Preparing Food at Home: What is the Labor cost?

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Abstract

Food demand is an important component of the agricultural sector and much food preparation occurs in the home. While there is much information about the market cost of food, there has been no information about the preparation cost of food at home because there has been no data available on the quantity of time spent in food preparation. Using newly released time diary data from the Bureau of Labor Statistics, this paper provides the first known estimates of the cost of time in food preparation at home. We also consider a demographic profile comparable with someone who may be on Food Stamps and following the recipes based on the USDA Thrifty Food Plan, which is designed to help low income groups on Food Stamps.

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

Preparing Food at Home: What is the Labor cost?

What is the average time (labor) cost of daily food preparation at home in the United States? Given the importance of food demand to the agricultural sector, and the fact that much food preparation occurs at home, it is surprising that this basic question has not been answered – at least until one realizes the type of data required to answer this question. As in estimating any cost, the answer requires the cost per unit of time *and* the quantity of time spent in food preparation. Economic theory provides a means of measuring 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.

The purpose of this article is to estimate the time cost spent in food preparation at home using data from the ATUS and compare it to the cost of food preparation in the market place. Why is estimating the time cost in at home food preparation important? Two obvious reasons come to mind. First, since the early 1970's, the American farmer's share of food expenditures has decreased from about 32 percent to 19 percent and the marketing services share of food expenditures has increased from 68 percent to 81 percent (USDA\ERS). During this same time, there were significant changes in the labor force. Men's labor force participation rates decreased from around 80 percent to around 73 percent and women's labor force participation rates increased from around 43 percent to around 60 percent (BLS 2003). The labor force changes are often cited as one of the main reasons for the increase in marketing services: as more time is devoted to market work, this simultaneously increases household income and decreases the amount of time available for other activities, such as at home food preparation. Consequently, as the cost of food preparation at home increases, the demand for convenience increases and households substitute time-saving services for their own time. While this theoretical argument is intuitively appealing, without direct estimates of the cost of at home food preparation it is difficult to know how much emphasis should be placed on this intuition.

Second, the efficacy of food assistance programs can be affected by the cost of at home food preparation. 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\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 or see Drewnowski and Darmon 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." How do we know these recipes require extensive time for food preparation? From the recipes given in the USDA document, *Recipes and Tips for Healthy, Thrifty Meals*, the average estimated time over all recipes is about 40 minutes. Is 40 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 food preparation cost. If the ignored preparation cost is excessive for TFP menus, then this ignored aspect of food demand will reduce the efficacy of Food Stamp programs.

The paper proceeds as follows. The next section gives a brief review of the related literature on the demand for Food-Away-From-Home (FAFH) and pre-prepared foods but points out that this literature does not estimate the cost of food preparation at home. The next section gives a summary of the underlying theory and empirical framework, which comes from the labor economics literature on valuing non-market labor. In the empirical section that follows, we estimate the marginal product function for home production along with a market wage rate equation. We also consider a demographic profile comparable with someone who may be on Food Stamps and following the recipes based on the Thrifty Food Plan. The paper closes with conclusions.

Relationship with Related Literature

Though there exist no direct estimates of the time cost of at home food preparation, there is a substantial related literature investigating the relationship between expenditures on various convenience food measures and various opportunity cost of time measures. 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., Prochaska, and Schrimper; McCracken, and Brandt; Yen; Nayga; Nayga and Capps; Redman; Byrne, Capps, and Saha).

The common element underlying these studies and the present study is the theoretical framework of household production and the optimal allocation of time (Becker, Gronau 1977). 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. Now while the increasing consumption of convenience food (i.e. FAFH or pre-prepared foods) may be associated with increasing opportunity cost of time, it would be incorrect – though tempting – to conclude the time cost of food preparation at home has increased. This is easily seen within the household production framework, where the cost of time spent in a household production activity, such as a meal, (C_H) is equal to the opportunity cost of time (i.e., the 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 at home cost of production may increase or decrease with an increase in s. As Prochaska and Schrimper point out, the home meal production time may decrease due to the increasing availability of time-saving foods and home cooking equipment. So the time cost component of the full price of home production may not increase as much or actually may decrease in spite of increasing opportunity cost of time of the homemakers. This result would be consistent with the increasing household expenditure on pre-prepared food (Redman; Nayga). While there is evidence that FAFH and pre-prepared food consumption has increased with the opportunity cost of time, this relationship really does not tell anything about the cost of food preparation at home.

Theoretical and Empirical Framework Overview

The theoretical and empirical frameworks for estimating and valuing non-market wage rates are well established in the labor market literature and are only briefly reviewed here (see Gronau 1986 for a more extensive review). The literature has generally pursued two approaches: (i) the opportunity cost method and (ii) the market substitute method. The *opportunity cost method* 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. The *market substitute method* uses a very close substitute that can be purchased in the market place to value the non-market activity. For example, suppose one wanted to place a dollar value on an hour of food preparation. The market substitute approach would use the wage rate of a food preparer in the food sector to value at home food preparation. In this study we will present estimates from both approaches. Given the market substitute approach just requires collecting a market wage rate for the service under consideration, attention in this sections focuses on the theory and empirics of the opportunity cost method.

Here we follow the approach of Kiker and de Oliveira (KO). The KO approach is based on the theoretical model of Gronau (1977) and extends the second generation of empirical models initiated by Heckman that accounted for lower limit censoring with endogeneity to account for double censoring with endogeneity. 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) $T = T_H + T_M + L$.

The optimal time allocation vector obtained from maximizing (1) subject to (2) – (5) will be denoted as $t^* = (T_M^*, T_H^*, L^*)$

All home produced goods are valued at their marginal product or shadow wage. Let $s = h(T_H^*, Z)$ denote the shadow wage and marginal product function for home production with respect to T_H, respectively. Let MRS_{XL} denote the marginal rate of substitution between goods and leisure. The interior solution implies 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) $$s = h(T_H^*, Z) = w = MRS_{XL} .$$

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 the work of Gronau and Heckman, 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 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 $t^* = (T_H^*, 0, L^*)$. The contribution of KO was to note that just as labor market participation or non-participation provided information to be exploited in estimation, household 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 marginal product function for household work, or shadow wage, is specified as

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

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

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

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} random error.

Though the left-hand side of equation (7) is unobserved (i.e., ln s_i), the parameters of (7) can still be estimated by exploiting the structure of the optimization solution; in particular the corner solutions. To see this, KO (p. 119) 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 $\tilde{T}_{Hi} \leq 0$.[1] 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

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

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.[2]

The joint distribution function characterizing these three groups then has three components. Let $F(\bullet)$ 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 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.[3]

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[2] Our Group M is KO's Group II, our Group B is KO's Group I, and our Group H is KO's Group III.
[3] The likelihood function can be found in the Appendix.

American Time Use Survey and Summary Statistics

This section summarizes the ATUS and provides summary statistics of the variables used in the analysis. The summary of the ATUS is based on documentation found at the BLS\ ATUS website, and more details can be found there.

A Summary of the ATUS

The ATUS is the culmination of almost ten years of work by the Bureau of Labor Statistics (BLS) to develop a federally administered, continuous survey on time use in the United States. While the survey is sponsored by the BLS, it is actually conducted by the U.S. Census Bureau. The 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 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.[4] 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.

Variable Definitions and Summary Statistics

The variables used in the analysis were selected based on available data and the existing literature (e.g., KO). The variables, their definitions, and units are listed in table 1. Variables that enter the market wage equation (i.e., the *y*s) are variables that are believed to affect the market wage the individual could obtain in a competitive job market. Variables that enter the marginal product function (i.e., the zs) are variables that

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

are believed to affect marginal productivity within the household. 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, y_2, y_3, and y_4), female (y_5), and metropolitan area (y_7).

The education variables are expected and have been found in other studies to be positively related to the market wage and the marginal product value. An empirical fact in labor markets is that women are paid less than men for the same job and so the female variable is expected to be negatively related to market wage and positively related to the (unobserved) shadow wage or marginal product value. This type of relationship has been documented elsewhere (see KO). Other variables of particular interest are being married (z_8), the number of children in the home (z_9), age of youngest child (z_{10}), and whether or not the spouse is employed (z_{11}), which are all expected to affect productivity within the home. Of course, the number of hours spent in home production (T_H) also is expected to affect marginal productivity. The remaining variables are included to control for factors that are recognized as possibly affecting work and home production.

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). For most variables in table 2, the general patterns across groups are similar. This is the case for education, metropolitan, white, black, married, and age of youngest variables. 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 not exist for the non-working group. Group M consists of 35 percent women, which is much lower than for Groups B and H, 60 and 71 percent respectively.

The 2 percent of Professionals in Group H is noticeably smaller than the other two groups, but is in agreement with intuition. 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. The average number of children is noticeably smaller for Group H (.68) than Group M (.94) and Group B (.95), which may be attributed to the higher average age of Group H. 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). Finally, and most importantly, for Group B the average amount of time spent in 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 was estimated by maximum likelihood. Starting values were obtained by first estimating a Type II Tobit (Amemiya) model for the household work and no household work distribution. The estimation results are presented in table 3.

As seen in table 3, all variables except Professional/Doctorate degree are highly significant in the market wage equation. In the marginal product equation all variables are significant at standard significance levels, except High School and married. Furthermore, the estimation results are completely consistent in sign with the results of

KO, which was based on an entirely different data set and time period. Recall in a semi-log model, the coefficient for a continuous regressor variable measures the percent change in the dependent variable for a one unit change in the regressor. For a dummy regressor variable, if *b* is the parameter on the dummy variable, the percent change in the dependent variable is calculated by $e^b - 1$ (Kennedy p. 123). Using this result, for the market wage equation, all education categories above grade school are associated with a higher wage rate: 25 percent higher for High School (i.e., $e^{.22} - 1$), 46 percent for Bachelors, 92 percent higher for Masters and 60 percent higher for Professional/Doctorate, *ceteris paribus*.[5] Being female is associated with a 30 percent decrease in the market wage rate, whereas being a member of a union increases the market wage rate by 46 percent. Being a white (black), Professional, in a Metropolitan area is associated with a higher market wage as well: 14, 15, 62, and 6 percent, respectively.

Turning to the marginal product equation, the same general pattern emerges with respect to education as in the market wage equation: 4 percent higher for High School, 20 percent higher for Bachelors, 118 percent higher for Masters and 80 percent higher for Professional/Doctorate. Opposite to the market wage equation where being a female was associated with a lower wage rate, being a female is associated with an 8 percent higher marginal product in the home than a male. For every one year increase in age there is a 9 percent increase in the home marginal product and being in a metropolitan area is associated with 8 percent higher marginal product in the home. For every additional child, the marginal productivity in the home increases by 5 percent. This is consistent with an increasing returns to scale argument in terms of number of children. As the age

[5] To avoid redundancy, all the results that follow are subject to the ceteris paribus qualification.

of the youngest increases by one year the marginal product in household production decreases by .4 percent, which is consistent with KO and as they point out this does not mean that younger children do not require more time. If the spouse is employed, the marginal product is 14 percent higher. Perhaps most importantly, consistent with decreasing marginal returns to time in household production, for every additional hour in household production, the marginal product decreases by 15 percent. Finally, the estimate of the variance for ε_2 (s_2^2), the variance for the error ($\varepsilon_1 - \varepsilon_2$) in the selection equation (9) ($s^2 = s_1^2 + s_2^2 - 2s_{12}$), and the correlation coefficient between the errors (r) are all statistically significant.

Using the maximum likelihood estimates, the expected marginal product (i.e. hourly shadow wage) can be calculated. The semi-log functional form implies that the expected values be calculated from

(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 p.127). Using the estimates provided by equation (11), several other estimates of interest also can be calculated.

Table 4 reports five different cost estimates of interest by group and gender. 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 the mean of the expected values within the stated group, so the results in table 4 are based on the mean value within the stated group.[6]

[6] If there is a nonlinear function $y = f(x)$, then Jensen's inequality states $E(y) \neq f[E(x)]$.

The mean predicted hourly shadow wage ranges from 10.05 (Group H) to 12.88 (Group B) for females and from 14.37 (Group H) to 17.50 (Group B) for males. The second row gives the mean hourly wage rate for food preparation workers as paid in the market place for November 2003 (BLS 2003). This number is obtained from the BLS for the Standard Occupational Code (SOC) 35-2000, which is Food Preparation and Serving Related Occupations. The value $8.43 is just an average over all individuals and is not broken down by gender, so is constant.

The great appeal of the ATUS data is that because there is data available on time allocations, the total daily cost of an activity can be calculated once the hourly cost is estimated. Multiplying the time spent on food preparation times the hourly shadow wage rate gives an estimate of the total daily cost of food preparation in the household. The average total cost of food preparation in the household based on the shadow wage rate ranges from zero (because of no time spent in food preparation) to $11.28 for females in Group H. Using this same time spent on food preparation times the hourly market wage rate in food preparation gives an estimate of the comparable cost of the same time in the market. The average total cost of food preparation based on the market wage rate for food preparation ranges from zero (because of no time spent in food preparation) to $9.53 for females in Group H. The bottom line in comparing the fourth row to the fifth row is that the cost of labor for food preparation in the market is much less than in the household. This result is perhaps not surprising as there are probably economies of scale and scope in the market place that can not be obtained in the home. These results are completely consistent with the arguments of an increase in the demand for convenience.

As indicated in the introduction, a criticism of the Thrifty Food Plan used for Food Stamp allocations is that it ignores food preparation cost. The estimated model and results can also be used to estimate this cost for a typical Food Stamp participant profile. Table 5 is similar to table 4, but is based on a demographic profile that is similar to a majority of individuals on Food Stamps. In particular, the large literature review by Gleason et al. and data published in Cunnygham and Brown suggest a typical demographic profile for someone on food stamps 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 then average for each group to obtain the estimates in the first three rows of table 5. While the expected shadow wage rates are lower in table 5 than for the full samples given in table 4, the same general pattern remains: the hourly shadow wage rate in food preparation is higher than the market wage rate in food preparation.

To get an idea of how much the Thrifty Food Plan Menus may cost in terms of preparation time, the cost per day measures in the last two rows of table 5 are based on the average time estimates from the Thrifty Food Plan Menus for preparing a single meal. The average estimated time over all recipes in the USDA publication *Recipes and Tips for Healthy, Thrifty Meals* is about 40 minutes. This is the amount of time for *one* meal. The data from the ATUS is for *all* meals in a single day. Just from the summary statistics in table 2 the average amount of time spent on *all* meals for people working in the market and at home is .52 hours or about 30 minutes. For people not working in the market place but working at home the average is .95 hours or about 57 minutes. While precise statements about the time for the recipes will depend on the specific recipe and how many are prepared in a day, these numbers suggest that the TFP recipes are time intensive relative to the amount of time that is allocated to food preparation in general. Assuming only a single meal is prepared in a day and using the average time over all recipes of 40 minutes, the time (labor) cost to prepare a single meal from the Thrifty Food Plan menu at home ranges from $6.35 to $6.95. This same amount of time in food preparation in the market place cost $5.65. The home labor cost is greater than the market labor cost, *ceteris paribus*. If the *ceteris paribus* claim is taken at face value, then these results suggests there are economic incentives to substitute food prepared in the market place for food prepared at home, and as has been documented, food prepared away from home is generally considered to be less nutritious than food prepared at home.

Summary and Conclusions

Food demand is an important component of the agricultural sector and much food preparation occurs in the home. As demand responds to price, it is important to understand that the ‘full price’ of food involves not only the market cost of food but also the preparation cost. While there is much information about the market cost of food, there has been no information about the preparation cost of food at home because there has been no data available on 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.

Using the ATUS data, the time cost spent in food preparation at home is estimated and compared to the time equivalent cost for food preparation in the market place. We also consider a demographic profile comparable with someone who may be on Food Stamps.

Furthermore, we also consider the time and cost of following the recipes based on the Thrifty Food Plan. Regarding time, the Thrifty Food Plan recipes are on average more time intensive than the average time spent in food preparation from the ATUS data. Regarding cost, the cost of time in preparing a TFP recipe based meal at home is estimated to range from $6.35 to $6.95 whereas for the same amount of time in the market the cost of food preparation is $5.65.

Ceteris paribus, these estimates are consistent with economic intuition and help in explaining the increase demand for convenience foods. However, more research needs to be done to include other components of meal cost, such as food input cost, before any more definitive statements can be made.

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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 8th grade or less; 0 otherwise
High school ($y_1 = z_1$)	1 if education is between 9th and 12th 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
Female ($y_5 = z_5$)	1 if gender is female; 0 otherwise
Union (y_6)	1 if a member of a union; 0 otherwise
Metropolitan ($y_7 = z_6$)	1 if live in a metropolitan area; 0 otherwise
Professional (y_8)	1 if management or professional occupation; 0 otherwise
White (y_9)	1 if race is white; 0 otherwise
Black (y_{10})	1 if race is black; 0 otherwise
Age (z_7)	Person's age/10
Married (z_8)	1 if married; 0 otherwise
Child number (z_9)	Number of children less than 18
Age of youngest (z_{10})	Age of youngest child in years
Spouse employed (z_{11})	1 if spouse is employed; 0 otherwise
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**
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)	0.01 (0.07)	0.01 (0.12)
Female	0.35 (0.48)	0.60 (0.49)	0.71 (0.45)
Union	0.16 (0.37)	0.15 (0.36)	0.00 (0.00)
Metropolitan	0.80 (0.40)	0.78 (0.41)	0.78 (0.42)
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)
Age	3.64 (1.39)	4.12 (1.26)	5.54 (2.02)
Married	0.43 (0.50)	0.52 (0.50)	0.49 (0.50)
Child Number	0.94 (1.19)	0.95 (1.11)	0.68 (1.13)

Age of Youngest	7.86	7.86	7.13
	(5.57)	(5.09)	(5.44)
Spouse Employed	0.33	0.46	0.27
	(0.47)	(0.50)	(0.44)
Time in household activities	0.00	1.63	3.04
	(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	**Market Wage Equation**	**Marginal Product Equation**
High school ($y_1 = z_1$)	.22	.04
	(.00)[a]	(.56)
Bachelors ($y_2 = z_2$)	.38	.18
	(.00)	(.02)
Masters ($y_3 = z_3$)	.65	.78
	(.00)	(.00)
Professional or Doctorate ($y_4 = z_4$)	.47	.63
	(.11)	(.02)
Female ($y_5 = z_5$)	–.35	.08
	(.00)	(.05)
Union (y_6)	.38	---
	(.00)	
Age (z_6)	---	.09
		(.00)
Metropolitan ($y_7 = z_7$)	.06	.08
	(.04)	(.02)
Professional (y_8)	.48	---
	(.00)	
Married (z_8)	---	.02
		(.49)
White (y_9)	.13	---
	(.00)	
Child number (z_9)	---	.05
		(.00)
Black (y_{10})	.14	---
	(.00)	
Age of youngest (z_{10})	---	–.004
		(.07)
Spouse employed (z_{11})	---	.13
		(.00)
Time in home production (T_h)	---	–.15
		(.00)
s_2^2	.57	
	(.00)	
s^2	.56	
	(.00)	
R	–.72	
	(.00)	

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

Table 4. Costs Comparisons by Group and Gender

	Group M		Group B		Group H	
Variable	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**
Mean predicted hourly shadow wage	12.63	16.53	12.88	17.50	10.05	14.37
Mean hourly market substitute wage	8.43	8.43	8.43	8.43	8.43	8.43
Mean food preparation cost per day based on hourly shadow wage	0.00	0.00	8.20	5.92	11.28	7.14
Mean food preparation cost per day based on hourly market substitute wage	0.00	0.00	5.40	2.85	9.53	4.22

a. Group M (market work), Group B (market and home work), Group H (home work).

Table 5. Costs Comparisons by Group for Comparable Food Stamp Participant Profile[a]

Variable	**Group M**	**Group B**	**Group H**
Mean predicted hourly shadow wage	10.37	9.87	9.48
Mean hourly market substitute wage	8.43	8.43	8.43
Mean food preparation cost per day based on hourly shadow wage and preparing one meal a day based on TFP recipes (40 minutes)	6.95	6.61	6.35
Mean food preparation cost per day based on market substitute wage and preparing one meal a day based on TFP recipes (40 minutes)	5.65	5.65	5.65

a. Group M (market work), Group B (market and home work), Group H (home work). Demographic Profile is for a single non-white non-professional female, with some high school education, not a member of a union living in a metropolitan area. Estimates are then averages over individual estimates within each group.

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

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

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

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