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Health capital investment and time spent on health-related activities

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Abstract One key component in the health capital investment model in (Grossman, M. *Journal of Political Economy*, 80: 223–255, 1972) is time spent on improving health. However, few empirical studies have examined how time spent on health investment is determined. In this paper, we fill this void in the literature by investigating how people allocate their time for different types of health-related activities in response to economic variables. Using the American Time Use Survey, we distinguish health-enhancing and health-deteriorating leisure activities, with the rationale that these activities may respond differently to socioeconomic environment. We find that health-enhancing and health-deteriorating time respond to economic variables in opposite directions. Specifically, a higher wage rate leads to a reduction in health-deteriorating activities but an increase in health-enhancing activities, particularly those with an investment nature. This finding holds for most subsamples we examine. Our result implies substantial substitution within nonmarket time.

Keywords Time allocation · Health production · Health capital · Leisure time · Labor supply

JEL classification I1 · J22

1 Introduction

In his seminal work, Grossman (1972) wrote, “Gross investments in health capital are produced by household production functions whose direct inputs include the own

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time of the consumer and market goods, such as medical care, diet, exercise, recreation, and housing." This statement emphasizes the indispensable role that time input plays in improving health. Health-related time use has become more important than ever due to several developments that took place during the past half-century. First, average time spent on health-related activities has been steadily rising. According to Aguiar and Hurst (2007), health-related activities (both health-enhancing and health-deteriorating) explain about two-thirds of the increase in total leisure time between 1965–2003.[1] Second, rising health care costs have put fiscal burdens on governments worldwide, prompting them to seek resource-saving alternatives such as promoting exercise and healthy lifestyles among the public (e.g., the "Let's Move" initiative led by Michelle Obama).[2] Third, more knowledge has been accumulated on the potential impact of business cycles on health-related time use. For example, Aguiar et al. (2013) find that as much as 30% of the foregone market time was allocated towards sleep and TV viewing during the 2008 recession, whereas Du and Yagihashi (2015) find that the utilization of routine medical care increased during the same period.[3]

Despite the important role of time in the Grossman model and the growth of leisure time in the past half-century, few empirical studies have examined the use of time as an input for health capital. Our study fills this void by examining how individuals allocate time for different types of health-related activities in response to economic variables. We start out by separating time use into four conceptual categories: time spent on health-enhancing (HE) activities, time spent on health-deteriorating (HD) activities, market work, and others. For HE activities, we further decompose it into activities with more of an investment nature (exercise, medical, and personal care) and activities involving more consumption or pleasure (socializing and relaxation). We then employ time diary data in the American Time Use Survey (ATUS) to map individuals' time use into these categories based on the existing literature.

Since our primary focus is to determine how time spent on HE and HD activities respond to the wage rate (i.e., the opportunity cost of time), we restrict our sample to employed individuals. The price of health-related goods and services is also incorporated in our analysis because we assume individuals produce utility-yielding "commodities" by choosing the optimal mix of market goods/services and nonmarket time (Becker 1965). Empirically, we estimate each type of time use using ordinary least squares, while taking into account the endogeneity of wages by using a Heckman sample selection procedure.

Using compensated wage elasticity we show that individuals devote *more* time to investment-nature HE activities but *less* time to sleep and HD activities when

[1] Aguiar and Hurst's (2007) leisure measure 2 includes mostly health-related activities. The change in leisure measure 2 accounts for about 68% of the total increase in nonmarket time during 1965–2003, based on their Table III.

[2] Hall and Jones (2007) predict that under the increased preference for good health and longer life expectancy, the US would spend 30% of its GDP on health care in 2030. This greater regard for good health could also have implications for health-related time use.

[3] For additional studies on the business cycle effect on health-related behaviors, see Ruhm (2005) and Xu (2013).

their wages are higher. The effect of wages on consumption-nature HE time is inconclusive: It is negative during weekdays and positive during weekends, rendering the net effect for the week to be statistically insignificant. Our results indicate that a 10% increase in the wage rate is predicted to increase HE time by 18.5 min and decrease HD time by 46.3 min over the course of a week. We further demonstrate that the aggregate HE time that combines investment- and consumption-nature activities has a positive and significant wage elasticity of 0.1, which contrasts with the wage elasticity of nonmarket time (total time−work time) of −0.08. Our main results generally hold when we stratify by gender, marital status, and education level.

This paper contributes to the literature in several ways. First, we add to the relatively scant literature on health-related time use by examining a broader array of health-related activities and allowing substitution to occur within health-related leisure time. Previous studies largely focus on *specific* types of time use and do not consider substitution within nonmarket time. For example, Mullahy and Roberts (2010) examine how time spent on physical activities differs by education. Podor and Halliday (2012) examine how sports and exercise time relate to health status. A few studies focus on other activities such as medical care at home and at doctors' offices (Gronau and Hamermesh 2006), personal self-care (Ettner et al. 2009), sleep (Biddle and Hamermesh 1990), and meal preparation (Dunn 2015; Kohara and Kamiya 2016; Senia et al. 2017). Our study encompasses the above studies by examining a broader set of health-related activities and further explores the heterogeneous nature of these activities.

Second, our result provides a rationale for future studies to distinguish time input for health production from other nonmarket time. In the health production literature, a common empirical strategy is to treat all nonmarket time as an approximation of the unobserved time input for health.[4] However, it would not be appropriate to lump all nonmarket time together if activities with different health effects respond differently to economic conditions. Our finding further challenges the assumption of the traditional labor / leisure model that assumes that all leisure time responds negatively to an increase in the wage rate. Our results show that this assumption does not apply to investment-nature HE time.

This paper is organized as follows. In section II, we introduce the model framework and derive the demand for health-related time use. Section III explains the data and estimation methodology. We present the main results in section IV and additional analysis in section V. Section VI presents the study's conclusions.

2 Theoretical framework

Our theoretical framework is largely based on the health capital model of Grossman (2000), with a few modifications. First, we strip away the intertemporal feature of the model by assuming health production is instantaneous. Second, consumption of health-related commodities generates utility directly, as in Becker (1965), whereas the health benefit of these activities is expressed in terms of extended

[4] See for example, Sickles and Yazbeck (1998).

healthy time.[5] Third, health-neutral time does not enter the utility function because our focus is health-related time use.

Specifically, a consumer's period utility can be expressed as

$$u = u(Z_{\mathrm{HE}}, Z_{\mathrm{HD}}, X), \tag{1}$$

where Z_j is a utility-generating "commodity" of type j, and X is a composite of consumption goods that have no direct impact on health. The marginal utilities $\partial u/\partial Z_j$ and $\partial u/\partial X$ are assumed to be positive and have diminishing marginal returns. Commodities Z_{HE}, Z_{HD}, and X are not independent, and they can correlate with each other. Commodity Z_j is produced through combining the relevant market goods and time as in Becker (1965),

$$Z_j = f_{Z,j}(C_j, T_j; V), \tag{2}$$

where C_j are goods and services essential in producing the commodity j, T_j is the time input, and V is the predetermined socioeconomic and demographic characteristics such as education, which affects efficiency in production. The marginal products $\partial Z_j/\partial C_j$ and $\partial Z_j/\partial T_j$ are assumed to be positive with diminishing marginal returns.

Healthy time (h) is produced through a health production function,

$$h = h(Z_{\mathrm{HE}}, Z_{\mathrm{HD}}), \tag{3}$$

where Z_{HE} and Z_{HD} are health-enhancing and health-deteriorating commodities (respectively), and they are assumed to be additively separable for simplicity. Eq. (3) satisfies $\partial h/\partial Z_{\mathrm{HE}} > 0$ and $\partial h/\partial^2 Z_{\mathrm{HE}} < 0$ for HE activities and $\partial h/\partial Z_{\mathrm{HD}} < 0$ and $\partial h/\partial^2 Z_{\mathrm{HD}} < 0$ for HD activities. We also assume that h has a natural upper bound, i.e., $h_{\max} < \Omega$, where Ω is physically endowed time (i.e., 1440 min per day).

An individual can spend healthy time h on work or leisure. Thus the time constraint can be expressed as

$$h = T_w + T_{\mathrm{he}} + T_{\mathrm{hd}} + T_{\mathrm{hn}}, \tag{4}$$

where T_w is time spent on market work, T_{he} is HE time, T_{hd} is HD time, and T_{hn} is health-neutral time that is assumed to stay constant for simplicity. We define the sum of T_{he}, T_{hd}, andT_{hn} as nonmarket work.

In our model, time spent on health-related activities T_j can affect utility in two ways. First, it can increase or decrease healthy time (h) depending on whether the activity is health-enhancing or health-deteriorating. The marginal effect of T_j on healthy time can be expressed as $MP_{T,j} = (\partial h/\partial Z_j)(\partial Z_j/\partial T_j)$, which represents the investment motive of health-related time use. Second, it can affect utility by contributing to the production of health-related commodities (Z_{HE} and Z_{HD}). The marginal effect of T_j on utility can be expressed as $MU_{T,j} = (\partial u/\partial Z_j)(\partial Z_j/\partial T_j) > 0$, which represents the consumption motive of health-related time use.

To determine how an increase in the wage rate affects health-related time use, it is useful to consider the two channels separately. First, a higher wage rate would make

[5] According to Becker (1965), utility-generating "commodities" are produced through combining goods and time, and consumption of commodities is distinguished from consumption of goods. Ghez and Becker (1975) extend the original idea of Becker (1965) to incorporate human capital.

HE time more attractive because the expanded earning makes the individual effectively wealthier by expanding the “full” income through reduced sick time. The opposite would apply to HD time. Second, because health-related commodities yield direct utility, a higher wage rate can trigger two (possibly opposing) effects depending on whether the commodity is a normal or an inferior good and the time-intensiveness in producing the commodity. In general, an increase in the wage rate would induce substitution away from more time-intensive commodities towards less time-intensive commodities, while simultaneously prompting a more intense use of goods relative to time. Similarly, an increase in the price of health-related goods would induce substitution away from the affected commodity, while simultaneously prompting a more intense use of time.

It is inherently difficult to determine a priori whether an activity has investment or consumption motive. For example, some people may regard physical exercise as pure investment, while others may derive pleasure from it. Similarly, TV viewing is generally an enjoyable activity, but prolonged TV viewing could become a health hazard. Those who are aware of the negative effect may consciously reduce TV viewing.

Another related issue is that the overall wage effect is the combination of the substitution and the income effect. To separate the substitution effect from the income effect, we use the Slutsky equation. The (uncompensated) elasticity of activity j with respect to the real wage rate (w) can be written as

$$\varepsilon_{u,j} \equiv \frac{dln(T_j)}{dln(w)} = \varepsilon_{c,j} + s_R \varepsilon_{R,j}, \tag{5}$$

where $\varepsilon_{c,j}$ is the *compensated* elasticity that keeps utility constant (substitution effect) and $\varepsilon_{R,j}$ is the elasticity of time use T_j with respect to full income while keeping the wage rate constant. The share of non-earning income R in the full income (i.e., $R/(w\Omega + R)$) is represented by s_R. The term $s_R \varepsilon_{R,j}$ represents the income effect. The sign of the income effect indicates whether time spent on activity j is a normal or an inferior good. To obtain the compensated elasticity, we subtract the income effect from the uncompensated elasticity.

Based on the traditional labor supply framework, a higher wage rate is predicted to reduce all types of nonmarket time once the income effect is properly accounted for. This may not be the case in our model because both Z_j and X yield utility, and the correlation between Z_j and X could change the prediction of the model. Suppose we ignore health-related goods C_j for a moment and let $Z_j = \tilde{f}_{Z,j}(T_j; V)$. We can decompose the compensated wage elasticity as,

$$\varepsilon_{c,j} = k_j \sigma_{T_j T_j} + k_{k \neq j} \sigma_{T_j T_k}, \tag{6}$$

where $k_j \equiv \frac{wT_j}{w\Omega + R}$ is the spending share of Z_j with respect to full income, $\sigma_{T_j T_j}$ is the own partial elasticity of substitution with respect to T_j and itself, and $\sigma_{T_j T_k}$ is the cross partial elasticity of substitution between T_j and T_k.[6] We note that the cross-partial

[6] Note that cross partial elasticity of substitution with multiple (=n) goods can be expressed as $\sigma_{ij} = \frac{\sum_n u_i x_i}{x_i x_j} \frac{U_{ij}}{U}$, where u_i is the marginal utility of good x_i, U is the determinant of the key bordered Hessian with marginal utilities entering the first row/column and zero in the top-left element, and U_{ij} is the cofactor of element in U that is associated with the second-order derivative of the utility function with respect to x_i, x_j. Own partial elasticity of substitution can be obtained by replacing the above index j with i.

elasticity times the spending shares can be expressed as,

$$k_j\sigma_{T_jT_j} = -k_{k\neq j}\sigma_{T_jT_k} - k_X\sigma_{T_jX}, \tag{7}$$

where σ_{T_jX} is the cross partial elasticity of substitution between T_j and X, whereas $k_X = 1 - k_{\mathrm{HE}} - k_{\mathrm{HD}}$. Combining Equations (6) and (7) yields

$$\varepsilon_{c,\mathrm{HE}} = -k_X\sigma_{T_{\mathrm{HE}}X}, \tag{8}$$

$$\varepsilon_{c,\mathrm{HD}} = -k_X\sigma_{T_{\mathrm{HD}}X}, \tag{9}$$

where the sign of the elasticities depends on the sign of the cross partial elasticities of substitution. If T_j and X are complementary in utility, i.e., $\sigma_{T_jX}<0$,[7] it follows that the remaining pairs of variables must be substitutes, i.e., $\sigma_{T_kX}>0$ and $\sigma_{T_jT_k}>0$. Thus the sign would necessarily be different for $\varepsilon_{c,\mathrm{HE}}$ and $\varepsilon_{c,\mathrm{HD}}$, and consequently an increase in the wage rate would have an opposite effect on HE and HD time in this case.

3 Data and estimation method

3.1 Data on time use

The main data are from the 2003–2014 American Time Use Survey (ATUS). The ATUS is conducted by the US Census Bureau on an annual basis to collect information on how Americans spend their time. The ATUS sample is randomly drawn from the larger Current Population Survey (CPS). Eligible persons are those above 15 years old and those who are not active military personnel. Each participant is randomly assigned a day of the week to report. About 50% of the sample is assigned to weekdays and 50% to weekends. Only one person from each CPS household is included in the ATUS, but we can link the ATUS with the CPS to obtain state identifiers and information on family members (such as the spouse's earnings). Being able to identify states is important for this study because many of the price variables and variables used to identify the wage effect are only available at the state level. The format of the survey is a time diary on the day before the interview. In the time diary, the respondent is required to identify the primary activity when multiple activities are performed at the same time; therefore, all activities sum to 24 h (or 1440 min).

Because our variable of focus is the wage rate, we dropped observations who are younger than 25 or older than 65 years old, enrolled in school, in the armed forces, unemployed, those not in the labor force, and those who reported an emergency on the diary day. Unemployed persons were dropped because they are likely to have unusual time-use patterns due to job search. Those not in the labor force were dropped because the health investment motive is less relevant for them. In Appendix Tables 12 and 13, we present results for the overall sample that combines the employed sample with the unemployed and those not in the labor force.

We define HE time (T_{he}), HD time (T_{hd}), sleep time (T_s), and market work time (T_w) using the six-digit classification codes in the ATUS, which are presented in

[7] This is not an unreasonable assumption to make in the health literature. For example, Case and Deaton (2005) assume health and consumption are complements in their model.

Appendix Table 9. The categorization of health-related activities is largely based on the existing literature on time use.[8] Five types of activities could potentially contribute to health: exercise, medical care, personal care, relaxation, and socializing. In our baseline regressions, we combine activities in the following way: (a) exercise; (b) medical + personal care; (c) socializing + relaxation. We classify (a) and (b) as investment-nature HE time and (c) as consumption-nature HE time.

Exercise includes most physical activities under the "sports and exercise" category such as gym workouts, walking, and hiking. The health benefit of exercise is widely known, and many studies have documented the beneficial effect from the perspectives of biomedical science, psychology, and public health.[9]

Medical and personal care includes health services at and outside the home, using personal care services (such as obtaining a massage), health-related self-care (such as taking medicine, dressing a wound, meditating, and doing stress management), and other personal care activities (washing, dressing, and grooming, etc). Medical care and health-related self-care are generally not very enjoyable and can even be associated with some pain (Krueger 2007), but they have the effect of improving and maintaining health. Washing/dressing/grooming activities may not improve health directly, but are likely associated with a higher utility (more relaxation, better self-image and hygiene, etc).

Relaxation includes activities that are enjoyable and have the nature of a "breather" and "restorer" (Pressman et al. 2009) and activities that are associated with happiness (Krueger 2007). Examples of such activities are listening to music, visiting museums, attending sports events and entertainments, and engaging in arts and crafts and personal hobbies. We note that a subset of recreational childcare activities (e.g., playing sports with children and arts and crafts with children) and a subset of home production activities (e.g., lawn and garden care and walking/exercising/playing with pets) are also included in relaxation because Krueger (2007) includes them in the most enjoyable activity cluster.[10] We do not include eating and drinking time because these activities do not have a clear health impact and may not be adjusted easily. Some studies show that primary eating and drinking time is inversely related to body weight (e.g., Zick et al. 2011), while others find secondary eating time contributes to calories consumed (Bertrand and Schanzenbach 2009).[11]

Socializing activities are defined as activities that involve interaction with others. Examples of socializing are attending religious services and events, attending meetings/trainings, hosting social events, and engaging in club activities and most volunteer activities. Ties to religious organizations are shown to be associated with

[8] See, for example, Aguiar and Hurst (2007); Bertrand and Schanzenbach (2009); Krueger (2007); Mullahy and Roberts (2010); Podor and Halliday (2012); Russell et al. (2007); Du and Yagihashi (2016), among others.

[9] See, for example, Batty et al. (2003), Moore et al. (2012), and Warburton et al. (2006), among others.

[10] Krueger (2007) separates nonmarket activities into six groups based on people's feelings (pain, happy, tired, stressed, sad, and interested). These activities are associated with more happiness and less stress and pain. See Table 1 in Krueger (2007). Most of our HE activities fall into Krueger's categories 2, 3, and 4, which are considered enjoyable activities.

[11] Zick et al. (2011) also show that time spent preparing food and cleaning up is inversely related to body mass index for women and that sleep time is inversely related to body mass index for men.

Table 1 Summary statistics for time use, measured in minutes per day

	One-week sample (weekday + weekend)	Weekday sample	Weekend sample	Percent reporting positive time use
Exercise	17.02	14.36	23.32	17.16%
	(56.45)	(46.45)	(74.57)	
Medical + personal care	50.08	52.67	43.97	84.87%
	(57.29)	(57.13)	(57.20)	
Socializing + relaxation	138.69	104.24	220.03	81.59%
	(160.75)	(126.15)	(199.66)	
Sleep time	491.34	469.65	542.55	99.90%
	(121.97)	(110.30)	(132.46)	
TV viewing	129.41	111.81	170.97	77.29%
	(135.47)	(115.21)	(166.99)	
Work	354.76	455.17	117.66	70.61%
	(281.63)	(241.46)	(221.17)	
HE time—narrow				
(Exercise, medical, personal,	67.11	67.03	67.29	87.11%
social, relax)	(79.40)	(73.03)	(92.71)	
HE time—broad				
(Exercise, medical, personal,	205.80	171.27	287.33	97.05%
social, relax, and sleep)	(176.03)	(142.89)	(215.61)	
Sample size	77,422	37,818	39,604	77,422

Note: Our sample is from the 2003-2014 ATUS, including employed people between 25 and 64 years old. All statistics reported in the table are adjusted for sample weights. The one-week sample is the combined weekday and weekend sample. The weekend sample also includes holidays. Time-use variables are measured in minutes. Travel and waiting time are included in each category. Standard deviations are included in parentheses

positive health behaviors and lower mortality (e.g., Musick et al. 2004). Family and friends relationships may also influence a variety of health behaviors, such as smoking and drinking (e.g., Engels et al. 1999).[12] Ristau (2011) finds that social interaction can slow down cognitive decline for the elderly. Umberson et al. (2010) summarize that the channels through which social interaction can influence health behaviors are in providing more social support, better coping with stress, and instilling more control and norms.

Health-deteriorating activities (T_{hd}) refer to watching non-religious television programs, movies, and videos. Screen time is often linked to an increased probability of obesity, which leads to many chronic conditions (e.g., Jeffrey and French 1998; Hamer et al. 2010; Hancox et al. 2004; Grøntved and Hu 2011). Watching TV/DVDs/YouTube on the computer is counted as TV viewing in the ATUS; thus, they

[12] We note that peer effects on health behaviors can be both positive and negative. Because we cannot distinguish the type of interaction using the ATUS data, we decide to include all types of social interactions in this category, rather than subjectively picking up specific time use.

are included in T_{hd}. However, watching religious programs is separately recorded in the ATUS. Because religious programs are often associated with positive emotions, we consider them as relaxation. We do not include computer use for other purposes as health-deteriorating because of its ambiguous health effect.[13] Lastly, we exclude cigarette smoking because it is most likely identified as a secondary activity rather than a primary activity. Only a very small percentage of the sample reported positive cigarette smoking time in the ATUS.[14]

Sleep time refers to "sleeping, napping, dozing, dreaming, and waking up" (ATUS). It includes both night sleep and daytime naps. Sleep is examined separately from HE and HD time because sleep is what most people must do every day, and its effect on health is likely to operate in a different manner.[15]

Finally, we examine work time.[16] The coefficient for work time represents labor supply elasticity. A reasonable value for the labor supply elasticity would reassure the validity of our results. Work time includes time spent on all jobs and activities that generate income. It also includes time associated with traveling to and from a work place. The remaining time spent on nonmarket activities is regarded as health-neutral, and it mainly consists of home production, childcare, and own educational activities.

3.2 Estimation

For each time use, we estimate the following equation,

$$lnT_{ijlt} = \beta_j^c + \beta_j^W \ln \widehat{W}_{ilt} + \beta_j^{Y'} \mathrm{Y}_{ilt} + \beta_j^{V'} \mathrm{V}_{lt} + \omega_d + \mu_t + \varphi_l + s_m + \varepsilon_{ijlt}, \tag{10}$$

where T_{ijlt} refers to time spent on activity j for individual i living in state l interviewed in year t. $\widehat{W}$ is individuals' real wage rate predicted from a Heckman sample selection equation. Y includes individuals' socioeconomic and demographic characteristics. V represents all state-level variables, including the price of related market goods (constructed by authors) and average temperature and total precipitation for the month of the interview. The model additionally controls for day of the week indicators (ω), year dummies (μ), state dummies (ϕ), and an indicator for summer months (s). The estimation uses ordinary least squares. Because the predicted wage rate is used to estimate time use, bootstrapped standard errors are applied to correct for bias. We bootstrap the first-stage Heckman equation and the

[13] We note that the length of TV viewing could play a role in terms of its health effect. For example, a meta-analysis study (Grøntved and Hu 2011) finds that there is no association between TV viewing of less than 3 h and mortality, but there is a positive association with Type 2 diabetes and heart disease. Moderate TV viewing may have a less detrimental effect than prolonged TV viewing. Because there is no consensus on the exact relationship between length of TV viewing and health, we assume all TV viewing time to be health-deteriorating.

[14] In alternative specifications, we include computer use and cigarette smoking as health-deteriorating activities, and our results remain largely the same as in the baseline.

[15] Many studies associate lack of sleep with various health conditions such as BMI and hypertension (e.g., Patel and Hu 2008; Pepin et al. 2014, among others).

[16] The effect of work time on health is mixed. For example, Abramowitz (2016) finds that non-strenuous jobs increase body mass index, but strenuous jobs do not.

second-stage linear regressions together for 100 times for each outcome we examine.[17] The resulting standard errors are generally 5–20% larger than those without bootstrapping.

Because people are interviewed on only one day in a week, there are non-participants (zero) in certain activities, though some of these non-participants may become participants (positive) on other days of the week. As we mentioned above, the ATUS randomly samples individuals across weekdays and weekends, thus the possibility that we observe someone with a zero for some time use on a Monday is balanced by the possibility that a similar individual is observed on a Friday with a non-zero time use.

Most of the time uses that we are interested in have a certain proportion of zeros except for sleep time (see Table 1). About 20% of the respondents report doing exercise on a given day, 85% report positive medical and personal care, 82% report positive socializing activities and relaxation, and 77% report positive TV viewing. To deal with the censoring problem, it might be more appropriate to use the Tobit model or the sample selection model. However, because zeros in the time-use survey might not represent non-participation, it can be argued that a linear model might be more appropriate. In addition, the linear model has the advantage of being more robust to model misspecifications such as heteroskedasticity. Since most activities we examine do not involve a significant proportion of zeros, we use the linear model with logged dependent variables in our baseline analysis and a Tobit model in our robustness analysis.[18] In additional analysis, we combine all components of HE time (which helps to reduce zeros) to examine the robustness of our finding. We use log transformation because most health-related time uses have a notable right-skewed distribution. Log transformation also facilitates the interpretation of the coefficient as elasticities.

Socioeconomic and demographic variables of the respondent include gender, age, age squared, race, educational attainment, spousal earnings, marital status, number of children per age bracket (0–2 year old, 3–6 year old, and 7–18 year old), urban/rural, and three regional dummies (Northeast, Midwest, or South).

State-level variables include weather conditions for the interview month and state-level prices. Weather conditions include average temperature and total precipitation for the month of the interview at the state level.[19] Both variables are obtained from

[17] We also conducted bootstraps for 200 times, and the resulting standard errors are not very different from doing it for 100 times. Given the large sample size and the multiple outcomes we examine, we report standard errors that use 100 times bootstrap in all tables.

[18] An alternative way to estimate time-use data is to treat the outcome as a fraction (e.g., a fraction of daily time spent on HE activities) and estimate using a fractional response model (Papke and Wooldridge 1996). Mullahy and Roberts (2010) use a multivariate fractional response model to estimate several time-use variables jointly. While the fractional response model gives consistent estimates when the dependent variable takes on extreme values of 0 or 1, it relies on the correct specification of the conditional mean (usually a logistic function or a standard normal distribution). In our case, because health-related time use has a long tail on the right side (see Fig. 1), the logistic or standard normal distribution would not fit very well.

[19] Mullahy and Roberts (2010) show that a higher temperature is associated with more exercise, whereas Connolly (2008) finds that people shift from leisure to work on rainy days.

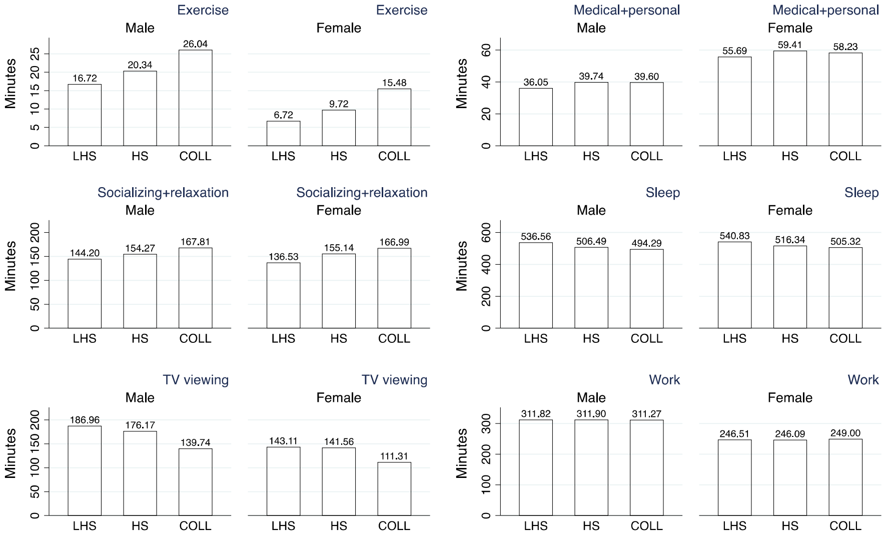

Fig. 1 Time use by education and gender. Note: Data source is the American Time Use Survey 2003–2014. LHS refers to less than high school, HS refers to high school degree, and COLL refers to some college, college degree, and graduate degree. This sample consists of employed persons between 25 and 64 years old. Weekday and weekend samples are combined

the National Oceanic and Atmosphere Administration (NOAA). Construction of state-level prices is detailed in section 3.4.

We control for day-of-the-week indicators to account for differences in the demand for time based on certain days of the week and a summer indicator (if the interview occurs in June, July, and August) to account for seasonal differences. Year dummies control for common economic activities occurring in a specific year, and state dummies control for time-invariant state-level differences (such as, health-related culture, availability of parks, etc).

We conduct estimation for the weekday and weekend combined sample and also separate estimations for the weekday and the weekend sample (including holidays). All estimations adjust for sample weights provided by the ATUS. Weighting is especially important when we combine weekday and weekend samples, because weekend interviews are over-represented in the ATUS.

3.3 Identification

Wage rates are measured as per-hour earnings for workers paid hourly. For non-hourly workers, we use their weekly earnings divided by their hours worked. The observed wage rate suffers from an endogeneity problem that could be caused by either reverse causality from physical activities to labor earnings or by an omitted variable that is correlated with both wages and time use.[20] To overcome this problem, we use the Heckman selection equation to predict wages and then use the predicted

[20] Lechner and Sari (2015) find that physically active individuals have higher earnings in the long run.

wages in estimation. The Heckman procedure is also helpful in predicting missing values of wages because 13% of the employed did not report a wage rate or lacked relevant information (either earning or hours worked) to calculate their wage rate.[21]

For the baseline estimation, the dependent variable in the first equation of the Heckman procedure (selection process) is whether the person reported a positive wage. The second equation estimates the natural log of the real wage rate conditional on observing a positive wage rate. The real wage rate is nominal wage rate divided by the state consumer price index (CPI), which is obtained using the overall CPI multiplied by the regional price parities. The base year of the overall CPI is 2009. Identification of the sample selection equation is through the interactions of age and education dummies, marital status, spousal earnings, and the number of children in three age brackets. The predicted wage rate used in the time use equations are obtained using the predicted probability of observing a positive wage rate multiplied by the mean wage rate conditional on observing a positive wage rate.

Identification of the wage rate in the time-use equation requires additional variables that affect wages but do not affect time use directly. Kimmel and Connelly (2007) use three state-level variables (state labor-force participation rate, unemployment rate, and the minimum wage) to identify the wage effect on mothers' time use. To capture the entire wage distribution and both genders, we added state occupational wages in addition to the variables used by Kimmel and Connelly (2007). Thus our identification relies on wage differentials both across states and over time. The ATUS provides information on detailed occupational categories based on the Census definition. We link individuals' occupation category in the ATUS (23 categories altogether) with the average hourly wage for that occupation in each state and year.[22] This average occupational wage variable and the three state-level variables are included in the equations that predict wages, but not in the time use equations.

3.4 Construction of relative prices

We prepare five price variables: Three correspond to HE activities ("exercise," "medical + personal," and "socializing + relaxation"), one for HD ("TV viewing"), and another one for the composite good X.[23] Each price variable is constructed as the weighted average of the price indexes of the relevant item(s),

$$P_{j,l,t} = \sum^{e} \omega_{j,e} P_{j,e,l,t}, \tag{11}$$

where $P_{j,l,t}$ refers to the price index of activity j for state l and year t. Item(s) corresponding to the activity (indexed by e) are selected from the item-based

[21] For the overall sample (shown in Appendix Tables 12 and 13), the Heckman procedure is used to predict wages for those with missing wages, the unemployed, and those not in the labor force. The same approach is also taken by Kimmel and Connelly (2007) and Hamermesh (2008), among others.

[22] The average hourly wage was obtained from the Occupational Employment Statistics (OES) Survey of the BLS. Because both the ATUS and the BLS use the Census Occupation Classification, there was no problem associated with matching.

[23] The price index for sleep is not considered because the relevant goods are more of a durable nature.

CPI prepared by the Bureau of Labor Statistics (BLS). For example, for exercise we choose "club dues and fees for participant sports and group exercises" (BLS code: CUUR0000SERF01) as the relevant goods input. When there are multiple relevant items for the activity, we aggregate them using the relative importance of components in the 2015 CPI as fixed weights.[24] Most items are drawn from nondurable goods and services because durable goods prices (such as beds, exercise machines, and TVs) appear to be less relevant in time allocation.[25]

The price index is constructed for a given state and year by multiplying the CPI at the national level with the regional price parity index (RPP) for a given year as follows,

$$P_{j,e,l,t} = P_{j,e,t} \times RPP_{c,l,t} \tag{12}$$

where $\mathrm{RPP}_{c,l,t} \equiv 100(P_{c,l,t}/P_{c,t})$ represents regional price parity for category c in state l.[26] The index represents the deviation of state-level prices from the national average $P_{c,t}$. In addition to the overall price, finer categories related to goods, rents, and services excluding rent are also available, as indexed by c.[27] In our analysis, we associate each item e with the corresponding category c, as we describe in Appendix Table 10. Because data for RPP are only available since 2008, we employ linear extrapolation to cover the period of 2003–07.

3.5 Summary statistics

Table 1 presents weighted summary statistics for time-use variables for the weekday sample, the weekend sample, and the combined one-week sample. For each time use, we present mean, standard deviation, and the percent reporting positive time use. The average person in our sample spends approximately 17 min per day on exercise (14 min on weekdays and 23 min on weekends) and 50 min on medical and personal care (53 min on weekdays and 44 min on weekends).[28] Individuals spend on average a little over 2 h per day on socializing and relaxation. Approximately 1.8 h per day are spent on TV viewing on weekdays and 3 h per day on weekends. Sleep time is slightly longer on weekends (9 h) than on weekdays (7.8 h), whereas work time is much longer on weekdays (7.5 h) than on weekends (2 h).

Figure 1 shows the time-use pattern by education and gender. Across education levels, we observe that better-educated individuals spend more time on exercise,

[24] For example, the price index for TV viewing is calculated by combining the price indexes of "Cable and satellite television and radio service" ($\omega_{\mathrm{TV},\,1} = 0.674$) and "Internet services and electronic information providers" ($\omega_{\mathrm{TV},\,2} = 0.326$). The actual weights are obtained from the BLS website: https://www.bls.gov/cpi/.

[25] Detailed documentation on the CPI is available in Chapter 17 of the Handbook of Methods prepared by the BLS (http://www.bls.gov/opub/hom/pdf/homch17.pdf).

[26] For more on RPP, visit the BEA website https://www.bea.gov/regional/index.htm.

[27] Four categories are available in the RPP: all Items ($c = all$), goods ($c = goods$), services: rents ($c = rent$), and services: other ($c = services$). We mostly use goods or services: other when constructing the price index. When an item covers both goods and services, we use the category "all items" instead of imposing our own judgment on whether it is predominantly goods or services.

[28] We note that the largest component of medical and personal care is washing/dressing/grooming activities, which accounts for about 80% of the total time spent on medical and personal care.

Table 2 Descriptive statistics

Variables	Mean (s.d.)
Natural log of hourly wage, predicted	2.540 (0.269)
Male	0.538
Age	43.746 (10.786)
Black, non-Hispanic	0.101
Hispanic	0.134
Other race	0.053
College	0.624
High school	0.296
Less than High School	0.081
Spouse's weekly earnings	389.994 (605.751)
Married, spouse present	0.648
Number of children ages 0–2	0.120 (0.365)
Number of children ages 3–6	0.184 (0.467)
Number of children ages 7–18	0.560 (0.913)
Urban	0.740
Summer	0.257
Diary day—Monday	0.145
Tuesday	0.144
Wednesday	0.141
Thursday	0.144
Friday	0.141
Saturday	0.144
Sunday	0.141

Note: Since weekday and weekend sample are very similar in demographic information, we do not present them separately. Sample size is 77,422. All statistics are adjusted for sample weights. Standard deviations for continuous variables are included in parentheses

socializing and relaxation, but less time on TV viewing. Across gender, men spend more time on exercise, whereas women spend more time on medical and personal care. We note that women spend more time on all categories, including medical care, grooming activities, and health-related personal care. Men spend on average 30 min longer watching TV than do women. Sleep time is similar across gender, but higher-educated individuals sleep slightly less.

Table 2 presents summary statistics for model variables adjusting for sample weights. We do not separately report statistics for weekdays and weekends because they are very similar and because assignment for weekdays and weekends is random in the ATUS. The sample size is 77,422 for the overall sample, 37,818 for weekdays, and 39,604 for weekends.

4 Main result

We will first explain results for the combined sample, and then discuss weekday and weekend estimates separately. To gauge the overall effect during a one-week period, we calculate the marginal effects in minutes for a 10% increase in the wage rate. We also present wage elasticities for aggregate HE measures and nonmarket time. Validity of identification is presented at the end.

4.1 Effect of wages on time use

The first row of Table 3 shows the compensated wage elasticities for six time uses. The estimates are considerably different across time use both in terms of sign and magnitude. In general, HE time with an investment nature (exercise, medical + personal care) and work time respond positively to a wage increase, whereas HD time (i.e., TV viewing) and sleep respond negatively. The positive wage effect on work time is consistent with the labor literature, whereas the negative wage effect on sleep corroborates Biddle and Hamermesh's (1990) finding. The wage elasticity for HE time with a consumption nature (i.e., socializing and relaxation) is found to be negative but not statistically significant (p-value = 0.372).

Among HE time, exercise has the largest wage elasticity of 0.541, followed by medical + personal care (0.175) and socializing + relaxation (−0.071). TV viewing has a large and negative elasticity of −0.611. The contrasting results between HE and HD time could be due to multiple factors. If exercise, medical, and personal care increase healthy time, as we conjectured, the higher wage effectively increases the return of health investment, which in turn increases the demand for HE time. The wage elasticity could also reflect a shift of time use from more time-intensive to less time-intensive activities to minimize the total opportunity cost. According to Gronau and Hamermesh (2006), sleep and TV viewing are among the most time-intensive activities and medical care is among the most goods-intensive (or least time-intensive) activities.[29] The negative coefficient on HD time is consistent with the finding of Berry (2007) that "passive activities" (e.g., TV watching, playing computer and video games, and thinking/doing nothing) are often observed among populations with low socioeconomic status. Finally, work time has a wage elasticity of 0.552, which is slightly higher than the labor supply elasticity typically found in micro studies (between 0–0.3). This could be because the time diary data we use are more likely to capture adjustment of hours during a short time span. It is possible that work hours across different days are easier to adjust than total hours during a longer time horizon (say, a month).

The compensated wage elasticity is the uncompensated wage elasticity net of income effect, which is obtained as the product of the coefficient of spousal earnings and the share parameter s_R. In calculating s_R, we define full income as the individual's full (labor) income plus the spouse's income. The share is approximately 0.133 for the employed sample.[30] For most health-related activities, the coefficient of spousal earnings is small and not significantly different from zero, which means that the

[29] HD activities and sleep involve almost no goods input *at the margin*; for example, TV, home-theater systems, beds, and pillows are purchased only occasionally.

[30] For singles, this share would be zero, implying zero income effect. Conditional on the married sample, the share becomes 0.219. In Section V, we conduct analysis for married and singles separately using the share for the subsamples.

Table 3 Determinants of time use

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Work time
Wage elasticity,	0.542***	0.175***	−0.071	−0.054***	−0.615***	0.556***
compensated	[$p = 0.000$]	[$p = 0.002$]	[$p = 0.372$]	[$p = 0.000$]	[$p = 0.000$]	[$p = 0.000$]
Wage elasticity,	0.541***	0.175***	−0.071	−0.054***	−0.611***	0.552***
uncompensated	(0.069)	(0.055)	(0.079)	(0.012)	(0.088)	(0.095)
	[$p = 0.000$]	[$p = 0.002$]	[$p = 0.373$]	[$p = 0.000$]	[$p = 0.000$]	[$p = 0.000$]
Log spousal earnings	−0.010***	0.0008	0.003	0.0008	0.027***	−0.031***
	(0.003)	(0.003)	(0.004)	(0.0006)	(0.005)	(0.006)
Male	0.099***	−0.520***	−0.084***	−0.024***	0.367***	0.396***
	(0.018)	(0.016)	(0.019)	(0.003)	(0.021)	(0.027)
Age	−0.028***	−0.002	−0.046***	−0.002	0.025**	0.012
	(0.008)	(0.006)	(0.010)	(0.001)	(0.011)	(0.011)
Age squared	0.003***	0.000	0.0006***	0.000	−0.0002*	−0.0001
	(0.000)	(0.000)	(0.0001)	(0.000)	(0.0001)	(0.0001)
Black non-Hispanic	−0.200***	0.231***	−0.143***	−0.017**	0.140***	−0.145***
	(0.024)	(0.021)	(0.033)	(0.006)	(0.040)	(0.037)
Hispanic	−0.113***	0.184***	−0.343***	0.026***	0.056	0.118***
	(0.022)	(0.025)	(0.035)	(0.005)	(0.038)	(0.038)
Other race	−0.107	0.046	−0.305***	0.016**	−0.050	0.070
	(0.041)	(0.030)	(0.052)	(0.007)	(0.055)	(0.057)
High school	−0.170***	−0.034	−0.207***	0.002	0.175***	−0.005
	(0.026)	(0.021)	(0.032)	0.005	(0.035)	(0.038)
Less than high school	−0.118**	−0.174***	−0.384***	0.025***	0.080	0.122
	(0.048)	(0.044)	(0.060)	(0.009)	(0.050)	(0.070)
Married	0.107***	0.029	0.076**	−0.009**	−0.140***	0.095**
	(0.024)	(0.023)	(0.032)	(0.004)	(0.039)	(0.037)
Number of children (0–2)	−0.131***	−0.117***	0.212***	−0.014***	−0.189***	−0.099**
	(0.019)	(0.018)	(0.032)	(0.004)	(0.028)	(0.038)
Number of children (3–6)	−0.033**	−0.077***	0.013	−0.013***	−0.146***	−0.037*
	(0.014)	(0.015)	(0.021)	(0.004)	(0.020)	(0.022)
Number of children (7–18)	0.012	−0.023***	0.018	−0.008***	−0.123***	−0.023*
	(0.009)	(0.007)	(0.011)	(0.002)	(0.012)	(0.012)
Urban	−0.004	0.026	−0.021	0.011**	0.191***	−0.086***
	(0.025)	(0.022)	(0.028)	(0.005)	(0.030)	(0.032)
Summer	0.158***	0.020	0.032	0.001	−0.100***	−0.117***
	(0.025)	(0.022)	(0.031)	(0.005)	(0.037)	(0.033)
State CPI, exercise	−0.891	−1.929	2.719*	0.148	−2.445	−1.796
	(1.238)	(1.208)	(1.625)	(0.258)	(1.731)	(1.894)
State CPI, medical + personal	1.188	−2.338	0.899	0.400	−0.007	1.766
	(1.998)	(1.671)	(2.611)	(0.420)	(2.759)	(2.926)
State CPI, social + relax	−1.307	5.046*	−4.102	−0.624	2.252	1.630
	(3.022)	(2.596)	(4.013)	(0.646)	(4.330)	(4.575)
State CPI, TV viewing	−0.114	0.076	0.227	0.191**	−0.031	0.673
	(0.605)	(0.516)	(0.752)	(0.096)	(0.764)	(0.904)
State CPI, other goods	−0.808	−0.914	1.005	0.218	0.262	−2.986**

Table 3 continued

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Work time
	(0.681)	(0.754)	(0.955)	(0.150)	(1.072)	(1.205)
State avg. temperature	0.004***	0.0006	0.007***	−0.0004***	−0.004***	0.003**
	(0.0006)	(0.0007)	(0.001)	(0.0001)	(0.001)	(0.001)
State avg. precipitation	−0.004	0.0005	0.016***	−0.0007	−0.007	−0.013**
	(0.005)	(0.004)	(0.006)	(0.0009)	(0.006)	(0.006)

Note: Each regression also includes three regional indicators, a summer indicator, day-of-the week indicators, state dummies, and year dummies. The reference groups are female, White non-Hispanic, college educated, single, no children, rural residence, non-summer months. Sample period is 2003–2014. All time-use variables are transformed into natural logarithm, thus the associated coefficients are to be interpreted as elasticities. Compensated wage elasticity is obtained by using uncompensated wage elasticity (coefficient of wage) subtract the income effect. The income effect is calculated as the product of the coefficient of spousal earnings and share of spouse's income in full income. Bootstrapped standard errors are included in parentheses. For compensated elasticities, *p*-values are provided in brackets. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

uncompensated and compensated wage effects are quantitatively similar.[31] The coefficient of spousal earnings for work time (−0.031) is statistically significant and larger than that for most health-related time. Combined with s_R, the income effect for work time is almost zero (−0.004), which is consistent with the recent evidence on labor supply elasticity that generally finds a much smaller income effect compared to the substitution effect.[32]

According to Grossman (2000), the wage effect on health is likely to be more positive in the pure investment model (with $MU_{T,j} = 0$) than in the pure consumption model (with $MP_{T,j} = 0$). Therefore, a positive wage elasticity on HE time could lend more support to the investment model. We find a positive wage coefficient for exercise and medical + personal care, but a negative and insignificant wage coefficient for socializing + relaxation. This result appears to suggest that investment motives apply strongly to certain types of HE time.

4.2 Effect of other variables on time use

We start with the effect of the price variables on time use. While the own price effect has the correct sign (negative) for all activities, they are not statistically significant. The low significance could be due to a lack of variation over the sample period (1996–2014) as well as the inclusion of both state and year dummies that may have absorbed some of the effect. However, there are a few statistically significant results, which suggests that people substitute among health-related activities to save costs. For example, when the price of exercise (e.g., gym membership) is higher, people

[31] The exceptions are exercise (−0.010) and TV viewing (0.027). However, the magnitude is rather small.

[32] For example, a recent CBO report (McClelland and Mok 2012) summarizes the findings in the literature that the substitution effect for men and women combined is between 0.1–0.3 and the income effect is between 0 and −0.1. For income effect estimates, see, for example, Imbens et al. (2001), Jacob and Ludwig (2012), and Bishop et al. (2009).

spend more time on socializing and relaxation, whereas when the price of socializing and relaxation is higher, people spend more time on medical and personal care. We also find that when the price of TV viewing (e.g., cable TV subscription) is higher, people spend more time sleeping instead.

The effects of socioeconomic and demographic variables are consistent with the time-use literature. We find that men spend more time on exercise and TV viewing, whereas women spend more time on medical + personal care, socializing + relaxation, and sleep.[33] We also find evidence of racial disparities among whites and non-whites. Blacks and Hispanics are less likely to engage in exercise and socializing + relaxation, but more likely to spend time on medical and personal care compared to whites. Having more children, especially young children (0–2 years old), reduces almost all health-related activities as well as work time. Marital status is associated with more exercise, more socializing and relaxation, and less TV viewing.[34] We find that those without a college degree spend less time on all HE activities and more time on HD activities. This result suggests that education is important in health investment, which is consistent with the finding of Mullahy and Roberts (2010). Higher temperature is associated with more HE activities, less HD activities, and less sleep.[35]

4.3 Weekday and weekend estimates

Because the time-use pattern for weekdays and weekends is different (as shown in Table 1), we present the compensated wage elasticities for the weekday sample and the weekend sample separately in Table 4. For exercise and TV viewing, the sign of the wage elasticity remains the same for both weekdays and weekends. For other activities, the wage effect differs across weekdays and weekends. The wage elasticity for socializing + relaxation is negative for weekdays and positive for weekends, and these opposing signs partially explain why the wage elasticity in the one-week sample was statistically insignificant. Likewise, the wage elasticity for medical and personal care is positive during weekdays and negative during weekends, though the latter is insignificant. For sleep, the wage elasticity is negative for both weekdays and weekends, but is only significant for the weekday sample. These different elasticities are partially affected by the response of work hours to the wage increase: Individuals increase work hours during weekdays but decrease work hours during weekends.

4.4 Wage effects by day of the week

To understand the economic significance of our findings, it would be interesting to examine how time allocation within a given week changes for a 10% increase in the wage rate. For this experiment, we would like to have information on weekday and

[33] Juster and Stafford (1991) report that men watch more TV than women. Podor and Halliday (2012) find men engage in more exercise than women.

[34] Contrast to our finding, Averett et al. (2013) find that marital status is associated with a lower probability of regular exercise using a Canadian sample.

[35] Mullahy and Roberts (2010) find a positive association between temperature and exercise time for the weekend sample. For the weekday sample, the effect is not statistically significant.

Table 4 Wage elasticity of time use by weekday and weekend

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Work time
Wage elasticity,	0.462***	0.265***	−0.363***	−0.071***	−0.696***	1.217***
compensated: weekday	[p=0.000]	[p=0.000]	[p=0.001]	[p=0.000]	[p=0.000]	[p=0.000]
Wage elasticity,	0.682***	−0.052	0.519***	−0.011	−0.351***	−0.905***
compensated: weekend	[p=0.000]	[p=0.571]	[p=0.000]	[p=0.476]	[p=0.001]	[p=0.000]

Note: Each regression also includes variables in the baseline specification, three regional indicators, a summer indicator, day-of-the week indicators, state dummies, and year dummies. Sample period is 2003–2014. All time-use variables are transformed into natural logarithm; thus the associated coefficients are to be interpreted as elasticities. Compensated wage elasticity is obtained by using uncompensated wage elasticity (coefficient of wage) subtract the income effect. The income effect is calculated as the product of the coefficient of spousal earnings and the share of spouse's income in full income. p-values are provided in brackets. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

weekend time use for one person, but such information is not available. Fortunately, we have individuals interviewed on each day of the week, and the number of observations is spread evenly across the days of the week after adjusting for sample weights. We first estimate the wage effect for each day of the week and then obtain the marginal effects, which are evaluated at the mean time use for a particular activity on that day of the week. We then aggregate the daily marginal effects to obtain an estimate for a "typical" week. Results are shown in Table 5.

For a hypothetical 10% increase in the wage rate, HE time increases by about 18.5 min over an entire week, 10.6 min from investment-nature HE time (exercise, medical + personal care), and 7.8 min from consumption-nature HE time (socializing + relaxation). HD time reduces by 46.3 min, and sleep time falls by 15.2 min during the one-week span. Table 5 also shows the decomposition by day of the week. For exercise and socializing + relaxation, the largest responses occur during weekend. For medical + personal care, the largest responses occur in the latter part of the week (Wednesday to Friday). The responses of HD time and sleep are spread across weekdays.

We find that work hours are relatively more responsive during weekdays than weekends. The increase in work hours during weekdays is offset by reduced TV viewing, sleep, socializing and relaxation, and other activities (on average 35 min' reduction per day), but not from exercise, medical, and personal care.

4.5 Aggregate HE time

One of the assumptions of the traditional labor/leisure model is that all nonmarket time responds negatively to an increase in the wage rate. We examine whether this assumption holds for aggregate HE measures. For this exercise, we compare three time uses: (a) all HE time combined (= exercise, medical + personal care, socializing + relaxation); (b) HE time plus sleep, and (c) nonmarket time (=1440-work time). Results are presented in Table 6. For the HE measure (a), the wage elasticity is

Table 5 Wage effect expressed in minutes, by day of the week

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Others	Work time
Total	6.333	4.319	7.816	−15.213	−46.255	−165.584	208.585
Monday	0.875***	−0.492	−0.189	−0.289	−7.089***	−29.561	36.743***
Tuesday	0.662**	0.972	−3.509*	−2.976**	−5.341**	−43.164	53.355***
Wednesday	0.576**	1.823**	−5.911**	−3.912*	−8.290***	−33.984	49.698***
Thursday	0.766***	1.174**	−4.491**	−3.393***	−3.215	−33.882	43.041***
Friday	0.259	1.353**	0.140	−4.627***	−10.144***	−36.428	49.444***
Saturday	1.684***	−0.163	10.813***	−0.522	−4.715**	8.322	−15.419***
Sunday	1.510***	−0.352	10.962***	0.507	−7.462**	3.112	−8.277***

Note: For each day of the week, we estimate each time use outcome as in Table 3. We then obtain the marginal effect for a 10% increase in the wage rate. The marginal effect is evaluated at the mean for each type of time use for a given day of the week. We then aggregate the daily marginal effects to obtain an estimate for a "typical" week. Because the sum of changes across all time uses should equal zero, we can back up the changes in the remaining category ("others"). ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

Table 6 Effect of wage rate on aggregate time-use measures

	(a) Exercise, medical, personal, social, relax	(b) Exercise, medical, personal, social, relax, and sleep time	(c) Nonmarket time (=24 h − work time)
Wage elasticity, compensated	0.097** [p=0.027]	−0.041*** [p=0.000]	−0.083*** [p=0.000]

Note: Each regression also includes variables in the baseline specification, three regional indicators, a summer indicator, day-of-the week indicators, state dummies, and year dummies. Sample period is 2003–2014. All time-use variables are transformed into natural logarithm; thus the associated coefficients are to be interpreted as elasticities. p-values are provided in brackets. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

positive and statistically significant (0.097), suggesting strong presence of the investment motive resulting in a net increase in aggregate HE time. Once we add sleep (measure (b)), the wage elasticity becomes negative (−0.041). For nonmarket time, the wage elasticity is more negative (−0.083), as predicted in the traditional labor model.

4.6 Validity of exclusion restrictions

In the Heckman selection equation, the inverse Mills ratio is statistically significant and the p-value for the likelihood-ratio test (0.002) is small, suggesting the errors of the two equations are correlated and the sample selection correction is needed. State occupation wages is highly statistically significant in both equations. State unemployment rate is statistically significant in predicting wages, but not significant in predicting the probability of reporting a positive wage. The joint F test for all instruments strongly rejects the null hypothesis that they are jointly zero with a p-value much smaller than 0.001, indicating the instruments are not weak. The results for the Heckman procedure are shown in Appendix Table 11.

5 Additional analysis

5.1 Subsamples

In Table 7, we present the wage elasticity for several subsamples: (a) male vs. female; (b) married vs. single; and (c) college vs. high school and less.

Gender difference is often emphasized in time-use studies partially because of the large difference in observed time-use patterns between men and women (see Fig. 1). We find that both men and women increase investment-nature HE time (exercise, medical + personal) in response to a higher wage rate, but the wage elasticity for men is much larger than that for women. Both genders decrease TV viewing and sleep time. For the latter, the wage effect is statistically significant for women, but insignificant for men.[36] Consistent with the literature, we find women's labor supply

[36] Although the sign of our coefficients is consistent with Biddle and Hamermesh (1990), their subsample analysis yields statistically insignificant results.

response is positive and much larger than men's labor supply response, which is not statistically different from zero.

There is also an interesting difference observed across marital status. Although both singles and married individuals increase exercise when their wages are higher, only singles increase medical and personal care. Both married and singles reduce HD time, but only singles reduce sleep time in addition. Generally, singles have a larger wage elasticity than married individuals.

The largest contrast in the response of HE time is by education. The wage elasticity for exercise is positive and significant for those with college education, but not for those with less than college education.[37] For medical and personal care, we observe positive wage elasticities for both subsamples, but the lower-educated group has almost five times larger elasticity than their higher-educated counterpart. This finding is partially in line with the result of Ettner et al. (2009) that finds socially disadvantaged patients spent more time on self-care than did socially advantaged patients. The lower-educated also spend *more* time on socializing and relaxation as the wage rate rises (0.625), but the same is not seen for the higher-educated group. For TV viewing, the higher-educated group has a negative wage elasticity (−0.553), whereas the lower-educated group has a positive wage elasticity (0.802). One possible reason is that the higher educated group is better-informed about the negative health effect of TV viewing than the lower-educated. Another possibility is that the lower-educated group is more susceptible to instant gratification from TV viewing.

5.2 The tobit model

In this and the next two subsections, we provide further robustness analysis with alternative model specifications. First, we address the mass zero problem by applying a Tobit model to predict time use. Similar to the linear model, standard errors are obtained by bootstrapping the first-stage Heckman equation and the second-stage Tobit equation together. To compare with the linear model, we present the censored and truncated marginal effects in Table 8. The censored marginal effect measures how the observed time use changes with the wage rate. The truncated marginal effect measures the change conditional on the positives.

We again observe a positive wage elasticity for HE time (0.534 for exercise and 0.192 for medical + personal care) and a negative elasticity for HD time (−0.677 for TV viewing). Some estimates are larger than the baseline while others are similar. This is consistent with Foster and Kalenkoski (2013) who also find similar results between Tobit and OLS for time-use data that involve many zeros.

5.3 Using fitted values as instruments

One issue associated with predicting wages using nonlinear regressions is that if the conditional mean is not specified correctly, it might yield inconsistent estimates in

[37] It is possible that lower educated individuals have less access to exercise facilities and equipment. In additional analysis, we excluded 14 categories of exercise that involve more fixed costs than others (such as, golfing, boating, and hunting). The results are very similar to the baseline. This suggests that the difference in wage elasticity between education groups is not driven by the access problem.

Table 7 Wage effect by gender, marital status, and education

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Work time
Wage elasticity,	0.556***	0.384***	0.164	−0.030	−0.580**	−0.048
compensated: male	[p=0.006]	[p=0.007]	[p=0.445]	[p=0.279]	[p=0.010]	[p=0.848]
Wage elasticity,	0.315***	0.079*	−0.102	−0.039***	−0.456***	0.526***
compensated: female	[p=0.000]	[p=0.067]	[p=0.116]	[p=0.000]	[p=0.000]	[p=0.000]
Wage elasticity,	0.543***	0.067	−0.197**	−0.028	−0.585***	0.578***
compensated: married	[p=0.000]	[p=0.396]	[p=0.045]	[p=0.117]	[p=0.000]	[p=0.000]
Wage elasticity,	0.582***	0.341***	0.137	−0.092***	−0.661***	0.585***
compensated: single	[p=0.000]	[p=0.000]	[p=0.303]	[p=0.000]	[p=0.000]	[p=0.000]
Wage elasticity,	0.525***	0.143***	−0.034	−0.042**	−0.558***	0.594***
compensated: college	[p=0.000]	[p=0.005]	[p=0.637]	[p=0.000]	[p=0.000]	[p=0.000]
Wage elasticity,	−0.216	0.640***	0.625**	0.046	0.804***	−1.147***
compensated: HS and less	[p=0.192]	[p=0.001]	[p=0.015]	[p=0.370]	[p=0.001]	[p=0.000]

Note: Each regression also includes variables in the baseline specification, three regional indicators, a summer indicator, day-of-the week indicators, state dummies, and year dummies. Sample period is 2003–2014. All time-use variables are transformed into natural logarithm; thus the associated coefficients are to be interpreted as elasticities. p-values are provided in brackets. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

the second stage (Angrist and Pischke 2009). One alternative is to use nonlinear fitted values of the wages from the Heckman equation as an instrument for actual wages in the time use equations, just like the conventional two-stage least squares. Identification is through the nonlinear functional form of the fitted value and exclusion restrictions (state-level variables in our case). Results using this alternative method are presented in the middle section of Table 8. This method produces qualitatively similar results to the baseline, though comparing to the baseline the wage elasticity is smaller for exercise, larger for medical and personal care, and smaller for TV viewing, sleep, and work. Statistical significance is the same as in the baseline.

5.4 Other specifications

The bottom part of Table 8 presents additional regression results that demonstrate that neither including state-month interactions nor excluding state-level prices change the results much. Furthermore, we ran regressions for the overall sample that combines employed, unemployed, and those not in the labor force. The results are shown in Appendix Table 12 (weekday and weekend combined) and Appendix Table 13 (weekday and weekend separately). These results are largely consistent with the baseline results in Table 3. The wage elasticities for exercise and medical + personal

Table 8 Robust analysis

	Exercise	Medical + personal	Social + relax	Sleep	TV viewing	Work time
(a) Tobit specification						
Wage elasticity,	0.535***	0.192***	−0.062	NA	−0.681***	0.591***
compensated: censored	[p=0.000]	[p=0.002]	[p=0.502]		[p=0.000]	[p=0.000]
Wage elasticity,	0.618***	0.170***	−0.501	NA	−0.542***	0.485***
compensated: truncated	[p=0.000]	[p=0.002]	[p=0.502]		[p=0.000]	[p=0.000]
(b) Use alternative instruments						
Wage elasticity,	0.443***	0.213***	−0.007	−0.035***	−0.438***	0.385***
compensated	[p=0.000]	[p=0.000]	[p=0.911]	[p=0.001]	[p=0.000]	[p=0.000]
(c) Including state-month interactions						
Wage elasticity,	0.472***	0.091**	−0.126**	−0.037***	−0.586***	0.592***
compensated	[p=0.000]	[p=0.060]	[p=0.037]	[p=0.000]	[p=0.000]	[p=0.000]
(d) Without state-level prices						
Wage elasticity,	0.544***	0.174***	−0.072	−0.054***	−0.617***	0.553***
compensated	[p=0000]	[p=0.002]	[p=0.364]	[p=0.000]	[p=0.000]	[p=0.000]

Note: Each regression also includes variables in the baseline specification, three regional indicators, a summer indicator, day-of-the week indicators, state dummies, and year dummies. Sample period is 2003–2014. Three specifications are run. In (a), the Tobit specification is used to take into account the mass zero problem. This specification is not run for sleep time because there are virtually no zeros for sleep. In (b), we use fitted values of the wage rate from the Heckman equation as instruments for actual wages in the time use equations. In (c), we dropped state-level variables but added state-month interactions. In (d), we dropped state-level prices. All time-use variables are transformed into natural logarithm; thus the associated coefficients are to be interpreted as elasticities. p-values are provided in brackets. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

care are slightly smaller for the overall sample, suggesting those unemployed and not in the labor force may not have as much investment motive as the employed.

6 Discussion and conclusions

This paper analyzes individuals' decisions on health-related time use. Based on the literature, we construct measures for health-enhancing (HE) time and health-deteriorating (HD) time. We examine how different components of HE and HD time respond to changes in the wage rate, price of related goods and services, and socioeconomic and demographic characteristics.

The main finding is that HE and HD activities respond in opposite directions to changes in the wage rate based on the sign of the compensated elasticity. In particular, positive elasticities are found for HE time that is of an investment nature (exercise, medical + personal care), while negative elasticities are found for HD time (TV viewing). We show that a hypothetical 10% increase in the wage rate increases

HE time by 18.5 min and reduces HD time by 46.3 min over the course of a week. We further show that all HE time combined increases with the wage rate while nonmarket time decreases. Our results also suggest potential substitution from time-intensive to goods-intensive activities due to a higher opportunity cost of time. These results are robust in various model specifications and alternative estimation methods.

Further analysis using subsamples point out the unique role of education: Facing a higher wage rate, college-educated individuals are found to spend more time on exercise and less time on TV viewing, while lower-educated individuals spend more time on TV viewing in addition to socializing and relaxation. Because TV viewing is generally considered detrimental to health, this differential response may explain the widely-reported disparity in health status across education groups (e.g., Berry 2007).

Our results have several implications. First, our results reject the basic premise of the conventional model that all leisure time responds uniformly to a change in the wage rate. We show that in addition to the substitution between work and leisure, there is also considerable substitution *within* health-related leisure time, specifically from HD towards HE activities (exercise, medical + personal care). Second, our finding that HE and total nonmarket time have wage elasticities of the opposite sign suggests that future studies on health production should clearly distinguish the two. The common practice of either ignoring time input or using non market time as the proxy for time input can yield biased estimates. Third, our result implies that many of the existing welfare programs could potentially induce changes in health behaviors if such programs also affect the wage rate. For example, a minimum wage law that increases the wage rate may lead to reallocation of time from HD to HE activities. Fourth, our results may shed light on the business cycle fluctuation of health. The recent finding is that people adjust health-related behaviors and medical care decisions along the business cycle (e.g., Ruhm 2005; Xu 2013; Du and Yagihashi 2015), causing health to fluctuate. Aguiar et al. (2013) note that majority of the foregone market work during the 2008–2009 recession was absorbed into TV viewing, while only 12% was reallocated toward health, education, and civic services combined. Our result suggests that lower wages might reduce incentives of health investment, which increases the "true" welfare cost of an economic downturn.

One question that is not answered in this paper is how people allocate time over their life span. An individual might prefer to "smooth out" his/her health over time to avoid sudden changes in their marginal utility. Longitudinal time use data would help in answering this question.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

7 Appendix

Tables 9–13

Table 9 Activity categories and corresponding ATUS codes

Activity category	List of activities	Codes in ATUS
Exercise	Doing aerobics, playing baseball, playing basketball, biking, boating, bowling, climbing, spelunking, caving, dancing, participating in equestrian sports, fencing, fishing, playing football, golfing, doing gymnastics, hiking, playing hockey, hunting, participating in martial arts, playing racquet sports, participating in rodeo competitions, rollerblading, playing rugby, running, skiing, ice skating, snowboarding, playing soccer, softball, using cardiovascular equipment, playing volleyball, walking, participating in water sports, weightlifting/ strength training, working out, wrestling, doing yoga	130101–130104, 130106–130128, 130130–130199
Relaxation	Lawn, garden, and houseplant care, walking / exercising / playing with animals, playing with hh children, not sports, arts and crafts with hh children, playing sports with hh children, playing with nonhh children (not sports), arts and crafts with nonhh children, playing sports with nonhh children, taking class for personal interest, eating and drinking, relaxing, thinking, television (religious), listening to the radio, listening to/playing music (not radio), playing games, arts and crafts as a hobby, collecting as a hobby, hobbies (except arts and crafts and collecting), reading for personal interest, writing for personal interest, attending performing arts, attending museums, attending movies/film, attending gambling establishments, playing billiards, vehicle touring/racing	020501, 020599, 020602, 030103–030105, 040103–040105, 060102, 110101, 110199, 119999, 120301, 120304–120307, 120309–120313, 120399, 120401–120404, 120499, 130105, 130129
Socializing activities	Watching sports, attending sporting events, volunteering activities (including organizing and preparing, reading, writing, administrative & support activities, food preparation, presentation, clean-up, collecting and delivering clothing and other goods, social service & care activities, building houses, wildlife sites, and other structures, indoor and outdoor maintenance, repair, and clean-up, indoor and outdoor maintenance, building and clean-up activities, security procedures related to volunteer activities, telephone calls (except hotline counseling), fundraising, providing care, teaching, leading, counseling, mentoring, performing, serving at volunteer events and cultural activities, Attending meetings, conferences, and training), telephone calls to/from family members, telephone calls to/from friends, neighbors, or acquaintances, travel as a form of entertainment, extracurricular club activities, extracurricular music and performance activities, extracurricular student government activities, socializing and communicating with others, socializing and communicating, attending or hosting parties/receptions/ ceremonies, attending meetings for personal interest (not volunteering), attending/hosting social events, attending religious services, participation in religious practices, religious education activities, religious and spiritual activities, public health activities, public safety activities, socializing, relaxing, and leisure as part of job, eating and drinking as part of job, sports and exercise as part of job	060201–060203, 120101, 120199, 120201, 120202, 120299, 129999, 130201–130232, 130299, 139999, 140101, 140102, 140105, 149999, 150104, 150106, 050201–050203, 150204, 150401, 150402, 150499, 150501, 150599, 150601, 150602, 150699, 150701, 150799, 159999, 150102, 150103, 150105, 150199, 150201, 150202, 150299, 150301, 150302, 150399, 150801, 150899, 160101, 160102, 181205
Travel and waiting time	Waiting associated with extracurricular activities, waiting associated w/eating and drinking, waiting associated with	060204, 110201, 110299,

Table 9 continued

Activity category	List of activities	Codes in ATUS
associated with exercise, relaxation, and socializing activities	volunteer, waiting assoc. w/socializing and communicating, waiting assoc. w/attending/hosting social events, waiting associated with relaxing/leisure, waiting associated with arts and entertainment, waiting associated with socializing, waiting related to playing sports or exercising, waiting related to attending sporting events, waiting associated w/religious and spiritual activities, travel related to lawn, garden, and houseplant care, travel related to extracurricular activities (e.g., Sports), travel related to eating and drinking, travel related to socializing and communicating travel related to attending or hosting social events, travel related to relaxing and leisure, travel related to arts and entertainment, travel related to participating in sports/exercise/recreation, travel related to attending sporting/recreational events, travel related to sports, exercise, and recreation, travel related to religious/spiritual practices, travel rel. to religious/spiritual activities, travel related to volunteering	120501–120504, 120599, 130301, 130399, 140103, 180205, 180602, 181101, 181199, 181201–181204, 181299, 181301, 181302, 181399, 181401, 181499, 181501, 181599
Medical + personal care + travel & waiting	Washing, dressing and grooming oneself, grooming, health-related self care, personal/private activities, using health and care services outside the home, using in-home health and care services, waiting associated with medical services, using medical services, using personal care services, waiting associated w/personal care services, telephone calls to/from professional or personal care svcs providers, travel related to personal care, travel related to using medical services, travel related to using personal care services, travel rel. to using prof. and personal care services	010201, 010299, 010301, 010399, 010401, 010499, 010501, 010599, 019999, 080401–080403, 080499, 080501, 080502, 080599, 160105, 180101, 180199, 180804, 180805, 180899
TV viewing	Television and movies (not religious)	120303
Sleep	Sleeping, napping, dozing, dreaming, waking up	010101, 010199
Work	Work, main job, Work, other job(s), security procedures as part of job, income-generating hobbies, crafts, and food, income-generating performances, income-generating services, income-generating rental property activities, waiting associated with other income-generating activities, other income-generating activities, security procedures related to work, waiting associated with working, waiting associated with work-related activities	050101–050104, 050199, 050204, 050205, 050299, 050301–050305, 050399, 059999, 180501–180503, 180599

Note: Definitions are based on American Time Use Survey Activity Coding Lexicons. Travel time categories were coded with a starting number of "17" before 2005 and "18" after 2005

Table 10 Price of health-related activities

Items used in constructing prices (e)	BLS code	Activity type (j)	Category (c)	CPI Weights (in %, $\omega_{e,j}$)
1. Club dues and fees for participant sports and group exercises	CUUR0000SERF01	1. HE: Exercise	services	0.602
2. Recreational reading materials	CUUR0000SERG	2. HE: Socializing + relaxation	goods	0.220
3. Admissions	CUUR0000SERF02	2. HE: Socializing + relaxation	services	0.640
4. Fees for lessons or instructions	CUUR0000SERF03	2. HE: Socializing + relaxation	services	0.211
5. Prescription drugs	CUUR0000SEMF01	3. HE: Medical + personal care	goods	1.345
6. Medical care services	CUUR0000SAM2	3. HE: Medical + personal care	services	5.944
7. Personal care services	CUUR0000SAM1	3. HE: Medical + personal care	services	0.638
8. Cable and satellite television and radio services	CUUR0000SERA02	4. HD: TV viewing	services	1.468
9. Internet services and electronic information providers	CUUR0000SEEE03	4. HD: TV viewing	services	0.711
10. Food and beverages	CUUR0000SAF	5. *X*: Composite goods	all	15.272
11. Housing	CUUR0000SAH	5. *X*: Composite goods	all	42.173
12. Apparel	CUUR0000SAA	5. *X*: Composite goods	all	3.343
13. Transportation	CUUR0000SAT	5. *X*: Composite goods	all	15.289
14. Education	CUUR0000SEHB02	5. *X*: Composite goods	all	3.325

Note: HE refers to health-enhancing activities and HD refers to health-deteriorating activities

Table 11 Estimates of the Heckman selection equations

	First equation	Second equation
	Selection equation	Conditional on positives
Male	−0.173***	0.194***
	(0.012)	(0.004)
Age	−0.019***	0.048***
	(0.005)	(0.002)
Age squared	0.000	−0.000***
	(0.000)	(0.000)
Black non-Hispanic	0.287***	−0.134***
	(0.021)	(0.006)
Hispanic	0.212***	−0.008
	(0.021)	(0.009)
Other race	0.145***	−0.008
	(0.027)	(0.009)
High school	−0.258***	−0.254***
	(0.061)	(0.005)
Less than high school	−0.362***	−0.416***
	(0.098)	(0.009)
Urban	0.099***	0.106***
	(0.017)	(0.006)
Summer	0.002	0.002
	(0.019)	(0.007)
Exclusion restrictions for selection		
Age x less than high school	0.007***	
	(0.002)	
Age × high school	0.006***	
	(0.001)	
Log spousal earnings	0.038***	
	(0.002)	
Married	−0.250***	
	(0.016)	
Number of children (0–2)	−0.075***	
	(0.016)	
Number of children (3–6)	−0.054***	
	(0.012)	
Number of children (7–18)	−0.041***	
	(0.007)	
Exclusion restrictions for time use		
State labor force participation rate	−0.005	0.002
	(0.007)	(0.002)
State minimum Wage	−0.008	−0.004
	(0.014)	(0.005)

Table 11 continued

	First equation	Second equation
	Selection equation	Conditional on positives
State unemployment rate	0.006	−0.007***
	(0.007)	(0.002)
State occupational wage	−0.007***	0.018***
	(0.001)	(0.0002)
Inverse Mills Ratio		0.031*** (0.009)
Likelihood-ratio test (*p*-value)		0.002
F-test for weak instrument		χ^2=9509.14 [*p*=0.000]

Note: This regression additionally includes state temperature, precipitation, five state-level prices, three regional dummies, year dummies, state dummies, and day of the week dummies. The reference groups are female, White non-Hispanic, college educated, single, no children, rural residence, non-summer months. Standard errors are included in the parentheses. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively. Hypothesis test (*F*-test) for the exclusion restrictions for time use strongly rejects the null that the coefficients are jointly zero

Table 12 Determinants of time use, the overall sample

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Work time
Wage elasticity,	0.311***	0.134***	−0.281***	−0.043***	−0.551***	1.314***
compensated	[*p*=0.000]	[*p*=0.000]	[*p*=0.000]	[*p*=0.000]	[*p*=0.000]	[*p*=0.000]
Wage elasticity,	0.312***	0.134***	−0.278***	−0.043***	−0.548***	1.306***
uncompensated	(0.042)	(0.039)	(0.050)	(0.007)	(0.053)	(0.065)
Log spousal earnings	0.001	−0.0002	0.010***	−0.0006	0.011***	−0.031***
	(0.003)	(0.003)	(0.003)	(0.0005)	(0.004)	(0.005)
Male	0.027	−0.515***	0.042***	−0.018***	0.475***	0.390***
	(0.021)	(0.020)	(0.025)	(0.004)	(0.026)	(0.034)
Age	−0.062***	0.006	0.033***	−0.0017	0.030***	0.016
	(0.008)	(0.007)	(0.010)	(0.0013)	(0.011)	(0.014)
Age squared	0.001***	−0.000	−0.0004***	−0.000	−0.0003***	−0.0002
	(0.000)	(0.000)	(0.0001)	(0.000)	(0.0001)	(0.0002)
Black non-Hispanic	−0.147***	0.223***	−0.139***	−0.009*	0.140***	−0.181***
	(0.021)	(0.020)	(0.028)	(0.005)	(0.033)	(0.036)
Hispanic	−0.109***	0.174***	−0.358***	0.026***	0.032	0.153***
	(0.021)	(0.025)	(0.030)	(0.005)	(0.031)	(0.038)
Other race	−0.006	0.001	−0.264***	0.014**	−0.113***	0.005
	(0.032)	(0.027)	(0.045)	(0.006)	(0.040)	(0.056)
High school	−0.176***	−0.093***	−0.293***	0.006	0.206***	0.056
	(0.024)	(0.022)	(0.028)	0.004	(0.030)	(0.040)

Table 12 continued

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Work time
Less than high school	−0.046	−0.331***	−0.541***	0.032***	0.091*	0.100
	(0.045)	(0.044)	(0.056)	(0.009)	(0.052)	(0.066)
Married	0.073***	0.050***	0.066***	−0.008**	−0.128***	0.211***
	(0.017)	(0.019)	(0.024)	(0.003)	(0.026)	(0.034)
Number of children (0–2)	0.086***	−0.147***	0.182***	−0.018***	−0.249***	−0.072**
	(0.018)	(0.019)	(0.028)	(0.004)	(0.024)	(0.031)
Number of children (3–6)	−0.005	−0.095***	−0.011	−0.014***	−0.201***	−0.017
	(0.015)	(0.016)	(0.019)	(0.004)	(0.018)	(0.024)
Number of children (7–18)	0.013	−0.038***	−0.011	−0.009***	−0.126***	−0.007
	(0.008)	(0.007)	(0.010)	(0.002)	(0.010)	(0.012)
Urban	0.042**	0.037*	0.005	0.007*	0.159***	−0.126***
	(0.019)	(0.021)	(0.024)	(0.004)	(0.026)	(0.032)
Summer	0.15***	0.004	0.039*	0.002	−0.102***	−0.092***
	(0.021)	(0.021)	(0.023)	(0.004)	(0.032)	(0.034)
State avg. temperature	0.004***	0.0007	0.008***	−0.0004***	−0.003***	0.002**
	(0.0006)	(0.0006)	(0.001)	(0.0001)	(0.001)	(0.001)
State avg. precipitation	−0.001	0.002	0.015***	−0.0006	−0.005	−0.015**
	(0.004)	(0.004)	(0.005)	(0.0009)	(0.005)	(0.007)
State CPI exercise	−0.398	−1.944*	3.176**	0.087	−1.393	−3.171*
	(1.262)	(1.093)	(1.345)	(0.220)	(1.474)	(1.846)
State CPI social + relax	1.129	5.563**	−4.668	−0.956*	−0.943	5.647
	(2.991)	(2.294)	(3.425)	(0.521)	(3.502)	(4.370)
State CPI medical + personal	0.064	−3.258**	1.486	0.614*	1.877	−2.151
	(1.947)	(1.454)	(2.289)	(0.334)	(2.241)	(3.018)
State CPI TV	0.031	0.225	−0.009	0.093	0.016	0.805
	(0.531)	(0.488)	(0.642)	(0.084)	(0.687)	(0.912)
State CPI other goods	−0.905	−0.682	0.633	0.205	0.426	−1.859
	(0.615)	(0.717)	(0.853)	(0.127)	(0.901)	(1.169)

Note: This regression additionally includes three regional indicators, a summer indicator, day-of-the week indicators, state dummies, and year dummies. The reference groups are female, White non-Hispanic, college educated, single, no children, rural residence, non-summer months. Sample period is 2003–2014. The overall sample includes employed, unemployed, and those not in the labor force. All time-use variables are transformed into natural logarithm; thus the associated coefficients are to be interpreted as elasticities. Wages are predicted using the Heckman sample selection procedure as detailed in the main text. Compensated wage elasticity is obtained by using uncompensated wage elasticity (coefficient of wage) subtract the income effect, which is calculated by using the share of spouse's income in full income multiplied by the coefficient of spousal earnings. Bootstrapped standard errors are included in parentheses. For compensated elasticity, *p*-values are included in the brackets. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

Table 13 Wage elasticity of time use by weekday and weekend, the overall sample

	Exercise	Medical + personal	Social + relax	Sleep time	TV viewing	Work time
Wage elasticity,	0.222***	0.198***	−0.532***	−0.059***	−0.641***	1.865***
compensated: Weekday	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]	[p=0.000]
Wage elasticity,	0.520***	−0.029	0.296***	−0.007	−0.329***	−0.002
compensated: Weekend	[p=0.000]	[p=0.607]	[p=0.000]	[p=0.462]	[p=0.000]	[p=0.978]

Note: This regression additionally includes control variables in the baseline specification, three regional indicators, a summer indicator, day of the week indicators, state dummies, and year dummies. Sample period is 2003–2014. The overall sample includes employed, unemployed, and those not in the labor force. All time-use variables are transformed into natural logarithm; thus the associated coefficients are to be interpreted as elasticities. Compensated wage elasticity is obtained by using uncompensated wage elasticity (coefficient of wage) subtract the income effect. The income effect is calculated by using the share of spouse's income in full income multiplied by the coefficient of spousal earnings. *p*-values are included in the brackets. ***, **, * indicate statistical significance at 1, 5, and 10%, respectively

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