Intertemporal Elasticity of Substitution with Leisure Margin

Takeshi Yagihashi* and Juan Du**

First draft: March 2016
This version: December, 2018

Abstract

This paper investigates whether the estimation of the intertemporal elasticity of substitution of consumption (IES) would be affected when leisure time is allowed to vary. To this end, we adopt a utility specification that allows interactions between consumption and leisure and estimate IES using a pair of Euler equations. We find that the IES estimates that allow leisure to respond to the market interest rate are consistently lower than the IES estimates using the conventional method that keeps leisure constant. We show that time spent on home production explains majority of the difference between the two IES estimates due to the higher substitutability of home production time, particularly the childcare component, compared with other leisure time. When we exclude home production from nonmarket time, we find the IES estimates become larger. Our findings demonstrate the importance of time allocation when individuals make decisions on consumption and saving.

Keywords: time allocation, labor supply, earning

JEL code: E21 (Consumption), D91 (Intertemporal household choice), J22 (Time allocation and labor supply)

* Corresponding author. Address: Policy Research Institute, Ministry of Finance Japan, 3-1-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8940, Japan; email: takeshi.yagihashi@mof.go.jp.
**Address: Department of Economics, Old Dominion University, 5115 Hampton Boulevard, Norfolk, VA 23529; phone (757) 683-3543; email: jdu@odu.edu.

I. Introduction

Intertemporal elasticity of substitution for consumption (hereafter IES) is widely regarded as one of the key mechanisms that influence consumption and saving behavior observed in the aggregate economy and has been extensively studied during the past four decades.[1] According to Friedman (1957), consumers allocate consumption over their lifetime based on their projected lifetime income and the relative price of consumption over time. IES indicates how strongly consumption responds to changes in the relative price, which is often represented by the market interest rate.

One puzzle in this literature is that the level of consumption exhibits a pronounced hump around mid-life, which is at odds with the Friedman-type life-cycle model that predicts a relatively flat consumption profile over the lifetime. Heckman (1974) argues that once leisure time and consumption are treated as additively nonseparable components in the utility function, the path of consumption becomes dependent on both the interest rate and the wage rate and can potentially explain the hump-shaped consumption. Motivated by Heckman's work, a few studies (which we will discuss later in more detail) have incorporated nonseparable preference in the utility specification and estimated IES while including labor-related variables in their Euler equations.[2] While this approach is clearly an improvement over studies that entirely ignore the role of labor supply, one limitation is that labor-related variables are effectively treated as exogenous. If consumption and leisure were to act as either substitutes or complements in raising utility as Heckman argues, it is natural to assume that an

[1] According to Havranek *et al*. (2015), over 300 academic papers have estimated IES during the same period: of the 169 published papers, 21 were published in the 1980s, 62 in the 1990s, and 86 during 2000-2014.
[2] Past studies that emphasized the general importance of nonseparable preference in the context of consumption/saving behavior, but did not specifically focus on obtaining the IES estimate, see for example, Aguiar and Hurst (2005), Altonji and Ham (1990), Attanasio (1995), Attanasio and Browning (1995), Attanasio and Weber (1993), Blundell *et al*. (1994, 2016), Browning and Meghir (1991), Eichenbaum *et al*. (1988), Ham and Reilly (2002), Mankiw *et al*. (1985), and Ziliak and Kniesner (2005). Attanasio and Weber (1995) and Blundell *et al*. (1994) have included labor in the Euler equation estimation.

individual would adjust *both* consumption and leisure in response to the interest rate. If so, treating labor as exogenous may result in biased IES estimates.

The main goal of this paper is to examine whether IES estimates would be affected when we treat leisure time as endogenous. Our approach is different from the existing literature in two aspects. One is that we use a utility specification that directly allows interaction between consumption and leisure. The second is that we examine the components of leisure time and identify the component that matters the most in consumption smoothing.

In the first half of this paper, we compare the IES estimates when leisure is held constant and when it is not. To this end, we employ an utility function of the King-Plosser-Rebelo form (King *et al*., 1987), in which consumption and leisure are additively non-separable, an extension of the CRRA utility function used in many macro studies. When estimating model parameters, we utilize two intertemporal efficiency conditions for consumption and leisure. We use the Consumer Expenditure Survey (CEX) for this analysis because the CEX has information on both consumption and work hours. Work hours are converted to nonmarket time, which serves as a proxy for leisure. For estimation, we construct a synthetic panel based on birth-year cohort and estimate the IES using the Generalized Methods of Moments (GMM). We find that the leisure-varying IES is 0.115 and the leisure-held-constant IES is 0.327. The almost threefold gap between the two IES estimates suggest that the leisure margin plays an important role in smoothing consumption over the lifetime. That leisure-varying IES is lower than leisure-held-constant IES also holds for other forms of utility function we experimented with (i.e., Jacob, 2007).

In the second half of the paper, we attempt to identify the leisure components that can explain the gap between the leisure-varying and leisure-constant IES by using alternative leisure measures. One could argue against using nonmarket time on several grounds. First, leisure activities are heterogeneous in nature. For example, much of the household chores (e.g., cooking, cleaning) can be either purchased from the market or produced at home by spending one's own time (Baxter and Jermann, 1999), whereas other leisure activities (e.g., eating, sleeping, socializing) do not have market alternatives. Second, activities that involve continued time investment, such as childcare, have the nature of "durable goods" that produce a constant flow of utility in the future (Kydland and Prescott, 1982).[3] Finally, different leisure components are associated with different utilities and respond differently to the wage rate. [4] In this exercise, we explore several alternative leisure measures that represent more "pure" leisure than nonmarket time.

Empirically this exercise requires information on detailed leisure time, which is not available in the CEX. We employ an imputation method that predicts time uses for individuals in the CEX with information in the American Time Use Survey (ATUS) in which detailed time use variables are available. We find that the leisure-varying IES estimated using "nonwork time" defined as nonmarket time *less home production* is 0.240, about twice the size of the IES estimated using nonmarket time.

Our results offer new and important insights to the literature. First, when consumption-leisure substitution is accounted for, the IES estimates become smaller. Our baseline IES estimate is 0.115, which is much lower than the median estimate of 0.5 as

[3] We note that similar argument is often employed in justifying the use of nondurable goods and services as the relevant consumption measure when estimating the IES. This is because the change in durable goods and services spending (e.g., purchase of cars, education, and health care) would not necessarily reflect the contemporaneous effect that interest rate has on these expenditures.

[4] Kahneman *et al*. (2004) and Krueger (2007) find that time spent on education and childcare is less pleasurable than other leisure activities. Also, different leisure components are known to respond differently to the wage rate. See, for example, Kimmel and Connelly (2007) for childcare time; Du and Yagihashi (2017) for exercise and medical/personal care time; Biddle and Hamermesh (1990) for sleep time; Du and Leigh (2015) for smoking.

reported in the meta-study of Havernek *et al*. (2015). The studies included in Havernek *et al*. largely ignore the role of labor/leisure. The few studies that incorporate labor-related variables in IES estimation only report *leisure-held-constant* IES.[5] In later analysis, we compare our estimates of the leisure-held-constant IES with theirs. To our knowledge, this paper is the first to provide IES estimates allowing for adjustment of the leisure margin and to compare with the leisure-held-constant IES often seen in the literature.

Second, we explore the heterogeneous nature of the leisure time by examining substitutability of different leisure components with consumption. We show that the IES estimates become larger when housework and/or childcare time are excluded from nonmarket time. This result is consistent with the change of a single parameter that measures the substitutability between consumption and leisure time. This parameter value becomes larger when we include housework and childcare time, either individually or jointly. Our work is the first in pointing out the importance of home production, particularly the childcare component, in smoothing consumption over the lifetime.

This paper is organized as follows. In Section II we discuss the theoretical framework. Section III provides details on the data and the estimation method. Section IV reports the main result and Section V conducts further analysis using predicted time use. Conclusions follow in section VI.

II. Theoretical Framework

II.A. Individual's Optimization Problem

[5] These studies include Attanasio and Weber (1995), Blundell *et al*. (1994), Jacobs (2007), Basu and Kimball (2002), Kilponen (2009).

In our model, individuals maximize their lifetime utility subject to constraints associated with budget and time. Specifically, their time-separable lifetime utility can be written as

$$\max \sum_{\tau=0}^{\infty} \beta^{\tau} u(C_{t+\tau}, L_{t+\tau}), \tag{1}$$

where C is consumption, L is leisure, and $\beta < 1$ is the time discount factor. We follow Becker (1965) and assume that consumption and leisure act as substitutes in producing utility-yielding "commodities" by selecting a period utility function of the King-Plosser-Rebelo form (King *et al*., 1987):

$$u(C_t, L_t) = \frac{1}{1-\gamma} C_t^{1-\gamma} L_t^{\chi(1-\gamma)}, \tag{2}$$

where γ and χ are curvature parameters associated with consumption and leisure, which are assumed to be nonnegative. These parameters capture how quickly people become satiated with increased consumption (when L is fixed) or leisure (when C is fixed). When χ is nonzero, the value of one variable would affect the marginal utility of the other. This parameter also influences the extent of substitutability between consumption and leisure because it enters the cross-partial derivative:

$$u_{12,t} = \chi(1-\gamma) C_t^{-\gamma} L_t^{\chi(1-\gamma)-1}. \tag{3}$$

The sign of $u_{12,t}$ is determined by $\chi(1-\gamma)$ because consumption and leisure can only take positive values. If $\chi(1-\gamma)$ is negative, then consumption and leisure are substitutes.

In maximizing the lifetime utility (1), individuals face two constraints: the budget constraint and the time constraint. The budget constraint can be expressed as

$$C_t + D_t \leq Inc_{Aft,t} + (1 + r_t) D_{t-1}, \tag{4}$$

where D_t represents savings that pay a predetermined real interest rate r_{t+1} in the next period. $Inc_{Aft,t}$ is the after-tax income

$$Inc_{Aft,t} \equiv (1-T)\left(w_t N_t + w_{s,t} N_{s,t}\right)^{1-\varphi} \quad (5)$$

where $w_t, w_{s,t}$is the real wage rate for the individual and the spouse, and N_t, $N_{s,t}$ are the time spent on market work by the individual and the spouse, respectively. Parameter φ captures the progressivity of the tax system, and T is the tax rate when the tax system is proportional (i.e., $\varphi = 0$). A larger φ implies higher penalty for working longer hours, which could affect consumption-leisure decisions at the margin. The time constraint is expressed as

$$\bar{T} = N_t + L_t + O_t, \quad (6)$$

where $\bar{T}$ is the total endowed time that is constant and the same across individuals (e.g., 24 hours a day). O_t is the time that generates neither utility nor income, which we treat as exogenous. Under this framework, individuals decide how to split time between leisure and work out of the "available" time ($= \bar{T} - O_t$). Deriving the first-order necessary conditions and combining them yield a pair of intertemporal efficiency conditions:

$$\left(\frac{C_{t+1}}{C_t}\right)^{\gamma} \left(\frac{L_{t+1}}{L_t}\right)^{-\chi(1-\gamma)} = \beta(1+r_{t+1}), \quad (7)$$

$$\left(\frac{C_{t+1}}{C_t}\right)^{-(1-\gamma)} \left(\frac{L_{t+1}}{L_t}\right)^{-[\chi(1-\gamma)-1]} = \beta(1+r_{t+1})\left(\frac{w_t}{w_{t+1}}\right)\left(\frac{Inc_{Bef,t+1}}{Inc_{Bef,t}}\right)^{\varphi}, \quad (8)$$

where before-tax income $Inc_{Bef,t} \equiv w_t N_t + w_{s,t} N_{s,t}$. Equation (7) is the conventional consumption Euler, whereas equation (8) is the leisure Euler, which describes intertemporal substitution of leisure demand.

Equation (7) implies that *when leisure is held constant*, the intertemporal elasticity of substitution for consumption is $\theta \equiv \gamma^{-1}$. When leisure is allowed to vary in response to the interest rate while keeping the wage rate fixed, the intertemporal elasticity of substitution of consumption (IES) becomes

$$\theta^{cl} \equiv [\gamma - \chi(1-\gamma)]^{-1}, \tag{9}$$

which follows directly from Swanson (2012) after substituting the partial derivatives of the utility function in Equation (2). The expression in Equation (9) implies that under a special case where $\chi = 0$ we have $\theta^{cl} = \gamma^{-1} \equiv \theta$, that is, the marginal utility of consumption is independent of leisure. For a nonnegative value of χ, θ^{cl} and θ will be positively associated. When $\gamma = 1$ (log-utility), θ^{cl} and θ both become one. Thus, for the leisure margin to influence the IES, we need both $\chi > 0$ and $\gamma \neq 1$.

III. Data and Estimation Strategy

We estimate the IES using the log-linearized version of Equations (7) and (8). These equations contain the growth rate of three variables (consumption, leisure, and wage rate). We first describe how these variables are defined and then explain the estimation methodology.

III.A. Consumer Expenditure Survey

Our data source is the 1996-2014 Consumer Expenditure Survey (CEX) conducted by the Bureau of Labor Statistics. The survey primarily records expenditures of a given "Consumer Unit (CU)" on a wide variety of items on a quarterly basis.[6] Each household is interviewed five times (four of them available to the public) over the course of one year and three months. In each quarter, the survey replaces 20% of the households with newly selected households. In addition to consumption, the CEX also collects data on wages, earnings, and

[6] A CU is defined as: (1) two or more people related by marriage, blood, adoption, or other legal arrangement who make joint financial decisions; (2) a person living alone, or sharing a house with others but is financially independent.

work hours for each CU member. While consumption data are recorded at the CU level, wage rate and work time are available at the member level.

To estimate parameters γ and χ in Equations (7) and (8), we use the synthetic cohort approach to capture cohort fixed effects arising from each generation's common lifetime experience.[7] We focus on employed individuals in their prime working years and restrict our sample to five birth-year cohorts (1951–1955, 1956–1960, 1961–1965, 1966–1970, and 1971–1975).[8] To be eligible for our sample, the individual must appear in both the second and the fifth waves of the interview and report positive wage rates (defined below). To mitigate measurement errors, households with zero food expenditures and those with negative entries for other nondurable goods are excluded.

III.B. Definition of Main Variables

Nondurable consumption is defined as the sum of consumption on all nondurable goods and services.[9] We convert it into real values using the Consumer Price Index (CPI). We assume the consumption growth rate to be the same for everyone in the same CU, because we cannot distinguish each CU member's consumption in the CEX. Major consumption decisions are usually made collectively within a household, and it is conceivable that the growth rate does not differ much among CU members. Following Attanasio and Weber (1995), we only consider consumption in the month immediately before the interview month. This helps to

[7] Other advantages are described in Chamberlain (1984) and Hayashi (1987). For examples of the synthetic cohort approach, see Attanasio and Weber (1995), Ghez and Becker (1975), and Rupert *et al*. (2000).
[8] Thus the age range in our sample is 21-45 in 1996 and 39-63 in 2014.
[9] Nondurable consumption includes food, alcoholic beverages, tobacco and smoking, apparel and services, household operation, utilities and fuels, gasoline, maintenance and repairs, vehicle-related expenses, public transportation, reading, fees and admissions, maintenance and insurance, baby day care, domestic services, and personal care. Rent, education, and health-related goods and services are not included in our definition.

avoid complicated error structures arising from having a monthly spending covering different quarters as well as helping to reduce recall bias.

In our baseline analysis, leisure time is defined as total time minus work time (i.e., “nonmarket time”). Specifically, we use total hours available in a year minus the product of hours worked per week and weeks worked per year.

For the wage rate, each CU member in the CEX is interviewed about their gross pay in the last pay period and the period that this payment covers (one week, two weeks, month, quarter, and year). CU members are also asked about their wages and salary income before deductions over the past twelve months. Our first wage measure is constructed by dividing the gross pay by the corresponding work hours during the reference period. This is our preferred measure, because it closely represents the wage rate paid at the time of the interview. For the second measure, we use annual wage and salary earnings divided by annual work hours. Whenever the first wage measure is missing, we replace the missing with the second wage measure.[10]

For the nominal interest rate, we use the 3-month treasury bill rate, which is common in the IES literature.

III.C. Estimation

The linearized Euler equations (7) and (8) are as follows:

$$\frac{1}{I}\sum_i \Delta\ln\left(C_{i,t+1}\right) = \beta_{0,c} + \theta r_{t+1} + \chi(\theta-1)\frac{1}{I}\sum_i \Delta\ln\left(L_{i,t+1}\right) + \beta_z{}'\frac{1}{I}\sum_i \Delta z_{i,t+1} + dseason_s + \varepsilon_{c,t+1}, \qquad (10)$$

$$\frac{1}{I}\sum_i \Delta\ln\left(C_{i,t+1}\right) = \beta_{0,l} + \left(\frac{\theta}{\theta-1} - \chi\right)\left[\frac{1}{I}\sum_i \Delta\ln\left(L_{i,t+1}\right)\right]$$

[10] Ham and Reilly (2002) use a similar approach when constructing the wage rate in the CEX.

$$+\frac{\theta}{\theta-1}\left[\frac{1}{I}\sum_i \Delta\ln\left(w_{i,t+1}\right) - r_{t+1} - \mu\Delta\ln\left(Inc_{Bef,i,t+1}\right)\right]$$
$$-\beta_z{}'\frac{1}{I}\sum_i \Delta z_{i,t+1} + dseason_s + \varepsilon_{l,t+1}, \quad (11)$$

where $\theta \equiv 1/\gamma$ is the leisure-held-constant IES and I is the number of observations of a cohort in a given quarter ("cell size"). The interest rate and the wage rate are both adjusted for inflation using the CPI. Vector z includes the number of adults (*adults*), the number of children less than age 18 (*children*), marital status (*single*), whether the spouse works full-time (*spouse fulltime*), spouse's nonmarket hours (*spouse nonmkt*), spouse's before-tax labor income (*spouse salary*), and before-tax labor income of other CU members (*other CU salary*).[11] $dseason$ represents seasonal dummies.

Cohort-based growth rates for consumption, leisure, and wage rate are obtained by first taking the growth rate for each respondent between the second and the fifth interview (9-month period), and then taking the average of these growth rates for a given cohort in each quarter.[12] By aggregating in this way, we can reduce the bias caused by serially correlated errors. This approach also ensures that the growth rate is constructed using the same individual across two periods so that any change in consumption growth is not caused by changes in sample composition due to lifetime events, such as marriage, divorce, and childbirth.

The linearized version of Equation (5) allows us to obtain an estimate for φ. Specifically, we regress the (log of) after-tax income Inc_{Aft} upon the (log of) before-tax income using Ordinary Least Squares. After-tax income is computed as before-tax CU income

[11] Spouse nonmarket hours are calculated as total hours available in a year (8736 hours = 24hrs × 7days × 52weeks) minus annual work hours, which is the product of hours worked per week and weeks worked per year. This number is multiplied by 0.75 for the 9-month period that consumption is measured.
[12] We note that since our sample consists of those having positive wages in the second and fifth interview waves, an individual could exit and re-enter the labor market between the waves. Our measure of annual nonmarket time may capture some of the changes due to these entries and exits.

net of federal, state, and social security taxes. These taxes are simulated jointly using TAXSIM 9.0 software provided by the National Bureau of Economic Research.[13] Our estimate for φ is 0.081, which is similar to Heathcote *et al*. (2010, 2014)'s estimates.

Equations (10) and (11) are jointly estimated using GMM. Identification is achieved using lagged variables as instruments. Specifically, we include the second, third, and fourth lags of the endogenous variables (consumption growth, leisure growth, nominal interest rate, inflation, and labor income growth), the second and third lags of the number of CU members (adults, children, and adults older than 64), age, age squared, and three seasonal dummies. Four observations are lost for each cohort because four lags are used to construct instruments. The total number of observations is 360 (= $5 \times (76 - 4)$).

The average cell size of our sample exceeds 100 for all cohorts (see Table 1), which helps to reduce the risk of a spurious MA(1) error structure induced by limited cell size.[14] The fact that one CU member only appears once in the sample reduces autocorrelation within cohorts over time. To further mitigate the problem, we apply a weight matrix that controls for both autocorrelation and potential heteroscedasticity arising from different cell sizes (i.e., the number of observations for each cohort in a quarter is different). Finally, clustered standard errors are applied at the cohort level.

III.D. Check on Concavity/Substitutability

[13] For simplicity, we treat each CU as a single tax unit and do not consider cases in which CU members file their taxes separately. The income used as input in the tax simulation is the sum of all members' labor income, self-employment income, and incomes from other sources such as rent, alimony, child support, estates, trusts, royalties, interest, social security, and transfer income. We largely follow the code and procedures provided by Lorenz Kueng on the NBER website: http://users.nber.org/~taxsim/to-taxsim/cex-kueng/cex.do.

[14] A spurious MA(1) structure in the error term would generally make the first lagged endogenous variables invalid instruments. See Attanasio and Weber (1995) for more details.

We conduct statistical tests on the concavity of the utility function. For the utility function to be concave, the estimated parameters must satisfy three conditions: (1) u_{11} is negative; (2) u_{22} is negative; (3) $u_{11}\,u_{22} - (u_{12})^2$ is nonnegative. In our model, this is equivalent to $\gamma > 0$, $\{\chi(1-\gamma) - 1\}\chi < 0$, and $\chi\gamma + \chi^2\gamma - \chi^2 \geq 0$. If one of these null hypotheses is rejected at the 1% significance level, the concavity assumption is violated. We also conduct hypothesis tests on whether consumption and leisure act as substitutes in generating utility. Specifically, we examine the sign of the cross-elasticity of equation (3), which depends on the sign of $\chi(1-\gamma)$. If the null $\chi(1-\gamma) \leq 0$ is rejected, the substitutability assumption can potentially be violated. Both tests serve as a check on the plausibility of the point estimates of γ and χ.

IV. Result

IV.A. Summary Statistics

Table 1 shows cohort summary statistics. Americans spend roughly 39 hours on work per week or 128 hours on nonmarket time. Nonwork time (nonmarket time less home production) occupies roughly 86% of the nonmarket time. Consumption at the CU level is the highest for the cohort born between 1961-65 ($2,314), which reflects both the relatively large household size (3.40 person, second highest) and the average before-tax CU income ($78,709.32, second highest). The average wage rate is the highest for the oldest cohort born between 1951-55 ($35.46/hour).

Figure 1 plots the average cohort nonmarket time, nondurable consumption, and hourly wage rate by age with a 5-year interval. Each line segment represents the average of each cohort. In panel (a), we see a mild U-shape for nonmarket time. This is expected as work time tends to be high in the middle ages and low for the very young and the very old. Consumption peaks around the middle ages[15] and the wage rate keeps rising until close to the retirement age, which are in concordance with the cohort-based summary statistics.

IV.B. Baseline Estimation

Table 2 reports IES estimates for different sets of control variables. Column (a) shows the result with no controls. The leisure-varying IES estimate θ^{cl} is 0.091 whereas the leisure-held-constant IES θ is 0.304, which is more than three times the size of θ^{cl}. The substitution parameter χ, which explains the gap between the two IES estimates are positive and statistically significant. The Sargan criterion suggests that the instruments used in the estimation are valid.

The importance of household characteristics in the context of IES estimation has been noted in the literature (e.g., see Attanasio and Weber, 1995). Schirle (2008) and others show that adults' labor supply decisions often depend on their spouse's labor market participation. Column (b) adds the number of household members (*adults*, *children*) and column (c) further adds marital status (*single*) and spouse's labor market variables (*spouse fulltime*, *spouse nonmkt*). In Column (b), θ^{cl} increases from 0.091 to 0.115 and θ increases from 0.304 to 0.327. In Column (c), the estimates for θ^{cl}, θ, and χ remain close to those in Column (b).[16]

Studies have repeatedly shown that the presence of a secondary earner in the household provides indirect insurance against unforeseen lifetime events that negatively

[15] Factors that explains the hump-shaped age profile other than household size include for example liquidity constraints, income uncertainty, and work-related expenses. For more on this topic, see, for example, Aguiar and Hurst (2013), Attanasio *et al.* (1999), Carroll (1994), and Hubbard *et al.* (1995).

[16] In later analysis, we experiment with an alternative utility specification in which the spouse's leisure enters differently into the individual's maximization problem.

impact the primary earner (Low, 2005).[17] To check whether such an effect is present, we consider two separate income variables. Column (d) adds spouse's salary and column (e) replaces spouse's salary in (d) with salary of the other CU members in case there are multiple earners in the household. In Column (d), the estimates for θ^{cl}, θ, and χ remain almost unchanged from (b). In Column (e), the estimates for θ and θ^{cl} go up slightly to 0.120 and 0.343, respectively.

In sum, we find that the leisure-varying IES to be consistently lower than the leisure-held-constant IES regardless of which control variables are used and that the substitutability parameter χ is positive and statistically significant. This result suggests that consumption-leisure substitution is important in understanding individuals' consumption decisions over the lifetime. The IES estimates in (b)-(e) are slightly higher compared to (a). To keep the model simple, we use the specification in (b) as our baseline specification in subsequent analyses.[18]

IV.C. Comparison with existing studies

Past studies that allow for consumption-leisure (or labor) interactions have mainly taken two different approaches: one uses fully-specified macroeconomic models to estimate model parameters,[19] and the other uses a more parsimonious model with fewer parameters. Here we compare our results with the latter.

One of the most commonly applied utility functions takes the exponential form of

[17] Blundell *et al*. (2016) specifically examine the effect of working spouses as an insurance against wage shocks. They find that wives' labor supply increases by 1.7 percentage points for a permanent 10% decrease in husbands' wages. See also Stephens (2002), which examines how labor supply of wives changes in response to husbands' job losses.

[18] We have also experimented whether the above result hold when *proportional* tax is assumed, which sets $\varphi = 0$. Compared to our baseline specification in column (b), the IES estimates θ^{cl} falls from 0.115 to 0.093. Since the change is quantitatively minor, we do not report the full estimation result in the main text.

[19] See, for example, Dotsey *et al*. (2014), Fujiwara *et al*. (2011), Smets and Wouters (2005, 2007).

$$u(C_t, L_t) = \frac{1}{1-\gamma} C_t^{1-\gamma} \exp[-(1-\gamma) f(N_t)], \quad (12)$$

where $f(N_t)$ satisfies the property of $f'(N_t) > 0$, $f''(N_t) > 0$ (increasing disutility of labor).[20] Basu and Kimball (2002) proposed an approach that does not require $f(N_t)$ to be parametrically specified. Instead, they imposed an economic restriction that labor income to spending ratio τ must be constant, which also means that the variation of labor hours in response to wage is suppressed. The estimating equation becomes the following modified consumption Euler equation,

$$\frac{1}{I}\sum_i \Delta\ln\left(C_{i,t+1}\right) - \tau\frac{1}{I}\sum_i \Delta\ln\left(N_{i,t+1}\right)$$

$$= \omega_{0,C} + \omega_{1,C}\left[r_{t+1} - \tau\frac{1}{I}\sum_i \Delta\ln\left(N_{i,t+1}\right)\right] + \varepsilon_{c,t+1}, \quad (13)$$

where $\omega_{1,C}$ represents the *labor*-held constant IES. Using US macro data, they find $\omega_{1,C}$ is within the range of 0.61 (for $\tau = 0.4$) and 0.74 (for $\tau = 1.2$). Kilponen (2012) repeats the same exercise using Finnland's household-level data and estimate $\omega_{1,C}$ to be 0.23 (for $\tau = 0.5$).

Appendix Table A.1 reports our estimates of $\omega_{1,C}$ for Basu and Kimball's specification using our micro-data. The IES estimates range between 0.41 (with demographic controls) and 0.65 (without any controls). Both values are reasonably close to Basu and Kimball's original estimates. We note that Basu and Kimball's approach cannot be used to obtain labor-varying IES, as we do in this paper.

Jacobs (2007) and others have used utility functions similar to ours,

$$u(C_t, L_t) = \frac{1}{1-\gamma}\left[C_t^{\sigma_C} L_t^{1-\sigma_C}\right]^{1-\gamma}, \quad (14)$$

[20] For example, within the macroeconomics literature it is common to assume $f(N_t) = \frac{N_t^{1+\sigma_N}}{1+\sigma_N}$, where $\sigma_N > 0$. However, the estimation of σ_N often encounters identification problem and requires this parameter to be either calibrated or impose a prior distribution in the estimation.

where consumption and leisure are assumed to be homogeneous of degree one. The linearized Euler equation for consumption is given as

$$\frac{1}{I}\sum_i \Delta\ln\left(C_{i,t+1}\right) = \omega_{0,C} + \omega_{1,C}r_{t+1} + \left(1-\gamma\omega_{1,C}\right)\frac{1}{I}\sum_i \Delta\ln\left(L_{i,t+1}\right) + \varepsilon_{c,t+1}, \qquad (15)$$

where $\omega_{1,C}$ is the leisure-held constant IES.[21] The Euler equation for leisure can be written as

$$\frac{1}{I}\sum_i \Delta\ln\left(C_{i,t+1}\right) = \omega_{0,l} + \frac{\omega_{1,C}}{1-\omega_{1,C}}\left[r_{t+1} - \frac{1}{I}\sum_i \Delta\ln\left(w_{i,t+1}\right)\right] - \left(\frac{\omega_{1,C}}{1-\omega_{1,C}}\right)\left(1+\gamma-\frac{1}{\omega_{1,C}}\right)\frac{1}{I}\sum_i \Delta\ln\left(L_{i,t+1}\right) + \varepsilon_{L,t+1}, \qquad (16)$$

where $\omega_{1,C}$ reappears in the leisure Euler equations. Jacobs (2007) only estimated Equation (15) and finds $\omega_{1,C}$ to be within the range of 0.036-0.224. He also provided *implied* parameter values for γ and σ_C based on the estimates of $\omega_{1,C}$ and $1-\gamma\omega_{1,C}$.[22] For comparison purpose, we estimate, $\omega_{1,C}$ using one Euler equation (consumption Euler only) as well as with two Euler equations (consumption and leisure Euler).[23] Appendix Table A.2 reports the result. We find that $\omega_{1,C}$ is 0.281 for single-equation estimation and 0.339 for two-equations estimation. The latter is remarkably close to our baseline estimate of 0.327. The (implied) IES θ^{cl} is 0.170 for the single-equation estimation and 0.185 for the two-equations estimation, which is also reasonably close to our baseline estimates. However, both the one-equation and two-equations IES estimates are not significantly different from zero. In addition, the estimates for γ and σ_C are *negative* in the two-equations case, which violates the assumption of concave utility.

[21] We note that this equation is observationally equivalent to our baseline specification, with $\omega_{1,C} = \theta$ and $1-\gamma\omega_{1,C} = \chi(\theta-1)$.

[22] He takes this approach because the nonlinearity in parameters combined with the homothetic preference makes the parameters γ, σ_C difficult to be directly estimated in the estimating model.

[23] We set $\varphi = 0$ to stay close to their original specification.

Lastly, we note that Low (2005) extends Heckman's (1974) model by introducing uncertainty and a precautionary motive of work. Low finds that consumption profile becomes less responsive to exogenous shocks once labor is allowed to vary. While we do not have the uncertainty component in our model, our finding is consistent with Low (2005) in the sense that labor supply serves as an additional adjustable margin to consumption fluctuations.

V. The Role of Home Production

V.A. Constructing Alternative Leisure Measures

Our next objective is to understand the nature of substitution between consumption and leisure. As we noted in the introduction, not all leisure activities can be substituted with consumption (e.g., eating and sleeping time). On the other hand, it is relatively easy to outsource home production activities to market-based goods and services. We define home production as the combination of housework (e.g., cooking, cleaning) and childcare (primary, educational, recreational), both of which have market-based alternatives.

In this section, we re-estimate the IES by replacing nonmarket time with alternative leisure measures. Particularly, we use nonmarket time less housework, nonmarket time less childcare, and nonmarket time less home production ("nonwork time").[24] The first two are used to identify which of the two components of home production matters in IES estimation. These alternative leisure measures are not readily available in the CEX. To overcome this issue, we apply an imputation method that allows us to incorporate the detailed time use data in the ATUS. The ATUS is conducted by the US Census Bureau and primarily collects

[24] We note that nonwork time includes both "core" leisure activities such as sleeping, eating, socializing, relaxing, and volunteering as well as "quasi" leisure activities such as medical care, religious/civic activities, care for adult household members, and education. Online Appendix Table O.2 provides the complete definition of the time use variables in this paper based on the ATUS code.

information on how Americans spent their time on a given day using a diary format. The imputation involves estimating the ratio of the alternative leisure measures and nonmarket time in the ATUS, and then using the predicted ratios and nonmarket time in the CEX to impute the alternative leisure measures. The observable individual characteristics are very similar across the two datasets, which allows us to impute leisure time on an individual basis. The details of the imputation method are available in Appendix A. We also conducted several checks to ensure that our imputation works properly. First, the predicted share of nonwork time over nonmarket time is 86.7% in the CEX, which is close to 86.6% reported in the ATUS. Second, we plotted the age and cohort profile of nonmarket and nonwork time in the two datasets and find that they track each other closely.[25] We regard these as a comforting sign that the imputation is working well.

V.B. Preliminary Analysis

Figure 2 presents the life-cycle profile of four different leisure measures (housework, childcare, nonmarket time less housework, nonmarket time less childcare) plotted in five-year age groups. Housework and childcare (top two panels) have an "inverted" U-shape. The peak for housework time occurs between ages 46-50, whereas the peak for childcare time occurs between ages 31-35.[26] The difference in peak timing is also reflected in the lifecycle profiles of the leisure measures that exclude housework or childcare from nonmarket time (bottom two panels).

[25] Both dataset show that the lifecycle profile of nonwork time exhibits U-shape whereas the birth-year cohort profile of nonwork time exhibits a monotonically increasing trend from the oldest to the youngest cohort. See Online Appendix for more details.

[26] We also observe that housework time does not overlap one another compared with childcare time. Part of this can be attributed to technology improvement as well as lifestyle changes that reduced time spent on housework more drastically over the sample period (1996-2014).

Figure 3 shows the time series plots of aggregate leisure measures averaged across employed individuals. As we move from the most broadly defined nonmarket time (top panel) towards the most narrowly defined nonwork time (bottom panel), the series become less volatile. Nonwork time shows a clear upward trend whereas nonmarket time does not. The upward trend for nonwork time is consistent with the findings in Aguiar and Hurst (2007).

To examine the statistical association between consumption and leisure, we estimate the following regression model,

$$\Delta LeisShare_{i,t} = \delta_0 + \delta_c \Delta \ln C_{i,t} + \delta_w \Delta \ln(w_{i,t}) + \delta_n \Delta \ln(nonmkt_{i,t}) + \delta_z' \Delta z_{i,t} + dyear_t + dseason_s + \varepsilon_{i,t} \quad (17)$$

where $LeisShare_{i,t}$ represents the percentage of nonmarket time spent on a specific leisure component, $nonmkt_{i,t}$ is nonmarket time, and $z_{i,t}$ is the vector of other control variables (marital status, whether the spouse works fulltime, spouse's nonmarket hours, family size, number of children).[27] We include individuals who are born between 1951 to 1975 to be consistent with the GMM estimation. δ_c represents the association between consumption and the leisure component. Figure 4 reports the estimates of δ_c for selected leisure time. The point estimate of δ_c is negative for childcare (-0.048), care for others (-0.038), and housework (-0.003), but positive for other leisure time, such as medical and personal care (0.002), sleep and eat (0.007), and exercise (0.035). The different signs indicate the heterogeneous nature of leisure time. The strength of substitution between consumption and leisure time is also

[27] The regression is similar to Aguiar and Hurst (2013) that explore the effect of labor supply on how consumption is allocated conditional on a given level of spending. We further utilize the short-panel nature of the CEX data to account for unobserved characteristics of individuals.

different, with childcare showing the strongest substitution and exercise showing the weakest.[28]

V.C. IES Estimation with Different Leisure Measures

In this subsection**,** we examine how sensitive IES estimates are when alternative leisure measures are used. Results are shown in Table 3. First, we observe that the leisure-held-constant IES θ remains within a narrow range (0.342-0.377) and is not much different from the baseline case when nonmarket time is used (0.327). Second, we find that the leisure-varying IES θ^{cl} for nonwork time is twice as large as the θ^{cl} for nonmarket time (0.240 vs 0.115). Finally, the leisure-varying θ^{cl} when nonwork time is used remains smaller than θ under the same leisure definition (0.240 vs 0.377), consistent with our baseline result presented in the last column of Table 3.

In the third and fourth columns of Table 3, we show that θ^{cl} increases from 0.115 (baseline) to 0.133 when we exclude housework from nonmarket time, and increases to 0.190 when we exclude childcare. The change in the estimate of χ can be used to infer the substitutability between leisure and consumption. When childcare is excluded from nonmarket time, the estimate of χ falls from 2.726 (baseline) to 1.222, whereas when housework is excluded χ falls from 2.726 (baseline) to 2.483. This implies that time spent on childcare is more substitutable with consumption compared with housework.

There are two possible explanations for this result. First, when leisure is defined broadly to include all nonmarket activities (i.e., nonmarket time), it is relatively easy for individuals to find the optimal mix of consumption and leisure. Second, in contrast to

[28] It should be further noted that the negative coefficient on housework is not statistically significant. Detailed estimation result is available in Online Appendix Table O.3 (home production time use) and O.4 (nonwork time use).

housework and childcare, some leisure activities are inherently more time-intensive and are more difficult to be substituted by consumption (e.g., sleeping and eating), whereas others require both consumption and time input (e.g., taking group exercise classes, visiting doctor's office, and getting a haircut). Childcare in contrast has readily available substitutes in the market such as daycare and baby-sitters.

V.D. Subsample Analysis

In this subsection, we examine whether our results on nonmarket and nonwork time hold for subsamples and whether the subsample differences are consistent with the literature. We select gender, the level of education, and stock-holding status as our subsample criterion. While there are no studies looking into the IES gap across gender, literature has provided ample evidence on how men and women differ in labor supply behavior and how they potentially affect consumption.[29] The IES gap across education levels and stock-holding status has been studied extensively in the literature.[30] For subsample analysis, we estimate the consumption and leisure Euler equations jointly for a pair of subsamples and test whether the difference in the IES estimates between the two subsamples are statistically significant.[31]

The results are shown in Figure 5.[32] For each subsample, we provide (leisure-varying) IES estimates using both nonmarket and nonwork time represented by two separate columns, with the gap between subsamples shown in the last set of columns. Women are found to have notably larger IES than men for both nonmarket time (0.18 vs 0.02) and nonwork time (0.24

[29] For example, see Apps and Rees (2005), Bishop *et al*. (2009), Blau and Kahn (2007), and Kumar and Liang (2016).
[30] For example, Attanasio and Borella (2014) study how IES varies by education and find that IES tend to be higher for the higher-educated. There is a large body of work that study the effect of financial market participation on IES, which find that IES tends to be higher for those who hold market-based financial assets. See, for example, Attanasio and Browning (1995), Attanasio and Paiella (2011), Blundell *et al*. (1994), Gorbachev (2011), Guvenen (2006), and Vissing-Jorgenson (2002).
[31] Yagihashi and Du (2015) use a similar method to examine the relationship between IES and risk aversion.
[32] For full estimation result, see Online Appendix Tables O.5-O.7.

vs 0.11), which can be linked to the higher θ (0.302-0.322 for women vs 0.092-0.246 for men). College-educated individuals have a larger IES estimate than lesser-educated individuals, though the gap appears to be small (0.05 vs 0.04 for nonmarket time and 0.12 vs 0.09 for nonwork time, only statistically significant for the latter). Similarly, stockholders have a marginally larger IES estimate than non-stockholders (0.063 vs 0.056 for the nonmarket time and 0.14 vs 0.11 for the nonwork time).[33] While there are no studies that allows comparison with regard to gender, those of education and stockholding are in line with the literature.

In all six subsamples, the leisure-varying IES is strictly lower than the leisure-constant IES. Figure 5 further shows that the IES estimate for nonmarket time (dark-colored column) is smaller compared with that for nonwork time (light-colored column) in all cases, consistent with the overall sample. Most notably, IES for men falls sharply from 0.11 (nonwork time) to 0.02 (nonmarket time), which suggests that men actively substitute consumption and home production time. For women, the change appears somewhat less apparent (0.23 for nonwork vs 0.18 for nonmarket). The result may be related to socio-economic facts on gender that makes substitution between consumption and home production more difficult for women.[34]

V.E. Robustness Analysis

[33] To define stockholding status, we follow Cogley (2002) to include not only those who reported a positive value for their stockholding, but also those who made investment in a private retirement account or IRA and those who reported positive income from interest and dividend. By including these additional categories, we have 61.09% of the sample categorized as stockholders.

[34] Possible reasons include, but not limited to, (a) the types of home production activities that women primarily engage (e.g., breastfeeding) have either limited market substitutes or makes them less eager to pay for it, (b) many women work in occupations with limited overtime hours that would give them less flexibility for work time adjustment, and (c) women tend to use labor adjustment at the extensive margin (find/quit work) more frequently than men, which would not be fully captured in our employed sample pool.

In Section III, we find that spouse's leisure (*spouse nonmkt*) is one of the highly significant explanatory variables, though including it in estimation did not affect the IES estimates much. It is possible that our baseline specification of Equations (10) and (11) fails to fully embrace the psychological effect that spouse's leisure has on one's consumption/leisure choices. We now consider a slightly different model in which the individual internalizes the spouse's leisure in the following manner,

$$u(C_t, L_t) = \frac{1}{1-\gamma} C_t^{1-\gamma} L_{c,t}^{\chi(1-\gamma)}, \tag{18}$$

$$L_{c,t} = {L_t}^{\alpha} {L_{s,t}}^{1-\alpha}, \tag{19}$$

where $L_{c,t}$ is the "composite" leisure, $L_{s,t}$ is the spouse's leisure, and $\alpha < 1$ is the weight for the individual's own leisure. The optimality condition implies that α equals the share of one's own labor income within the household.[35] We estimate our model under the following two scenarios: (a) nonmarket time is applied to L_t, $L_{s,t}$, and (b) nonwork time is applied to L_t, $L_{s,t}$. From the individual's perspective, specification (a) is less restrictive than specification (b) in the sense that it adopts a broader leisure measure that includes home production.

Table 4 shows the estimation result. We observe that the leisure-held-constant IES is lower in both cases compared with the baseline: θ is 0.024 when nonmarket time is used and 0.263 when nonwork time is used. This indicates that spouse's leisure serves as an independent channel of consumption smoothing. We note that the gap between θ^{cl} and θ still exists. For nonmarket time, substitutability parameter χ slightly increases from 2.726 (baseline) to 2.906, which contributes in pushing down the leisure-varying IES from 0.115 (baseline) to 0.006. The same applies when nonwork time is used (χ increases from 0.916 to

[35] Further details of this specification and the linearized Euler equations are provided in Appendix B.

1.452; θ^{cl} decreases from 0.240 to 0.147). This result shows that consumption-leisure substitutability increases when spouse's leisure is included in the utility function, suggesting one's consumption decision is not only affected by his/her own labor supply but also the spouse's labor supply.

VI. Conclusions

This paper provides estimates for the intertemporal elasticity of substitution (IES) when leisure is allowed to vary. We utilize a utility function that allows interaction between consumption and leisure to identify model parameters and show that the IES estimates that allow adjustment of the leisure margin are consistently lower than leisure-held-constant IES. This result holds for various robustness analysis and subsamples.

To further understand the source of the gap between the two IES measures, we incorporate detailed time use data to construct alternative leisure measures. This also enables us to explore whether IES estimates are sensitive to different leisure measures. We find that the IES estimate is larger when we use nonwork time as the leisure measure (that is, nonmarket time excluding home production). This is because consumption-leisure substitutability of housework and childcare activities is higher than other leisure components. The findings in this paper indicate that any public policies that affect labor supply decisions (such as taxation and childcare subsidies) could have unintended spillover effects on individuals' consumption/saving decisions.

The major contribution of this paper is that we have endogenized labor/leisure in estimating IES, which has not been done by previous studies. Another contribution is that we are able to examine the sensitivity of the IES estimates when leisure is defined differently.

Our result points out that the substitutability of home production time (in particular childcare) matters in the IES estimates.

One possible extension of this paper is to endogenize other time uses (such as, home production, education, or medical care) that are neither market work nor pure leisure. While modeling time spent on home production is relatively straightforward, it is difficult to incorporate it empirically. This is because imputing a small fraction of leisure time such as housework and childcare time would accompany substantial measurement errors. In addition, in order to calculate the growth rate accurately, we would also need home production time surveyed at different timings, which requires longitudinal time use data. Likewise, modeling time spent on education and medical care would be an interesting venue, though testing the empirical relevance of such models would also call for a dataset that tracks individuals more than just a few years.

References

Altonji, Joseph and John C. Ham (1990), "Intertemporal substitution, exogeneity, and surprises: estimating life cycle models for Canada," *The Canadian Journal of Economics*, 23(1), 1-43.

Aguiar, Mark and Erik Hurst (2005), "Consumption versus expenditure," *Journal of Political Economy*, 113(5), 919-948.

Aguiar, Mark and Erik Hurst (2007), "Measuring Trends in Leisure: The Allocation of Time Over Five Decades," *The Quarterly Journal of Economics*, 122(3), 969-1006.

Aguiar, Mark and Erik Hurst (2013), "Deconstructing Life Cycle Expenditure," *Journal of Political Economy*, 121(3), 437-492.

Apps, Patricia and Ray Rees (2005), "Gender, time use, and public policy over the life cycle," *Oxford Review of Economic Policy*, 21(3), 439-461.

Attanasio, Orazio P (1995), "The intertemporal allocation of consumption: theory and evidence," *Carnegie-Rochester Conference Series on Public Policy*, 42, 39-89.

Attanasio, Orazio P., James Banks, Costas Meghir, and Guglielmo Weber (1999), "Humps and bumps in lifetime consumption," *Journal of Business & Economic Statistics*, 17(1), 22-35.

Attanasio, Orazio P. and Margherita Borella (2014), "Modeling movements in individual consumption: A time-series analysis of grouped data," *International Economic Review*, 55(4), 959-991.

Attanasio, Orazio P. and Martin Browning (1995), "Consumption over the Life Cycle and over the Business Cycle," *The American Economic Review*, 85(5), 1118-1137.

Attanasio, Orazio P. and Monica Paiella (2011), "Intertemporal consumption choices, transaction costs and limited participation in financial markets: Reconciling data and theory," *Journal of Applied Econometrics*, 26, 322-343.

Attanasio, Orazio P. and Guglielmo Weber (1993), "Consumption growth, the interest rate and aggregation," *The Review of Economic Studies*, 60(3), 631-649.

Attanasio, Orazio P. and Guglielmo Weber (1995), "Is Consumption Growth Consistent with Intertemporal Optimization? Evidence from the Consumer Expenditure Survey," *Journal of Political Economy*, 103(6), 1121-1157.

Basu, Susanto and Miles S. Kimball (2002), "Long-run labor supply and the elasticity of the intertemporal substitution for consumption," working paper, University of Michigan.

Baxter, Marianne and Urban J. Jermann (1999), "Household production and the excess sensitivity of consumption to current income," *The American Economic Review*, 89(4), 902-920.

Becker, S. Gary (1965), "A theory of the allocation of time," *The Economic Journal*, 75(299), 493-517.

Biddle, Jeff E. and Daniel S. Hamermesh (1990), "Sleep and the allocation of time," *Journal of Political Economy*, 98(5), Part 1, 922-943.

Bishop, Kelly, Bradley Heim, and Kata Mihaly (2009), "Single women's labor supply elasticities: Trends and policy implications," *Industrial and Labor Relations Review*, 63(1), 146–168.

Blau, Francine D. and Lawrence M. Kahn (2007), "Changes in the Labor Supply Behavior of Married Women: 1980-2000," *Journal of Labor Economics*, 25(3), 393–438.

Blundell, Richard, Martin Browning, and Costas Meghir (1994), "Consumer demand and the life-cycle allocation of household expenditures," *Review of Economic Studies*, 61, 57-80.

Blundell, Richard, Luigi Pistaferri, and Itay Saporta-Eksten (2016), "Consumption Inequality and Family Labor Supply," *American Economic Review*, 106(2), 387–435.

Browning, Martin and Costas Meghir (1991), "The Effects of Male and Female Labor Supply on Commodity Demands," *Econometrica*, 59(4), 925–51.

Carroll, Christopher D. (1994), "How does future income affect current consumption?" *The Quarterly Journal of Economics*, 109(1), 111-147.

Chamberlain, Gary (1984), "Panel data," in Handbook of Econometrics, 2, edited by Zvi Griliches and Michael D. Intriligator, Amsterdam: North Holland.

Cogley, Timothy (2002), "Idiosyncratic risk and the equity premium: Evidence from the Consumer Expenditure Survey," *Journal of Monetary Economics*, 49, 309-334.

Dotsey, Michael, Wenli Li, and Fany Yang (2014), "Consumption and time use over the life cycle," *International Economic Review*, 55(3), 665-692.

Du, Juan and J. Paul Leigh (2015), "Effects of wages on smoking decisions of current and past smokers," *Annals of Epidemiology*, 25: 575-582.

Du, Juan and Takeshi Yagihashi (2017), "Health capital investment and time spent on health-related activities," *Review of the Economics of the Household*, 15(4), 1215-1248.

Eichenbaum, Martin S., Lars Peter Hansen, and Kenneth J. Singleton (1988), "A time series analysis of representative agent models of consumption and leisure choice under uncertainty," *Quarterly Journal of Economics*, 103(1), 51-78.

Friedman, Milton (1957), 'A theory of the consumption function,' Princeton University Press, Princeton, New Jersey.

Fujiwara, Ippei, Yasuo Hirose, and Mototsugu Shintani (2011), "Can news be a major source of aggregate fluctuations? A Bayesian DSGE approach," *Journal of Money, Credit and Banking*, 43(1), 1-29.

Ghez, Gilbert, Gary S. Becker (1975), 'The allocation of time and goods over the life cycle,' NBER Books, National Bureau of Economic Research, Cambridge, Massachusetts.

Gorbachev, Olga (2011), "Did household consumption become more volatile?" *The American Economic Review*, 101(5), 2248-2270.

Guvenen, M. Fatih (2006), "Reconciling conflicting evidence on the elasticity of intertemporal substitution: A macroeconomics perspective," *Journal of Monetary Economics*, 53(7), 1451-1472.

Ham, John C. and Kevin T. Reilly (2002), "Testing intertemporal substitution, implicit contracts, and hours restriction models of the labor market using micro data," *The American*

Economic Review, 92(4), 905-927.

Havranek, Thomas, Roman Horvath, Zuzana Irsova, and Marek Rusnak (2015), "Cross-country heterogeneity in intertemporal substitution," *Journal of International Economics*, 96, 100-118.

Hayashi, Fumio (1987), "Tests for liquidity constraints: A critical survey and some new results," in Advances in Econometrics Fifth World Congress, 2, edited by Truman F. Bewley, Amsterdam: North-Holland (for Econometric Soc.)

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante (2010), "Unequal we stand: An empirical analysis of economic inequality in the United States, 1967-2006," *Review of Economic Dynamics*, 13, 15-51.

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante (2014), "Consumption and labor supply with partial insurance: An analytical framework," *The American Economic Review*, 104(7), 2075-2126.

Heckman, James J. (1974), "Life cycle consumption and labor supply: An explanation of the relationship between income and consumption over the life cycle," *The American Economic Review*, 64(1), 188-194.

Hubbard, R. Glenn, Jonathan Skinner, and Stephen P. Zeldes (1995), "Precautionary saving and social insurance," *Journal of Political Economy*, 103(2), 360-399.

Jacobs, Kris (2007), "Consumption-leisure nonseparabilities in asset market participants' preferences," Journal of Monetary Economics, 54, 2131-2138.

Kahneman, Daniel, Alan B. Krueger, David Schkade, Norbert Schwarz, and Arthur Stone (2004), "Towards national well-being accounts," *The American Economic Review*, 94(2), 429-434.

Kimmel, Jean and Rachel Connelly (2007), "Mothers' time choices: caregiving, leisure, home production, and paid work," *The Journal of Human Resources*, 42(3), 643-681.

Kilponen, Juha (2012), "Consumption, leisure and borrowing constraints," *The B.E. Journal of Macroeconomics*, 12: Iss.1 (Topics), Article 10, 1-23.

King, Robert G., Charles I. Plosser, and Sergio T. Rebelo (1988), "Production, growth and business Cycles: I. The basic neoclassical model," *Journal of Monetary Economics*, 21, 2-3, 195–232.

Krueger, Alan B. (2007), "Are we having more fun yet? Categorizing and evaluating changes in time allocation," *Brookings Papers on Economic Activity*, 2, 193-215.

Kumar, Anil and Che-Yuan Liang (2016), "Declining female labor supply elasticities in the U.S. and implications for tax policy: Evidence from panel data", *National Tax Journal*, 69(3), 481-516.

Kydland, Finn E. and Edward C. Prescott (1982), "Time to bulid and aggregate fluctuations," Econometrica, 50(6), 1345-1370.

Low, Hamish (2005), "Self-insurance in a life-cycle model of labour supply and savings," *Review of Economic Dynamics*, 8, 945-975.

Mankiw, Gregory N., Julio J. Rotemberg, and Lawrence H. Summers (1985), "Intertemporal Substitution in Macroeconomics," *Quarterly Journal of Economics*, 100(1), 225-251.

Rupert, Peter, Richard Rogerson, and Randall Wright (2000), "Homework in labor economics: home production and intertemporal substitution," *Journal of Monetary Economics*, 46, 557–579.

Schirle, Tammy (2008), "Why have the labor force participation rates of older men increased since the mid-1990s?" *Journal of Labor Economics*, 26(4), 549-594.

Smets, Frank and Rafael Wouters (2005), "Comparing Shocks and Frictions in US and Euro Area Business Cycles: A Bayesian DSGE Approach," *Journal of Applied Econometrics*, 20, 161-183.

Smets, Frank and Rafael Wouters (2007), "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *The American Economic Review*, 97(3), 586-606.

Stephens, Melvin Jr. (2002), "Worker displacement and the added worker effect," *Journal of Labor Economics*, 20(3), 504-537.

Swanson, Eric T. (2012), "Risk aversion and the labor margin in dynamic equilibrium models," *The American Economic Review*, 102(4), 1663-1691.

Vissing-Jørgensen, Annette (2002), "Limited asset market participation and the elasticity of intertemporal substitution," *Journal of Political Economy*, 110(4), 825-853.

Yagihashi, Takeshi and Juan Du (2015), "Intertemporal elasticity of substitution and risk aversion: are they related empirically?" *Applied Economics*, 47 (15): 1588-1605.

Ziliak, James P. and Thomas J. Kniesner (2005), "The effect of income taxation on consumption and labor supply," *Journal of Labor Economics*, 23(4), 769–796.

u

Appendix A: Imputation Method

Our proposed method consists of the following steps: (1) estimate the ratio of a specific time use over nonmarket time using the American Time Use Survey (ATUS); (2) predict leisure time in the Consumer Expenditure Survey (CEX) by using the estimated ratio in (1), nonmarket time available in the CEX, and other observables in the CEX.

A.1 American Time Use Survey (ATUS)

ATUS is a nationally representative time diary survey that records detailed individual time use data in the past 24 hours. About 50% of the sample is randomly assigned to weekdays and 50% to weekends. Respondents are required to identify the primary activity when multiple activities are performed at the same time; therefore, all activities sum up to 24 hours.

In Appendix Table A.3, we present summary statistics for the variables used in estimating time use in the CEX sample (1996 - 2014) and in the ATUS sample (2003 - 2014) for employed individuals. While the CEX and the ATUS are conducted independently, the statistics are similar once sample weights are adjusted for: for example, in the CEX the average age is 42.21 years, 52% of the sample are male, and 62% of them are college-educated, whereas the corresponding averages in the ATUS are 41.22 years, 53%, and 64%.

A.2 Fractional logistic regression

For each of the three leisure measures, we estimate the ratio of the leisure measure and nonmarket by using the ATUS and then predict the ratio using the same variables in the CEX. Specifically, we define the ratio of leisure time and nonmarket time as

$$l_i \equiv \frac{L_i}{\bar{\bar{T}} - N_i}. \quad (A.1)$$

We apply a fractional logistic regression (Papke and Wooldridge, 1996) to predict l for each individual i on a given day. The advantage of the fractional regression compared with Least Square regressions is that it takes into account boundary values and restricts the fitted values to be between 0 and 1, which avoids generating implausible values for the fraction of time use. In addition, we can choose the most appropriate functional form for the conditional mean for each leisure measure separately by weekday and weekend. The functional forms include Cauchit, Logit, Probit, Log-Log, and Complementary Log-Log.[36] The estimation model is specified as

$$l_{day,it} = \beta_c + \beta_s single_{day,it} + \beta_{nc}' nchild_{day,it}$$
$$+\beta_v' \mathrm{V}_{day,it} + dyear_t + \varepsilon_{it}, \qquad \text{(A. 2)}$$

where $l_{day,it}$ represents the fraction of leisure time for individual *i* in year *t*. The variable $single_{it}$ represents dummy variable for marital status and the vector $nchild_{it}$ represents the number of children for different age groups (0-2 years old, 3-6 years old, 7-18 years old). The vector V includes other socioeconomic and demographic characteristics, which are gender, age, age squared, race (white, black, hispanic, other), education (less than high school, high school diploma, college degree), self-employment, occupation (manager and professional, administrative, sales, protective services, personal care services, other services, laborer, construction, and farming)[37], regional dummies (Northeast, Midwest, South, West), and an indicator for whether the interview was conducted during the summer months (June, July, and

---

[36] We tested the goodness-of-functional-form of five link functions (Cauchit, Logit, Probit, Log-Log, Complementary Log-Log) by using two different test statistics (RESET-LM, GOFF-Ramalho). We used the RESET-LM test which is the heteroskedasticity robust version of the original RESET test proposed by Ramsey (1969). The GOFF test was proposed by Ramalho and Ramalho (2011), who show that the GOFF test performs better than RESET-LM in terms of size and power. We used version 1 of the GOFF test in Ramalho and Ramalho (2011) and results were similar when using other versions of the test. In a few cases where all link functions were rejected, we chose the distribution that has the smallest test statistics (or the largest *p*-value).

[37] The occupation codes do not match exactly across the two datasets. The ATUS has 22 categories while the CEX has 18 categories. See Appendix Table A.4 for the matching of the occupation codes between the two datasets.

August). $dyear$ represents the interview year dummies. We estimate equation (A. 2) separately for weekdays (day = wd) and weekends (day = we).

A.3 Predicting Leisure Time

We predict individual's daily leisure time in the CEX using estimated coefficients of Equation (B.2). We then convert the predicted daily leisure measure to an annual measure based on additional information in the CEX. The CEX records how many hours each member of the CU worked during a given week (N_{week}) and how many weeks they worked in the past year (H_{year}). Using this information, we compute leisure time for the work week and the nonwork week separately.[38] Leisure time i during an average work week is computed as

$$L_{\text{work},i} = 5\left(24 - \frac{N_{\text{week},i}}{7}\right) l_{wd,i} + 2\left(24 - \frac{N_{\text{week},i}}{7}\right) l_{we,i}, \tag{A.3}$$

whereas leisure time during an average nonwork week is computed as

$$L_{\text{nonwork},i} = 7 \times 24 l_{we,i}. \tag{A.4}$$

Annual measure for leisure time i is calculated as the sum of leisure time during the work and the nonwork weeks as

$$L_{\text{year},i} = H_{year} L_{\text{work},i} + \left(52 - H_{year}\right) L_{\text{nonwork},i}. \tag{A.5}$$

Appendix B: Including Spouse's Leisure in Time Allocation

We assume that a "composite" leisure consists of one's own leisure and the spouse's leisure, as described in Equation (19), i.e., the individual internalizes the spouse's leisure time when deciding his/her own time use. Parameter α in Equation (19) represents the weight of

[38] Since the CEX does not provide the breakdown of how work hours are split between weekdays and weekends, we take an agnostic stance and evenly split work hours into seven days.

one's own leisure in the composite leisure. We assume that within a given period a couple jointly minimizes the opportunity cost associated with time, i.e., $wL + w_s L_s$. The optimality condition implies that α equals the share of one's own labor income in a two-earner household. If the person is single or has a non-working spouse, α is automatically set to unity and $L_c = L$. Thus, both singles and married individuals can be included in the same estimation.

The first-order necessary conditions that describe the intertemporal substitution in consumption and leisure are modified as,

$$C_t^{-\gamma} L_{c,t}^{\chi(1-\gamma)} = \beta E_t\left[(1+r_{t+1}) C_{t+1}^{-\gamma} L_{c,t+1}^{\chi(1-\gamma)}\right], \tag{B.1}$$

$$\frac{-\chi C_t^{1-\gamma} L_{c,t}^{\chi(1-\gamma)-1}\left(\frac{\alpha L_{c,t}}{L_t}\right)}{w_t} = \beta E_t\left[(1+r_{t+1}) \frac{-\chi C_{t+1}^{1-\gamma} L_{c,t+1}^{\chi(1-\gamma)-1}\left(\frac{\alpha L_{c,t+1}}{L_{t+1}}\right)}{w_{t+1}}\right], \tag{B.2}$$

and the linearized version of Equations (B.1) and (B.2) can be expressed as

$$\frac{1}{I}\sum_i \Delta\ln(C_{i,t+1}) = \beta_C + \theta r_{t+1} + \chi(\theta-1)\frac{1}{I}\sum_i \Delta\ln(L_{c,i,t+1}) + \theta_c{}'\frac{1}{I}\sum_i \Delta\ln(z_{i,t+1}) + \varepsilon_{c,t+1}, \tag{B.3}$$

$$\frac{1}{I}\sum_i \Delta\ln(C_{i,t+1}) = -\beta_C + (-\chi)\left[\frac{1}{I}\sum_i \Delta\ln(L_{c,i,t+1})\right] + \frac{\theta}{\theta-1}\left[\frac{1}{I}\sum_i \Delta\ln(w_{i,t+1}) + \frac{1}{I}\sum_i \Delta\ln(L_{i,t+1}) - r_{t+1}\right] - \theta_l{}'\frac{1}{I}\sum_i \Delta\ln(z_{i,t+1}) + \varepsilon_{l,t+1}, \tag{B.4}$$

where the growth rate of the composite leisure for each individual *i* is calculated as

$$\Delta\ln(L_{c,i,t+1}) = \alpha_i \Delta\ln(L_{i,t+1}) + (1-\alpha_i)\Delta\ln(L_{s,i,t+1}). \tag{B.5}$$

Online Appendix

The online appendix can be downloaded from the author's personal website:

https://sites.google.com/site/takeshiyagihashi/research

Appendix References

Papke, Leslie E., Jeffrey M. Wooldridge (1996), “Econometric methods for fractional response variables with an application to 401(K) Plan participation rates,” *Journal of Applied Econometrics,* 11(6), 619-632.

Ramalho, Esmeralda A. and Joaquim J.S. Ramalho (2011), “Alternative estimating and testing empirical strategies for fractional regression models,” *Journal of Economic Surveys* 25(1), 19–68.

Ramsey, James B. (1969), “Tests for specification errors in classical linear least-squares regression analysis,” *Journal of the Royal Statistical Society: Series B (Methodological)*, 31(2), 350-371.

Table 1 Cohort Summary Statistics

Birth-year	1951-1955	1956-1960	1961-1965	1966-1970	1971-1975
age in 1996	41-45	36-40	31-35	26-30	21-25
age in 2014	59-63	54-58	49-53	44-48	38-43
Work time, weekly	39.7	39.6	39.7	39.2	38.9
Nonmkt.time, weekly	128.3	128.4	128.3	128.8	129.1
Nonwork time, weekly	112.0	110.6	109.2	109.3	110.3
Consumption, monthly	2,217.81	2,293.38	2,314.20	2,219.36	2,093.47
Wage rate, hourly	35.46	34.57	30.41	31.43	27.71
# of adults	2.25	2.25	2.17	2.10	2.06
# of children below18	0.54	0.88	1.23	1.37	1.30
CU income, annual	77,466.62	80,330.85	78,709.32	74,657.05	70,987.89
Observations	10,212	12,206	12,170	10,703	8503
ave. cell size	138	165	164	145	115

Note: The sample consists of employed individuals who have positive wages in both the second and the fifth waves of the interview in the Consumer Expenditure Survey. Sample period is 1996Q1-2014Q2. Average cell size is the number of observations for a given cohort in each quarter, and it is calculated as the total number of observations for a given cohort divided by the number of quarters (74 quarters). Leisure and work time are measured in hours per week for convenience of understanding. Consumption is defined as average nondurable consumption per CU over one month, measured in 2014 dollar. Wage rate is the average hourly wage measured in 2014 dollar. CU income is (before-tax) labor income per CU over one year measured in 2014 dollar.

Table 2 IES Estimates with Different Control Variables

	(a)	(b)	(c)	(d)	(e)
θ^{cl}	0.091***	0.115***	0.113***	0.115***	0.120***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
θ	0.304***	0.327***	0.323***	0.324***	0.343***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
χ	3.358***	2.726***	2.734***	2.708***	2.824***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.120)
Δ ln (*adult*)		0.241***	0.035	0.031	0.001
		(0.000)	(0.496)	(0.484)	(0.986)
Δ ln (*children*)		-0.072***	-0.023	-0.030	-0.024***
		(0.000)	(0.293)	(0.104)	(0.253)
Δ *single*			0.525***	0.375***	0.829***
			(0.000)	(0.000)	(0.000)
Δ *spouse fulltime*			-0.203**	-0.148**	0.460***
			(0.014)	(0.039)	(0.000)
Δ *spouse nonmkt*			-1.818***	-2.060***	-0.828***
			(0.000)	(0.000)	(0.000)
Δ *spouse salary*				-0.107***	
				(0.000)	
Δ *other CU salary*					-0.039***
					(0.000)
Sargan criterion	61.107	60.166	60.867	60.290	62.011
	(0.740)	(0.710)	(0.747)	(0.608)	(0.712)
Concave utility?	Yes	Yes	Yes	Yes	Yes
C and *L* are substitutes?	Yes	Yes	Yes	Yes	Yes

Note: θ^{cl} is constructed based on Equation (9) and for the null hypotheses H_0: $\theta^{cl}=0$, we use Wald-type of tests and the delta method to estimate the standard errors. The number in the parentheses represents the p-value for the test. ***, ** and * represent statistical significance at the 1%, 5%, and 10% level, respectively. The instruments in (a)-(c) include the second, third, and fourth lags of consumption growth, leisure growth, nominal interest rate, inflation, and labor income growth, and the second and third lag of the number of adults, children, and elderly (those older than 64), number of earners, single status, whether the spouse works full-time, spouse's nonmarket time, average age, age squared, and three seasonal dummies. The instruments in (d)-(e) further include the second, third, and fourth lags of spouse salary and salary of other CU members, respectively. In addition to the variables presented in the table, three seasonal dummies are also included in estimation.

Table 3 IES Estimates with Different Leisure Measures

	Nonwork time	Nonmarket time less housework	Nonmarket time less childcare	cf. Non-market time (baseline)
θ^{cl}	0.240***	0.133***	0.190***	0.115***
	(0.000)	(0.000)	(0.000)	(0.000)
θ	0.377***	0.349***	0.342***	0.327***
	(0.000)	(0.000)	(0.000)	(0.000)
χ	0.916***	2.483***	1.222***	2.726***
	(0.009)	(0.000)	(0.000)	(0.000)
Δ ln (*adult*)	0.253	0.270***	0.202***	0.241***
	(0.000)	(0.000)	(0.000)	(0.000)
Δ ln (*children*)	-0.073	-0.073***	-0.067***	-0.072***
	(0.000)	(0.000)	(0.000)	(0.000)
Sargan criterion	60.313	58.716	60.673	60.166
	(0.705)	(0.755)	(0.694)	(0.710)
Concave utility?	Yes	Yes	Yes	Yes
C and *L* are substitutes?	Yes	Yes	Yes	Yes

Note: θ^{cl} is constructed based on Equation (9) and for the null hypotheses H_0: $\theta^{cl}=0$ we use Wald-type of tests and the delta method to estimate the standard errors. The number in the parentheses represents the p-value for the test. ***, ** and * represent statistical significance at the 1%, 5%, and 10% level, respectively. The instruments include the second, third, and fourth lags of consumption growth, leisure growth, nominal interest rate, inflation, and labor income growth, and the second and third lag of the number of adults, children, and elderly (those older than 64), number of earners, single status, whether the spouse works full-time, spouse's nonmarket time, average age, age squared, and three seasonal dummies. In addition to the variables presented in the table, three seasonal dummies are also included in estimation.

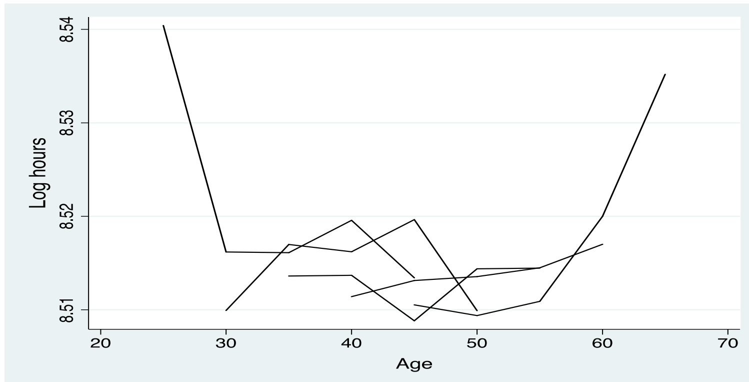
Table 4 IES Estimates with Joint Leisure Utility Specification

Parameter estimates	Nonmarket time as $L_t, L_{s,t}$	Nonwork time as $L_t, L_{s,t}$
θ^{cl}	0.006***	0.127***
	(0.000)	(0.000)
θ	0.024***	0.263***
	(0.000)	(0.000)
χ	2.906**	1.452**
	(0.000)	(0.000)
Δ ln (*adult*)	0.012***	0.038***
	(0.001)	(0.000)
Δ ln (*children*)	-0.005***	-0.046***
	(0.000)	(0.000)
Sargan criterion	61.257	61.293
	(0.675)	(0.674)
Concave utility?	Yes	Yes
C and L are substitutes?	Yes	Yes

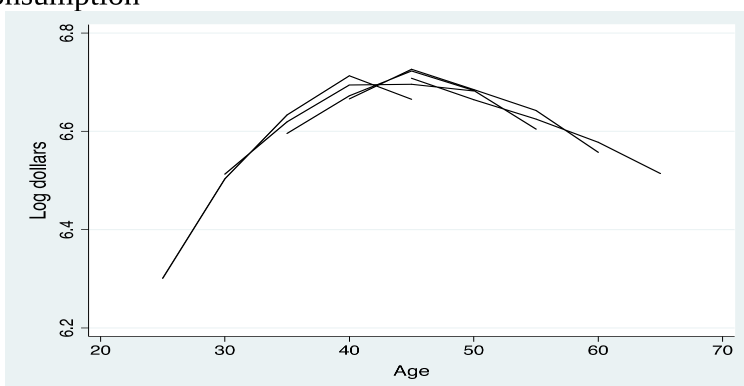
Note: $L_t, L_{s,t}$ are own/spouse's leisure, respectively. θ^{cl} is constructed based on Equation (9). For the null hypotheses H_0: $\theta^{cl} = 0$ we use Wald-type of tests and the delta method to estimate the standard errors. ***, ** and * represent statistical significance at the 1%, 5%, and 10% level. P-values are included in parentheses. The instruments include the second, third, and fourth lags of consumption growth, the corresponding leisure growth, nominal interest rate, inflation, and labor income growth, and the second and third lags of the number of adults, children, and elderly (those older than 64), number of earners, average age, age squared, and three seasonal dummies. In addition to the variables presented in the table, three seasonal dummies are also included.

Figure 1 Life-cycle Profile of Nonmarket time, Consumption, and Wage Rate

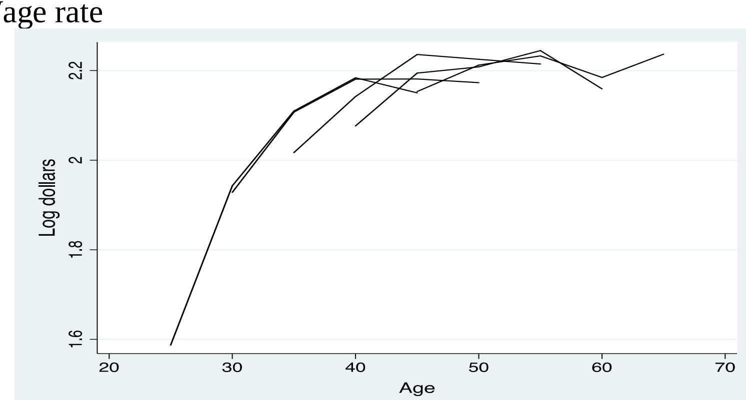
(a) Nonmarket time



(b) Consumption

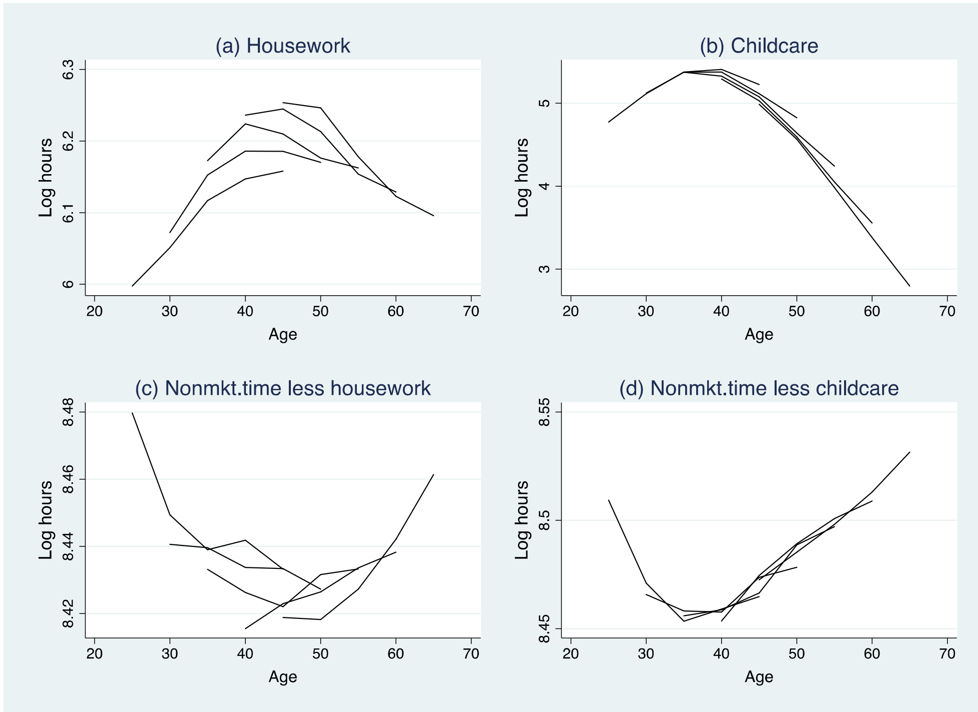


(c) Wage rate



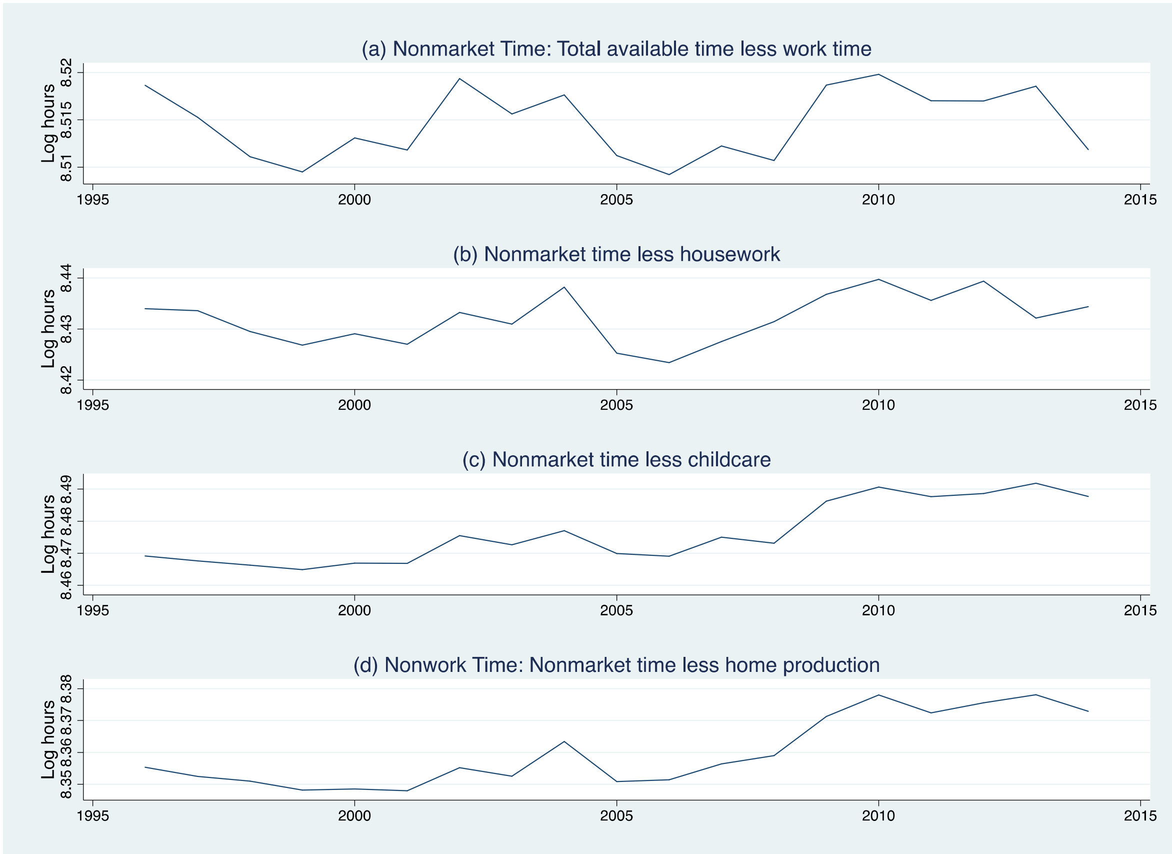
Note: The figure plots the average cohort nonmarket time, nondurable consumption, and hourly wage rate by age. Each line segment represents one cohort and the sample period of 1996-2014 in the Consumer Expenditure Survey. Consumption represents nondurable nominal consumption deflated by the Consumer Price Index and log transformed. The wage rate is the nominal wage rate deflated by the Consumer Price Index and log transformed. Consumption is measured at the household level and wage rate is measured at the individual level. The sample consists of employed persons only.

Figure 2 Life-cycle Profile of Leisure Measures



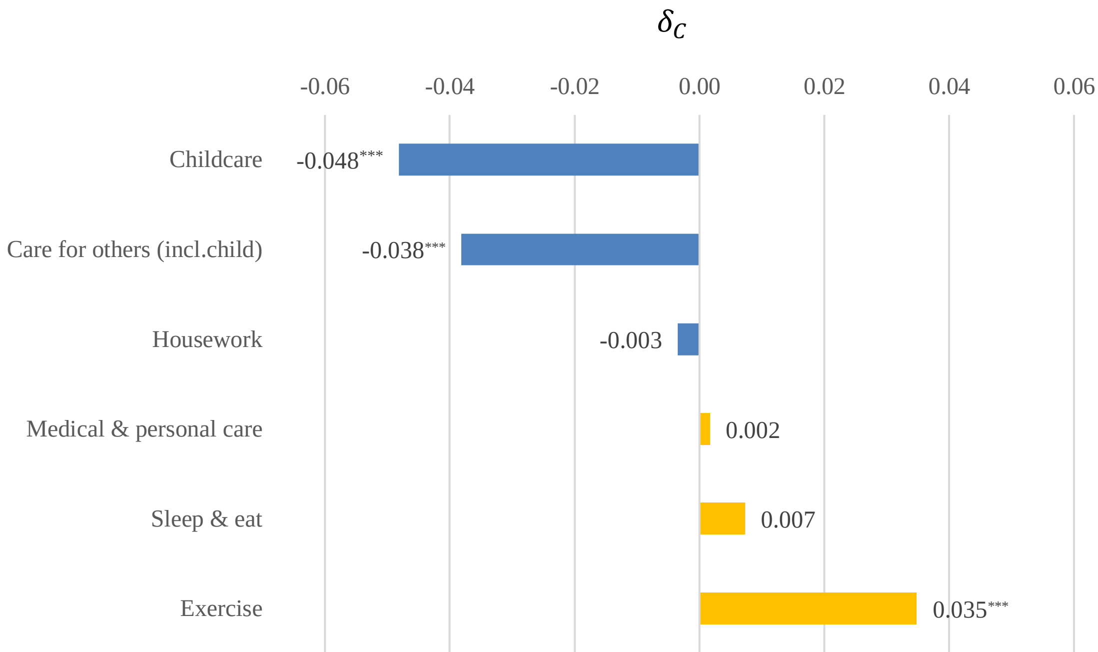
Note: This figure plots the average cohort leisure by age. Each line segment represents one cohort and the sample period of 1996-2014 in the CEX. All leisure measures are predicted using data from the ATUS and the CEX and apply for employed persons.

Figure 3 Time-series Plots of Different Leisure Measures



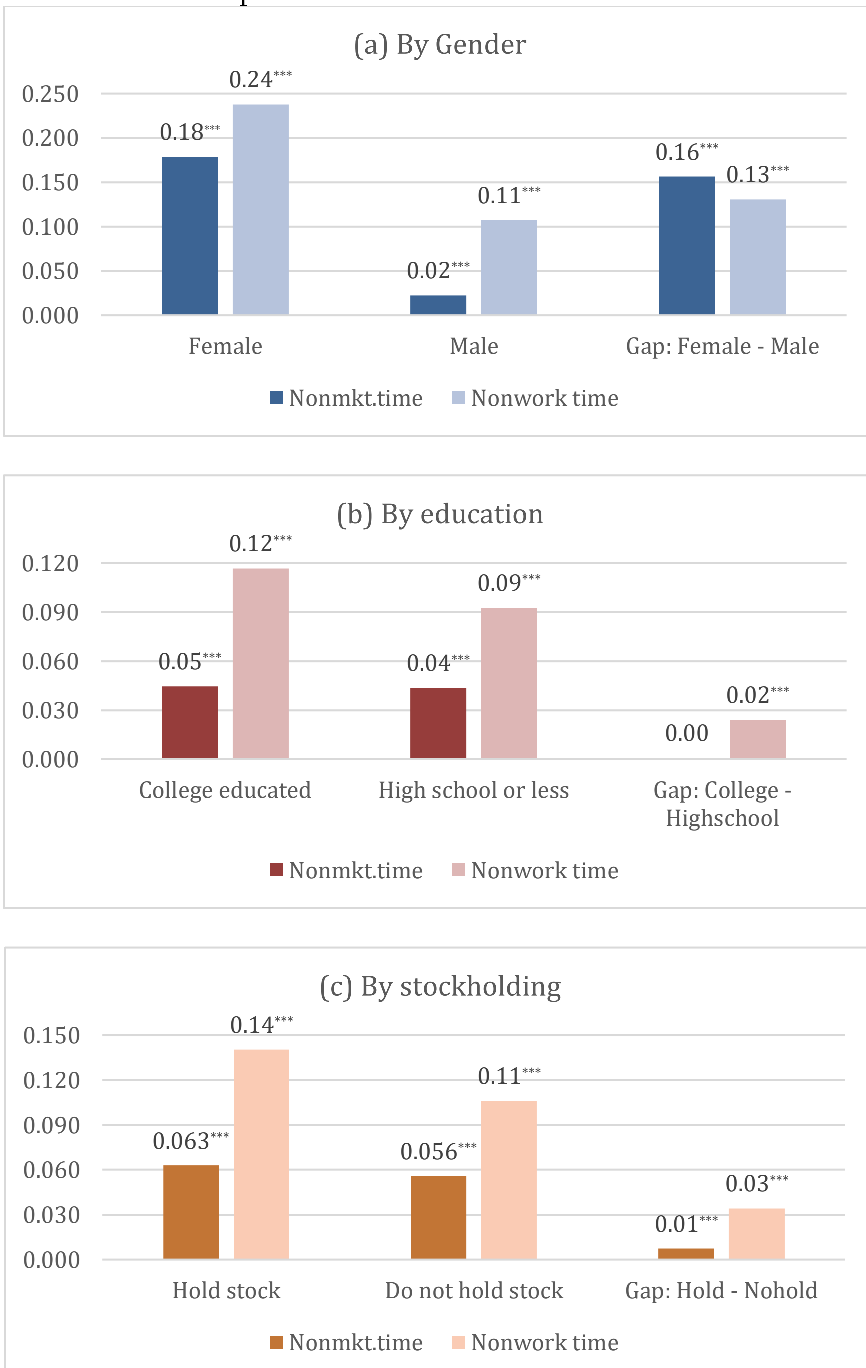
Note: Leisure time is plotted over time from 1996 to 2014 at the annual frequency. Nonmarket time is calculated from the CEX as total time minus annual work hours. Work hours are obtained as weeks worked per year times hours worked per week. Remaining leisure measures (b)-(d) are predicted using data from the ATUS and the CEX. All measures are for employed persons.

Figure 4 Relationship between Consumption and Specific Time Use



Note: The numbers reported are the coefficient of nondurable consumption (δ_C) in Equation (17). Standard errors clustered at the individual level are included in the parentheses. *** indicates statistcal significance at the 1% level.

Figure 5 IES Estimates for Subsamples



Note: The columns represent the IES estimates for subsamples using nonmarket time (dark color) and nonwork time (light color), respectively. The last column shows the difference between the two subsamples presented in the first and second column. For a given pair of subsamples, four equations (two times consumption and leisure Euler) are jointly estimated. The control variables include the number of adults, the number of children, and seasonal dummies. A formal test with regard to the significance of the gaps are provided in the Online Appendix Table O.5-O.7. *** indicates statistcal significance at the 1% level.

Appendix Tables and Figures

Table A.1 Alternative Estimates with Basu and Kimball (2002)'s Utility Specifications

	No controls	With controls
$\omega_{1,C}$	0.646**	0.408***
	(0.046)	(0.000)
Δ ln (*adult*)	-	-0.461***
		(0.005)
Δ ln (*children*)	-	0.034
		(0.288)
Sargan criterion	7.501	45.626
	(1.000)	(0.026)

Note: Labor income to spending ratio is set to 0.8. Basu and Kimball (2002)'s specification does not require wage rate, instead they use labor hours. Instruments include the second, third, and fourth lags of consumption growth, annual hours' growth, nominal interest rate, inflation, and labor income growth, and the second and third lag of the number of adults, children, and elderly (those older than 64), number of earners, single status, whether the spouse works full-time, spouse's nonmarket time, average age, and age squared.

Table A.2 Alternative Estimates with Jacobs (2007)'s Utility Specifications

	One equation	Two equations
θ^{cl}	0.170	0.185
	(0.414)	(0.414)
$\omega_{1,C}$	0.281*	0.339***
	(0.100)	(0.000)
Implied σ_C	0.669	-0.663
	(0.144)	(0.138)
Implied γ	4.828	-1.934
	(0.349)	(0.239)
Δ ln (*adult*)	0.094	0.055
	(0.695)	(0.685)
Δ ln (*children*)	0.124**	0.107***
	(0.070)	(0.006)
Sargan criterion	32.485	45.353
	(0.052)	(0.548)

Note: Instruments include the second, third, and fourth lags of consumption growth, annual hours' growth, nominal interest rate, inflation, and the second and third lag of the number of adults, children, single status, whether the spouse works full-time, spouse's nonmarket time, average age, and age squared.

Table A.3 Summary Statistics of Consumer Expenditure Survey (CEX) and American Time Use Survey (ATUS)

	CEX	ATUS
Age	42.21	41.22
Less than high school	0.11	0.08
High school diploma	0.26	0.28
College degree	0.62	0.64
Gender (male = 1)	0.52	0.53
White, non-hispanic	0.71	0.70
Black, non-hispanic	0.10	0.10
Hispanic	0.12	0.14
Other race	0.06	0.06
Marital status (single = 1)	0.34	0.40
# of children, aged 0-2	0.08	0.13
# of children, aged 3-6	0.19	0.18
# of children, aged 7-18	0.60	0.54
Observation	210,861	84,996

Note: Samples are restricted to those between 21-64 years old and those who are employed. All statistics are adjusted using sample weights.

Table A.4 Occupation Categories

Occupation categories	ATUS code	CEX code
Manager and professional	1 - 10	1 - 3, 7
Administrative support	17	4
Sales	16	5, 6
Protective services	12	8
Private household services	15	9
Other services	11, 13, 14	10
Laborer (operator, assembler, inspector, repairer, precision production)	20 - 22	11 - 14
Construction, mining	19	15
Farming, fishing, forestry, armed forces	18	16 - 18

Note: The occupation variable in the ATUS is trdtocc1. The occupation variable in the CEX is occucode.