Does *Daylight Saving Time* Burn Fat?
Time Allocation with Continuous Activities

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Most activities in life require a certain amount of continuous time. Yet, within the traditional model of time allocation, the same amount of utility is derived from an activity regardless of whether it is performed continuously over one time block or over disjoint periods. This paper reconsiders Becker's theory and models preferences over continuous time blocks. In applying our model to evaluate changes in Daylight-Saving-Time (DST), we find that people reallocate towards outdoor recreational activities and reduce TV watching. Simple back of the envelope calculations indicate that this would burn an additional 10% of calories. We conclude with policy recommendations regarding the future status of DST. (*JEL* I18, I31, J22, Q48)

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In daily life, people's time allocation problems involve scheduling many activities around pre-existing time block requirements. Importantly, the natural environment and institutions also constrain the availability of time blocks. Outdoor recreational activities, such as gardening or jogging are preferably performed during daylight hours, whereas housecleaning or TV watching generate lower opportunity costs if performed in less favorable conditions. Some activities can only be separated into different time blocks under considerable costs or may be impossible to split up. For example, going on a vacation requires some number of days and this can be costly as other activities may need to be shifted around.

The objective of this paper is to examine preferences over continuous time blocks. We present a simple extension of Becker's theory of time allocation (1965). In the traditional economic model of labor-leisure choice, the time block is not explicitly taken into account. In this setting, an activity yields the same utility measure regardless of whether the activity is split up into *n* separated blocks or is performed continuously over one block of time. Conventionally, the theory assumes that the household production function exhibits constant returns to scale and consequently the opportunity cost of time is a linear function of forgone wages. Although this assumption has been critiqued in the literature by Pollak and Wachter (1975) and Gronau (1977)—with the important exception of Palmquist et al. (2010)—the consequences for heterogeneous time blocks have not been systematically investigated. By extending the Becker model to non-constant returns, we show that the cost can be substantially different between i.e. one 2-hour period and two separated 1-hour periods. We derive expressions of the relative opportunity costs for competing activities as a function of the lengths of available time blocks and show implications on the extensive margin (whether to participate) and on the intensive margin (how long to participate).

To investigate whether the predictions of the model are supported empirically, the challenge is to find a setting where *ceteris paribus* the length of a continuous time-block changes, but the context of the setting does not produce other confounding effects on the allocation of time. We argue that the following natural experiment comes close to this requirement. Title 1 of the U.S. Energy Policy Act (2005) extends the period of Daylight Saving Time (DST) by one month—three weeks in the Spring and one week in the Fall. In accordance with this policy, since 2007 DST has begun in March, whereas in prior years the starting date of DST was not until April. Holding calendar day fixed, clearly, the overall amount of daylight does not change. However, with DST, the time block of after-work evening daylight increases by one hour, while the time block of pre-work morning daylight is shortened by one hour. This shift of daylight leads individuals to re-optimize their activity schedule. Our model predicts that agents will engage in longer outdoor recreational activities in the evening, which would be more costly if performed separately in the morning and evening under Standard Time.

Importantly, our identification strategy compares people's activities during a particular calendar day in a DST "treatment" year with the *same* corresponding calendar day in "control" years, when Standard Time was observed.[1] Finally, deriving the estimates in the difference-in-difference framework, our year fixed effects control for overall changes in activity patterns over time. This identification strategy allows us to isolate the effect of the DST extension on time use.

Using the American Time Use Survey (ATUS) from 2005 to 2008 and detailed weather information—to control for the outdoor conditions at the time and location of the ATUS

[1] Clearly, there is much more variation in daylight by geographical location and by calendar day. In our identification strategy, we do not use this variation because of simultaneous changes of other conditions which makes it impossible to isolate the causal effect of DST. For example, comparing different latitudes does not account for differences in sorting and habit formation. Equally, comparing a i.e. 'summer day' with DST to a 'winter day' under Standard Time would be invalidating the approach as other conditions do change as well over the seasons. A number of studies (e.g. Shapiro et al. (1990) on mental health, Taylor and Hammer (2008) on heart attacks or Ferguson et al. (1995) on traffic accidents) compare outcomes in the week(s) before DST with the week(s) after the start of DST. This "local discontinuity approach", however, does not take into account that people behave differently over changing weather conditions and seasons. Wolff (2007) and Kellogg and Wolff (2008) show that the local discontinuity approach leads to biased results with opposite signs of the effect of DST on energy consumption. Instead, comparing the *same* calendar day in years with and without DST avoids this source of bias using a difference-in-difference framework.

interview—we find that people's latent outdoor recreational behavior significantly increases by a striking 30 minutes per day under DST. At the same time, the duration of America's most time intensive indoor leisure activity—TV watching—modestly decreases by around 9 minutes.[2] On the extensive margin, outdoor activities increase by 3%, implying a behavioral shift in people that would have stayed indoors under Standard Time.

These results are consistent with our model predictions wherein outdoor activities enjoy increasing returns to scale during daylight and TV watching has constant returns to scale. Importantly, the conventional model of time use would not have predicted this change in behavior, as the same amount of utility is derived from an activity regardless of whether it is performed continuously, or separated into two periods.

We conclude that DST merges existing time blocks in such a way that it lowers costs of health-augmenting outdoor activities. According to the ATUS data, Americans devote 165 minutes per day to indoor TV watching but spend on average 27 minutes on outdoor activities. Given the concerns about health costs and obesity, these numbers are alarming. Our finding that DST reallocates activities from indoors to outdoors roughly implies that an extra 10% of calories are burnt, or, put differently, that the average individual could potentially lose one pound of body fat every 2.5 weeks. A naïve (holding everything else constant and not allowing for intertemporal substitution) back of the envelope calculation indicates $250 million U.S. dollars in annual health expenditure savings on the extensive margin due to the extension of DST.[3] This paper

[2] Our interpretation is that the 30 minutes increase in outdoors is substituted away from 9 minutes of TV watching. We cannot statistically identify the activities of the 'missing 21 minutes'. We tested changes in other activities (i.e. sleep, work, other indoor activities), but the minute change of any other activity is too small and noisy, such that the DST coefficients in these alternative regressions render insignificant. The only two statistical significant changes due to DST are for the outdoor recreational activity and indoor TV watching.

[3] $250 million is a lower bound welfare estimate because it includes the health benefits of the 3% of the adult population only that would have stayed indoor under Standard Time. Hence the calculation assumes no benefit for the subpopulation that already engaged outdoors under Standard Time (but may still increase time outdoors under DST). As an alternative, using our latent estimate of 30 minutes on the intensive margin, the welfare effect increases to a striking 8 billion U.S. dollar annually. The range of 8 billion to 250 million arises due to the nature of the Tobit model and whether to report the conditional or unconditional marginal effects.

highlights the fact that a simple modification of existing theory can have considerable implications for welfare measures which we then identify empirically using the unique natural experiment of DST.

The paper proceeds as follows. Section I discusses this paper in the context of the previous literature; Section II outlines the theoretical model of time allocation. In Section III we describe the ATUS data and in Section IV our estimation strategy. We present the results in Section V and conclude in Section VI with a broader policy recommendation concerning the future status of DST.

I. Literature

The study of time allocation stems from Becker's household production model (Becker 1965). The individual maximizes utility subject to a time constraint and a budget constraint. Utility itself is a function of commodities which are governed by commodity-specific technologies modeled as household production functions of market goods and time use. In Becker's model, the home production function has fixed coefficients and exhibits constant returns to scale in time. Most studies of time allocation follow these assumptions (e.g. Biddle and Hamermesh (1990) on the demand for sleep, Corneo (2005) on social leisure and TV watching, Jacobsen and Kooreman (2005) on the effects of shopping hour regulations on time use patterns.) Pollak and Wachter (1975) criticize Becker's production function approach arguing that the assumptions of constant returns to scale and no joint production are unlikely to be satisfied in practice. To our knowledge, there are only two studies which relax constant returns to scale in the home production function. First, Gronau (1977) considers home production functions which are subject to decreasing marginal productivity due to fatigue. While Gronau (1977) studies an empirical dataset to illuminate his theoretical work, the issue of the continuous time block is not investigated.

More closely related to our paper is the recent work by Palmquist et al. (2010) in the context of the environmental valuation literature. The authors investigate how short run constraints can increase the marginal value of time in recreation. To analyze this, Palmquist et al. (2010) construct a conceptual model of inter-temporal allocation of time where an individual must fulfill a given number of household chores, M, over a sequence of J weeks, such that $M = \sum_{j=1}^{J} M_j$. The individual is free, however, to decide how many hours t_j she devotes to $M_j(t_j)$ and how many hours are spent in recreation. To obtain more time for continuous recreation, chores have to be reallocated over the weeks. Palmquist et al. (2010) assume monotonic increasing and concave household maintenance functions $M_j(t_j)$, and hence the marginal value of time for recreation is increasing as a larger block of time is allocated to recreation. In order to empirically estimate the model, Palmquist et al. (2010) combine real world time allocation data with stated preference data on potential substitutes for personal time in household chores.

Our paper is different in important aspects from Palmquist et al. (2010). First, in our set-up we do not rely on the intertemporal allocation of time, but instead we go back to Becker’s (1965) theory in its simplest comparative static form. Secondly, we do not add the artificial constraints of a maintenance production function, but instead vary the returns to scale of Becker’s household production function. Third, in our empirical analysis, we do not make use of data on stated preferences but analyze revealed time allocation decisions.

Finally, note that our empirical findings are consistent with recent studies on shopping hour regulations (Jacobsen and Kooreman 2005) and time zones (Hamermesh et al. 2008), which show that institutions can significantly impact people’s time allocation.

II. Model

This section introduces an extension of Becker's (1965) seminal theory. To fix ideas, we present the model in terms of two commodities, referring to outdoor recreational activity, Z_o, and indoor leisure activity Z_i. An individual maximizes the utility function

$$U=U(Z_o, Z_i|\delta) \tag{1}$$

with common regularity conditions and preference parameter δ. The commodities are produced through the individual's time allocation, T_o and T_i, and market goods, X_o and X_i, respectively. Let the endowment of time $T = T_m + T_o + T_i$, be spent either at work, T_m, outdoors, T_o, or indoors, T_i. Further, consistent with Becker (1965), we assume that a linear technology

$$X_j = a_j Z_j, \tag{2}$$

relates the commodities to the market goods, parameterized by some positive constants a_j and indexed by $j \in \{o, i\}$. For simplicity, we also keep the assumption of constant returns to scale in time for the indoor activity[4],

$$T_i = b_i Z_i \tag{3}$$

with parameter $b_i > 0$. Departing from Becker, however, we assume increasing marginal productivity of time for the outdoor activity in the relevant area of the function[5] such that

$$T_o = g^o(Z_o|\theta) \ with \ g^{o\prime} > 0, \ g^{o\prime\prime} < 0 \ \forall \ T_o < T_+ \tag{4}$$

4 Indoor activities are generally more fungible compared to outdoor activities.

5 As for the specification of θ, we do not need to assume that $g^{o\prime\prime} < 0$ globally, but in the relevant range of time. For example, fishing at a lake (including the time to prepare the tools and finding a good spot) can have increasing returns to scale for the first couple of hours. Eventually the second derivative of g may change in sign, however, due to boredom or fatigue. Increasing returns in recreational activities were also suggested by Palmquist *et al*. (2010).

Importantly, we assume that the individual gains increasing returns only if she engages in the outdoor activity without any interruption until an alternative activity is started at time T_{+}. The parameter θ determines the slope and curvature of g^{o} and reflects the heterogeneity of exogenous outdoor conditions.

Combining the conventional budget function $\Sigma P_j X_j = wT_m + I$, with the individual's time constraint, the budget constraint becomes,

(5) $$w(T - T_o - T_i) + I = \sum P_j X_j.$$

where w denotes wage per hour, nonlabor income is I and the price of X_j is given by P_j.

Utility maximization implies that the marginal rate of substitution[6]

(6) $$\frac{\frac{\partial U}{\partial Z_o}}{\frac{\partial U}{\partial Z_i}} = \frac{a_o P_o + w\frac{\partial g^0}{\partial Z_o}}{a_i P_i + b_i w} = \frac{\pi_o(Z_o)}{\pi_i}$$

equals the ratio of the outdoor and indoor prices π_o/π_i. Importantly, note that the total price of a unit of the commodity Z_j consists of the following two elements:

a. it reflects the cost of the goods required to produce the commodity, $a_j P_j$, plus
b. the shadow price of time for the production of the commodity, which equals $b_i w$ for the indoor activity and is $w\frac{\partial g^0}{\partial Z_o}(Z_o)$ for the outdoor activity.

This second term of the numerator in (6) is the key difference from the traditional Becker model and implies that the total price of the outdoor activity depends on the magnitude of the time T_o allocated to $Z_o = g^{o-1}(T_o)$.

6 Equation (6) is derived by maximizing (1) subject to (5) after replacing the X_j and T_j for the right hand sides of (2) to (4) and canceling out the shadow value of the constraint.

Proposition 1: *Equations (1) to (5) imply that agents are strictly better off performing the outdoor activity in one continuous time block T*, instead of spreading the outdoor activity over N multiple time blocks* $\sum_{n=1}^{n=N} t_n$ *= T*, where* t_n *is the length of the* n^{th} *time block,* $t_n > 0 \; \forall \; n = \{1,2,\ldots,N\}$ *and N > 1.*

Proof: See Appendix 1.

While the proof in the appendix is provided for the more general case of spreading the activity into *N* potentially unequal time blocks, here, we consider two scenarios that mimic the introduction of DST. In the first scenario, assume we are given one continuous T^* hour time block (say 2 hours of after-work daylight during DST). In the second case, T^* is separated into two equal $\frac{T^*}{2}$ time blocks (i.e. one hour of daylight pre-work and one hour of daylight after-work as is the case during Standard time). If the individual chooses to spend her leisure time entirely outdoors, it is easy to show that the commodity price π_o is necessarily smaller under the scenario of the one continuous *T** time block (compared to the two $\frac{T^*}{2}$ time blocks) because $2w\frac{\partial g^0(g^{0^{-1}}(\frac{T^*}{2}))}{\partial Z_o} > w\frac{\partial g^0(g^{0^{-1}}(T^*))}{\partial Z_o}$. Hence, it is welfare enhancing to merge the two separated daylight time blocks under Standard Time into one block twice the length under DST. Figure A1 illustrates the nonlinear commodity price of the outdoor activity as a function of time, and also displays the commodity price of the indoor activity (which is independent of the amount of time allocated).

Proposition 2: *Let U be additively separable and assume that Z_o and Z_i are normal goods. Equations (1) to (5) imply that increasing total endowment time T has the effect that*

(a) agents unambiguously allocate more time to the activity with increasing returns, Z_o, while,

(b) the impact on the substituting constant return activity, Z_i, is ambiguous.

Proof: See Appendix 1.

In summary, under DST, the outdoor activity becomes less costly (in terms of total cost and the shadow value of time), and hence unambiguously more time will be allocated to Z_o. On the other hand, part (b) of Proposition 2 implies that the indoor activity level Z_i can increase *or* decrease with an additional after-work daylight hour, which is determined by the relative magnitude of U_{ii} and $\lambda w g^{o''}$,[7] as shown in the proof of the Appendix 1. The monetary willingness to pay (WTP) measure of an exogenous change in the availability of continuous time from T^1 to T^2 is defined by the equality condition of the indirect utility functions $v(I,T^1|[P_i,P_o,a_i,a_o,b_i,b_o,\theta,\delta,w]) = v(I - WTP,T^2|[P_i,P_o,a_i,a_o,b_i,b_o,\theta,\delta,w])$.[8]

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[7] Intuitively, if the marginal utility of consuming Z_o decreases faster compared to the increase in the marginal productivity of time producing Z_o, then an increase in endowment time *T* leads to an increase in the constant returns to scale indoor activity Z_i.

[8] This expression is analogue to the literature in i.e. hedonics or environmental economics, where a discrete exogenous change in an attribute (i.e. air quality) is monetized by the *WTP* measure (compensating variation) holding utility constant (i.e. Randall and Stoll, 1980).

III. Data

A. Individual Time Use Data

We draw the time-use data from the American Time Use Survey (ATUS). A person of age 15 and over is randomly chosen from each household that has completed the Current Population Survey (CPS). The ATUS interview includes a detailed time-use diary, which accounts for the respondent's activities, starting at 4am on the previous day and ending at 4am on the interview day. For a more detailed description of the ATUS, see U.S. Bureau of Labor Statistics (2008) and Hamermesh et al. (2005).

We carefully examine the ATUS activity codes in order to categorize activities as outdoor or indoor activities. In particular, we classify each activity code into five categories: 'clearly outdoor', 'mostly outdoor', 'ambiguously outdoor', 'mostly indoor', and 'clearly indoor'. Table A1 describes in detail our five tier categorization system. We mainly follow the classification by Eisenberg and Okeke (2009) for the categories 'clearly outdoor' and 'mostly outdoor'. The category 'ambiguously outdoor' includes those codes which do not clearly delineate where the activity is taking place. For example, the code 020601 refers to "care for animals and pets" and it does not specify whether the activity is performed outside or inside. Both taking a dog for a walk and feeding a cat are categorized into the single code while the former is an outside activity and the latter is likely an inside activity. In our main regression we define the variable "outdoor" to include the 'clearly' and 'mostly' outdoor activities. Hence, as can be seen from the details of Table A1, our variable "outdoor" consists of outdoor sports (both participating and watching), lawn maintenance, gardening, exterior maintenance of the house, and related travel for these activities. We check the robustness of our results by including 'ambiguously outdoor' activities into the outdoor variable.[9]

Additional socio-economic information about each household member is obtained from the associated CPS database. The information on family income takes discrete values, corresponding to the amount of income in ranges. Following the method used by Humphreys and Ruseski (2011), we reconstruct the income variable so that it takes the midpoint of the range or 150 percent of the unbounded top range. In order to take inflation into account, we deflate the income variable by the CPI in the base year of 2005.

B. Weather Data

Because weather conditions can drastically affect daily activity patterns, we include detailed geographic daily weather information in our analysis. Daily precipitation[10] and max/min/mean temperature are drawn from the National Climatic Data Center of the National Oceanic and Atmospheric Association (NOAA). Further, because each ATUS respondent can be linked to the CPS, the exact location can be assigned to those respondents who reside in a Metropolitan Statistical Area (MSA), which comprises 80% of the sample. For the other 20% of sample—who reside in nonmetropolitan areas—the geographical within-state information is missing. For these individuals we choose to assign the weather data of the most populous city of the respondents' state.[11] A few daily weather observations are missing. We impute these missing observations by

[9] Including 'ambiguously outdoor' activities do not affect our conclusion while it makes our results slightly weaker, likely due to the additional measurement error. See Appendix 2 Tables A2-A3 for details.

[10] We assign the value "0" to the precipitation values recorded as "T" (= Trace). "Trace" is defined as the amount of rain that is less than 0.01 inches. As a robustness test, we alternatively assign the value "0.01" to "Trace". This change does not affect our results qualitatively; see Appendix 2 Tables A4-A7 for details.

[11] As a robustness check, we test our results restricting our sample to those ATUS individuals residing in MSAs. These results are not qualitatively different from those using the full sample. See Appendix 2 Tables A8-A11 for details.

regressing the weather variable of a MSA-specific station onto the observations of other stations in the same state.

Following the recommendation of Eisenberg and Okeke (2009), we use the daily maximum temperature variable, which is more relevant for the decision to participate in outdoor activities, compared to the daily mean temperature variable[12]

IV. Estimation Strategy

To identify the effect of lifting a time-block-constraint on daily activity patterns, we use the extension of DST as an exogenous policy change, as mandated in the U.S. Energy Policy Act of 2005. Since 2007, DST starts at 2am on the second Sunday of March and ends at 2am on the first Sunday of November whereas under the former 1986 timing legislation (US Public Law, 1986), DST started at 2am on the first Sunday of April and ended at 2am on the last Sunday of October. Table 1 shows the starting and ending dates of DST since 2005. To illustrate the effect, assume that in mid-March the sun typically sets at 6pm under Standard Time (as was the case in the years prior to 2007), but with DST (since 2007) the sun sets at 7pm clock time. This implies that a person working until 5pm is able to enjoy a 100 percent increase in after-work daylight under DST. This new 2-hour time block with daylight (which formerly under Standard Time was divided into one 1-hour time block in the morning and another 1-hour time block in the evening) can create new opportunities for outdoor behavior.

We define the extension period as three weeks starting on the second Sunday of March and one week starting on the last Sunday of October. We consider the extension period in 2007 and in 2008 as "treatment" (i.e., March 11th – March 31st and October 28th - November 3rd in 2007 and

[12] As a robustness test, we use daily average temperatures in the appendix regressions (Appendix 2 Tables A12-A15) and find that the main estimation results are qualitatively the same as those regressions using daily maximum temperatures.

March 9th – March 29th and October 26th - November 1st in 2008) and the days during the same extension weeks in 2005 and in 2006 as the "control" period (i.e., March 13th - April 2nd and October 30th - November 5th in 2005 and March 12th -April 1st and October 29th - November 4th in 2006). Note that we do not define the extension period in different years by the calendar date but that we are consistent by defining the extension period starting on Sunday and ending on Saturday in order to control for the fact that people behave differently on different days of the week. Figure A2 visualizes the extension periods.

In our main estimation, we use the relevant evening time block from 3pm to 7pm.[13] In separate regressions below, as in Hamermesh et al. (2008), we further examine the extensive margin of TV watching by splitting the time period into 15-minute blocks. Using the difference-in-difference framework, we estimate the linear probability model[14]

$$(7) \qquad Y_{it} = \alpha\left(Year\ Fixed\ Effects\right)_{it} + \beta\left(DST\ Extension\right)_{it}$$

$$+\gamma\left(Year07 \text{ and } Year08\right)_{it} * \left(DST\ Extension\right)_{it} + \delta X_{it} + \rho W_{it} + \varepsilon_{it}$$

wherein the dummy Y_{it} reflects the participating decision in "outdoor" (or "TV watching" depending on the regression below) in day *t* for ATUS respondent *i*. Similarly, to model the time allocation decision on the intensive margin, we estimate the Tobit model.

[13] We perform robustness checks with respect to different hours of the day. (a) Using all 24 hours of the day leads to qualitatively very similar results, indicating that there is no intra-day substitution to other time-blocks of the day. (b) In alternative 'morning regressions', we check the effect of DST on outdoor activities and indoor activities from 6am to 9am, but we find no significant change. In the main regressions presented here, we restrict the analysis to 3pm to 7pm. 24 hour and morning hour results are available upon request.

[14] Ai and Norton (2003) show that the interaction effect in a nonlinear probit model is not necessarily equal to the marginal effect in the linear probability model. As a robustness test, we also estimate probit models of the following form,

$$\gamma = \Phi\left(Y \middle| Year07 \text{ and } Year08 = 1, DST\ Extension = 1\right) - \Phi\left(Y \middle| Year07 \text{ and } Year08 = 1, DST\ Extension = 0\right)$$

$$-\Phi\left(Y \middle| Year07 \text{ and } Year08 = 0, DST\ Extension = 1\right) + \Phi\left(Y \middle| Year07 \text{ and } Year08 = 0, DST\ Extension = 0\right).$$ Results are provided in Appendix 2 Table A16 which do not qualitatively differ from the results of the linear probability model.

(8) $$A_{it}^{*} = \alpha\left(Year\ Fixed\ Effects\right)_{it} + \beta\left(DST\ Extension\right)_{it}$$

$$+\gamma\left(Year07\ and\ Year08\right)_{it} * \left(DST\ Extension\right)_{it} + \delta X_{it} + \rho W_{it} + \varepsilon_{it}$$

with $$A_{it} = \begin{cases} A_{it}^{*}\ if\ A_{it}^{*} > 0 \\ 0\ if\ A_{it}^{*} \leq 0 \end{cases}$$

in which A_{it} is the observed total minutes spent on "outdoor" (or "TV watching" depending on the regression). *Year Fixed Effects* include the years 2006 to 2008 (with 2005 as the reference year) and take the value "1" if the diary date is in the respective year and zero otherwise.[15] Equally *DST Extension* takes the value "1" if the diary day is during the extension period as defined above. X_{it} includes a set of covariates of the individual for age, sex, ethnicity, marital status, number of children, school enrollment, educational level, working status, household income, regional dummies, and a constant term. W_{it} consists of the weather variables daily maximum temperature and precipitation. The main parameter of interest is γ, the coefficient of the interaction term $\left(Year07\ and\ Year08\right)_{it} * \left(DST\ Extension\right)_{it}$ taking the value "1" if the diary day falls in the extension period of the year 2007 or 2008, and zero otherwise.

To test whether the individuals interviewed in the "treatment" period are qualitatively different from those interviewed in the "control" period, Table 2 reports descriptive statistics of the explanatory socio-economic variables of the ATUS respondents, during the "treatment" period in 2008 and in 2007 (column 1), and the "control" period in 2006 and in 2005 (column 2), as well as over the entire sample (column 3). The average individual is of age 45.8, 43 percent of the sample are male, 51 percent are married, and 51 percent are full-time workers. *t*-statistics, displayed in the last column, show that the ATUS sample is similar across the treatment status,

[15] Including our excluding month fixed effects does not qualitatively change the results.

with the exception that a slightly larger proportion of individuals is interviewed in the South during the treatment period (with a *t*-value of -2.2). This is not a serious concern to us because the South generally engages in fewer outdoor activities and in more TV watching (compared to the rest of the U.S.), hence making our results overall more conservative.

V. Results

Table 3 reports the average minutes per day that ATUS respondents participate in various activities during the "treatment" period, displayed in column 1, and the "control" period (column 2) as well as over the entire sample (column 3). Strikingly, according to this dataset, the average American devotes 165 minutes per day to indoor TV watching but spends only 27 minutes on outdoor activities. TV watching is hence the second most time intensive "leisure" (= non-working) activity, after sleeping. On the extensive margin, while 80.1 percent of the sample watches TV, only 10.4 percent, 9.2 percent and 3.1 percent engage in outdoor sports, lawn maintenance, and exterior home work, respectively.

Table 4 shows the linear probability estimation results of engaging in outdoor activities. The treatment effect γ of the DST extension interaction term is significantly positive. We also re-estimate the regression using the probit model, as suggested in Ai and Norton (2003).[16] These results (displayed in Table A16) are weaker, but not essentially different from those given by the linear probability model. The estimates (both of the linear probability model and of the probit model) indicate that the likelihood to participate in outdoor activities increases by 3 percentage points, implying a shift in the behavior of people that would have stayed indoors under Standard Time. Overall, the signs of the other coefficient estimates are as expected; consistent with

[16] See footnote 13.

intuition, daily maximum temperature and rainfall have significantly positive and negative effects respectively on the probability of participating in outdoor activities. Also, full-time workers are less likely to participate in outdoor activities, and respondents are more likely to participate in outdoor activities on weekends.

Table 5 displays the effect of DST on outdoor recreational behavior on the intensive margin, in minutes per day of A^* from the Tobit regressions. We consider the effect on the latent variable more interesting than that on the conditional outcome[17] because the potential impact on health is strongest for those who decide to participate in outdoor activities only after the extension of DST, and not for those who always participate in the outdoors regardless of the status of DST. The main treatment parameter of interest γ is significant and shows a striking 30 minutes increase in outdoor recreational behavior. Table 5 confirms that daily maximum temperature and precipitation have the expected signs. Overall, our results indicate that more people engage in outdoor activities and for a longer period of time when an extra hour of evening daylight becomes available.

Turning towards the indoor recreational behavior of TV watching, our Tobit estimates in Table 6 show that TV watching decreases by a modest 8 to 9 minutes. On the extensive margin, Table 7 suggests that DST does not affect the likelihood of TV watching during the 3pm to 7pm period. Overall, these results are consistent with part (b) of Proposition 2, implying that respondents have a low opportunity cost when watching TV for short periods. To investigate this further, in Table 8 we turn towards the 15-minute time block regressions. The table shows that the negative impacts of DST are strongest and significant from 4:15pm to 5:45pm, but not significant in other 15-minute blocks between 3pm and 7pm. Hence we find that the timing of TV watching changes

[17] The conditional on spending time outdoors DST effect is 4 to 5 minutes, depending on the specification.

as outdoor activities (and likely other activities that we do not control for) replace TV watching during 4:15pm to 5:45pm under the extended DST period.[18]

VI. Conclusion

Becker's (1965) seminal work on the theory of time use is the leading framework by which economists understand time allocation problems today. One important feature of time has not been modeled however; many activities require a minimum amount of continuous time in order to fully generate their benefits. This paper studies the effects of DST on outdoor recreational behavior and indoor leisure. We hypothesize that time use is affected by the length of contiguous daylight and propose a simple extension of the original Becker model. The model generates the predictions that (*i*) the time spent on outdoor activities unambiguously increases in response to an extra hour of daylight, while (*ii*) the effect on a constant-returns-to-scale indoor activity is ambiguous. ATUS data confirms these hypotheses.

According to the ATUS data, Americans spend 6 minutes in front of the TV for every minute that they spend outdoors. This figure is alarming, especially in light of the healthcare costs imposed by obesity, diabetes, and heart disease. We find that DST has the potential to increase outdoor activity by 30 minutes and burns an additional 10% of calories[19]. This may have important policy implications. In the U.S., the Department of Energy (DoE) currently determines the starting date and ending date of DST purely based on energy efficiency arguments, as mandated in the U.S. Energy Bills. Recent empirical evidence suggests, however, that the energy

[18] In separate regressions we study the morning hour time allocation of TV watching in each 15-minute time block from 6am-9am but find no significant effect. These results are available to the reader upon request.

[19] To put these numbers into context: A person of weight 185 pounds burns, on average, 33 calories by watching TV for 30 minutes, while e.g. 200, 266, or 733 calories are burnt by 'gardening', 'walking' or 'running 10mph' for 30 minutes, respectively. The often recommended diet of 2000 calories per day has to vary based on age, sex and activity level (Harvard Heart Letter, July 2004). The additional 10% in calories is calculated by assuming 'walking' as the extra outside activity relative to 'twice' the calories burnt staying indoor from TV watching, divided by a diet of 2000 calories (266-33*2)/2000. Burning an additional 200 calories per day implies burning one pound of fat in 2.5 weeks (Van Horn et al., 2010).

conservation goal of DST fails (Kotchen and Grant 2011, Kellogg and Wolff 2008). The most recent 2005 Energy Bill demands that if the 2007 DST extension does not lead to appropriate energy savings, the Congress has to reconsider the DST schedule.[20] We here strongly suggest that the future status of DST should be based on a different welfare measure.

A naïve[21] calculation suggests that during the DST extension period, the average American has the potential to reduce their Body Mass Index (BMI) by 0.91%[22] relative to the counterfactual of Standard Time, implying an annual decrease in medical expenditures of $37.57 per adult, using the recent BMI health-cost estimates by Parks et al. (2012).[23] Aggregating across the U.S. population, this translates into healthcare savings of $8.33 billion annually overall, but to $250 million only when applying it to the 3% of the population at the extensive margin.[24] Clearly, this welfare figure is not precise as it does not take into account heterogeneity or intertemporal substitution. Note, however, that the magnitude of our welfare effect is in stark contrast to the minimal DST effect on energy. Based on our findings, we recommend that the Department of Health could potentially be a more appropriate unit to decide on the future DST schedule (rather than the DoE). Ultimately, DST is a policy that affects the pattern of time, and whether the

[20] The original motivation of DST is to conserve energy (Kellogg and Wolff, 2008; Kotchen and Grant 2011). The objective of the recent 2007 extension is clarified in Title 1 of the Energy Bill which explicitly states that the starting date and ending date of DST was altered in order to save energy by 1% (Energy Policy Act of 2005).

[21] This calculation is clearly naïve, as it assumes no inter-temporal substitution of calorie burning activities. I.e. that due to the weight increase in the 3 weeks of the DST extension, there is no compensating weight loss in other weeks of the year. We tested for intertemporal substitution, but do not find any statistical significant effect.

[22] The average American male has a BMI of 27.8 (weighs 189.8 pounds and is 69.2 inches tall); for the average American woman, a similar calculation yields a BMI of 28.1 (Ogden et al., 2004). Given that the DST extension lasts for 4 weeks, and assuming that individuals burn an additional 1.6 pounds of fat (see footnote 19), this translates into a reduction of the average BMI to 27.63 for males and 27.86 for females. Taking the average of the change in BMI for both genders yields the estimate of a decrease in BMI of 0.26 or 0.91%.

[23] Parks et al. (2012) find that a 1-unit increase in BMI for every adult in the U.S. increases annual public medical expenditures by $32.6 billion; an average marginal cost of $147 per unit of BMI per person. The magnitude of our welfare calculations are in accord with the literature on the social costs of obesity; estimates range from $147 billion per year in direct medical expenditures (Finkelstein et al., 2004) to $250 billion per year once indirect costs such as lost work are accounted for (Lightwood et al., 2009).

[24] These differences arise due to the nature of the Tobit model and whether to report the conditional or unconditional marginal effects. Here we report both. See i.e Wooldridge (2002) for the advantages and disadvantages of the interpretation of the conditional vs. unconditional estimates.

society should keep DST depends on how people value the additional availability of contiguous daylight.

More generally, we suggest that modeling activities subject to continuous time blocks may reveal important welfare consequences for many other policies, such as holiday schedules, shopping hour regulations or retirement policies. This should be explored in future research.

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TABLE 1— DST EXTENSION SINCE 2007

Year	DST start date and time	DST end date and time
2008	March 9th at 2am	November 2nd at 2am
2007	March 11th at 2am	November 4th at 2am
2006	April 2nd at 2am	October 29th at 2am
2005	April 3rd at 2am	October 30th at 2am

TABLE 2— DESCRIPTIVE STATISTICS

	"Treatment"	"Control"	Entire	t-test:
	(1)	(2)	(3)	(2)-(1)
Demographics				
Age	46.15	45.35	45.82	-1.431
	(17.34)	17.62	(17.71)	
Sex (male =1)	0.434	0.430	0.433	-0.258
	(0.496)	(0.495)	(0.495)	
Married (yes =1)	0.510	0.523	0.511	0.836
	(0.500)	(0.500)	(0.500)	
Number of children	0.921	0.920	0.932	-0.027
	(1.16)	(1.16)	(1.16)	
Student (yes =1)	0.102	0.116	0.100	1.420
	(0.303)	(0.320)	(0.300)	
Full time worker (yes =1)	0.509	0.504	0.510	-0.306
	(0.500)	(0.500)	(0.500)	
Education	9.18	9.05	9.10	-1.399
	(2.91)	(2.97)	(2.92)	
Family income	61,106	60,478	60,088	-0.348
	(52,654)	(52,960)	(51,838)	
Interview on weekend (yes=1)	0.503	0.500	0.502	-0.195
	(0.500)	(0.500)	(0.500)	
MSA (yes =1)	0.824	0.820	0.815	-0.326
	(0.381)	(0.384)	(0.388)	
Region				
Northeast (yes =1)	0.172	0.194	0.183	1.820
	(0.377)	(0.396)	(0.386)	
Midwest (yes =1)	0.232	0.248	0.238	1.209
	(0.422)	(0.432)	(0.426)	
South (yes =1)	0.390	0.357	0.375	-2.202
	(0.488)	(0.479)	(0.484)	
West (yes =1)	0.206	0.201	0.204	-0.386
	(0.405)	(0.401)	(0.403)	
Ethnicity				
White (yes =1)	0.679	0.705	0.694	1.733
	(0.467)	(0.456)	(0.461)	
Black (yes =1)	0.140	0.131	0.132	-0.826
	(0.347)	(0.337)	(0.338)	
Hispanic (yes =1)	0.128	0.119	0.131	-0.801
	(0.334)	(0.324)	(0.338)	
Number of observations	1,934	2,036	48,731	

Note: Standard deviations are in parentheses. Number of observations for family income is smaller (= 42,177) than overall number of observations.

Education takes discrete values. Its mean (= 9.1) corresponds to the level between "9 = some college (no degree)" and "10 = associate degree (vocational)".

"Treatment" period is March 9th - March 29th and October 26th - November 1st in 2008 and March 11th - March 31st and October 28th - November 3rd in 2007.

"Control" period is March 12th - April 1st and October 29th - November 4th in 2006 and March 13th - April 2nd and October 30th - November 5th in 2005.

TABLE 3— ACTIVITY SUMMARY:
AVERAGE MINUTES SPENT PER DAY IN EACH ACTIVITY BY ATUS RESPONDENTS

	(1) "Treatment"	(2) "Control"	(3) Entire sample
ATUS activity variable			
Exterior home work	3.43 (32.66) [40]	2.61 (22.89) [48]	3.84 (32.36) [1,516]
Lawn	10.29 (46.09) [147]	9.37 (47.51) [137]	12.70 (52.38) [5,097]
Pet	5.24 (21.34) [265]	5.51 (22.62) [286]	5.29 (22.67) [6,616]
Car	2.12 (15.93) [57]	2.24 (23.13) [45]	2.44 (22.11) [1,327]
Playing sports with household children	0.16 (4.09) [3]	0.36 (5.64) [10]	0.37 (5.89) [287]
Playing sports with non-household children	0.057 (1.59) [3]	0.059 (2.10) [2]	0.057 (2.50) [38]
Relax	16.79 (60.77) [368]	16.59 (59.11) [401]	18.50 (65.85) [9,682]
TV	171.93 (178.98) [1,524]	165.40 (166.22) [1,647]	164.73 (168.20) [39,018]
Film	1.98 (16.09) [31]	1.77 (14.53) [31]	2.21 (17.72) [816]
Volunteer work	0.73 (16.55) [10]	0.39 (7.54) [11]	0.59 (11.99) [261]
Travel related to exterior home work	0.050 (1.48) [4]	0 (0) [0]	0.021 (0.90) [47]
Travel related to gardening	0 (0) [0]	0 (0) [0]	0.001 (0.20) [3]
Travel related to sports	2.56 (17.20) [152]	2.17 (13.31) [148]	2.57 (13.38) [4,269]
Outdoor sports	7.99 (36.05) [176]	7.73 (43.35) [159]	9.39 (45.40) [4,470]
Indoor sports	3.45 (20.74) [93]	4.70 (26.62) [115]	3.23 (20.70) [2,083]
Basketball	0.72 (10.02) [12]	0.60 (8.89) [15]	0.65 (10.81) [276]
Climbing	0 (0) [0]	0.17 (5.75) [2]	0.033 (3.66) [6]

(TABLE 3 CONTINUED)

Hockey	0.047 (2.05) [1]	0 (0) [0]	0.038 (2.60) [15]
Tennis	0.50 (11.65) [6]	0.25 (6.57) [4]	0.32 (6.84) [133]
Volleyball	0.21 (5.47) [3]	0.14 (4.41) [3]	0.17 (5.74) [68]
Swimming	0.53 (9.35) [8]	0.38 (5.89) [11]	1.75 (17.18) [791]
Stretching	1.82 (12.52) [58]	0.76 (7.80) [33]	1.21 (9.55) [1,180]
Watching sports outdoors	0.95 (15.16) [9]	0.36 (10.15) [4]	1.47 (18.94) [398]
Watching sports indoors	0 (0) [0]	0.03 (1.15) [1]	0.10 (5.71) [26]
Watching a basketball game	0.31 (11.41) [3]	0.52 (14.51) [4]	0.40 (9.05) [130]
Watching a hockey game	0.32 (8.10) [3]	0.10 (4.32) [1]	0.08 (3.75) [21]
Watching tennis	0.12 (5.46) [1]	0 (0) [0]	0.029 (2.32) [9]
Watching a volleyball game	0.02 (1.02) [1]	0 (0) [0]	0.024 (1.84) [11]
Sleep	524.16 (134.97) [1932]	524.33 (140.75) [2034]	526.01 (136.38) [48683]
Eat & drink	66.87 (48.88) [1860]	67.46 (47.01) [2013]	67.88 (49.99) [46816]
Number of observations	1,934	2,036	48,731

Note: Standard deviations are in parentheses. Numbers of participants of each activity are in brackets.

Definition of "treatment" and "control" is the same as in Table 2. For the detailed description of activities, see Table A1 in Appendix 2.

TABLE 4— EFFECTS ON PARTICIPATION (LINEAR PROBABILITY MODEL): OUTDOOR DURING 3PM-7PM

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	0.0286***	0.0220**	0.0303***
	(0.01010)	(0.01010)	(0.01070)
DST extension	-0.0390***	-0.0243***	-0.0265***
	(0.00707)	(0.00707)	(0.00754)
year 2006	-0.00989**	-0.0109***	-0.00714*
	(0.00388)	(0.00386)	(0.00411)
year 2007	-0.00731*	-0.00643	-0.00721*
	(0.00402)	(0.00400)	(0.00425)
year 2008	-0.0103***	-0.00968**	-0.00787*
	(0.00398)	(0.00396)	(0.00422)
T_max (maximum temperature)		0.00155***	0.00186***
		(0.00007)	(0.00008)
Precipitation		-0.0147***	-0.0118***
		(0.00390)	(0.00419)
Age			0.00133**
			(0.00054)
Age squared			-0.00000646
			(0.00001)
Sex (male =1)			0.0550***
			(0.00306)
Married (yes =1)			0.0114***
			(0.00345)
Number of children			0.000519
			(0.00149)
Student (yes =1)			0.0120**
			(0.00605)
Full time worker (yes =1)			-0.0111***
			(0.00353)
Family income			0.000000180***
			(0.00000)
Education			-0.000261
			(0.00061)
Weekend (yes =1)			0.0200***
			(0.00293)
MSA (yes =1)			-0.0215***
			(0.00391)
Midwest (yes =1)			0.0227***
			(0.00466)
South (yes =1)			-0.0140***
			(0.00444)
West (yes =1)			0.00501
			(0.00484)
White (yes =1)			0.0342***
			(0.00684)
Black (yes =1)			-0.0246***
			(0.00780)
Hispanic (yes =1)			0.00101
			(0.00774)
Constant	0.113***	0.00863	-0.108***
	(0.00280)	(0.00569)	(0.01590)
Number of observations	48731	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE 5— EFFECTS ON MINUTES PARTICIPATED (TOBIT ESTIMATES): OUTDOOR DURING 3PM-7PM

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	28.41***	22.13**	30.54***
	(8.904)	(8.824)	(9.269)
DST extension	-35.77***	-20.78***	-22.95***
	(6.502)	(6.467)	(6.895)
year 2006	-8.480***	-9.046***	-5.440*
	(3.179)	(3.161)	(3.305)
year 2007	-5.594*	-5.102	-5.369
	(3.260)	(3.244)	(3.402)
year 2008	-8.373***	-7.561**	-5.651*
	(3.235)	(3.216)	(3.374)
T_max (maximum temperature)		1.376***	1.568***
		(0.065)	(0.072)
Precipitation		-12.77***	-10.68***
		(3.490)	(3.677)
Age			0.962**
			(0.439)
Age squared			-0.0053
			(0.004)
Sex (male =1)			48.50***
			(2.507)
Married (yes =1)			9.517***
			(2.801)
Number of children			-0.127
			(1.225)
Student (yes =1)			10.52**
			(5.086)
Full time worker (yes =1)			-8.855***
			(2.894)
Family income			0.000143***
			(0.000)
Education			-0.68
			(0.489)
Weekend (yes =1)			19.73***
			(2.377)
MSA (yes =1)			-18.06***
			(3.031)
Midwest (yes =1)			17.34***
			(3.778)
South (yes =1)			-9.133**
			(3.654)
West (yes =1)			5.706
			(3.927)
White (yes =1)			27.03***
			(5.892)
Black (yes =1)			-33.52***
			(7.093)
Hispanic (yes =1)			-1.111
			(6.698)
Constant	-183.5***	-277.0***	-357.3***
	(3.376)	(6.198)	(14.130)
Number of observations	48731	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE 6— EFFECTS ON MINUTES PARTICIPATED (TOBIT ESTIMATES): TV WATCHING DURING 3PM-7PM

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	-7.562	-6.448	-8.559*
	(4.604)	(4.604)	(4.606)
DST extension	8.196**	5.888*	5.826*
	(3.212)	(3.224)	(3.225)
year 2006	3.615**	3.791**	1.481
	(1.784)	(1.783)	(1.785)
year 2007	6.396***	6.244***	3.594*
	(1.847)	(1.846)	(1.845)
year 2008	11.39***	11.29***	8.348***
	(1.820)	(1.819)	(1.824)
T_max (maximum temperature)		-0.250***	-0.431***
		(0.033)	(0.035)
Precipitation		3.951**	3.256*
		(1.773)	(1.782)
Age			-0.195
			(0.226)
Age squared			0.00949***
			(0.002)
Sex (male =1)			29.77***
			(1.321)
Married (yes =1)			-7.515***
			(1.482)
Number of children			-7.700***
			(0.663)
Student (yes =1)			-17.75***
			(2.698)
Full time worker (yes =1)			-27.44***
			(1.533)
Family income			-0.000213***
			(0.000)
Education			-5.581***
			(0.260)
Weekend (yes =1)			29.94***
			(1.274)
MSA (yes =1)			-1.317
			(1.666)
Midwest (yes =1)			0.567
			(2.032)
South (yes =1)			11.23***
			(1.929)
West (yes =1)			6.078***
			(2.109)
White (yes =1)			-2.435
			(3.031)
Black (yes =1)			14.52***
			(3.390)
Hispanic (yes =1)			8.350**
			(3.378)
Constant	-27.88***	-11.24***	47.00***
	(1.362)	(2.627)	(6.888)
Number of observations	48731	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE 7—EFFECTS ON PARTICIPATION (LINEAR PROBABILITY MODEL): TV WATCHING DURING 3PM-7PM

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	-0.0262	-0.0217	-0.0265
	(0.01630)	(0.01630)	(0.01690)
DST extension	0.0303***	0.0211*	0.0191
	(0.01140)	(0.01150)	(0.01190)
year 2006	0.0117*	0.0123**	0.00667
	(0.00627)	(0.00626)	(0.00647)
year 2007	0.0160**	0.0154**	0.00838
	(0.00649)	(0.00649)	(0.00669)
year 2008	0.0330***	0.0325***	0.0258***
	(0.00642)	(0.00642)	(0.00664)
T_max (maximum temperature)		-0.000973***	-0.00154***
		(0.00012)	(0.00013)
Precipitation		0.0155**	0.0137**
		(0.00633)	(0.00659)
Age			-0.00277***
			(0.00084)
Age squared			0.0000557***
			(0.00001)
Sex (male =1)			0.0857***
			(0.00481)
Married (yes =1)			-0.0131**
			(0.00543)
Number of children			-0.0214***
			(0.00234)
Student (yes =1)			-0.0546***
			(0.00952)
Full time worker (yes =1)			-0.0874***
			(0.00555)
Family income			-0.000000617***
			(0.00000)
Education			-0.0166***
			(0.00096)
Weekend (yes =1)			0.0754***
			(0.00461)
MSA (yes =1)			-0.00769
			(0.00615)
Midwest (yes =1)			0.00719
			(0.00733)
South (yes =1)			0.0369***
			(0.00698)
West (yes =1)			0.0208***
			(0.00762)
White (yes =1)			0.0024
			(0.01080)
Black (yes =1)			0.0340***
			(0.01230)
Hispanic (yes =1)			0.0359***
			(0.01220)
Constant	0.404***	0.469***	0.671***
	(0.00452)	(0.00923)	(0.02490)
Number of observations	48731	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE 8—EFFECTS ON PARTICIPATION: TV WATCHING, REPORTING TREATMENT EFFECT (γ) ONLY

Time Block	(1)	(2)	(3)
3:00-3:15	0.0042	0.00574	0.00382
	(0.0111)	(0.0111)	(0.0115)
3:15-3:30	0.00081	0.00279	0.000322
	(0.0113)	(0.0113)	(0.0117)
3:30-3:45	-0.00511	-0.00309	-0.00726
	(0.0115)	(0.0115)	(0.0120)
3:45-4:00	-0.00994	-0.00799	-0.0099
	(0.0118)	(0.0118)	(0.0122)
4:00-4:15	-0.0147	-0.0132	-0.0131
	(0.0116)	(0.0116)	(0.0120)
4:15-4:30	-0.0216*	-0.0202*	-0.0185
	(0.0118)	(0.0118)	(0.0123)
4:30-4:45	-0.0270**	-0.0257**	-0.0273**
	(0.0119)	(0.0119)	(0.0124)
4:45-5:00	-0.0345***	-0.0333***	-0.0373***
	(0.0122)	(0.0122)	(0.0127)
5:00-5:15	-0.0291**	-0.0279**	-0.0387***
	(0.0121)	(0.0121)	(0.0126)
5:15-5:30	-0.0263**	-0.0251**	-0.0351***
	(0.0124)	(0.0124)	(0.0129)
5:30-5:45	-0.0229*	-0.0219*	-0.0288**
	(0.0127)	(0.0127)	(0.0132)
5:45-6:00	-0.0208	-0.0195	-0.0209
	(0.0130)	(0.0131)	(0.0136)
6:00-6:15	-0.00396	-0.00196	0.00071
	(0.0131)	(0.0131)	(0.0136)
6:15-6:30	-0.00156	0.000678	-0.000958
	(0.0135)	(0.0135)	(0.0141)
6:30-6:45	0.00336	0.00597	-0.00101
	(0.0139)	(0.0139)	(0.0145)
6:45-7:00	-0.00269	0.000592	-0.00815
	(0.0143)	(0.0143)	(0.0149)

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%.
Columns 1 to 3 correspond to columns 1 to 3 in Table 7, respectively.

Appendix 1

Proof of Proposition 1: Equation (6) states that the total price of the commodity Z_o is equal to the cost of goods required to produce it, a_oP_o, plus the shadow price of time, $w\frac{\partial g^0}{\partial Z_o}$. Since a_oP_o is a constant, independent of the amount of time allocated to the commodity, it remains to show that the shadow price $w\frac{\partial g^0}{\partial Z_o}[g^{-1}(T^*)]$ evaluated at T^* is *smaller* compared to the sum of the N shadow values spread over multiple time blocks $\Sigma_n w\frac{\partial g^0}{\partial Z_o}[g^{-1}(t_n)]$.

From (4), the inverse function g^{-1} has derivatives

(A1) $$g^{-1\prime} > 0,\ \ g^{-1\prime\prime} > 0.$$

Let Z^* and $\tilde{Z}_n$ be the outcomes produced by T^* and t_n respectively as

(A2) $$Z^* = g^{-1}(T^*)$$

and

(A3) $$\tilde{Z}_n = g^{-1}(t_n).$$

Because $T^* > t_n$, from (A1)-(A3) it follows that

(A4) $$Z^* > \tilde{Z}_n.$$

From (A4) it follows that $\frac{\partial g^0(Z^*)}{\partial Z_o} < \frac{\partial g^0(\tilde{Z}_n)}{\partial Z_o}$ because $\frac{\partial g^0(Z_o)}{\partial Z_o}$ is a decreasing function in Z_o. Multiplying a positive number w on both sides of the inequality yields

(A5) $$w\frac{\partial g^0(Z^*)}{\partial Z_o} < w\frac{\partial g^0(\tilde{Z}_n)}{\partial Z_o}.$$

Finally, summing over the right hand side and using (A2) and (A3) yields

(A6) $$w\frac{\partial g^0}{\partial Z_o}[g^{-1}(T^*)] < \Sigma_n w\frac{\partial g^0}{\partial Z_o}[g^{-1}(t_n)].$$

This shows that the shadow price of the increasing returns activity Z_o over one continuous time block of length T^* is smaller than the sum of the shadow prices under multiple N time blocks. Hence agents will be strictly better off to perform the outdoor activity in the one continuous time block.

Proof of Proposition 2: The first-order conditions of model (1) to (5) are given by

(A7) $$\begin{aligned} &U_0 + \lambda\left(-wg^{o\prime} - a_oP_o\right) = 0 \\ &U_i + \lambda(-wb_i - a_iP_i) = 0 \\ &w(T - g^o - b_iZ_i) + I - a_oP_oZ_o - a_iP_iZ_i = 0. \end{aligned}$$

Solving this system simultaneously yields the demand functions of Z_o, Z_i, and λ. Plugging these back into (A7) and differentiating with respect to T yields

(A8) $$\begin{pmatrix} U_{oo} - \lambda wg^{o\prime\prime} & 0 & -wg^{o\prime} - a_oP_o \\ 0 & U_{ii} & -wb_i - a_iP_i \\ -wg^{o\prime} - a_oP_o & -wb_i - a_iP_i & 0 \end{pmatrix}\begin{pmatrix} \partial Z_o/\partial T \\ \partial Z_i/\partial T \\ \partial\lambda/\partial T \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ -w \end{pmatrix}.$$

Additive separability and Z_j being normal commodities implies $U_{jj} < 0$. Solving (A8) yields that the derivate of the increasing returns to scale activity Z_o with respect to T is strictly positive

(A9) $$\frac{\partial Z_o}{\partial T} = \frac{1}{\Delta}\left(-wU_{ii}(wg^{o\prime} + a_oP_o)\right) > 0$$

and the sign of the derivate of the constant returns to scale activity Z_i with respect to T is arbitrary

(A10) $$\frac{\partial Z_i}{\partial T} = \frac{1}{\Delta}(-w(wb_i + a_iP_i)(U_{oo} - \lambda wg^{o\prime\prime})) \gtreqless 0,$$

where

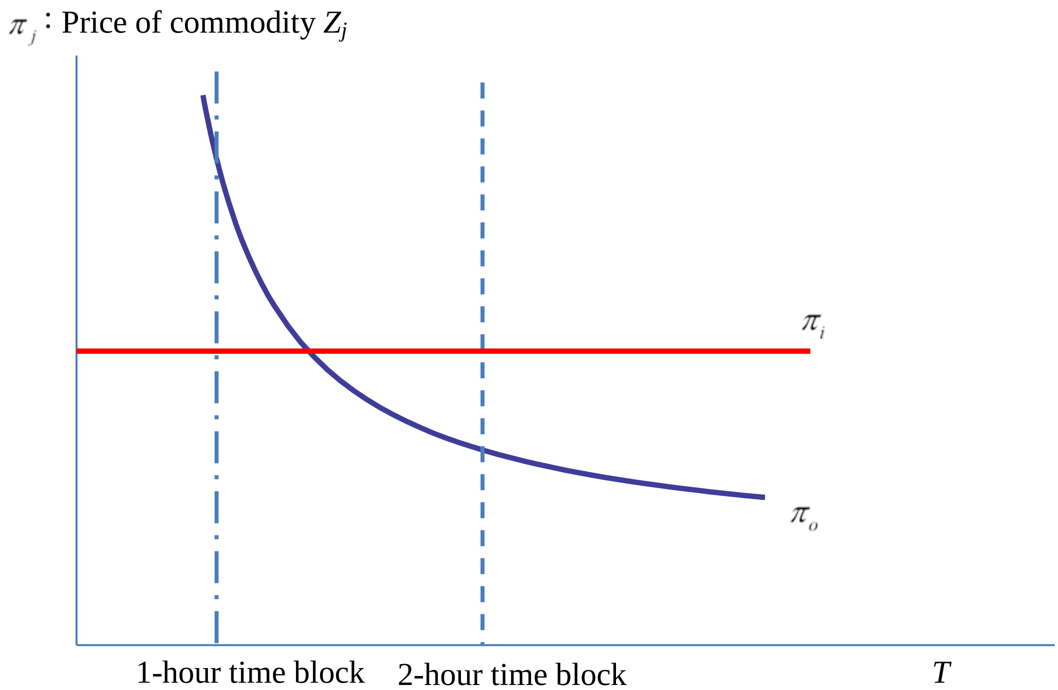
(A11) $$\Delta = -U_{ii}(wg^{o\prime} + a_o P_o)^2 - (U_{oo} - \lambda w g^{o\prime\prime})(wb_i + a_i P_i)^2$$

is the determinant of the bordered Hessian. While the element $(U_{oo} - \lambda w g^{o\prime\prime})$ in (A8) and (A9) cannot be signed, it follows from the rules of maximization of (1) subject to (5) that $\Delta > 0$ if evaluated at the utility maximum.

These results imply that increasing the endowment T unambiguously increases the time spent on Z_o, while the effect on the substituting activity Z_i is ambiguous.

[THE FOLLOWING APPENDIX COULD BE FOR WEB BASED ONLINE PUBLICATION]

Appendix 2



Note: Endowment time displayed as *T*.
π_o here calculated based on the functional form $g^o = (b_o Z_o)^{0.5}$.

FIGURE A1. PRICE OF COMMODITIES

DST starts DST ends Extension period

March-April 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Mar 6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	Apr 1	2
3	4	5	6	7	8	9

March-April 2006

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Mar 5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	Apr 1
2	3	4	5	6	7	8

March-April 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Mar 4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
Apr 1	2	3	4	5	6	7

March-April 2008

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Mar 2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	Apr 1	2	3	4	5

October-November 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Oct 23	24	25	26	27	28	29
30	31	Nov 1	2	3	4	5
6	7	8	9	10	11	12

October-November 2006

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Oct 22	23	24	25	26	27	28
29	30	31	Nov 1	2	3	4
5	6	7	8	9	10	11

October-November 2007

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Oct 28	29	30	31	Nov 1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17

October-November 2008

Sun	Mon	Tue	Wed	Thu	Fri	Sat
Oct 26	27	28	29	30	31	Nov 1
2	3	4	5	6	7	8
9	10	11	12	13	14	15

FIGURE A2. DEFINITION OF EXTENSION PERIODS

TABLE A1— ACTIVITY CODE

Activity variable	ATUS code	Activity description	Activity examples	Outdoor/Indoor
Exterior home work	t020401	exterior cleaning	sweeping steps	Out (clearly)
	t020402	exterior repair, improvement & decoration	fixing the roof, painting house exterior	Out (clearly)
	t020499	exterior maintenance, repair & decoration, n.e.c.		Out (clearly)
Lawn	t020501	lawn, garden, and houseplant care	gardening, watering houseplants, mowing lawn	Out (clearly)
	t020502	ponds, pools, and hot tubs	draining pool	Out (mostly)
	t020599	lawn and garden, n.e.c.		Out (clearly)
Pet	t020601	care for animals and pets (not veterinary care)	taking pets for a walk, playing with pets, feeding pets	Out/In (ambiguous)
	t020699	pet and animal care, n.e.c.		Out/In (ambiguous)
Car	t020701	vehicle repair and maintenance (by self)	adding oil, washing cars	Out/In (ambiguous)
	t020799	vehicles, n.e.c.		Out/In (ambiguous)
Playing sports with household children	t030105	playing sports with hh children	walking with a hh child	Out/In (ambiguous)
Playing sports with non-household children	t040105	playing sports with nonhh children	walking with a nonhh child	Out/In (ambiguous)
Relax	t120301	relaxing, thinking	sunbathing, resting, reflecting	Out/In (ambiguous)
TV	t120303	television and movies (not religious)	watching sports on TV, watching movies on DVD.	In (clearly)
	t120304	television and movies(religious)	watching religious broadcasting	In (clearly)
Film	t120403	attending movies/film	attending the movies	In (clearly)
Volunteer Work	t150301	building houses, wildlife sites & other structures	building playgrounds (volunteer)	Out/In (ambiguous)
	t150302	Indoor & outdoor maintenance, repair & clean-up	cleaning parks, planting trees (volunteer)	Out/In (ambiguous)
	t150399	indoor & outdoor maintenance, building & clean-up activities, n.e.c.		Out/In (ambiguous)
Travel related to exterior home work	t180204	travel related to exterior maintenance, repair & decoration		Out (clearly)
	t180205	travel related to lawn, garden, and houseplant care		Out (mostly)
Travel related to gardening	t180904	travel related to using lawn and garden services		Out (mostly)
Travel related to sports	t181301	travel related to participating in sports/exercises		Out/In (ambiguous)
	t180302	travel related to attending sporting/recreational events		Out/In (ambiguous)
	t180399	travel related to sports, exercises & recreation, n.e.c.		Out/In (ambiguous)

(TABLE A1 CONTINUED)

Outdoor sports	t130102	playing baseball		Out (clearly)
	t130104	biking		Out (clearly)
	t130106	boating	kayaking	Out (clearly)
	t130110	participating in equestrian sports	horseback riding, playing polo	Out (mostly)
	t130112	fishing		Out (clearly)
	t130113	playing football		Out (clearly)
	t130114	golfing		Out (clearly)
	t130116	hiking		Out (clearly)
	t130118	hunting	hunting game	Out (clearly)
	t130121	participating in rodeo competitions		Out (clearly)
	t130122	rollerblading	skateboarding	Out (clearly)
	t130123	playing rugby		Out (clearly)
	t130124	running	jogging	Out (mostly)
	t130125	skiing, ice skating		Out (mostly)
	t130126	playing soccer		Out (clearly)
	t130127	softball		Out (clearly)
	t130129	vehicle touring, racing	stock car racing, doing motocross	Out (clearly)
	t130131	walking		Out (mostly)
Indoor sports	t130101	doing aerobics		In (clearly)
	t130105	playing billiards		In (clearly)
	t130107	bowling		In (clearly)
	t130109	dancing		In (mostly)
	t130111	fencing		In (clearly)
	t130115	doing gymnastics	tumbling	In (clearly)
	t130119	participating in martial arts	doing karate, kickboxing	In (clearly)
	t130128	using cardiovascular equipment	using treadmill, riding stationary bicycle	In (clearly)
	t130133	weightlifting/strength training	lifting weights	In (clearly)
	t130135	wrestling		In (clearly)
	t130136	doing yoga		In (clearly)
Basketball	t130103	playing basketball		Out/In (ambiguous)
Climbing	t130108	climbing	mountain climbing	Out/In (ambiguous)
Hockey	t130117	playing hockey	playing ice hockey, field hockey	Out/In (ambiguous)
Tennis	t130120	playing racket sports	playing tennis, squash, badminton, lacrosse	Out/In (ambiguous)
Volleyball	t130130	playing volleyball		Out/In (ambiguous)
Swimming	t130132	participating in water sports	swimming, diving, snorkeling	Out/In (ambiguous)
Stretching	t130134	working out	stretching	Out/In (ambiguous)
Watching sports outdoors	t130202	watching baseball		Out (clearly)
	t130204	watching biking		Out (mostly)
	t130206	watching boating		Out (clearly)
	t130210	watching equestrian sports		Out (mostly)
	t130212	watching fishing		Out (clearly)
	t130213	watching football		Out (clearly)
	t130214	watching golfing		Out (clearly)
	t130219	watching rodeo competitions		Out (clearly)
	t130220	watching rollerblading	watching skateboarding	Out (clearly)
	t130221	watching rugby		Out (clearly)
	t130222	watching running		Out (mostly)
	t130223	watching skiing, ice skating		Out (mostly)

(TABLE A1 CONTINUED)

Watching sports indoors	t130201	watching aerobics	In (clearly)
	t130205	watching billiards	In (clearly)
	t130207	watching bowling	In (clearly)
	t130209	watching dancing	In (mostly)
	t130215	watching gymnastics	In (clearly)
	t130217	watching martial arts	In (clearly)
	t130232	watching wrestling	In (clearly)
Watching a basketball game	t130203	watching basketball	Out/In (ambiguous)
Watching a hockey game	t130216	watching hockey	Out/In (ambiguous)
Watching tennis	t130218	watching racket sports	Out/In (ambiguous)
Watching a volleyball game	t130227	watching volleyball	Out/In (ambiguous)

TABLE A2— ROBUSTNESS CHECK WITH 'AMBIGUOUSLY OUTDOOR' DURING 3PM-7PM (LINEAR PROBABILITY MODEL)

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	0.0227*	0.0142	0.0231
	(0.0137)	(0.0136)	(0.0145)
DST extension	-0.0346***	-0.0152	-0.0174*
	(0.0096)	(0.0096)	(0.0102)
year 2006	-0.0107**	-0.0120**	-0.00817
	(0.0052)	(0.0052)	(0.0056)
year 2007	-0.0179***	-0.0168***	-0.0174***
	(0.0054)	(0.0054)	(0.0058)
year 2008	-0.0213***	-0.0205***	-0.0183***
	(0.0054)	(0.0054)	(0.0057)
T_max (maximum temperature)		0.00207***	0.00233***
		(0.0001)	(0.0001)
Precipitation		-0.0131**	-0.0153***
		(0.0053)	(0.0057)
Age			-0.000393
			(0.0007)
Age squared			0.0000164**
			(0.0000)
Sex (male =1)			0.0775***
			(0.0041)
Married (yes =1)			0.00622
			(0.0047)
Number of children			-0.00152
			(0.0020)
Student (yes =1)			0.00474
			(0.0082)
Full time worker (yes =1)			-0.00888*
			(0.0048)
Family income			0.000000127***
			(0.0000)
Education			-0.00589***
			(0.0008)
Weekend (yes =1)			-0.00854**
			(0.0040)
MSA (yes =1)			-0.0396***
			(0.0053)
Midwest (yes =1)			0.0192***
			(0.0063)
South (yes =1)			-0.0162***
			(0.0060)
West (yes =1)			-0.00278
			(0.0066)
White (yes =1)			0.00542
			(0.0093)
Black (yes =1)			-0.0119
			(0.0105)
Hispanic (yes =1)			-0.0277***
			(0.0105)
Constant	0.232***	0.0918***	0.106***
	(0.0038)	(0.0077)	(0.0214)
Number of observations	48731	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A3— ROBUSTNESS CHECK WITH 'AMBIGUOUSLY OUTDOOR' DURING 3PM-7PM (TOBIT ESTIMATES)

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	12.60**	8.839	13.59**
	(5.787)	(5.740)	(6.008)
DST extension	-16.54***	-6.910*	-7.839*
	(4.068)	(4.054)	(4.279)
year 2006	-5.313**	-5.720***	-3.935*
	(2.148)	(2.132)	(2.235)
year 2007	-8.177***	-7.889***	-8.178***
	(2.231)	(2.217)	(2.324)
year 2008	-10.13***	-9.811***	-8.716***
	(2.211)	(2.196)	(2.306)
T_max (maximum temperature)		0.950***	1.020***
		(0.042)	(0.047)
Precipitation		-5.600**	-7.255***
		(2.226)	(2.382)
Age			-0.184
			(0.291)
Age squared			0.00712**
			(0.003)
Sex (male =1)			36.88***
			(1.679)
Married (yes =1)			1.944
			(1.894)
Number of children			-0.57
			(0.826)
Student (yes =1)			2.408
			(3.414)
Full time worker (yes =1)			-5.645***
			(1.959)
Family income			0.0000600***
			(0.000)
Education			-3.162***
			(0.330)
Weekend (yes =1)			3.498**
			(1.606)
MSA (yes =1)			-16.95***
			(2.078)
Midwest (yes =1)			8.693***
			(2.570)
South (yes =1)			-5.656**
			(2.454)
West (yes =1)			-0.579
			(2.680)
White (yes =1)			1.183
			(3.806)
Black (yes =1)			-2.802
			(4.338)
Hispanic (yes =1)			-14.29***
			(4.322)
Constant	-92.54***	-156.9***	-144.4***
	(1.832)	(3.593)	(8.883)
Number of observations	48731	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A4— ROBUSTNESS CHECK BY ASSIGNING TRACE=0.01 INCHES OF PRECIPITATION: OUTDOOR DURING 3PM-7PM (LINEAR PROBABILITY MODEL)

Regressor Variables	(1)	(2)
Treatment effect (γ)	0.0220**	0.0303***
	(0.0101)	(0.0107)
DST extension	-0.0243***	-0.0265***
	(0.0071)	(0.0075)
year 2006	-0.0108***	-0.00714*
	(0.0039)	(0.0041)
year 2007	-0.00642	-0.00721*
	(0.0040)	(0.0043)
year 2008	-0.00967**	-0.00787*
	(0.0040)	(0.0042)
T_max (maximum temperature)	0.00155***	0.00186***
	(0.0001)	(0.0001)
Precipitation	-0.0147***	-0.0118***
	(0.0039)	(0.0042)
Age		0.00133**
		(0.0005)
Age squared		-6.5E-06
		(0.0000)
Sex (male =1)		0.0550***
		(0.0031)
Married (yes =1)		0.0114***
		(0.0035)
Number of children		0.000519
		(0.0015)
Student (yes =1)		0.0120**
		(0.0061)
Full time worker (yes =1)		-0.0111***
		(0.0035)
Family income		0.000000180***
		(0.0000)
Education		-0.00026
		(0.0006)
Weekend (yes =1)		0.0200***
		(0.0029)
MSA (yes =1)		-0.0215***
		(0.0039)
Midwest (yes =1)		0.0227***
		(0.0047)
South (yes =1)		-0.0140***
		(0.0044)
West (yes =1)		0.005
		(0.0048)
White (yes =1)		0.0342***
		(0.0068)
Black (yes =1)		-0.0246***
		(0.0078)
Hispanic (yes =1)		0.00101
		(0.0077)
Constant	0.00866	-0.108***
	(0.0057)	(0.0159)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A5— ROBUSTNESS CHECK BY ASSIGNING TRACE=0.01 INCHES OF PRECIPITATION: OUTDOOR DURING 3PM-7PM (TOBIT ESTIMATES)

Regressor Variables	(1)	(2)
Treatment effect (γ)	22.13**	30.54***
	(8.824)	(9.269)
DST extension	-20.78***	-22.95***
	(6.467)	(6.895)
year 2006	-9.047***	-5.440*
	(3.161)	(3.305)
year 2007	-5.101	-5.367
	(3.244)	(3.402)
year 2008	-7.559**	-5.649*
	(3.216)	(3.374)
T_max (maximum temperature)	1.376***	1.568***
	(0.065)	(0.072)
Precipitation	-12.79***	-10.74***
	(3.494)	(3.681)
Age		0.962**
		(0.439)
Age squared		-0.0053
		(0.004)
Sex (male =1)		48.50***
		(2.507)
Married (yes =1)		9.516***
		(2.801)
Number of children		-0.127
		(1.225)
Student (yes =1)		10.52**
		(5.086)
Full time worker (yes =1)		-8.855***
		(2.894)
Family income		0.000143***
		(0.000)
Education		-0.679
		(0.489)
Weekend (yes =1)		19.73***
		(2.377)
MSA (yes =1)		-18.06***
		(3.031)
Midwest (yes =1)		17.34***
		(3.778)
South (yes =1)		-9.134**
		(3.654)
West (yes =1)		5.699
		(3.927)
White (yes =1)		27.03***
		(5.892)
Black (yes =1)		-33.52***
		(7.093)
Hispanic (yes =1)		-1.111
		(6.698)
Constant	-276.9***	-357.3***
	(6.198)	(14.130)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A6— ROBUSTNESS CHECK BY ASSIGNING TRACE=0.01 INCHES OF PRECIPITATION: TV WATCHING DURING 3PM-7PM (LINEAR PROBABILITY MODEL)

Regressor Variables	(1)	(2)
Treatment effect (γ)	-0.0217	-0.0265
	(0.0163)	(0.0169)
DST extension	0.0211*	0.0191
	(0.0115)	(0.0119)
year 2006	0.0123**	0.00667
	(0.0063)	(0.0065)
year 2007	0.0154**	0.00838
	(0.0065)	(0.0067)
year 2008	0.0325***	0.0258***
	(0.0064)	(0.0066)
T_max (maximum temperature)	-0.000973***	-0.00154***
	(0.0001)	(0.0001)
Precipitation	0.0155**	0.0137**
	(0.0063)	(0.0066)
Age		-0.00277***
		(0.0008)
Age squared		0.0000557***
		(0.0000)
Sex (male =1)		0.0857***
		(0.0048)
Married (yes =1)		-0.0131**
		(0.0054)
Number of children		-0.0214***
		(0.0023)
Student (yes =1)		-0.0546***
		(0.0095)
Full time worker (yes =1)		-0.0874***
		(0.0056)
Family income		-0.000000617***
		(0.0000)
Education		-0.0166***
		(0.0010)
Weekend (yes =1)		0.0754***
		(0.0046)
MSA (yes =1)		-0.00769
		(0.0062)
Midwest (yes =1)		0.00719
		(0.0073)
South (yes =1)		0.0369***
		(0.0070)
West (yes =1)		0.0208***
		(0.0076)
White (yes =1)		0.00239
		(0.0108)
Black (yes =1)		0.0340***
		(0.0123)
Hispanic (yes =1)		0.0359***
		(0.0122)
Constant	0.469***	0.671***
	(0.0092)	(0.0249)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A7— ROBUSTNESS CHECK BY ASSIGNING TRACE=0.01 INCHES OF PRECIPITATION: TV WATCHING DURING 3PM-7PM (TOBIT ESTIMATES)

Regressor Variables	(1)	(2)
Treatment effect (γ)	-6.449	-8.559*
	(4.604)	(4.606)
DST extension	5.888*	5.827*
	(3.224)	(3.225)
year 2006	3.792**	1.481
	(1.783)	(1.785)
year 2007	6.244***	3.594*
	(1.846)	(1.845)
year 2008	11.29***	8.348***
	(1.819)	(1.824)
T_max (maximum temperature)	-0.250***	-0.431***
	(0.033)	(0.035)
Precipitation	3.940**	3.243*
	(1.775)	(1.784)
Age		-0.195
		(0.226)
Age squared		0.00949***
		(0.002)
Sex (male =1)		29.77***
		(1.321)
Married (yes =1)		-7.515***
		(1.482)
Number of children		-7.700***
		(0.663)
Student (yes =1)		-17.75***
		(2.698)
Full time worker (yes =1)		-27.44***
		(1.533)
Family income		-0.000213***
		(0.000)
Education		-5.581***
		(0.260)
Weekend (yes =1)		29.95***
		(1.274)
MSA (yes =1)		-1.317
		(1.666)
Midwest (yes =1)		0.565
		(2.031)
South (yes =1)		11.23***
		(1.929)
West (yes =1)		6.077***
		(2.109)
White (yes =1)		-2.435
		(3.031)
Black (yes =1)		14.52***
		(3.390)
Hispanic (yes =1)		8.350**
		(3.378)
Constant	-11.24***	46.99***
	(2.627)	(6.889)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A8— ROBUSTNESS CHECK WITH ONLY MSA: OUTDOOR DURING 3PM-7PM (LINEAR PROBABILITY MODEL)

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	0.0257**	0.0193*	0.0317***
	(0.0110)	(0.0109)	(0.0116)
DST extension	-0.0357***	-0.0222***	-0.0243***
	(0.0077)	(0.0077)	(0.0082)
year 2006	-0.00837**	-0.00940**	-0.00578
	(0.0042)	(0.0042)	(0.0045)
year 2007	-0.00679	-0.00602	-0.00773*
	(0.0044)	(0.0044)	(0.0046)
year 2008	-0.00794*	-0.00769*	-0.00663
	(0.0043)	(0.0043)	(0.0046)
T_max (maximum temperature)		0.00142***	0.00166***
		(0.0001)	(0.0001)
Precipitation		-0.0167***	-0.0135***
		(0.0043)	(0.0046)
Age			0.00117**
			(0.0006)
Age squared			-0.00000427
			(0.0000)
Sex (male =1)			0.0510***
			(0.0033)
Married (yes =1)			0.0149***
			(0.0038)
Number of children			0.000765
			(0.0016)
Student (yes =1)			0.0143**
			(0.0065)
Full time worker (yes =1)			-0.00891**
			(0.0038)
Family income			0.000000177***
			(0.0000)
Education			-0.000756
			(0.0007)
Weekend (yes =1)			0.0227***
			(0.0032)
Midwest (yes =1)			0.0223***
			(0.0050)
South (yes =1)			-0.00824*
			(0.0047)
West (yes =1)			0.00824
			(0.0051)
White (yes =1)			0.0379***
			(0.0072)
Black (yes =1)			-0.0203**
			(0.0082)
Hispanic (yes =1)			0.00165
			(0.0081)
Constant	0.108***	0.0119*	-0.118***
	(0.0031)	(0.0062)	(0.0168)
Number of observations	39726	39726	34369

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A9— ROBUSTNESS CHECK WITH ONLY MSA: OUTDOOR DURING 3PM-7PM (TOBIT ESTIMATES)

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	27.99***	21.60**	32.53***
	(9.804)	(9.720)	(10.130)
DST extension	-33.72***	-19.52***	-20.88***
	(7.167)	(7.130)	(7.548)
year 2006	-7.115**	-7.892**	-4.33
	(3.542)	(3.524)	(3.685)
year 2007	-5.314	-4.896	-5.905
	(3.629)	(3.613)	(3.798)
year 2008	-6.807*	-6.353*	-5.114
	(3.598)	(3.578)	(3.760)
T_max (maximum temperature)		1.285***	1.444***
		(0.072)	(0.080)
Precipitation		-15.93***	-13.42***
		(4.070)	(4.288)
Age			0.897*
			(0.491)
Age squared			-0.00406
			(0.005)
Sex (male =1)			45.55***
			(2.786)
Married (yes =1)			12.70***
			(3.129)
Number of children			0.082
			(1.350)
Student (yes =1)			12.89**
			(5.540)
Full time worker (yes =1)			-7.728**
			(3.216)
Family income			0.000143***
			(0.000)
Education			-1.009*
			(0.541)
Weekend (yes =1)			22.28***
			(2.647)
Midwest (yes =1)			18.07***
			(4.184)
South (yes =1)			-5.047
			(3.982)
West (yes =1)			8.037*
			(4.222)
White (yes =1)			31.44***
			(6.347)
Black (yes =1)			-28.80***
			(7.630)
Hispanic (yes =1)			0.966
			(7.166)
Constant	-186.0***	-272.8***	-370.4***
	(3.825)	(6.906)	(15.520)
Number of observations	39726	39726	34369

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A10— ROBUSTNESS CHECK WITH ONLY MSA: TV WATCHING DURING 3PM-7PM (LINEAR PROBABILITY MODEL)

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	-0.0275	-0.0235	-0.0306*
	(0.0180)	(0.0180)	(0.0186)
DST extension	0.0260**	0.0177	0.0154
	(0.0126)	(0.0126)	(0.0131)
year 2006	0.00797	0.0086	0.00293
	(0.0070)	(0.0070)	(0.0072)
year 2007	0.0121*	0.0116	0.00411
	(0.0072)	(0.0072)	(0.0074)
year 2008	0.0286***	0.0284***	0.0217***
	(0.0071)	(0.0071)	(0.0074)
T_max (maximum temperature)		-0.000871***	-0.00139***
		(0.0001)	(0.0001)
Precipitation		0.0134*	0.0121
		(0.0071)	(0.0074)
Age			-0.00322***
			(0.0009)
Age squared			0.0000600***
			(0.0000)
Sex (male =1)			0.0881***
			(0.0053)
Married (yes =1)			-0.0117*
			(0.0060)
Number of children			-0.0217***
			(0.0026)
Student (yes =1)			-0.0565***
			(0.0104)
Full time worker (yes =1)			-0.0844***
			(0.0061)
Family income			-0.000000598***
			(0.0000)
Education			-0.0181***
			(0.0011)
Weekend (yes =1)			0.0826***
			(0.0051)
Midwest (yes =1)			0.0131
			(0.0080)
South (yes =1)			0.0366***
			(0.0076)
West (yes =1)			0.0246***
			(0.0081)
White (yes =1)			-0.00172
			(0.0115)
Black (yes =1)			0.0238*
			(0.0131)
Hispanic (yes =1)			0.0259**
			(0.0129)
Constant	0.400***	0.458***	0.677***
	(0.0050)	(0.0103)	(0.0269)
Number of observations	39726	39726	34369

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A11— ROBUSTNESS CHECK WITH ONLY MSA: TV WATCHING DURING 3PM-7PM (TOBIT ESTIMATES)

Regressor Variables	(1)	(2)	(3)
Treatment effect (γ)	-9.077*	-8.083	-10.95**
	(5.133)	(5.134)	(5.143)
DST extension	7.677**	5.588	5.49
	(3.583)	(3.597)	(3.603)
year 2006	2.891	3.069	0.622
	(2.001)	(2.000)	(2.003)
year 2007	5.638***	5.517***	2.923
	(2.067)	(2.066)	(2.066)
year 2008	10.85***	10.84***	7.776***
	(2.038)	(2.038)	(2.043)
T_max (maximum temperature)		-0.224***	-0.391***
		(0.037)	(0.040)
Precipitation		3.491*	3.024
		(2.009)	(2.023)
Age			-0.422*
			(0.254)
Age squared			0.0117***
			(0.003)
Sex (male =1)			30.35***
			(1.478)
Married (yes =1)			-7.323***
			(1.663)
Number of children			-7.967***
			(0.734)
Student (yes =1)			-18.79***
			(2.967)
Full time worker (yes =1)			-26.77***
			(1.710)
Family income			-0.000204***
			(0.000)
Education			-5.948***
			(0.289)
Weekend (yes =1)			32.08***
			(1.425)
Midwest (yes =1)			2.099
			(2.254)
South (yes =1)			10.95***
			(2.113)
West (yes =1)			7.084***
			(2.278)
White (yes =1)			-3.402
			(3.267)
Black (yes =1)			12.14***
			(3.654)
Hispanic (yes =1)			6.790*
			(3.617)
Constant	-29.76***	-14.81***	50.45***
	(1.535)	(2.962)	(7.497)
Number of observations	39726	39726	34369

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A12— ROBUSTNESS CHECK WITH MEAN TEMPERATURE: OUTDOOR DURING 3PM-7PM (LINEAR PROBABILITY MODEL)

Regressor Variables	(1)	(2)
Treatment effect (γ)	0.0230**	0.0315***
	(0.0101)	(0.0107)
DST extension	-0.0242***	-0.0265***
	(0.0071)	(0.0076)
year 2006	-0.0104***	-0.00674
	(0.0039)	(0.0041)
year 2007	-0.00627	-0.00714*
	(0.0040)	(0.0043)
year 2008	-0.00926**	-0.00757*
	(0.0040)	(0.0042)
T_mean (mean temperature)	0.00156***	0.00187***
	(0.0001)	(0.0001)
Precipitation	-0.0178***	-0.0154***
	(0.0039)	(0.0042)
Age		0.00132**
		(0.0005)
Age squared		-0.00000637
		(0.0000)
Sex (male =1)		0.0549***
		(0.0031)
Married (yes =1)		0.0114***
		(0.0035)
Number of children		0.000588
		(0.0015)
Student (yes =1)		0.0118*
		(0.0061)
Full time worker (yes =1)		-0.0110***
		(0.0035)
Family income		0.000000176***
		(0.0000)
Education		-0.00028
		(0.0006)
Weekend (yes =1)		0.0200***
		(0.0029)
MSA (yes =1)		-0.0215***
		(0.0039)
Midwest (yes =1)		0.0244***
		(0.0047)
South (yes =1)		-0.0106**
		(0.0044)
West (yes =1)		0.00877*
		(0.0048)
White (yes =1)		0.0350***
		(0.0069)
Black (yes =1)		-0.0240***
		(0.0078)
Hispanic (yes =1)		0.00148
		(0.0078)
Constant	0.0226***	-0.0934***
	(0.0054)	(0.0157)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A13— ROBUSTNESS CHECK WITH MEAN TEMPERATURE: OUTDOOR DURING 3PM-7PM (TOBIT ESTIMATES)

Regressor Variables	(1)	(2)
Treatment effect (γ)	23.13***	31.69***
	(8.834)	(9.284)
DST extension	-20.97***	-23.20***
	(6.479)	(6.911)
year 2006	-8.666***	-5.156
	(3.164)	(3.308)
year 2007	-4.931	-5.288
	(3.246)	(3.405)
year 2008	-7.291**	-5.542
	(3.219)	(3.378)
T_mean (mean temperature)	1.378***	1.581***
	(0.069)	(0.077)
Precipitation	-15.93***	-14.10***
	(3.528)	(3.722)
Age		0.962**
		(0.439)
Age squared		-0.00533
		(0.004)
Sex (male =1)		48.32***
		(2.509)
Married (yes =1)		9.673***
		(2.804)
Number of children		-0.101
		(1.227)
Student (yes =1)		10.37**
		(5.094)
Full time worker (yes =1)		-8.662***
		(2.897)
Family income		0.000140***
		(0.000)
Education		-0.698
		(0.490)
Weekend (yes =1)		19.81***
		(2.380)
MSA (yes =1)		-18.05***
		(3.035)
Midwest (yes =1)		18.88***
		(3.782)
South (yes =1)		-6.715*
		(3.644)
West (yes =1)		8.920**
		(3.920)
White (yes =1)		27.73***
		(5.896)
Black (yes =1)		-33.12***
		(7.098)
Hispanic (yes =1)		-0.753
		(6.702)
Constant	-264.0***	-345.3***
	(5.848)	(13.990)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A14— ROBUSTNESS CHECK WITH MEAN TEMPERATURE: TV WATCHING DURING 3PM-7PM (LINEAR PROBABILITY MODEL)

Regressor Variables	(1)	(2)
Treatment effect (γ)	-0.0222	-0.0274
	(0.0163)	(0.0169)
DST extension	0.0207*	0.0188
	(0.0115)	(0.0119)
year 2006	0.0121*	0.00633
	(0.0063)	(0.0065)
year 2007	0.0153**	0.00829
	(0.0065)	(0.0067)
year 2008	0.0322***	0.0256***
	(0.0064)	(0.0066)
T_mean (mean temperature)	-0.00102***	-0.00158***
	(0.0001)	(0.0001)
Precipitation	0.0176***	0.0168**
	(0.0063)	(0.0066)
Age		-0.00276***
		(0.0008)
Age squared		0.0000557***
		(0.0000)
Sex (male =1)		0.0858***
		(0.0048)
Married (yes =1)		-0.0131**
		(0.0054)
Number of children		-0.0214***
		(0.0023)
Student (yes =1)		-0.0545***
		(0.0095)
Full time worker (yes =1)		-0.0875***
		(0.0056)
Family income		-0.000000613***
		(0.0000)
Education		-0.0166***
		(0.0010)
Weekend (yes =1)		0.0753***
		(0.0046)
MSA (yes =1)		-0.00765
		(0.0062)
Midwest (yes =1)		0.00574
		(0.0073)
South (yes =1)		0.0345***
		(0.0070)
West (yes =1)		0.0179**
		(0.0076)
White (yes =1)		0.00169
		(0.0108)
Black (yes =1)		0.0335***
		(0.0123)
Hispanic (yes =1)		0.0356***
		(0.0122)
Constant	0.462***	0.661***
	(0.0087)	(0.0248)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A15— ROBUSTNESS CHECK WITH MEAN TEMPERATURE: TV WATCHING DURING 3PM-7PM (TOBIT ESTIMATES)

Regressor Variables	(1)	(2)
Treatment effect (γ)	-6.588	-8.800*
	(4.604)	(4.606)
DST extension	5.821*	5.732*
	(3.226)	(3.227)
year 2006	3.725**	1.378
	(1.783)	(1.785)
year 2007	6.215***	3.565*
	(1.846)	(1.845)
year 2008	11.22***	8.271***
	(1.820)	(1.824)
T_mean (mean temperature)	-0.258***	-0.445***
	(0.035)	(0.038)
Precipitation	4.466**	4.098**
	(1.773)	(1.782)
Age		-0.193
		(0.226)
Age squared		0.00947***
		(0.002)
Sex (male =1)		29.81***
		(1.321)
Married (yes =1)		-7.510***
		(1.482)
Number of children		-7.719***
		(0.663)
Student (yes =1)		-17.73***
		(2.699)
Full time worker (yes =1)		-27.47***
		(1.533)
Family income		-0.000212***
		(0.000)
Education		-5.580***
		(0.260)
Weekend (yes =1)		29.94***
		(1.274)
MSA (yes =1)		-1.316
		(1.666)
Midwest (yes =1)		0.154
		(2.032)
South (yes =1)		10.56***
		(1.920)
West (yes =1)		5.263**
		(2.103)
White (yes =1)		-2.62
		(3.031)
Black (yes =1)		14.38***
		(3.390)
Hispanic (yes =1)		8.279**
		(3.378)
Constant	-13.12***	44.28***
	(2.478)	(6.840)
Number of observations	48731	42177

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

TABLE A16— MARGINAL EFFECTS (PROBIT ESTIMATES) , REPORTING TREATMENT EFFECT (γ) ONLY

LHS Variable	(1)	(2)	(3)
Pr(outdoor)	0.0288***	0.0240**	0.0132***
	(0.0092)	(0.0098)	(0.0048)
Pr(TV watching)	-0.0267*	-0.0222	-0.0287
	(0.0164)	(0.0164)	(0.0179)

Note: Standard errors are in parentheses. * significant at 10%; ** at 5%; *** at 1%

Estimated by the Difference-in-Differences of four Probit estimates given by the equation in footnote 10. The results are comparable to those in the linear probability model of Table 4 and Table 7.