NBER WORKING PAPER SERIES

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Working Paper 13127
http://www.nber.org/papers/w13127

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 2007

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NBER Working Paper No. 13127
May 2007
JEL No. D13,J22,J26

ABSTRACT

With the American Time Use Survey of 2003 and 2004 we first examine whether additional market work has neutral impacts on the mix of non-market activities. The estimates indicate that fixed time costs of market work alter patterns of non-market activities, reducing leisure time and mostly increasing time devoted to household production. Similar results are found using time-diary data for Australia, Germany and the Netherlands. Direct estimates of the utility derived from goods consumption and two types of non-market time in the presence of these fixed costs indicate that they generate a utility-equivalent of as much as 8 percent of income that must be overcome before market work becomes an optimizing choice. Market work also alters the timing of a fixed amount of non-market activities during the day, away from the schedule chosen when market work imposes no timing constraints. All of these effects are mitigated by higher family income. The results provide a new supply-side explanation for the frequently observed discrete drop from full-time work to complete retirement.

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> The reason I am retiring fully is to have control of my schedule, so that I can travel, concentrate on big research projects, etc. Since it's scheduled at certain times, teaching always pushes other activities away. [Comment by astronomy professor]

I. Introduction

Theoretical models and empirical analyses of the allocation of time have nearly universally dichotomized work and non-work. A few exceptions do exist (e.g., Becker, 1965, Gronau, 1980; Kooreman and Kapteyn, 1987, and Biddle and Hamermesh, 1990); but in general such mundane activities as eating, washing or sleeping are implicitly assumed to be aggregable with such activities as enjoying a Mahler symphony or a round of golf, and their opportunity costs are assumed to be the same. This treatment may be correct; but among many other questions it precludes analyzing such important topics as: 1) The interaction of market work and people's choices about undertaking household production versus enjoying leisure; 2) The role of fixed costs of labor-market entry on the mix of non-market activities, an issue that is inherently related to labor-force participation; and 3) How spouses interact in choosing how to divide household chores and leisure. In this study we concentrate on the first two topics.

We examine several aspects of the potential role of the fixed costs of market work in affecting the allocation of non-market time. The bulk of the study focuses on answering the analytical question of whether and how market work—both the amount of time devoted to it and its timing—generates an impediment to optimizing the amount and sequencing of non-market activities. In the first part we analyze how the decision to make the discrete choice to work in the market alters the mix of non-market activities. To the extent that households' allocations of time suggest that entering or remaining in the labor market changes time allocations outside the market, we may infer that the fixed time costs of work may make remaining in the labor force unattractive for older workers who would not choose complete retirement given other incentives. In line with regression results suggesting the importance of this phenomenon, we then construct and estimate a structural model of an individual's choice of whether or not to work in the market, and how to allocate his/her time among market work, leisure and household production/personal maintenance in the possible presence of fixed time costs. This allows us to measure the utility-equivalent of the fixed time costs and to infer the dollar amount needed to offset the utility loss when labor-force entry occurs.

The second part concentrates on discovering **when** people perform different activities and examining the determinants of this timing. There is an excellent theoretical study of the timing of activities (Winston, 1982), and some empirical work has been done (Hamermesh, 1999, 2002) on the general population; but there has been no examination of how the timing of different non-market activities interacts with the choice of whether and how much market work to undertake. Given the likely importance of scheduling in employers' demand for labor and the spillovers that these constraints may impose on people's schedules outside the labor market (see the epigraph), discovering what scheduling looks like when the constraint of market work is not relevant would seem crucial for understanding how this dimension of choice may alter the supply of labor to the market. This consideration too may be useful in analyzing motives for retirement from the labor force.

II. Defining Time Aggregates in the American Time Use Survey, 2003 and 2004

The usual retrospective records that form the bases for most of the analysis of labor-force behavior in the economics and sociology literatures ask individuals how many hours they worked in some recent time period, be it last week (as in the Current Population Survey) or last year (as in the Panel Study of Income Dynamics). A number of data sets also provide information on how people divide their hours in a typical day (with no information on timing), or the most recent week or month, among a number of non-market activities that are either exhaustive (as in the Health and Retirement Survey) or partial (as in the PSID and other longitudinal household surveys, e.g., the Australian HILDA and the German SOEP), but that are not constrained to equal the total number of minutes or hours in the day or other time period. A time-budget survey gives respondents a daily log and asks them to indicate when they started each new activity and what that activity was. These are then coded into a variety of categories. The surveys have the virtue of immediacy and exhaustiveness, both of the time period covered and of the panoply of possible activities.

While there is a very long history of large-scale time-budget surveys in the United States (Sorokin and Berger, 1939), the U.S. lagged behind many other countries in developing these surveys from the 1970s through 2000. That changed in 2003 with the fielding of the American Time Use Survey. This data set initially provides time diaries from one person per household, for a total of 20,720 in 2003

and 13,973 in 2004 (and similar numbers in subsequent years). Because the respondents are recent members of the CPS panel, substantial information is also available on their work and earnings, on their families, and on other demographics.[1]

The choice of how to aggregate the 406 individual activities that are reported in the ATUS is inherently arbitrary. We take two approaches to aggregation. At the highest level of aggregation, and in most of this study, we divide activities into four groups: 1) Market work; 2) Household production—those activities for which the individual might have purchased market substitutes. These activities satisfy Reid's (1934) third-party rule defining household production. 3) Tertiary activities, those that one must perform for oneself but that are essentially personal maintenance; and 4) Leisure.[2] Also included is a category "Other," which accounts for a few miscellaneous activities and those few minutes in some respondents' days for which no activity is recorded. At a slightly less aggregated level we also include such sub-aggregates in household production as household work and shopping, and child and other care, including volunteering; and we disaggregate tertiary activities into sleeping, eating and drinking, and personal care. The allocation of the individual activities in the ATUS to the four major aggregates is shown in Appendix Table A.

To obtain a feel for the importance of these aggregates, in the 2003-04 ATUS samples these choices about aggregation yield 220, 222, 634 and 353 minutes of market work, household production, tertiary activities and leisure respectively for the typical American on a representative day of the week. Unclassifiable or unclassified activities constituted the remaining 11 of the daily 1440 minutes. Among individual activities sleep is by far the most important, with work for pay second and television-watching third. Together, these three individual categories of activities alone account for 62 percent of the representative day.

[1]See Hamermesh *et al* (2005) for a description of the survey, and Horrigan and Herz (2005) for details on its origins and construction.

[2]The choice of aggregation is always arbitrary. That marginal choices may not affect the conclusions too much is suggested by the results of Aguiar and Hurst (2007), who show that various aggregations into the category leisure yield the same trends across time-diary studies in the U.S.

III. A Model of the Fixed Time Costs of Market Work

Consider the simplest possible formulation, in which there are three uses of time: M, market work; S, household production and tertiary activities; and L, leisure. Assume that the individual is single and faces a parametric wage w and unearned income I. Each minute devoted to market work must necessarily reduce the time devoted to other activities by one minute. This is obviously true in reality, and it is also necessarily true in time-diary data. There may also be fixed time costs of market work such that the efficiency of the remaining time devoted to S and L is reduced by constant fractions μ_S and μ_L when even a small amount of market work is undertaken.[3] The fixed time costs might, for example, stem from a need to hurry in one's other activities (e.g., racing through one's breakfast in order to get to work on time, foregoing watching *The Tonight Show* in order to be rested for work the next morning). They might induce workers to engage in different and perhaps less satisfying mixes of other activities (tying a necktie as personal care rather than enjoying a relaxing bath, work-related socializing with clients rather than playing a game of tennis with a personal friend). Working even a small amount may also reduce the worker's efficiency in non-market activities, as s/he spends non-market time worrying/thinking about work-related problems.

Assuming no saving, the person's utility is:

(1a) $U(I, S, L)$, if $M = 0$;

and

(1b) $U(I + w[24- S - L], \mu_S S, \mu_L L)$, $0 < \mu_S, \mu_L < 1$, if $M > 0$.[4]

The utility cost of the first moment of market work—the fixed (utility) cost of market work—is:

(2) $V = U(I, S, L) - U(I, \mu_S S, \mu_L L) > 0$.

The individual maximizes utility, choosing maximizing time allocations $S^* > 0$ and $L^* > 0$, and $M^* \geq 0$. If $M^* = 0$ is maximizing:

(3a) $U_2/U_3 = 1$;

[3]These differ from the possible fixed money costs of work discussed by Cogan (1981) and assumed to be absent here.

[4]In this formalization we thus ignore Becker's (1965) notion of substituting goods for time, although we bring it in later in the discussion of the role of differences in unearned income.

if $M^* > 0$ is maximizing:

(3b) $U_2/U_3 = \mu_L/\mu_S$.

Because of the presence of these fixed costs, it is only optimal to set $M^* > 0$ if the benefits of supplying positive hours of market work exceed the fixed costs, i.e., if:

(4) $U(I + w[24- S^* - L^*] , \mu_S S^*, \mu_L L^*) - U(I, \mu_S S^*, \mu_L L^*) > V,$

for some combination of S^* and L^* such that $M^* = 24 - S^* - L^* > 0$.[5] If s/he does so, the effective relative price of S to L changes from unity to $\mu_S/\mu_L \neq 1$. We will observe that the very first minute of market work alters the relative amounts of secondary/tertiary and leisure activities chosen. Thus while we cannot observe the fixed time costs of work directly, we can observe whether their impact on the individual's allocation of time across other activities is neutral by examining how patterns of time use change in response to an initial moment of market work.

Unlike prices of market goods, the relative price change generated by the existence of fixed time costs of work can differ among individuals. Those who have a higher I might use their additional unearned income to substitute purchased goods and/or services for those household production/tertiary activities whose price has risen because the individual has chosen to bear the fixed time costs of working. One benefit of additional unearned income may be to mitigate the impact of the fixed time costs of work.

This discussion suggests that there may be discontinuous changes in the allocation of individuals' time when they leave the labor force. It also implies that these potential effects will differ depending on the income in the household to which the worker belongs. Taken together, the model provides guidelines for an indirect test for the presence of fixed time costs of work in order to analyze how market work may impose costs on workers and hints about estimating a formal structural model that embodies these costs.

IV. Inferring the Presence of Fixed Time Costs of Market Work

A. Basic Results

One way to infer the existence of fixed costs would use some kind of instrument that might help to identify the determinants of labor-force participation. No such instrument is available in the ATUS;

[5]One could instead model the fixed costs simply as a loss in available time, F, so that this inequality becomes $M^* = 24 - S^* - L^* - F > 0$ with the $\mu_i \equiv 1$. This seems less appealing, partly because it is worthwhile identifying the separate reductions in inefficiency in the household as the μ_i, partly because doing so would make any effects of the fixed time costs dependent solely on the shape of the cross-partial derivatives U_{12} and U_{13}.

nor would one even appear to be imaginable were more data available. While instruments that might determine selectivity into market work have been used with some success (e.g., the now-classic use of the presence of young children by Heckman, 1976), it does not seem possible to find an one that might convincingly determine selection into only a small amount of market work and that is independent of the mix of non-market activities (such as child care).

Given this difficulty, we initially rely instead on examining how a person's allocation of non-market time changes when s/he crosses the threshold into market work. There are unobserved differences between those who engage in market work and those who do not; but if we still observe an apparent impact of fixed time costs as we restrict the sample to non-workers and those with successively fewer hours of market work, we may be more confident that we are measuring the effects of fixed costs. Essentially we provide a regression discontinuity approach to the impact of hours of work on time allocation outside the market.

In this section we thus estimate regressions relating minutes spent in household production, tertiary activities and leisure to minutes spent in market work and an indicator *WORK* equaling one if any market work is performed. In these three equations the estimated coefficients on the former variable must sum to –1, except for tiny differences due to the few minutes unclassifiable or unaccounted for in some diaries. The estimated coefficients on the indicator for positive market work must sum to 0 (again with the minor exception). If the fixed time costs of market work on time allocation outside the market create neutral effects, each of these latter three coefficients will equal zero. Thus a test for the neutrality of labor-force participation (essentially a test for whether we can treat non-market activities as separable from market work) is a test of the null hypothesis that these coefficients differ from each other.

We restrict the sample to people under age 60 to avoid concerns about how the availability of public or private pension benefits might affect the allocation of non-market time.[6] In addition to the measure of market work time and the indicator for market work we also include in the equations describing the allocation of non-market time a quadratic in age and indicators for whether the respondent is African-American or Hispanic and for the presence of children in various age categories (ages 0-2, 3-5,

[6]The results hardly differ if all adults in the ATUS survey are included.

6-13, 14-17). In equations describing all individuals indicators for gender and marital status are included, while those equations, and the equations describing married people, also include a measure of spouse's hours of market work (CPS-style retrospective data on usual weekly hours, since only one time diary is collected per household). All the equations are weighted so that the estimates reflect behavior on a representative day of the week.[7]

Table 1 presents the estimates of the three equations for the entire sample and then separately by marital status and gender.[8] The first column in each panel lists the estimated effects of moving from no market work to an infinitesimal amount of work, while the second column shows the effect of adding one additional minute of market work. The results are striking: Among all adults the impact of beginning market work is not neutral across household production, tertiary activities and leisure. The estimates suggest a substantial negative effect on leisure activities and a nearly equal but opposite-sign effect on household production. A test of the equality of the three estimated parameters demonstrates that they are jointly significantly different from each other (and thus *ipso facto* jointly significantly different from zero).[9]

Disaggregating the sample by marital status and gender changes the results somewhat, but the results still show the same significant impacts. Among all four marital/gender categories, beginning market work generates a shift of non-market time away from leisure and toward household production. The negative impacts on time spent in leisure activities are not greatly different from each other across the

[7]The ATUS final weights are used, so that the results also reflect the behavior of the adult population of the U.S. on a representative day of the week.

[8]In order to examine later the impact of differences in family income on the non-neutrality of fixed time costs we restrict the samples to those ATUS respondents for whom a measure of family income by income bracket is available from the monthly CPS.

[9]A nearly infinite number of alternative categorizations might be tried. One obvious possibility is to include eating/drinking, which accounts for 69 minutes of the representative day in this sample, in leisure rather than tertiary activities. Re-estimating the model with this alternative aggregation hardly changes the qualitative conclusions implicit in the top panel of Table 1: An almost identical amount of the negative impact of WORK remains on leisure.

groups: The 23-minute daily decrease in leisure in the entire sample that results from beginning market work characterizes these subgroups fairly well.[10]

B. Tests for Robustness, and Extensions

As noted above, one might be concerned that the average worker differs unobservably from non-workers, and that all we have shown is that they have different preferences for leisure and different inherent productivity in market and household production. We cannot completely refute that possibility; but we can obtain some insight into its validity by restricting the sample to a possibly less unobservably heterogeneous group of people, namely those who work zero or relatively few hours in the market on a given day. The upper panel of Table 2 restricts the sample respectively to individuals working in the market fewer than 4 hours on the day that they kept a time diary, or fewer than 2 hours on that day. In both cases we observe, as in Table 1, that there is a significant non-neutrality of beginning market work. As in the results based on the unrestricted sample, and excluding the nearly 9000 people who are observed working four hours or more on the diary day, we find that beginning market work generates a large reduction in leisure activities, nearly one-half hour per day. Unlike in the entire sample, however, it also generates a reduction in tertiary activities and leads to a huge increase in household production. The results are qualitatively similar but not so extreme if we restrict the sample further to exclude the nearly 900 additional workers putting in between two and four hours of market work on the diary day.

The results disaggregated by gender and marital status, shown in the bottom two panels of Table 2, look remarkably like those presented for the aggregates in the upper panel. The impacts of starting work on non-market activities are statistically unequal within each of the four groups and are even more similar to each other across the four groups than they were in the unrestricted samples for which the results were shown in Table 1. As observed throughout, leisure activities are diminished, while household production activities increase. The results suggest that the findings for the entire sample are

[10]Freeman and Schettkat (2005) compare older U.S. and European time-budget data and claim that longer U.S. hours of market work are fully offset by reductions in their home production. This does not seem to be true when one compares the U.S. to individual European countries (Burda *et al*, 2007a); and the results here make it absolutely clear that market and home production are complements at the margin of work at the individual level, with both substitutes for leisure.

not an artifact of including workers who are far beyond the margin of choice about whether to work for pay on a given day.[11]

Another possibility is that individuals with strong preferences for non-market activities may have inherently different set-up costs from those whose distaste for market work may be less. Following the suggestion of Friedberg and Webb (2006), we can take advantage of the over-sampling on weekends in the ATUS and of its CPS information on weekly hours of market work to examine how the allocation of time of those who did not work on a weekend day is affected by the total time they devoted to the market during the rest of the week. To do so we use the CPS weekly hours measure along with an indicator of positive weekly hours, substitute these two variables for the two variables that form the focus of Tables 1 and 2, and re-estimate the equations over the sample of weekend respondents who reported no market work on the diary day.

Table 3 presents the results. Each triad of coefficients should nearly (because of the small miscellaneous category) sum to zero, since there is no market work on the (weekend) diary day. The first thing to notice is that the vector of coefficients on the indicator of positive market work during the week is not significantly different from zero. There appear to be only small differences in set-up costs between non-workers and others on days when no market work is performed. Additional hours of work during the week are, however, not neutral with respect to the allocation of time on a non-working weekend day.[12] They reduce leisure time on weekends and increase time devoted to household production among those who do no market work on weekend days. Workers use their "free time" on weekends to catch up on the household production that the rigidities of their market work prevented them from doing during the workweek.

[11]Nor is the central result that beginning market work produces a decline in leisure generated by the inclusion of individuals who may usually work longer hours but who are observed on weekends. If the sample in the top panel of Table 1 is restricted to individuals observed on weekdays, the estimated impacts of beginning market work on the three aggregates of activities are 16.73, 12.09 and -27.94 minutes respectively, again significantly different from each other and from 0. When the same restriction is applied to the sample in the left half of the upper panel of Table 2, the results are even more strikingly similar to those that include people whose diary-day covers a weekend day.

[12]A test of the equality of the three estimated parameters to 0 yields $\chi^2 = 26.98$.

Having demonstrated the existence of non-neutral fixed costs of market work using the very broadest aggregates of non-market activity, it is worth discovering along what disaggregated dimensions of non-market activity these effects work themselves out. Of particular interest is television-watching, which accounts for roughly half of all leisure in the United States. Table 4 disaggregates leisure into television-watching and other leisure. Very clearly, the results demonstrate that the main effect on leisure of beginning market work is on television-watching. This is not surprising, insofar as reducing television-watching may be the least-cost mechanism of accommodating a shift to market work.

Is the change in behavior imposed by these fixed costs overcome if the individual has sufficiently high income to purchase market substitutes? We expand the specifications in Table 1 to include a measure of household income and its interaction with the indicator for market work. Desiring to maintain parsimony in these interactions, and because the data on household income in the main ATUS files are categorical, we form the single indicator variable, income above $50,000 per annum (from the bracketed CPS income measures). 51 percent of all the observations included in the estimates in the upper panel of Table 1, and 58 percent of married couples in the sample have incomes above this threshold.

The results of re-estimating the equations describing non-market allocations of time are shown for all individuals, and for married men and women separately, in Table 5. The interaction terms in each case are of opposite sign from the main effect terms on *WORK* and are jointly significantly different from zero in all three samples. The interaction terms do not, however, fully offset the main effects of *WORK*: The χ^2 statistics testing the equality in the three equations fail to reject equality only in the sub-sample of married women. Nonetheless, higher incomes in the entire sample and the sub-sample of married men do moderate the non-neutral effects of the fixed time costs of market work, allowing the individual to avoid a large reduction in leisure time and a large increase in household production when s/he enters the labor market. The results for married women, the majority of whose household income stems from their husband's earnings and from unearned income, are especially convincing of the impact of fixed time costs and of the role of higher income in enabling the household to offset those costs.[13]

[13]If we restrict the sample to married women observed on weekdays and working fewer than 240 minutes on those days, which cuts the sample by 75 percent, we still observe the same general results—a moderation of the apparent non-neutrality of fixed time costs as income increases.

We can use the estimates in Tables 1 and 5 to measure the impact of market work on the allocation of time outside the market. For the entire sample used in those estimates, the average worker cuts his/her household production time on a day when s/he works in the market by 36 percent, tertiary time by 7 percent and leisure by 42 percent compared to an otherwise identical non-worker. Among workers in households with incomes above $50,000, however, the corresponding decreases are 54 percent, 8 percent and 36 percent. Higher incomes enable families to purchase market substitutes for their time spent in household production and to mitigate the reduction in leisure that occurs when they work in the market.

C. Replication Using Other Countries' Time-Diary Studies

A reasonable concern, especially when the concept being examined is so different and this kind of data set has been examined by economists thus far so rarely, is that the results shown in this Section may reflect the idiosyncrasies of the data and, perhaps even more problematic, of the American labor market. To examine this potential difficulty we obtained recent time-diary data for Australia (1992), Germany (2001/02) and the Netherlands (2000). Each survey used a different categorization of activities from the others (and from the ATUS), thus making exact comparisons across the surveys impossible, but increasing the probative value of these replications. We combined categories in each survey to create the same four aggregates used for the U.S., with the particular aggregations chosen presented for each of the three data sets in Appendix Table A.

For each of the three samples we estimated equations like those presented in Tables 1 and 2 using the U.S. data. As in those estimates, a variety of demographic variables are included in the equations, with the exact variables differing among the three countries depending on data availability. For Germany we only use the former West Germany, since even by 2001/02 time allocations in the West and East still differed substantially (see, e.g., Burda *et al*, 2007b). Because each of the surveys contains at least two days of diaries for each respondent, the standard errors account for clustering.

The estimates for the three countries are shown in Table 6. They are listed exactly like those in Tables 1 and 2, except here *N* is the number of different individuals (since each of these surveys has multiple diary days for each respondent). While they vary across the samples and, indeed, even vary

somewhat when the set of respondents is restricted to individuals with fewer than four daily hours of market work, they are remarkably supportive of the results shown for the United States in the previous Parts of this Section. The hypothesis that the coefficients on *WORK* equal zero is generally rejected—the mix of time outside the market is affected by labor-force entry. Moreover, exactly as in the United States, the major effect of entering the labor force is to increase time spent in household production. In some of the samples the reallocation toward household production is more from leisure than tertiary activities, in others the opposite; but in all six samples, as in the U.S., the inference is that the fixed costs of labor-force entry lead to reduced leisure and increased time in household production.

V. Measuring the Importance of the Fixed Time Costs

The estimates in Section IV do not prove the existence of non-neutral fixed time costs of market work. In several ways, however, particularly the consistent pattern of a shift from leisure activities to household production when market work hours are few but positive and the apparent diminution of that shift as household incomes increase, they are consistent with this type of fixed cost. They suggest that market work imposes some additional constraints on those who choose it. To estimate the importance of these costs directly we specify a stochastic quadratic utility function:

$$(5)\quad U(c, s, \ell) = \alpha_c c + [\alpha_s + \varepsilon_1 + \varepsilon_2]s + [\alpha_\ell + \varepsilon_1]\ell - c[.5\beta_{cc}c + \beta_{cs}s + \beta_{c\ell}\ell] - s[\beta_{cs}c + .5\beta_{ss}s + \beta_{s\ell}\ell]$$
$$- \ell[\beta_{c\ell}c + \beta_{s\ell}s + .5\beta_{\ell\ell}\ell], \text{ if } c = I,\ m = [1-s-\ell] = 0;$$
$$= \alpha_c c + [\alpha_s + \varepsilon_1 + \varepsilon_2]\mu_s s + [\alpha_\ell + \varepsilon_1]\mu_\ell \ell - c[.5\beta_{cc}c + \beta_{cs}\mu_s s + \beta_{c\ell}\mu_\ell \ell]$$
$$- \mu_s s[\beta_{cs}c + .5\beta_{ss}\mu_s s + \beta_{s\ell}\mu_\ell \ell] - \mu_\ell \ell[\beta_{c\ell}c + \beta_{s\ell}\mu_s s + .5\beta_{\ell\ell}\mu_\ell \ell],$$
$$\text{if } c = I + wm,\ m > 0.$$

The α's and β's are parameters of the utility function that are to be estimated; μ_s and μ_ℓ are the efficiency parameters in (1b) describing the impact of market work on household production/tertiary activities and on leisure, and the ε are error terms. We normalize α_c=1, and note that the error terms enter the utility function in a way that is convenient for estimation. In the estimation we treat s and ℓ as the fractions of the diary day devoted respectively to household production/tertiary activities and to leisure, with the share $1-s-\ell = m \geq 0$ devoted to market work.

To estimate the parameters in (5) we solve the individual's utility-maximization problem, derive the corresponding likelihood function and use the method of maximum likelihood. The Technical Appendix derives the likelihood function defined over the $\alpha_{s,}$ $\alpha_{\ell,}$ the six β's, the two μ's, and $\sigma_{11,}$ σ_{12} and σ_{22} (which are the parameters of the bivariate normal distribution that is assumed for the two error terms).[14] We estimate the parameters using the derivation of the likelihood function in the Technical Appendix. We perform the estimation first assuming $\mu_s = \mu_\ell = 1$, which generates a model similar to a censored selection model (see Wooldridge, 2002, Ch. 17), and then allow μ_s and μ_ℓ to vary freely. In this latter case the likelihood function requires integration over a set that now depends on two conditions, the second of which accounts for the fixed time cost of market work.

Estimating these parameters requires additional data beyond those used in the previous sections. In particular, we need a measure of the shadow price of each person's time and of income other than the person's earnings that accrues to the household. The ATUS presents weekly earnings and hours information for those respondents who worked for pay during the survey week (whether or not they worked on the diary day). We use these data to estimate a log-earnings equation, including the usual explanatory vector of measures of experience, education and demographic variables such as marital status and race/ethnicity. For women an auxiliary probit predicting labor-force participation that identifies the wage by the presence of young children is also used. Using the parameter estimates from these earnings equations, we obtain predicted hourly earnings for *both* those people on whom the regression was estimated *and* those who did not work. Hourly earnings are then imputed for non-workers as the actual hourly earnings of the sample member whose predicted hourly earnings are nearest theirs. This score-matching approach has the virtue of (asymptotically) maintaining the variance of the shadow price among those respondents who did not work for pay equal to that of those respondents who did.

Information on both unearned income and the earnings of others in the household is not included in the ATUS. For those ATUS respondents who were included in the March CPS, however, we have detailed data on income sources for the previous year. We define other income as the household's total income (from the March CPS) less the earnings (in the ATUS) of the ATUS respondent. To account for

[14]The issue here is a more complex version of the problem discussed by Blundell and MaCurdy (1999, Section 6.5).

the role of taxes in altering incentives, we obtain net (after-tax) income by subtracting reported federal and state taxes paid and an estimate (based on earnings) of individuals' OASDHI tax liabilities from household income. To calculate the marginal net wage we multiply the actual (or imputed) hourly wage by one minus the household's federal marginal tax rate minus the household's average state income tax minus the marginal OASDHI tax rate facing the individual (0.0765 for most respondents).[15] Using this measure, we obtain other income, I, as the difference between net household income and net hourly earnings (based on actual or imputed earnings) times actual weekly hours.

In order again to obviate problems of people being affected by pension incentives, and following the example of the previous section, we restricted the sample to individuals ages 22-59. We were able to match 8,854 ATUS 2003 and 2004 respondents to the March 2003 or 2004 CPS, of whom 5,825 had information on actual usual weekly earnings and hours (with the remainder being either unemployed or out of the labor force). Of the former (latter) 4,345 (2,828) were observed on weekdays. Small fractions of the samples reported s=0 or ℓ=0 and were thus not usable in the estimation, so that the final four samples (all days, and weekdays only) used to estimate the parameters in equation (5) have 8,572, 5,638, 4,163 and 2,705 observations.

The results of estimating the model are shown in Table 7 for each of the four samples. The first column in each pair shows the estimates of the model with $\mu_s \equiv \mu_\ell \equiv 1$, and the second estimates all thirteen parameters freely. (In interpreting the results, recall that observations underlying the second and fourth pairs of columns all have information on actual earnings and thus cannot be affected by any issues in our score-matched imputations of earnings.) The estimates generally make sense, implying that the utility function in (5) has the desired properties of positive first and negative second derivatives.[16] Except for some of the terms $\beta_{s\ell}$, the parameter estimates are generally highly significant statistically. The estimated cross-partial derivatives between goods consumption and household production/tertiary time

[15]While the March CPS provides the household's federal marginal tax rate, it only gives information on the amount of its state income tax liability.

[16]At the means of the variables in (5) the utility function is, of course, at a maximum. As is common in formal estimation of such specific functions, although not often mentioned, for some of the observations the parameters yield estimated first partial derivatives with incorrect signs. This is true for 25 percent of the observations in the first (complete) and second sub-samples, 15 percent of observations in the third sub-sample, and 5 percent in the fourth sub-sample.

are positive in four cases, negative in four. That result is not unreasonable: It suggests that the two types of activity, while they are obviously substitutes given the time constraint, are independent in terms of their impact on utility. The estimated cross-partial derivatives of goods consumption and leisure are generally negative.

The main outcomes of this exercise are the estimates of μ_s and μ_ℓ. The estimates are, as the theory predicts, all below unity, and in all four samples the parameter estimates are significantly less than one. Moreover, in each case $\mu_s < \mu_\ell$, implying that the effect of choosing to work in the market initially decreases one's efficiency in household production and tertiary activities more than in one's production of commodities whose time inputs can be classified as leisure. That this occurs is not inconsistent with the findings in Section IV: The net effect on time inputs depends on both these fixed costs and the shape of the utility function as *m* becomes positive.

The purpose of estimating the quadratic utility function was to generate measures of the utility equivalent of the fixed time costs of market work. Consider a non-worker who adds an infinitesimal amount of market work, so that her earnings are infinitesimal but she now incurs the fixed time cost so that her household production/tertiary time and leisure time become less productive. How much additional unearned income would be required to maintain her utility at the same level as it was before she worked this infinitesimal amount? In other words, what value of ΔI solves:

$$(6) \qquad U(I + \Delta I, \mu_s s^*, \mu_\ell \ell^*) = U(I, s^*, \ell^*) \, , \Delta I > 0,$$

where the asterisks denote the actual values of *s* and ℓ?

The calculations of the utility costs are shown for each of the four samples in Table 8, with the required changes in unearned income listed in percentages of income and in dollar amounts. Among non-workers the incremental unearned income required to hold utility constant if they work an infinitesimal amount in a day ranges from little more than zero to nearly 8 percent across the four samples. Given their sizes, it is perhaps unsurprising that we observe discrete changes in labor-force behavior.

VI. The Timing of Activities

The demonstration of the likely impact of fixed costs and the estimates of the sizes of the cost parameters have been based on the potential non-neutral effects of market work on the *amounts* of

household production and leisure undertaken. Yet as the epigraph suggests and some of the discussion indicated, these fixed costs may work through their impacts on the temporal pattern of daily activities—on *when* these activities are conducted. Conditional on the amount of an activity (household production, tertiary activities or leisure) that is undertaken over the day, are the times when those non-market activities are performed affected by the amount of market work and by the fixed time cost of entering the labor market? In other words, is there an *instantaneous* non-neutrality of market work on household activities analogous to the *integrative* impacts demonstrated in Sections IV and V?

To examine this possibility we estimate equations:

$$(7) \qquad P_{At} = \mathrm{H}(A;\ WORK;\ M;\ X),\ A = S, T, L;\ t=1,\ldots,96,$$

where P_{At} is an indicator equaling one if activity A was performed during quarter-hour t, and X is a vector of controls. These equations are analogous to those estimated in Section IV, except that here we hold constant the total amount of time spent in activity A to concentrate on how its diurnal distribution is affected by market work. The sum of the coefficients on the A across the t should equal zero, since the total amount of time spent in activity A over the day equals $15\Sigma P_{At}$. Thus conditional on A the coefficient estimates of M show whether an additional minute of market work alters the temporal pattern of the activity A. Similarly, again conditional on A, the estimated coefficients on *WORK* show whether the discrete choice to begin market work alters the temporal pattern of the activity A. These estimates thus provide tests of the impact of the fixed costs of market work on the timing of household activities.

The raw ATUS data are presented in sequence, with each activity having a particular starting time (coded to the minute). For purposes of analysis, as is implicit in (7) we combine the data into periods of 96 quarter-hours, examining what each respondent was doing during each quarter-hour beginning at 4AM and ending at 4AM the next day.[17] Given the massive amount of information here, throughout the rest of this Section we present it graphically.

[17]Where more than one activity was in progress during a quarter-hour, we included the one that comprised the majority (or plurality) of the 15 minutes. In the very few instances where more than two activities were in progress for the same length of time we coded the first of them as representing the quarter-hour.

In Figure 1a we present the temporal patterns of the coefficients on the variable *WORK* from the three sets of probits (7).[18] Each point represents a regression coefficient at a particular quarter-hour of the day, and around each is a 95-percent confidence interval. The very fact of being in the labor market, even for only a few hours in a day, causes significant displacement in the timing of activities conditional on the total amount of the activity that is undertaken. Particularly interesting are the displacement of leisure away from prime working hours and the displacement of household production to late afternoon and early evening. In addition to increasing the amount of household production and reducing leisure, as shown in Section IV, engaging in labor-market activity also causes temporal displacements in their performance.

Figure 1b presents the same kind of information, but for the coefficients on *M* from the estimates of equations (7). It shows that additional time devoted to market work, conditional on being in the labor market, has especially large effects on the timing of tertiary activities. The marginal effect of another minute of market work is biggest on sleeping, eating, etc. during normal waking hours. The effects on leisure are also large and significant, and indicate that additional minutes of market work shift leisure away from prime daytime working hours. The impacts of an additional minute of work time on the timing of household production are smaller, with the biggest shift being toward evening hours.[19]

For each of the three major aggregates of non-market activities, Figures 2a-2c respectively show the coefficients at each quarter-hour on the indicator *WORK* and an interaction of that indicator with the indicator of family income above $50,000 per year that, along with a main-effect term, is added to the

[18]All the data and coefficients presented in the Figures in this Section are based on statistics that have been weighted to provide information on a representative day of the week.

[19]For purposes of comparison to the direct utility calculations in the previous section, assume that the average person's instantaneous utility function is the iso-elastic:

$$U = \sum U(p_{Lt}) = \sum p_{Lt}^{[1-\delta]}/[1-\delta] \text{ , } t = 1,\ldots,96,$$

where p_{Lt} is the fraction of workers (non-workers) who enjoy leisure during the short time interval t. We are implicitly ignoring the fixed costs of switching activities.

We wish to compare U^N, the utility of the average non-worker, to U^W of the average worker. In order to abstract from differences due to the lower total leisure enjoyed by workers, we multiply each p_{Lt} for workers by the inverse of the fraction of the day that workers are not working. The utility comparison assumes that non-workers, whose allocation of time over the day is not disrupted by work, have chosen an optimal sequence of leisure, and it assumes additive separability across the day. In percentage terms the average shortfall in utility of workers W over the entire day is

$$\sum\{ \left| p^{N}_{Lt}{}^{[1-\delta]} - p^{W}_{Lt}{}^{[1-\delta]} \right| \}/\sum p^{N}_{Lt}{}^{[1-\delta]}$$

Assuming values of δ =1, 2, 3 and 5, the shortfalls in the utility from leisure due to scheduling are 30, 40, 57 and 75 percent respectively. This back-of-the-envelope calculation suggests that the utility cost of market work resulting from the scheduling changes that it imposes far exceeds the utility cost it induces due to the reallocation of the amount of household time.

probits (7). The question is whether the impact of labor-market participation on the timing of non-market activities differs between otherwise identical workers who are in higher- or lower-income households.

A test of the role of income in mitigating the disruptions to scheduling that are produced by market work is whether the confidence intervals around the dotted lines in Figures 2 include the zero line. While they do in many cases, in many others they do not. More often than not, however, the coefficients on the interaction term between higher income and *WORK* and the main-effect term in *WORK* are of opposite signs, suggesting that additional family income does reduce the disruption to the timing of household activities generated by labor-force participation. The correlation between the coefficients on *WORK* and its interaction with family income in the probit estimates for household production is +0.19 (46 of 96 opposite signs), not significantly different from zero; the correlation of the two coefficients in the probits for tertiary activities is -0.61 (57 opposite signs); that for leisure is -0.38 (58 opposite signs). The correlations and numbers of opposite-signed coefficients in the equations describing tertiary activities and leisure are significantly different from what is expected under the null hypothesis of randomness. These results suggest that people in higher-income households are able to use their income to overcome some of the set-up costs that market work imposes on the timing of non-market activities.

The final set of figures, 3a and 3b, is analogous to Figures 1a and 1b, except the sample is restricted to individuals whose diaries describe weekend days when they did no market work, but who may or may not report positive hours of market work during the week. Here, analogous to the integrative analysis in Section IV that was reported in Table 3, the purpose is to examine whether it is market work *per se* that alters schedules, or whether workers' home schedules differ from others' schedules for reasons having nothing to do with time spent in the market on the particular day. Comparing these figures to Figures 1a and 1b, there are only slight effects on the timing of a given amount of other activities on the weekend of having worked in the market on weekdays. What matters for the determination of the timing of non-market activities is the amount of work on the particular day. As was true for the implications of fixed costs of market work for the amounts of non-market activities that we discussed in Section IV, there is only weak evidence that small amounts of work on weekdays cause people to behave on the weekends any differently from otherwise identical people who do not work during the week at all.

VII. Relevance for Retirement

The importance of making these distinctions among types of non-market activities seems especially great for older people. One of the most important labor-market important problems facing the United States and other industrialized countries over the next few decades will be the declining supply of skilled/experienced workers. Retirement ages are only now beginning to increase, despite continuing rapid increases in life expectancy among older Americans (a 3.0 year increase among males age 65 between 1980 and 2004, a 1.7 year increase among women). Indeed, the labor-force participation rate of males 65+ fell from 33.1 percent in 1960 to 16.3 percent in 1990. Even in 2006 the rate was only 20.3 percent. With the baby-boom generation approaching retirement (and reaching it in the 2010s), the problem will be substantially exacerbated.[20]

The evidence from studies of older workers' labor supply suggests that it is fairly inelastic with respect to wage increases. To encourage that supply, work opportunities may need to be re-structured to make them consistent with older Americans' desires to have their free time as unconstrained as possible, both in terms of what is done and when it is accomplished. Interestingly, a web-search for "phased retirement" shows that most of the "hits" are on universities' programs: Academics are one of the few groups whose employers' allow them the flexibility that meets workers' preferences and employers' demand for skill; and a recent survey (Hutchens and Grace-Martin, 2006) indicates that phased retirement is only rarely available among private firms.

Relating this concern to patterns of time use, consider Table 9, which presents the average time allocations by age in the ATUS for 2003-04 in the four main aggregates and several sub-aggregates that we have used here. This non-behavioral accounting of time use mirrors what constitutes the overwhelming amount of research on the allocation of time outside the market, including the only available examinations of older workers (Gauthier and Smeeding, 2003; Sayer *et al*, 2001). Of course,

[20]The issue is summarized perfectly in the leader in *The Economist*, February 18, 2006, p. 65, "Older workers want to retire later; companies fear they will soon be short of skills. Why can't the two get together?" A survey of 1000 American workers suggests that many more wish to phase retirement than believe that their employers will allow them to do so (reported in *Wall Street Journal*, March 25, 2004, p. D3). Gustman and Steinmeier (2004) show that in the Health and Retirement Survey relatively few older workers believe that they will be able to reduce hours to the level that they wish as they age.

the biggest change with age is the decline in market activity. As is well known, and as the time diaries show, the major declines begin at age 60. What is interesting is how the time that is freed up, roughly 170 minutes on a typical day among 65-69 year-olds compared to 55-59 year-olds, is used. Household production increases by about 40 minutes, sleeping increases by 20 minutes, and time devoted to eating and drinking increases by 10 minutes across this ten-year age range. There is essentially no change in the time devoted to personal care. Of the extra nearly three hours that become available, the majority, over 1-1/2 hours, are devoted to additional leisure. Not only is this the largest absolute change generated by the decline in the time devoted to market work in these aggregates, it is also by far the largest in percentage terms. Leisure is the main activity that is crowded out by market work.[21] This substitution and the switch of many people from full-time work to retirement is consistent with our finding that the fixed costs of market work shift the mix of non-market time away from leisure.

Since we showed how the fixed timing costs of market work alter the timing of non-market activities, it is worth examining how they may create differences in the timing of activities between older and other Americans. Figures 4a-4d show the daily patterns of market work, household production, tertiary activities and leisure for people under 55 and those 55+. (The graphs present the mean fractions of people in the group engaged in the activity at the particular quarter-hours.) Most of the differences between the two age groups are the unsurprising result of the higher incidence of market work among younger people. The diurnal patterns of market work are identical between the two age groups, with the downward shift among the older group at each point being nearly directly proportional to their lower market participation.[22]

The time patterns of tertiary activities differ little across these two groups; and even the timing of leisure differs little once we account for differences in market work, a mainly daytime activity. The chief difference is in the temporal pattern of household production. Younger people perform their household production disproportionately during the late afternoon and evening when they are less likely to be

[21]These inferences do not change qualitatively if we adjust for such controls as race, ethnicity and, marital status. The central conclusion—that the main change as workers withdraw from the labor force is an increase in leisure time—still holds.

[22]This finding is consistent with the evidence in Hamermesh (1999) on self-reported work patterns by age in the CPS.

working; older people, perhaps to avoid congestion costs at times when more younger people are at their workplaces, perform them disproportionately during prime daytime hours.

Strikingly, a similar difference in the pattern of the timing of household production by age is observed even among those whose time diaries showed no market work on the diary day and who responded to the CPS question about usual hours of work by saying theirs were zero. Even non-working younger people engage in household production disproportionately in the late afternoon and early evening, at times when older Americans disproportionately engage in leisure activities. Since the main difference in the kinds of leisure undertaken across age groups is that older people watch more television, the differences reflect the greater attractions of prime-time television to older audiences. Differences in the timing of tertiary activities by major age group are slight—those under or over 55 sleep, eat, etc. at roughly the same times. The only significant differences are that older Americans are more likely to engage in tertiary activities between 11PM and 4AM, and less likely to do so from 8AM to 11AM. Since sleep accounts for most tertiary time use, these differences reflect older Americans going to bed and waking up earlier than younger people.

VIII. Conclusions, Implications and Extensions

We have focused on how the discrete choice to work in the market alters allocations among differing non-market uses of time. Using four countries' time-diary surveys, we have examined the empirical implications of a model in which working in the market alters the relative efficiency of home time in different activities. A structural econometric model of this phenomenon was estimated using a recently available data set of time diaries of Americans. Neither the discrete move to participation nor marginal increases in hours of work are neutral with respect to the kinds of activities undertaken outside the market, even when we confine the analysis to the three broad aggregates household production, tertiary activities and leisure. Working in the market initially increases household production relative to the amount of leisure consumed. Also, the diurnal distributions of given amounts of these three major aggregates are altered on working days when a person enters the labor market and when s/he increases hours of market work. That all of these impacts are mitigated by the ability to purchase market substitutes suggests further that they arise from the presence of non-neutral fixed costs of market work.

Our findings may be useful in expanding the debate (Benhabib *et al*, 1991) over how total work—market work plus household production—varies over business cycles. The extent of cyclical declines in hours worked for pay and in labor-force participation in recessions differs. With non-neutral fixed costs of participation in the market, as they differ the impacts on households' time allocations, including the amount of household production that may be substituted for market work, will differ. Our results suggest that the greater the share of a cyclical decline in total work-hours arising from decreased labor-force participation, the smaller will be the increase in household production, and thus the smaller will be the extent to which it substitutes for market production.

The fixed timing costs whose existence is demonstrated here have implications for a variety of public policies. As one example, requiring welfare recipients to take jobs (as in TANF of 1996) forces them to incur the fixed costs that alter their allocation of time outside the market. This utility-decreasing reallocation clearly adds to the economic welfare costs of imposing these requirements. Similarly, basing food assistance on the assumption that people will spend substantial time preparing food from raw materials imposes welfare costs if the recipients are forced to engage in market work.

Our finding that it is market work on a particular day that generates the fixed costs and alters the allocation of time has important implications for policies that reduce the workweek (e.g., the French and Quebec experiments with various shortened workweeks—c.f., Crépon and Kramarz, 2002; Skuterud, 2007). Even aside from its implications for the monetary costs of commuting, shortening the average workweek by cutting days rather than hours worked per day have different implications for how workers will spend their non-market time. Ignoring issues of which approach might lead to the smaller decline in market output, the results here strongly suggest the desirability of relying on reductions in days worked rather than on reduced daily hours.

Perhaps most important, while incentive effects of government and private pension programs have been pointed to as rationalizing sharp reductions in market work after age 60, the approach here offers an alternative explanation based on the nature of household production and its interaction with the demand side of the labor market for older workers. Coupled with the implied relative change in the efficiency of household activities if an individual engages in market work, firms' inability or

unwillingness to increase the flexibility of work scheduling may be one reason for the existence of sharp reductions in market work among older people. To the extent that this explanation makes sense, it offers a much different prescription for inducing skilled older workers to remain in the labor force from the usual ones. Instead of concentrating on incentives in pension plans, offering firms incentives to encourage increased flexibility of work timing so as to mesh better with the apparent desire of workers to enjoy more leisure activities and to time them more flexibly might at least partly vitiate the disincentive effects that market work produces on household activities.

The model we have proposed and estimated can be extended in a variety of potentially interesting ways. Our assumption of fixed costs simplifies the basic empirical implications and the estimation of the structural model, but it is restrictive: One could well imagine that there are also (quadratic) costs that vary with the amount of market work. This extension would require a still more complex structural model, but would be a useful step toward generality. Estimating the structural model, and thus inferring the fixed-cost parameters, on other countries' time-diary data would provide a useful comparison to the U.S. results, especially given how unusual American work schedules and total work are among industrialized economies. Finally, while it is not possible with the American data, many foreign time-diary surveys, including those used here, would allow the estimation of a household model of the fixed time costs of market work in which the costs might differentially alter the relative efficiencies of spouses' time in household production and leisure.

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Table 1. Impacts of Market Work on Daily Minutes of Other Activities, ATUS 2003 and 2004, Individuals <60 (Minutes per Representative Day)

All Individuals

	WORK	*Minutes of Work*	R^2
Household Production	22.54	-0.366	0.387
	(3.97)	(0.007)	
Tertiary Activities	0.72	-0.209	0.173
	(3.40)	(0.006)	
Leisure	-23.05	-0.410	0.449
	(4.25)	(0.008)	
$\chi^2(2)$; N =	37.56	23673	

	Married Men			**Married Women**		
	WORK	*Minutes of Work*	R^2	*WORK*	*Minutes of Work*	R^2
Household Production	14.36	-0.360	0.329	13.93	-0.481	0.417
	(7.41)	(0.011)		(7.93)	(0.015)	
Tertiary Activities	10.98	-0.217	0.226	0.80	-0.186	0.149
	(5.67)	(0.009)		(5.95)	(0.011)	
Leisure	-26.81	-0.389	0.436	-15.00	-0.317	0.270
	(7.58)	(0.011)		(7.33)	(0.014)	
$\chi^2(2)$; N =	12.68	6001		4.14	7044	

	Single Men			**Single Women**		
	WORK	*Minutes of Work*	R^2	*WORK*	*Minutes of Work*	R^2
Household Production	39.05	-0.257	0.151	42.17	-0.357	0.296
	(8.29)	(0.015)		(7.96)	(0.015)	
Tertiary Activities	6.44	-0.252	0.156	-17.06	-0.194	0.145
	(8.82)	(0.016)		(7.47)	(0.014)	
Leisure	-44.59	-0.481	0.474	-22.28	-0.440	0.433
	(10.62)	(0.019)		(9.11)	(0.018)	
$\chi^2(2)$; N =	25.50	4617		27.65	6011	

*Standard errors in parentheses below the parameter estimates here and in Tables 2-7. All the estimating equations here and in Tables 2-5 include a quadratic in age, and indicators for African-American and Hispanic and the presence of children in various age categories. Those for all workers also include indicators for marital status and gender; they and the equations for married individuals in Tables 2 and 5 also include a measure of spouse's usual hours of market work during the work.

Table 2. Impacts of Market Work on Daily Minutes of Other Activities, ATUS 2003 and 2004, Individuals <60 Working Short or Zero Hours (Minutes per Representative Day)

	All Individuals with <4 Daily Hours of Market Work			All Individuals with <2 Daily Hours		
	WORK	*Minutes of Work*	R^2	*WORK*	*Minutes of Work*	R^2
Household Production	57.50 (7.87)	-0.597 (0.063)	0.301	46.48 (11.07)	-0.347 (0.182)	0.300
Tertiary Activities	-27.37 (6.51)	-0.077 (0.052)	0.027	-11.04 (9.16)	-0.445 (0.151)	0.025
Leisure	-28.86 (8.46)	-0.324 (0.067)	0.228	-33.03 (11.91)	-0.230 (0.196)	0.223
$\chi^2(2)$; N =	56.85	14951		17.12	14093	

	Married with <4 Daily Hours of Market Work					
	Men			Women		
	WORK	*Minutes of Work*	R^2	*WORK*	*Minutes of Work*	R^2
Household Production	61.87 (15.73)	-0.716 (0.135)	0.061	45.83 (15.11)	-0.696 (0.121)	0.121
Tertiary Activities	-30.56 (10.53)	-0.016 (0.091)	0.018	-11.23 (10.87)	-0.144 (0.087)	0.038
Leisure	-29.52 (16.10)	-0.322 (0.138)	0.050	-36.87 (13.81)	-0.118 (0.110)	0.083
$\chi^2(2)$; N =	18.75	3110		9.89	4954	

	Single with <4 Daily Hours of Market Work					
	Men			Women		
	WORK	*Minutes of Work*	R^2	*WORK*	*Minutes of Work*	R^2
Household Production	76.77 (16.95)	-0.487 (0.132)	0.110	62.72 (15.26)	-0.546 (0.114)	0.262
Tertiary Activities	-27.49 (17.40)	-0.089 (0.136)	0.017	-47.44 (14.04)	-0.051 (0.105)	0.026
Leisure	-43.41 (21.54)	-0.466 (0.168)	0.107	-13.85 (17.52)	-0.386 (0.131)	0.178
$\chi^2(2)$; N =	19.99	2942		22.07	3945	

Table 3. Impacts of Market Work on Daily Minutes of Other Activities on Weekends, ATUS 2003 and 2004, Individuals <60 with No Weekend Work

	WORK During Week	*Weekly Work Hours*	R^2
Household Production	-5.92	0.961	0.207
	(9.41)	(0.223)	
Tertiary Activities	2.58	0.251	0.043
	(7.41)	(0.175)	
Leisure	-0.51	-1.149	0.139
	(10.02)	(0.237)	
$\chi^2(2)$; N =	0.39	8,874	

Table 4. Impacts of Market Work on Daily Minutes of Other Activities, ATUS 2003 and 2004, Individuals <60 (Minutes per Representative Day)

	All Individuals*		
	WORK	*Minutes of Work*	R^2
TV Watching	-19.82	-0.144	0.135
	(3.43)	(0.006)	
Non TV Leisure	-3.23	-0.266	0.305
	(4.31)	(0.008)	
$\chi^2(3)$; N =	52.96	23,673	

*****This model also includes estimates of equations describing household production and tertiary activities, which are identical to those presented in Table 1.

Table 5. Impacts of Market Work on Daily Minutes of Other Activities, ATUS 2003 and 2004, Individuals <60, with Income Interactions (Minutes per Representative Day)

All Individuals

	WORK	*WORK x Income>50K*	*Minutes of Work*	R^2
Household Production	33.16	-21.94	-0.366	0.388
	(4.48)	(4.18)	(0.007)	
Tertiary Activities	-5.17	12.05	-0.209	0.173
	(3.84)	(3.58)	(0.006)	
Leisure	-29.59	13.74	-0.410	0.450
	(4.80)	(4.48)	(0.008)	
$\chi^2(3)$; N =		16.22	23673	

Married Men

	WORK	*WORK x Income>50K*	*Minutes of Work*	R^2
Household Production	27.52	-23.43	-0.361	0.333
	(8.96)	(8.60)	(0.011)	
Tertiary Activities	8.89	4.06	-0.216	0.227
	(6.87)	(6.59)	(0.009)	
Leisure	-37.36	18.56	-0.403	0.437
	(9.18)	(8.81)	(0.012)	
$\chi^2(3)$; N =		7.33	6001	

Married Women

	WORK	*WORK x Income>50K*	*Minutes of Work*	R^2
Household Production	24.70	-18.93	-0.482	0.419
	(9.53)	(8.43)	(0.015)	
Tertiary Activities	1.92	-1.75	-0.186	0.149
	(7.17)	(6.34)	(0.011)	
Leisure	-27.57	22.09	-0.316	0.274
	(8.80)	(7.78)	(0.014)	
$\chi^2(3)$; N =	0.62	7044		

Table 6. Estimates of Basic Equations, 3 Countries, Total Sample, and Those with Work < 4 Hours per Day*

	All Individuals		Individuals with <4 Daily Hours	
	WORK	*Minutes of Work*	*WORK*	*Minutes of Work*
AUSTRALIA, 1992				
Household Production	9.51	-0.318	28.08	-0.416
	(5.43)	(0.009)	(8.42)	(0.069)
Tertiary Activities	0.42	-0.179	-17.47	-0.125
	(4.62)	(0.008)	(6.69)	(0.054)
Leisure	-9.92	-0.503	-10.61	-0.458
	(6.17)	(0.064)	(9.59)	(0.077)
$\chi^2(2)$; N =	3.90	5302	10.61	3550
WEST GERMANY, 2001/02				
Household Production	24.32	-0.343	34.10	-0.380
	(4.68)	(0.008)	(9.89)	(0.066)
Tertiary Activities	-20.53	-0.277	-30.34	-0.156
	(3.59)	(0.007)	(6.88)	(0.049)
Leisure	-3.78	-0.380	-3.77	-0.463
	(4.38)	(0.008)	(9.09)	(0.063)
$\chi^2(2)$; N =	43.87	6264	18.50	5834
THE NETHERLANDS, 2000				
Household Production	23.04	-0.298	22.32	-0.251
	(7.11)	(0.013)	(14.57)	(0.100)
Tertiary Activities	-6.91	-0.235	-21.39	-0.123
	(6.09)	(0.011)	(11.06)	(0.071)
Leisure	-16.12	-0.294	-0.93	-0.625
	(7.97)	(0.064)	(15.90)	(0.108)
$\chi^2(2)$; N =	14.08	1318	4.39	1306

*Standard errors which account for clustering of observations are in parentheses. Australian observations are for two days, German two or three days, Dutch seven days. The estimates for Germany are weighted to account for uneven reporting of different days of the week. The German and Dutch estimates include quadratics in age and spouse's age, indicators of gender and marital status, spouse's work hours and the presence of children of different ages. The Australian estimates include all of these except spouse's age and work hours, but do include spouse's labor-force status.

Table 7. Estimates of the Parameters in (5)

	All Matched Observations		All Matched Observations, Weekdays Only		With Actual Wage		With Actual Wage, Weekdays Only	
	$\mu_s \equiv \mu_\ell \equiv 1$	$\mu_s, \mu_\ell \neq 1$	$\mu_s \equiv \mu_\ell \equiv 1$	$\mu_s, \mu_\ell \neq 1$	$\mu_s \equiv \mu_\ell \equiv 1$	$\mu_s, \mu_\ell \neq 1$	$\mu_s \equiv \mu_\ell \equiv 1$	$\mu_s, \mu_\ell \neq 1$
α_s	0.829	0.334	1.145	0.575	0.369	0.242	0.746	0.993
	(0.001)	(0.0002)]	[0.017)	(0.0023)	(0.0057)	(0.0046)	(0.0207)	(0.1177)
α_ℓ	0.208	0.215	0.356	0.346	0.242	0.211	0.337	0.014
	(0.0014)	(0.0005)	(0.0007)	(0.0103	(0.007)	(0.001)	(0.008)	(0.1303)
β_{cc}	0.061	0.096	0.059	0.087	0.071	0.084	0.066	0.044
	(1.094* 10^{-5})	(4.45* 10^{-6})	(1.58* 10^{-5})	(7.25* 10^{-5})	(2.60* 10^{-5})	(1.40* 10^{-9})	(2.60* 10^{-8})	[2.2* 10^{-5})
β_{cs}	0.0036	0.0033	-0.0002	-0.0001	0.0035	0.0024	-0.0097	-0.0016
	(0.0003)	(0.0001)	(0.0003)	(0.0007)	(0.0005)	(1.56*10^{-5})	(0.0004)	(0.0002)
$\beta_{c\ell}$	0.0008	0.0006	-0.0053	-0.0055	0.0032	0.0023	-0.0002	0.0002
	(0.0002)	(0.0001)	(0.0004)	(0.0004)	(0.00046)	(3.82*10^{-5})	(0.0005)	(0.0005)
β_{ss}	0.356	0.449	0.702	0.573	0.410	0.301	1.241	0.506
	(0.0128)	(0.0021)	(0.0247)	(0.0078)	(0.0057)	(2.20*10^{-8})	(0.0332)]	(0.0814)
$\beta_{s\ell}$	0.0019	0.0023	-0.0018	-0.0011	0.0280	0.0006	-0.0007	0.0008
	(0.0067)	(4.87*10^{-5})	(0.0078)	(0.0100)	(0.0057)	(0.001)	(0.0012)	(0.0697)
$\beta_{\ell\ell}$	0.3876	0.176	0.271	0.248	0.511	0.354	1.059	0.368
	(0.0061)	(3.87*10^{-9})	(0.0118)	(0.0188)	(0.0073)	(0.01)	(0.0179)	(0.0843)
σ_{11}	0.2434	0.231	0.231	0.168	0.0096	0.132	0.0491	0.0491
	(0.019)	(0.0021)	(0.0261)	(0.0140)	(0.0005)	(0.0066)	(0.0013)	(0.0089)
σ_{12}	0.0013	0.0004	0.0041	0.0023	0.0007	0.0003	0.0037	0.0030
	(0.0021)	(0.0002)	(0.0048)	(0.0065)	(0.0006)	(0.0021)	(0.0015)	(0.0040)
σ_{22}	1.337	1.994	1.165	1.600	3.026	2.767	1.760	4.178
	(0.0003)	(0.0002)	(0.0010)	(0.0093)	(0.0036)	(0.0025)	(0.0010)	(0.1342)
μ_s		0.856		0.791		0.945		0.756
		(0.0001)		(0.0010)		(0.0004)		(0.0122)
μ_ℓ		0.913		0.875		0.974		0.821
		(0.0002)		(0.0006)		(0.0005)		(0.0208)
ln L	-157,990	-139,660	-81,349	-94,697	-67,391	-71,680	-43,461	-38,991
N	8572	8572	4163	4163	5638	5638	2705	2705

Table 8. Change in Unearned Income Required to Equalize Utilities (Based on Estimates of (5))

	Sample			
	1	2	3	4
	Non-workers if market work			
Percent	1.8	4.7	0.2	7.6
Dollar amount	$854	$2,226	$96	$3964
N =	4590	1350	2530	448

Figure 1a. The Effect of Work Status on Activity Type
(by Type and Quarter-hour—coefficient and 95-percent confidence interval)

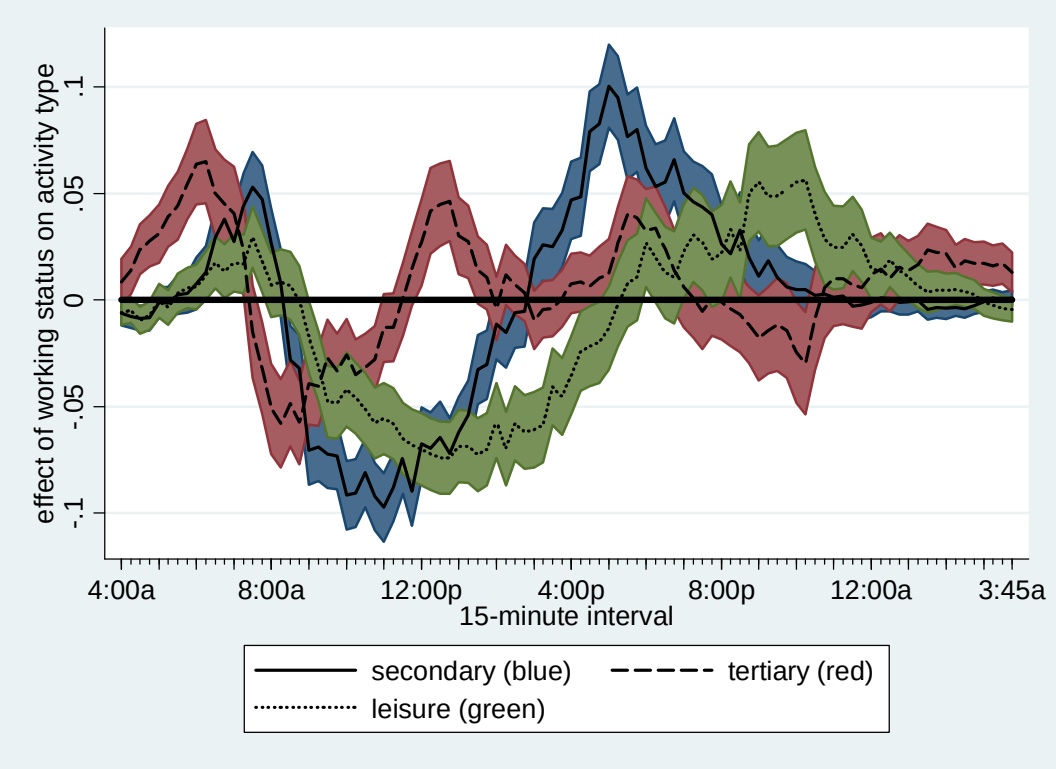


Figure 1b. The Effect of Work Time on Activity Type
(by Type and Quarter-hour—coefficient and 95-percent confidence interval)

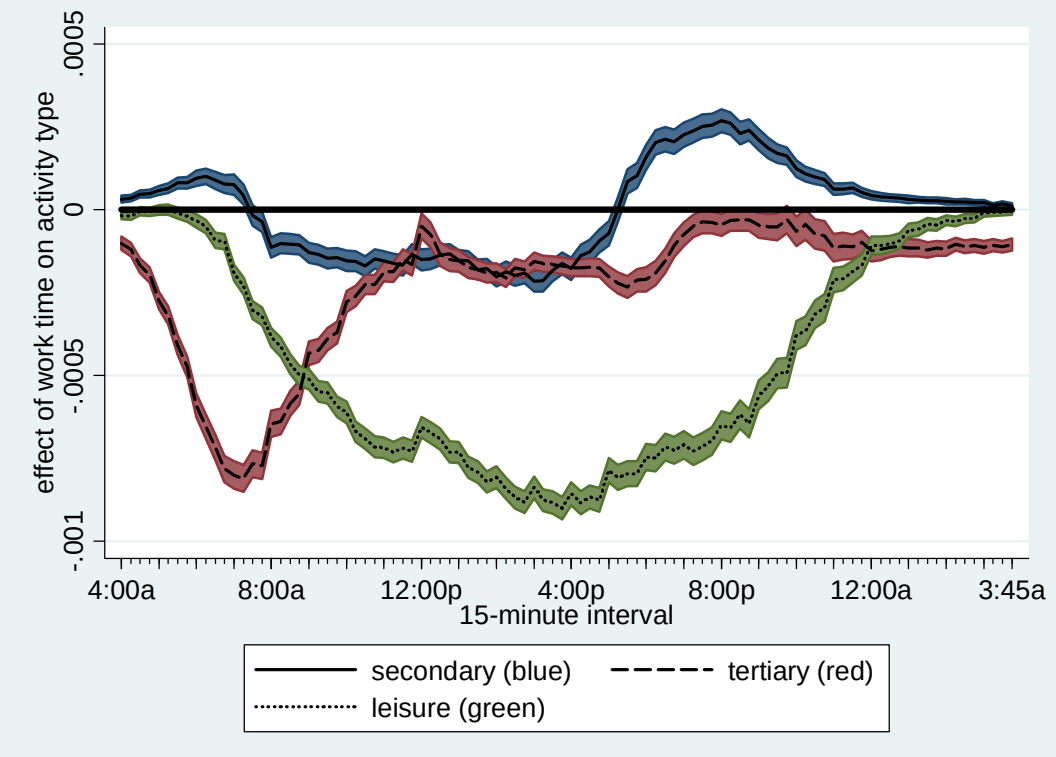


Figure 2a. The Effect of Work Status and Family Income on Household Production (by Quarter-hour—coefficient and 95-percent confidence interval)

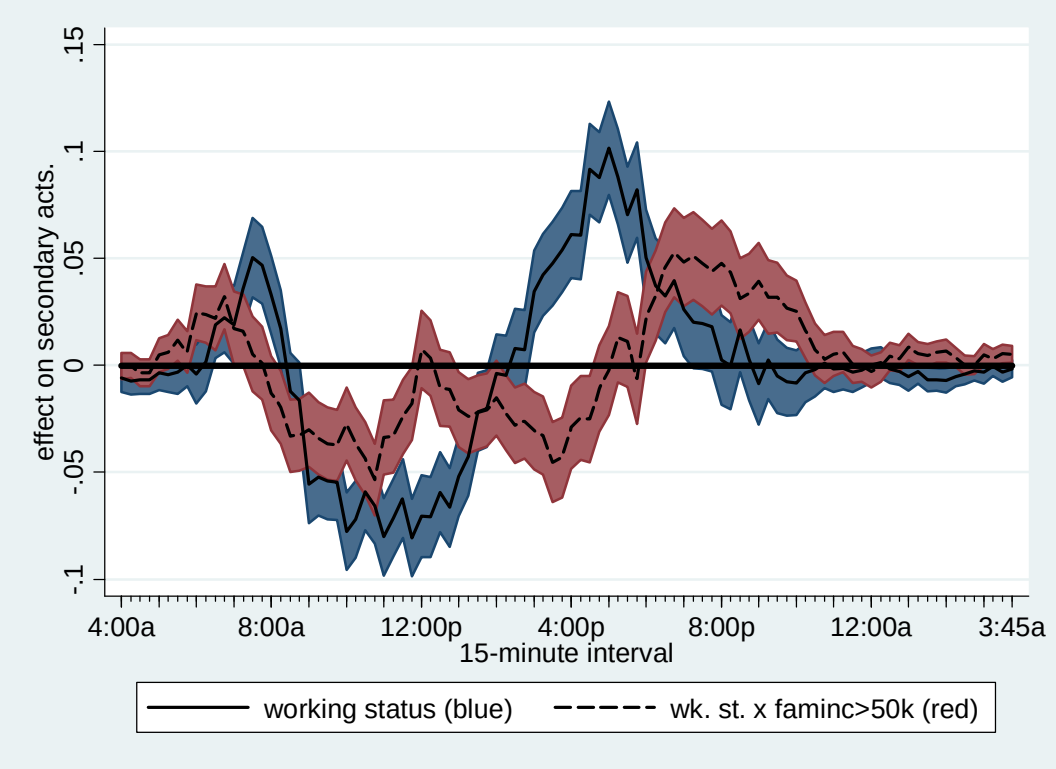


Figure 2b. The Effect of Work Status and Family Income on Tertiary Activities (by Quarter-hour—coefficient and 95-percent confidence interval)

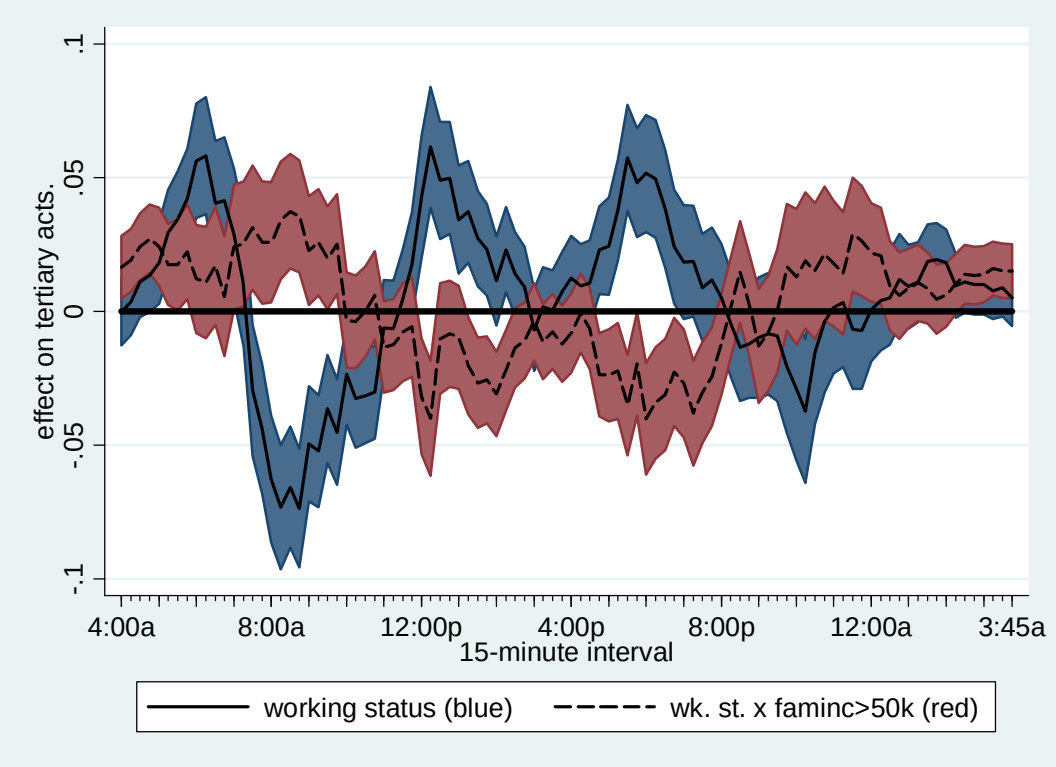


Figure 2c. The Effect of Work Status and Family Income on Leisure (by Quarter-hour—coefficient and 95-percent confidence interval)l

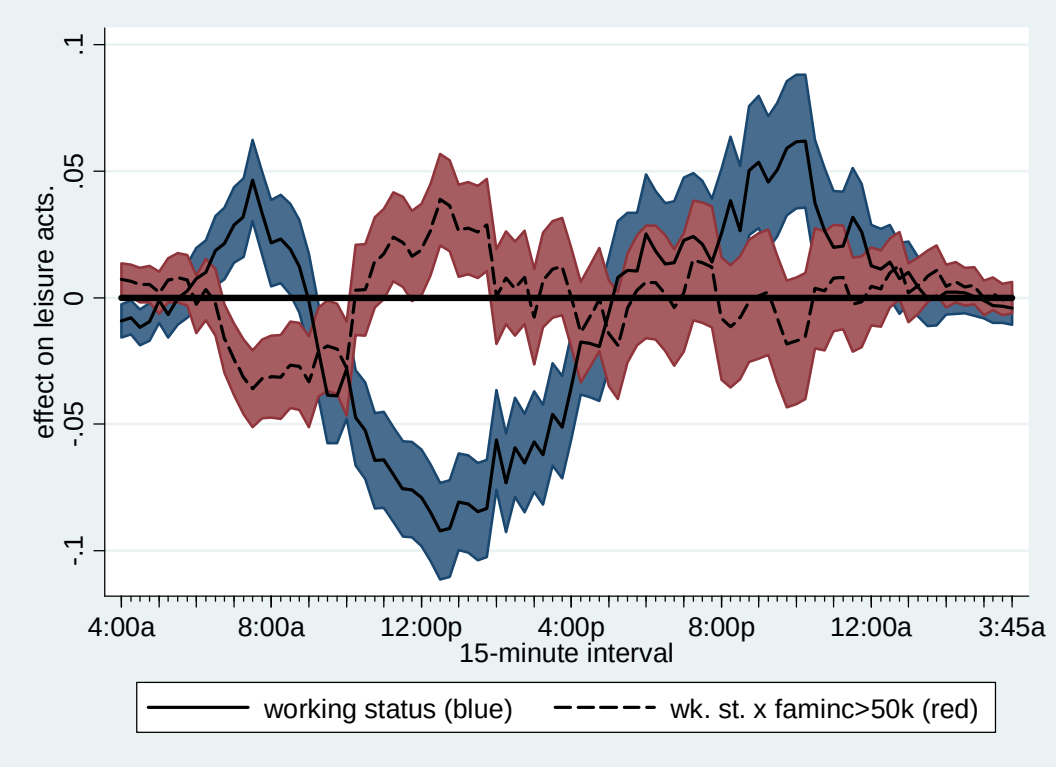


Figure 3a. The Effect of Working During the Week on Activity Type on Weekends (by Type and Quarter-hour—coefficient and 95-percent confidence interval)

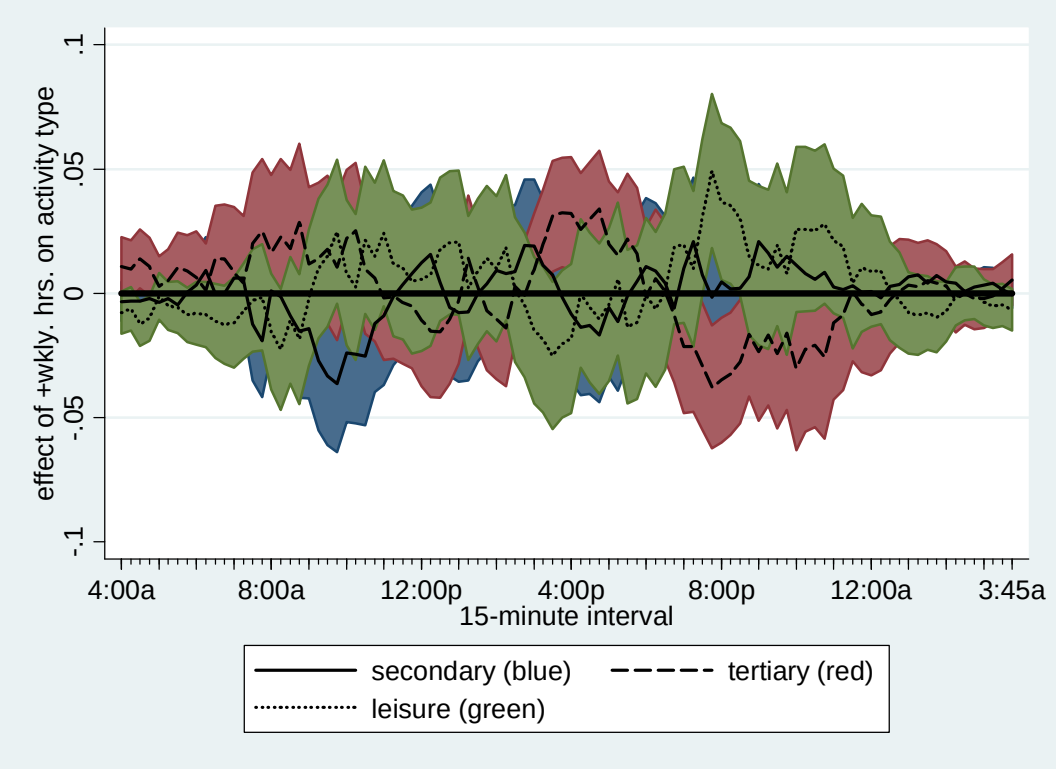


Figure 3b. The Effect of Weekly Workhours on Activity Type on Weekends (by Type and Quarter-hour—coefficient and 95-percent confidence interval)

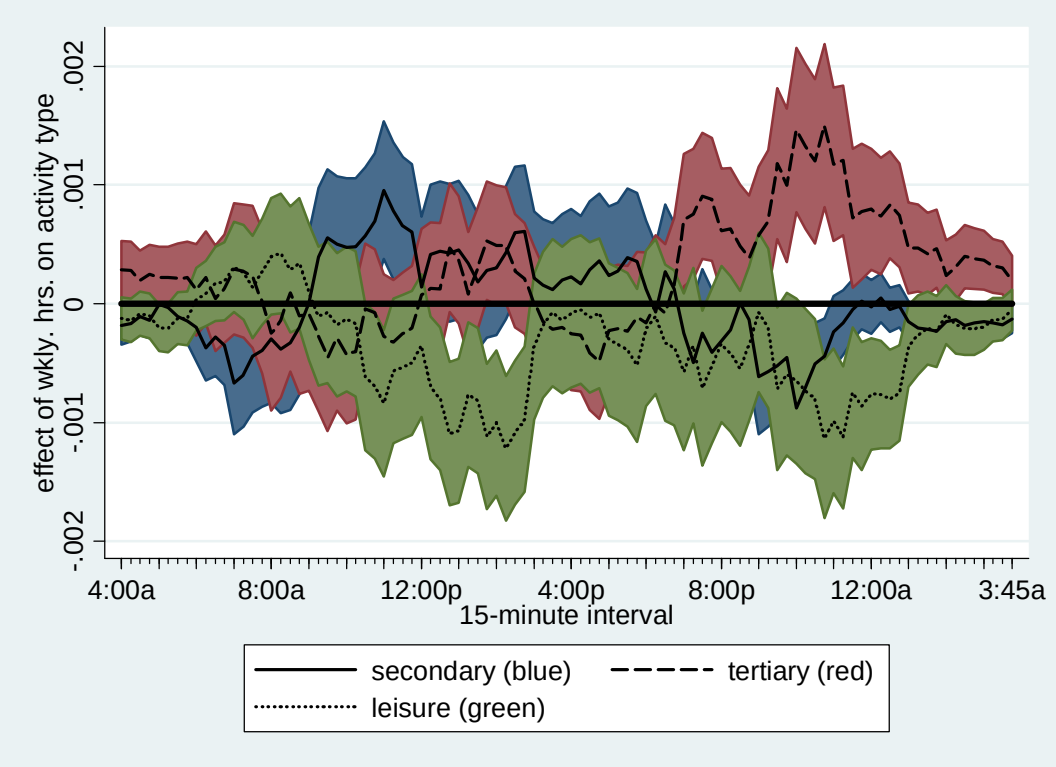


Table 9. Mean Time Use by Age, ATUS 2003 and 2004 (Minutes per Representative Day)*

	Age					
Activity	<55	55-59	60-64	65-69	70-74	75+
Market work:	256.73	257.87	178.32	86.72	50.64	14.28
	(1.83)	(5.46)	(5.75)	(4.63)	(3.96)	(1.52)
Household production:	212.80	227.43	246.89	267.58	263.79	235.61
	(1.32)	(3.98)	(4.48)	(4.75)	(5.13)	(3.47)
Household care	145.83	187.72	197.55	221.10	225.58	203.34
	(1.01)	(3.51)	(3.87)	(4.23)	(4.84)	(3.17)
Tertiary:	627.23	621.09	637.71	650.94	667.54	684.58
	(0.98)	(2.72)	(3.07)	(3.35)	(3.65)	(2.90)
Sleep	512.91	492.13	505.36	514.92	528.34	542.67
	(0.90)	(2.33)	(2.63)	(2.67)	(3.05)	(2.31)
Eating and drinking	68.39	79.50	84.01	88.19	93.73	92.72
	(0.39)	(1.18)	(1.38)	(1.58)	(1.67)	(1.31)
Leisure:	333.50	322.56	364.41	419.39	443.21	486.28
	(1.51)	(4.12)	(4.80)	(5.16)	(5.59)	(3.97)
TV Watching	141.56	164.91	189.16	217.61	229.99	250.01
	(0.95)	(3.19)	(3.98)	(4.42)	(4.88)	(3.97)
Other:	9.74	11.04	12.66	15.36	14.82	19.24
	(0.27)	(0.82)	(1.19)	(1.09)	(1.22)	(1.16)
N =	23958	2698	2101	1812	1469	2655

*Standard errors of the means in parentheses.

Figure 4a. Fraction of the Population Engaged in Market Work (by Quarter-hour—coefficient and 95-percent confidence interval)

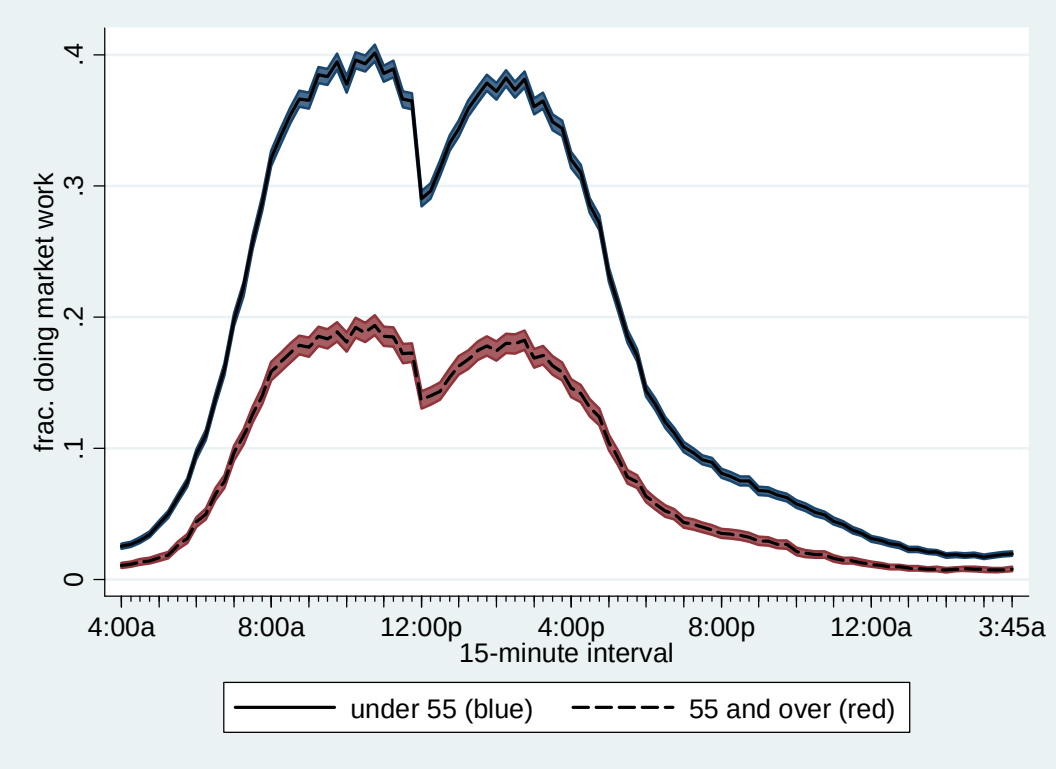


Figure 4b. Fraction of the Population Engaged in Household Production (by Quarter-hour—coefficient and 95-percent confidence interval)

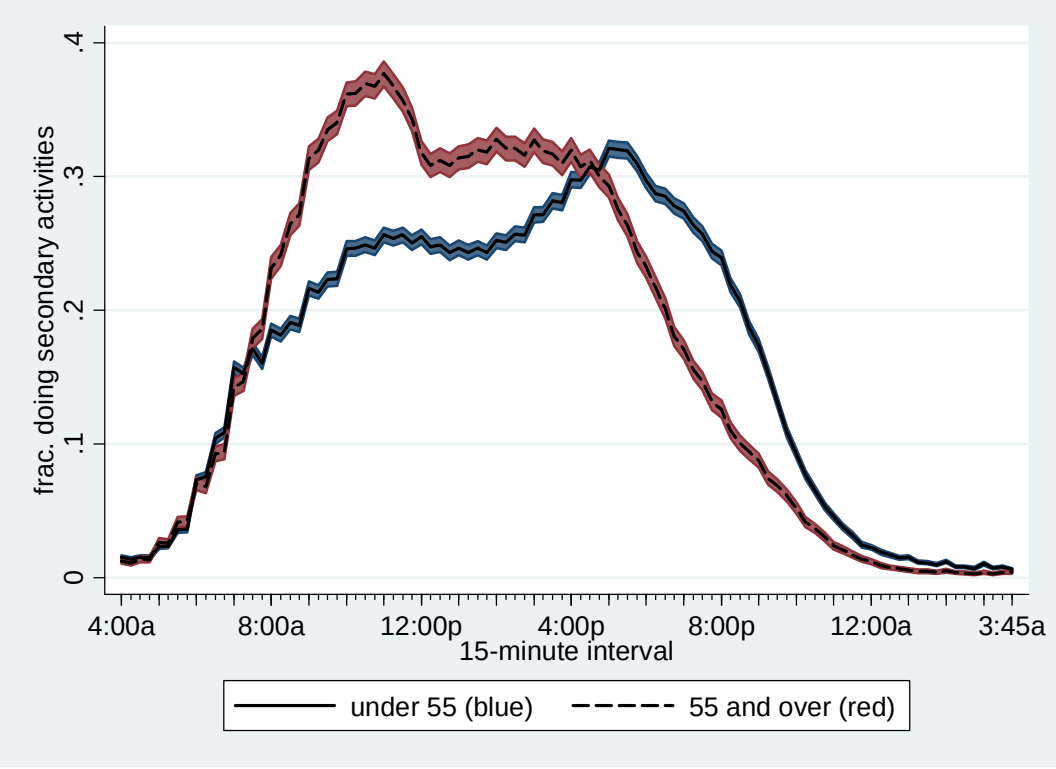


Figure 4c. Fraction of the Population Engaged in Tertiary Activities (by Quarter-hour—coefficient and 95-percent confidence interval)

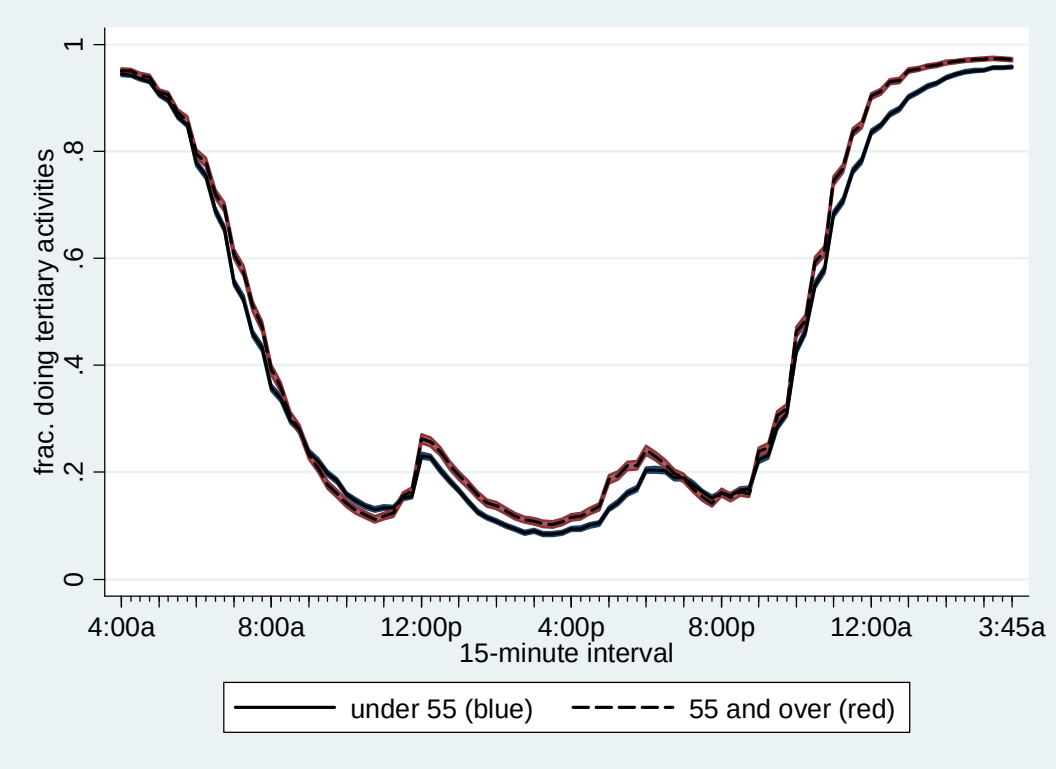
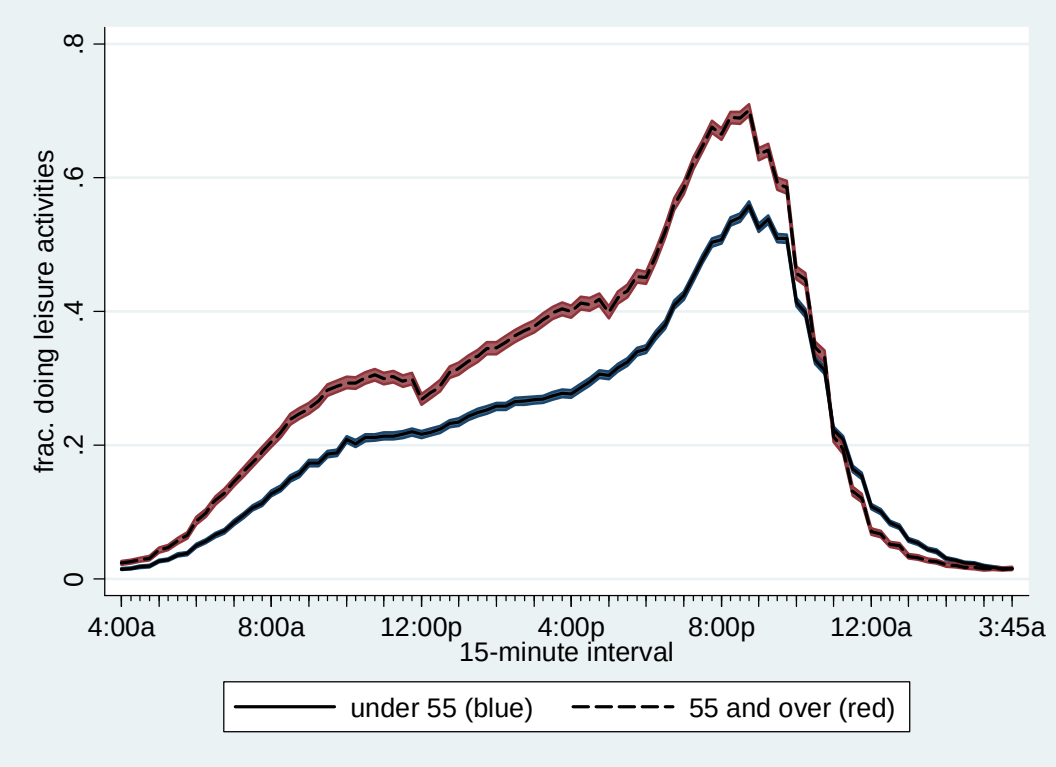


Figure 4d. Fraction of the Population Engaged in Leisure Activities (by Quarter-hour—coefficient and 95-percent confidence interval)



APPENDIX Table A. Assignment of Activity Categories in Time Use Surveys

MAJOR CATEGORY	COUNTRY AND CODES
	United States, 2003-04
Market Work	0501-0599, 1705
Household Production	0201-0299, 0301-0499, 0701-1099, 1501-1599, 1603-1608, 1702-1704, 1707-1710, 1715
Tertiary activities	0101-0199, 1101-1199, 1701, 1711
Leisure	0601-0699, 1201-1499, 1601-1602, 1706, 1712-1714
	Australia, 1992
Market Work	000-099
Household Production	100-399 except 163, 611
Tertiary activities	400-499
Leisure	163; 500-998 except 611
	West Germany, 2001-02
Market Work	211-299
Household Production	011-199, 811-899, 970
Tertiary activities	511-599
Leisure	310-499, 600-799, 910, 981-999
	Netherlands, 2000
Market Work	000-099
Household Production	100-399, 420
Tertiary activities	400-499 except 420
Leisure	500-999