Nonresponse in the American Time Use Survey:
Who is Missing from the Data and How Much Does It Matter?

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I. <u>Introduction</u>

        The American Time Use Survey (ATUS) represents a great advance in helping scholars and policymakers to understand how Americans spend their time. The ATUS collects a large number of time diaries each month from a sample designed to be broadly representative of the American population age 15 and older. The data from this ongoing national survey will make it possible to examine the hours devoted to almost any activity in which a researcher may be interested – care of children, household production, education, sleep, aerobic exercise, religious services, work, or commuting, to give just a few examples. Because the survey sample is large, estimates can be produced not only for the population as a whole but also for demographic subgroups. Because the ATUS data are collected on an ongoing basis, they will be useful for studying changes in time allocation patterns over short time intervals (for example, over the course of a business cycle) as well as over longer periods of time. From a policy perspective, being able to examine the time allocation consequences of policy changes in addition to their implications for earnings, work hours, household incomes and other monetary outcomes will contribute to a richer understanding and more meaningful evaluation of available policy options.

        While there is good reason to be excited about the research potential of the ATUS, concerns also have been voiced about the quality of the data. Despite the survey's official imprimatur and the efforts of the survey staff, the ATUS response rate has been below 60 percent. Given the large fraction of the survey sample who did not provide time diary information, questions naturally arise about whether and how the responses obtained can be generalized to the target population (see, for example, the

concerns of the Panel to Study the Design of Nonmarket Accounts, Committee on National Statistics, National Research Council, as discussed in Abraham and Mackie, 2005).

One advantage of the design of the ATUS for learning about the causes and consequences of survey nonresponse is that the ATUS sample was drawn from the outgoing rotation groups of the Current Population Survey (CPS). This means that the ATUS respondent is a member of a household that has been interviewed for the CPS up to eight times in the preceding two years. Thus, we know a considerable amount about both the respondents and the nonrespondents among those selected for the ATUS survey sample.

We begin our analysis of ATUS nonresponse by discussing two alternative hypotheses about the nature of nonresponse to be expected in a time diary study such as the ATUS, considering the hypothesis that busy people are less likely to be among the respondents versus the hypothesis that people with weaker social ties are less likely to be interviewed. This is followed by a brief description of the design of the ATUS, together with a discussion of the experience to date with obtaining responses to the survey. Our analysis indicates that difficulties in contacting sample members account for a higher percentage of nonresponse than outright refusals to participate. Noncontact explains about 60 percent of nonresponse to the ATUS.

In the next section of the paper, we examine the characteristics of ATUS nonrespondents, looking separately at the factors associated with noncontact and non-cooperation given contact. We evaluate whether the associations between various observable respondent characteristics and nonresponse are more consistent with busy

people not responding or with people who are less socially integrated not responding. We find more support for the latter explanation than the former.

Finally, using the estimated coefficients from our model of the determinants of overall survey nonresponse, we construct a set of nonresponse adjustments to the ATUS base weights. We then compare aggregate estimates of time use calculated using the ATUS base weights without any adjustment for nonresponse to estimates calculated using the ATUS final weights, which incorporate raking adjustments designed to calibrate the survey estimates to selected demographic totals as a means of adjusting for survey nonresponse, and to estimates calculated using weights that incorporate our own nonresponse adjustments. While there are some modest differences among them, the three sets of estimates are broadly similar. The paper concludes with a discussion of the limitations of our analysis and some suggested avenues for further research.

II.   Non-reponse Rates and Nonresponse Bias

Rates of nonresponse to household surveys have grown in recent years, creating concern among both Federal and private survey organizations about potential nonresponse bias in their survey estimates. Survey nonresponse rates commonly are taken as an indicator of the quality of the survey data.

In fact, however, nonresponse is a source of bias in survey estimates only to the extent that those who respond are different from those who do not with respect to the characteristic of interest. Formally, for estimates of the mean of some variable:

(1) $\bar{Y}_r = \bar{Y}_n + (\frac{m}{n})[\bar{Y}_r - \bar{Y}_m]$,

where $\bar{Y}_r$ is the mean of the variable of interest among survey respondents, $\bar{Y}_n$ is the true mean for the full survey sample, $\bar{Y}_m$ is the mean for survey nonrespondents, m is the number of nonrespondents and n is the number of people in the full survey sample. The nonresponse bias in the estimate of $\bar{Y}$ thus is equal to:

(2) $\qquad \bar{Y}_r - \bar{Y}_n = (\frac{m}{n}) \left[\bar{Y}_r - \bar{Y}_m \right]$

This formula makes clear that, even if there is a significant amount of survey nonresponse, the estimated mean of a variable of interest will not be biased unless respondents differ from nonrespondents with respect to that characteristic.

The preceding formulas are deterministic, in the sense that any given individual is either a respondent or a nonrespondent. An alternative is to treat response as stochastic, with different individuals viewed as having different propensities to respond. In this case, nonresponse is a source of bias only to the extent that response propensities are correlated with the estimates of interest. Formally, the expected nonresponse bias in a survey estimate can be expressed as:

(3) $\qquad E(\bar{Y}_r - \bar{Y}_n) = E\left[\dfrac{\sigma_{YP}}{\bar{P}} \right]$

where $\bar{P}$ is the mean probability of responding to the survey and σ_{YP} is the covariance between the variable of interest and the response propensity in the survey sample. This expression implies that, absent an expected association between the probability of response and the variable of interest, survey nonresponse should not be a source of bias in survey estimates.[1]

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[1] For a discussion and references to the extensive literature on the subject of household survey nonresponse, see Groves (2005).

In thinking about nonresponse, it can be useful to consider the different possible reasons why a sample member might not respond to a survey. Some sample members may be difficult to contact. Once contacted, other sample members may refuse to participate, and a smaller number may not be interviewed because of problems such as the inability to speak English. It is possible that different kinds of people are lost as respondents because they are never contacted than are lost because they refuse to participate in a survey. In thinking about the potential effects of survey nonresponse on survey estimates, it therefore may be important to consider the mechanism whereby the nonresponse occurs (see Groves and Couper, 1998, and Groves et al, 2004).

Two competing hypotheses about household survey response propensities seem especially relevant to time diary studies such as the American Time Use Survey (ATUS). One hypothesis is that people who are busy with other activities might be both harder to contact because they are less frequently at home and, if contacted, less willing to take the time to respond to requests for participation in surveys (see, for example, Hochschild, 1989). If true, this would be a particular problem for a time diary study such as the ATUS, since it is precisely the use of time that such studies are designed to measure, and the under-representation of busy people could seriously distort the estimates produced (Abraham and Mackie, 2005).

An alternative hypothesis is that a person's response propensity reflects the degree to which he or she is socially integrated, or, put differently, the degree of attachment to the broader community (see, Robinson and Godbey, 1997, for discussion of a similar idea). Like "busyness," "social integration" might be related both to how easy it is to contact a potential respondent and to the likelihood that, if contacted, the person

will cooperate with the survey request. Difficulties in contacting people who are less socially integrated may arise because they move away, do not have valid phone numbers, and so on, in addition to their perhaps being less likely to be at home. If people with strong social connections spend their time differently than people with weak social connections, differences in response propensities between the two groups could lead to bias in aggregate time use estimates.

Some limited evidence from previous research seems consistent with the hypothesis that busy people are less likely to participate in time diary studies. Drago et al (1999) conducted a pilot time diary study of 58 teachers, some of whom were employed at a "high stress" school and others of whom were employed at a "low stress" school. Teachers at the "high stress" schools were much less likely to volunteer to participate in the time diary study. Paakkonen (1999) analyzed data from the nationwide Finnish time diary study conducted in 1987-88. Among 10,574 people contacted for the study, 8,540 participated in an initial interview in which they were asked a short set of questions. Of these, 7,758 completed a time diary. Those who participated in the initial interview but refused to keep the time diary were no more likely to report feeling "rushed" than those who agreed, but those who refused the diary did report working somewhat longer hours and feeling more rushed at work.

The results of other studies hint that busy people could be overrepresented, not underrepresented, in time diary reports. Robinson (1999) examined differences in the distribution of activities reported in the first wave of the 1975 University of Michigan time use survey for those who did and did not participate in the second wave of the same survey. Those who responded to the first wave of the survey but not to the second wave

reported in the first wave that they spent less time working and doing housework, but more time sleeping and watching television. Similar results were obtained from an examination of data from a later time use study conducted in 1985 (Robinson and Godbey, 1997). Knulst and van den Broek (1999) examine rates of response to the several official time diary studies conducted in the Netherlands since 1975 for groups defined on the basis of their age, gender, urbanization of place of residence, position in the family and position in the labor market. The Dutch time use studies require completion of a 7-day diary, and nonresponse rose from about a quarter of the survey sample in 1975 to about three-quarters in 1995. Response rates generally were higher, rather than lower, for those groups in which respondents reported longer hours of paid work and larger total time commitments.

DISCUSS EVIDENCE FROM PREVIOUS RESEARCH RELEVANT TO THE SOCIAL INTEGRATION HYPOTHESIS.

Whether response rate differences across groups affect aggregate estimates of time use depends, of course, the extent to which those with differing response propensities also use their time in different ways. In the analysis that follows we look first at whether there is evidence of systematically different response propensities in the ATUS for individuals with different characteristics, both overall and by type of nonresponse, and then at whether the differences in overall response propensities we identify appear to bias the time use estimates derived from the survey.

III.   Design of the American Time Use Survey

The households chosen for participation in the ATUS are selected randomly from households completing the eighth wave of participation in the Current Population Survey (CPS).   The CPS sample over-represents small states; a first stage of selection for the ATUS sample eliminates this over-representation. Households then are stratified by the race/ethnicity of the householder, the presence and age of children in the household, and the number of adults in adult-only households. The rates at which households are sampled for the ATUS differ across the strata.

In the third stage of sample selection, one randomly-selected person aged 15 or older in each sampled household is designated for participation in the ATUS. Each sample member is assigned a designated day for which time use information will be collected and telephone interviews are conducted on the day following the designated day. If the person cannot be contacted on his/her assigned interview date, he/she may be called on the same day the following week. People who have moved away are considered ineligible for participation and dropped from the sample. Efforts to contact an eligible sample member may be continued for up to eight weeks. ATUS interviews generally are conducted between two and four months after the last CPS interview for the ATUS household. Sample members for whom no telephone number is available (approximately 5 percent of the total) are sent a letter asking that they call the telephone center on a specified day to complete the interview. These respondents are offered an incentive of $40.00 for participating in the study.[2]

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[2] See Horrigan and Herz (2005) for a discussion of the development of the ATUS and Bureau of Labor Statistics and U.S. Census Bureau (2005) for a more detailed description of the ATUS design.

The ATUS diary days are distributed across the days of the week, with 10 percent allocated to each of the weekdays Monday through Friday, 25 percent to Saturdays and 25 percent to Sundays, and distributed evenly across the weeks of the year. In 2003, the first year of ATUS data collection, 20,720 usable ATUS time diaries, or about 1,700 diaries per month, were collected (Hamermesh, Frazis and Stewart, 2005). As a result of budget constraints, the number of usable ATUS time diaries fell to just under 14,000, or about 1,150 diaries per month, in 2004 and will remain at about that level in future years (Bureau of Labor Statistics and U.S. Census Bureau, 2005). Even this smaller number remains large by both historical and comparative standards.

Once the ATUS respondent is contacted and agrees to report about the designated day, the telephone interviewer leads the respondent through his/her activities over the 24-hour period from 4:00 a.m. the previous day through 4:00 a.m. on the interview day. The respondent lists activities, describing in his/her own words the *primary* activity in which he/she was engaged. Information on activities is collected sequentially and an ending time is recorded for each activity. After the survey interview is completed, respondents' verbal descriptions of activities are coded into a detailed set of activity categories. The full ATUS coding structure is a 3-tier, 6-digit system, consisting of 17 major activity groupings, more than 100 4-digit intermediate groupings and more than 400 6-digit detailed activity categories (Shelley, 2005). Except for child care, information on *secondary* activities – other activities undertaken simultaneously with whatever the respondent identifies as his/her primary activity – is not recorded. The respondent also is asked to provide a location for each activity (at home, at the respondent's workplace, in someone else's home, at a restaurant or bar, etc.) and to indicate who else was present

during the activity (nobody else, spouse/partner, child/children, friend/s, co-workers, etc.). Summary questions at the end of the survey ask respondents to identify all periods of time during which they had a child under the age of 13 in their care (used to identify secondary child care undertaken simultaneously with other activities), as well as to identify all activities done for work and or in connection with volunteering through an organization.

Beyond the information collected as part of the ATUS interview, additional information about the ATUS sample members and their households is available from the CPS interviews in which they participated. As already noted, the ATUS sample is drawn from among the members of households participating in the eighth (and final) wave of the CPS sample rotation pattern. The ATUS-CPS data file provided by the BLS contains most of the information collected as part of the last basic CPS interview for ATUS sample members' households, together with identifiers that allow the records on the file to be linked to the records of the ATUS interviews. Importantly for our purposes, the ATUS-CPS file contains records not only for ATUS respondents and the other members of their households, but also for people picked as ATUS respondents who did not complete the survey and the members of their households. A few pieces of information relevant to the analysis of survey nonresponse – specifically, whether the household rented or owned its housing unit and whether the household was located in a central city – are not included on the ATUS-CPS data file, but we were able to extract this information from the relevant CPS basic interview files. In addition, although we have not done so to date, it is possible in principle to link the ATUS records to information for the same individuals provided during up to seven earlier CPS interviews.

IV.   Sources of Nonresponse in the American Time Use Survey

As just noted, the ATUS sample consists of a set of named individuals selected from among the members of households in the outgoing rotations of the CPS. People in households that were selected for the CPS but did not complete a wave-eight interview have no chance of being selected for the ATUS. Response rates for the basic CPS questionnaire generally are very high.   Over the recent past, response rates for the eighth-month-in-sample basic CPS questionnaire have averaged about 94 percent. CPS weights that incorporate an adjustment for CPS nonresponse are used in selecting the ATUS sample and constructing the ATUS estimation weights. Still, to the extent that non-responding CPS households differ from those with similar characteristics that did respond, there is the potential for bias that might carry over to the ATUS estimates. Unfortunately, there is no obvious means of assessing the nature or magnitude of this potential bias, and we do not consider it further in the discussion that follows.

A noteworthy feature of the ATUS design is that people designated as ATUS respondents who move out between the time of their household's last CPS interview and the scheduled date of their ATUS interview are considered ineligible and removed from the survey sample. Household personal interview surveys conducted by the Federal government most commonly sample designated housing units rather than designated individuals. Household surveys conducted using random-digit-dialing (RDD) methods sample telephone numbers. With these designs, mobility is not a significant problem for the representativeness of the survey sample, since people who move out implicitly are

replaced by people who move in. In the ATUS sample, people who move out are lost and not replaced by anyone else.

In the analysis that follows, we calculate ATUS response rates both for the full survey sample and for subgroups within the full sample using AAPOR response rate definition RR2:

$$(4) \quad RR2 = \frac{C}{C + R + NC + O + UE},$$

In this expression, C represents completed interviews (including sufficient partial interviews), R represents refusals, NC represents noncontacts, O represents other non-interviews, and UE represents cases of unknown eligibility. Note that cases deemed ineligible (NE) do not appear in this expression. Reclassifying certain cases considered ineligible as noncontacts (NC), as we suggest below, would raise the denominator of the response rate expression and lower the estimated response rate.

We also make use of contact rates for the ATUS sample. For this purpose, we use AAPOR contact rate definition CON1:

$$(5) \quad CON1 = \frac{C + R + O}{C + R + NC + O + UE},$$

where all terms are as defined above. Finally, we use AAPOR cooperation rate definition COOP2 to develop estimates of the share of respondents who complete an interview, conditional on their having been contacted:

$$(6) \quad COOP2 = \frac{C}{C + R + O}$$

The response rate defined in equation (4) is equal to the product of the contact rate defined in equation (5) times the cooperation rate defined in equation (6).[3]

As shown in these equations, nonresponse to a survey may occur either because the designated respondent could not be contacted or because that person did not cooperate in completing an interview. Calculating the survey response rate requires, of course, that appropriate determinations be made regarding the disposition of individual survey cases. An issue to be resolved for the ATUS is which cases should be assigned to the noncontact category. The ATUS interviewer may be unable to contact a designated respondent because that person has moved away; because the interviewer does not have a valid telephone number for the household; or because the designated respondent is never available to speak to the interviewer. The codes recorded on the ATUS survey methodology files, however, place these three different situations into three different outcome categories. First, as already noted, designated respondents who have moved are categorized as ineligible. While the decision not to attempt to contact people who have moved is entirely understandable from an operational perspective, from a statistical perspective it is hard to justify classifying them as not eligible to participate. Movers are a part of the survey sample originally selected to be representative of the target population and the ATUS survey design is such that they are not replaced by others. In our own coding structure, we re-categorize these people as noncontacts. Second, the codes on the ATUS survey methodology file assign people in households for which the survey interviewers did not have a valid phone number to the "unknown eligibility" category. The target population for the ATUS is the civilian non-institutionalized

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[3] See American Association for Public Opinion Research (2004) for further discussion of various survey outcome rate measures and the relationships among them.

population age 15 and older. Named respondents who join the Armed Forces, become

institutionalized or die between the date of their last CPS interview and the scheduled

date of their ATUS interview thereby become ineligible for the ATUS. Strictly speaking,

it is true that, if no contact has been made with a household, it is possible that a person's

status might have changed from eligible to not eligible. These disqualifying events are

very rare, however, and we would argue that it is more informative to categorize those in

the ATUS "unknown eligibility" category as noncontacts, which is what we have chosen

to do. The only cases categorized as noncontacts in the ATUS coding scheme are cases

for which the validity of a respondent's phone number is established but the interviewer

does not succeed in speaking with the respondent. We also consider these cases to be

noncontacts. The net result of all of this is that we classify as noncontacts many more

cases than does the official categorization scheme.

Making contact is only the first step in obtaining a survey response. Some

designated respondents who are contacted may refuse to complete the interview.

Language barriers may prevent the completion of interviews in other cases. We look at

these cases in the same way as do the ATUS survey managers – the former are classified

as refusals and the latter as other non-interviews. [4]

The distributions of sample dispositions for the 2003 and 2004 ATUS are shown

in Table 1. The first column in the top panel of the table shows the number of sample

members assigned to each major sample disposition category based on the codes from the

survey methodology file provided by the BLS; the second column shows the percentage

distribution of these cases for the portion of the sample considered to be eligible

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[4] See Appendix A for a tabulation of the detailed case disposition codes recorded on the ATUS data files
that shows how the official categorization scheme and our categorization scheme group the detailed codes
into broader case disposition categories.

respondents. The next two columns show the same information for 2004 sample members. The distributions are very similar across the two years. The reported figures imply an unweighted response rate for the ATUS of 56.2 percent in 2003 and 54.6 percent in 2004.[5] Both in 2003 and again in 2004, somewhat more than 5 percent of the cases are classified as ineligible (2,086 out of 38,941 cases in 2003 and 1,392 out of 27,004 cases in 2004). Most of the ineligibles are people who have moved; only a very small number are people who joined the Armed Forces or were institutionalized.[6]

The bottom panel of Table 1 is similar to the top panel, except that, consistent with our understanding of the AAPOR guidelines, we have used our preferred sample disposition category assignments. As just explained, we assign many more cases to the noncontact category than does the official categorization. Movers classified by the BLS as "not eligible" we consider to belong to the "contact not attempted" subcategory within overall noncontact (NC-1), a grouping that also includes cases classified by the BLS as "other non-interview" because the designated person was absent, ill or hospitalized. Cases classified in the survey methodology file as being of "unknown eligibility" are categorized as noncontacts due to inadequate contact information (NC-2). Our NC-3 category is equivalent to the official noncontact category. Almost all of the cases that

[5] The BLS reports an ATUS response rate of 57.8 percent for 2003 and 57.3 percent for 2004. There are two main reasons why the response rates reported by the BLS differ from those we have calculated. First, our rates are based on the set of cases for which a final disposition was obtained during the calendar year in question; the BLS response rates are based on the set of cases initiated during the calendar year and thus cover a slightly different time period. Second, the BLS response rates were calculated prior to editing of the survey data. In both 2003 and 2004, the data collected for several hundred cases were evaluated during editing to be of poor quality, and these cases were recoded from completed interviews to refusals. Working with the edited data thus produces somewhat lower response rates.

[6] For confidentiality reasons, people who die are excluded from the ATUS public use files. We would have liked to report *weighted* as well as *unweighted* ATUS response rates, but the necessary base weights were missing for 2,755 cases in the 2003 ATUS and 436 cases in the 2004 ATUS. Of the 2003 ATUS cases without weights, 2,086 were cases classified as ineligible and 669 were cases with reported data deemed to be of poor quality that were recoded as refusals. The 2004 ATUS cases without weights were all in the latter category.

remain in the "other nonresponse" category (O) in our categorization scheme are cases in which language barriers prevented the conduct of an interview; the small number of cases that remain in the not eligible category (NE) are those in which the designated respondent had joined the Armed Forces or was institutionalized, together with a few people it would appear should not have been selected for the sample in the first place.

The alternate categorization scheme makes clear the importance of problems with contacting respondents, defined somewhat more broadly than in the official ATUS disposition category structure, as a source of nonresponse to both the 2003 and the 2004 ATUS. In both 2003 and 2004, using our classification scheme, noncontact accounts for roughly 60 percent of all survey nonresponse, with refusals accounting for between 35 and 40 percent and other reasons for the small number remaining. In addition, because the alternative disposition category structure places far fewer cases in the not eligible category, the estimated nonresponse rate is a bit lower than that obtained using the official ATUS disposition codes – 53.4 percent rather than 56.2 percent in 2003, and 52.0 percent rather than 54.6 percent in 2004.

V.   Who Were the Nonrespondents to the American Time Use Survey and Why Did
        They Not Respond?

The next step in our analysis of the ATUS data is to examine the household and individual characteristics that are associated with survey nonresponse. In selecting the characteristics to consider, we were guided by our hypotheses about the nature of nonresponse in the ATUS. As discussed earlier, one hypothesis regarding nonresponse in the ATUS is that busy people are less likely to respond. Busy people may be less likely

to be at home to talk with the interviewer, resulting in larger shares of busy people being assigned to the third noncontact category (NC-3). In addition, busy people may be more likely to refuse to participate in the survey. The alternative hypothesis we consider is that people who are less socially integrated – more transient and less engaged in their communities – may be less likely to respond. Again, this could reflect both higher noncontact rates and higher refusal rates. People who are more transient may be more likely to have moved from the household in which they resided at the time of their last CPS interview by the time they are scheduled for the ATUS or to have bad contact information recorded in their survey records, resulting in larger amounts of noncontact (especially of types NC-1 and NC-2). In addition, people whose ties to their communities are weaker may be less willing to take the time required to complete the survey interview and more likely to end up refusing.

We have identified several personal characteristics that can be interpreted as proxies for "busyness." All else the same, we would expect people who work longer hours to be busier. Among those who are married, given own hours of work, people whose spouses work longer hours seem likely to be busier. Our last proxy for "busyness" is the presence of children in the home. Unfortunately, these observable characteristics are relatively crude proxies for the underlying characteristic in which we are interested. We have no way of identifying, for example, children with special needs who may require larger amounts of time than other children, adult family members who may require an unusual amount of care, or workers who may have exceptionally long commutes. Still, if being busy is an important determinant of response to the ATUS, we

would expect to see some association between the characteristics we can measure and the survey response, contact and cooperation rates.

A second set of individual and household characteristics proxy for the strength of respondents' social integration into their communities. All of these characteristics seem especially likely to be related to residential stability, which would affect the probability of contact as we have defined it, but also may be related to the motivation an individual feels to cooperate in a survey. Marital status is one of the characteristics we consider. Married people arguably have stronger ties to their communities on average than people who are not married. Marital separations often are associated with changes in living arrangements, so that people who are married but separated from their spouse may be more transient on average than others, and perhaps less willing to spend time talking to a survey interviewer.[7] We have discussed hours of work in connection with the "busyness" hypothesis, but being out of the labor force also could be indicative of a lack of social integration. Similarly, the presence of children may be relevant not only to the "busyness" hypothesis but also to the "social integration" hypothesis. People in households that include children, especially children age 6-17, may be both less likely to move and more strongly connected to their communities through their children's schools. Homeowners can be expected to have stronger ties to their communities than renters, and the same may tend to be true of people who live in non-metropolitan areas. Finally, we have created a variable that captures whether people are living in households that include adults who are not related to the householder. As a group, these households seem likely to be more transient than households composed only of people who are related to the

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[7] The married but separated category includes a small number of people who report that they are married but are neither the householder nor the spouse of the householder. We were unable to determine whether these individuals' spouses resided in the same household and assigned them to the separated category.

householder. For completeness, we also have created a variable that captures the presence in the household of other adults who are relatives of the householder; we have no strong hypothesis about any effects of this variable.

In addition to the individual and household characteristics just mentioned that seem related either to the "busyness" hypothesis or the "social integration" hypothesis, we consider the ATUS sample member's sex, age, race/ethnicity, household income, education, region and telephone status as potential influences on survey response.

In Table 2, we display estimates of the overall response rate, contact rate and cooperation rate for the 2004 ATUS.[8] These are shown for the sample as a whole and then broken out separately by hours of work, presence of children, marital status and so on.[9] As with the numbers shown in Table 1, the rates we report are unweighted. All of the rates shown in the table are multiplied by 100, so that they appear as percentages. In addition to the response, contact and cooperation rates, the table also reports the noncontact rate, the refusal rate, and the other non-interview rate. The noncontact rate is the complement to the contact rate;[10] we further disaggregate the noncontact rate into noncontact due to not having attempted to contact the designated respondent or bad contact information (the NC-1 and NC-2 groups, reported in the column labeled "Type 1/2 Noncontact") and noncontact due to difficulty in finding the designated respondent at home (the NC-3 group, reported in the column labeled "Type 3 Noncontact"). The

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[8]From this point forward, we focus on the 2004 ATUS data. In the course of developing our hypotheses regarding the causes and consequences of nonresponse in the ATUS, we carried out a variety of preliminary analyses using the 2003 data, and did not want to test these hypotheses using the same set of observations. In addition, as already noted, information on base weights was missing for many of the cases on the 2003 ATUS public use file; this was less of a problem for the 2004 data, though even with the 2004 data we lose 436 cases in all analyses that involve the survey weights. For all of the analyses we report, results obtained using the 2003 data were qualitatively very similar to those based on the 2004 data.

[9] The construction of the variables that appear in the rows of Table 2 is outlined in Appendix B.

[10] In other words, the contact rate plus the noncontact rate equals 100 percent.

complement to the cooperation rate is the sum of the refusal rate and the other non-interview rate.

The simple tabulations of overall nonresponse rates that we report in Table 2 offer little support for the hypothesis that busy people are less likely to respond to the time diary survey. People who work full-time (35-44 hours a week) have lower response rates than people who work part-time (less than 35 hours a week), but the response rate for people who work more than full time (45 or more hours a week) is comparable to that for people who work part-time, and both are higher than the response rate for people who do not work at all. Among married people, those whose spouses work very long hours have the highest response rates. The presence of children in the household does not seem to be strongly related to response propensity.

Looking at the separate components of nonresponse tells a somewhat different story. Noncontact due to the designated respondent never being available to talk to the survey interviewer (the NC-3 rate) rises monotonically with hours of work, with those who are out of the labor force having the lowest rate and those working very long hours the highest rate. Presence of children does not have a consistent effect on this category of noncontact, however, and none of the "busyness" proxies has an obvious or consistent relationship to the refusal rate.

In contrast, there are consistent and significant differences in response rates across groups that seem to conform to the prediction of the "social integration" hypothesis. Response rates are relatively low for people who are out of the labor force, and also for people who are separated or have never been married. Renters' response rates are a full 15 percentage points lower than homeowners' response rates. People identified as living

in a central city are approximately 10 percentage points less likely to respond than people living in a non-metropolitan area. People who live in households that include an adult who is not related to the householder are roughly 13 percentage points less likely to respond than people who live in households where everyone is related to the householder. Interestingly, differences in contact rates – and especially differences in the probability of noncontact related to the respondent having moved or to bad contact information having been recorded for the respondent – account for most of the response rate differences related to marital status, housing tenure, urbanicity and household structure.

Looking at the other variables in the table, those who are young, Hispanic or black have significantly lower probabilities of responding to the ATUS; those who are well educated, especially those who have a graduate degree, and those with higher household incomes are significantly more likely to respond. For most of the characteristics that seem predictive of response rates, variation in contact rates is much more important than variation in cooperation rates. This generalization does not hold, however, for people for whom household income is missing, the group that has the lowest overall response rate. The contact rate for this group was just 4 percentage points below the overall average of 70.2 percent, but its cooperation rate was a full 15 percentage points below the sample average of 75.3 percent. This is perhaps not surprising, as one might expect people who were not willing to answer a question about their household income to be less inclined than the average person to answer a battery of questions about how they spend their time.

A limitation of the simple tabulations reported in Table 2 is that the effects of different variables on the rates of interest may be confounded. The natural progression of

people's lives over the course of the life cycle, as many of them marry, buy homes and have children, and then later see children leave home to start their own families, perhaps find themselves divorced, and eventually die or become widowed, creates a significant confounding between age and the marital status, housing tenure and presence of children variables. To take another example, education is associated with both hours of work and household income. Partly for this reason, in addition to looking at the simple tabulations displayed in Table 2, we also have estimated multivariate models designed to shed light on the independent influence of various characteristics on survey response outcomes. These estimates are reported in Table 3.

The coefficient estimates and standard errors in Table 3 come from weighted logistic regressions, using as weights the ATUS base weights calculated at the sample design phase of the survey.[11] For the full survey sample, we modeled the probability of nonresponse; noncontact; noncontact due to survey protocols and bad contact information (NC-1 or NC-2); and noncontact due to respondents simply never being available to be interviewed (NC-3). Among those who were contacted, we also modeled the probability of refusing the survey interview. Each of these models was estimated independently. Standard errors for the estimates from the logistic regressions were estimated using a replicate variance method proposed by Fay (1989) that accounts for the increase in variance associated with the clustering of the ATUS sample relative to the variance that would have been expected for a simple random sample of the same size.[12]

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[11] Once again, the observations used to produce the estimates reported in Table 3 exclude 436 cases for which the survey base weights were not available.

[12] The SAS-callable procedure RLOGIST in SUDAAN, a statistical software package for the analysis of survey data collected using complex sample designs, was used to calculate the standard errors of the logistic regression parameters. The necessary replicate weights were provided by the BLS. Further details are available from the authors upon request.

All of the explanatory variables included in the logistic regression models are dummy variables that take on a value of either one or zero. In these models, a dummy variable coefficient that is significant and positive (negative) implies that having the characteristic in question raises (lowers) the probability of the outcome being modeled. Larger coefficient estimates imply larger effects than smaller coefficients. The size of these effects on the probability of the modeled outcome, however, depends a great deal on the baseline against which the effect is calculated. To assist in interpreting the logistic regression results, we have calculated for each of the coefficient estimates reported in Table 3 the implied change in the probability of the outcome of interest associated with having versus not having the specified characteristic, evaluated at the average probability of observing the outcome for the sample as a whole. These probability effects are reported in Table 4; estimated effects that are associated with statistically significant coefficient estimates are shown in bold.

Like the tabulations reported in Table 2, the results in Table 4 offer little support for the "busyness" hypothesis. Part-time workers are less likely to be nonrespondents than either those who do not work or those who work longer hours, and married people whose spouses work very long hours have lower nonresponse probabilities than others. As was also true in the simple tabulations, however, we find that longer hours of work are associated with a higher probability that the respondent will not be available to talk with the interviewer (noncontact of type NC-3).

Something we did not examine in Table 2 was the interaction between marital status and presence of children in the household. The presence of children has no significant effect on survey nonresponse for married sample members, but the presence

of children age 6-17 actually raises the response probability (reduces the nonresponse probability) for unmarried sample members. This is not what the "busyness" hypothesis would have lead us to expect, but may be consistent with the "social integration" hypothesis, insofar as having school-age children may tend to engage single parents in their communities.

Most of the "social integration" variables discussed in connection with Table 2 turn out to have statistically significant effects in the logistic regression with nonresponse as the outcome of interest. Nonresponse probabilities are significantly higher for renters as compared to homeowners, people who live in metropolitan areas, and people who live in households that include adults not related to the householder. In this model, people who live in households that include other adult relatives of the householder also have lower response rates. As was true in the simple tabulations, digging a little deeper reveals that most of these differences in response rates reflect differences in the probability of contact.

Other control variables that are significantly related to the probability of nonresponse in the models reported in Table 3 include respondent age (younger people have higher nonresponse rates), race (blacks but not Hispanics have higher nonresponse rates) and education (those with less education have higher nonresponse rates). These differences reflect primarily differences in contact rates. And as before, nonresponse is much higher for people who did not report their household income in the CPS, this being the one difference in overall response that is driven more by the group's refusal rate than by its noncontact rate.

VI.   Weighting Adjustments for Survey Nonresponse

The results reported in the previous section of the paper establish that there are significant differences across people with different personal and household characteristics in the probability that they will provide usable ATUS responses. A further question is whether accounting for these differences in response propensities by giving greater weight in estimation to responses from people with relatively low response propensities, and vice versa for those with relatively high response propensities, would make a material difference to estimated patterns of time use. That is the question we turn to next.[13]

For each of the people who completed the ATUS interview, the estimated coefficients reported in Table 3 can be used to calculate the probability that a person with that set of characteristics would have responded to the survey.[14] The differences in response propensities across individuals with different characteristics are sizable. Taking two admittedly extreme examples, the implied response rate for a never-married black male with a high school education who lives in a rented housing unit in a metropolitan area in the Northeast, works 35-44 hours per week, resides in a household that includes both young children and adults who are not related to the householder, has no telephone, and did not provide household income information to the CPS interviewer is just 9.5 percent. At the other end of the scale, the implied response rate for a married white female homeowner with a graduate education who lives in a non-metropolitan area in the Midwest, has a telephone, works variable hours and has a spouse who works 45 hours or

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[13] The approach we take in this section of the paper is similar to that employed by Rizzo, Kalton and Brick (1994) in their study of panel nonresponse in the Survey of Income and Program Participation.
[14] More precisely, the coefficient estimates can be used to calculate the probability that a person with given characteristics would be a *nonrespondent*, and one minus that probability then equals the person's response propensity.

more per week, and resides in a household that includes no children or other adults and has a reported income in the range $40-75,000 has an implied response rate of 86.3 percent. Looking at the empirical distribution of response propensities among the 13,973 people who actually responded to the survey, the average response propensity for those in the bottom 10 percent of the response propensity distribution was 32.3 percent, and the average response propensity for those in the top 10 percent of the response propensity distribution was 76.1 percent.

ADD PARAGRAPH HERE ON DIFFERENCES IN TIME USE FOR SELECTED GROUPS THAT VARY IN THEIR RESPONSE PROPENSITIES

To determine whether nonresponse associated with observable characteristics of the ATUS sample members is associated with bias in the time use estimates from the survey, we used the estimated response propensities based on the coefficients reported in Table 3 to calculate nonresponse weight adjustments for each survey respondent. If, based on their characteristics, a survey respondent had an estimated response propensity of 0.500, in effect that person represents themselves and another survey sample member who did not respond. The weight adjustment applied for this individual would be 2.000. More generally, the weight adjustment we apply is equal to the inverse of the estimated response propensity.[15] Because different days of the week were represented in different proportions in the survey data and this was not accounted for in the survey base weights, we also adjusted the final weights to ensure that each day of the week (Sunday through Saturday) received one-seventh of the total of the final survey weights. This weight

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[15] An alternative approach would have been to group the estimated response propensities and assign respondents a weight adjustment equal to the inverse of the average response propensity for those in their group. Weights estimated in this fashion would be less subject to spurious variability, though at the cost of some increase in bias.

adjustment was equal to the ratio of one seventh to the weighted share of observations

accounted for by the day of the week in question, using weights that incorporate the

nonresponse adjustment just described to calculate the day-of-the-week shares. Our final

weight for each respondent thus is equal to:

(4) $W_{final} = W_{base} \; x \; W_{nonresponse} \; x W_{day}$

where W_{final} is the final weight, W_{base} is the ATUS base weight, $W_{nonresponse}$ is the

propensity-score-based weight adjustment factor that accounts for differences across

observations in their response propensities, and W_{day} is the day-of-week adjustment

factor that ensures each day of the week receives the same total weight.

The official ATUS estimates reported by the BLS also are calculated using

weights that incorporate nonresponse and day-of-the-week adjustments. Our final

weights and the final weight provided on the ATUS data files take different individual

and household characteristics into account in performing the weight adjustments. The

official weights control the estimated totals from the respondent sample along the

dimensions of race, sex, age, presence of children and education. We also control for

these factors, though our age breaks are somewhat less detailed and our education breaks

somewhat more detailed than those used to produce the official survey weights.   In

addition, we control for marital status, hours worked both by the respondent and his/her

spouse, ages of children in the household, presence of other adults in the household,

housing tenure, and urbanicity, all factors that we find have some significant association

with the probability of responding to the survey. The official weighting procedures

control the day-of-the-week distribution within each month to the actual representation of

days within that month; we adjust the weight totals for the year as a whole so that each

day gets one-seventh of the total weight. A final difference is that the official weights control for whether the respondent was offered an incentive to participate, something we do not do.[16]

In order to see how much difference it makes whether the ATUS estimates are adjusted for survey nonresponse, and also to learn whether adjusting for differences in nonresponse related to factors not taken into account in the official weight construction procedures leads to different conclusions about the effects of nonresponse on the survey estimates, in Table 5 we report three different sets of weighted time use estimates based on the 2004 ATUS.

DISCUSS TABLE 5 HERE. SOME MODEST DIFFERENCES BETWEEN ESTIMATES OF WORK ACTIVITY AND LEISURE ACTIVITY, ESPECIALLY TV TIME, USING THE OFFICIAL FINAL WEIGHTS VERSUS OUR WEIGHTS, BUT OVERALL PATTERN VERY SIMILAR.

VII.   Discussion and Conclusions

The relatively high rate of nonresponse to the ATUS has prompted concern about the potential for bias in the ATUS estimates. Since the inauguration of the ATUS in 2003, the survey response rate consistently has been below 60 percent, with the 2004 response rate actually slightly less than that achieved in 2003. Our study provides new evidence on both the sources and the implications of ATUS nonresponse.

One contribution of our study is to document the importance of difficulties in contacting survey respondents for overall nonresponse. According to our estimates, the

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[16] Bureau of Labor Statistics and U.S. Census Bureau (2005) provides an overview of how the ATUS weights are constructed and Tupek (2004a, 2004b) gives additional details.

number of designated respondents who were not contacted by the ATUS interviewers is 50 percent larger than the number who, once contacted, refused to participate in the survey. The survey's high noncontact rate reflects in part the fact that the ATUS sample consists of designated individuals rather than households or phone numbers, meaning that the survey interviewers must find a particular person at home, rather than speaking with just any member of the household who may answer the telephone. The operational decision not to track designated respondents who move undoubtedly adds to the noncontact rate, though movers likely would be difficult to contact in any case. The fact that designated respondents must be interviewed on a particular day of the week (e.g., interviewed on Tuesday about their activities on Monday) may be another contributing factor, although BLS research conducted during the process of designing the ATUS found that allowing day-of-week substitutions across the five weekdays did not boost the overall survey response rate significantly (CITE).

Noncontact in the ATUS is noteworthy not only because it is so high but also because the personal and household characteristics of those who are contacted differ systematically from the characteristics of those who are not. Even after controlling for demographic characteristics such as age, sex, race and education that are taken into account in standard weighting adjustments, we find that people whose characteristics suggest weaker ties to the broader community are more difficult to contact than those whose characteristics suggest a greater degree of social integration. In contrast to the pattern for noncontacts, refusals are less predictable, with only a very few observable characteristics having any systematic association with the probability of refusing to participate in the survey.

Although even random nonresponse reduces effective sample sizes and raises standard errors, nonrandom nonresponse is more worrisome because it creates the potential for bias in survey estimates. As a first step in exploring whether the nonresponse we observe in the ATUS is a source of bias in the survey estimates, we have constructed new weights for the survey that account for differences in response propensities associated with a variety of observable characteristics. It turns out that using these new weights has relatively little effect on aggregate estimates of time use. Although there are differences in the patterns of time use associated with individuals' observable characteristics and the probability of responding to the ATUS differs with respect to these same characteristics, including a number of characteristics not taken into account in producing the official survey estimates, the net effects of our reweighting on the aggregate survey estimates just are not very large.

These findings do not rule out nonresponse as a source of bias in the ATUS estimates. It is possible that there are differences in the characteristics of respondents and nonrespondents for which we have not been able to account, and that these characteristics are strongly associated with how people spend their time. Although there are inherent limitations on the ability of any researcher studying survey nonresponse to compare the characteristics of respondents and nonrespondents, there are at least two ways in which the work we have reported can be extended.

First, the BLS has made available call history data for all of the cases selected for the 2004 ATUS. We can use these data to categorize respondents to the survey as difficult versus easy to contact, based on the number of telephone calls required to reach them and other indicators. If we assume that designated ATUS respondents who were

difficult to contact are more similar to those who did not respond than are designated respondents who were easy to contact, a comparison of the responses received from "difficult" and "easy" respondents should be informative about the direction, if not the magnitude, of nonresponse bias in the survey.

Second, we know a great deal about the ATUS respondents from the full cycle of eight CPS interviews conducted for each ATUS household. Recall that, in the CPS, the unit of observation is the physical housing unit rather than a particular set of people. This means that, for a given housing unit, the specific individuals interviewed may change across CPS waves. We have noted that people who move between the time of their last CPS interview and the scheduled date of the ATUS interview account for a significant share of ATUS nonrespondents. In most cases, people who move out of one housing unit move into another housing unit. This suggests that we might be able to learn something about the ATUS nonrespondents who were absent because they moved out by using the CPS information to identify ATUS respondents who recently moved in to a housing unit (for example, people who were not present for the wave seven CPS interview but were present for the wave eight CPS interview), and then comparing the time use reports provided by recent movers to those for ATUS respondents who had lived in the same housing unit for the full CPS fielding cycle.

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Table 1: Sample Disposition, 2003 and 2004 American Time Use Survey

Sample Disposition Code	2003 N	2003 Percent	2004 N	2004 Percent
Official Category				
Complete or sufficient partial	20,720	56.2	13,973	54.6
Refusal	7,119	19.3	4,705	18.4
Noncontact	2,694	7.3	1,827	7.1
Other non-interviews	2,685	7.3	1,932	7.5
Unknown eligibility	3,637	9.9	3,175	12.4
Total eligible sample	36,855	100.0	25,612	100.0
Not eligibile	2,086	---	1,392	---
Total	38,941	---	27,004	---
Regrouped Category				
(C) Complete or sufficient partial	20,720	53.4	13,973	52.0
(R) Refusal	7,119	18.4	4,705	17.5
(NC-1) Contact not attempted	4,113	10.6	2,895	10.8
(NC-2) Inadequate contact information	3,637	9.4	3,175	11.8
(NC-3) Unsuccessful contact attempt	2,694	6.9	1,827	6.8
(O) Other nonresponse	506	1.3	321	1.2
Total eligible sample	38,789	100.0	26,896	100.0
(NE) Not eligible	152	---	108	---
Total	38,941	---	27,004	---

Table 2: Distribution of Survey Outcomes by Respondent Characteristics, 2004 American Time Use Survey

Variable	Number in Sample	Response Rate	Contact Rate	Total Noncontact Rate	Type 1/2 Noncontact	Type 3 Noncontact	Number Contacted	Coopera-tion Rate	Refusal Rate	Other non-interview Rate
Total	26,460	52.8	70.2	29.8	22.9	6.9	18,563	75.3	23.0	1.7
Respondent's marital status										
Married householder	12,900	58.5	77.8	22.2	16.4	5.8	10,037	75.2	22.9	1.9
Widowed	1,995	53.2	70.9	29.1	25.1	4.0	1,415	75.0	22.8	2.2
Divorced	3,242	51.3	67.3	32.7	23.6	9.1	2,184	76.1	23.2	0.7
Separated	1,368	42.5	60.5	39.5	33.4	6.1	827	70.3	24.9	4.8
Never married	6,955	44.9	58.9	41.1	32.1	9.0	4,100	76.1	23.0	1.0
Respondent's hours worked										
NILF or unemployed	10,250	52.3	70.1	29.9	25.6	4.3	7,192	74.5	23.3	2.2
Less than 35 hrs/wk	2,359	58.0	74.4	25.6	19.5	6.1	1,755	77.9	21.1	1.0
35-44 hrs/wk	9,322	50.6	68.3	31.7	22.9	8.8	6,367	74.1	24.0	1.9
45 or more hrs/wk	3,057	57.6	73.3	26.7	17.5	9.2	2,241	78.5	20.9	0.5
Hours vary	1,472	52.2	68.5	31.5	21.9	9.6	1,008	76.3	22.4	1.3
Spouse hours worked										
NILF or unemployed	4,155	57.1	76.6	23.4	19.1	4.3	3,182	74.5	23.0	2.5
Less than 35 hrs/wk	1,094	59.4	79.6	20.4	14.4	6.0	871	74.6	23.8	1.6
35-44 hrs/wk	4,706	56.7	76.7	23.3	16.2	7.1	3,610	73.9	24.0	2.1
45 or more hrs/wk	2,017	65.5	81.3	18.7	12.8	5.9	1,639	80.6	18.6	0.8
Hours vary	775	57.3	79.6	20.4	14.6	5.8	617	72.0	25.9	2.1
LF status unknown	153	60.8	77.1	22.9	19.0	3.9	118	78.8	20.3	0.9
No Spouse	13,560	47.4	62.8	37.2	29.2	8.0	8,526	75.4	23.2	1.5
Presence of children age 5 and under										
No	21,432	53.0	70.8	29.2	22.5	6.7	15,170	74.9	23.5	1.7
Yes	5,028	52.0	67.5	32.5	24.8	7.7	3,393	77.1	21.0	2.0
Presence of children age 6-17										
No	17,245	52.6	69.6	30.4	23.4	7.0	12,003	75.5	22.9	1.6
Yes	9,215	53.3	71.1	28.9	22.2	6.7	6,560	74.9	23.2	2.0

Table 2: Distribution of Survey Outcomes by Respondent Characteristics, 2004 American Time Use Survey (continued)

Variable	Number in Sample	Response Rate	Contact Rate	Contact Status Total Noncontact Rate	Noncontact Rates Type 1/2 Noncontact	Type 3 Noncontact	Number Contacted	Completion Status Coopera-tion Rate	Refusal Rate	Other non-interview Rate
Housing tenure										
Own	18,288	57.3	75.9	24.1	18.0	6.1	13,878	75.5	23.4	1.2
Rent	7,862	42.3	56.8	43.2	34.5	8.7	4,470	74.4	22.0	3.6
Not in universe	310	55.2	69.3	30.7	23.6	7.1	215	79.5	20.5	0.0
Urbanicity										
Central city	6,548	47.1	64.2	35.8	27.8	8.0	4,205	73.4	23.2	3.4
Balance on MSA	11,296	53.8	72.0	28.0	21.1	6.9	8,135	74.6	23.7	1.7
Metro-Other	3,719	54.7	70.9	29.1	22.7	6.4	2,639	77.0	21.9	1.1
Non-metropolitan	4,844	56.8	73.2	26.8	20.9	5.9	3,543	77.7	21.9	0.4
Not identified	53	56.6	77.3	22.7	15.1	7.6	41	73.2	26.8	0.0
Presence of other adults not related to the householder										
No	24,321	53.9	71.5	28.5	21.8	6.7	17,396	75.3	22.9	1.8
Yes	2,139	40.7	54.5	45.5	35.8	9.7	1,167	74.6	24.1	1.3
Presence of other adults related to the householder										
No	21,143	54.2	71.4	28.6	21.7	6.9	15,102	75.9	22.7	1.4
Yes	5,317	47.2	65.1	34.9	27.9	7.0	3,461	72.5	24.4	3.2
Respondent sex										
Male	11,981	51.1	68.2	31.8	24.4	7.4	8,182	74.8	23.4	1.8
Female	14,479	54.2	71.7	28.3	21.8	6.5	10,381	75.6	22.7	1.7
Respondent age										
30 and under	6,383	45.0	58.9	41.1	32.5	8.6	3,760	76.3	22.4	1.3
31-45	8,358	51.6	69.4	30.6	21.9	8.7	5,799	74.4	23.7	1.9
46-55	4,593	57.9	76.4	23.6	16.7	6.9	3,511	75.7	22.8	1.5
56-65	3,155	60.3	79.0	21.0	16.1	4.9	2,494	76.2	21.8	2.0
Over 65	3,971	56.2	75.6	24.4	22.4	2.0	2,999	74.4	23.6	2.0
Respondent race/ethnicity										
Hispanic	3,443	45.9	59.9	40.1	33.6	6.5	2,062	76.6	18.2	5.1
Non-Hispanic Black	3,771	40.7	56.7	43.3	33.7	9.6	2,140	71.7	27.4	0.8
Other	19,246	56.4	74.6	25.4	18.9	6.5	14,361	75.6	23.0	1.4

Table 2: Distribution of Survey Outcomes by Respondent Characteristics, 2004 American Time Use Survey (continued)

Variable	Number in Sample	Response Rate	Contact Rate	Total Noncontact Rate	Type 1/2 Noncontact	Type 3 Noncontact	Number Contacted	Coopera-tion Rate	Refusal Rate	Other non-interview Rate
				Contact Status Noncontact Rates				**Completion Status**		
Household income										
Missing	4,968	40.0	66.1	33.9	27.2	6.7	3,283	60.5	37.1	2.4
Less than $20,000	4,842	46.5	60.6	39.4	33.2	6.2	2,938	76.6	20.4	3.0
$20,000-$39,999	5,696	54.2	69.7	30.3	23.2	7.1	3,966	77.9	20.1	2.1
$40,000-$74,999	5,910	59.0	74.6	25.4	17.7	7.7	4,411	79.0	19.7	1.3
$75,000 or more	5,044	62.7	78.6	21.4	14.8	6.6	3,965	79.8	19.9	0.3
Education										
Less than high school	5,106	46.4	63.7	36.3	31.6	4.7	3,251	72.9	22.9	4.3
High school	8,094	48.1	67.3	32.7	25.4	7.3	5,451	71.4	26.7	1.9
Some college	6,801	53.9	71.0	29.0	21.1	7.9	4,827	76.0	23.3	0.8
Bachelor's degree	4,293	60.5	76.3	23.7	16.2	7.5	3,273	79.4	19.7	0.9
Graduate degree	2,166	66.8	81.2	18.8	12.7	6.1	1,761	82.2	17.2	0.6
Region										
Northeast	5,216	52.1	71.5	28.5	20.9	7.6	3,732	72.8	25.1	2.2
Midwest	6,174	56.9	73.9	26.1	19.0	7.1	4,564	77.0	22.2	0.8
South	9,678	50.0	66.3	33.7	26.7	7.0	6,415	75.4	23.4	1.2
West	5,392	53.9	71.4	28.6	22.7	5.9	3,852	75.5	21.3	3.3
Telephone status										
Yes	24,975	54.0	71.9	28.1	21.1	7.0	17,965	75.0	23.3	1.7
No	1,485	33.5	40.2	59.8	54.7	5.1	598	83.1	14.1	2.8

**Table 3: Determinants of Survey Nonresponse, Noncontact and Refusal,
2004 American Time Use Survey**

Predictor	Non-response	Noncontact Total	Types 1/2	Type 3	Refusals
Intercept	-1.225	-2.033	-2.417	-3.251	-1.714
	(0.088)	(0.105)	(0.106)	(0.176)	(0.116)
Married householder (yes=1)	-0.020	-0.236	-0.178	-0.339	0.073
	(0.059)	(0.058)	(0.063)	(0.131)	(0.088)
Widowed (yes=1)	0.154	0.206	0.163	0.340	0.002
	(0.073)	(0.074)	(0.082)	(0.159)	(0.108)
Divorced (yes=1)	0.066	0.085	-0.022	0.323	0.075
	(0.056)	(0.062)	(0.066)	(0.106)	(0.089)
Spouse absent/ separated (yes=1)	0.313	0.118	0.223	-0.327	0.211
	(0.081)	(0.082)	(0.087)	(0.165)	(0.121)
Work less than 35 hrs/wk (yes=1)	-0.167	-0.182	-0.227	0.077	-0.096
	(0.055)	(0.066)	(0.073)	(0.118)	(0.101)
Work 35-44 hrs/wk (yes=1)	0.080	0.095	-0.033	0.399	0.001
	(0.043)	(0.050)	(0.052)	(0.075)	(0.071)
Work 45 or more hrs/wk (yes=1)	0.074	0.139	-0.062	0.562	-0.025
	(0.054)	(0.065)	(0.068)	(0.101)	(0.081)
Work hours vary (yes=1)	0.023	0.123	-0.091	0.610	-0.091
	(0.066)	(0.069)	(0.079)	(0.116)	(0.096)
Spouse works less than 35 hrs/wk (yes=1)	-0.069	-0.189	-0.239	0.041	0.072
	(0.080)	(0.093)	(0.104)	(0.155)	(0.278)
Spouse works 35-44 hrs/wk (yes=1)	-0.041	-0.126	-0.205	0.156	0.065
	(0.054)	(0.058)	(0.067)	(0.108)	(0.101)
Spouse works 45 or more hrs/wk (yes=1)	-0.222	-0.172	-0.227	0.029	-0.205
	(0.059)	(0.075)	(0.084)	(0.146)	(0.089)
Spouse work hours vary (yes=1)	-0.004	-0.174	-0.202	0.002	0.150
	(0.095)	(0.113)	(0.125)	(0.183)	(0.123)
Spouse labor force status unknown	-0.354	-0.274	-0.153	-0.479	-0.261
	(0.203)	(0.228)	(0.240)	(0.469)	(0.278)
Children under age 6 in household (yes=1)	0.033	0.092	0.038	0.132	-0.155
	(0.065)	(0.078)	(0.073)	(0.127)	(0.109)
Children age 6-17 in household (yes=1)	-0.278	-0.324	-0.219	-0.418	-0.094
	(0.051)	(0.060)	(0.061)	(0.108)	(0.075)
Married*Children under age 6 (yes=1)	-0.106	-0.054	0.051	-0.189	-0.001
	(0.083)	(0.101)	(0.098)	(0.165)	(0.128)
Married*Children age 6-17 (yes-1)	0.288	0.276	0.227	0.288	0.131
	(0.061)	(0.069)	(0.071)	(0.124)	(0.092)
Renter (yes=1)	0.340	0.464	0.468	0.188	-0.065
	(0.039)	(0.040)	(0.047)	(0.066)	(0.054)
Central city resident (yes=1)	0.291	0.210	0.183	0.191	0.120
	(0.047)	(0.054)	(0.058)	(0.088)	(0.065)
Balance of MSA resident (yes=1)	0.191	0.139	0.132	0.098	0.096
	(0.041)	(0.050)	(0.054)	(0.086)	(0.054)
Other metropolitan area resident (yes=1)	0.055	0.066	0.080	0.001	-0.039
	(0.047)	(0.053)	(0.061)	(0.112)	(0.066)
Adult non-relatives in household (yes-1)	0.320	0.336	0.400	-0.069	0.126
	(0.056)	(0.062)	(0.068)	(0.095)	(0.083)

Table 3: Determinants of Survey Nonresponse, Noncontact and Refusal,
2004 American Time Use Survey (continued)

Predictor	Non-response	Noncontact Total	Noncontact Types 1/2	Noncontact Type 3	Refusals
Adult relatives in household (yes-1)	0.253	0.253	0.317	-0.062	0.045
	(0.040)	(0.041)	(0.043)	(0.074)	(0.055)
Male (yes=1)	0.113	0.160	0.172	0.043	0.047
	(0.029)	(0.036)	(0.037)	(0.060)	(0.034)
Age 15-30 (yes=1)	0.522	0.775	0.652	0.727	0.179
	(0.061)	(0.072)	(0.079)	(0.117)	(0.080)
Age 31-45 (yes=1)	0.447	0.571	0.428	0.686	0.282
	(0.058)	(0.064)	(0.070)	(0.107)	(0.073)
Age 46-55 (yes=1)	0.084	0.100	0.012	0.294	0.108
	(0.057)	(0.062)	(0.071)	(0.098)	(0.071)
Age 65 plus (yes-1)	0.067	0.176	0.330	-0.794	-0.016
	(0.063)	(0.079)	(0.083)	(0.169)	(0.079)
Hispanic (yes=1)	-0.018	0.204	0.264	-0.124	-0.359
	(0.045)	(0.051)	(0.056)	(0.093)	(0.076)
Non-Hispanic Black (yes=1)	0.335	0.431	0.353	0.371	0.223
	(0.047)	(0.050)	(0.052)	(0.076)	(0.071)
Household income missing (yes=1)	0.723	0.318	0.406	-0.064	0.873
	(0.047)	(0.051)	(0.058)	(0.102)	(0.059)
Household income under $20,000 (yes=1)	0.223	0.205	0.290	-0.141	0.075
	(0.052)	(0.056)	(0.058)	(0.108)	(0.076)
Household income $20-39,999 (yes=1)	0.044	0.042	0.090	-0.067	0.009
	(0.048)	(0.055)	(0.055)	(0.086)	(0.067)
Household income $75,000 plus (yes=1)	0.048	0.059	0.113	-0.099	0.103
	(0.046)	(0.054)	(0.063)	(0.088)	(0.063)
Less than high school (yes=1)	0.198	0.086	0.159	-0.224	0.072
	(0.050)	(0.051)	(0.056)	(0.105)	(0.071)
High school graduate (yes=1)	0.218	0.146	0.163	0.025	0.190
	(0.038)	(0.042)	(0.047)	(0.077)	(0.054)
Bachelor's degree (yes=1)	-0.242	-0.190	-0.191	-0.115	-0.253
	(0.049)	(0.052)	(0.059)	(0.090)	(0.068)
Graduate degree (yes=1)	-0.394	-0.320	-0.347	-0.164	-0.400
	(0.059)	(0.072)	(0.085)	(0.115)	(0.082)
Northeast (yes=1)	0.123	0.078	0.037	0.155	0.083
	(0.043)	(0.048)	(0.056)	(0.081)	(0.060)
South (yes=1)	0.198	0.269	0.310	0.029	0.057
	(0.037)	(0.045)	(0.049)	(0.067)	(0.050)
West (yes=1)	0.110	0.069	0.151	-0.180	0.015
	(0.040)	(0.050)	(0.054)	(0.082)	(0.060)
No telephone in household (yes=1)	0.469	0.890	1.065	-0.542	-0.644
	(0.066)	(0.068)	(0.066)	(0.148)	(0.132)
N	26,460	26,460	26,460	26,460	18,563

Note. Standard errors shown in parentheses were computed in SUDAAN using a replicated variance technique.

Table 4: Marginal Effects on the Probabilities of Survey Nonresponse, Noncontact and Refusal, 2004 American Time Use Survey

Predictor	Non-response	Noncontact Total	Types 1/2	Type 3	Refusals
Married householder (yes=1)	-0.49	**-4.54**	**-2.92**	**-1.72**	1.30
Widowed (yes=1)	**3.83**	**4.36**	**2.93**	**2.31**	0.03
Divorced (yes=1)	1.64	1.76	-0.38	**2.18**	1.34
Spouse absent/ separated (yes=1)	**7.80**	2.47	**4.08**	**-1.66**	6.89
Work less than 35 hrs/wk (yes=1)	**-4.10**	**-3.56**	**-3.66**	0.46	-1.63
Work 35-44 hrs/wk (yes=1)	2.00	1.97	-0.57	**2.79**	0.02
Work 45 or more hrs/wk (yes=1)	1.84	**2.91**	-1.06	**4.22**	-0.43
Work hours vary (yes=1)	0.57	2.56	-1.52	**4.68**	-1.55
Spouse works less than 35 hrs/wk (yes=1)	-1.72	**-3.68**	**-3.84**	0.25	1.27
Spouse works 35-44 hrs/wk (yes=1)	-1.01	**-2.49**	**-3.32**	0.98	1.15
Spouse works 45 or more hrs/wk (yes=1)	**-5.44**	**-3.37**	**-3.66**	0.17	**-3.37**
Spouse work hours vary (yes=1)	-0.10	-3.40	-3.28	0.01	2.71
Spouse labor force status unknown	-8.59	-5.23	-2.52	-2.29	-4.22
Children under age 6 in household (yes=1)	0.81	1.92	0.66	0.82	-2.58
Children age 6-17 in household (yes=1)	**-6.79**	**-6.10**	**-3.55**	**-2.05**	-1.60
Married*Children under age 6 (yes=1)	-2.63	-1.08	0.90	-1.02	-0.01
Married*Children age 6-17 (yes-1)	**7.19**	**5.93**	**4.15**	**1.92**	2.37
Renter (yes=1)	**8.48**	**10.29**	**9.08**	**1.20**	-1.11
Central city resident (yes=1)	**7.26**	**4.45**	**3.30**	**1.22**	2.16
Balance of MSA resident (yes=1)	**4.77**	**2.90**	**2.37**	0.60	1.72
Other metropolitan area resident (yes=1)	1.37	1.36	1.40	0.00	-0.67
Adult non-relatives in household (yes-1)	**7.99**	**7.30**	**7.65**	-0.39	2.27
Adult relatives in household (yes-1)	**6.31**	**5.40**	**5.95**	-0.35	0.80
Male (yes=1)	**2.82**	**3.35**	**3.10**	0.25	0.83
Age 15-30 (yes=1)	**12.94**	**17.87**	**13.17**	**5.88**	**3.27**
Age 31-45 (yes=1)	**11.12**	**12.85**	**8.24**	**5.45**	**5.30**
Age 46-55 (yes=1)	2.09	2.08	0.21	**1.96**	1.94
Age 65 plus (yes-1)	1.66	**3.72**	**6.19**	**-3.33**	-0.28
Hispanic (yes=1)	-0.44	**4.32**	**4.88**	-0.69	**-5.64**
Non-Hispanic Black (yes=1)	**8.35**	**9.49**	**6.66**	**2.56**	**4.12**
Household income missing (yes=1)	**17.71**	**6.88**	**7.78**	-0.36	**18.52**
Household income under $20,000 (yes=1)	**5.55**	**4.35**	**5.40**	-0.78	1.34
Household income $20-39,999 (yes=1)	1.08	0.85	1.58	-0.38	0.15
Household income $75,000 plus (yes=1)	1.20	1.21	2.02	-0.56	1.85
Less than high school (yes=1)	**4.94**	1.78	**2.86**	**-1.19**	1.29
High school graduate (yes=1)	**5.44**	**3.05**	**2.93**	0.15	**3.48**
Bachelor's degree (yes=1)	**-5.91**	**-3.69**	**-3.12**	-0.64	**-4.11**
Graduate degree (yes=1)	**-9.51**	**-6.04**	**-5.40**	-0.90	**-6.21**
Northeast (yes=1)	**3.07**	1.62	0.64	0.98	1.48
South (yes=1)	**4.93**	**5.77**	**5.80**	0.17	1.00
West (yes=1)	**2.74**	1.43	**2.71**	**-0.98**	0.25
No telephone in household (yes=1)	**11.65**	**20.74**	**23.05**	**-2.52**	**-9.27**

Note: Changes in probability associated with having versus not having the indicated characteristic are evaluated at the mean probability for the sample, based on the coefficient estimates reported in Table 3. Figures shown in bold are statistically significant.

Table 5: Effects of Alternative Weights on Estimates of Time Devoted to Different Activities, 2004 American Time Use Survey (average hours/day)

Activity	Weight Used for Estimates		
	ATUS Base Weight	ATUS Final Weight	Weight Based on Table 3 Model
Personal care	9.26	9.33	9.32
Sleep	8.49	8.56	8.54
Household activities	1.95	1.82	1.87
Housework	0.63	0.59	0.61
Food preparation	0.55	0.51	0.53
Interior maintenance	0.12	0.11	0.11
Exterior maintenance	0.07	0.06	0.06
Lawn, garden and houseplants	0.21	0.19	0.19
Caring for household members	0.48	0.48	0.47
Caring for nonhousehold members	0.19	0.19	0.19
Work and related activites	3.29	3.37	3.30
Work	3.25	3.31	3.25
Education	0.40	0.46	0.43
Consumer purchases	0.43	0.41	0.41
Professional and personal services	0.10	0.09	0.10
Household services	0.02	0.02	0.02
Government services and civic activities	0.01	0.01	0.01
Eating and drinking	1.15	1.11	1.12
Leisure activities	4.62	4.62	4.69
Socializing	0.64	0.65	0.66
Attending and hosting social events	0.10	0.10	0.10
Relaxing	3.76	3.77	3.83
Watching television	2.59	2.64	2.68
Arts and entertainment	0.11	0.11	0.11
Sports and exercise	0.32	0.33	0.31
Religious activities	0.12	0.12	0.12
Volunteer activities	0.16	0.15	0.15
Telephone calls	0.12	0.12	0.12
Travel	1.26	1.26	1.26
Commuting to work	0.27	0.28	0.28

Appendix A: Concordance Between BLS and Own Case Disposition Codes, 2003 and 2004 American Time Use Survey

Description	BLS Case Disposition Codes Detailed	Aggregated	Own Case Disposition Codes	Number of Cases 2003	2004
Completed interview	1	C	C	20,640	13,886
Sufficient partial	2	C	C	80	87
Not eligible: Designated person underage	14	NE	NE	8	5
Not eligible: Designated person not household member	15	NE	NE	-	3
Not eligible: Designated person moved out	17	NE	NC-1	1,940	1,284
Other: Designated person absent, ill, or hospitalized	18	O	NC-1	2,173	1,611
Other: Designated person institutionalized	19	O	NE	6	5
Other: Language barrier	21	O	O	486	318
Unknown eligibility: Unpublished or non-listed number	22	UE	NC-2	1,798	1,623
Unknown eligibility: Incorrect phone number	23	UE	NC-2	360	137
Not eligible: Designated person in Armed Forces	24	NE	NE	5	6
Unknown eligibility: Privacy detector	27	UE	NC-2	8	-
Other: Non-interview	29	O	O	1	-
Not eligible: Miscellaneous	100	NE	NE	62	33
Other: Invalid input	104	O	O	11	1
Refusal: Congressional case	106	R	R	1	-
Not eligible: Case deleted as sample reduction	108	NE	NE	-	-
Refusal: Hostile break-off, Interview progress achieved	109	R	R	460	342
Refusal: By parent	110	R	R	66	40
Refusal: By individual	111	R	R	4,710	3,145
Refusal: By parent/guardian/gatekeeper	112	R	R	1,182	742
Unknown eligibility: Unproductive call counter	113	UE	NC-2	65	103
Refusal: Pre-refusal based on explicit refusal or hostile break off	116	R	R	31	-
Noncontact: Incomplete callbacks, unable to contact or call back	118	NC	NC-3	1,745	1,193
Noncontact: Temporarily unavailable, absent, ill, hospitalization	119	NC	NC-3	7	1
Not eligible: Temporarily unavailable, institutional	120	NE	NE	71	56
Other: Unresolved language barrier	121	O	O	8	2
Unknown eligibility: Privacy detectors	123	UE	NC-2	215	301
Noncontact: Never contacted, confirmed number	124	NC	NC-3	942	633
Unknown eligibility: Never contacted, unconfirmed number	125	UE	NC-2	31	15
Other: Instrument error	126	O	O	-	-
Unknown eligibility: Never tried, no telephone number	127	UE	NC-2	1,160	996

Appendix A: Concordance Between BLS and Own Case Disposition Codes, 2003 and 2004 American Time Use Survey (continued)

Description	BLS Case Disposition Codes		Own Case Disposition Codes	Number of Cases	
	Detailed	Aggregated		2003	2004
Refusal: Diary contains less than 5 activities	130	R	R	157	46
Refusal: Don't know/refuse equals more than 180 diary minutes	131	R	R	458	356
Refusal: Diary contains less than 5 activities and DK/R equals more than 180 diary minutes	132	R	R	49	32
Refusal: Other data quality issues	133	R	R	5	2
Total	---	---	---	38,941	27,004

Note: The following abbreviations are used for the case disposition codes:
　C=Complete (including sufficient partial interviews)
　NC=Noncontact
　R=Refusal
　O=Other non-interview
　UE=Unknown eligibility
　NE=Not eligible

Appendix B: Creation of Explanatory Variables Used in Analyzing ATUS Nonresponse

Code	Label	Comment
	Respondent's Marital Status (MARSTAT)	
1	Married to householder	PEMARITL=1, PERRP=1 or PERRP=3, spouse is present in the data set
3	Widowed	PEMARITL=3
4	Divorced	PEMARITL=4
5	Separated	PEMARITL=5, or respondent is married with no spouse present in the data set, or respondent is married to someone other than the householder
6	Never married	PEMARITL=6
	Respondent's hours worked (HOURS)	
-1	NILF or unemployed	PEHRUSLT=-1
2	Less than 35 hrs/wk	PEHRUSLT<35
3	35-44 hrs/wk	PEHRUSLT>=35 and PEHRUSLT<=44
4	45 or more hrs/wk	PEHRUSLT>=45
5	Hours vary	PEHRUSLT=-4
	Spouse hours worked (SPHRSC)	
-2	Labor force status unknown	No information for PEHRUSLT or PEMLR for spouse
-1	NILF or unemployed	MARSTAT=1 and PEHRUSLT=-1
2	Less than 35 hrs/wk	MARSTAT=1 and PEHRUSLT<35
3	35-44 hrs/wk	MARSTAT=1 and PEHRUSLT>=35 and PEHRUSLT<=44
4	45 or more hrs/wk	MARSTAT=1 and PEHRUSLT>=45
5	Hours vary	MARSTAT=1 and PEHRUSLT=-4
999	No spouse	MARSTAT ne 1
	Presence of children age 5 and under (AGE5C)	
0	No	Counted all persons with age <6 in household, then dichotomized
1	Yes	
	Presence of children age 6-17 (AGE617C)	
0	No	Counted all persons with age 6-17 in household, then dichotomized
1	Yes	
	Housing tenure (HTENURE)	
1	Own	HETENURE=1
2	Rent	HETENURE=2 (rented for cash) or HETENURE=3 (occupied without payment of cash rent)
3	Not in universe	HETENURE=-1 (included with reference category [owners] in regression models)
	Urbanicity (URBAN)	
1	Central city	GEMETSTA=1 or GTMETSTA=1 and GTMSAST=1 or GTCBSAST=1
2	Balance on MSA	GEMETSTA=1 or GTMETSTA=1 and GTMSAST=2 or GTCBSAST=2
3	Metro-Other	GEMETSTA=1 or GTMETSTA=1 and GTMSAST=4 or GTCBSAST=4
4	Non-metropolitan	GEMETSTA=2 or GTMETSTA=2 and GTMSAST=3 or GTCBSAST=3
5	Not identified	GEMETSTA=3 or GTMETSTA=3 and GTMSAST=4 or GTCBSAST=4
	Presence of other adults not related to householder (NORELC)	
0	No	PERRP and PRTAGE used to count the number of adults living in the household who are unrelated to the householder, then dichotomized
1	Yes	

Code	Label	Comment

Presence of other adults related to householder (RELC)

0	No	PERRP and PRTAGE used to count the number of adults living in the household who are related to the householder, then dichotomized
1	Yes	

Respondent's sex (PESEX)

0	Female	PESEX=2
1	Male	PESEX=1

Respondent's age (RAGE)

1	30 and under	PRTAGE<=30
2	31-45	PRTAGE>=31 and PRTAGE<=45
3	46-55	PRTAGE>=46 and PRTAGE<=55
4	56-65	PRTAGE>=56 and PRTAGE<=65
5	65+	PRTAGE>65

Respondent's race/ethnicity (RACE)

1	Hispanic	PEHSPNON=1
2	Non-hispanic black	PEHSPNON ne 1 and PTDTRACE=2
3	Other	PEHSPNON ne 1 and PTDTRACE ne 2

Household income (FAMINC)

-1	Missing	HUFAMINC=-1
1	Less than $20,000	HUFAMINC>=1 and HUFAMINC<=6
2	$20,000-$39,999	HUFAMINC>=7 and HUFAMINC<=10
3	$40,000-$74,999	HUFAMINC>=11 and HUFAMINC<=13
4	$75,000 or more	HUFAMINC>13

Education (ED)

1	Less than high school	PEEDUCA<=38
2	High school	PEEDUCA=39
3	Some college	PE >=40 and PEEDUCA<=42
4	Bachelor's degree	PEEDUCA=43
5	Graduate degree	PEEDUCA=44

Region (GEREG)

1	Northeast	
2	Midwest	
3	South	
4	West	