The Time Cost of Food at Home:
General and Food Stamp Participant Profiles

George C. Davis

and

Wen You

George C. Davis is a Professor at Virginia Tech University and Wen You is an Assistant Professor at Virginia Tech University

Contact Information: George C. Davis, Virginia Tech University, 214 Hutcheson Hall Blacksburg VA, 24060 Ph: (540) 231-6783. E-mail: georgedavis@vt.edu.

The Time Cost of Food at Home:
General and Food Stamp Participant Profiles

Abstract

Little is known about the cost of time in food preparation at home. Yet, this economic variable is a common thread running through recent concerns about obesity and the Food Stamp (FS) program. This paper provides initial estimates of the time cost in food preparation at home for the United States. Two standard methods of estimation are implemented and three demographic profiles are considered: (i) the general population, (ii) the typical FS participant, and (iii) the typical FS participant following the United States Department of Agriculture Thrifty Food Plan. For the general population and averaging across methods, the time cost share of total food cost is about 30% if the individual works in the market and at home, but it is about 49% if the individual does not work in the market. For the typical FS participant, especially one following the Thrifty Food plan, the time cost share of total food cost can be as much as 26% higher than the general population. These substantial percentages provide strong incentives to purchase food away from home and help undermine overall diet quality and the efficacy of the FS program, which ignores the time cost in food at home production.

JEL: D1, I1, I3, J2

Key Words: American Time Use Survey, Convenience Foods, Food Preparation at Home, Food Stamps, Labor Cost, Thrifty Food Plans, Time Cost

The Time Cost of Food at Home:
General and Food Stamp Participant Profiles

Between 1990 and 2004 the food expenditures on food away from home increased from 45% to 50% (United States Department of Agriculture\Economic Research Service (USDA\ERS) 2006 a). During this same time the population considered obese went from 11.6% to 22.1% (Centers for Disease Control (CDC) 2006). While a causal link is difficult to establish, several studies suggest that the increasing consumption of food away from home is a contributing factor to the obesity problem in the United States (Binkley, Eales, and Jekanowski 2000; Chou, Grossman, and Saffer 2004; McCroy, et al. 1999; Nestle and Jacobsen 2000). The argument is simple. Food away from home generally contains more calories per eating occasion and has more total fat, saturated fat, and cholesterol on a per-calorie basis than food at home and therefore is generally of lower nutritional quality (Guthrie, Lin, and Frazao 2002). Furthermore, Variyam (2005) finds that based on the USDA Healthy Eating Index, individuals who consume more food away from home have a "poorer" index value than those who consume more food at home.

A key economic variable in understanding the food at home (FAH) versus food away from home (FAFH) decision is the cost of time in preparing FAH (Becker 1965; Gronau 1986). Given the important role time plays in food production and possibly health outcomes, it is surprising that there are no estimates of the time cost in FAH production – at least until one realizes the type of data required to estimate the cost. Estimating the cost of any input requires a cost per unit *and* the quantity of the input. Basic household production theory provides a means of estimating the first component because if time is allocated in an optimal fashion, then the wage rate will equal the per unit cost of time, at least for internal solutions, and wage rates are easily found. The main difficulty is the second component – the quantity of time in food preparation in the home. Contrary to many countries, the United States historically has not collected data on time allocations so there has been no way to obtain estimates of the quantity of time spent in food preparation. However, with the debut of the Bureau of Labor Statistics' (BLS) 2004 American Time Use Survey (ATUS) data, there is now time diary data available for the United States and this data includes time spent in food preparation. From this data the time cost of food preparation at home can be estimated.

While the obesity argument provides a significant motivation for understanding food preparation cost at home, the seminal work of Vickery (1977) indicates that a minimum poverty threshold is affected not only by income poverty but also 'time poverty.' Consequently, the efficacy of food assistance programs that ignore time inputs will be diminished. For example, Food Stamp allocations are based on the Thrifty Food Plan (TFP) and the TFP

> "serves as a national standard for a nutritious diet at a minimal cost and is used as the basis for food stamp allotments…. Each TFP market basket identifies the type and quantity of foods that people in specific age-gender groups could consume at home to achieve a healthful diet that meets dietary standards." (USDA\Center for Nutrition Policy and Promotion (CNPP) 1999 p. ii).

However, there has been some evidence that more nutritious diets may be more expensive than less nutritious diets (Basiotis and Lino 2000 or see Drewnowski and Darmon 2005 and accompanying citations). To address this issue, USDA has provided recipes based on the TFP market baskets that illustrate ways of preparing nutritious meals based on TFP baskets (USDA\CNPP 2000). Yet, as the Food Research and Action Center points out,

> "The Thrifty Food Plan [TFP] contains a number of assumptions which may not be accurate for many food stamp recipients. For example, purchasing foods for a nutritious diet requires adequate food preparation facilities, *extensive time for food preparation* (emphasis added), an in-depth knowledge about nutrition and inexpensive transportation to warehouse-type grocery stores or supermarkets." (Food Research and Action Center 2006).

How do we know if the TFP recipes require extensive time for food preparation? From the recipes given in the USDA\CNPP (2000) document, *Recipes and Tips for Healthy, Thrifty Meals*, the median time over all recipes is about 35 minutes. Is 35 minutes excessive? There is no way to know unless there is data available on time spent in food preparation. More generally, while the TFP and the sample recipes are based on food input costs, the TFP does not consider the time input cost in food preparation. If the ignored time input cost is excessive for TFP menus, then this ignored aspect of food demand will reduce the efficacy of Food Stamp programs.

The purpose of this article is to estimate the time cost spent in food preparation at home using the ATUS data and the well established opportunity cost approach and market substitute approach (Gronau 1986). Estimates are provided by gender and three time allocation categories: working only at home, working at home and in the market, and working only in the market. Attention focuses on using these estimates in conjunction with some supplemental data to estimate the percentage of total food cost at home attributable to time for three demographic profiles of interest: (i) the general population, (ii) a typical FS participant, and (iii) a typical FS participant following the Thrifty Food Plan. The analysis reveals that in general time input cost constitutes a sizable amount of total food at home cost for the general population, and the FS participant has a higher percentage of time cost in food production than the general population. This in turn implies the efficacy of the FS program is being diminished by this ignored time cost.

The paper proceeds as follows. The next section gives a brief review of the related literature on the demand for FAFH and pre-prepared foods but points out that this literature does not estimate the time cost of food preparation at home. The following section gives a summary of the underlying theory and empirical framework. In the empirical section that follows, we estimate simultaneously the marginal product function for home production along with a market wage rate equation. The results for three demographic profiles are then discussed followed by conclusions, caveats, and areas of future research.

Relationship with Related Literature

Though there are no direct estimates of the time cost of food at home production, there is a substantial related literature investigating the relationship between expenditures on various convenience food measures and various opportunity cost of time measures.[1] In general, several authors have found that there is a positive association between the consumption of convenience food, as measured by food away from home (FAFH) or pre-prepared food expenditures, and the opportunity cost of time, whether measured by the market wage rate, or some positively correlated variable, such as labor income, hours worked, or employment status (see e.g., Byrne, Capps, and Saha 1996; McCracken, and Brandt 1987; Nayga 1998; Nayga and Capps 1992; Prochaska and Schrimper 1973; Redman 1980;).

[1] The terms ‘food at home production’ and ‘food production’ are used interchangeably and represent food preparation and cleanup at home.

The common element underlying these studies and the present study is the theoretical framework of household production and the optimal allocation of time (Becker 1965, Gronau 1986). In this theory, the 'full price' of a good is not just the observable market price, but the market price plus the time cost of home production. While the increasing consumption of convenience food (i.e. FAFH or pre-prepared foods) may be associated with increasing opportunity cost of time, this does *not* imply that the time cost of food preparation at home has increased. The cost of time spent in a household production activity (C_H), such as a meal, is equal to the opportunity cost of time or shadow wage (s) times the amount of time spent in the home production activity (T_H), which is a function of s, or $C_H = s \times T_H(s)$. Because of the inverse relationship between s and T_H, the cost of time spent in a household production activity may increase or decrease with an increase in s. As Prochaska and Schrimper (1973) point out, the home meal production time may decrease due to the increasing availability of time-saving foods and home cooking equipment. So while there is evidence that FAFH and pre-prepared food consumption has increased with the opportunity cost of time s, this relationship really does not tell anything about the time input cost of food preparation at home C_H.

Theoretical and Empirical Framework Overview

The theoretical and empirical framework for estimating and valuing non-market wage rates is well established in the labor market literature and is only briefly reviewed here (see Gronau 1986, 1997 for a more extensive review). The literature has generally pursued two approaches: (i) the market substitute approach and (ii) the opportunity cost approach. The *market substitute approach* prices the home activity at the rate at which it is priced in the market. For example, the dollar value of an hour in food preparation at home would be set equal to the hourly wage rate of a food preparer in the food sector. The *opportunity cost approach* estimates the opportunity cost associated with the non-market activity. This method is based on exploiting the structure of the individual's time allocation problem and estimating the individual's marginal product or shadow wage, which represents the individual's opportunity cost of time. In this study we will present estimates from both approaches. Given the market substitute approach just requires collecting a market wage rate for food production, attention in this section focuses on the theory and empirics of the opportunity cost method.

The theoretical model of Kiker and de Oliveira (1990 KO) is chosen to represent the household decision and is based on the standard theoretical model discussed in Gronau (1986). This is a relatively simple model and is chosen because the model matches well with the data that is available. Data limitations prevent the consideration of a more complex model and these limitations and possible implications will be discussed.

The individual is assumed to possess a well-behaved utility function

(1) $U = U(X, L)$

where X and L denote consumption goods (or services) and leisure (or consumption time). Home produced goods X_H are produced by the production function

(2) $X_H = f(T_H, Z)$

where T_H is time allocated to home production and Z is a vector of determinants of productivity in X_H. Market consumption, X_M, is 'produced' by the function or budget constraint

(3) $X_M = wT_M + v$

with w being the market wage rate, T_M being the amount of time allocated to the market good acquisition, and v non-market income. Total consumption is then the sum of (2) and (3),

(4) $X = X_M + X_H$

and the individual faces the time constraint

(5) $T = T_H + T_M + L$.

For interior solutions, the first order conditions imply the well known result that time should be allocated to each activity to the point where the marginal returns to each activity are all equal or

(6) $h(T_H, Z) = s = w = MRS_{XL}$,

where $h(T_H, Z)$ is the marginal product function with respect to T_H, s is the shadow wage (the ratio of the Lagrangean multipliers of time and income), and MRS_{XL} denotes the marginal rate of substitution between the market good and leisure. If there are corner solutions then the middle equality does not hold.[2]

As KO discuss, the first generation of empirical models were not based on any formal optimization model and only considered interior solutions (i.e., employed individuals). The second generation of models, ushered in by Heckman (1974), made two contributions. First, they were guided by a well-structured optimization model as described above. Second, they recognized that within such a framework there is valuable information in the corner solution where individuals do not work and that ignoring this information leads to a sample selectivity bias problem. The standard second generation

[2] This is an aggregate household model that implicitly assumes the marginal product is the same for all household activities. This assumption makes the empirical analysis tractable as different production functions for different activities leads to an extremely large number of possible corner solutions, which is an issue that has not been addressed in the literature and is beyond the scope of this paper.

of models proceeds by specifying functions to correspond to the first order condition represented by (6) and then working through the implications of the non-market participation corner solution. The contribution of KO was to note that just as labor market participation or non-participation provided information to be exploited in estimation, household production participation and non-participation alternatively provide information that can be exploited.

The empirical analysis begins by specifying functions for equation (6). Following the literature and KO, the market wage rate is written as

(7) $$\ln w_i = Y_i\beta + \varepsilon_{1i}$$

where i is the individual subscript, Y_i is a vector of individual market wage determinants, β is an unknown parameter vector and ε_{1i} is the random error. The marginal product function for household work, or shadow wage, is specified as

(8) $$\ln s_i = Z_i\delta + \gamma T_{Hi} + \varepsilon_{2i}$$

where Z_i is a vector of individual marginal product determinants and δ is an unknown parameter vector. The unknown parameter γ allows for variable returns to scale in time spent in household production and ε_{2i} is a random error.

Though the left-hand side of equation (8) is unobserved, the parameters of (8) can still be estimated by exploiting the structure of the optimization solution; in particular the corner solutions. To see this, define the latent variable,

(9) $$\tilde{T}_{Hi} = \gamma^{-1}(Y_i\beta - Z_i\delta) + \gamma^{-1}(\varepsilon_{1i} - \varepsilon_{2i}),$$

which is obtained by setting (7) equal to (8) and solving for T_{Hi}. The latent variable $\tilde{T}_{Hi}$ represents the amount of household time that would be required to satisfy the equilibrium condition (6) (or (7) = (8)). There are three values of $\tilde{T}_{Hi}$ that characterize the joint distribution of ln s_i and ln w_i. First, if the market wage rate is greater than the marginal product in home production for the individual (ln w_i > ln s_i) for all $\tilde{T}_{Hi} > 0$, then $T_{Hi} = 0$, $T_{Mi} = T - L$ and the desired latent variable must be $\tilde{T}_{Hi} \leq 0$.[3] This solution characterizes the lower censoring sample of individuals that do not work in the home, but do work in the market. Let this be Group M, for market. Second, if the market wage rate is equal to the marginal product in home production for the individual (ln w_i = ln s_i) for some $0 < \tilde{T}_{Hi} < (T - L)$, then $0 < \tilde{T}_{Hi} = T_{Hi} < (T - L)$ and $T_{Mi} > 0$. This solution characterizes the no censoring sample of individuals that work in the home and in the market. Let this be Group B, for both. Third, if the market wage rate is less than the marginal product in home production for the individual (ln w_i < ln s_i) for all $\tilde{T}_{Hi} > 0$, then $T_{Hi} = T - L$, $T_{Mi} = 0$ and the desired latent variable must be $0 < (T - L) \leq \tilde{T}_{Hi}$. This solution characterizes the upper censoring sample of individuals that work in the home, but not in the market. Let this be Group H, for home.

The joint distribution function characterizing these three groups then has three components. Let $F(\cdot)$ denote the cumulative distribution function for $(\varepsilon_1 - \varepsilon_2)$. For Group M, the lower limit is characterized by $Pr(\tilde{T}_{Hi} \leq 0) = 1 - F(Z_i\delta - Y_i\beta)$, for Group B the joint distribution is $g(\ln w_i, T_{Hi})$, and for Group H, the upper limit is $Pr(\tilde{T}_{Hi} \geq T - L_i) = F(Z_i\delta + \gamma(T - L_i) - Y_i\beta)$. These three components imply the joint

[3] It is assumed that consumption time (L) is always positive, which is certainly the case.

likelihood function can be written as

$$(10)\quad L(\beta,\delta,\sigma_1^2,\sigma_2^2,\sigma_{12}^2 \mid Y_i, Z_i, \ln w_i, T_{Hi})$$

$$= \prod\nolimits_{\mathrm{M}} [1 - F(Z_i\delta - Y_i\beta)] \prod\nolimits_{\mathrm{B}} g(\ln w_i, T_{Hi}) \prod\nolimits_{\mathrm{H}} [F(Z_i\delta + \gamma T_{Hi} - Y_i\beta)],$$

where $\sigma_1^2, \sigma_2^2,$ and σ_{12}^2 denote the variances and covariance of ε_1 and ε_2, respectively. Assuming ε_1 and ε_2 are jointly normally distributed, maximum likelihood estimation can be applied to the likelihood function to simultaneously take into account the censoring and endogeneity of home production returns and time allocation.[4] The model will be estimated separately for males and females.

American Time Use Survey and Summary Statistics

This section summarizes the ATUS and provides summary statistics of the variables used in the analysis.

A Summary of the ATUS

The ATUS data collection began in January 2003 and approximately 21,000 individuals were interviewed in 2003. ATUS households are chosen from the households that completed their eighth (final) interview for the Current population Survey (CPS), which is the nation's monthly household labor force survey. The ATUS sample households are selected to ensure that estimates will be nationally representative. The ATUS data contains demographic information such as sex, race, age, educational attainment, marital status, and the presence of children in the household in addition to employment status, occupation, and hourly wage rate. Although some of these variables

[4] The likelihood function can be found in the Appendix.

are updated during the ATUS interview, most of this information comes from earlier CPS interviews.

From each ATUS sample household, one individual age 15 or older is randomly chosen. This "designated person" is interviewed by telephone about his or her activities the previous day—the "diary day." Designated persons report their activities for their single designated diary day. The ATUS sample is randomized by day, with 50 percent of the sample reporting about the weekdays, Monday through Friday, and 50 percent reporting about Saturday and Sunday. The interviews are conducted using computer assisted telephone interviewing.[5] Each designated person is preassigned a day of the week about which to report in order to reduce variability in response rates across the week.

During the time diary interview, respondents report sequentially activities they did between 4 a.m. on the day before the interview ("yesterday") until 4 a.m. on the day of the interview. Respondents are asked how long each activity lasted. If respondents report doing more than one activity at a time, they are asked to identify which one was the "main" (primary) activity. If none can be identified, it is assumed to be the first one mentioned. A 3-tier coding system consists of 17 broad activity categories, each with multiple second- and third-tier subcategories. Primary activity descriptions are assigned a single 6-digit code (third tier) using the ATUS Coding Lexicon. There are a total of 438 distinct categories in the 2003 ATUS Coding Lexicon. In this study the first tier code, 02 Household Activities, is considered along with the second-tier code 0202, Food and Drink Preparation, Presentation and Clean-up.

[5] Data also is collected from the small number of households that did not provide a telephone number during the CPS interview.

This data represents a significant step forward for conducting time allocation analysis. Most analysis prior to the ATUS has been based on very crude measures of time at home derived from work time data or from questionnaires about average time use in various categories. The ATUS data provides much more accurate measures of these activities. However, while these data are a significant improvement, the data are still not ideal and three obvious limitations should be mentioned. First, time use data are only collected from one individual in the household so spousal or other family member time spillover can not be directly captured. Excluding this variable in the analysis means that the results may be picking up spillover effects as well. That is, if spillover effects are correlated with the time the "designated person" spent in home production, then the coefficient on time in household production will not be a "pure scale effect" but will also include spillover effects as well. Depending on whether the spousal spillover is a substitute or complement in household production will determine the direction of the bias and it is not clear *a priori* whether spousal time is a substitute or complement (Leeds and von Allmen 2004). Second, the "designated person" is not necessarily the person who does the food preparation in the home. In this case it would be expected that the reported food preparation time is an underestimate. However, the effect this will have on the marginal product estimate is unclear. One would expect the marginal productivity of the person who prepares the meals would be higher than the person who does not prepare the meals over the relevant time range. Assuming both marginal products are declining in time, if the meal preparer spends more time on meal preparation than the non-meal preparer, then a simple graph reveals that their marginal products could be the same or the marginal product of the meal preparer could be *less* than the non-meal preparer. Third, household production is obviously affected not only by labor inputs but other inputs and the ATUS does not collect data on other inputs. This has been an ongoing problem for valuing non-labor time (see Gronau 1980) and as in the first two cases it is difficult to determine the directional impact this will have on the estimated marginal product *a priori*.

Variable Definitions and Summary Statistics

The data used in this analysis is for 2003 and the variables were selected based on available data and guided by the existing literature (e.g., Kiker and Oliveira 1990). The variables, their definitions, and units are listed in table 1. Variables that enter the market wage equation (7) are denoted by *y*s and variables that enter the marginal product equation (8) are denoted by zs. Several of the variables are common to both the market wage equation (7) and the marginal product equation (8). These common variables are education level (y_1 to y_4), age (y_5), age squared (y_6), and metropolitan area (y_7).

The education variables (y_1 to y_4) are expected to be positively related to the market wage and the marginal product value. Age (y_5 and y_6) is expected to be positively related to the market wage and the marginal product value but at a decreasing rate (i.e., y_5 coefficient would be positive but y_6 coefficient would be negative). The metropolitan variable (y_7) is included in the market wage equation to account for different labor market conditions and is expected to be positively related to the wage rate. The metropolitan variable (y_7) is also included in the marginal product equation because being in a metropolitan area may indirectly affect the transaction cost associated with food production (e.g., access to a grocery store or commuter cost). The direction of the effect is *a priori* indeterminate as arguments may be made both ways. The variables union (y_8), professional (y_9), white (y_{10}), and black (y_{11}) are included to control for factors that are recognized as possibly affecting wages and home production.[6]

Four variables are included to account for possible spillover effects from family members: being married (z_8), whether or not the spouse is employed (z_9), child number (z_9), and adult number (z_{11}). One important aspect of these variables is the inclusion of the number of children and the number of adults as separate variables. The coefficient on number of family members is often interpreted as a scale effect, however, this assumes the effect of children is the same as the effect of adults. Here we allow for different effects by including two separate variables. As indicated earlier, it is difficult to sign these spillover effects *a priori*. Of course, the number of hours spent in home production (T_H) is expected to be negatively related to marginal productivity.

Table 2 gives the means and standard deviations of the variables that correspond with the three groups: Group M (market work), Group B (both market and home work), and Group H (home work). Because separate models will be estimated for males and females, the first row gives the summary statistics for percent of females. Group M has 35 percent women, which is much lower than for Groups B and H, 60 and 71 percent, respectively. For most variables in table 2, the general patterns across groups are similar. This is the case for education, metropolitan, white, black, married, and number of adults. The other variables show some obvious differences across groups. The average log of the wage is slightly higher for Group B (2.51) than Group M (2.42) and of course does

[6] Another limitation of the ATUS data is the lack of any measures of job tenure or experience, which are often incorporated in the wage equation. However, it would be expected that the demographic variables listed here would be highly correlated with these excluded variables and should capture to some extent their effects. Given the main equation of interest in this analysis is the marginal product equation, and it does not suffer this excluded variable problem, the affect of this data limitation is indirect through the simultaneous estimation of the wage and marginal product equations.

not exist for the non-working group. The 2 percent of Professionals in Group H is noticeably smaller than the other two groups, but is in agreement with intuition as this group only works in the home. Age tends to increase across the groups from an average of 3.64 (or 36.4 years old) in Group M to 5.54 (55.4 years old) in Group H, which again agrees qualitatively with intuition because one reason for not working in the market is retirement. Only 33 percent of the spouses are employed in Group M on average, whereas 46 percent are employed in Group B on average but only 27 percent in Group H on average. These differences likely reflect very different demographic characteristics within these households (e.g., perhaps more retirement for Group H). The average number of children is noticeably smaller for Group H (.67) than Group M (.94) and Group B (.93), which may be attributed to the higher average age of Group H. Finally, and most importantly, for Group B the average amount of time spent in all household activities in a day is 1.63 hours and .52 hours in food preparation. For Group H, with no market work, the average amount of time spent in household activities in a day is 3.04 hours and .95 hours in food preparation. While these numbers may seem low, note the standard deviations are quite high relative to the means. Group M, by definition, reports spending no time in household activities.

Estimation Results and Time Cost Estimates

The model is a simultaneous system and the specific likelihood function given in the appendix was estimated by maximum likelihood. The estimation results are presented in table 3.[7] All variables are highly significant and have the expected signs in both the female and male market wage equations, with the exception of metropolitan in the male

---

[7] Starting values were obtained by first estimating a Type II Tobit (Amemiya 1985) model for the household work and no household work distribution.

wage equation, which is insignificant. For this analysis the marginal product equations are of more interest and in particular comparing the results between females and males. For the variables that are significant in both female and male marginal product equations the signs are consistent between the sexes. For the female marginal product equation all variables are highly significant except for the age squared, spouse employed, and perhaps adult number. While these same variables are insignificant in the male marginal product equation, a few other variables are insignificant as well in the male marginal product equation.

In particular while an additional year – the significant linear term – increases the female marginal product by about 2.1 percent (recall age is divided by 10), age has no significant impact on the male marginal product. In addition, being in a metropolitan area increases the female marginal product by about 16 percent (i.e., for this discrete variable, $e^{.15} - 1$), but it has no effect on the male marginal product. An important result to note for future reference is that being married increases the female marginal productivity by about 23 percent, but decreases male marginal productivity by about 6 percent, though this is only significant at the .14 significance level. Stated alternatively, *ceteris paribus*, being a single female reduces the marginal product by 23 percent. For every additional child under the age of 18, marginal productivity for females increases by 9 percent and for males it increases by 4 percent. This result is interesting in light of the results related to number of adults, where each additional adult decreases female marginal productivity by about 2 percent and male marginal productivity by about 6 percent, though the female result is only significant at the .07 significance level. This suggests that different family members have very different impacts on marginal productivity. Finally and most importantly, the marginal product is decreasing in time and it decreases faster for men than for women. For every additional hour, marginal productivity decreases by about 11 percent for women but by about 17 percent for men. This result is important to keep in mind because depending on where the marginal product function is evaluated determines the shadow value. Because the marginal product is declining in time and men tend to spend less time in household work than women, it is entirely possible for the male shadow value to be *higher* than the female shadow value. This of course does not mean their total output is greater.

Using the maximum likelihood estimates, the expected marginal product (i.e. hourly shadow wage) from the semi-log functional form is

(11) $E(h_i) = \exp(Z_i d + gT_{hi} + .5 \times s_2^2)$

where $d, g,$ and s_2^2 are the corresponding maximum likelihood parameter estimates (KO 1990 p.127). Using the estimates provided by equation (11), the main estimates of interest also can be calculated.[8]

General Population Profile

Table 4 reports the median estimates for four categories of variables: (i) time input cost, (ii) food input cost, (iii) total food cost, and (iv) time input cost as a percent of total food cost by group and gender. The time input costs estimates are based on the estimated model and the ATUS data. The other three categories of variables require some supplemental data but provide useful insights into the relative importance of the time

[8] In contrast to KO, who report expected values at mean explanatory variable levels, the nonlinear nature of (11) and Jensen's inequality implies that it is more appropriate to report a central tendency measure of the expected values within the stated group. We choose to present the median because several of the empirical distributions are skewed.

input cost in total food production cost. Because all the results are estimates based on food at home production we drop the repetitive terms 'food at home' and 'estimate' in the discussion.

The first three rows of table 4 present the median time in food production, the hourly shadow wage, and the market substitute wage. The median amount of time in food preparation and clean up for females ranges from 0.00 hours per day for those working exclusively in the market (Group M) to 0.83 hours per day for those working exclusively at home (Group H). For males the comparable numbers range from 0.00 hours per day (Group M) to 0.17 hours per day (Group H). Based on the opportunity cost approach, the median hourly shadow wage for females ranges from $15.72 for those working at home and in the market (Group B) to $16.73 for those working only in the market (Group M). For males the values range from $17.96 for Group B to $27.44 in Group H. As indicated earlier, a greater marginal product for men is consistent with men spending *less* time in food production. The median hourly wage rate from the market substitute approach is $7.92 and comes from the May 2003 BLS Standard Occupational Code (SOC) 35-2000, which is Food Preparation and Serving Related Occupations (BLS 2006). This value is not reported by gender. In general the market substitute approach yields a lower hourly wage than the opportunity cost approach, which as Gronau (1986, p. 298 footnote 40) indicates is a common finding.

The fourth row gives the median time input cost based on the opportunity cost approach and is calculated from multiplying the hourly shadow wage estimate (i.e., marginal product) times the number of hours in food production for each individual. We do not estimate costs for Group M because FAH cannot be prepared without some time input. Based on the opportunity cost approach, the median daily time input cost is $6.70 for females working at home and in the market (Group B) and $12.61 for females not working in the market (Group H). The median daily time input cost is $2.37 for men working at home and in the market (Group B) and $4.37 for men not working in the market (Group H). The fifth row gives the median daily time input cost based on the hourly market substitute wage rate and is calculated by multiplying the hourly market wage rate in food production times the number of hours in food production for each individual. The median daily time input cost for females is $3.30 for those working at home and in the market (Group B) and $6.60 for those not working in the market (Group H). For men, the median daily time input cost is $1.32 for both Groups B and H. Regardless of the method employed, these differences across genders and working conditions reflect the differences in the amount of time allocated to food production by gender and by working conditions. That is, the more time allocated to food production, the higher the time cost, *ceteris paribus*.

Row six gives an estimate of the median *food input* cost per day. The ATUS does not collect information on food input expenditures so this estimate is calculated as follows. The USDA\ERS provides annual estimates of the *per capita* expenditures on FAH. For 2003 this estimate was $1535 or on a daily basis $4.20 per capita (USDA\ERS 2006). Just as the time input cost estimate controls for household size, the food input cost estimate must be adjusted for household size so we simply multiply $4.20 times the total number of household members in the household for each individual. While there may be some economies of scale, there is no definitive set of scale multipliers so we just assume they are all one. The median daily food input cost (row six) is $12.60 for females and males who work in the market and at home (Group B) and $8.40 for females and males who only work in the home (Group H). This constancy across gender just reflects the fact that this is the median of a constant ($4.20 per person) times the number of household members, and the median number of household members for females and males is 3 in Group B and 2 in Group H.

Rows seven and eight give the median *total food cost* estimates based on the opportunity cost approach and the market substitute approach, respectively. These estimates are obtained by adding together the time input cost and the food input cost for each individual and calculating the median value. Based on the opportunity cost approach, the daily median total food at home cost is $19.21 for a female working in the home and in the market (Group B) and $23.28 for a female just working at home (Group H). The higher cost for a female working at home indicates that the higher time input cost more than offsets the lower food input cost. For males, the daily median total food at home cost is the same $16.80 regardless of group. Based on the market substitute approach, the daily median total food at home cost is $16.32 for a female working in the home and in the market (Group B) and $16.80 for a female just working at home (Group H). For males, the daily median total food at home cost is $13.68 for a male working in the home and in the market (Group B) and $11.04 for a male just working at home (Group H).

Rows nine and ten give the percentage of total food cost accounted for by the time input cost, again based on the opportunity cost and market substitute approaches. These are the median percentages over all individuals. Based on the opportunity cost method, the daily median percent of total food cost associated with time is 38% for a female working in the home and in the market (Group B) and 57% for a female just working at home (Group H). For males, the daily median percent of total food cost associated with time is 15% for a male working in the home and in the market (Group B) and 31% for a male just working at home (Group H). Based on the market substitute approach, the daily median percent of total food cost associated with time is 24% for a female working in the home and in the market (Group B) and 41% for a female just working at home (Group H). For males, the daily median percent of total food cost associated with time is 7% for a male working in the home and in the market (Group B) and 14% for a male just working at home (Group H). These differences between Group B and Group H again reflect more time allocated to food production in Group H.

Typical Food Stamp Participant Profile

As indicated in the introduction, a criticism of the Thrifty Food Plan used for Food Stamp allocations is that it ignores food preparation cost. Though the ATUS does not collect data on whether or not the individual is on Food Stamps, the estimated model can also be used to estimate this cost for a typical Food Stamp (FS) participant profile. In general, we find that the time input cost percentage for a typical FS participant that works at home and in the market (Group B) is higher than for the general population. However, for an individual that works solely at home (Group H), the time input cost percentage for a typical FS participant is less than for the general population.

Specifically, table 5 is similar to table 4, but is based on a typical FS participant demographic profile. According to the large literature review by Gleason, Schochet, and Moffitt (1998) and data published in Cunnygham and Brown (2004), a typical FS participant demographic profile is a single non-white non-professional female, with some high school education, not a member of a union and living in a metropolitan area. For individuals satisfying this profile, other variables are allowed to take their actual values and, as in table 4, we calculate the median values for each group.

Focusing on Group B and Group H, from row one of table 5, the median amount of time for the typical FS participant and working in the home and in the market is 0.67 hours per day (Group B) whereas for those only working in the home the median amount of time is 0.50 hours per day (Group H). Based on the opportunity cost approach, the median hourly shadow wage for the typical FS participant is $13.58 for Group B and $14.68 for Group H. The median hourly wage rate based on the market substitute approach is the same as before, $7.92. Based on the opportunity cost approach, the median daily time cost in food production for the typical FS participant is $8.66 for those working at home and in the market (Group B) and $8.92 for those not working in the market (Group H). Based on the market substitute approach, the median daily time input cost for females is $5.28 for those working at home and in the market (Group B) and $3.96 for those not working in the market (Group H). The median daily food input cost (row six) is $8.40 for Group B and Group H. For the typical FS participant, the daily median total food cost based on the opportunity cost approach is $16.99 for the participant working in the home and in the market (Group B) and $18.87 for the participant just working at home (Group H). Based on the market substitute approach the corresponding numbers are slightly lower: $14.55 for Group B and $14.53 for Group H.

Most importantly, for the typical FS participant, the median percent of total daily food cost attributable to time by the opportunity cost method is 47% for a participant working in the home and in the market (Group B) and 50% for a participant just working at home (Group H). Again, these percentages are lower if the estimates are based on the market substitute approach: 32% for Group B and 39% for Group H.

Comparing these numbers to those in table 4 indicates that for a FS participant working in the home and in the market (Group B), the percentage of food cost attributable to time is higher than for the general population – about 9% higher based on the opportunity cost approach and about 8% higher based on the market substitute approach. For a FS participant not working in the market (Group H), the percentage of food cost attributable to time is lower than for the general population – about 7% lower based on the opportunity cost approach and about 3% lower based on the market substitute approach. These estimates are congruent with Vickery's (1977) argument that individuals working in the market place and at home may be time poor, especially if they are single and female.

Typical Food Stamp Participant Profile with Thrifty Food Plan Values

To get an idea of how much the Thrifty Food Plan (TFP) may cost in terms of time input, table 6 repeats the analysis of table 5 except calculations are based on data from the TFP. Specifically, rather than using the actual time FS participants allocated to food production as in table 5, all calculations are based on the median time input of 35 minutes (.58 hours) indicated from the USDA\CNPP (2000) publication *Recipes and Tips for Healthy, Thrifty Meals*. This is the median time for a single meal. The single meal time is converted to a daily estimate by multiplying by 2.05, which is the average number of meals prepared at home per day (National Restaurant Association 2006). Furthermore, the food input cost calculations are based on the maximum benefit formula for TFP. The maximum benefit allotment varies by household size and, as indicated in the introduction, represents the minimum amount of money required to reach the targeted nutritional standard.[9] The idea of this analysis is to determine the time cost if someone adheres to the TFP.

Again focusing on Group B and Group H, from row one of table 6, the median amount of time for the typical FS-TFP participant is the constant .58 hours from the TFP recipes. Based on the opportunity cost approach, the median hourly shadow wage for the typical FS-TFP participant is $13.20 for Group B and $14.38 for Group H. The median hourly wage rate based on the market substitute approach is again $7.92. Based on the opportunity cost approach, the median daily time input cost for the typical FS-TFP participant is $15.84 for those working at home and in the market (Group B) and $17.26 for those not working in the market (Group H). Based on the market substitute approach, the median daily time cost in food production for females is $9.50 for Group B and Group H. The median daily food input cost (row six) is $8.56 for Group B and Group H. For the typical FS-TFP participant, the daily median total food cost based on the opportunity cost approach is $25.06 for the participant working in the home and in the market (Group B) and $26.32 for the participant just working at home (Group H). Based on the market substitute approach the corresponding number is $18.06 for Group B and for Group H.

[9] The maximum benefit is based on a family of four with two adults and two children. Maximum benefit allotments are based on the June TFP from the *Official USDA Food Plans*: *Cost of Food at Home at Four Levels* (USDA\CNPP 2006). From the June 2003 TFP, the weekly allotment for the baseline family is $108.9 or on a daily basis $15.56. This number is then converted to a per person amount by dividing by 4 or $3.89. This per person amount is then multiplied by the number of people in the household *and* a scaling factor. The scaling factors for 1 – 8 household sizes are: 1.2 for 1, 1.1 for 2, 1.05 for 3, 1 for 4, 0.95 for 5, 0.95 for 6, 0.9 for 7, and 0.9 for 8. Every additional person above 8 adds $3.8 per day. Appreciation is expressed to Vicky Robinson at USDA\CNPP for explaining these calculations.

Most importantly, for the typical FS-TFP participant, the median percent of total daily food cost attributable to time by the opportunity cost method is 61% for a participant working in the home and in the market (Group B) and 65% for a participant just working at home. Again, these percentages are lower if the estimates are based on the market substitute approach: 53% for Group B and for Group H.

Comparing these numbers to those in table 4 indicates that for a FS participant working in the home and in the market (Group B), the percentage of food cost attributable to time is much higher than for the general population – about 23% higher based on the opportunity cost approach and about 29% higher based on the market substitute approach. For a FS participant not working in the market (Group H), the percentage of food cost attributable to time is still higher than for the general population – about 8% higher based on the opportunity cost approach and about 12% higher based on the market substitute approach. These estimates suggests that the TFP imposes a high time cost on FS participants and that ignoring this cost will likely reduce the efficacy of the FS program.

Summary and Conclusions

To our knowledge, this research provides the first known estimates of the cost of time in food preparation at home in the United States based on the ATUS. Both the market substitute and opportunity cost approaches are implemented and used to estimate the daily total time input cost in food production at home. These estimates are then coupled with daily food input cost to yield estimates of the total daily cost of food production at home. We consider three demographic profiles to evaluate. For the general population, we find that on average the time input cost accounts for about 35% of total food cost at home based on the opportunity cost approach and about 21% of total food cost at home based on the substitute approach. For a typical Food Stamp Participant profile, we find that on average the time input cost accounts for about 48% of total food cost at home based on the opportunity cost approach and about 35% of total food cost at home based on the substitute approach. And for a typical Food Stamp Participant profile following the USDA Thrifty Food Plan, we find that on average the time input cost accounts for about 63% of total food cost at home based on the opportunity cost approach and about 53% of total food cost at home based on the substitute approach.

The general finding is that the percentage of total food production cost at home attributable to the time input is substantial, which likely provides strong incentives to purchase food away from home and help undermine overall diet quality. Furthermore, these substantial costs likely reduce the efficacy of the Food Stamp program, which ignores the time input cost in food at home production.

As with all research there are caveats to be considered in future research. The ATUS data are a tremendous step forward in terms of time allocation data, but the data are still not ideal and consequently future research on the cost of food at home will need to develop ways to circumvent these limitations without adding to the uncertainty of the results. Three of these were mentioned related to no data on inputs other than time, spousal time spillover, and the designated person perhaps not being the main meal preparer. Along with these issues are the normal caveats related to estimating household production models (see Gronau 1986 for discussion). It is not clear whether addressing these issues would lead to an upward or downward revision of the numbers presented here. The main concern is probably that the estimates are too high. However, even if future research cuts the time cost shares in half, they would still represent a sizable percentage of total cost that may seriously undermine policy options that ignore time cost.

References

Amemiya, T. (1985) *Advanced Econometrics*, Harvard University Press, Cambridge.

Basiotis, P. P., and M. C. Lino. (2000) "Cost of a Healthy Diet." Paper presented at the 128th meeting of the American Public Health Association.

Becker, G.S. (1965) "A Theory of Allocation of Time." *Economic Journal* Vol. 75: 493-517.

Binkely, J.K., J. Eales, and M. Jekanowski. (2000) "The Relation Between Dietary Change and Rising U.S. Obesity." *International Journal of Obesity*. 24: 1032-1039.

Bureau of Labor Statistics. (2005). American Time Use Survey. http://www.bls.gov/tus/home.htm.

Bureau of Labor Statistics. (2006). Occupational Employment Statistics. "Occupational Employment and Wages, November 2003." http://www.bls.gov/oes/2003/may/oes352021.htm.

Byrne, P.J., O. Capps, Jr. and A. Saha. (1996) "Analysis of Food-Away-from-Home Expenditure Patterns for U.S. Households, 1982-89." *American Journal of Agricultural Economics* 78:614-27.

Centers for Disease Control. (2006). Overweight and Obesity: Obesity Trends: U.S. Obesity Trends 1985–2004. http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/index.htm.

Chou, S.Y., M. Grossman and H. Saffer. (2004) "An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System." *Journal of Health Economics 23:565-587*.

Cunnygham, K. and B. Brown. (2004) *Characteristics of Food Stamp Households: Fiscal Year 2003*. Alexandria, VA. U.S. Department of Agriculture, Food and Nutrition Service.

Drewnowski, A. and N. Darmon. (2005) "Food Choices and Diet Costs: An Economic Analysis." *Journal of Nutrition*. Vol. 135. No. 4:900-904.

Food Research and Action Center. (2006) "Food Stamp Program Frequently Asked Questions." http://www.frac.org/html/federal food_programs/programs/fsp_faq.html.

Gleason, P., P. Schochet and R. Moffitt. (1998) *The Dynamics of Food Stamp Program Participation in the Early 1990s*. Alexandria, VA. U.S. Department of Agriculture, Food and Nutrition Service.

Gronau, R. (1997) "The Theory of Home Production: The Past Ten Years." *Journal of Labor Economics.* Vol. 15. No. 2: 197-205

________ (1986) "Home Production – A Survey." Chapter 4 in *Handbook for Labor Economics*. Vol. I. Eds. O. Ashenfelter and R. Layard. New York: Elseveier.

________ (1980) "Home Production – A Forgotten Industry." *The Review of Economics and Statistics.* Vol. 62. No. 3: 408-416.

Guthrie, J.F., B.-H. Lin, and E. Frazao.(2002) "Role of Food Prepared Away from Home in the American Diet, 1977-78 versus 1994-96: Changes and Consequences." *Journal of Nutrition Education and Behavior* 34: 140-150.

Heckman, J. (1974) "Shadow Prices, Market Wages, and Labor Supply." *Econometrica*. Vol. 42. No. 4:679-694.

Kiker, B. and M. de Oliviera. (1990) "Estimation and Valuation of Non-Leisure Time." *Oxford Bulletin of Economics and Statistics*. Vol. 52. No. 2: 115-141.

Leeds, M.A. and P. von Allmen. (2004) "Spousal Complementarity in Home Production." *The American Journal of Economics and Sociology.* Vol. 63. No. 4: 795-811.

McCracken, V.A., and J.A. Brandt. (1987) "Household Consumption of Food-Away-From-Home: Total Expenditure and by Type of Food Facility." *American Journal of Agricultural Economics* 69:274-84.

McCrory, M.A., P.J. Fuss, N.R. Hays, A.G. Vinken, A.S. Greenberg, and S.B. Roberts. (1999) "Overeating In America: Association Between Restaurant Food Consumption and Body Fatness in Healthy Adult Men and Women ages 19 to 80." *Obesity Research* 7: 564-571.

National Restaurants Association. (2006) *Restaurants USA Online*. "Americans' Dining-Out Habits." November, 2000. http://www.restaurant.org/rusa/magArticle.cfm?ArticleID=138

Nayga Jr., R.M. (1998) "A Sample Selection Model for Prepared Food Expenditures." *Applied Economics*. 30:345-52.

Nayga Jr., R.M., and O. Jr. Capps. (1992) "Determinants of Food Away From Home Consumption: An Update." *Agribusiness* 8:549-59.

Nestle, M., and M.F. Jacobson. (2000) "Halting the Obesity Epidemic: A Public Health Policy Approach." *Public Health Reports* 115: 12-23.

Prochaska, F.J., and R.A. Schrimper. (1973) "Opportunity Cost of Time and Other Socioeconomic Effects on Away-From-Home Food Consumption." *American Journal of Agricultural Economics* 55:595-603.

Redman, B.J. (1980) "The Impact of Women's Time Allocation on Expenditure for Meals Away From Home and Prepared Foods." *American Journal of Agricultural Economics* 62:234-7.

United States Department of Agriculture. Economic Research Service. (2006a). *Briefing Room*: *Food CPI*, *Prices*, *and Expenditures*: *Per Capita Food Expenditures Table 15*. http://www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/Data/Table15.htm.

United States Department of Agriculture. Center for Nutrition Policy and Promotion. (2006 b) Official USDA Food Plans: Cost of Food at Home at Four Levels, U.S. Average, June 2003. http://www.cnpp.usda.gov/using3.html.

____________ (2000). *Recipes and Tips for Healthy, Thrifty Meals*. CNPP-11. Washington, DC.

_____________ (1999) *The Thrifty Food Plan*, *1999*: *Executive Summary*. CNPP-7A. Washington, DC.

Variyam, J.N. (2005). "Nutrition Labeling in the Food-Away-From-Home Sector: An Economic Assessment." United States Department of Agriculture. Economic Research Service. Economic Research Report Number 4. April.

Vickery, C. (1977) "The Time-Poor: A New Look at Poverty." *The Journal of Human Resources*. 12: 27-48.

Table 1. Variable definitions and units

Variable	Units
Log of hourly wage rate (ln w)	Dollars per hour (log)
Middle school (base)	1 if education is 8^{th} grade or less; 0 otherwise
High school ($y_1 = z_1$)	1 if education is between 9^{th} and 12^{th} grade; 0 otherwise
Bachelors ($y_2 = z_2$)	1 if education is between some college and bachelors degree; 0 otherwise
Masters ($y_3 = z_3$)	1 if education is a master's degree; 0 otherwise
Professional or Doctorate ($y_4 = z_4$)	1 if education is Professional (e.g., MD) or Doctorate degree; 0 otherwise
Age ($y_5 = z_5$)	Person's age/10
Age squared ($y_6 = z_6$)	$(\text{Person's age}/10)^2$
Metropolitan ($y_7 = z_7$)	1 if live in a metropolitan area; 0 otherwise
Union (y_8)	1 if a member of a union; 0 otherwise
Professional (y_9)	1 if management or professional occupation; 0 otherwise
White (y_{10})	1 if race is white; 0 otherwise
Black (y_{11})	1 if race is black; 0 otherwise
Married (z_8)	1 if married; 0 otherwise
Spouse employed (z_9)	1 if spouse is employed; 0 otherwise
Child number (z_{10})	Number of children less than 18
Adult number (z_{11})	Total number in household minus child number
Time in home production (T_H)	Hours per day in home production
Time in food preparation (T_f)	Hours per day in food and drink preparation and clean-up

Table 2. Means and Standard Deviations by Group

Variable	**Group[a]**		
	Group M	**Group B**	**Group H**
Female	0.35 (0.48)	0.60 (0.49)	0.71 (0.45)
Log of Wage	2.42 (0.51)	2.51 (0.50)	-----
High School	0.51 (0.50)	0.43 (0.50)	0.48 (0.50)
Bachelors	0.42 (0.49)	0.50 (0.50)	0.35 (0.48)
Masters	0.02 (0.14)	0.03 (0.18)	0.05 (0.23)
Professional or Doctorate	0.003 (0.05)	0.004 (0.07)	0.01 (0.12)
Age	3.64 (1.39)	4.12 (1.26)	5.54 (2.02)
Age squared	15.22 (11.22)	18.57 (10.81)	34.78 (20.56)
Metropolitan	0.80 (0.40)	0.78 (0.41)	0.78 (0.42)
Union	0.16 (0.37)	0.15 (0.36)	0.00 (0.00)
Professional	0.18 (0.38)	0.25 (0.43)	0.02 (0.13)
White	0.80 (0.40)	0.83 (0.39)	0.84 (0.37)
Black	0.16 (0.36)	0.12 (0.33)	0.12 (0.33)
Married	0.43 (0.50)	0.52 (0.50)	0.49 (0.50)

Spouse Employed	0.33	0.46	0.27
	(0.47)	(0.50)	(0.44)
Child Number	0.94	0.93	0.67
	(1.19)	(1.10)	(1.13)
Adult Number	2.15	1.95	1.83
	(0.96)	(0.82)	(0.80)
Time in household activities	0.00	1.63	3.03
	(0.00)	(1.62)	(2.57)
Time in food preparation	0.00	0.52	0.95
	(0.00)	(0.71)	(1.17)

a. Group M (market work), Group B (market and home work), Group H (home work). Standard deviation in parenthesis. N = 9104.

Table 3. Maximum Likelihood Estimation Results

Variable	Wage		Marginal Product	
	Female	**Male**	**Female**	**Male**
High school	0.34 (.00)	0.15 (.02)	0.08 (.27)	0.19 (.03)
Bachelors	0.48 (.00)	0.22 (.00)	0.23 (.00)	0.33 (.00)
Masters	0.74 (.00)	0.23 (.02)	0.67 (.00)	0.68 (.00)
Professional or Doctorate	0.55 (.01)	0.74 (.00)	0.52 (.00)	1.18 (.00)
Age	0.51 (.00)	0.71 (.00)	0.21 (.00)	0.08 (.51)
Age squared	–0.06 (.00)	–0.08 (.00)	–0.006 (.45)	0.02 (.25)
Metropolitan	0.12 (.00)	0.01 (.87)	0.15 (.00)	–0.02 (.59)
Union	0.29 (.00)	0.32 (.00)	---	---
Professional	0.41 (.00)	0.31 (.00)	---	---
White	0.06 (.05)	0.16 (.00)	---	---
Black	0.09 (.02)	0.13 (.02)	---	---
Married	---	---	0.21 (.00)	–0.06 (.14)
Spouse employed	---	---	0.02 (.36)	0.05 (.19)

Child number	---	---	0.09 (.00)	**0.04** (.02)
Adult number	---	---	–0.02 (.07)	–0.06 (.00)
Time in home production	---	---	–0.11 (.00)	–0.17 (.00)
s_2^2		0.52 (.00)		0.72 (.00)
s^2		0.44 (.00)		0.64 (.00)
R		–0.67 (.00)		–0.84 (.00)

a. Intercepts are not reported. P-value in parenthesis.

Table 4. Food at Home Costs Comparisons by Group and Gender for the General Population

	Group M		Group B		Group H	
Variable	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
Time Input Cost						
1. Median time in food preparation and clean up	0.00	0.00	0.42	0.17	0.83	0.17
2. Median hourly shadow wage	16.23	20.19	15.72	17.96	15.77	27.44
3. Median hourly market substitute wage	7.92	7.92	7.92	7.92	7.92	7.92
4. Median time cost per day based on hourly shadow wage	---	---	6.70	2.37	12.61	4.37
5. Median time cost per day based on hourly market substitute wage	---	---	3.30	1.32	6.60	1.32
Food Input Cost						
6. Median food cost at home per day[b]	---	---	12.60	12.60	8.40	8.40
Total Food Cost						
7. Median total food cost per day based on hourly shadow wage	---	---	19.21	16.80	23.28	16.80
8. Median total food cost per day based on hourly market substitute wage	---	---	16.32	13.68	16.80	11.04
Time Input Cost as Percent of Total Cost						
9. Median time cost percent based on hourly shadow wage	---	---	38	15	57	31
10. Median time cost percent based on hourly market substitute wage	---	---	24	7	41	14

a. Group M (market work), Group B (market and home work), Group H (home work). b. Based on USDA Annual Food at Home Expenditures.

Table 5. Food at Home Cost Comparisons for Typical Food Stamp Participant Profile

Variable	Group M	Group B	Group H
Time Input Cost			
1. Median time in food preparation and clean up	0.00	0.67	0.50
2. Median estimated hourly shadow wage	14.38	13.58	14.68
3. Median hourly market substitute wage	7.92	7.92	7.92
4. Median time cost per day based on hourly shadow wage	---	8.66	8.92
5. Median time cost per day based on hourly market substitute wage	---	5.28	3.96
Food Input Cost			
6. Median food cost at home per day[b]	---	8.40	8.40
Total Food Cost at Home Per Day			
7. Median total food cost per day based on hourly shadow wage	---	16.99	18.87
8. Median total food cost per day based on hourly market substitute wage	---	14.55	14.53
Time Cost as Percent of Total Cost			
9. Median time cost percent based on hourly shadow wage	---	47	50
10. Median time cost percent based on hourly market substitute wage	---	32	39

a. Group M (market work), Group B (market and home work), Group H (home work). b. Based on USDA Annual Food at Home Expenditures.

Table 6. Cost Comparisons for Typical Food Stamp Participant Profile Using Thrifty Food Plan Values

Variable	Group M	Group B	Group H
Time Input Cost			
1. Median time in food preparation and clean up[b]	0.00	0.58	0.58
2. Median estimated hourly shadow wage	12.61	13.20	14.38
3. Median hourly market substitute wage	7.92	7.92	7.92
4. Median time cost per day based on hourly shadow wage	---	15.84	17.26
5. Median time cost per day based on hourly market substitute wage	---	9.50	9.50
Food Input Cost			
6. Median food cost at home per day[c]	---	8.56	8.56
Total Food Cost at Home Per Day			
7. Median total food cost per day based on hourly shadow wage	---	25.06	26.32
8. Median total food cost per day based on hourly market substitute wage	---	18.06	18.06
Time Cost as Percent of Total Cost			
9. Median time cost percent based on hourly shadow wage	---	61	65
10. Median time cost percent based on hourly market substitute wage	---	53	53

a. Group M (market work), Group B (market and home work), Group H (home work). b. Based on median time of USDA Thrifty Food Plan Recipes. c. Based on USDA Thrifty Food Plan maximum benefits.

Appendix

The error terms of equations (7) and (8) are assumed to be jointly normally distributed with zero mean vector, variances σ_1^2 and σ_2^2 and covariance σ_{12}. This implies the error term for equation (9), (ε_1 - ε_2), is also a normal random variable with zero mean and variance

(A.1) $\sigma^2 = \sigma_1^2 + \sigma_2^2 - 2\sigma_{12}$

Furthermore, ε_2 and (ε_1 - ε_2) are then jointly normal. Let ρ denote their correlation coefficient and the symbols s^2, s_2^2, and *r* denote the maximum likelihood (ML) estimates of σ^2, σ_2^2 and ρ.

By the method of transformations, the probability density function (pdf) of ln *w* and $\tilde{T}_H$, $g(\ln w, \tilde{T}_H)$ is given by

(A.2) $g(\ln w, \tilde{T}_H) = -\gamma\, \Psi[(\ln w - Z\beta - \gamma\tilde{T}_H), (Z\beta + \gamma\tilde{T}_H - Y\alpha)]$.

This is the non-censored part of the distribution (Group B individuals) where in (A.2), Ψ(., .) denotes the bivariate normal pdf and $T_H = \tilde{T}_H$.

For the censored part of the distribution, the lower censoring (Group M individuals) is given by,

(A.3) $\Pr(\tilde{T}_H \le 0) = \Pr(\varepsilon_1 - \varepsilon_2 \ge Z\beta - Y\alpha) = 1 - \Phi[(Z\beta - Y\alpha)/\sigma]$,

where Φ(.) stands for the standard normal cumulative distribution function (cdf). For Group M, T_H is identically equal to zero for all observations. The upper censoring (Group H individuals) is given by

(A.4) $\Pr(\tilde{T}_H \ge T - L) = \Pr(\varepsilon_1 - \varepsilon_2 \le Z\beta + \gamma T_H - Y\alpha) = \Phi[(Z\beta + \gamma T_H - Y\alpha)/\sigma]$

for T-L=T_H in this subsample. The sample likelihood function is the product of (A.2) through (A.4) and the logarithmic likelihood function, $l(\theta)$, is thus

$$l(\theta) = \Sigma_M [\ln(1-\Phi_i)] + \Sigma_B [\ln(-\gamma / 2\pi\sigma_2\sigma\sqrt{1-\rho^2}) - Q_i / 2(1-\rho^2)] + \Sigma_H (\ln \Phi_i)$$

where θ denotes a vector whose components are the scalar parameters γ, σ_2^2, σ^2, and ρ and the parameters in the vectors α and β, the subscripts M, B, H following the summation signs indicate the group over which the individual subscript *i* ranges, and

$$Q_i = [(\ln w_i - Z_i\beta - \gamma T_{Hi}) / \sigma_2]^2 - 2\rho[(\ln w_i - Z_i\beta - \gamma T_{Hi}) / \sigma_2] \times$$

$$[Z_i\beta + \gamma T_{Hi} - Y_i\alpha) / \sigma] + [(Z_i\beta + \gamma T_{Hi} - Y_i\alpha) / \sigma]^2$$

$$\Phi_i = \int_{-\infty}^{(Z_i\beta + \gamma T_{Hi} - Y_i\alpha)/\sigma} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}t^2\right) dt \, .$$