HOW DO ADOLESCENTS *SPELL* TIME USE? *

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March 2007

JEL Codes: J22
Keywords: Event history models

Abstract:

Adolescence is an important stage in a child's development. Yet, research on adolescents has concentrated either on developmental outcomes or on risky behaviors, largely overlooking the day-to-day activities of teenagers that give rise to these outcomes. We investigate teens' time use using event-history methods and time-diary information for nearly 2,300 15-18 year olds from the 2003-2005 American Time Use Survey and find evidence that disadvantaged teens spend time differently than do other teens. Living in a single-parent household and being behind grade-level in school both reduce time spent in schooling-related activities while weak labor market opportunities reduce the time teens spend in market work. The effects of household earnings and the number of adult workers in the household are found to have more complex effects.

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Introduction

Adolescence is an important stage in a child's development. Neither completely dependent nor wholly independent, adolescents occupy a middle ground in modern societies. It is during these years that individuals make significant investments in education and have their first experiences in the labor market, but it is also a period during which individuals are, as a result of their growing independence, exposed to substantial risk. Accordingly, research on adolescents has concentrated either on developmental outcomes, such as academic achievement and transitions into adult roles, or on "risky" behaviors, such as substance abuse, pregnancy, and criminal activity. In the process, researchers have largely overlooked the day-to-day activities of teenagers that give rise to these outcomes.

In this study, we investigate these activities using teenagers' time-diary reports. We hypothesize that teenagers' daily activities are affected by household circumstances, such as family composition and parental work behavior; their own employment opportunities; and institutional constraints, such as whether school is in session. Of particular interest is whether adolescents who live in economically, socially, or educationally disadvantaged circumstances possibly compound those disadvantages by spending less time in school or other beneficial activities. Time investments in schooling could be reduced, for instance, if teenagers in disadvantaged households are called upon by parents to work more outside the home or to perform more housework or child care than other teenagers. In addition, adolescents' time investments in schooling might fall in these households if teenagers are not effectively supervised.

We study these issues using time diary data for almost 2,300 15-18 year-olds who participated in the 2003-2005 American Time Use Survey (ATUS). In the diaries, subjects

reported their activities, including school, market work, household work, and sleep, over a particular 24 hour period, indicating the start, stop, and duration times of each activity. Information was also collected on many other personal, household, and geographic characteristics that we can then examine as explanatory variables.

In addition to its substantive contributions regarding adolescent time use, our study also makes an important methodological contribution by using event-history methods to analyze and model the episodes in the time diaries. Previous time use research has typically aggregated the time spent during a day on selected activities and then examined these total daily amounts. For many activities, this means working with censored distributions in which some people report spending no time at all in an activity while other people report spending varying positive amounts. Standard models for such data, including the Tobit and two-part hurdle models, make strong distributional assumptions and unfortunately, may be very sensitive to departures from those assumptions. The standard models also have trouble accounting for other features of the data, including the overall constraint on time.

In contrast to these approaches, we use event-history methods that mimic more closely the way that the time diaries are reported – as episodes or spells. We adopt a repeated spell framework that accounts for the fact that the end of one activity transitions into the beginning of another and thereby accounts for the 24-hour constraint on all activities. We also use a multiple-destination (competing-risk) framework that accounts for choices among several activities. This modeling technique also opens up new analytical possibilities, allowing us to examine time-of-day or schedule effects. We are also able to incorporate semiparametric adjustments for unobserved heterogeneity that further relax the models' distributional assumptions.

We find evidence that disadvantaged teens spend time differently than do other teens. Living in a single-parent household and being behind grade-level in school both reduce time spent in schooling-related activities while weak labor market opportunities reduce the time teens spend in market work. The effects of household earnings and the number of adult workers in the household are found to have more complex effects depending upon the gender of the teen, the level of household earnings, and the number of employed adults living in the household. We also find that time use varies greatly by age, by the type of day (school-day or non-school day), and even by the hour of the day. Our event-history models indicate that there are both direct associations between different types of time use throughout the day as well as indirect associations through the common time constraint.

Motivation

The decisions adolescents make about time use can affect them throughout their lives. Certainly it is during the teenage years that individuals make some of the most important decisions about their education, with the decisions to complete and achieve in high school being prime examples. Likewise, individuals often have their first experiences in the labor market during adolescence. The impact of formal education on subsequent earnings potential is widely documented; the impact of early work experience is less clear. Oettinger (1999), for example, found a decline in the grades of minority high school students who work long hours. Similarly, Tyler (2003) found that employment while in high school has a negative effect on 12^{th} grade math achievement. However, Ruhm (1995, 1997) and Rothstein (2006) have reported that there is little evidence that early employment is associated with reduced educational investment. In

addition, Ruhm (1995, 1997) has found that employment of high school seniors is associated with higher future earnings in many cases.

The potential links between teenagers' time use and their subsequent educational and economic attainments has motivated researchers to examine the characteristics that are associated with such time use. Family structure and income have been special items of interest. Several researchers (Peters and Haldeman 1987, Goldscheider and Waite 1991, Hilton and Haldeman 1991, Demo and Acock 1993, and Gager et al. 1999) have found that teenagers living in single-parent households spend more time in housework (including child care) than those in dual-parent households, although Hilton and Haldeman (1991) found the effect only for girls. This association makes sense if single parents are more time constrained and are more likely to call upon their older children to help. However, Goldscheider and Waite found little evidence that maternal employment or income had much of an effect on the extent to which children took responsibility for household tasks.

With respect to the time adolescents spend caring for siblings in particular, Capizzano et al. (2004) found that the probability with which adolescents are called upon to perform child care is similar by family structure but the time spent on such care is greater in single-parent households. They also found that the decision to use adolescent child care and the amount of adolescent care used are related to different factors in two-parent versus single-parent families. For two-parent but not single-parent families, parents' employment and work schedules are important. Unexpectedly, they found that in both married and single-parent households, lower income is associated with a lower probability of adolescent care but a longer duration of such care than higher income. There is other indirect evidence suggesting that older siblings do more child care in single-parent or other low-income households. Gennetian et al (2002) found that,

among adolescents whose parents were subject to state policies designed to move welfare-recipients to market work, those with younger siblings experienced the most negative effects. Indeed, adolescent children of welfare recipients who had younger siblings experienced larger negative effects on school performance, and were more likely to be suspended or expelled from and to drop out of school, than adolescent children of welfare recipients who were not subject to such policies. Thus, if parental time constraints cause adolescents to be called upon to spend more time on child care, there may be negative spill-over effects on the adolescents' educational outcomes.

Parental income constraints could also dictate adolescent time use. Attanasio et al. (2006) evaluated the effect of a subsidy program on the school enrollment and labor of children in Columbia, where the subsidy provided the equivalent of US$6 to the mothers of children attending primary school and US$12 to the mothers of children attending secondary school, and found that the program substantially increased the enrollment rates of 14-17 year old children and had a positive smaller effect on the enrollment of younger children. They also found that the program had a positive effect on time children spent in school, with a larger effect for younger children. They also found for younger children that the subsidy substantially reduced their participation in domestic work; however, participation in income-generating work was unaffected. However, Johnson and Lino (2000) found that while approximately a third of all teens in the U.S. were employed at some time during the period 1997-1998, working teens do not appear to be contributing toward family necessities, even those living in lower-income or single-parent households.

There exists as well a broader literature linking family structure and household income to children's outcomes. For example, there are a number of studies that linked family structure to

children's educational attainment (DeLeire and Kalil 2002; Ermisch, Francesconi, and Pevalin 2004; Painter and Levine 2004). Painter and Levine (2004) further found that the lower income available in single parent households reduced the probability of attending college. Other studies link family structure to other outcomes. DeLeire and Kalil (2002) found that teenagers who live in nonmarried families are more likely to smoke or drink and to be sexually active. Ermish, Francesconi, and Pevalin (2004) found that living in a single-parent family with jobless parents during early childhood leads to higher risks of early birth, smoking, and psychological distress. Lang and Zagorsky (2001) found that living without a mother affects girls' cognitive development. However, none of these articles directly addresses teenage time use itself.

We examine time use itself for adolescents, using information on a broad array of explanatory variables. As observed in the literature, we hypothesize that family structure and income are likely associated with time use. Specifically, we believe that single parent households may face greater time constraints than two parent households and these constraints may result in adolescents in such households being more likely to be called upon to perform household service in the form of housework, child care, and possibly employment. Alternatively, it may be that single parent households are less able to supervise adolescents and this lack of supervision could have time use implications. Household resource issues may also come to bear in low-income households where adolescents may be relatively low-cost service providers. Youths who are already disadvantaged in the education sector may either spend additional time to try to catch up, or may allocate their time in such a way as to further their disadvantage.

Of course, other household characteristics are also likely to influence the time allocation decisions of teenagers either because they reflect household or personal needs or because they

reflect opportunities. Call, Mortimer, and Shanahan (1995) found that both boys and girls contributions to household work were responsive to family need as measured by the size of the family, the amount of financial resources available to the family, and the time availability of mothers. In the case of child care concerns, only households with younger children are likely to demand child care services. For market work, local unemployment rates are likely to wield some influence as a harbinger of employment opportunities though Ribar (2001) previously reported that local economic conditions have only modest effects on the schooling and work among youths who have yet to complete high school.

Data and Methodology

The data proposed for this analysis are publicly available time-diary data from the American Time Use Survey for 2003-2005. The ATUS is a nationally representative time diary study that has been conducted monthly since January 2003 by the U.S. Bureau of the Census for the U.S. Bureau of Labor Statistics. Subjects for the ATUS are drawn from households in their last month of participation in the Current Population Survey (CPS). One person aged 15 or over within each outgoing CPS household is randomly-selected to participate. Our analysis focuses on 15-18 year olds who live with at least one parent, do not have children of their own living in the household, and have not completed a high school degree. The lower-end age restriction is imposed because of the ATUS interview restrictions. The restriction to those without a high school credential is imposed in order to capture youth who are still potentially in the secondary school system rather than introduce additional questions about the time use and living arrangements of college students. This latter restriction has a substantial impact only on the sample of 18 year olds in our sample.

The most distinctive feature of the ATUS survey is its time-use component which consists of a short (24-hour), retrospective time diary describing how the respondent spent his or her time. Individuals describe what they were doing throughout the day, and the descriptions are later coded into standardized activities. Respondents whose diaries are missing an hour or more of information are excluded from our analysis. Each respondent completes only one such survey, but the interviews are conducted every month of the year and every day of the week, with a higher proportion of interviews occurring on weekends to achieve an approximate balance between weekday and weekend reports within the sample.

The survey also collects household roster and demographic information. The survey subjects are asked to identify who else lives in the household and to list each member's gender, age, and relationship to the subject. These rosters are used to construct household composition measures. Adolescents who report having only one parent present at the time of the time diary and adolescents whose parent indicates being unmarried are coded as living in a single-parent household.[1] Other conditioning variables include indicators for whether the parents in the household worked and whether their earnings reports were missing as well as a measure of the log of their combined weekly earnings; the number of other adults and the number of other adolescents in the household; the number of younger children in different age ranges in the household; indicator variables for the race/ethnicity, age, metropolitan status of the household; and the state unemployment rate. We also include an indicator for whether the teenager was more than a year behind average in his/her grade level.

In our analysis we also condition upon characteristics of the diary day itself. Dummy variables are included to identify diary days that fell on weekends or holiday days and diary days

[1] We code married couples who are living apart as single-parent households because the household time constraints more nearly resemble those of single-parent households.

that likely fell on weekdays during the school year. To identify weekdays during the school year, we examined the relation between month and school enrollment status. Relatively few secondary students were actively enrolled during June, July, or August. Likewise, school is rarely in session between the Christmas and New Year's holidays. Thus, we designated weekdays during September through May, excluding the winter holiday as school weekdays. It is important to distinguish between these types of days because attending school takes up a substantial portion of the day on school days. Characteristics of our analysis variables are shown in Table 1.

Activity spell data. The activity data in the ATUS are recorded in a spell format that includes the type of activity, its start time, and its end time. The focus of our analysis will be upon school-related activities including classroom time, homework, and other school-related activities (but not school sports activities); market work activities; household work activities such as those generally designated housework and care for household children; and sleep- or rest-related activities. To prepare these data for our analysis, we collapse the detailed activity types into these four mutually exclusive categories and a fifth category we designate as 'other'. We then concatenate all consecutive spells for a person that are of the same broad type; for instance, a spell of doing the laundry followed by a spell of house cleaning is treated as a single spell of housework. Collapsing the activities this way reduces the number of spells by about two-thirds.

Next we take some steps to simplify our subsequent event history analyses and reduce the number of minor transitions that we need to consider. In particular, we restrict the sample to only include teenagers who were sleeping at or within 10 minutes of 4 a.m. on the initial day of the diary and at or within 10 minutes of 4 a.m. on the final day of the diary. Thus, we only have

to consider a single origin and a single terminating type of activity—sleep. This restriction reduces the sample by 130 teenagers, or about 5 percent. From our concatenated spells, we then drop 433 activity spells that were reported to have lasted 5 minutes or less (a reduction of 2.5 percent of the available concatenated activities and 0.05 percent of the total time reported in the diaries).

We next concatenate "new" sleep spells that began before 6:30 a.m. and that were preceded by single short non-sleep activities with earlier sleep spells, thus dropping the intervening activities and treating the initial and subsequent periods of sleep as continuous spells. Similarly, we concatenate non-terminal sleep spells that began after 12:30 a.m. with the terminal sleep spells. These changes only affect 10 spells. We then recode all of the remaining (373) non-initial and non-terminal sleep spells (naps) as "other" activities. Although we would have like to have examined these sleep spells, there were simply too few of them to model separately.

Our final analysis sample has information on 8,198 concatenated activity spells for 1,115 teenage girls and 7,615 such spells for 1,164 teenage boys. All of the teenagers report at least three activity spells. The median number of concatenated activity spells is seven. For our event history analyses we break the spells into 10-minute segments. Each segment indicates whether the spell continued or whether a transition occurred.

The transition patterns based on the interval data are shown in Table 2.[2] As we would expect given the large number of intervals (144) and the modest number of spells during the day, most of the interval-to-interval observations are continuations of activities. Thus, spell continuations vastly outnumber spell transitions. When we do look at the actual changes in

[2] Although the ATUS diary format is very flexible and allows individuals to report spells of any length, most of the activities were reported to end on 10-minute intervals. Thus, the time intervals are essentially reported in discrete intervals.

activities we see that that most of these (80 percent) involve transitions into or out of the other activity.

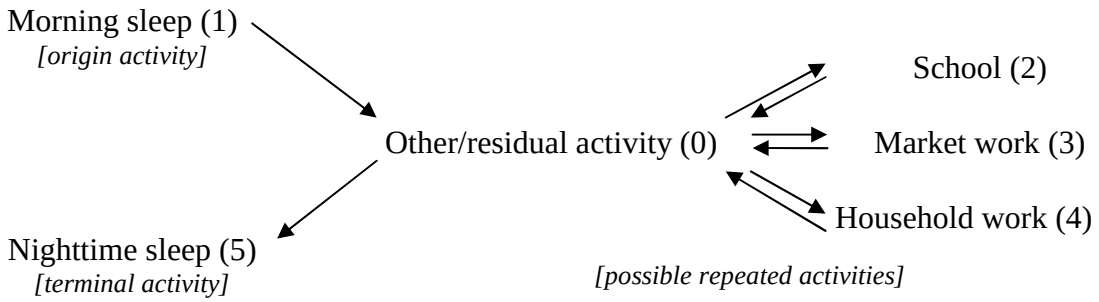
The distributions of activities across the spans of school days and non-school days are shown in Figure 1 separately for teenage girls and boys. Figure 1 plainly shows that activities are not evenly distributed within or across days, mostly in ways that we would anticipate. For example, most schooling occurs between 7 a.m. and 3 p.m. on weekdays during the school year—hardly a surprising result. Sleep is concentrated early and late in a diary day, with teenagers rising earlier on school weekdays. Household and market work are more likely to occur on non-school days than school days. To the extent that these activities do take place on school days, they tend to occur in the afternoon and early evening. Finally, the graphs show that when teenagers are not attending school, the "other" activity dominates their waking hours.

Econometric Model

We model the transitions between the broad groups of activities defined in the previous section using discrete-time hazard methods. In principle, we could use these methods to examine each of the 20 types of spell transitions in Table 2; however, several of the transitions occur relatively infrequently. To simply the econometric analysis, we avoid directly modeling some of the rarer patterns by assuming that all spells of morning sleep, school, market work, and household work transition into a spell of the other/residual activity category and that all spells of school, market work, household work, and nighttime sleep similarly begin after a spell of other activities. We do this in the data by inserting a short, artificial other-activity spell between each pair of adjoining "named" spells. This simplification reduces the types of transitions we model to eight: four transitions from the "named" activities into the other/residual activity and four

transitions from the other/residual activity into "named" activities. The observations for each teenager begin with a spell of morning sleep and end with a spell of nighttime sleep; so these activities are modeled as one-way, origin and terminal activities. All of the other activities may be repeated during the day. The types of transitions are illustrated in the following diagram.

Modeled transition processes



Transitions into the other/residual activity. Spells of morning sleep, school-related activities, market work, and household work activities are modeled using single-destination, discrete-time logistic hazard specifications (Allison 1982). In these specifications, the log odds ratio of the hazard of exiting a spell of activity j (= 1 morning sleep, = 2 school, = 3 market work, = 4 housework and care) is a function of the duration of the spell (d), the time of day (t), family structure and economic circumstances (F), other observed covariates (X), and an unobserved, person-specific variable (η) such that

$$\ln[h_{j,d,t}/(1-h_{j,d,t})] = \alpha_{j0}A_d + \beta_{j0}B_t + \gamma_{j0}F + \delta_{j0}X + \lambda_{j0}\eta \qquad j = 1, 4 \qquad (1)$$

where A_d is a vector of duration controls for the spell, B_t is a vector of time-of-day and cumulative activity duration controls, and α_{j0}, β_{j0}, γ_{j0}, and λ_{j0} are vectors of coefficients to be

estimated.[3] The specification is a proportional hazards model, in which the term $\alpha_{j0}A_d$ accounts for the baseline duration dependence pattern, and the other terms shift this pattern up or down.

Transitions out of the other/residual activity. For the transitions out of the other/residual activities ($j = 0$), we use a discrete-time, multiple-destination (competing-risk) framework. In particular, we use a multinomial logit specification for the potential destinations

$$h_{0j,d,t} = \frac{\exp\left(\alpha_{0j}A_d + \beta_{0j}B_t + \gamma_{0j}F + \delta_{0j}X + \lambda_{0j}\eta\right)}{1 + \sum_{k=2}^{5}\exp\left(\alpha_{0k}A_d + \beta_{0k}B_t + \gamma_{0k}F + \delta_{0k}X + \lambda_{0k}\eta\right)} \qquad j = 2, 5 \qquad (2)$$

where the variables and coefficients have the same definitions as in the single-destination specifications. Also like the earlier specifications, the multinomial models incorporate a proportional hazards restriction.

Unobserved characteristics. Each of the models includes a common unobserved variable, or factor, η, to control for possible problems of spurious duration dependence within spells and for potential associations in behavior across spells that may arise from unmeasured, person-specific characteristics. The factor-analytic specification is moderately flexible, yet tractable. In principle, more factors could be introduced; however, we found that the model had trouble converging when we moved beyond one factor.

For the distribution of the unobserved factor, we adopt a semi-parametric, discrete distribution, following the approach of Heckman and Singer (1984). The distributions include four points of support for girls and three points of support for boys, with the locations and probabilities of these points being estimated. For each gender, the system of specifications, consisting of a single-destination logit for the initial spell of morning sleep and repeating single- and multiple-destination models for spells of the other activities, together with the common

[3] To reduce the amount of notation, we omit subscripts identifying the teenager and the spell.

discrete factor for unobserved heterogeneity, are estimated jointly using the aML software package (Lillard and Panis 2003).

Although our event-history approach is more complicated than the methods that are usually employed to examine daily time-use data, we see several crucial advantages in this technique. Most importantly, our approach conforms to the underlying structure of the data and reporting process for activities in the ATUS. Event history models are a natural way to model the duration of spells and hence activities, but they also respect other features of the data. In particular, they allow us to model entry into different activities, thus letting us examine and distinguish between characteristics that contribute to the incidence and duration of these activities. The models also fully account for the reported uses of time being mutually exclusive. In previous research, the restrictions associated with mutual exclusivity and the daily time constraint for multiple activities have only been addressed informally, such as through seemingly unrelated regression specifications (e.g., Kalenkoski et al. 2005, 2007). Through the spell duration, cumulative duration, schedule and finite-mixture heterogeneity controls, the models account for the distributions of activity times in a comprehensive and logically consistent way. We avoid the distributional problems inherent in standard Tobit models and can apply the methods in circumstances where other less restrictive approaches, such as Censored Least Absolute Deviations (CLAD), cannot be applied.[4] Finally, the methods allow us to examine particular, relevant features of time use, such as time-of-day effects and heaped reporting times, that studies have typically either overlooked or addressed in relatively ad hoc ways (e.g., Brayfield 1995, Hamermesh 2005, Presser 1986, 1988, 1994).[5]

[4] The CLAD procedure can only be applied if the incidence of an activity is more than 50 percent.
[5] An exception is Hamermesh's (1999) study, which comprehensively examined work probabilities at every hour of the day.

General specification issues. Our event history models incorporate parametric controls for duration and time-of-day effects. While the controls we adopt are relatively flexible, some initial specification decisions are still required. After an examination of the spell distributions and some initial testing, we adopted piecewise linear specifications (linear splines) for the duration dependence patterns, with the segments connecting at two-hour intervals during a spell up to the eighth hour. Unlike a series of dummy-variable (step-function) controls, the piecewise linear specifications avoid discrete jumps at the connecting points of the baseline hazard function. That said, descriptive analyses did reveal that all of the hazards exhibited spikes at regular 30- and 60-minute intervals—these occur because people tend to report activities in half-hour and hour increments. To account for this reporting behavior, all of our models include dummy controls for spell intervals that end in a 30- or 60-minute increment. This approach is similar to the method commonly used to address "seam" reporting in event history analyses of panel data with retrospective questions covering intervening activities. While the locations of the connecting segments and the dummy controls are fixed, the other shape parameters—the slopes along the piecewise linear functions and the levels of the spikes associated with the dummy controls—are all estimated and therefore determined by the data.

Our model also allows for separate time-of-day effects depending on whether the activity occurred on a weekday during the school year or some other day. For each type of day and for most of our activities, we specify piecewise linear functions that are constrained to be flat from 4 a.m. to 7 a.m., to have a two-hour segment running to 9 a.m., and to have three-hour segments thereafter through either 9 p.m. or 12 a.m., depending on the activity. The transition to nighttime sleep is specified somewhat differently with a long flat segment running through 6 p.m. and two three-hour intervals thereafter. In each of the models, the flat segments early and late in the day

correspond to times when there were very few transitions. These restrictions are needed to avoid conditioning (near-complete sample separation) problems in the discrete-choice models at thin points in the time-of-day distributions. Again, slopes of the other segments of the piecewise linear functions are estimated.

In addition to these controls, all of our models, except the hazard function for morning sleep, incorporate measures for the cumulative amounts of time spent in sleep, school, market work, and household work and care from 4 a.m. forward. These cumulative duration effects are identified separately from the within-spell duration effects by times spent in previous spells (the cumulative duration and within-spell durations are the same within the first spell of an activity but differ in any subsequent spells).

Results

Table 3 lists coefficient estimates from the time-use transition models for teenage girls, and Table 4 lists the corresponding estimates for teenage boys. In each table the first four columns contain estimates from the single-destination logit models of transitions from morning sleep, schooling, market work, and household work activities to the other/residual category. The last four columns contain estimates from the competing-risk, multinomial logit models of transitions from the other/residual category to schooling, market work, household work, and nighttime sleep activities.

The first row in each table lists coefficients for living in a single parent household. The estimates indicate that girls in single-parent households sleep much later in the mornings, on average, than girls in other households. Boys in single-parent households are also estimated to sleep later than boys in other households, though the coefficient is not statistically significant.

Single parenthood is significantly negatively associated with transitions into household work for boys. More generally, single parenthood is associated with continuing with other/residual activities for boys. The pattern of results is consistent with adolescents in single-parent households engaging in less structured activities perhaps because they are less supervised than adolescents in couple-headed households.

The effect of parental employment and earnings on adolescent time use necessitates examining more than one parameter estimate. That is because we separately identify the impact of having a working adult and the impact of parental earnings and they frequently enter with different signs. Thus, a teenage girl with employed parents is less likely to transition out of housework but higher parental earnings increase the transition rate. The 'tipping' point in this case occurs when earnings are around $170 per week: earnings below about $170 per week are associated with longer spells of housework for girls, whereas earnings above about $170 per week are associated with shorter spells. Similarly, living in a household with a working, but low-earning adult is associated with earlier waking times for boys and earlier bed times for boys. In households with high-earning adults the patterns are reversed with weekly earnings above about $170 being associated with shorter spells of housework for girls and weekly earnings above about $300 being associated with later nights for boys. Living in a household with a second working adult reduces the chances that a teenage girl will begin a school activity.

Girls living in households with children aged six years and under appear to perform less market work than other girls. They are significantly more likely to transition out of a spell of market work and somewhat less likely to transition into a spell of market work. In contrast, the number of children aged 7-11 is associated with a higher probability of transitioning to market

work for girls. Children aged 7-11 are also positively associated with initiating household work spells for girls and continuing household work spells for boys.

As one might expect, time use changes as teenagers age. Older boys and girls are substantially more likely to transition to market work activities in the course of a day and somewhat less likely to transition to school activities. They also tend to stay up later than younger teenagers. Older girls have a higher probability of transitioning into household work but also have a higher probability of transitioning out of household work (have more but shorter spells) than younger girls. For boys, the length of household work spells appears to increase as they age.

Teenage girls who are below grade-level in their schooling are less likely than other girls to transition into school-related activities and slightly more likely to transition out of a school activity, indicating that they are more likely to fall even farther behind. Girls who are behind in their schooling also tend to have longer household work spells and to go to bed earlier in the evening. Being behind in schooling is less predictive of boys' time use.

There are also racial and ethnic differences in teenagers' time use. Black girls are less likely to begin spells of household work than other girls, while black boys are more likely to curtail a spell of household work. Black teenagers (boys and girls) also tend to stay up later than other teenagers. Hispanic youth are less likely to begin a market work spell than non-Hispanic youth. Hispanic girls tend to have longer school activity spells than other girls.

Economic conditions also appear to play a role. Girls in weak labor markets have lower probabilities of transitioning into either work or school but also lower probabilities of transitioning out of these activities than girls in better labor markets. Boys in weak labor

markets have lower probabilities of transitioning into market work or household work and higher probabilities of transitioning out of school than other boys.

The cumulative amounts of time that teenagers spend during the day in certain activities are also associated their subsequent time use. For example, sleeping later in the morning is associated with a lower probability of starting a school activity for girls and boys. Sleeping later is also associated with staying up later in the evening. It is also associated with a lower probability of going to work for girls. There is a positive association between the amount of school time earlier in the day and participating in school activities later in the day. More school-time earlier in the day for girls is associated with fewer transitions to work later. More household work is associated with fewer but longer subsequent market work spells for girls and boys.

Testing confirmed that controls for unobserved heterogeneity should be included in the models. For girls and boys, the coefficients on the heterogeneity term tended to be either significantly positive or close to zero. Positive heterogeneity terms indicate that the unobserved characteristics were associated with more transitions generally. For example, girls with unobserved characteristics that made them more likely to transition out of the other/residual activity into market work were also more likely to transition into schooling and household work; they were also more likely to transition out of schooling and market work. Boys who were more likely to transition into market work were also more likely to transition into household work and transition out of market and household work.

Simulation results. Several complications in the transition models make the coefficients from Tables 3 and 4 difficult to interpret. First, the coefficients all come from non-linear models, and the coefficients for the multiple-destination portion of the model are expressed in

terms of a relative, rather than an absolute index. So transformations are needed just to determine the marginal effects on transition probabilities. Second, the transitions themselves are hard to interpret in a repeated events framework because increases (decreases) in the time spent in one activity reduce (increase) the time available for subsequent activities. And third, all but one of the transition models (the transition that involves waking up) include cumulative amounts of time in previous activities as explanatory variables, which leads to additional dependencies across specifications.

To better examine the implications of the transition models, we conduct a series of simulations. The simulations apply the coefficient estimates from Tables 3 and 4 to samples in which we replicate each observation from the 2,279-person analysis sample 25 times, randomly assigning different values of the unobserved characteristic, η, to each replicated person. Selected observable characteristics from the analysis sample are changed in each simulation, while the remaining characteristics are held at their observed values. Transitions are simulated by calculating hazard probabilities at each point in time throughout a day for the constructed samples conditioned on what was simulated for the person previously in the day. This hazard is then compared to a random draw to simulate a possible transition. Daily time use amounts are then calculated based on the simulated transition paths. Table 5 lists results from simulations that use the model for our sample of teenage girls, while Table 6 lists similar results for teenage boys.

The first row of each table lists results from a baseline simulation conducted using the actual observed characteristics in the sample. The simulations do an excellent job of reproducing the average minutes and incidence of each of our activities. The results are even more remarkable when we consider that the outcome data from Table 1 were transformed to remove

very short activity spells and short breaks in spells, recode non-terminal sleep activities into "other" activities, and insert short artificial "other" spells between some types of transitions.

The remaining rows in Tables 5 and 6 list average estimated changes in the amount and incidence of each activity (marginal effects) associated with changes in selected characteristics. The first of these marginal effect simulations compares the predicted time use for the sample assuming that all of the teenagers were in single-parent households, with the predicted time use assuming that all of the teenagers were in married-parent households. As we examine the results for girls, we see that single-parenthood is associated with a sizeable increase (more than half an hour) in girls' sleep times, which is consistent with our earlier interpretation of Table 3. The simulations reveal that single-parenthood is also associated with small increases in girls' market and household work; these arise mostly because of the modestly positive but insignificant coefficients on transitions from "other" activities to market and household work and the small negative coefficients on transitions from these activities back into the other category. There is also a small decrease in minutes girls spend in the "other" category. As a consequence of these changes, the average time spent in school-related activities drops by three-quarters of an hour (about 20% calculated using the baseline school time of 247 minutes). Recall that the coefficients on single-parenthood in the schooling components of the model are close to zero. Thus, the large association between parents' living arrangements and the time that girls' devote to schooling is almost entirely indirect.

When we examine the corresponding results for teenage boys, we see the highlighted result from Table 4 that single-parenthood is associated with less household work. This comes about mostly because of a large reduction (about one-sixth) in the incidence of household work. The simulations for boys also indicate that living in a single parent household is associated with

roughly a 10 percent decrease in the amount of schooling, a 20 percent decrease in the amount of market work, a ten percent increase in the amount of "other" activities, and almost no change in sleep.

The simulations indicate that teenagers in households with a working but low-earning parent spend more time in school-related activities and market work and less time in household work, "other" activities, and sleep than those with non-working parents. As the earnings of the parent increase, girls' and boys' uses of time respond differently. For girls, higher parental earnings are associated with more schooling and sleep but less market and household work. For boys, higher parental earnings are associated with less schooling and sleep and slightly more market and household work. The addition of a second worker, holding total earnings and other things constant, is associated with a decrease in girls' school times and an increase in their market work times. For boys, the addition of a second worker is associated with a decrease in their own market work but few other changes in time use.

For girls and boys, the addition of a child 11 and under is associated with more household work. For girls, more young children are associated with small decreases in schooling; for boys, the changes are smaller still. The marginal associations with market work for teenage girls differ depending on the age of the added child, with children ages six and under being associated with less market work and children ages seven to eleven being associated with more market work.

The simulations indicate that black and Hispanic teenage girls spend more time in school (though with almost no change in the incidence) than other girls. Black girls also spend less time sleeping than non-black girls, while Hispanic girls spend less time in market work. Black boys spend substantially less time in school and less time in household work than non-black boys. Teenage Hispanic boys spend less time in market work than other boys, especially blacks.

The incidence of market work and the time devoted to this activity consistently increase with age for teenage girls. Among the boys in our sample, market work increases through age 17 then drops off. The time spent in school is substantially lower among the 18-year olds in our sample than other teenagers. Recall, however, that the sample is restricted to teenagers who have not completed high school.

Teenage girls who are educationally disadvantaged, as measured by being more than a year behind in school, spend much less time (almost an hour less) in educational activities than other girls. Boys who are behind in school spend almost half an hour less time in educational activities than other boys. Girls who are behind in school are estimated to spend more time in household work and sleep than their peers, while boys who are behind in school are estimated to spend more time in market work and sleep.

Higher unemployment rates are associated with less time in market work for teenage girls and boys. The implied elasticities in terms of work times are substantial at -0.8 for girls and -1.2 for boys. Unemployment rates do not appear to be strongly associated with the amounts of time that teenagers devote to schooling, household work, or sleep.

The simulations show that there are profound differences in time use between schooldays and other days. On weekdays outside the school year, teenagers spend very little time on educational activities (about 90 minutes for girls and 60 minutes for boys).[6] Teenage girls are twice as likely to work on non-school weekdays as on school weekdays, while boys are 50 percent more likely. Market work hours show even more pronounced differences increasing by 150 percent on non-school weekdays for girls and by 118 percent for boys. Teenagers also sleep more on non-school days and perform more household work. The contrast between weekend

[6] Recall that our school-year variable is relatively crude and misses regular school days that occur in June and August.

days and school weekdays is very similar, with the exception that teenagers work less on weekend days than non-school weekdays.

Sensitivity analyses. Our transition models include numerous controls for the distributions of and associations among different types of time use. Tests generally reject restricted specifications that omit these controls. Nevertheless, we estimated and examined transition models with fewer controls. The substantive results from these specifications were similar to those reported in Tables 3 and 4. The differences in the specifications were mostly confined to the activity spell duration controls and to the time-of-day controls.

As a second general check of our specifications and simulation results, we ran simple regressions of the total amounts of time use and the incidence of schooling, market work, and household work. The regressions do not account for censoring, clumped reporting, and other problems in the data. However, the resulting coefficients can be directly interpreted as marginal effects and help us to evaluate whether the estimates from our more complicated specifications are reasonable. Results from these regressions, shown in Appendices A1 and A2, are similar to results shown in Tables 5 and 6.

Finally, we were concerned that some of our results regarding schooling might simply be attributable to youths' enrollment decisions. About one-eighth of the teenagers in our sample report that they were not enrolled in school at the time of the ATUS interview. We re-estimated our models on a restricted sample of enrolled youth but found few differences in the results.

Conclusion

Adolescence is an important stage in a child's development. Yet, research on adolescents has concentrated either on developmental outcomes or on risky behaviors, largely overlooking

the day-to-day activities of teenagers that give rise to these outcomes. We investigate these activities using event-history methods and time-diary information from nearly 2,300 15-18 year olds available in the 2003-2005 ATUS. Specifically, we examine the time that teenagers spend in school, market work, household work, sleep, and other activities across the day.

Our analysis considers several measures of disadvantaged circumstances, including living with a single parent, living in a non-working or low-earning household, living in a high unemployment area, and being behind in schooling. We find evidence that each of these forms of disadvantage affects how teens spend their time and that the effects are different for boys and girls. For example, girls who live in a single-parent household sleep more, work more inside and outside the home, and spend less time in school than other girls. Boys who live in a single-parent household spend less time in school than other boys, but they also perform less market and household work, a result opposite to that for girls.

With respect to household income and parents' employment status, living in a household with one working, low-earning parent is associated with teens spending more time in school and market work and less time in household work, sleep, and other activities than teens with non-working parents. However, as earnings increase, boys and girls respond differently. Higher household earnings lead girls to spend more time in school and sleep and less time in market work and household work while boys do just the opposite, spending less time in school and sleep and more time in market and household work. The employment of a second household adult is associated with girls spending less time in school and more time in market work and boys spending less time in market work.

Educational disadvantage is also found to have an impact on teens' time use. Girls who are behind in their schooling spend less time in school, more time in household work, and more

time in sleep than other girls. However, while boys also spend less time in school, they spend more time in market work and sleep. Finally, weak labor market opportunities, as measured by the unemployment rate, decrease market work for both boys and girls.

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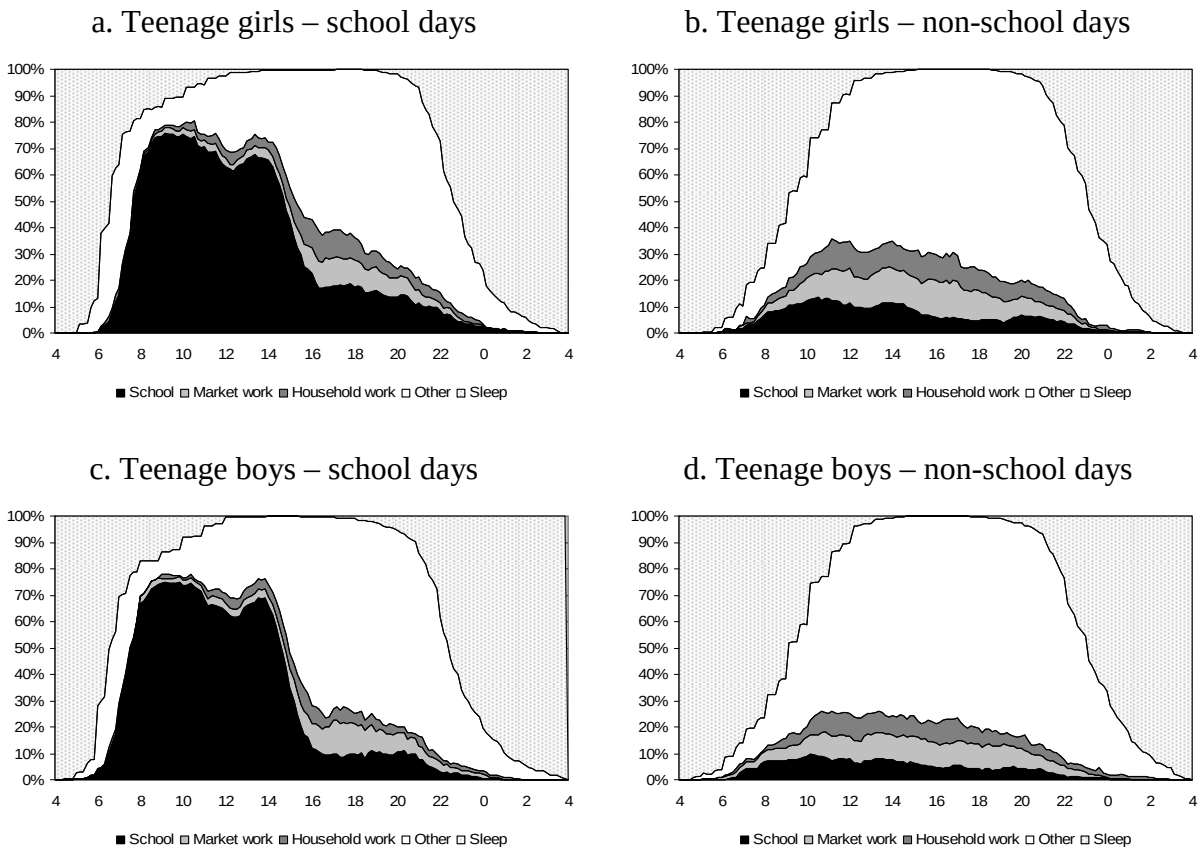
Figure 1. Distributions of time use across the day



Notes: Statistics calculated using data from the 2003-5 ATUS; statistics incorporate sampling weights supplied with ATUS.

Table 1. Means and Standard Deviations of Analysis Variables

	Teenage girls		Teenage boys	
	Mean	Std. dev.	Mean	Std. dev.
Outcome Variables				
Minutes spent in school and related activities	239.42	250.00	214.01	237.31
Any time in school and related activities	0.59	0.49	0.53	0.50
Minutes spent in market work	66.15	146.46	63.24	151.96
Any time in market work	0.22	0.41	0.20	0.40
Minutes spent in household work	59.67	94.13	44.93	82.04
Any time in household work	0.61	0.49	0.47	0.50
Minutes spent in other activities	539.32	210.30	571.40	228.15
Minutes spent in sleep	544.47	142.11	554.31	144.40
Explanatory Variables				
Single-parent household	0.28	0.45	0.24	0.45
Earnings information missing for all adults	0.05	0.21	0.03	0.17
One adult works	0.90	0.30	0.89	0.31
Earnings information missing for second adult	0.43	0.50	0.38	0.49
Second adult works	0.43	0.49	0.46	0.51
Weekly adult earnings	1033.95	842.08	1011.52	789.39
Number of children aged 0-6 in household	0.13	0.41	0.16	0.44
Number of children aged 7-11 in household	0.28	0.54	0.27	0.54
Number of children aged 12-18 in household	0.73	0.77	0.74	0.77
Number of other adults in household	0.39	0.65	0.45	0.74
Hispanic	0.16	0.37	0.20	0.40
Black	0.16	0.36	0.16	0.36
Urban	0.82	0.38	0.84	0.36
Age	16.39	1.05	16.43	1.05
Behind in schooling	0.07	0.26	0.12	0.32
School weekday	0.52	0.50	0.51	0.50
Weekend or holiday	0.28	0.45	0.32	0.47
State unemployment rate	5.60	0.99	5.63	0.98
Year = 2004	0.27	0.45	0.30	0.46
Year = 2005	0.28	0.45	0.27	0.45
Number of respondents	1115		1164	

Notes: Statistics calculated using data from the 2003-5 ATUS; statistics incorporate sampling weights supplied with ATUS.

Table 2. Numbers and percentages of interval transitions

a. Teenage girls

		Destination activity				
		School	Market work	HH work	Other	Sleep
Origin activity	Sleep	24 **0.01**	11 **0.01**	63 **0.04**	1016 **0.63**	59593 **36.88**
	School	25312 **15.67**	23 **0.01**	148 **0.09**	1156 **0.72**	58 **0.04**
	Market work	19 **0.01**	7014 **4.34**	29 **0.02**	306 **0.19**	8 **0.00**
	Household work	97 **0.06**	30 **0.02**	5501 **3.40**	973 **0.60**	52 **0.03**
	Other	1244 **0.77**	298 **0.18**	912 **0.56**	56683 **35.08**	997 **0.62**

b. Teenage boys

		Destination activity				
		School	Market work	HH work	Other	Sleep
Origin activity	Sleep	57 **0.03**	22 **0.01**	68 **0.04**	1017 **0.60**	63358 **37.59**
	School	23687 **14.05**	34 **0.02**	80 **0.05**	1063 **0.63**	47 **0.03**
	Market work	23 **0.01**	6990 **4.15**	36 **0.02**	300 **0.18**	13 **0.01**
	Household work	42 **0.03**	24 **0.01**	4327 **2.57**	797 **0.47**	39 **0.02**
	Other	1102 **0.65**	293 **0.17**	719 **0.43**	63333 **37.58**	1065 **0.63**

Note: Authors' calculations from the 2003-5 ATUS. Numbers of transitions appear in regular font and percentages appear in bold. Sleep-to-sleep transitions combine transitions with initial and terminal spells and do not include any transitions from initial to terminal spells. Calculations incorporate sampling weights.

Table 3. Activity Transition Model Results for Teenage Girls

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market work	HH work	Schooling	Market work	HH work	Sleep
Household and personal controls:								
Single parent household	-0.4517**	-0.0588	-0.0652	-0.1313	0.0199	0.2303	0.1791	-0.1048
	(0.1808)	(0.1422)	(0.4014)	(0.1417)	(0.1362)	(0.2837)	(0.1406)	(0.1663)
Earnings information	-0.1122	0.0721	0.7183	0.0824	0.5735**	0.8990*	-0.1205	-0.2843
missing for all adults	(0.3176)	(0.2469)	(0.7280)	(0.3003)	(0.2522)	(0.5353)	(0.2790)	(0.2812)
Adult in household works	0.5137	0.5528	0.5156	-0.9330*	-0.0915	1.6057	-0.4363	-0.1155
	(0.6541)	(0.4578)	(1.6441)	(0.5632)	(0.4708)	(1.0858)	(0.4860)	(0.5142)
Earnings information	0.1714	-0.2168	-0.6576	0.0156	-0.1705	0.0246	0.0036	-0.0747
missing for second adult	(0.1879)	(0.1394)	(0.4759)	(0.1531)	(0.1371)	(0.3148)	(0.1517)	(0.1711)
Second adult works	-0.0492	-0.2148	-0.3303	-0.1580	-0.2441**	0.3048	-0.1430	-0.1356
	(0.1513)	(0.1375)	(0.5161)	(0.1558)	(0.1231)	(0.2605)	(0.1333)	(0.1358)
ln(weekly adult earnings)	-0.0793	-0.0647	-0.0248	0.1815**	0.0725	-0.1710	0.0668	0.0084
	(0.0966)	(0.0684)	(0.2417)	(0.0839)	(0.0698)	(0.1537)	(0.0743)	(0.0785)
Number of children 0-6	-0.1064	-0.0310	1.1279**	-0.0742	-0.0010	-0.2005	0.0879	0.0646
	(0.1582)	(0.1330)	(0.5511)	(0.1197)	(0.1327)	(0.3250)	(0.1029)	(0.1107)
Number of children 7-11	-0.0328	-0.0636	0.1979	0.1145	-0.0235	0.4189**	0.2563***	0.0351
	(0.1120)	(0.0945)	(0.3037)	(0.0937)	(0.0927)	(0.1807)	(0.0871)	(0.0928)
Number of children 12-17	0.0604	0.0563	0.2105	0.0815	0.0552	0.0851	0.0389	0.0384
	(0.0755)	(0.0579)	(0.1793)	(0.0660)	(0.0519)	(0.1230)	(0.0584)	(0.0593)
Number of other adults	-0.0046	0.0508	-0.0317	0.0012	0.1103	0.1944	0.0295	0.0717
	(0.0918)	(0.0936)	(0.2245)	(0.0792)	(0.0705)	(0.1530)	(0.0713)	(0.0761)
Hispanic	0.0793	-0.2355*	-0.5960	0.0747	-0.1195	-0.7210**	0.1956	0.0842
	(0.1558)	(0.1275)	(0.5456)	(0.1464)	(0.1397)	(0.3514)	(0.1242)	(0.1119)
Black	0.1360	-0.1589	0.2252	-0.0405	-0.0616	-0.0204	-0.3139**	-0.2538*
	(0.1601)	(0.1551)	(0.4309)	(0.1671)	(0.1333)	(0.2862)	(0.1366)	(0.1391)
Age 16	0.1226	-0.0122	-0.1905	0.2130	-0.0401	0.9846***	0.2281*	-0.1417
	(0.1435)	(0.1203)	(0.5876)	(0.1403)	(0.1100)	(0.3284)	(0.1181)	(0.1139)

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market work	HH work	Schooling	Market work	HH work	Sleep
Age 17	-0.0892	0.0408	-0.2031	0.2136	0.1093	1.5515***	0.3170***	-0.3339***
	(0.1468)	(0.1190)	(0.6147)	(0.1428)	(0.1163)	(0.3145)	(0.1167)	(0.1257)
Age 18	-0.1607	0.1674	-0.7456	0.3089*	-0.2480*	1.7800***	0.4620***	-0.5244***
	(0.1679)	(0.1578)	(0.6317)	(0.1574)	(0.1502)	(0.3434)	(0.1522)	(0.1565)
Behind in schooling	0.1429	0.1251	-0.2414	-0.3796*	-0.4805**	-0.2278	-0.2211	0.3663**
	(0.2064)	(0.2100)	(0.4953)	(0.1998)	(0.1872)	(0.4032)	(0.2007)	(0.1796)
Urban	-0.1057	0.0221	-0.7334*	0.1791	0.0866	0.1809	0.0355	-0.0522
	(0.1497)	(0.1360)	(0.3838)	(0.1266)	(0.1181)	(0.2272)	(0.1120)	(0.1150)
Unemployment rate	-0.0116	-0.1040**	-0.2452*	-0.0833	-0.0873**	-0.2231**	-0.0633	-0.0380
	(0.0610)	(0.0509)	(0.1307)	(0.0548)	(0.0430)	(0.0996)	(0.0485)	(0.0481)
Time and date controls:								
Spline 7:30 - 9 a.m.	0.1500***	0.0058	-0.3556*	-0.1755***	-0.0499	0.0554	-0.0015	
	(0.0162)	(0.1613)	(0.2094)	(0.0603)	(0.0417)	(0.0609)	(0.0422)	
Spline 9 a.m. - noon	0.0658***	0.0958***	0.1512**	0.0280	-0.0182	-0.0004	-0.0246	
	(0.0142)	(0.0354)	(0.0648)	(0.0189)	(0.0219)	(0.0368)	(0.0176)	
Spline noon – 3 p.m.		0.0217	-0.0250	0.0003	-0.0236	0.0233	-0.0084	
		(0.0215)	(0.0297)	(0.0140)	(0.0217)	(0.0315)	(0.0133)	
Spline 3 - 6 p.m.		0.0115	0.0552*	0.0226	-0.0062	-0.0537	-0.0047	
		(0.0248)	(0.0331)	(0.0156)	(0.0220)	(0.0347)	(0.0144)	
Spline 6 - 9 p.m.		0.0026	-0.0477	0.0100	-0.0158	-0.0663	-0.0262*	0.2784***
		(0.0241)	(0.0406)	(0.0191)	(0.0207)	(0.0406)	(0.0148)	(0.0360)
Spline 9 p.m. - midnight		0.0714**	0.2033***	0.0429*			-0.0202	0.1208***
		(0.0337)	(0.0565)	(0.0234)			(0.0217)	(0.0115)
School weekday	1.6661***	1.4650	-2.1554	-0.1540	0.5074	-2.9776***	-0.8169*	-0.7404
	(0.1847)	(1.7216)	(3.1668)	(0.6945)	(0.3933)	(1.0792)	(0.4709)	(0.8774)
School weekday x	-0.1384***	-0.2160	0.2519	0.0458	0.1410***	0.2529**	0.0686	
spline 7:30 - 10 a.m.	(0.0293)	(0.1653)	(0.2743)	(0.0855)	(0.0448)	(0.1120)	(0.0625)	
School weekday x	-0.0126	0.0205	0.0136	-0.0148	-0.0454*	-0.0804	-0.0080	
spline 9 a.m. - noon	(0.0303)	(0.0394)	(0.1151)	(0.0428)	(0.0271)	(0.0608)	(0.0361)	

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market Work	HH work	Schooling	Market Work	HH work	Sleep
School weekday x spline noon - 3 p.m.		0.0283	-0.0332	0.0031	-0.1043***	0.0745	0.0435**	
		(0.0250)	(0.0756)	(0.0269)	(0.0267)	(0.0481)	(0.0219)	
School weekday x spline 3 - 6 p.m.		0.0452*	-0.0518	-0.0105	0.0311	-0.0008	-0.0472**	
		(0.0273)	(0.0529)	(0.0223)	(0.0256)	(0.0518)	(0.0191)	
School weekday x spline 6 - 9 p.m.		0.0101	0.0943*	-0.0076	-0.0289	-0.0042	0.0030	0.0786
		(0.0280)	(0.0517)	(0.0285)	(0.0240)	(0.0723)	(0.0231)	(0.0519)
School weekday x spline 9 p.m. - midnight		-0.0555	-0.1085	0.0147			0.0123	-0.0332**
		(0.0388)	(0.1068)	(0.0424)			(0.0344)	(0.0158)
Weekend or holiday	0.0270	0.2267	-0.0216	-0.1637	-0.0139	-0.6933***	-0.0160	-0.2832**
	(0.1374)	(0.2061)	(0.3194)	(0.1460)	(0.1763)	(0.2319)	(0.1356)	(0.1382)
Year = 2004	-0.0274	0.0179	0.2757	-0.1130	-0.0376	-0.4651**	-0.1481	0.0486
	(0.1321)	(0.1068)	(0.3182)	(0.1272)	(0.1071)	(0.2342)	(0.1080)	(0.1147)
Year = 2005	-0.0002	0.1573	-0.2086	0.0463	-0.1470	-0.3224	-0.2995**	0.1187
	(0.1417)	(0.1159)	(0.3422)	(0.1169)	(0.1017)	(0.2298)	(0.1185)	(0.1152)
Spell and cumulative duration controls:								
Duration first 10 minutes					-0.0442	0.2663	1.3946***	1.6004***
					(0.1507)	(0.2849)	(0.1571)	(0.2127)
Duration spline 0-2 hours		0.1059***	0.1696***	-0.0523***	-0.0635***	-0.1631***	-0.0189	0.0054
		(0.0182)	(0.0478)	(0.0194)	(0.0174)	(0.0376)	(0.0177)	(0.0219)
Duration spline 2-4 hours		0.0616***	0.1084***	0.0039	-0.0494**	-0.0221	0.0252	-0.0421**
		(0.0128)	(0.0331)	(0.0306)	(0.0205)	(0.0508)	(0.0173)	(0.0174)
Duration spline 4-6 hours		-0.0938***	0.1807***	0.0094	0.0300	-0.0614	-0.0307	0.0229
		(0.0192)	(0.0557)	(0.0605)	(0.0296)	(0.0746)	(0.0222)	(0.0186)
Duration spline 6-8 hours		0.1488***	-0.0695	0.0022	-0.0286	0.0761	0.0250	-0.0093
		(0.0274)	(0.0846)	(0.1473)	(0.0339)	(0.0869)	(0.0229)	(0.0154)
Duration spline 8+ hours		-0.0417	0.3532**					
		(0.0479)	(0.1770)					
Cumulative time in schooling		-0.0105*	-0.0152	0.0006	0.0220***	-0.0394***	0.0063	0.0023
		(0.0061)	(0.0183)	(0.0055)	(0.0064)	(0.0140)	(0.0063)	(0.0032)

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market Work	HH work	Schooling	Market Work	HH work	Sleep
Cumulative time in market work		-0.0001	-0.0042	0.0039	0.0004	-0.0002	0.0045	-0.0020
		(0.0097)	(0.0180)	(0.0072)	(0.0091)	(0.0162)	(0.0071)	(0.0051)
Cumulative time in household work		0.0098	-0.1307***	-0.0139	-0.0173	-0.0577**	0.0094	-0.0020
		(0.0144)	(0.0410)	(0.0102)	(0.0113)	(0.0272)	(0.0102)	(0.0062)
Cumulative time in sleep		-0.0073	-0.0272	0.0022	-0.0379***	-0.0389***	-0.0017	-0.0108**
		(0.0080)	(0.0188)	(0.0067)	(0.0078)	(0.0146)	(0.0083)	(0.0055)
Intercept	-6.3019***	-5.3014***	-5.4159	-0.3966	-1.9944***	-4.7617***	-4.0263***	-8.0522***
	(0.5005)	(1.7403)	(3.4280)	(0.7492)	(0.5538)	(1.4322)	(0.6460)	(0.7818)
30 minute indicator	2.5658***	0.5134***	0.3425	0.7587***	0.5742***	0.3889	0.4984***	0.6109***
	(0.1423)	(0.1020)	(0.2621)	(0.1085)	(0.0917)	(0.2569)	(0.1119)	(0.1068)
60 minute indicator	0.8905***	0.4830***	-0.1373	0.5206***	0.1925	0.3755	0.2224*	0.0093
	(0.0956)	(0.1103)	(0.3111)	(0.1531)	(0.1302)	(0.3296)	(0.1305)	(0.1254)
Unobserved heterogeneity controls:								
λ_{jk}	0.0063	0.2260***	2.2913***	0.0789	0.1790**	1.0000	0.3739**	-0.0358
	(0.0864)	(0.0771)	(0.6266)	(0.1141)	(0.0854)		(0.1549)	(0.0613)
	point 1	point 2	point 3	point 4	weight 1	weight 2	weight 3	
	-3.2400	0.9334	2.2734**	4.0060***	-1.3277***	0.0521	2.3434***	
		(0.9859)	(1.0983)	(1.3664)	(0.3112)	(0.1763)	(0.3200)	

Notes: Transition models, described in the text, are estimated using data for 1,115 teenage girls from the 2003-5 ATUS and incorporate sampling weights supplied with the ATUS. The log likelihood value is -28,405.56. Estimated standard errors appear in parentheses.

* Significant at .10 level. ** Significant at .05 level. *** Significant at .01 level.

Table 4. Activity Transition Model Results for Teenage Boys

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market work	HH work	Schooling	Market work	HH work	Sleep
Household and personal controls:								
Single parent household	-0.1531	-0.0213	0.3133	0.0416	-0.1649	-0.1024	-0.3060*	-0.1669
	(0.1783)	(0.1455)	(0.4364)	(0.1985)	(0.1553)	(0.3591)	(0.1800)	(0.1576)
Earnings information	0.2580	0.1451	1.3617	0.0827	-0.0473	0.2248	-0.2635	0.1143
missing for all adults	(0.4035)	(0.2786)	(1.0236)	(0.6315)	(0.4145)	(0.8012)	(0.3633)	(0.3232)
Adult in household works	1.1493**	-0.6696	-0.4265	0.4096	-0.2370	0.1729	-0.1881	1.2470***
	(0.5540)	(0.5356)	(1.7688)	(0.6674)	(0.4688)	(1.3239)	(0.5567)	(0.3568)
Earnings information	-0.0553	-0.0183	-0.1521	-0.2674	0.0351	-0.1728	0.2284	-0.0384
missing for second adult	(0.1836)	(0.1510)	(0.4182)	(0.2134)	(0.1407)	(0.3761)	(0.1827)	(0.1585)
Second adult works	-0.0412	-0.0537	0.2138	-0.2557	-0.0065	-0.2810	-0.0282	0.0774
	(0.1487)	(0.1209)	(0.3301)	(0.1968)	(0.1192)	(0.3024)	(0.1432)	(0.1209)
ln(weekly adult earnings)	-0.1468*	0.1174	0.1043	-0.0124	0.0587	0.0860	0.0217	-0.2197***
	(0.0821)	(0.0786)	(0.2443)	(0.1010)	(0.0691)	(0.2037)	(0.0809)	(0.0516)
Number of children 0-6	0.0379	0.0015	-0.7049	0.0013	-0.0839	-0.3277	0.0719	0.0305
	(0.1307)	(0.1063)	(0.6160)	(0.1448)	(0.1421)	(0.3479)	(0.1306)	(0.1168)
Number of children 7-11	0.1190	0.0564	0.0944	-0.2811**	-0.0472	0.0568	0.1135	-0.0162
	(0.0925)	(0.0812)	(0.2471)	(0.1210)	(0.0924)	(0.1817)	(0.0953)	(0.0743)
Number of children 12-17	0.0230	0.0259	-0.2759	-0.0659	-0.0551	0.0862	-0.0428	0.0905
	(0.0721)	(0.0638)	(0.2004)	(0.0910)	(0.0607)	(0.1496)	(0.0709)	(0.0614)
Number of other adults	-0.0393	-0.0774	-0.1116	-0.0235	-0.0844	-0.1407	0.0032	-0.0226
	(0.0801)	(0.0730)	(0.2034)	(0.0864)	(0.0573)	(0.1823)	(0.0738)	(0.0577)
Hispanic	-0.1375	-0.0337	-0.1191	-0.1152	0.0342	-0.6090*	-0.1084	0.0421
	(0.1333)	(0.1309)	(0.5762)	(0.1721)	(0.1197)	(0.3547)	(0.1507)	(0.1236)
Black	-0.2247	-0.0116	0.0258	0.6519***	-0.2448	0.2823	0.1248	-0.3603**
	(0.1502)	(0.1891)	(0.3803)	(0.1880)	(0.1829)	(0.3349)	(0.1631)	(0.1415)
Age 16	-0.1149	-0.1464	0.1144	0.0661	-0.0504	0.8544**	-0.0040	-0.1786
	(0.1375)	(0.1118)	(0.4462)	(0.1817)	(0.1145)	(0.3387)	(0.1517)	(0.1157)

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market work	HH work	Schooling	Market work	HH work	Sleep
Age 17	0.0592	0.0023	0.0720	-0.1584	0.0133	1.5420***	0.2254	-0.3839***
	(0.1389)	(0.1126)	(0.4117)	(0.1898)	(0.1127)	(0.3444)	(0.1631)	(0.1113)
Age 18	-0.3456**	-0.1418	-0.2535	-0.4390**	-0.3495**	1.1681***	0.2582	-0.7220***
	(0.1563)	(0.1511)	(0.4330)	(0.1976)	(0.1466)	(0.3869)	(0.1712)	(0.1433)
Behind in schooling	-0.0968	-0.0897	-0.3507	-0.1300	-0.1986	0.2673	0.1225	0.1509
	(0.1693)	(0.2081)	(0.3915)	(0.1768)	(0.1629)	(0.3605)	(0.1874)	(0.1327)
Metro	-0.0189	-0.1204	0.8427**	0.4647***	0.0559	0.1232	-0.0663	0.1312
	(0.1452)	(0.1373)	(0.3549)	(0.1689)	(0.1239)	(0.3338)	(0.1519)	(0.1210)
Unemployment rate	0.0039	0.0747*	0.1135	0.0346	0.0441	-0.2496**	-0.1084*	-0.0085
	(0.0509)	(0.0453)	(0.1103)	(0.0669)	(0.0488)	(0.1129)	(0.0576)	(0.0539)
Time and date controls:								
Spline 7:30 - 9 a.m.	0.1524***	-0.0907	0.0576	-0.0809*	-0.1219***	-0.0522	0.0189	
	(0.0154)	(0.0937)	(0.3505)	(0.0464)	(0.0425)	(0.0587)	(0.0423)	
Spline 9 a.m. - noon	0.0730***	0.0937**	0.0810	0.0328	-0.0052	0.0012	-0.0139	
	(0.0132)	(0.0409)	(0.0545)	(0.0248)	(0.0345)	(0.0344)	(0.0192)	
Spline noon - 3 p.m.		-0.0233	-0.0146	-0.0061	-0.0343	-0.0024	-0.0075	
		(0.0257)	(0.0380)	(0.0180)	(0.0284)	(0.0349)	(0.0167)	
Spline 3 - 6 p.m.		0.0506**	0.0341	0.0331*	0.0338	0.0044	0.0012	
		(0.0256)	(0.0360)	(0.0198)	(0.0240)	(0.0324)	(0.0171)	
Spline 6 - 9 p.m.		0.0082	0.0109	0.0214	-0.0524**	-0.1325**	-0.0261	0.2795***
		(0.0298)	(0.0388)	(0.0196)	(0.0212)	(0.0577)	(0.0170)	(0.0329)
Spline 9 p.m. - midnight		0.0412	0.1120**	0.0174			0.0169	0.1061***
		(0.0427)	(0.0545)	(0.0203)			(0.0219)	(0.0111)
School weekday	1.4878***	-0.3395	3.0606	1.0362	0.9478***	-2.2160**	-0.7708	0.8791
	(0.1980)	(1.0046)	(4.2787)	(0.7022)	(0.3054)	(0.8996)	(0.5031)	(0.6432)
School weekday x	-0.1404***	-0.0974	-0.0938	-0.0333	0.1530***	0.1283	0.0251	
spline 7:30 - 10 a.m.	(0.0278)	(0.1027)	(0.3721)	(0.1131)	(0.0453)	(0.1639)	(0.0666)	
School weekday x	0.0173	0.0369	-0.0963	-0.0733	-0.0483	-0.0183	0.0057	
spline 9 a.m. - noon	(0.0262)	(0.0438)	(0.0948)	(0.0684)	(0.0373)	(0.1190)	(0.0394)	

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market work	HH work	Schooling	Market work	HH work	Sleep
School weekday x spline noon - 3 p.m.		0.0753***	0.0527	0.0555*	-0.1155***	0.0842	0.0323	
		(0.0276)	(0.0745)	(0.0315)	(0.0321)	(0.0677)	(0.0283)	
School weekday x spline 3 - 6 p.m.		-0.0191	-0.0774	-0.0260	-0.0382	-0.0809*	-0.0583**	
		(0.0281)	(0.0556)	(0.0300)	(0.0290)	(0.0447)	(0.0242)	
School weekday x spline 6 - 9 p.m.		0.0188	0.0491	0.0219	0.0394	0.0735	0.0525**	-0.0277
		(0.0352)	(0.0505)	(0.0343)	(0.0271)	(0.0699)	(0.0256)	(0.0379)
School weekday x spline 9 p.m. - midnight		-0.0042	-0.0630	-0.0520			-0.0451	-0.0026
		(0.0483)	(0.0782)	(0.0422)			(0.0326)	(0.0149)
Weekend or holiday	-0.1567	0.1474	-0.2798	-0.1561	-0.1390	-0.5989*	-0.2990*	-0.2581*
	(0.1359)	(0.2523)	(0.3605)	(0.1808)	(0.2267)	(0.3052)	(0.1577)	(0.1346)
Year = 2004	0.0394	-0.0169	-0.0742	0.0447	0.0832	-0.2250	-0.2372*	-0.1464
	(0.1172)	(0.0985)	(0.3044)	(0.1479)	(0.1056)	(0.2527)	(0.1296)	(0.1147)
Year = 2005	0.0296	0.0488	0.6096*	-0.0307	-0.0154	-0.0358	-0.0327	-0.0437
	(0.1293)	(0.1168)	(0.3471)	(0.1570)	(0.1208)	(0.2647)	(0.1315)	(0.1202)
Spell and cumulative duration controls:								
Duration first 10 minutes					-0.2991*	0.3548	1.3199***	1.5614***
					(0.1580)	(0.3073)	(0.1827)	(0.2434)
Duration spline 0-2 hours		0.1402***	0.1143**	-0.0503*	-0.0746***	-0.1950***	-0.0687***	-0.0277
		(0.0195)	(0.0481)	(0.0261)	(0.0212)	(0.0428)	(0.0233)	(0.0251)
Duration spline 2-4 hours		0.0349***	0.0729**	0.0484	-0.0383*	0.0144	0.0152	0.0190
		(0.0134)	(0.0321)	(0.0349)	(0.0219)	(0.0514)	(0.0195)	(0.0186)
Duration spline 4-6 hours		-0.0967***	0.0223	-0.0249	0.0179	-0.0865	-0.0168	-0.0087
		(0.0175)	(0.0502)	(0.0679)	(0.0305)	(0.0852)	(0.0223)	(0.0177)
Duration spline 6-8 hours		0.1130***	0.0821	0.1130	-0.0817**	0.0414	0.0380*	-0.0147
		(0.0224)	(0.0694)	(0.1523)	(0.0387)	(0.0961)	(0.0221)	(0.0151)
Cumulative time in schooling		0.0022	-0.0204	-0.0011	0.0336***	-0.0056	0.0002	0.0028
		(0.0064)	(0.0198)	(0.0077)	(0.0084)	(0.0162)	(0.0066)	(0.0033)
Cumulative time in market work		0.0033	-0.0087	-0.0060	0.0069	0.0150	-0.0019	0.0058
		(0.0107)	(0.0171)	(0.0071)	(0.0114)	(0.0176)	(0.0080)	(0.0048)

	Single-destination models of [ ] to "other" activity				Multiple destination models of "other" activity to			
	Sleep	Schooling	Market work	HH work	Schooling	Market work	HH work	Sleep
Cumulative time in household work		-0.0080	-0.0684*	-0.0153	-0.0180	-0.0392	0.0049	0.0100
		(0.0250)	(0.0414)	(0.0114)	(0.0209)	(0.0283)	(0.0105)	(0.0067)
Cumulative time in sleep		0.0089	-0.0213	-0.0072	-0.0217***	-0.0090	-0.0056	-0.0142**
		(0.0079)	(0.0179)	(0.0086)	(0.0081)	(0.0194)	(0.0090)	(0.0055)
Intercept	-6.4043***	-5.2192***	-9.1733**	-1.8560**	-2.3669***	-4.0349***	-3.3544***	-7.8354***
	(0.4412)	(1.0306)	(4.6196)	(0.7233)	(0.5137)	(1.4965)	(0.6811)	(0.7540)
30 minute indicator	2.5097***	0.5514***	0.1385	0.6703***	0.4679***	0.5577**	0.5612***	0.3250***
	(0.1399)	(0.1016)	(0.2626)	(0.1337)	(0.0981)	(0.2593)	(0.1293)	(0.1076)
60 minute indicator	0.9341***	0.0960	0.3490	0.6817***	0.1828	0.3628	0.1153	0.3648***
	(0.0920)	(0.1125)	(0.3217)	(0.1824)	(0.1369)	(0.3949)	(0.1481)	(0.1245)
Unobserved heterogeneity controls:								
λ_{jk}	0.0252	-0.0230	0.8970**	0.2498**	-0.0421	1.0000	0.3990***	-0.0782
	(0.0952)	(0.0560)	(0.4398)	(0.1233)	(0.0665)		(0.1534)	(0.0650)
		point 1	point 2	point 3		weight 1	weight 2	
		-1.3507	0.9044	2.3707**		-0.4296	0.3672	
			(1.2338)	(1.1231)		(0.3666)	(0.3197)	

Notes: Transition models, described in the text, are estimated using data for 1,164 teenage boys from the 2003-5 ATUS and incorporate sampling weights supplied with the ATUS. The log likelihood value is -26,182.74. Estimated standard errors appear in parentheses.

* Significant at .10 level. ** Significant at .05 level. *** Significant at .01 level.

Table 5. Simulation Results for Teenage Girls

	Minutes in school activities	Any school activities	Minutes in market work	Any market work	Minutes in household work	Any household work	Minutes in other activities	Minutes in sleep
Baseline simulation	247	0.63	69	0.23	59	0.60	531	535
Simulated change associated with								
Single-parent vs. couple HH	-46	-0.08	8	0.02	13	0.04	-11	37
1 low earner vs. no earners	21	0.05	40	0.13	-7	-0.06	-31	-23
1 med. earner vs. 1 low earner	20	0.02	-27	-0.07	-14	0.04	1	21
2 earners vs. 1 medium earner	-18	-0.05	17	0.04	-1	-0.04	7	-5
Extra child age 0-6	-9	-0.02	-27	-0.03	11	0.04	7	18
Extra child age 7-11	-10	-0.03	23	0.07	6	0.06	-25	5
Hispanic vs. non-Hispanic	12	0.00	-29	-0.10	11	0.07	7	-1
Black vs. non-black	24	0.02	-3	0.00	-13	-0.09	27	-35
Age 16 vs. age 15	1	0.00	34	0.12	1	0.07	-13	-23
Age 17 vs. age 16	-14	-0.03	32	0.09	-1	0.00	-21	4
Age 18 vs. age 17	-64	-0.09	44	0.08	5	0.05	24	-9
Behind vs. at grade level	-54	-0.07	-1	-0.01	15	-0.04	25	14
Unemployment rate increase 1%	-3	-0.01	-10	-0.03	2	-0.01	13	-1
Non-school vs. school weekday	-297	-0.48	74	0.17	9	0.03	122	92
Weekend vs. school day	-301	-0.45	21	0.05	25	0.06	188	67

Notes: Results from simulations conducted using coefficient estimates from Table 3 and 25 replications of observed data for 1,115 teenage girls from the 2003-5 ATUS. Statistics incorporate sampling weights supplied with the ATUS.

Table 6. Simulation Results for Teenage Boys

	Minutes in school activities	Any school activities	Minutes in market work	Any market work	Minutes in household work	Any household work	Minutes in other activities	Minutes in sleep
Baseline simulation	218	0.57	59	0.21	44	0.49	569	550
Simulated change associated with								
Single-parent vs. couple HH	-25	-0.04	-13	-0.01	-14	-0.08	51	1
1 low earner vs. no earners	50	0.06	30	0.08	-17	-0.04	-39	-24
1 med. earner vs. 1 low earner	-32	-0.02	6	0.03	3	0.03	33	-11
2 earners vs. 1 medium earner	1	0.00	-17	-0.03	6	0.00	2	8
Extra child age 0-6	-5	-0.01	-2	-0.04	4	0.02	4	-1
Extra child age 7-11	0	0.00	2	0.01	17	0.04	-7	-12
Hispanic vs. non-Hispanic	-2	-0.01	-27	-0.08	0	-0.03	13	16
Black vs. non-black	-43	-0.07	18	0.05	-13	0.04	47	-10
Age 16 vs. age 15	-9	-0.03	25	0.09	-4	-0.01	-8	-4
Age 17 vs. age 16	4	0.02	48	0.12	13	0.05	-31	-34
Age 18 vs. age 17	-57	-0.11	-24	-0.08	16	0.03	58	6
Behind vs. at grade level	-28	-0.06	24	0.04	9	0.02	-25	21
Unemployment rate increase 1%	4	0.01	-13	-0.03	-4	-0.02	15	-1
Non-school vs. school weekday	-307	-0.57	54	0.09	28	0.16	162	63
Weekend vs. school day	-320	-0.60	17	-0.01	21	0.10	230	51

Notes: Results from simulations conducted using coefficient estimates from Table 4 and 25 replications of observed data for 1,164 teenage boys from the 2003-5 ATUS. Statistics incorporate sampling weights supplied with the ATUS.

Appendix A1. Regression Results for Teenage Girls

	Minutes in school activities	Any school activities	Minutes in market work	Any market work	Minutes in household work	Any household work	Minutes in other activities	Minutes in sleep
Single-parent household	-39	-0.07	5	0.01	13	0.04	-15	35
Earn. info. missing for all adults	54	0.12	23	0.13	-27	-0.02	-28	-22
One adult works	7	0.12	60	0.11	21	-0.15	-29	-56
Earn. info. missing for 2nd adult	9	-0.01	7	0.01	-5	-0.01	13	-24
Second adult works	-17	-0.07	12	0.03	-4	-0.02	17	-8
ln(weekly adult earnings)	7	0.01	-7	-0.01	-7	0.02	0	6
Number of children aged 0-6	-10	-0.02	-16	-0.04	11	0.01	-5	20
Number of children aged 7-11	-13	-0.01	11	0.04	2	0.05	-9	9
Number of children aged 12-18	10	0.03	-1	0.02	1	0.05	-9	-1
Number of other adults	2	-0.02	11	0.05	1	-0.02	-24	9
Hispanic	28	0.00	-22	-0.10	13	0.09	-18	-2
Black	36	0.00	-6	-0.01	-20	-0.11	24	-34
Urban	7	0.04	26	0.05	-8	0.00	-20	-4
Age 16	-1	-0.01	30	0.10	4	0.07	-11	-20
Age 17	-15	-0.05	68	0.20	4	0.07	-37	-16
Age 18	-84	-0.17	116	0.27	15	0.13	-10	-33
Behind in education	-54	-0.14	-16	-0.04	14	0.02	41	12
State unemployment rate	-1	-0.01	-16	-0.04	1	-0.01	21	-5
Year = 2004	-14	0.01	-26	-0.06	0	-0.01	26	14
Year = 2005	-29	-0.07	-14	-0.06	-10	-0.03	38	16
School weekday	278	0.46	-76	-0.17	-10	-0.04	-86	-103
Weekend or holiday	-58	-0.02	-60	-0.16	19	-0.01	93	5

Notes: Coefficients from regressions estimated using data from the 2003-5 ATUS and incorporating sampling weights supplied with the ATUS.

Appendix A2. Regression Results for Teenage Boys

	Minutes in school activities	Any school activities	Minutes in market work	Any market work	Minutes in household work	Any household work	Minutes in other activities	Minutes in sleep
Single-parent household	-19	-0.04	-18	-0.05	-13	-0.08	54	-5
Earn. info. missing for all adults	36	0.15	-13	-0.02	-20	-0.13	11	-15
One adult works	170	0.06	7	0.15	1	0.00	-189	16
Earn. info. missing for 2nd adult	-5	0.00	-5	-0.01	13	0.14	-5	2
Second adult works	1	-0.01	-21	-0.05	8	0.02	-1	13
ln(weekly adult earnings)	-22	0.00	3	0.00	-3	0.00	29	-7
Number of children aged 0-6	6	-0.01	-14	-0.06	4	0.09	2	2
Number of children aged 7-11	6	0.01	4	0.01	14	0.04	-14	-10
Number of children aged 12-18	-7	-0.01	14	0.03	1	-0.03	-8	1
Number of other adults	-6	-0.03	-2	0.00	1	0.00	2	5
Hispanic	-16	-0.02	-33	-0.11	-2	0.01	21	29
Black	-44	-0.09	13	0.02	-10	-0.01	39	2
Urban	20	0.06	-20	-0.04	-21	-0.05	12	9
Age 16	-18	-0.05	27	0.12	0	-0.01	-3	-6
Age 17	-12	-0.05	75	0.22	15	0.08	-39	-38
Age 18	-80	-0.13	53	0.14	29	0.09	39	-42
Behind in education	-13	-0.06	26	0.02	5	0.02	-41	23
State unemployment rate	4	0.00	-15	-0.03	-4	-0.04	15	0
Year = 2004	17	0.01	-13	-0.04	-8	-0.06	19	-15
Year = 2005	-16	-0.08	-21	-0.05	4	-0.04	30	4
School weekday	278	0.53	-44	-0.09	-22	-0.17	-151	-59
Weekend or holiday	-57	-0.08	-32	-0.11	1	-0.10	43	43

Notes: Coefficients from regressions estimated using data from the 2003-5 ATUS and incorporating sampling weights supplied with the ATUS.