. In the case of married-couple households (3) can be expressed as:

$$\ln\left(\frac{X}{T}\right) = (Z\sigma)\left(ln\frac{\beta Z}{1-\beta Z} + ln\,(\,\rho\, w_m + (1-\ \rho\,)w_f\right) \tag{4}$$

where ρ represents the weight on the husband's price of time, w_m is the husband's wage and w_f is the wife's wage.

To account for the potential endogeneity of the wages and to impute the wages of not-working individuals (those who have missing wages), we follow Hamermesh (2008) and Baral et al. (2011) and use a two-stage procedure. In the first stage, we predict wages using age, age squared, education, race, and yearly dummy variables (to account for potential recession effects during 2004–12). In the case of women, we also correct for sample selection bias by using the Heckman selection model with the presence of children 0–5 years old and 6–14 years old as identifying variables in the selection probit. In the second stage, we estimate equations (2) for single-headed and (3) for married-couple households using a nonlinear least squares approach.

To account for the multi-stage nature of our estimation, we report survey-bootstrapped standard errors of the coefficient estimates. Standard errors are also clustered by the CE household identifier because the matching procedure can match multiple CPS households to the same CE household.

4. RESULTS

The estimation of equation (1) using our dataset yields results which are very similar to those of Baral et al. (2011) and Hamermesh (2008). Our estimates for single-headed households are almost identical to those of Baral et al. (2011), and the estimate for the elasticity of substitution in food production for married-couple households is somewhat higher than those of Hamermesh (2008), but remains well below 1. Our results are also consistent with the finding in Baral et al. (2011) that in single-headed households, the elasticity of substitution in food production is higher than the elasticity of substitution in eating. We find that this result also extends to married-couple households using Hamermesh's (2008) specification; using our specification, the difference is not statistically significant. We further observe that single-headed households have a lower elasticity of substitution in food production and eating than their married-couple counterparts, suggesting that they might not substitute time with money to the degree that married-couple households might.

Our results also shed light on the goods intensity of the food production and eating processes. Whereas the food production process in both single-headed and married-couple households is goods intensive, their eating process is substantially less so. Indeed, in married-couple households, the eating process is time intensive. More generally, single-headed households use more goods-intensive food production technology than their married-couple counterparts, potentially reflecting their greater reliance on ready-made meals.

With respect to the presence and age of children, the variation is particularly strong in the food production process of single-headed households with older children. These households use less goods-intensive food production technology—placing more weight on time—than their counterparts without children. However, their time is also more readily substitutable with money, indicating that monetary incentives may yield greater change in their food production and consumption behavior.

Despite the evidence of variation, we find that the elasticity of substitution remains small in all household types, underscoring the difficulties in substituting money for time across different segments of the population.

Table 2 Estimates of the Parameters of the Production Function

	Singles				**Married**			
	Food	Eating	Food[1]	Eating[1]	Food	Eating	Food[2]	Eating[2]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
σ_0	0.477***	0.359***	0.524***	0.324***	0.498***	0.307**	0.580***	0.472***
	(0.0332)	(0.0514)	(0.0304)	(0.0252)	(0.0936)	(0.127)	(0.0154)	(0.0145)
σ_1	0.103	0.160			0.0470	0.102		
	(0.0713)	(0.115)			(0.112)	(0.141)		
σ_2	0.183***	0.212*			0.162	0.239*		
	(0.0601)	(0.110)			(0.105)	(0.134)		
β_0	0.840***	0.485***	0.787***	0.581***	0.740***	0.398***	0.644***	0 .294***
	(0.0347)	(0.0607)	(0 .0333)	(0.0497)	(0.101)	(0.0938)	(0.0185)	(0.0100)
β_1	-0.098	-0.041			-0.0706	-0.0610		
	(0.0649)	(0.122)			(0.125)	(0.110)		
β_2	-0.192***	-0.078			-0.158	-0.0901		
	(0.0576)	(0.115)			(0.113)	(0.0988)		
ρ					0.331***	0.409***	0.324***	0.361***
					(0.0251)	(0.0287)	(0.0237)	(0.0262)
Obs.	86,226	86,226	86,226	86,226	172,396	172,396	172,396	172,396
McFadden's R^2	0.004	0.005	0.004	0.002	0.007	0.012	0.007	0.008

Notes: [1]Baral et al. (2011) specification; [2]Hamermesh (2008) specification; survey-bootstrapped standard errors with 200 replications; in (1), (2), (5) and (6), σ_0 represents the EOS for households without children; $\sigma_0+\sigma_1$ represents the EOS for households with children 0–5 years old; and $\sigma_0+\sigma_2$ represents the EOS for households with children 6–14 years old.

5. CONCLUSIONS

Our results suggest that the effectiveness of economic policies aimed at encouraging healthful cooking and eating habits is likely to vary by household type. Despite this variation, the elasticity of substitution is low for all household types, underscoring the challenges that monetary compensation-based policies may face in effecting a change in food production and eating behavior.

Although we apply our dataset to food and the eating production process, the applicability of the dataset extends to the examination of the substitutability in other household production processes.

References

Baral, R., Davis, G. C., and You, W. (2011) "Consumption Time in Household Production: Implications for the Goods-time Elasticity of Substitution," *Economics Letters*, 112(2), 138–140.

Davis, G. C. and You, W. (2013) "Estimates of Returns to Scale, Elasticity of Substitution, and the Thrifty Food Plan Meal Poverty Rate from a Direct Household Meal Production Function," *Food Policy*, 43, 204–2012.

Hamermesh, D. S. (2008) "Direct Estimates of Household Production," *Economics Letters*, 98(1), 31–34.

Kum, H. and Masterson, T. N. (2010) "Statistical Matching Using Propensity Scores: Theory and Application to the Analysis of the Distribution of Income and Wealth," *Journal of Economic and Social Measurement*, 35(3–4), 177–196.