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Time as an Ingredient in Meal Production and Consumption

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Abstract

Economic factors such as wages may have different influences on meal production and consumption times. Previous research has typically investigated only production or consumption time, and has produced mixed results. After developing a stylized model that illustrates how higher wages may reduce meal production time but have ambiguous effects on meal consumption time, I examine these relationships using time diary information from the ATUS supplemented with wage information from the CPS. Using standard and censored regression models, I find that for meal production time, women experience a negative effect from wages on weekdays, as expected, and no effect on weekends. However, men show no weekday effect and a surprising positive effect of wages on weekends, suggesting that men with a high value of weekday time may substitute weekend meal production time for weekday time. Higher wages are associated with more meal consumption time for both men and women on weekdays and weekends, indicating that consumption time is a normal good.

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Introduction

Meals consume a substantial portion of people's time; people in the U.S. spend an average of over two hours every day on meals (Hamermesh 2007, and Table 1 in this paper). Underlying the total time used for meals are two important components that can behave very differently: meal production time and meal consumption time. However, past research has largely choosen to focus on only one of these components or on combined meal time, making it difficult to compare results for the two types of time. This can lead to apparent paradoxes. For example, economic theory suggests that people with higher levels of education will have higher wages and a correspondingly greater value of time, which could lead to less time spent on meals. However, Aguiar and Hurst (2007) find the opposite – more educated people spend more time on meals! Are results like this are a consequence of failing to clarify the distinction between meal time that may be a cost, and meal time that is a consumption good? I will examine the factors that affect the time allocated to meal production and consumption, with a particular focus on wages as an estimate of the value of time.

These factors are relevant because meal production and meal consumption time have both been found to have significant health effects. A greater amount of time on meal preparation may result in a healthier and better balanced meal, particularly relative to meals prepared away from home (Chou et al. 2004). Similarly, for a given meal, a slower rate of consumption may result in earlier satiation and a lower risk of obesity (Stibich, 2007). Hamermesh (2009) finds that more time spent eating each day is associated with lower BMI and better health. Finally, eating meals with family members has been shown to improve communication skills in children (Ochs et al. 1992) and reduce problem behaviors in teenagers (CASA 2005), and presumably a longer meal allows more time for these benefits to come into play. Factors that affect meal times may therefore indicate a hidden cost or additional benefit to factors such as earnings that might not otherwise be apparent.

In this paper, I empirically examine how wages and other factors such as family structure influence meal times. To motivate investigating meal production and consumption times separately, I build upon past research by adapting the general time use models of Becker (1965) and Gronau (1977) to incorporate both of these varieties of time. In particular, I use this stylized model to illustrate how these types of time use may be affected differently by economic and demographic characteristics. A conjecture, based on my model, is that increases in an individual's monetary resources will allow that person to increase food quantity and quality while replacing preparation time with goods. This means that there may be a negative income effect on meal production time, but that there could be a positive income effect on meal consumption time. Increasing an individual's wages should have such an income effect. However, higher wages also increase the opportunity cost of spending time in ways other than working. Therefore, people with higher wages will tend to substitute time working for time producing and consuming meals, leading to a negative substitution effect of wages for both sorts of meal time. If this is so, an increase in the wage rate will have both negative income and substitution effects to reduce meal production time, but positive income and negative substitution effects on meal consumption time, making the outcome ambiguous.

My empirical analysis investigates this hypothesis using the 2006-2008 American Time Use Survey. This time diary dataset allows me to measure meal production and consumption times separately, using multivariate models of the effects of imputed wages, family size, and other demographic variables. I also separate my analyses by gender, as well as weekdays and weekends. For the analyses of meal consumption times, I estimate standard linear regression models. For the analyses of meal production times, I estimate Tobit models that account for the substantial proportion of observations with censored data. As a sensitivity analysis, I also examine Two-Part and Censored Least Absolute Deviations model specifications.

These analyses of the time used producing and eating meals illuminate issues such as the apparent paradox that people with higher wages and education increase eating times, yet increased wages seem to decrease the time spent on meals. For example, similar to Hamermesh (2009), I find that men and women with higher wages spend significantly more time consuming meals each day than people with lower wages. However, higher wages are associated with women spending significantly fewer minutes producing meals on weekdays, which is consistent with my conjecture of negative substitution effects for meal production times. By demonstrating the importance of treating meal production and consumption times separately, I also hope to illuminate the possibility that production and consumption times should be considered separately for other commodities.

Theory

Becker (1965) theorized that households utilize not simply goods, but also time to produce and consume those goods. He called these consumed combinations "commodities." More formally, a commodity is produced through the combination of goods inputs with time inputs. For this analysis, I focus upon one important commodity, meals, in the context of a highly stylized model. This commodity is produced as a combination of two types of inputs: meal production time T_{MP}, and market goods and services X_M. Also of interest is another type of time related to meals, meal consumption time, T_{MC}, but rather than being used to produce meals, T_{MC} instead affects a person's utility directly.

The first type of meal-related time is meal production time T_{MP}, a form of home production. This type of time is generally considered to be primarily a cost – an input into acquiring and creating food items. Meal production includes many sorts of food-related activities; cooking, cleaning up, grocery shopping, and buying from a restaurant all fall into this category of time. Depending upon circumstances, meal production times can vary significantly. Preparing a meal from scratch requires a large amount of meal production time, while heating up a TV dinner is likely to take only a small amount. These variations are partially driven by the fact that compared to other commodities, inputs of meal production time and goods are often highly substitutable.[1]

To model the substitutable nature of meal production time and goods, I borrow the stylized home production model of Gronau (1977) for the production of meals. Prepared meals *M* are a function of meal production time T_{MP} and market goods and services for meals X_M,

$$M(T_{MP}, X_M) = f(T_{MP}) + X_M \qquad (1)$$

This function is additively separable, meaning that changing the quantity of time or goods does not affect the marginal productivity of the other input. If no time is spent, then *M* is equal to the purchased goods: $f(0) = 0$, $M(0, X_M) = X_M$. Also, I assume that $f' > 0$, so additional time on meal production always increases the quantity or quality of meals, but $f'' < 0$, indicating that meal production time has diminishing returns. *M* is a measure of both quality and quantity of food.

These prepared meals *M* factor into a person's utility to produce well-being. The second type of meal-related time, meal consumption time, T_{MC}, helps produce utility as well, and is defined as eating food after it has been prepared. Other commodities also affect utility; since

[1] Leung et al. (1997) demonstrate a systematic tradeoff between goods and time across almost 900 recipes in Hawaii.

these commodities are not the focus of this analysis, I aggregate them together as non-meal leisure time L and non-meal goods X. Utility can therefore be expressed as a function, $U(M, T_{MC}, L, X)$. I constrain this function to follow a Stone-Geary specification,

$$U(M, T_{MC}, L, X) = (M - \gamma_1)^{\alpha_1}(T_{MC} - \gamma_2)^{\alpha_2}(L - \gamma_3)^{\alpha_3}(X - \gamma_4)^{\alpha_4} \quad (2)$$

In this function, each of the four inputs benefits utility, and has productivity α, which determines how much increasing that input will improve utility. Without loss of generality, I assume that $\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 1$. Each input also has a minimum level for subsistence, γ, which consumption must remain above for a person to survive. It is worth noting that this function is log-separable across its inputs; in particular, increasing the quantity of meals M will not affect the demand for T_{MC} relative to L and X, and vice versa.

In addition to meal production time, meal consumption time, and leisure time, there is a fourth possible use of time: hours worked H. For a given time interval, the four uses of time are assumed to be mutually exclusive, and over a day, their sum must equal the total time available:

$$T_{MP} + T_{MC} + L + H = T \quad (3)$$

Similarly, earnings and non-labor income must equal total expenditures on meals and other goods, with prices assumed to be constant and equal to 1:

$$wH + N = X_M + X \quad (4)$$

Therefore, individuals will make time allocation decisions for T_{MP}, T_{MC}, L, and H, and goods allocation decisions X_M and X, to maximize utility subject to the time, budget, and production constraints. These decisions are based upon their wages, non-labor income, and the characteristics of the utility function, which includes both needs and the value placed upon quality meals, as well as factors that influence the production technologies for meals and other commodities. The mathematics of this optimization are shown in the theory appendix, with the following results.

The optimal value of meal production time T_{MP}, is determined by its diminishing marginal productivity, implied by $f''(T_{MP}) < 0$. This reduced productivity means that after a certain level of meal time input, it will be more efficient for a person to work and purchase goods X_M than to spend additional time on meal production. This will occur when the marginal productivity of meal time, $f'(T_{MP})$, equals *w*. This makes T_{MP} an implicit function of only *f* and *w*, which I express as $T_{MP}(w)$. As I show in the theory appendix, increasing wages will have a negative effect upon T_{MP}. However, because *w* and *N* are independent, there should be no effect of non-labor income on meal production time.

$$\frac{dT_{MP}}{dN} = 0, \frac{dT_{MP}}{dw} = \frac{1}{f''(T_{MP})} < 0 \tag{5}$$

Since the negative wage effect is a sum of income and substitution effects, and the income effect is zero, then the substitution effect for meal production time must also be negative.

Meal consumption time has an explicit solution, as shown in the theory appendix:

$$T_{MC} = \alpha_2\big(T + N/w - \gamma_1/w - \gamma_2 - \gamma_3 - \gamma_4/w - T_{MP}(w) + f\big(T_{MP}(w)\big)/w\big) + \gamma_2 \tag{6}$$

Increasing non-labor income reduces the need for labor hours relative to other time, so there is a positive income effect on meal consumption time. The effect of wages on meal consumption time is ambiguous.

$$\frac{dT_{MC}}{dN} = \frac{\alpha_2}{w} > 0, \frac{dT_{MC}}{dw} = \frac{-\alpha_2(N + f(T_{MP}(w)) - \gamma_1 - \gamma_4)}{w^2} \tag{7}$$

When non-labor income is high, relative to the subsistence levels of meals and other goods, increasing wages are likely to have a negative effect on consumption time, as it becomes more efficient to produce commodities through goods than through time. However, if the sum $N + f(T_{MP}(w)) - \gamma_1 - \gamma_4$ is negative, then the person is in the backwards-bending portion of the labor supply curve, and increasing wages will reduce labor hours and increase meal consumption (and leisure) time.

Although the results presented above are for interior solutions to the model, there are a few corner cases which can lead to different results. In particular, a person may choose not to spend any time on meal production, $T_{MP} = 0$, instead purchasing prepared food or having another household member produce the meal. For an employed individual, this will happen when the marginal productivity of meal production time is lower than the wage rate for all values of T_{MP}; in other words, $f^{'}(0) < w$. In this case, meal production time will not be affected by changes in either income or wages, at least not unless wages fall below $f^{'}(0)$. The results for meal consumption time are very similar to those of the interior solution.

$$T_{MC} = \alpha_2(T + N/w - \gamma_1/w - \gamma_2 - \gamma_3 - \gamma_4/w) + \gamma_2 \quad (8)$$

Increasing non-labor income will cause people to cut back on labor hours, leading to a positive income effect on meal consumption time.

$$\frac{dT_{MC}}{dN} > 0, \frac{dT_{MC}}{dw} = \frac{-\alpha_2(N-\gamma_1-\gamma_4)}{w^2} \quad (9)$$

As with the interior solution, the effect of wages on T_{MC} is ambiguous, and will have a sign opposite of that of the expression $N - \gamma_1 - \gamma_4$.

Another possibility is that a person may choose not to spend any time working, $H = 0$. If non-labor income is sufficiently high relative to wages (and the minimum subsistence levels for time use $w\gamma_2 + w\gamma_3$ are sufficiently large relative to the subsistence levels for goods $\gamma_1 + \gamma_4$), then a person will select labor hours H of zero. In this case, changing the wage rate will not affect a person's total income or time use decisions, so long as wages are not increased enough to induce the person to enter the labor force. Increasing non-labor income, however, will cause a person to increase meal goods and reduce meal production time, resulting in a negative income effect for T_{MP}. There will be a corresponding increase in meal consumption time, indicating a positive effect of income on T_{MC}.

$$\frac{dT_{MP}}{dN} < 0, \frac{dT_{MP}}{dw} = 0, \frac{dT_{MC}}{dN} > 0, \frac{dT_{MC}}{dw} = 0 \qquad (10)$$

Overall, this model has shown that even given a relatively simple structure, meal production and consumption time can respond quite differently to monetary inputs. Across the main and corner cases, non-labor income has a zero or negative effect upon meal production time, but a positive effect on meal consumption time. Wages also have a zero or negative effect on meal production time, and an ambiguous influence on consumption time. It is important to remember, however, that these outcomes are the result of strong modeling assumptions that may not accurately mirror the real world. Empirical analysis is necessary to investigate these relationships.

Previous Empirical Research

Most past empirical research into meal times has generally focused on only a single time measure within a given paper, making it difficult to compare meal production and consumption times. For example, Zick, McCullough, and Smith (1996) considered just meal preparation time (the dominant component of meal production time), as did Florkowski et al. (2000), Aguiar and Hurst (2005), Mancino and Newman (2007), and Tashiro (2009). By contrast, Aguiar and Hurst (2007) and Hamermesh (2009) looked at meal consumption time. Finally, Hamermesh (2007) examined a summed value of meal production and consumption times. These localized approaches present a potential problem, as looking at only one outcome can obscure situations that affect meal production and consumption in different ways.

Most of the literature on meal production time suggests that higher wages reduce time spent, as suggested by my model. Zick, McCullough, and Smith (1996) found that mothers with higher wage rates significantly reduced meal preparation time, and also found a negative (but not statistically significant) effect for non-labor income. Similarly, Florkowski et al. (2000) found that in Bulgaria, increased household income reduced both the probability of and the time that women spent preparing meals. For people before and after retirement, Aguiar and Hurst (2005) showed that retirees spend substantially larger amounts of time preparing food. If retirement represents reduced wage opportunities, then this result is also consistent with a negative wage effect. Finally, using a sample divided by race, Tashiro (2009) found small negative effects for family income on meal production, particularly for whites.

However, Mancino and Newman's (2007) results were only partially consistent with a negative wage effect on meal production time. For higher income women, increased weekly earnings reduce food preparation time, but for low and middle income women, there is no significant effect. For men, higher household income was found to increase food preparation times! These different gender effects are difficult to explain, but may be related to a finding by Zick et al. (2008) that increasing a wife's level of education has a negative effect on her own housework time but a positive effect on her husband's time, while the husband's education has no significant effect on the housework of either spouse. If a man's weekly earnings are positively correlated with his wife's education, and he substitutes his time for hers, that could produce Mancino and Newman's result.

Meanwhile, greater amounts of meal consumption time have been found to correspond to higher wages and levels of education. Hamermesh (2009) found that for workers with wages, higher wages increase eating and drinking as primary activities, and seem to increase them as secondary activities while doing something else as well, although in a less statistically significant manner. Hamermesh also found that higher levels of education also increase both primary and secondary meal consumption time. Similarly, Aguiar and Hurst (2007) found that in the past few decades, college graduates have increased meal consumption time by over an hour per week, while people without a high school degree have reduced eating by around an hour and a half. This result is in contrast with a relative overall increase in leisure time for less educated individuals, and suggests that better wage opportunities are increasingly leading to greater demand for meal consumption time.

In the case of aggregate food time, the sum of both meal production and consumption time, Hamermesh (2007) found that higher wages reduce time spent on food, while (controlling for wages) higher income increases time. These total meal time results could be explained as a combination of a dominant negative wage effect for meal production time and a dominant positive income effect for meal consumption time. Mancino and Newman's (2007) disparate results for male and female meal production times are puzzling, however, and suggest that men may not fit this theory. Therefore, using 2006-2008 ATUS data, I will examine measures of both meal production and consumption time separately for men and women. By examining both production and consumption time under the same models, I hope to better discern differences and similarities for how factors influence the two types of time.

Data

In order to identify the factors which influence meal times, I model meal preparation and meal consumption using data on activity times taken from the 2006, 2007, and 2008 years of the American Time Use Survey (ATUS). These time-diary surveys are well-suited for this analysis, as they contain a report of the primary activities each person in the survey spent his or her time on over the course of a twenty-four hour period. This makes it possible to identify not only the amount of time people spent eating, but also when they were waiting to eat, preparing or cleaning up from meals, shopping for groceries, purchasing other sorts of food, traveling to purchase food, or participating in many other activities. The 2006 through 2008 years of the ATUS also include an Eating and Health Supplement, which reports whether or not individuals were engaged in secondary eating or drinking simultaneously with another activity. This information is important as well, as people in modern society often participate in multiple activities at once, such as eating while watching television. Without data on secondary eating, those instances could be missed; this would be a problem, particularly if different types of people are more likely to multitask than others.

The ATUS, along with its extension, the Eating and Health Supplement (EHS), is a time-diary survey conducted by the Census Bureau. A subsample of households from the Current Population Survey (CPS) are contacted by telephone two to six weeks after the final CPS interview, and one individual in that household is interviewed about the use of time during the preceding 24-hour period, from 4:00 a.m. until 4:00 a.m. In addition to demographic information, the ATUS includes a detailed sequence of the activities each person participated in over the course of a day, as well as the locations each of those activities took place. It is important to note that weekends are over-sampled, such that one half of all observations occur on a weekend; sample weighting controls for this, non-response, and other sample design characteristics.

My two categories of meal time use are meal consumption and meal production. However, each of those is itself an aggregation of more specific uses of time. I define meal production time as the sum of four parts: food preparation, purchasing groceries, purchasing food elsewhere, and time spent acquiring meal preparation services. I calculate meal consumption time using two components: primary eating and secondary eating. Table 1 displays the average amounts of time that men and women spend on meals on weekdays and weekends.

The first dependent variable is meal production time, the sum of four categories of time use. The first two categories are part of making one's own meals: preparing food and purchasing groceries. Food preparation itself includes time preparing meals, time presenting meals, and time cleaning up from meals, and takes an average 34 minutes per day for my sample. Purchasing groceries takes an average of six minutes (only one in six people buy groceries on a given day). The third type of meal production time is purchasing food from a non-grocery source, such as a restaurant. People spend about 75 seconds on this each day (most time in a restaurant is classified as eating and thus part of meal consumption). A fourth but trivial method of food production is using meal preparation services, on which the sample spends less than a tenth of a second on average.

For most of my analyses, my measure of meal production time excludes travel time. In principle, travel time should be included because it represents a very real cost for both purchasing groceries and eating at a restaurant. People seem to spend around 13 minutes on travel related to eating and drinking, travel to purchase groceries, and travel to purchase other food each day. The reason for excluding this component, however, is that the ATUS does not specifically ask why people are traveling. Instead of a clear description of the purpose of a trip, people are coded according to their destination (if it is not home), or their origin (if the destination is home). This may be very misleading, particularly in the case of trips with multiple destinations, so I exclude this time from my main analyses. However, in some sensitivity analyses, I consider an alternative specification for meal production time that includes travel time as well as food preparation and purchase times.

My second dependent variable is meal consumption time, of which the first part is primary eating, time that a person spends focused solely on meal consumption. In the ATUS, this is time that people spend eating and drinking, time waiting to eat, and time eating as part of a job. Time spent eating and drinking as a primary activity during the day, along with time spent waiting to eat or drink, combine for an average of 65 minutes a day for individuals in the sample. The third component, eating and drinking as part of a job, is very minor, averaging only about 25 seconds a day.

The second part of my meal consumption measure is somewhat harder to interpret: eating as a secondary activity. This can often be thought of as snacking, because secondary eating is eating that takes place at the same time as another activity. Although daily activities in the ATUS are interpreted as one primary activity per time period, the Eating and Health Supplements question people whether they were also eating during other activities, and for how long. The sample spends about 24 minutes a day on secondary eating.

It is worth noting that eating and drinking are measured differently as primary and secondary activities. The ATUS does not distinguish between primary eating and primary drinking; these are both simply recorded as "eating or drinking". However, the EHS does report secondary eating and secondary drinking separately. The ATUS Eating and Health Module includes a report of secondary drinking of beverages other than water, for which people average 61 minutes a day. However, unlike Hamermesh (2009), I do not include this time in my analysis, as secondary drinking time seems unlikely to represent a meal. It is less likely to be related to health outcomes[2] than eating, and may have a low opportunity cost to the concurrent

[2] Time spent drinking alcohol may affect health, but this effect is likely to be very different than that of time spent

activity.

As sensitivity analyses, however, I test alternative specifications for meal consumption time, in order to determine the degree to which my definitions of consumption time are driving my results. One such specification excludes secondary eating, similar to Aguiar and Hurst (2007), leaving only primary eating and drinking. Alternatively, Hamermesh (2009) included secondary drinking in his measure of food time, and I also test the inclusion of secondary drinking in meal consumption time along with primary and secondary eating.

A person's wage opportunities are an important factor in determining the value of time, but about 22% of my sample are not employed, and lack wage data for that reason. In addition, another 9% of my sample do not report their earnings. These are unacceptably large fractions of my sample to drop, and a failure to answer wage questions is likely to be endogenous. Therefore, I follow the lead of Zick and Bryant (1990) and Zick and Stevens (2009) and impute wage values for my sample.

Using data from the Integrated Public Use Microdata Series (IPUMS) version of the March Current Population Survey (CPS) for 2006, 2007, and 2008, wage values are imputed via a three-step process. As the first step, I estimate the probability of being employed with wage data, and for the second step, I regress the log of wages on demographic and regional variables. I use maximum likelihood to estimate these two steps jointly, which controls for the fact that there may be unobserved factors which influence both employment and wages. Finally, in the third step the coefficients on the explanatory variables in the wage regression are used to predict log wage values for the ATUS sample, both workers and non-workers.[3] These wage values are the predicted opportunities if a person were to work, and by calculating them for the entire

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eating.

[3] Please see the Wage Imputation Appendix for further details.

sample, even those who do report wages, I avoid possible endogeneity between hours worked, time spent on meals, and wages earned. However, it should be noted that (as per Murphy and Topel 1985) imputing the wage variable may cause the standard error associated with its effect to be somewhat underestimated.

People's meal behaviors are also likely to vary by race, ethnicity and age, as different types of food may be preferred. I classify race and ethnicity into five mutually exclusive categories: white, black, Hispanic, Asian, and other. In the ATUS, Hispanic ethnicity is reported separately from race; I count as Hispanic everyone who reports having a Hispanic ethnicity, regardless of whether the person's race is reported as white, black, Asian, or something else. For the rest of the sample, people are categorized by race, with white, as the largest group, considered to be the reference group. I restrict ages to the range of 25 to 64. These people are potential members of the labor force, and therefore likely to be more consistent in their behavior than people still in school or into retirement.

It is also important to know a household's composition, in order to identify food needs, an individual's meal production responsibilities, and other issues related to family structure. I approximate food needs by controlling for the number of children in the household; the presence of children may also affect the utility gained through meal consumption time. Children are divided into two age groups; those between zero and five, and those from age six to seventeen. The presence of a spouse or significant other may also affect food needs and utility from meals, as well as serving as an indicator of the degree of responsibility the individual has for meal preparation in the household. I also include a dummy variable for whether or not the spouse is employed, as that will affect the time the spouse has available for household tasks such as meal preparation; this variable is assumed to be zero if there is no spouse. Finally, I also control for the number of other adults in the household, besides the respondent and the spouse (if there is one).

Prices of food and preferences for time use may vary at different places and times. Therefore, I control for survey year, and whether the individual lives in the Northeast, South, Midwest, or Western census regions of the country. I also control for whether or not the person is reported as living in a metropolitan area. In addition, towards the end of 2006, the ATUS changed how secondary eating was reported, so I include an indicator for whether an individual was interviewed before or after this change.

In determining my sample, initially the 2006-2008 ATUS files contain time use data for 37,914 individuals. I restrict this sample as follows. 37,832 completed the Eating and Health supplement. Of those, 33,432 are at least age 25, and restricting to people under 65 brings the sample to 26,818. Finally, I drop all of the respondents on days identified as holidays in the ATUS, since meal patterns may be different on those days. These days include New Year's Day, Easter, Memorial Day, the Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day, and dropping them leaves me with a final sample size of 26,374.

For much of my analysis, I break this sample apart into several smaller groups. I do this because different situations may lead to fundamentally different meal behaviors. The first such factor is gender; in the U.S. more responsibility for housework is often assigned to women than to men. Specialized skills and human capital can also raise a person’s efficiency at utilizing meal time and encourage one member of the family to take on a disproportionate share of the task (Becker 1985). The second axis is the day of the week; people may have more time available for preparing and eating food on weekends than they do on weekdays. I believe that both of these factors may lead not just to different quantities of time spent on meals, but to entirely different patterns of meal production and consumption. Therefore, I perform my analyses separately for each combination of men and women, weekdays and weekends. Table 1 shows the average values of my dependent and independent variables for each of those combinations.

Descriptive Analysis

Tables 2 and 3 display the average levels of wages and the education completed for men and for women who engage in different quantities of meal production time and meal consumption time. Table 2 has four groups: people who spend no time on meal production, people who spend up to 30 minutes, people between 30 and 60 minutes, and people who spend more than 60 minutes on meal production. The columns one through four present the values for women, while five through eight display those of men. The values for education illustrate why I have chosen to perform my analyses for men and women separately. For women, only 28% spending over an hour on meal production graduated from college, while 34% of women spending less than an hour and 37% of the women not participating in meal production had done so. This pattern is reversed for women who did not attend college. However, roughly the same proportions of men from each educational category participate in each level of food production time. If education functions as a proxy for wages, then the female results suggest a negative combined income and substitution effect, as predicted, but the male values fail to demonstrate such an effect.

The pattern for imputed wages backs up these results. The women who spend larger amounts of time on meal production have lower average wages, indicating a possible negative income or substitution effect. However, average imputed wages for men are nearly flat across different amounts of meal production time, with a slight increase as production time increases.

Table 3, however, finds opposite effects for consumption time. The columns indicate meal consumption times for women and men of zero minutes, up to 45 minutes, 45 to 90 minutes, and over 90 minutes. Both men and women who spend over 90 minutes on meal consumption are much more likely to be college graduates than those who spend up to 45 minutes or between 45 and 90. (The same is also true for those people who spend 0 minutes on food consumption, but the sample size is extremely small.) If education causes this result by changing wages, then a positive income effect may be dominating a negative substitution effect. Longer periods of consumption time are associated with higher wages for both men and women, supporting this result, particularly for men. In an attempt to separate these effects, as well as to control for other possible variables influencing these meal times, I perform multivariate linear and non-linear analyses.

Multivariate Approach

As I discussed in the data section, many factors are likely to influence the time people spend on meals. In addition to a person's gender and whether the day is a weekday or weekend, which could be expected to change a person's entire approach towards meal times, other variables could also push meal times up or down. For example, ethnic or regional values could raise or lower meal times, dependent family members could boost meal production time but restrict meal consumption time, and people may change their priorities as they age. Since many of these variables are likely to also be correlated with wages (particularly since my wage variable is imputed), it is important to control for them in my analyses. Therefore, I perform multivariate analyses, controlling for wage, age, ethnic categories, numbers of children under six and six and older, marital status and spouse's employment status, other adults in the household, regional categories, and year.

The types of multivariate analyses I use are dictated by concern that my dependent variables may be truncated. The amount of time that a person spends on a particular activity is clearly a continuous variable, but there are constraints; it is not possible to spend fewer than zero minutes on an activity, nor can more than twenty-four hours be used in a single day. The latter constraint does not appear to be binding; no one reports eating or preparing food for all 1,440 minutes in a day. However, there are quite a number of zeros. Of the 26,818 people remaining after restricting the sample, when weighted appropriately, 32% do not spend time acquiring food.

This large numbers of zeros (32%) for meal production indicates that a limited dependent variable analysis may be most appropriate. To account for the censoring in meal production times, I use a Tobit model to predict how much time (or none) that a person spends acquiring food in a day. In this model, a person has an index representing the amount of time he or she wants to spend on meal production time. Whenever this would cause the person to spend a negative amount of time, that person spends zero time instead. This allows the expected distribution of results to match the censoring found in the data, and is consistent with the theory that people substitute money and time in the production of meals, but since a person cannot actually spend money to purchase additional time in the day, everyone who might want to do so instead bottoms out at zero meal production time.

A valuable feature of the Tobit model is that in the limiting case of no censored observations, it should produce identical coefficient estimates as linear regression; this makes it a natural extension to the linear models that form my initial analysis. When censored observations exist, however, the coefficients for the Tobit model only indicate the effects on meal production time conditional on production time being greater than zero. Therefore, I report unconditional marginal effects for the independent variables. The unconditional marginal effects are approximately equal to the conditional effects times the probability that meal production time is greater than zero, averaged over all observations.

In contrast, very few people spend no time on meal consumption. Although 4% spend no time on primary eating, and 45% spend no time on secondary eating, only 0.8% spend no time on either primary or secondary eating. When censoring is not present and the distribution is reasonably symmetric, ordinary least squares (OLS) is an efficient and easy to interpret way of measuring partial correlations of one variable on another. Therefore, I use OLS, with the standard weights provided in the Eating and Health Supplement to weight each observation by the probability of selection, to examine both the time spent on meal consumption and on combined daily meal time. This will estimate the best fit linear prediction for the effects of the independent variables on meal consumption times. Since an even larger fraction of people have a positive amount of total meal time, I use OLS to model that combined measure of time use as well.

Empirical Analyses

The results of the Tobit model for meal production time are shown in table 4. Columns 1 and 2 display the marginal effects for female time use on weekdays and weekends, and columns 3 and 4 show male marginal effects, while the rows represent the various control variables. The first row of column 1 indicates that on weekdays, women with higher potential wages have significantly lower meal production time, ceteris paribus. This is consistent with theory, and is probably driven in large part because a person with higher wages is more likely to enter the labor force. On weekends, however, wages do not have a statistically significant effect on a woman's meal production time. If wage opportunities are different on weekends and weekdays, and the imputed wage values represent potential weekday wages (as the majority of the CPS sample from whom wages are imputed presumably work on weekdays), then it makes sense that these imputed wages may not have much effect upon weekend time.

Meal production time for men on weekdays (column 3) is unaffected by wages, a surprising result. One possible explanation is that men may default to entering the labor force full time regardless of wage opportunities, limiting their ability to respond to different monetary incentives. This question becomes particularly acute for weekend male meal production (column 4). On weekends, men with higher wages spend significantly more time on meal production! This counter-intuitive result could be explained by men substituting weekend time for weekday time. If weekend wage opportunities are low, men might prepare food on weekends to be eaten on weekdays. However, if that is the case, higher wages should reduce weekday production time, so then the column 3 result may still be a puzzle. Another possibility is that men with higher wages are married to women with higher wages and opportunity cost, causing substitution of inputs within the household and placing a relatively greater share of meal production on the men. A secondary analysis that splits the sample by marital status supports this hypothesis – there is a significant positive effect for married men on weekends, but not for unmarried men.

Although not a primary focus of this analysis, some of the other marginal effects for other variables on meal production time are also noteworthy. In particular, married women spend significantly more weekday time on meal production than do unmarried women; marriage has a much weaker positive effect on women's weekend time, while married men spend significantly less time on meal production than do unmarried men. This accentuates the importance of examining men and women separately. People with children spend significantly more time on meal production, although the effect of older children is small for men. This result confirms the expectation that caring for others and producing more food requires greater inputs of time.

Effects on meal consumption time are shown in table 5. All four linear models, for women and men, weekdays and weekends, find that people with higher wages spend more time on meal consumption. In the case of women on weekdays (column 1), the effect is not statistically significant. However, for the other three columns, particularly for men, the relationship between wages and meal consumption time is large and very significant. This indicates that a positive income effect for increased wages dominates any negative substitution effect. One possible mechanism for this result is a backwards bending labor supply curve, as suggested in the theory section; people with low wages must work many hours in order to meet minimum levels of subsistence, while higher wages allow for greater amounts of leisure and consumption time. Another possibility is that increasing meal-related goods boosts the value of meal consumption time by more than increasing other goods enhances leisure time. In the first case, meal consumption time would increase at the expense of labor hours; in the second, meal consumption time crowds out other leisure time.

As with the analysis of production time, the independent variables with the most interesting effects on meal consumption time are the controls for family structure. Marriage increases meal consumption time for women and for men on weekdays. Children under six reduce weekday consumption time, particularly for men, but increase weekend consumption. This suggests that childcare responsibilities may reduce weekday leisure time. Children six and older lower women's weekday consumption time, consistent with the effect of children under six, and also reduce men's weekend consumption time, which is opposite the effect of younger children.

Alternative Model Specifications

One concern with these analyses of production and consumption time is that meal production time is examined using Tobit, while consumption time is modeled linearly. Part of the purpose of this paper is to examine differences in people's production and consumption time behaviors, and analyzing them with different models may make comparison of these results difficult. Furthermore, a drawback to the Tobit model for meal production time is that although it does allow for the truncation of activity times at zero, it places fairly strong restrictions on the underlying model (namely, that people decide to spend zero time according to the same normally distributed index that determines the positive amount of time that might be spent). Stewart (2009) has shown that when time use spells are positive but infrequent, Tobit estimation can generate biased results. Therefore, although examination of the meal production time distribution suggests that it may correspond to a single normal index, as a sensitivity check I estimate the linear and Tobit models for both sorts of meal time, as well as two other approaches which support censored observations: the Two-Part model and the CLAD model.

The Two-Part model predicts which people will spend time on meal production, and then identifies effects for just the sub-population who do spend such time. The advantage of this model over Tobit is that it places fewer structural restrictions; the model for the probability of spending time on meal production is independent of the model predicting the quantity of time spent. The first part of the Two-Part model uses a Probit regression to calculate the probability that a person will spend time on meal production. Then, for the people who do participate in meal production, I use a linear model to determine which variables influence the amount of time they spend.

The other model I use for truncated data is censored least absolute deviations (CLAD). Although the CLAD model, like Tobit, assumes the censored observations correspond to a same index as the observed data, CLAD minimizes absolute deviations instead of squared deviations to avoid over-emphasizing the missing extreme values. The CLAD model assumes that the bottom tail of the distribution is censored (at zero minutes). Therefore, to regain symmetry, CLAD effectively censors the people who spend the most time as well, so that equal numbers of observations are missing above and below. Finally, it calculates coefficients for the model that minimize the absolute differences from the observed values, and estimates standard errors through 100 bootstrap repetitions of the analysis. It is important to note that use of the CLAD model can be complicated when substantial numbers of observations are censored, such as the large fraction of men who spend no time on meal production. CLAD results are also less comparable to the other three models because the results are calculated without weighting the observations.

Tables 6 and 7 display the effects of wages on meal production and consumption time for each of the linear, Tobit, Two-Part, and CLAD models. Coefficients are shown for the linear and CLAD models, while the latent indices of the Tobit and Two-Part models indicate that for ease of comparison, displaying marginal effects is more important (due to computational difficulties, standard errors are omitted for the Two-Part model). Results are almost identical for the linear, Tobit, and Two-Part models. The CLAD analyses are not fully comparable to the others, as they are both unweighted and minimize absolute deviations rather than squared deviations. As a result, the magnitudes are somewhat different. Nevertheless, the CLAD model still finds effects with the same sign as the other three models. This suggests that my results are relatively robust across choices of models. However, I still need to consider the robustness of my independent and dependent variable definitions.

Alternative Independent Variables and Meal Time Definitions

There are a number of other potentially relevant independent variables which I excluded from my primary analyses and tables. Although non-labor income is not measured in the ATUS, household income is. However, since an important component of household income is actual earnings, it is likely to be endogenous with time use decisions and labor hours. Food stamp eligibility and receipt are also likely to be endogenous with time use decisions. Therefore, I exclude all of these variables from my primary analyses. However, alternative specifications which include these variables produce very similar results for wages and other variables of interest, indicating that my findings are not sensitive to the inclusion or exclusion of family income or food stamp receipt.

Levels of education might also be expected to influence meal times. Unfortunately, testing finds education controls to be highly correlated with wages; inclusion roughly triples the standard error for wages in each of my analyses. Fortunately, these controls are only jointly significant in one out of the eight meal production and consumption time specifications. This indicates that levels of education do not actually have much independent explanatory power. Therefore, I exclude them from my analyses to avoid concerns about collinearity.

One possible explanation for how wages appear to affect meal times is through correlation with a spouse’s wage, causing a substitution of the time of one household member for another. To test this, in other analyses (again, not included in the tables here) I have split the sample by marital status and ran the analyses on each group. Single and married women had basically the same response to wages for both meal production and consumption time. By contrast, single men do not show the significant positive meal production time response to higher wages on weekends that is found in the full sample, whereas married men display an even stronger effect. These findings for women and men are consistent with Zick et al.'s (2008) finding that a husband's education has no effect on the wife's housework time, but that increasing the wife's education raises the husband's time. In addition, higher wages increase weekday meal consumption time by much more for single men than for married men. It is not clear why this should be the case, but perhaps single men have a greater amount of discretionary time available, which they only use for eating when wages are high.

As discussed in the data section, there are also other possible constructions of my dependent variables. In order to test the sensitivity of my results to the methods used to construct my variables, I test a few alternative specifications. An alternative measure of meal production time includes time travelling to purchase food or consume food, in addition to the food purchasing, meal preparation, and meal cleanup times from my main definition. Testing this definition indicates that adding travel time does not change the effects from wages or other key variables in a significant way.

In order to improve comparability to other research, I also test two alternative definitions of meal consumption time. The first includes only primary eating and drinking, and lines up with the meal consumption definition used by Aguiar and Hurst (2007). The second includes everything from the main specification, primary eating and drinking as well as secondary eating, and also includes secondary drinking, a measure which Hamermesh (2009) includes in his definitions of meal consumption. The results from the first alternative definition, the main specification, and the second alternative fall into a natural ordering. The analyses including only primary eating and drinking have much smaller standard errors and more precise effect estimates than the main specification with secondary eating, while adding secondary drinking makes the errors much larger than in my main specification. Most statistically significant effects remain the same across these definitions, including the effect of wages.

Finally, for comparison with other research and to get a sense of the overall time cost of meals, I have also tried examining total food time as a third type of dependent variable. Total food time is calculated by aggregating primary eating, secondary eating, and food production, then subtracting the overlap between secondary eating and meal production (about a minute, on average). Linear coefficients for total food time are almost identical to the sums of the effects for meal production and meal consumption. Increased wages lower total meal time for women on weekdays (although the effect is not quite significant at a five percent level), and significantly increase total meal time for women on weekends, as well as for men on both weekdays and weekends.

Conclusion

In this paper, I have sought to establish how economic factors such as wages influence meal production and consumption times, and whether the two sorts of time respond differently. To this end, I have combined time diary information and demographic information from the ATUS with imputed wage data from the CPS. Since a significant portion of the sample spends no time on meal production, potentially biasing a linear analysis, I have estimated non-linear censored regression Tobit models for meal production time. I also estimated linear regression analyses of time spent on meal consumption and total meal time.

Overall, results for meal production time for women on weekdays are consistent with my theory that increased wages will cause people to substitute market goods for meal production time. They also match the effects of wages on meal preparation found in the literature. However, women on weekends and men on weekdays have no wage effect on meal production time, and men on weekends have a surprising positive effect (but one that matches the finding of Mancino and Newman 2007). I speculate that these outcomes are a result of different employment opportunities on weekdays and weekends, as well as correlation between the wages of husbands and wives. Future research could benefit from more detailed demographic data to investigate this relationship.

Meal consumption time behavior, by comparison, is fairly consistent across women and men on both weekdays and weekends. Higher expected wage opportunities have a positive effect upon meal consumption time in each case. This effect is consistent with Hamermesh's (2009) finding for the effect of actual wages on workers' primary and secondary eating times.

This contrast between production and consumption time effects, particularly for women on weekdays, highlights why it is important to distinguish between the two types of time use if the mechanisms involved are to be understood. Combining the two into total meal time only magnifies standard errors and conceals complicated meal production behavior with simple meal consumption. Future research into meal production and consumption times would also benefit from further examination of the distinction between primary and secondary eating behaviors; although the wage effects are similar, other factors, such as ethnicity, have very different effects on these types of time. Finally, the study of income and substitution effects on meal time could be augmented by data that include a reliable measure of non-labor income.

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Table 1

Summary Statistics

	Women		Men	
VARIABLES	Weekday	Weekend	Weekday	Weekend
Production Time	55.327	63.581	20.975	30.273
Preparing/Cooking	46.832	51.530	16.847	22.163
Buying Groceries	7.117	10.642	3.039	6.819
Consumption Time	87.866	92.511	88.585	99.763
Primary Eating	60.969	70.002	66.391	73.368
Secondary Eating	26.897	22.515	22.194	26.399
Total Meal Time	142.022	154.547	109.111	129.144
Imputed Log Wage	2.640	2.639	3.091	3.092
H.S. Drop Out	0.104	0.108	0.118	0.115
H.S. Graduate	0.287	0.289	0.312	0.315
Some College	0.277	0.273	0.253	0.243
College Graduate	0.332	0.331	0.317	0.327
Age	43.912	43.947	43.632	43.635
White	0.124	0.123	0.103	0.108
Black	0.133	0.135	0.144	0.143
Hispanic	0.041	0.037	0.033	0.032
Asian	0.018	0.020	0.021	0.019
Other	0.684	0.686	0.700	0.697
# of Children <6	0.284	0.303	0.286	0.275
# of Children >5	0.635	0.639	0.548	0.546
Married/Cohabiting	0.691	0.691	0.703	0.705
Spouse Employed	0.583	0.582	0.480	0.472
# of Other Adults	0.447	0.414	0.428	0.478
Northeast	0.173	0.176	0.184	0.187
Midwest	0.249	0.241	0.236	0.248
South	0.363	0.361	0.352	0.347
Rural	0.179	0.172	0.174	0.171
Year 2007	0.335	0.336	0.333	0.333
Year 2008	0.336	0.336	0.338	0.336
Revised E&H Quest.	0.726	0.727	0.724	0.723
Observations	7,234	7,471	5,791	5,878

Weighted Data from the 2006-2008 American Time Use Surveys and Eating and Health Supplements. Meal times are in minutes. The excluded geographic region is West, the excluded survey year is 2006.

Table 2

Average Characteristics by Levels of Meal Production Time

Production Time	Women				Men			
(Minutes)	T=0	0<T≤30	30<T≤60	T>60	T=0	0<T≤30	30<T≤60	T>60
Observations	3216	3518	2715	5256	5252	3260	1594	1563
Log Wage	2.657	2.658	2.656	2.607	3.065	3.106	3.123	3.126
H.S. Drop Out	0.082	0.083	0.090	0.144	0.134	0.092	0.099	0.127
H.S. Graduate	0.276	0.267	0.286	0.309	0.326	0.308	0.312	0.274
Some College	0.271	0.303	0.276	0.260	0.241	0.259	0.254	0.264
College Graduate	0.370	0.347	0.348	0.287	0.300	0.341	0.335	0.335
Weekend	0.308	0.250	0.250	0.315	0.282	0.243	0.291	0.409

Weighted data from the 2006-2008 American Time Use Surveysand Eating and Health Supplements

Table 3

Average Characteristics by Levels of Meal Consumption Time

Consumption Time	Women				Men			
(Minutes)	T=0	0<T≤45	45<T≤90	T>90	T=0	0<T≤45	45<T≤90	T>90
Observations	120	4085	5943	4557	99	2949	4685	3936
Log Wage	2.537	2.567	2.644	2.698	2.990	3.017	3.084	3.158
H.S. Drop Out	0.215	0.137	0.102	0.077	0.129	0.143	0.131	0.076
H.S. Graduate	0.378	0.337	0.284	0.244	0.538	0.376	0.305	0.267
Some College	0.227	0.276	0.276	0.277	0.174	0.264	0.247	0.244
College Graduate	0.180	0.250	0.339	0.402	0.159	0.216	0.316	0.413
Weekend	0.369	0.256	0.266	0.337	0.393	0.269	0.253	0.343

Weighted Data from the 2006-2008 American Time Use Surveys and Eating and Health Supplements

Table 4

Meal Production Time, Tobit Model

	Women		Men	
	(1)	(2)	(3)	(4)
VARIABLES	Weekday	Weekend	Weekday	Weekend
Imputed Log Wage	-19.027***	-3.682	-0.570	10.598***
	(2.907)	(3.319)	(2.765)	(3.487)
Age	0.778***	0.899***	0.255***	0.111
	(0.090)	(0.102)	(0.070)	(0.083)
Black	-3.367	0.198	2.397	-4.556*
	(2.412)	(2.851)	(1.714)	(2.453)
Hispanic	20.939***	16.238***	-3.487*	0.142
	(2.632)	(2.939)	(1.791)	(2.556)
Asian	20.873***	32.496***	2.540	6.941
	(4.368)	(5.436)	(3.027)	(4.708)
Other	9.643	8.493	1.386	-0.379
	(6.669)	(10.582)	(3.634)	(6.509)
# of Children <6	12.955***	11.211***	5.099***	4.119***
	(1.314)	(1.452)	(1.520)	(1.097)
# of Children >5	9.054***	8.620***	1.350*	1.526**
	(0.876)	(0.913)	(0.777)	(0.737)
Married/Cohabiting	17.137***	5.984*	-9.458***	-6.079***
	(3.119)	(3.566)	(1.593)	(2.136)
Spouse Employed	1.127	8.101**	5.754***	4.990***
	(3.064)	(3.538)	(1.397)	(1.862)
# of Other Adults	-0.075	-1.121	-0.349	-2.551**
	(1.375)	(1.471)	(1.361)	(1.089)
Northeast	5.829**	-0.529	-2.686	-3.974*
	(2.480)	(3.019)	(1.841)	(2.365)
Midwest	-0.143	1.785	-4.696***	-2.143
	(2.257)	(2.946)	(1.691)	(2.197)
South	-1.277	-1.206	-3.970**	-3.997*
	(2.156)	(2.510)	(1.625)	(2.060)
Rural	-1.159	-1.114	-0.110	-4.525**
	(2.291)	(2.686)	(1.530)	(2.129)
Year 2007	0.721	-1.872	-0.493	-1.733
	(3.991)	(4.126)	(2.167)	(3.689)
Year 2008	0.530	3.058	-0.057	1.043
	(4.029)	(4.108)	(2.208)	(3.688)
Revised E&H Quest.	-1.792	1.483	0.106	0.466
	(4.079)	(4.158)	(2.212)	(3.691)
Observations	7,234	7,471	5,791	5,878

Unconditional marginal effects for weighted Tobit analyses of minutes of meal production (preparing meals, cleaning up, and purchasing food).
Excluded race is White, excluded region is West, excluded year is 2006.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5
Meal Consumption Time, Linear Model

	Women		Men	
	(1)	(2)	(3)	(4)
VARIABLES	Weekday	Weekend	Weekday	Weekend
Imputed Log Wage	8.424	24.994***	37.439***	46.357***
	(6.496)	(4.610)	(8.544)	(9.553)
Age	-0.385	0.165	-0.337*	-0.619***
	(0.254)	(0.137)	(0.202)	(0.208)
Black	-12.711**	-15.135***	-4.589	-7.813
	(5.034)	(3.689)	(6.356)	(7.951)
Hispanic	-12.091**	-4.728	-8.119*	-6.721
	(5.915)	(3.594)	(4.763)	(5.212)
Asian	14.137	13.986*	-13.421*	-12.680*
	(13.616)	(7.518)	(7.278)	(6.608)
Other	15.937	5.316	-11.878*	0.697
	(18.934)	(8.805)	(6.614)	(8.176)
# of Children <6	-6.346**	7.831***	-2.266	6.684**
	(2.922)	(2.399)	(2.527)	(2.932)
# of Children >5	-5.675***	0.680	-2.861*	-5.673***
	(1.742)	(1.441)	(1.529)	(1.515)
Married/Cohabiting	22.545	8.717*	12.400**	2.061
	(17.242)	(4.488)	(4.827)	(4.847)
Spouse Employed	-20.005	-2.423	-6.718	5.215
	(14.763)	(4.432)	(4.202)	(3.810)
# of Other Adults	7.108	-2.565	2.054	1.355
	(6.708)	(1.605)	(2.451)	(2.535)
Northeast	-7.394	-3.177	-4.902	-5.404
	(4.519)	(3.482)	(5.119)	(6.338)
Midwest	1.835	-1.105	-5.353	-3.993
	(8.396)	(3.712)	(4.480)	(5.927)
South	-7.706*	-3.685	-5.497	-6.834
	(4.649)	(3.276)	(4.415)	(5.619)
Rural	-3.861	-6.193*	4.888	1.010
	(6.730)	(3.248)	(4.253)	(6.093)
Year 2007	5.059	10.546**	5.546	8.949
	(7.432)	(4.262)	(8.731)	(8.179)
Year 2008	10.071	7.034*	8.285	15.308*
	(6.767)	(4.112)	(8.958)	(7.969)
Revised E&H Quest.	8.527	1.524	4.457	4.734
	(5.942)	(3.842)	(8.473)	(7.504)
Constant	76.204***	11.019	-18.867	-25.002
	(21.216)	(16.342)	(23.421)	(29.067)
Observations	7,234	7,471	5,791	5,878
R-squared	0.020	0.026	0.018	0.026

Weighted linear regression for minutes of meal consumption (primary eating/drinking, eating at work, secondary eating).
Excluded race is White, excluded region is West, excluded year is 2006.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6

Wage Effects on Meal Production Time Models

	Women		Men	
	(1)	(2)	(3)	(4)
MODELS	Weekday	Weekend	Weekday	Weekend
Linear	-21.128***	-4.720	-4.647	7.733**
	(3.236)	(3.635)	(3.413)	(3.941)
Tobit	-19.027***	-3.682	-0.570	10.598***
	(2.907)	(3.319)	(2.765)	(3.487)
Two-Part	-20.707	-4.910	-4.982	7.688
CLAD	-15.523***	5.652**	9.241***	29.113***
	(1.892)	(2.443)	(1.739)	(3.469)

Weighted linear regression. Unconditional marginal effects for weighted Tobit analyses. Conditional marginal effects for weighted Two-Part (Probit/Linear) model. Unweighted Censored Least Absolute Deviations (CLAD) model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7

Wage Effects on Meal Consumption Time Models

	Women		Men	
	(1)	(2)	(3)	(4)
MODELS	Weekday	Weekend	Weekday	Weekend
Linear	8.424	24.994***	37.439***	46.357***
	(6.496)	(4.610)	(8.544)	(9.553)
Tobit	6.959	21.326***	30.593***	39.097***
	(5.131)	(3.900)	(6.971)	(7.809)
Two-Part	8.173	24.930	36.405	46.469
CLAD	13.111***	19.699***	26.294***	42.046***
	(1.498)	(2.065)	(2.665)	(2.411)

Weighted linear regression. Unconditional marginal effects for weighted Tobit analyses. Conditional marginal effects for weighted Two-Part (Probit/Linear) model. Unweighted Censored Least Absolute Deviations (CLAD) model. Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Appendix A: Wage Imputation

Information on wages and salaries in the 2006, 2007, and 2008 ATUS data is missing for many individuals; in particular, people who are not employed don't earn wages. Also, a person's time use preferences and decisions could affect wages, making this variable endogenous. To get around these difficulties, I impute wages using the IPUMS files for the 2007, 2008, and 2009 March supplements of the Current Population Survey (CPS) data, as these files include people's wage and income values from the previous year. I restrict the sample to individuals between ages 25 and 64 (to match the ATUS sample). Using a maximum likelihood Heckman selection model (Heckman 1979) and following the structure of Zick and Stevens (2007), I simultaneously estimate the probability of working with a linear model of log wages for those who work. I use the individual weights in the CPS to calculate effects for men and women separately. Finally, using the coefficients derived from those equations, I return to the ATUS data and generate an imputed log wage value for each individual, regardless of whether or not he or she is employed.

Since most individuals in the CPS do not report hourly earnings, instead I calculate hourly wages as annual wage and salary income from the previous year, divided by the number of weeks worked and by the usual hours worked per week. I drop the approximately 1% of my sample with top-coded earnings (primary wage source greater than $200,000 or secondary wage source greater than $35,000), the 1% with allocated earnings data, and the 0.1% with top-coded usual weekly hours. After calculating real hourly wages in 2006 dollars, I also drop the 0.2% who make less than one dollar per hour, and the 0.2% who make $100 or more per hour. Within this final sample, people with positive values for wages, weeks worked, and hours worked (the latter two categories overlap perfectly) are considered to be employed (75% of the remaining sample), while someone with a value of zero for any of those is not employed (25%).

My explanatory variables for wages include several demographic characteristics. Using the average values of age for men and women in the restricted sample, I calculate a centered age variable, which I include in the analysis, as well as the centered age variable squared. This centering allows me to avoid the collinearity problems of age and age squared. I also control for three of four educational categories: did not complete high school, high school graduate, and some college, leaving college graduates as my excluded category. Finally, I include indicator variables for Hispanic and black non-Hispanic ethnicities.

I also control for the person's state of residence, year, and whether or not the person lives in a rural area or not, as well as interactions between state and rural status. People are defined as rural residents if they either do not live in a metropolitan area, or if their metropolitan area is not identified. Although the latter may seem ambiguous, in practice there are only four states with unidentified people – Colorado, Louisiana, Nevada, and Utah, and none of these states contain people reported as not living in a metropolitan area. Therefore, as these are known to be states with large rural areas, it seems reasonable to assume that unidentified individuals must represent the rural population. Alternatively, since there is no overlap between states with non-metropolitan residents and unidentified residents, the controls for those four states can be thought of as a control for not identifying metropolitan status. Apart from those four, the District of Columbia, New Jersey, and Rhode Island report no rural residents of any sort in the sample. Massachusetts has only 42 men and 61 women in rural areas, followed by Maryland, with 134 men and 157 women.

By contrast, Zick and Stevens (2007) control only for which of the four geographic areas of the country (Northeast, South, Midwest, or West) a person lives in, as well as whether or not an area is rural. I test the explanatory power of state controls versus regional controls, and find that states together have significantly more explanatory power than regions over log wages, at a 0.01% significance level. The interactions between state and rural status are also jointly significant at that level for both men and women. Therefore, I choose to include all of these in the wage imputation model.

In order to predict the probability of employment, I also include three variables which should affect the decision to work but not the wages received when working. The first two of these exclusion restrictions are the number of the person's own children in the household under five years old, and the number of his or her own children who are five or older. I control for these separately, as children not yet old enough to enter kindergarten may affect parental employment differently from those who are old enough. The amount of non-labor income available may also affect the need to work, which I approximate as the sum of income from interest, income from dividends, and income from rent, adjusted for inflation.

The CPS sample and the ATUS sample used for imputing wages are very similar, as can be seen in the table below. The fraction of the sample inhabiting each of the state and rural interaction cells is very similar as well, including the empty rural cells of the District of Columbia, New Jersey, and Rhode Island, so the inability to estimate coefficients for those variables is not a problem. One possible concern is that the large negative coefficient on lambda in the wage regression for men causes the average imputed log wages to be significantly larger than the average actual log wages for employed men. In an attempt to account for this variation, I also perform a linear regression for log wage without controlling for selection. The results for women are almost identical for the Heckman and linear models. For men, most of the coefficient effects are similar across the two models, with age being the main exception; the Heckman model finds maximum wages at age 68, while linear regression indicates that wages are maximized at just age 50.

Table A1

Weighted Variable Means

	Women			Men		
VARIABLES	CPS-Full	CPS-Emp	ATUS	CPS-Full	CPS-Emp	ATUS
% Employed	0.699	1.000		0.797	1.000	
Log(Wage)		2.693			2.914	
Impute Wage (Heckman)	2.636	2.669	2.639	3.082	3.082	3.091
Impute Wage (OLS)	2.662	2.693	2.663	2.899	2.914	2.915
H.S. Drop Out	0.106	0.070	0.106	0.129	0.110	0.116
H.S. Grad	0.292	0.277	0.288	0.316	0.306	0.314
Some College	0.288	0.303	0.275	0.258	0.262	0.248
Black	0.125	0.130	0.123	0.107	0.098	0.105
Hispanic	0.135	0.120	0.134	0.154	0.161	0.143
Age	43.988	43.119	43.930	43.640	42.520	43.634
Northeast	0.184	0.188	0.174	0.179	0.180	0.186
Midwest	0.219	0.229	0.245	0.221	0.225	0.242
South	0.367	0.362	0.362	0.361	0.356	0.350
Year 2007	0.333	0.335	0.335	0.334	0.335	0.333
Year 2008	0.336	0.335	0.336	0.336	0.335	0.337
Rural	0.158	0.154	0.175	0.160	0.149	0.173
Nonlabor $	1,343.30	1,274.30		1,509.61	1,439.96	
# children<5	0.189	0.165		0.181	0.203	
#children>=5	0.836	0.826		0.692	0.736	

This table displays the weighted means for people in the full sample of the 2007, 2008, and 2009 March CPS data, those who were employed with positive wages in that data, and the values for members of the 2006, 2007, and 2008 ATUS and E&H survey. Excluded education category is college graduates, excluded race is white, the excluded region is West, and the excluded year is 2006.

Table A2

Heckman Maximum Likelihood and Linear Models of Log Wage

	Women			Men		
	Heckman M.L.		Linear	Heckman M.L.		Linear
VARIABLES	Log(Wage)	Employment	Log(Wage)	Log(Wage)	Employment	Log(Wage)
Centered Age	0.005***	-0.020***	0.005***	0.013***	-0.021***	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Centered Age	-0.000***	-0.001***	-0.000***	-0.000***	-0.001***	-0.001***
Squared	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
High School	-0.820***	-0.834***	-0.797***	-0.553***	-0.647***	-0.708***
Drop Out	(0.011)	(0.018)	(0.010)	(0.010)	(0.019)	(0.009)
High School	-0.531***	-0.345***	-0.523***	-0.388***	-0.350***	-0.463***
Graduate	(0.006)	(0.012)	(0.006)	(0.007)	(0.014)	(0.006)
Some	-0.340***	-0.144***	-0.337***	-0.274***	-0.210***	-0.314***
College	(0.006)	(0.013)	(0.006)	(0.007)	(0.014)	(0.006)
Black	-0.077***	0.126***	-0.079***	-0.151***	-0.197***	-0.203***
	(0.007)	(0.016)	(0.007)	(0.009)	(0.018)	(0.008)
Hispanic	-0.145***	0.020	-0.145***	-0.214***	0.174***	-0.164***
	(0.008)	(0.016)	(0.008)	(0.008)	(0.018)	(0.008)
Constant	3.003***	0.926***	3.022***	3.417***	1.133***	3.337***
	(0.024)	(0.048)	(0.024)	(0.024)	(0.054)	(0.022)
athrho		0.095***			-1.149***	
		(0.020)			(0.019)	
lnsigma		-0.586***			-0.447***	
		(0.004)			(0.005)	
R-squared			0.220			0.237

Predicted log wages in the 2007-2009 waves of the March CPS. Excluded education category is college graduates, excluded race is white, and the excluded region is West. Year, state, rural, and state*rural interaction terms are omitted. Robust standard errors are displayed in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Appendix B: Theoretical Model Solution

Suppose meals, meal consumption time, leisure time, and other goods are all factors in a Stone-Geary Utility function $U(M, T_{MC}, L, X) = (M-\gamma_1)^{\alpha_1}(T_{MC}-\gamma_2)^{\alpha_2}(L-\gamma_3)^{\alpha_3}(X-\gamma_4)^{\alpha_4}$. The alphas are the relative intensities of each commodity in the production of utility, while the gammas are the various subsistence levels of consumption. Meals M are produced using meal production time and meal goods following Gronau's (1977) home production model, $M(T_{MP}, X_M) = f(T_{MP}) + X_M$. Meal production time has positive but decreasing marginal returns in the creation of meals, $f' > 0$, $f'' < 0$, and $f(0) = 0$. Time use is subject to the constraint ($T_{MC} + T_{MP} + L + H = T$), while income equals expenditures ($wH + N = X_M + X$), with the assumption that prices are equal to 1. Then the Lagrangian equation for utility is:

1. £= $U(M, T_{MC}, L, X) + \lambda_1(T - T_{MC} - T_{MP} - L - H) + \lambda_2(wH + N - X_M - X)$, with choice variables $T_{MP}, T_{MC}, L, H, X_M, X$.

In that order, the following first order conditions hold, assuming an interior solution:

2. $U_M(M, T_{MC}, L, X) * M_T(T_{MP}, X_M) - \lambda_1 = 0$
$\Rightarrow \alpha_1(M-\gamma_1)^{\alpha_1-1}(T_{MC}-\gamma_2)^{\alpha_2}(L-\gamma_3)^{\alpha_3}(X-\gamma_4)^{\alpha_4} * f'(T_{MP}) = \lambda_1$

3. $U_T(M, T_{MC}, L, X) - \lambda_1 = 0$
$\Rightarrow \alpha_2(M-\gamma_1)^{\alpha_1}(T_{MC}-\gamma_2)^{\alpha_2-1}(L-\gamma_3)^{\alpha_3}(X-\gamma_4)^{\alpha_4} = \lambda_1$

4. $U_L(M, T_{MC}, L, X) - \lambda_1 = 0$
$\Rightarrow \alpha_3(M-\gamma_1)^{\alpha_1}(T_{MC}-\gamma_2)^{\alpha_2}(L-\gamma_3)^{\alpha_3-1}(X-\gamma_4)^{\alpha_4} = \lambda_1$

5. $-\lambda_1 + w\,\lambda_2 = 0 \Rightarrow \lambda_1 = w\,\lambda_2$

6. $U_M(M, T_{MC}, L, X) * M_X(T_{MP}, X_M) - \lambda_2 = 0$
$\Rightarrow \alpha_1(M-\gamma_1)^{\alpha_1-1}(T_{MC}-\gamma_2)^{\alpha_2}(L-\gamma_3)^{\alpha_3}(X-\gamma_4)^{\alpha_4} * 1 = \lambda_2$

7. $U_X(M, T_{MC}, L, X) - \lambda_2 = 0$
$\Rightarrow \alpha_4(M-\gamma_1)^{\alpha_1}(T_{MC}-\gamma_2)^{\alpha_2}(L-\gamma_3)^{\alpha_3}(X-\gamma_4)^{\alpha_4-1} = \lambda_2$

Using 2, 5, and 6, $U_M(M, T_{MC}, L, X) * M_T(T_{MP}, X_M) = \lambda_1 = w\,\lambda_2 = wU_M(M, T_{MC}, L, X) * M_X(T_{MP}, X_M)$, implying that $M_T(T_{MP}, X_M) = wM_X(T_{MP}, X_M)$ and

8. $f'(T_{MP}) = w$, so T_{MP} is an implicit function only of w, denoted $T_{MP}(w)$.

By 3, 4, 5, and 7, $U(M, T_{MC}, L, X) * \alpha_2(T_{MC}-\gamma_2)^{-1} = U(M, T_{MC}, L, X) * \alpha_3(L-\gamma_3)^{-1} = \lambda_1 = w\,\lambda_2 = wU(M, T_{MC}, L, X) * \alpha_4(X-\gamma_4)^{-1}$, so

9. $(X-\gamma_4)/\alpha_4 = w(L-\gamma_3)/\alpha_3 = w(T_{MC}-\gamma_2)/\alpha_2$

Using the constraints to solve for H yields:

10. $wT_{MC} + wL + X = wT + N - wT_{MP} - X_M$

11. $w(T_{MC} - \gamma_2) + w(L - \gamma_3) + (X - \gamma_4) = wT + N - w\gamma_2 - w\gamma_3 - \gamma_4 - wT_{MP} - X_M$

12. $\left(\frac{\alpha_2+\alpha_3+\alpha_4}{\alpha_4}\right)(X - \gamma_4) = wT + N - w\gamma_2 - w\gamma_3 - \gamma_4 - wT_{MP} - X_M$

13. $(X - \gamma_4) = \left(\frac{\alpha_4}{\alpha_2+\alpha_3+\alpha_4}\right)(wT + N - w\gamma_2 - w\gamma_3 - \gamma_4 - wT_{MP} - X_M)$

Now we just need to solve for *Xm*, using 6 and 7:

14. $U_M(M, T_{MC}, L, X) * M_X(T_{MP}, X_M) = \lambda_2 = U_X(M, T_{MC}, L, X)$

15. $\alpha_1(X - \gamma_4) = \alpha_4(M - \gamma_1)$

16. $(M - \gamma_1) = f(T_{MP}) + X_M - \gamma_1 = \left(\frac{\alpha_1}{\alpha_2+\alpha_3+\alpha_4}\right)(wT + N - w\gamma_2 - w\gamma_3 - \gamma_4 - wT_{MP} - X_M)$

17. $\left(\frac{\alpha_1+\alpha_2+\alpha_3+\alpha_4}{\alpha_2+\alpha_3+\alpha_4}\right)(X_M - \gamma_1) = \left(\frac{\alpha_1}{\alpha_2+\alpha_3+\alpha_4}\right)(wT + N - \gamma_1 - w\gamma_2 - w\gamma_3 - \gamma_4 - wT_{MP}) - f(T_{MP})$

18. $(X_M - \gamma_1) = \left(\frac{\alpha_1}{\alpha_1+\alpha_2+\alpha_3+\alpha_4}\right)\left(wT + N - \gamma_1 - w\gamma_2 - w\gamma_3 - \gamma_4 - wT_{MP} - \left(\frac{\alpha_2+\alpha_3+\alpha_4}{\alpha_1}\right)f(T_{MP})\right)$

19. $(X - \gamma_4)/\alpha_4 = w(L - \gamma_3)/\alpha_3 = w(T_{MC} - \gamma_2)/\alpha_2$
$= \left(\frac{1}{\alpha_1+\alpha_2+\alpha_3+\alpha_4}\right)\left(wT + N - \gamma_1 - w\gamma_2 - w\gamma_3 - \gamma_4 - wT_{MP} + f(T_{MP})\right)$

20. $T_{MC} = \left(\frac{\alpha_2}{\alpha_1+\alpha_2+\alpha_3+\alpha_4}\right)\left(T + N/w - \gamma_1/w - \gamma_2 - \gamma_3 - \gamma_4/w - T_{MP}(w) + f\left(T_{MP}(w)\right)/w\right) + \gamma_2$

Now all of our choice variables are in terms of the exogenous constraints w, N, and T. We can find the signs of the income and wage effects. Using 8,

21. $\frac{dT_{MP}}{dN} = T'_{MP}(w) * \frac{dw}{dN} = T'_{MP}(w) * 0 = 0$

22. $f'(T_{MP}) = w \Rightarrow f''(T_{MP}) * \frac{dT_{MP}}{dw} = 1 \Rightarrow \frac{dT_{MP}}{dw} = \frac{1}{f''(T_{MP})} < 0$

The income effect on meal production time is zero, while the wage effect is negative; since the wage effect is a sum of income and substitution effects, we can surmise that the substitution effect of increased wages on meal production time must be negative as well. Using 20,

23. $\frac{dT_{MC}}{dN} = \left(\frac{\alpha_2}{\alpha_1+\alpha_2+\alpha_3+\alpha_4}\right) * \frac{1}{w} > 0$

24. $\frac{dT_{MC}}{dw} = \left(\frac{\alpha_2}{\alpha_1+\alpha_2+\alpha_3+\alpha_4}\right)\left(-\frac{N}{w^2} + \frac{\gamma_1}{w^2} + \frac{\gamma_4}{w^2} - \frac{dT_{MP}}{dw} + \left(\frac{f'(T_{MP})}{w}\right)\frac{dT_{MP}}{dw} - \left(\frac{f(T_{MP}(w))}{w^2}\right)\right)$
$= \frac{-\alpha_2(N+f(T_{MP}(w))-\gamma_1-\gamma_4)}{w^2(\alpha_1+\alpha_2+\alpha_3+\alpha_4)}$

There is a positive income effect on meal consumption time in this case. The effect of wages could be either positive or negative, depending upon the magnitude of $N + f(T_{MP}(w))$ relative to $\gamma_1 + \gamma_4$. This represents the backwards bending portion of the labor supply curve; if merely meeting subsistence requirements for goods requires all non-labor income and some earned income, then increasing the wage rate will allow a person to cut back on labor hours and increase meal consumption time.

It is also possible to perturb the Meal function M so that $\frac{dT_{MP}}{dN} < 0$. (For example, if X_M has slight returns to scale, such as M = $f(T_{MP}) + {X_M}^{1.01}$, then $f^{'}(T_{MP}) = 1.01 * w * {X_M}^{0.01}$. Increasing N will boost X_M, forcing $f^{'}(T_{MP})$ to rise and T_{MP} to fall, without much effect on the rest of the variables.)

Corner cases:

The results above hold for interior solutions. As structured, T_{MC}, L, X must all be greater than zero (so long as the corresponding γ's are non-negative). However, the other three choice variables T_{MP}, H, X_M can potentially be equal to zero, and in those corner cases, the partial statics may be different.

1. H = 0. $T_{MP} > 0, X_M > 0$. The wage is insufficient to motivate the individual to enter the labor force. The individual divides T between T_{MP}, T_{MC}, L, and N between X_M, X. $\frac{dT_{MP}}{dN} < 0, \frac{dT_{MC}}{dN} > 0$. Will happen when $X_M + X \leq N$, or:
$(\alpha_1 + \alpha_4)(wT - w\gamma_2 - w\gamma_3 - wT_{MP}(w)) \leq (\alpha_2 + \alpha_3)\left(N - \gamma_1 - \gamma_4 - f(T_{MP}(w))\right)$

2. $T_{MP} = 0$. $f^{'}(0) < w \implies$ no time will be spent on meal production.
$T_{MC} = \left(\frac{\alpha_2}{\alpha_1+\alpha_2+\alpha_3+\alpha_4}\right)(T + N/w - \gamma_1/w - \gamma_2 - \gamma_3 - \gamma_4/w) + \gamma_2$. $\frac{dT_{MC}}{dN} = \frac{\alpha_2}{w(\alpha_1+\alpha_2+\alpha_3+\alpha_4)} > 0$,
$\frac{dT_{MC}}{dw} = \frac{-\alpha_2(N-\gamma_1-\gamma_4)}{w^2(\alpha_1+\alpha_2+\alpha_3+\alpha_4)}$ is ambiguous and will have the opposite sign from $N - \gamma_1 - \gamma_4$. Could rule out this case by assumption, $f^{'}(0) > w$.

3. $X_M = 0$. $f^{'}(T_{MP}) > w$. All of $wH + N$ is needed for spending on X. $\frac{dT_{MP}}{dN} > 0, \frac{dT_{MC}}{dN} > 0$.
$\frac{dT_{MP}}{dw}$ and $\frac{dT_{MC}}{dw}$ are ambiguous, and will have the opposite sign from $N - \gamma_4$. (18 provides the conditions for this to happen.)

4. $H = 0$. $T_{MP} = 0$. T is used for T_{MC}, L, while N is used for X_M, X. $\frac{dT_{MC}}{dN} = 0, \frac{dT_{MC}}{dw} = 0$.

5. $H = 0$. $X_M = 0$. All of N is needed for spending on X. Neither w nor N will affect meal production or consumption time.