TIME TO EAT:
HOUSEHOLD PRODUCTION UNDER INCREASING
INCOME INEQUALITY

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ABSTRACT

Eating requires the raw food materials that make up meals and also the time devoted to buying food, preparing meals and eating them, and cleaning up afterwards. Using time-diary and expenditure data for the U.S. for 1985 and 2003, I examine how income and time prices affect time and goods inputs into this household-produced commodity. Focusing on these two years, between which income and earnings inequality increased, allows examining how household production is affected by changing economic opportunities. The results demonstrate that both inputs into eating increase with income, and that higher time prices at a given level of income reduce time inputs. Over this period the relative goods intensity of producing this commodity increased, especially at the lower part of the income distribution, and the average time input dropped substantially. The results are consistent with goods-time substitution being relatively difficult for eating and with substitution being more difficult as production expands.

I. Introduction

There are two activities that every person must do to survive: Eat and sleep. While the latter is amenable to economic analysis (see Biddle and Hamermesh, 1990), with the exception of an infrequent purchase of bedding and mattresses the production of sleep is a decision solely about time use. Not so for eating: Generating meals requires decisions about money expenditures on capital required to engage in this activity and on the non-durable good food itself, as well as about the time spent in obtaining food, preparing it, consuming it and cleaning up the detritus from the meal. How people combine expenditures on the goods and time that make up the production of the commodity "eating" is the major focus of this study, and I will present evidence on these combinations and their changes over the past two decades in the United States.

Essentially no attention has been paid to analyzing how the production of eating takes place in the household. The only relevant literature includes Gronau and Hamermesh (2003), who provide measures of the relative goods intensity of "eating" (and other commodities) in the U.S. and Israel, and Lecocq (2001), who examines food spending and (only) meal preparation time (from recall data) in France. Crossley and Lu (2004) study the details of food spending and meal preparation time using two separate surveys, while Aguiar and Hurst (2004) examine time and goods inputs into eating at a point in time using data on older Americans from two separate surveys, one of expenditures on goods, the other a time-diary study. Vernon (2004) has data on food spending and (recall data) on time use for samples of Russian households in the 1990s. No study tries to combine the spending and time use measures to infer how the goods-intensity of household production varies with full income.

Because decisions about how to generate "eating" depend on choices about how time is spent in the activity, and because the value of time differs across individuals (and for the same person at different times of the day, week, year and lifetime), they are inherently economic. Thus even though we all may face the same price of the goods that are inputs into "eating," we will choose different combinations of goods and time to generate the same amount of "eating" (Becker, 1965; Gronau, 1977) even when our household incomes are equal. A second purpose here will thus be to analyze how household members'

choices of the amounts of time and goods to devote to eating are affected by differences in economic incentives.

Gronau's (1980) pioneering work considered *inter alia* the role of income in affecting household production. Given the potential importance of income effects, it seems sensible to examine the dynamics of this relationship, since arguably the most important change in the American economy (and to a lesser extent in many other industrialized economies too) in the last quarter century has been the rise in inequality in earnings and incomes (see e.g., Gottschalk and Smeeding, 2000). Among its many potential impacts rising income inequality, and the relative changes in time prices that constitute the source of much of the increased inequality, may also have altered the incentives for generating commodities in the household, including "eating," that face people at different points of the distributions of earnings and incomes. The extent of changes resulting from these changed incentives, and therefore the distributional impacts of rising inequality on how Americans generate "eating," is the third central focus of this study.[1]

In the next Section I provide a brief motivation for the analysis. Section III discusses the large variety of data sets that are used in this study and outlines ways to overcome a number of complex estimation problems that are thrown up by difficulties with the available data, including the likely endogeneity of variations in wages and incomes. Section IV presents the empirical results that shed light on the first two foci of the study. It also analyzes changes in the inputs into eating over the two decades from the mid-1980s to the mid-2000s and what they imply about the household production function for eating.

II. Theoretical Motivation

The discussion of the household production for eating is fairly standard and stems directly from Becker (1965). The typical household chooses to supply its members' labor to the market, and to use its remaining time in a variety of activities that it combines with the income generated by its members' labor market time and any non-labor income it may receive. Among these activities are those related to eating; and among the goods purchased are food and the capital necessary to convert that food into meals. Given

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[1]Gottschalk and Mayer (2002) examine the general question of how changing household time use affects inferences about changing inequality by valuing several (recall) measures of time spent in household activities and adding the total to household income.

the household's preferences, it will thus determine its utility-maximizing production of the commodity eating. It will generate demands for time and goods inputs into eating as:

(1a) $T = T(W_M, W_F, I; Z)$;

and

(1b) $X = X(W_M, W_F, I; Z)$,

where T is its time input into eating, X its dollar expenditures on food, W_M and W_F are the husband's and wife's value of time, I is unearned income, and Z is a vector of demographic characteristics that might shift the demand functions for time and goods. We have written the model for a two-adult household, since the data require us to use such households in the empirical analyses; but a similar, simpler model could be written down for a single-adult household.

The economically interesting questions have to do with the expansion paths of the demand for inputs into eating and their changes as the prices of time and income change. The effects of exogenous changes in the economic variables on the choices of T and X are fairly standard: 1) Because the total endowment of time is fixed, in (1a) a higher price of time may or may not cause a shift away from using time in producing eating. The outcome depends on the relative time intensity of eating compared to other commodities and on the relative complementarity of goods and time in eating. There is some evidence (Gronau and Hamermesh, 2003) that eating is relatively goods-intensive. If so, as the price of time increases people would expand their production of eating, although they would surely attempt to do so in an increasingly goods-intensive way. As their non-labor income increases, they will expand their production of eating, perhaps using more time (again, depending on the relatively complementarity of goods and time in producing this commodity compared to others). In the end the directions of the effects of W_M, W_F and I on T depend on a variety of characteristics of the production of eating and of eating relative to other household-produced commodities; but we do expect that I will have a more positive effect on T than will W_M or W_F. 2) For most commodities, including probably eating, increases in income, whether due to a higher price of time (as reflected in higher wages per hour of market work) or higher non-labor income will increase total goods expenditures. We thus expect each of the three

economic variables in (1b) to have positive effects on X.

III. Data and Measurement Issues

Sadly there are no data sets that combine information on households' goods expenditures and time actually spent (as recorded in time diaries) by all household members in the production of eating. One data set does make it possible to combine such information for one household member's time use and the household's food spending, and I return to that later. Both for the U.S. and for other countries, however, we do have detailed consumer expenditure surveys covering large samples of households. We also have detailed time budgets that typically cover smaller samples. In this study we use the 1985 Time Use Survey (TUS85) for the United States, a relatively small privately conducted survey that obtained one day's time diaries from single individuals and from both spouses in a married household and collected some demographic information on both spouses and other household members (Robinson and Godbey, 1999). The 1985 Consumer Expenditure Survey (CEX85) contains detailed categories of spending as well as a set of demographic variables that are similar in scope to those included in the TUS85.

Because I am interested in comparing how rising wage and income inequality affects the production of eating in the household, I estimate the same models on data from 2003, when income inequality was greater than in 1985.[2] The year 2003 is chosen because it is the first year in which the Bureau of Labor Statistics collected data in the American Time Use Survey (ATUS03), which offers for that year a sample of one-day time diaries from nearly 21,000 individuals who had recently been Current Population Survey (CPS) respondents (see Horrigan and Herz, 2005). I analyze these data along with information on goods expenditures from households in the 2003 Consumer Expenditure Survey (CEX03). Particularly in the TUS85 there are too few single individuals to allow a useful analysis to be conducted, so I restrict the study to married individuals with spouse present. I further restrict the analyses to married persons ages 18-64, as I wish to avoid issues related to the well-known unexpectedly large drop that occurs around the normal retirement age (Hamermesh, 1984).

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[2]In 1985 the Gini coefficient on household incomes in the U.S. was 0.425, and the 80/20 ratio was 4.25. In 2003 the same statistics were 0.464 and 4.83.

One of the reasons why there have been so few efforts to estimate household production functions may be because of the necessity of classifying activities and expenditures into commodities. Any classification is necessarily arbitrary; and the difficulty is exacerbated if we wish to compare household production across time, since the list of activities included in time diaries, at least in the U.S., changes from one survey to the next. I thus arbitrarily classify certain time and expenditure categories as representing inputs into eating.

The exact classifications used in extracting information from the four samples, the TUS85, the ATUS03, and the CEX85 and CEX03, are listed in Appendix Table 1. The general idea in classifying activities is to include as time inputs into eating those activities that are described as eating at home and away from home (including at work), meal preparation and clean-up, and grocery shopping and travel related to grocery shopping. I thus try to include all time spent at meals no matter where they are taken or what the purpose. Nonetheless, some people may classify an activity such as drinking at a bar as part of their leisure activities, so that it may not, and perhaps should not be included as a time input into this commodity. Because it is not separately classified in both the TUS85 and ATUS03, I do not include travel to eat away from home, in order to maintain comparability across the two years. Because the TUS85 collected no information on secondary activities (things done simultaneously with the activity that is reported in the survey), and the ATUS03 only reported secondary childcare activity, there is nothing we can do about the possibility that food preparation or clean-up might have been done as an activity secondary to something else and might thus have been under-reported.[3]

Expenditures on food and alcohol (the latter counted only as half) are the main components of goods inputs into eating; but I also include spending on small appliances (presumably for the kitchen) and arbitrarily treat one-third of expenditures on major appliances as inputs into eating (on the assumption that some of these items represent kitchen appliances such as refrigerators, stoves and dishwashers).

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[3]Evidence from the 1991 German *Zeitbudgeterhebung*, which includes reports of secondary activities, suggests that this is not a problem. Only 5 percent of all eating time was reported as secondary, far less than the average incidence of secondary time reported. Cleaning, cooking and shopping (for all items, not just groceries) accounted for only 9% of all secondary activities, again less than its representation among primary activities. When people report eating, shopping, food preparation or clean-up, it is the primary activity, with television-watching, radio-listening or childcare often being secondary to them. The small extent of secondary time spent in the commodity "eating" suggests that our necessary neglect of it here is unimportant.

While these classifications are arbitrary, they are identical for all households. Moreover, since in the empirical analysis I shall essentially be differencing patterns of household production across income levels and across years, so long as the full-income elasticity of demand for the various inputs is constant across the years much of any mis-classifications will be differenced out. Finally, I replicated the analyses of the determinants of expenditures using only the narrowest CEX definition of expenditures on eating, namely spending on food alone, and found no qualitative differences from the results presented here.

The TUS85 has only extremely broad classifications of household income and spouses' hourly earnings. While the ATUS03 provides good information on earnings, good information on incomes is available for the fewer than one-third of respondents who are included in the March 2003 CPS Income Supplement. Even if the data sets had better and more extensive measures of these economic variables, however, using them would introduce biases into estimates of household production: An individual's earnings, and his/her household income, are generated by the wage rate. But the latter in turn depends on the time that the individual chooses to devote to market work (Biddle and Zarkin, 1989); and that choice in turn is determined simultaneously with choices of time inputs into producing different commodities, including eating, in the household. In order to obtain unbiased estimates of the household production function we must somehow find instrumental variables for the wage and income measures that are central to the analysis.

Write the estimating equations for time and goods expenditures into eating as:

(2a) $T_{it} = \alpha Y_{it} + \varepsilon_{it}$,

and

(2b) $X_{it} = \beta Y_{it} + \nu_{it}$, $t = 1985, 2003$,

where i is an observation (couple), t is a year (1985 or 2003) and Y denotes a vector of economic variables consisting of the spouses' wage rates and household income in (2a) and perhaps the same variables or a subset of them in (2b). There are no satisfactory instruments for the variables in the vector Y in these data sets. The data sets do, however, provide information on a set of variables Z that are reasonably viewed as determinants of the Y and as exogenous to goods and time use by adults.

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Moreover, information on both the Z and the Y variables is available from other sets of data that also sample randomly from the U.S. population at the same times as the 1985 and 2003 time-use and expenditure surveys that we use.

I use the Panel Study of Income Dynamics for 1986 (PSID86), which has information on 1985 household net (after federal taxes) income, Y1, to estimate:

(3a) $Y1_{it} = \gamma Z1_{it} + \xi_{it},$

where Z1 is a vector of exogenous variables. I then take the estimates of the vector of parameters $\gamma*$ to create instruments Y1* using the $Z1_{it}$ in the TUS85 and the CEX85. Similarly, I use the Panel Study of Income Dynamics for 2003 (PSID03) to create instruments for net income using the $Z1_{it}$ in the ATUS03 and CEX03.[4] Included in the vector Z1 are a vector of indicators of the educational attainment of each spouse, quadratics in each spouse's age, and the number of children under age 6 and ages 6-17.

For each spouse's wage rate I estimate:

(3b) $W_{jit} = \delta Z2_{jit} + \zeta_{jit},$ t = 1985, 2003,

where W_j (j=M,F) is the usual weekly earnings of workers in the Merged Outgoing Rotation Groups of the 1985 and 2003 CPS. For each married person age 18-64 (the same age group that we use in the main data sets), the wage is predicted from a vector Z2 describing their education, usual weekly hours and a quadratic in their age. In describing the earnings of married women we account for Gronau's (1974) wage selectivity into the labor force by using Heckman's (1979) two-step method. The imputations of both net income and hourly earnings using this two-sample instrumental variable approach (Angrist and Krueger, 1992) circumvent both the potential endogeneity of these variables in the time use and CEX data sets, and the absence of good information on earnings and incomes in the TUS85 and on incomes in the ATUS03.

The absence of information on both time use and goods expenditures in the same sample presents difficulties for generating estimates of how these are combined to create the commodity eating. We simply do not observe time and goods expenditures on eating in any particular household. One solution

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[4]Only information on gross income is available in the PSID03. To derive analog to the data for 1985 I subtract the standard deduction and personal exemptions from gross income and apply the 2002 tax tables.

would be to aggregate the measures in each sample into age-education cell averages. The difficulty with this solution, at least for 1985 because the TUS85 sample is quite small, is that the cells would either be very few in number or very sparsely populated. A better solution is to recognize that both the time-use survey and the CEX for each year sample from the same underlying population. Similarly, the instruments for income and hourly earnings are also based on the same populations. Each sample's imputed values of the variables in the vector Y thus represent unbiased estimates of the underlying distributions of the variables in the vector. We can thus use them as if they were measuring income and time prices in the household to which they are imputed and treat the estimates of equations (2) as reflecting the demands for goods and time inputs into eating.[5] To maintain comparability across the two years, and to allow concentrating on the impacts of changing inequality, we transform the instrumental estimates into percentile points (so that, for examples, in the TUS85 the household with the median imputed net income would be assigned a value of 50 for imputed net income, the wife in the household in the CEX03 with an imputed hourly earnings at the 75th percentile of wives' earnings would be assigned a value of 75 for this variable, etc.)[6]

The central estimates are of the equations:

(2a') $\ln(T)_{it} = \alpha' YP_{it} + \varepsilon_{it,}$

and

(2b') $\ln(X)_{it} = \beta' YP_{it} + \nu_{it}$, t = 1985, 2003

where the YP are the percentile points of the distributions of imputed net income and hourly earnings measures.[7] The estimated α' and β' measure the percentage impacts of one-percentile increases in household incomes or hourly earnings (time prices) on the representative household's total time and goods inputs respectively into the production of eating.

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[5]These input-demand equations leave out the prices of goods under the assumption that they are identical for all individuals at a point in time.

[6]Appendix Table 2 presents a concordance of all the data sets used in this study.

[7]The equations were also estimated with linear forms of the dependent variables with little qualitative difference in the results.

A final but less central difficulty is that, while we have time diaries for both spouses in the TUS85, the ATUS03 only collected a time diary for one household member. We thus cannot obtain T simply by summing up spouses' time spent on food. Because ATUS03 households have been in the CPS, however, we do have information on all the variables Z characterizing ATUS03 respondents and their spouses that we used to create the instruments for the variables in the vector Y. As a first step I thus estimate T_{Mi} for a husband i for whom there is no time diary by regressing T_M for all husbands with diaries on all the demographic characteristics of husbands and wives in the CPS (quadratic in age, vectors of education indicators, race, ethnicity, CPS hours of work, and wife's CPS hours of work). I then use the estimated regression coefficients and husband i's characteristics to obtain his predicted input of time into eating, T^*_{Mi}.

To account for the inter-spousal correlation of food time and for the low variance of the predicted values T^*_M, I then generate:

(4) $T^{**}_{Mi} = T^*_{Mi} + \beta^*[H_{Wi} - Mean(H_W)] + \theta,$

where β^* is the estimated effect of a minute of wife's eating time on husband's food time (from a regression using the 1985 TUS data), H_{Wi} is wife i's CPS weekly hours of market work, and θ is a normal deviate with zero mean.[8] The variance of θ is set so that the variance of the prediction T^{**}_M equals the variance of food time among husbands for whom diary days are included in the ATUS03. Including this white-noise in the predictions T^{**}_M ensures that the husband's predicted food time has the same mean and variance as the time spent by husbands whose eating time we observe. Total eating time for couple i, $T_{i,03}$, is calculated by summing the observed eating time for the wife whose diary day is included in the ATUS and the predicted eating time T^{**}_{Mi} for the husband for whom no diary is included. A similar set of imputations is performed for wives for whom the ATUS03 lacks diary days to obtain the total eating time for couples where the husband's eating time is observed. Because the imputations for husbands and

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[8] $\beta^* > 0$ in the TUS85 and is highly significant statistically. Eating is partly socializing/interacting, and shopping may be too in some cases. That $\beta^* > 0$ is quite consistent with evidence (Hamermesh, 2002) of the complementarity of spouses' leisure.

wives may differ in quality, in the next section I present the results for all couples in 2003, and then separately for couples in which the husband, or the wife, was the ATUS respondent.

IV. Income, Wages and the Production of Eating, 1985 and 2003

    A. Some Descriptive Statistics

    While the ultimate focus of this study is on the changing relationship between choices of household production technique and household income and time prices, an initial examination of the raw amounts of time and goods devoted to generating eating is itself inherently interesting. The final columns of Table 1 show the means and their standard deviations of various components of time and goods spent generating eating, and they break the time inputs down into those of the husband and wife. Of the 2880 minutes available to a couple in a day, the average couple spent 332 minutes, roughly 5-1/2 of its 48 available hours, in the activity eating in 1985, and 248 minutes, barely 4 hours per day, in 2003.[9]

    The time input of the median couple is less than the average time input—the distribution is skewed rightward. In 1985 time spent actually eating meals comprised 47 percent of all time inputs into generating eating, and it was 58 percent of the total in 2003. Wives' time accounted for 63 percent of the total time input into eating in 1985, but only 59 percent of time inputs in 2003. Since the average spouse spends 70 to 80 minutes per day actually eating, with little difference between husbands and wives, the information on husbands' and wives' time inputs shows that husbands spent only 32 percent as much time as wives on shopping/preparation/clean-up in 1985 and only 37 percent as much in 2003.

    An interesting question is why the total time inputs into eating appear to have declined by over 25 percent between 1985 and 2003. One explanation might simply be that the aggregation processes that created the total eating time measures differ across the two surveys. This is possible, but the basic categories (see the Appendix) seem very similar. Another possibility is that the survey methods differed and generated substantial differences in how activities are classified. This too is possible, but it is hard to believe that something as basic as eating, food shopping, and cooking and cleaning up could be classified so differently in the two sets of time diaries.

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[9]That the distributions of the couples' time inputs for 2003 look very similar when we alternatively impute the husband's or wife's time should be encouraging that the imputation procedure is not generate errors.

Table 1 shows that the larger decline in time use in this commodity is among wives: Their time input declined by 31 percent, husbands' by only 20 percent. The Table also shows that by far the bigger decline among wives was in the time they spent shopping/cooking/cleaning that is an input into the production of eating. Food shopping and cleaning-up especially are the kinds of secondary activity (one for which purchased inputs could be substituted—see Reid, 1934) that yield little utility and for which technical change has caused market substitutes to decrease in relative price. With rising real incomes households have become able to purchase market substitutes. The substantial decline could simply reflect optimizing behavior by households in the face of rising time prices of wives and households' rising real incomes.

Table 1 also presents the order statistics of time spent on eating. What is intriguing is the great heterogeneity in the amount of time input into eating: Going from the 10th to the 90th percentile of the distribution of time that couples spend generating eating involves nearly quadrupling the time input, from 2 hours 40 minutes per day to 9 hours 20 minutes per day for a couple in 1985, and from 1 hour 40 minutes per day to 6-1/2 hours per day in 2003. Whether this heterogeneity is related to the economic determinants that affect inputs into eating is the major focus of this Section.

The average food expenditure of $4,874 for these married couples in the CEX85 constituted about 19 percent of their total expenditures, while that of married couples in the CEX03 accounts for only 16 percent of total expenditures. Like that of time inputs into eating, the distributions of goods spending are skewed to the right. The Table also breaks food expenditures down into spending on food consumed at home and that on food consumed away from home. (These figures total less than the total expenditure on goods inputs into eating because the total includes the other food-related purchases, mostly on capital goods, as Appendix Table A.1 shows.) Food consumed away from home constitutes about one-fourth of total spending on food, and its distribution unsurprisingly exhibits much more inequality than that of food consumed at home.

Finally, Table 1 lists statistics (means and order statistics) describing total expenditures on all goods and the share of food spending from the CEX85 and CEX03 data. Inequality in total expenditures

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increased, with the coefficient of variation rising from 0.71 to 0.77 (a smaller increase in inequality of consumption than the increased income inequality over the same period, thus mirroring the relation of inequality of expenditures and incomes in the cross section shown by Dynarski *et al*, 1997). The increased inequality in total expenditures was concentrated entirely above the median expenditure. Indeed, while there were essentially no changes in total spending (relative to the median) at the lower percentiles, the relative change was positive above the median, with the biggest relative increase occurring at the 95th percentile.[10] The share of spending on food in total expenditure fell at all points of the distribution; but in percentage terms the declines are smaller toward the bottom of the distribution of total expenditures.

B. Estimating the Determinants of Goods and Time Inputs

The first step in estimating the demand functions is the creation of the instrumental variables for household income and the prices of the spouses' time. I use household net income, thus creating an instrument for the actual amount of income at a household's disposal. The results for instrumenting net income are based on estimating regressions using the PSID86 and PSID03 data and are presented in columns (1) and (4) of Table 2. The estimates make very good sense in light of the vast literature on income determination. Households' net incomes rise with education, especially so for husband's education (since men's age-earnings profiles rise more rapidly with education than women's, and because wives are less likely to participate in the labor force); they are quadratic in each spouse's age (again reflecting the shape of age-earnings profiles); and they are lower if young children are present, presumably indicating the impact on wives' labor-force participation.

The equations underlying the creation of instruments for husbands' and wives' values of time are the earnings equations whose estimates are shown in columns (2), (3), (5) and (6) of Table 2. The regressions reported in columns (2) and (5) are simple log-earnings equations including indicators of educational attainment, a quadratic in age and hours of work. Those for women also include an auxiliary

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[10]This corresponds perfectly to the distribution of changes in inequality in the upper tail of the distribution of men's earnings. Data from the Outgoing Rotation Groups of the CPS show that between 1979 and 2003 the 90/50 ratio rose by 25 log points, but the 95/50 ratio rose by 34 log points.

selectivity equation in which the probability of working is affected by the presence of pre-school and young children, who are assumed not to affect earnings directly. The results, and the estimation itself, are completely standard and merit no further comment.

The results of the imputations in the TUS85, ATUS03 and CEX85 and CEX03 are presented in Table 3. For each imputation I present various order statistics and the mean and standard deviation (just as was done for the distributions of time and goods inputs in the two years in Table 1). Each imputation was made using the coefficient estimates shown in Table 2 and each observation's values of the vector of variables Z1 and Z2. To standardize the wage rates and avoid endogeneity I assume that hours of work equal 40 for all observations. (Any number could be chosen, so long as it is identical for all sample members.)

The distributions of imputed wage rates look fairly standard: Women's average imputed hourly wage rates are 64 percent of men's in 1985 and 77 percent in 2003, reflecting the well-documented increase in women's relative wages and approximating fairly closely the actual increase that occurred (Blau and Kahn, 2004).

The coefficients of variation of imputed net incomes, husband's wage rates and wife's wage rates were 0.28, 0.24 and 0.21 respectively in 1985; in 2003 they are 0.32, 0.33 and 0.25 respectively. All of them have increased, with the greatest increase in inequality in husband's imputed earnings. The 50/10 ratio of imputed husband's hourly wage rates was 1.40 in 1985, but fell to 1.35 in 2003; the 90/50 ratio rose from 1.42 to 1.50. Since Autor *et al* (2005) show that the biggest increase in inequality in men's actual earnings over this period was in the upper part of the distribution of earnings and that wage inequality in the lower half of the distribution may even have narrowed, the changing inequality in the distribution of imputed earnings accords with the facts and enhances our confidence in the instrumental-variables approach used here.

While the distributions of imputed earnings are skewed slightly to the right, the distributions of net incomes are not skewed rightward. That there is relatively little skewness in all of the distributions of the imputed variables is the result of the fact that the distributions of returns to the unobservable

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determinants of wage rates and incomes, which we cannot account for, are more right-skewed than the distributions of returns to their observable determinants. Finally, it is comforting to note that the shapes of the distributions of imputed net income look quite similar across samples within years, as do the distributions of imputed wage rates.

Columns (1) and (4) in Table 4 show the results of estimating equations (2a') and (2b'), the demand functions for the inputs into the household production of eating. These relate time and goods spending to a household's position (percentile) in the distributions of imputed household net income and the spouses' imputed wage rates. While these are the central equations in the model, in the other columns I present estimates of the determinants of some of their subcomponents, including husbands' and wives' time inputs separately, and goods expenditures on food consumed at home and away from home. All of the equations include a vector of variables indicating the age distribution of children in the household. The time-demand equations also include a vector of indicators for the day of the week for which the time diary was kept.[11] That the fractions of variance explained in these equations are not very high is the result of our excluding idiosyncratic variation in incomes and time prices when we necessarily use imputations for these for each household.

The estimated parameters in equation (2a'), the demand for time inputs into eating, accord completely with what we know about the relative time-intensity of the demand for eating. Higher prices of husbands' and wives' time lead them to economize on their time used in producing this commodity. Moreover, we cannot reject the hypothesis that the impacts of equal-percentile increases in their time prices generate the same impact on the total time input into eating in both years. Holding time prices constant, however, a movement up the distribution of net incomes increases the time used in generating eating.

In estimating the goods-demand equations I assume that the only economic determinant is the household's net income. The results suggest that the demand for food increases with (imputed) net income, and that the demand for food eaten away from home is much more income elastic than that for

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[11]The estimates from the ATUS03 are weighted to account for the over-sampling of weekend days, so that the results reflect a representative day.

food consumed at home. The income elasticities of total goods expenditure into eating (calculated around the medians) are about 0.40, quite similar to estimates for food spending in a now-hoary literature (e.g., Houthakker and Taylor, 1966).

One might be concerned that my measure of goods expenditures, which includes more than just food, may be too broad. I re-estimated the equations in columns (1) and (4) using narrower measures, the logarithms of total food expenditures, in each year. The parameter estimates on the percentile of imputed net income are 0.00590 (s.e. = 0.00017) for 1985, 0.00497 (s.e.=0.00014) for 2003. The elasticities are unsurprisingly smaller than those describing eating expenditures that include part of alcohol and appliances, but they reproduce the qualitatively similar result that the expenditure elasticity is lower in 2003 than in 1985.

C. Inferring the Household Production Function

One of the major purposes in estimating these demand equations is to examine how the relative goods intensity of eating varies along the expansion path at a point in time. Figures 1a and 1b show how the amounts of goods and time used in producing the commodity eating increase as we move up the income distribution. Treating goods expenditures by the lowest-income household in the sample (at nearly the 0th percentile of the distribution of imputed net income) as 100, the calculations simply take the parameter estimates from column (4) of Table 4 and move up the distribution of incomes by percentiles.

The calculation of the indices of demand for time inputs into eating is more complex, as we need to account for the relationship between income and wage rates, and for the possible correlation of spouses' wage rates. To do so I estimate regressions of I on W_M, I on W_F and W_F on W_M. (Since these variables are percentiles and thus have the same means and standard deviations, the estimated $dI/dW_M = dW_M/dI$, and similarly for the other two relationships.) We can thus calculate the effect of a one-percentile increase in a household's income as:

(5) $\alpha'_I[1 + dI/dW_M + dI/d\ W_M] + \alpha'_{WM}[1 + d\ W_M/dI + d\ W_M/d\ W_M] +$

$\alpha'_{WF}[1 + dW_M/dI + d\ W_M/dW_M]$.

Again letting the index equal 100 at the 0th percentile of income, I apply the changes implicit in (5) as we

move up the distribution of income.

Figure 1a shows that goods spending roughly doubled (increased 101 percent) over the range of the distribution of (imputed) net incomes in 1985. Time expenditures barely increased as a household moved up the distribution of imputed net income, rising 10 percent from the bottom to the top of the distribution. Even though the three correlations that underlie the calculation in (5) are very high, a general increase in income did increase time spent in producing eating.

The results for 2003 shown in Figure 1b differ substantially from those in Figure 1a. By then the increase in goods spending as one moved up the (less equal) distribution of net incomes was relatively smaller, with an increase of only 72 percent. The gradient on time spent in eating was steeper than in 1985, however, so that a household at the top of the distribution of imputed income spent nearly 40 percent more time on eating than one at the bottom.[12]

For both years the figures show that there are positive relationships between imputed net income and time and goods used in generating eating. While these suggest numerous conclusions (see below), they ignore the idiosyncratic relationship between time and goods that could exist across different households. The ATUS03 provides a unique opportunity to examine this idiosyncratic variation, as some of the respondents in that survey can be linked to the December 2002 CPS in which a Food Security Supplement was included. That supplement included questions eliciting the amount the respondent's household spent on all food last week, and the amount usually spent in a week. A match between the ATUS03 and the December 2002 CPS was possible for 2580 of the 9324 respondents used in the estimates presented in Table 4. The same measure of time devoted to eating was included; and for each respondent I calculated annual household spending on food based on the actual and usual weekly expenditures that were reported.

One view of the relationship between goods and time spending in these households is presented by Figures 2, showing the results of fitting food expenditures, first for actual then for usual expenditures,

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[12]If we use the narrower measure, spending only on food, the gradient for 1985 shows an increase of 81 percent from the lowest to the higher percentile of imputed net income, while that for 2003 shows an increase of 64 percent. None of the conclusions in this Part is changed in any important way if we base them on the response of this concept of expenditures on eating.

to a quadratic in time use after trimming the tails of the distributions of the variables. The relationships implicit in these figures corroborate the conclusions from the estimation and Figures 1: Those households in which the couple spends more time in eating-related activities are also those in which more money is spent on food.

To separate out the idiosyncratic part of the relationship from the part due to variations in observables (in imputed net income), in Table 5 I present estimates of equations describing the logarithms of the expenditure measures (again for the trimmed samples). Columns (1) and (4) of the Table corroborate the results in Figures 2, as they show positive and statistically significant relationships between time spent and goods expenditures on food. Columns (2) and (5) merely replicate the unsurprising finding in Table 4 that expenditures on food increase with imputed net income. Columns (3) and (6) show that, even accounting for differences in imputed net income, those couples that spend more time in eating activities also spend more money on food. The idiosyncratic components of goods spending and time use are positively related (statistically significantly so in the case of usual expenditures). Taken together, Figures 2 and Table 5 suggest that the implied positive relationship between time and goods spending on eating is not an artifact of our imputations that necessarily base the relationship only on observables.

In Table 6 I summarize the results underlying Figure 1. The top part of the table shows the real goods (dollars per year) and time inputs (converted from minutes per day to hours per year to increase comparability to the expenditure measures). It also presents the goods/time ratio at various percentiles of the distribution of imputed net incomes for each year, and it lists the percentage change in this ratio over the eighteen-year period. To make the expenditure data comparable across years the spending data for 1985 are converted by the PCE deflator for food to 2003 dollars.[13] The bottom part of the table lists the same information at the actual means and medians of net incomes, goods spending and time use. These latter correspond quite closely to the ratios and changes at the measures of central tendency based on our calculations of imputed net income and wage rates.

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[13]Using the CPI Food and Beverages index lowers the percentage increases in X/T, with the increase at the 5th percentile of the distribution of imputed income becoming 46.6 percent and that at the 95th percentile becoming 4.2 percent.

Coupled with the statistics in Table 1 the estimates presented in Figure 1 and Table 6 suggest the following central conclusions:

1. In both years both goods expenditures and time inputs into eating rose with income; and the sparse 2003 evidence implies they are positively correlated within households.

2. Between 1985 and 2003 total time spent in eating fell sharply while goods spending declined relative to all expenditures and stayed essentially constant in real terms.

3. Consequently, over this period the relative goods intensity of eating rose at the mean and at all other points of the distribution of net incomes.

4. The relative goods intensity of eating rose most sharply in the lower part of the distribution of net income, with the rate of increase declining steadily as one moves up the distribution.

What does this combination of findings tell us about the nature of the household production function for eating? What minimal reasonable set of inferences about the nature of that production function is suggested by the results? The two sets of cross-section results match expectations: Those households with higher full incomes produce this commodity more goods-intensively than those in which the spouses' time prices and full incomes are lower. While the results in Table 4 demonstrated that a higher price of time (especially the wife's time) leads to substitution against time used in producing eating, the positive income effects lead higher-income couples to devote more time to eating (in combination with their greater goods purchases). This result suggests that it is relatively difficult for people to substitute goods for time in the production of this commodity compared to the composite of all other commodities.

The changes in the relative goods-intensity of production across the changing income distribution are more difficult to reconcile. If, however, the household production function for eating is heterothetic, and goods-time substitution becomes more difficult as one moves out along the expansion path, then we would find the greater cut in time inputs into eating in lower-income households that we have observed

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between 1985 and 2003. Implicitly the difficulty of substituting goods for time in the production of the other, composite commodity does not increase as rapidly as production expands. Higher-income families, that experienced the largest increases in income over this period, thus found it increasingly difficult to expand the production of this commodity by increasing its goods intensity.

One could also explain the results by technical change in the production of meals (preparation, shopping and cleaning). Indeed, even the relative decline in time inputs at the lower end of the income distribution might be explicable if one could demonstrate that there was more rapid time-saving technical change in the sub-aggregates of those categories that are used particularly by lower-income households. In the end, both biased technical change and heterothetic production without biased technical change are consistent with the findings.

The results on goods used in producing eating suggest a weakening positive relation to net incomes over this period. However, time inputs into eating became more positively correlated with net income over this period, so that changes in the use of time added to the inequality in the amount of this commodity that was produced. It is thus unclear whether inequality in production/consumption of the commodity "eating" increased or decreased, since we can only infer the general shape of the production function and not the specific parameters characterizing the marginal products of the two inputs.

VI. Conclusions

In this study I have examined the determinants of the household production function characterizing eating, a commodity whose production involves using purchased food and some capital goods in conjunction with time spent preparing the food, eating it and cleaning up afterwards. Particular attention has been paid to ensuring that the economic variables that determine how different households produce this commodity are truly exogenous—uncontaminated by the simultaneous determination of time spent in producing the commodity and time spent in generating earnings. The results show a large decrease over time in the time inputs into eating—a rise in its goods-intensity. Eating appears to be a relatively goods-intensive commodity, one in which the substitution of goods for time as incomes and time prices rise is relatively difficult and becomes even more difficult as more is produced.

Taken together the results in Section IV offer some insights into likely changes in the demand for goods used in producing the commodity eating as incomes and time prices rise. In particular, if, as the findings indicate, goods-time substitution becomes increasingly difficult as production of the commodity expands, we should expect spending on food to rise even more slowly than a simple consideration of the income elasticity of demand for expenditures on food would suggest. If the growing inequality in incomes and time prices that we have observed for the past three decades ceases and even begins to reverse, the cost of substituting services (of lower-wage workers) for time (by higher-wage consumers) will rise, making it even harder to increase the goods-time ratio and less likely that spending on goods that are q-complementary with time in producing eating will rise.

Beginning with Altonji (1986) economists have used spending on food, which is readily available in a variety of household surveys that concentrate on measuring income, such as the PSID, as a proxy to identify intertemporal substitution in labor supply. While some difficulties with focusing on food spending because of its income inelasticity have been pointed out (Attanasio and Weber, 1995), the approach here makes it clear that the problems go deeper. In particular, because the commodity eating apparently is full-income inelastic, and because by inference the household production function for eating exhibits less substitutability between goods and time than is true for household production generally, goods expenditures on food are systematically related nonlinearly to the prices of time. Using any measure of goods expenditures in this context will induce biases unless it describes spending on goods that are used in the household production of a representative commodity.

The exercise conducted here could (and should) be done (with varying amounts of effort) for other commodities that are produced at home to examine how their production has changed over time and as the distributions of earnings and income have changed. Indeed, one can envision a complete system of demand and household production equations that defines commodities *a priori*, accounts for all goods expenditures and all uses of (non-market) time and examines how each is affected by incomes and time prices. With the development of a comprehensive and continuing time-use survey in the United States (the ATUS) there is every reason to begin estimating household production technologies using

methodologies similar to those that have been used for so long in describing the production of goods.

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Table 1. Statistics Describing Households' Eating Time and Goods Expenditures, 1985 and 2003

				Percentile						
	5	**10**	**25**	**50**	**75**	**90**	**95**		**Mean**	**Std. dev.**

1985

Time (minutes/day), N = 688*:

	5	10	25	50	75	90	95	Mean	Std. dev.
Total	121	160	224	313	405	559	639	331.8	(154.1)
Husband	30	44	70	105	160	233	287	124.2	(82.4)
Eating	20	30	50	70	105	140	180	81.6	(47.2)
Wife	50	80	125	193	271	362	416	207.7	(110.6)
Eating	16	25	45	70	95	135	165	75.4	(45.8)

Goods (dollars/year), N = 11,418:

	5	10	25	50	75	90	95	Mean	Std. dev.
Total	$1648	2160	3039	4320	6036	8067	9663	4874	(2868)
Home	$1020	1356	2040	2928	4104	5280	6120	3187	(1648)
Away	$ 0	0	300	666	1200	2400	3000	996	(1178)
Total expenditure	$8283	10,382	14,748	21,295	30,985	47,353	61,740	26,069	(18634)
Relative to Median	0.389	0.488	0.693	1.000	1.455	2.224	2.899		
Food share (at percentiles of total expenditure)	.278	.262	.232	.196	.153	.120	.091	.193	(0.099)

2003

Time (minutes/day), N = 9324*:

	5	10	25	50	75	90	95	Mean	Std. dev.
Total (wife imputed)	70	95	149	225	312	407	470	241.6	(127.1)
Total (husband imputed)	74	99	153	223	313	414	480	244.0	(128.2)
Husband total	10	25	50	90	135	190	230	99.6	(71.6)
Eating	0	15	30	60	95	135	160	71.7	(51.5)
Wife total	25	45	80	130	190	260	315	143.8	(91.4)
Eating	0	15	30	60	90	130	156	68.9	(50.1)

Goods (dollars/year), N = 16,596:

	5	10	25	50	75	90	95	Mean	Std. dev.
Total	$2786	3453	4746	6663	9240	12,473	15,060	7576	(4545)
Home	$2028	2360	3380	4680	6240	8320	9880	5127	(2752)
Away	$ 0	0	480	1200	2400	4200	5756	1884	(2650)
Total expenditure	$16,428	20,198	28,729	42,599	64,286	98,263	131,119	53,847	(41,744)
Relative to Median	0.386	0.474	0.674	1.000	1.509	2.307	3.078		
Food share (at percentiles of total expenditure)	.247	.233	.195	.154	.125	.105	.082	.162	(0.087)

*Means are based on time use on a representative day.

Table 2. First-Round Estimates of Net Income and the Price of Husbands' and Wives' Time, PSID 1986 and 2003, CPS-MORG 1985 and 2003*

Dep. Var.:	1985 Net Income	Ln(WM)	Ln(WF)	2003 Net Income	Ln(WM)	Ln(WF)
	(1)	(2)	(3)	(4)	(5)	(6)
Husband:						
Educ. 9-11	-6662.60	-0.256		-8227.00	-0.208	
	(521.57)	(0.0061)		(6752.42)	(0.0065)	
Educ. 13-15	3059.69	0.125		13097.51	0.106	
	(516.53)	(0.0057)		(4968.40)	(0.0053)	
Educ. ≥16	11954.60	0.365		31353.79	0.442	
	(603.24)	(0.0051)		(5313.84)	(0.0049)	
Age	1496.29	0.072		5226.86	0.073	
	(216.61)	(0.0014)		(3014.62)	(0.0012)	
Age^2/100	-1602.19	-0.073		-6592.81	-0.076	
	(267.25)	(0.0017)		(3170.46)	(0.0014)	
Wife:						
Educ. 9-11	-5189.00		-0.232	-10494.58		-0.249
	(527.62)		(0.0084)	(7358.55)		(0.0090)
Educ. 13-15	1147.72		0.172	-480.73		0.141
	(503.19)		(0.0060)	(4738.68)		(0.0058)
Educ. ≥16	7407.11		0.376	17743.35		0.470
	(639.259)		(0.0063)	(5495.70)		(0.0055)
Age	1237.46		0.036	-4005.95		0.044
	(217.07)		(0.0015)	(2960.81)		(0.0017)
Age^2	-1002.24		-0.039	5668.04		-0.047
	(272.23)		(0.0020)	(3238.41)		(0.0020)
Usual weekly hours		0.022	0.047			
		(0,0002)	(0.0002)			
#Kids<6	-1857.35					
	(239.28)					
#Kids6-17	-1418.71					
	(188.75)					
N =	11,884	59,417	44,655	1,891	80,187	56,095
Adj. R^2	0.250	0.302		0.069	0.448	

*Standard errors in parentheses here and in Table 4. The estimates describing net income are based on data from the PSID. The estimates of male weekly earnings are least-squares coefficients from regressions using CPS-MORG data. Those describing female weekly earnings are also based on CPS-MORG data and are from a selection model in which the presence of children ages 0-5 and 6-17 identifies the labor-force participation decision.

Table 3. Statistics Describing Imputed Net Income and Prices of Time, 1985 and 2003

| | Percentiles | | | | | | | | | |
	5	10	25	50	75	90	95		Mean	Std. dev.
1985										
From TUS85:										
Imputed Net income	$21,295	24,781	30,909	40,267	46,923	54,540	58,205		39,433	(11224)
W_M	$7.14	7.58	8.42	10.50	12.36	14.96	15.49		10.75	(2.62)
W_F	$5.10	5.27	6.07	6.63	7.85	9.31	9.66		6.95	(1.41)
From CEX85:										
Imputed Net income	$18,464	23,187	30,101	38,894	46,521	54,673	57,843		38,494	(11897)
W_M	$6.89	7.52	8.37	10.55	12.31	14.96	15.49		10.69	(2.67)
W_F	$4.92	5.16	5.92	6.63	7.85	9.31	9.61		6.89	(1.44)
2003										
From ATUS03:										
Imputed Net income	$36,444	44,162	56,015	72,092	92,928	105,867	110,878		73,570	(23444)
W_M	$11.03	12.10	14.42	16.63	22.16	24.46	24.76		17.67	(4.52)
W_F	$8.80	9.63	11.46	13.19	17.56	18.82	19.00		13.87	(3.40)
From CEX03:										
Imputed Net income	$36,948	43,538	55,713	70,354	92,067	106,542	110,691		72,944	(23237)
W_M	$11.11	12.10	14.40	16.30	22.02	24.51	24.76		17.52	(4.51)
W_F	$8.80	9.27	11.45	13.01	17.09	18.78	19.00		13.59	(3.33)

Table 4.   Regression Estimates, Determinants of Logarithms of Eating Time and Goods Expenditures, TUS85 (N =688) and CEX85 (N=11,418), ATUS03 (N=9324) and CEX03 (N=16,596)*

	Time (Ln(Minutes))				Goods (Ln(Expenditures))		
	Total	**Husband**	**Wife**		**Total**	**Home**	**Away**
	(1)	(2)	(3)		(4)	(5)	(6)
				1985			
Net income percentile	0.0108 (0.0025)	0.0066 (0.0029)	0.0028 (0.0017)		0.00702 (0.00018)	0.00439 (0.00020)	0.02032 ().00076)
W_M percentile	-0.0067 (0.0020)	-0.0048 (0.0028)					
W_F percentile	-0.0044 (0.0012)		-0.0031 (0.0016)				
Adjusted R^2	0.0432	0.0207	0.0022		0.1607	0.1153	0.0726
				2003			
Net income percentile	0.00212 (0.00066)	0.00218 (0.00066)	0.02013 (0.00045)		0.00543 (0.00014)	0.00298 (0.00017)	0.02110 ().00067)
W_M percentile	-0.00038 (0.00047)	-0.00075 (0.00067)					
W_F percentile	-0.00063 (0.00034)		-0.00117 (0.00046)				
Adjusted R^2	0.0058	0.0059	0.0073		0.1234	0.0730	0.0631

*The estimating equations all include measures of the number of children under age 6, and between ages 6 and 17. The equations describing time use also include indicators for the day of the week on which the time diary was kept.

Table 5. Regression Estimates, Determinants of Logarithms of Eating Time and Goods Expenditures, Merged ATUS03 and December 2002 CPS Food Security Supplement (N=2375)*

	Ln(Actual Food Expenditures)			Ln(Usual Food Expenditures)		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Minutes)	0.0456 (0.0243)		0.0307 (0.0241)	0.0574 (0.0216)		0.0434 (0.0214)
Net income percentile		0.0035 (0.0004)	0.0035 (0.0004)		0.0031 (0.0004)	0.0030 (0.0004)
Adjusted R^2	0.0094	0.0344	0.0346	0.0120	0.0341	0.0353

*The estimating equations all include measures of the number of children under age 6, and between ages 6 and 17. The samples are trimmed to remove .5 percent tails of eating time and eating expenditures.

Table 6 Annual Goods (dollars) and Time (hours) Spent on Eating Production, 1985 and 2003, at Points on the Distributions of Imputed and Actual Household Incomes[a]

Percentile and Year	X	T	X/T ($/hour)	Percent Change in X/T
Imputed Income				
5th				
1985	$4379	1716	2.55	
2003	4677	1166	4.01	57.18
10th				
1985	4536	1724	2.63	
2003	4805	1184	4.06	54.23
25th				
1985	5040	1748	2.88	
2003	5214	1241	4.20	45.72
50th				
1985	6008	1789	3.36	
2003	5973	1342	4.45	32.56
75th				
1985	7161	1831	3.91	
2003	6842	1450	4.72	20.59
90th				
1985	7957	1856	4.29	
2003	7422	1520	4.88	13.94
95th				
1985	8241	1865	4.42	
2003	7627	1544	4.94	11.80
Actual Income				
Mean				
1985	7767	2018	3.85	
2003	7575	1470	5.15	33.95
Median				
1985	6885	1904	3.62	
2003	6663	1366	4.88	34.87

[a]Predicted goods expenditures are all in 2003 dollars using the PCE deflator for food expenditures. Expenditures are annual, minutes are daily.

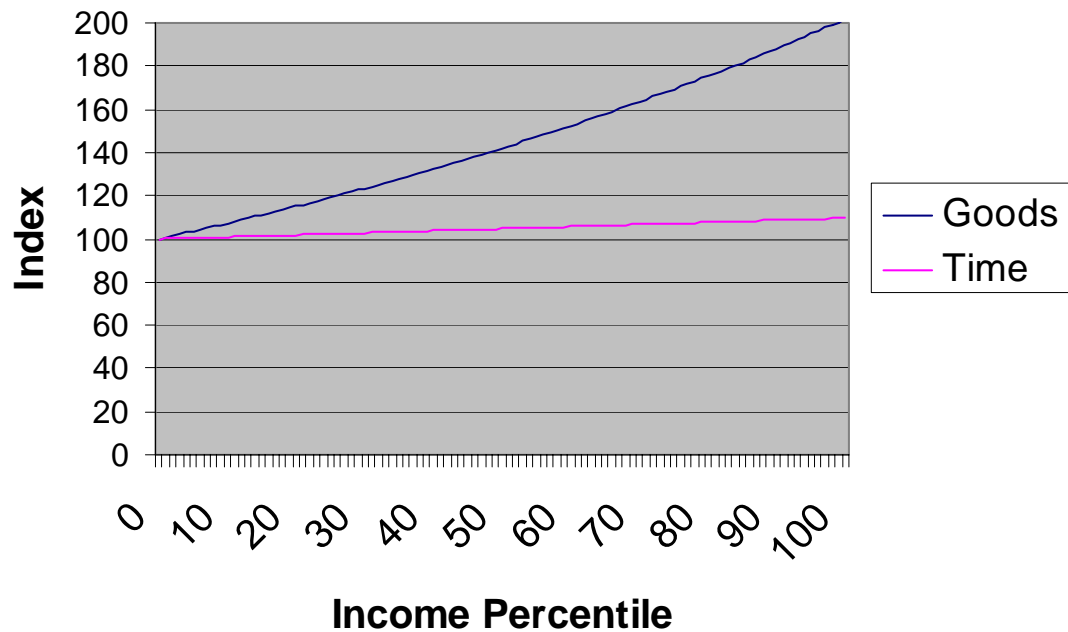# Figure 1a. Indices of Time and Goods
Spent on Eating, 1985

Figure 1b. Indices of Time and Goods
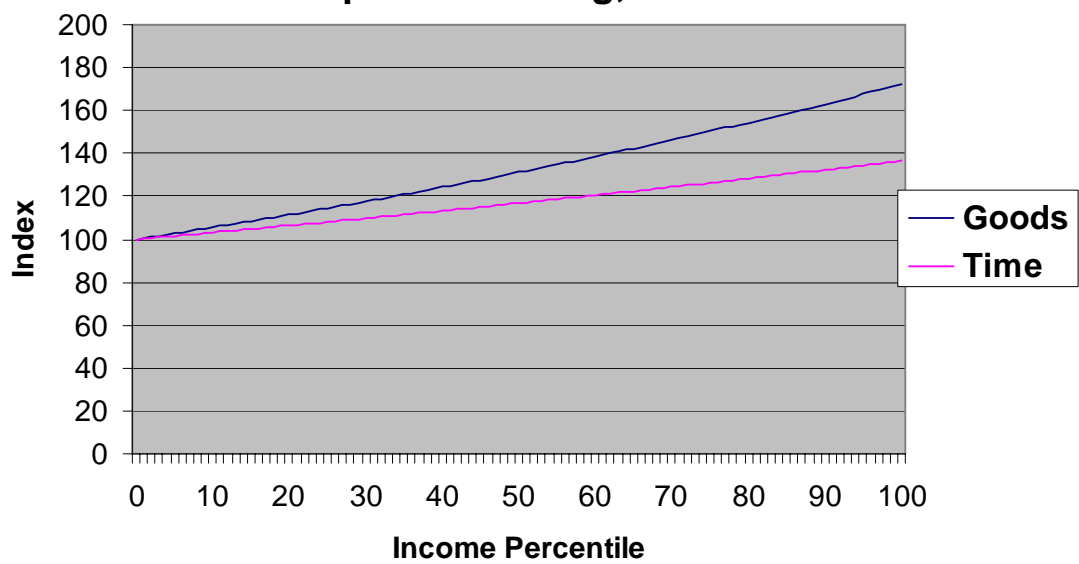## Spent on Eating, 2003

Figure 2a. **Quadratic Prediction of Actual Food Expenditures from Food Time, ATUS03 and December 2002 Food Security Supplement**
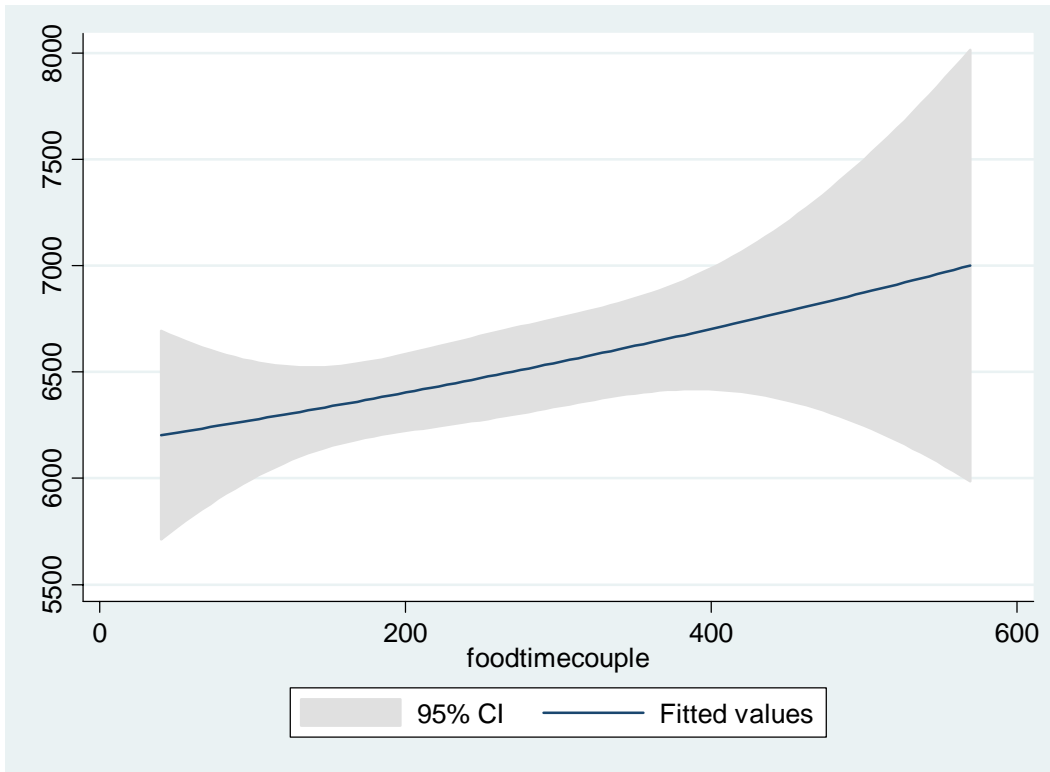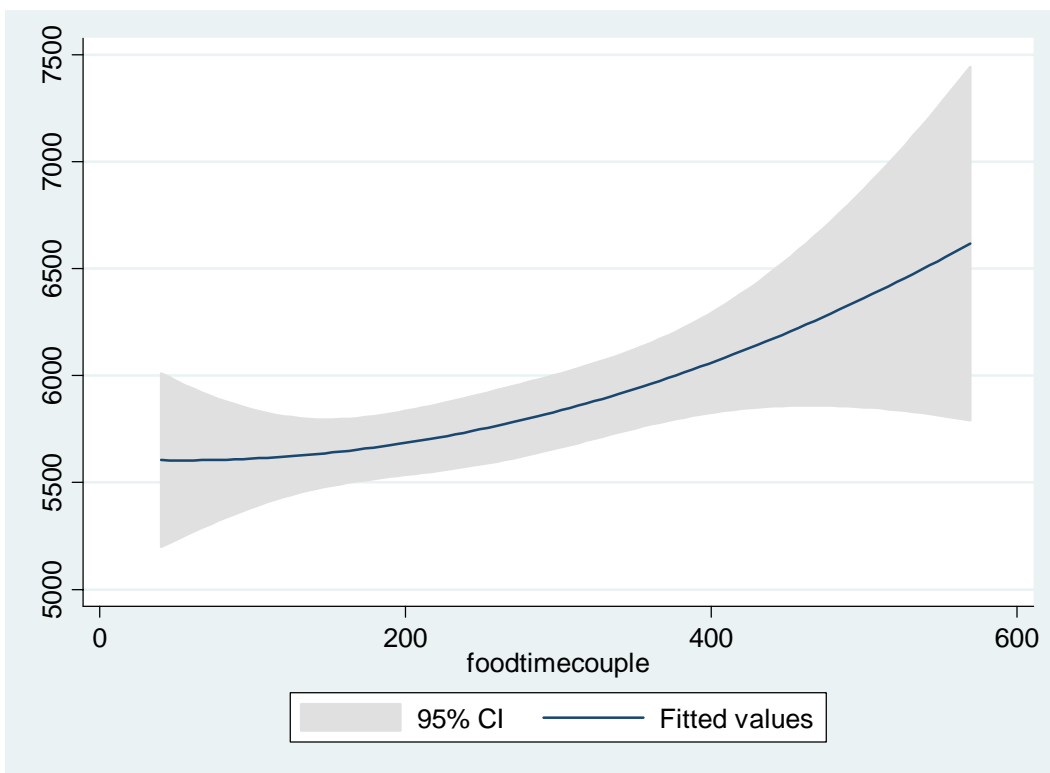

Figure 2b. **Quadratic Prediction of Usual Food Expenditures from Food Time, ATUS03 and December 2002 Food Security Supplement**

Appendix Table 1. Definitions—Eating Time and Goods Expenditure Categories, 1985 and 2003

TIME

TUS85   **ATUS03**

TUS85	ATUS03
Meals at work	Eat/drink as part of job
Meal preparation; meal clean-up	Food & drink preparation, presentation and clean-up
Groceries, supermarket shopping for food	Grocery shopping; purchasing non-grocery food
Travel related to outside activities prorated by share of outside activities that are grocery shopping	Travel to/from grocery store; waiting associated with shopping prorated by grocery and non-grocery food shopping shares in all shopping
Meals, snacks at home; meals, snacks away from home	Eating and drinking

GOODS

CEX85   **CEX03**

CEX85	CEX03
Food	Food
.5*Alcohol	.5*Alcohol
.333*(Major appliances + miscellaneous appliances)	.333*(Major appliances + miscellaneous appliances)
Small appliances	Small appliances

Appendix Table 2. Data Sets Used—Main and for Imputation

MAIN	IMPUTATION
	1985	

Time Use Survey, Univ. of Maryland (TUS85	Currently Population Survey, Merged Outgoing Rotation Groups, BLS (CPS-MORG85)
Consumer Expenditure Survey, BLS (CEX85)	University of Mchigan Panel Study of Income Dynamics (PSID86)

2003

American Time Use Survey, BLS (ATUS03)	Currently Population Survey, Merged Outgoing Rotation Groups, BLS (CPS-MORG03)
Consumer Expenditure Survey, BLS (CEX03)	University of Michigan Panel Study of Income Dynamics (PSID03)
ATUS03 and December 2002 CPS Food Security Supplement	