Back to Becker: Producing Consumption with Time and Goods

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Abstract

Households combine time and expenditures in many different ways to produce consumption activities. Most economic models restrict the substitutability between expenditures and time to be equal across activities. These models struggle to generate the cross-sectional dispersion in hours worked that we observe in the data. We provide a novel framework for thinking about time allocation choices by revisiting Becker's notion of consumption as production of different activities. The Beckerian framework reconciles important cross-sectional differences in time and expenditure allocations of households. It generates dispersion in hours worked that is twice as large compared to a set of benchmark models.

JEL Codes: J22, E21, D11
Keywords: Time Allocation, Consumption Expenditures, Hours Dispersion, Non-separability

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1 Introduction

Earnings are a product of wages and hours. While a large literature documents the contribution of increasing wage inequality to the rise in earnings inequality, less attention has been paid to the dispersion of hours worked[1]. Depending on the correlation between individual wages and hours, dispersion in hours worked may amplify or dampen earnings inequality. Understanding the source of hours dispersion is thus crucial for explaining how earnings inequality translates into welfare inequality and it informs the design of policies aimed at reducing inequality.

We propose a new framework to rationalize the cross-sectional variation in hours worked that we observe in the data. To do so, we revisit Becker (1965)'s notion that every activity consumed by the household is a combination of time and expenditure inputs. While Becker's seminal work has inspired a large literature on home production and a slightly smaller literature on the production of leisure, no paper has fully internalized the potentially large heterogeneity in the way households combine consumption expenditures and time spent outside the market. This paper attempts to fill this gap. We argue that variation in the elasticity of substitution between time and expenditures for different consumption activities is crucial to understand cross-sectional dispersion in hours worked.

We explore Becker (1965)'s notion in the data by defining detailed consumption activities consistently across the American Time Use Survey (ATUS) and the Consumer Expenditure Survey (CE). We group information from both surveys by dividing households into four education and four income groups. According to Becker (1965), households produce consumption activities by setting the marginal product of expenditures to time equal to the ratio of their marginal costs. Thus, we expect low income and low educated households to work fewer hours in the market while allocating more time to leisure activities that require fewer expenditures. Consistent with this notion, we find that households in the lowest education group spend on average 12 hours less per week working in the market compared to highly educated households. They allocate a larger share of their budget to non-market work (61% versus 46%) and engage to a larger extent in time-intensive leisure activities. These time and expenditure allocation patterns are very similar when we distinguish households by income rather than education.

Motivated by these facts, we develop a Beckerian framework in which households require both time and expenditures to enjoy utility from all consumption activities. In this framework, the response of hours worked to income shocks depends on the substitutability between expenditures and time outside the market

[1]See Doiron and Barrett (1996) for an analysis of hours disperison using Canadian data, and Checchi et al. (2016) for a recent cross-country analysis. Add wage inequality literature.

for different consumption activities. The response in hours worked may or may not be larger compared to a framework that assumes a single elasticity of substitution between expenditures and time across all activities.

To answer this question, we estimate a nested CES production function of consumption activities. Each activity is produced by taking time and expenditure shares as inputs. We allow the parameters that govern input shares as well as the elasticity of substitution between expenditures and time to be activity-specific. In addition, the weight of each activity in the consumption aggregate can vary. In this flexible setup, the optimal allocation of time and expenditures is not only determined by the relation between wages and the relative prices of expenditures, but also by the degree of substitutability between time and expenditures.

The estimation results strongly support the Beckerian notion that a combination of time use and expenditures best describes consumption from activity production. In fact, the estimated substitution parameters for different consumption activities lie between 0.06 and 0.54, thus strongly rejecting the assumption that time use and expenditures are highly substitutable.[2] Interesting patterns emerge across consumption activities: the substitution parameter for home production activities is close to zero with a share parameter of 0.5 for expenditure inputs, suggesting that home production can be described by a Cobb-Douglas production function. Leisure activities follow a different production function and parameter estimates across different leisure activities are very similar. The share parameter on leisure expenditures is much smaller and on average below 0.2, the substitution parameter is around 0.5. Even though the elasticity between time and expenditures is much higher for leisure activities, it is well below the degree of substitutability implied by an additive separable framework.

To understand whether the non-separability between consumption expenditures and times is crucial for our estimation results, we estimate four alternative utility specifications. In two of these specifications, expenditures and time are additive separable. We show that even in a model, in which we allow expenditures to differ across consumption activities, hours dispersion is only half as big as in the Beckerian framework. Next, we relax additive separability, but limit the production of consumption activities to a single activity: home production or leisure production. We show that such models generate on average x% of dispersion in hours worked in the data. Thus, the elasticity of substitution between consumption activities of 1.4 in the Beckerian framework is an important driver of hours dispersion in the model (??? - still to be checked).

[2] As the substitution parameter approaches zero, activity production follows a Cobb-Douglas production function. When the substitution parameter approaches one, time use and expenditures become perfect substitutes.

We rely on the Aguiar and Hurst (2007) and Aguiar et al. (2013) framework to classify expenditures and time use into detailed consumption categories. We are, to our knowledge, the first paper to provide a detailed mapping of time use and consumption expenditures in order to consistently measure consumption activities. This mapping allows us to study how combinations of time and expendi-ture differ across a wide set of activities and across different household types.

Our analysis contributes to a growing literature on home production[3] and leisure production.[4] Our framework generalizes the idea that households combine market goods and time to produce activities. We argue that such a framework is crucial to understand the cross-sectional dispersion in hours worked. In addition, our framework has novel implications for the way earnings inequality translates into consumption and welfare inequality. Attanasio and Pistaferri (2016), who summarize empirical facts about the evolution of consumption inequality in the U.S., conclude their analysis stating that cross-sectional variation in aggregate consumption expenditures provide an incomplete picture of household well-being. In their view, a complete welfare analysis has to seriously consider the value that households assign to time and the goods they consume. The framework proposed in this paper takes an important step in this direction.

A large macroeconomic literature studies the implications of cross-sectional hours dispersion for earnings and consumption inequality as well as imperfect risk-sharing.[5] Utility in these models is defined additive separately over consumption expenditures and leisure time. Without assuming ex-ante heterogeneity in preferences for leisure, these models can only generate a small fraction of the observed dispersion in hours worked. Our framework, instead, does not rely on preference heterogeneity. It generates a dispersion in hours worked twice as large compared to additive separable frameworks, given common preference parameters and prices across individuals. The only source of heterogeneity in our framework is wages, something that is observable and relatively well-measured.

The rest of the paper is organized as follows. Section 2 presents stylized facts using our consumption expenditures and time use mapping. Section 3 formalizes Becker (1965)'s idea and lays out a structural framework. Section 4 contains details of the estimation procedure, while section 5 summarizes our results. Section 6 concludes.

[3]See, for example, Benhabib et al. (1991), Greenwood and Hercowitz (1991), McGrattan et al. (1997), Ngai and Pissarides (2011) and Ngai and Petrongolo (2017).

[4]Vandenbroucke (2009), Kopecky (2011) and, more recently, Bridgman (2016).

[5]See, for example, Heathcote et al. (2014), Kaplan (2012), del Rio (2015), or Bils et al. (2012).

2 Stylized Facts

The dispersion of hours worked is large within and across education groups. One explanation put forth by Becker (1965) is that households face different shadow prices of time and that these differences are driven by consumption activities outside the market. In this section, we document that cross-sectional dispersion in hours worked and variation in time and expenditure allocations across consumption activities for different education groups. The data facts motivate the structural framework proposed in section 3.

2.1 Dispersion in Hours Worked

We measure dispersion of hours worked as the standard deviation of log usual hours worked in the CPS Outgoing Rotation Group between 2003 and 2014. We restrict the sample to individuals between the ages of 21 and 65 and divide the sample into four education groups. Table 1 summarizes the results across all years and for two subsamples: 2003–2007 and 2008–2014. Dispersion in hours worked is slightly higher for higher educated individuals and increased somewhat during and after the financial crisis. However, the variation in hours dispersion across education groups and across time periods is surprisingly small. We will therefore use total hours dispersion across all education groups as the key measure for our analysis.

Table 1: Dispersion in Hours Worked

	2003-2014	2003-2007	2008-2014
Less than HS	0.402	0.380	0.419
Highschool	0.397	0.385	0.405
Some College	0.445	0.439	0.449
College	0.464	0.469	0.460
Total	0.435	0.428	0.440

Data Source: IPUMS-CPS Outgoing Rotation Group 2003-2014. The sample is restricted to workers ages 21-65. Dispersion of hours worked is measured as the standard deviation of log usual hours worked per week. If usual hours worked per week is not available, we use information on actual hours worked.

2.2 Time and Expenditure Allocations

In order to match information about expenditures and time use for consumption activities consistently across surveys, we start by limiting both samples to reference persons between the ages 21–65. We remove students and retirees since their time

allocation decisions are likely to have a strong intertemporal component, a feature that will not be captured by our static framework. Finally, we limit ourselves to households with working individuals. This implies that we drop unemployed, people absent from work, and people on layoff looking for a job in the ATUS. The unit of measurement in the CE is the household. To identify households with working individuals, we only include households in which either the respondent or the spouse reports to have worked at least 1 week in the previous year.

Clearly, the ideal data set for the analysis we have in mind would allow us to match detailed time diaries of all household members to individual consumption expenditures. In the absence of such data, we exploit the detailed nature of the ATUS and CE to classify households consistently along observable dimensions such as education, age or income. We interpret our results as follows. Every time and expenditure allocation bundle reflects the average time and average expenditures that an average person living in a specific household invests into the production of a certain consumption activity.[6]

A natural starting point for our analysis is the comprehensive classification of time uses by Aguiar and Hurst (2007). Based on 24–hour time diaries, they identify 16 different uses of time that provide the baseline for our activity classification. To link time uses and consumption expenditures consistently, we use Universal Classification codes (UCCs), the most most detailed level of expenditures available in the CE Interview Survey. Between 2003 and 2014, close to 700 UCCs allow for a very detailed mapping of expenditures to the 16 categories of time use.

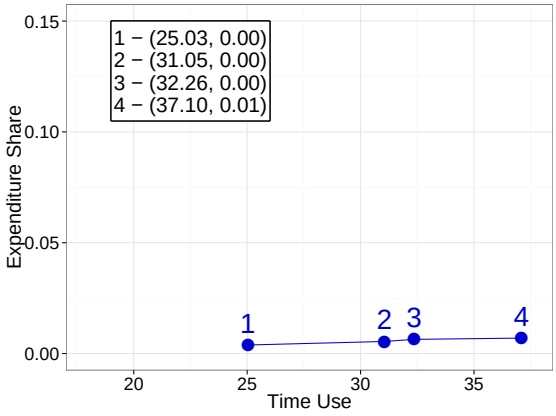
A fraction of consumption expenditures cannot be directly linked to a specific activity as they constitute investment decisions, such as the purchase of a house or a car. Similarly, we exclude educational and medical time and expenditure decisions from our main analysis as we view them as human capital investments. We construct additional expenditure categories to summarize these investments.

Table A.1 summarizes the activity categorization. The majority of time uses and expenditures can be combined into three categories: market work, non-market work, and leisure. Figure 1 summarizes the time allocation and expenditure share bundles for the three major consumption activities. The average time per week spent on an activity is reported on the x-axis. We express expenditures related to each activity as a fraction of core expenditures. Core expenditures are defined as total expenditures minus investment expenditures. Expenditure shares are plotted on the y-axis.

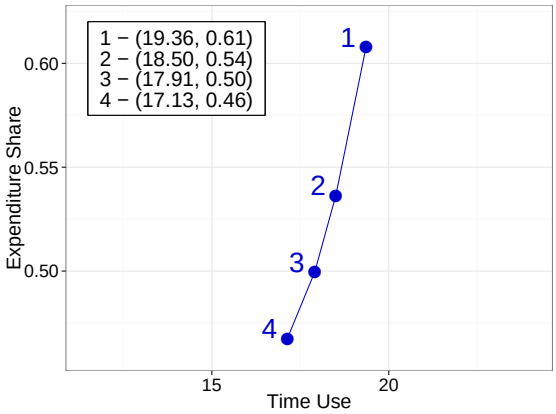
While expenditures for market work activities are on average zero, we find that higher educated households supply more hours. Given higher wages, they face a

[6] Acknowledge literature on bargaining within the household and its impact on time and expenditure allocations. Include relevant citations.

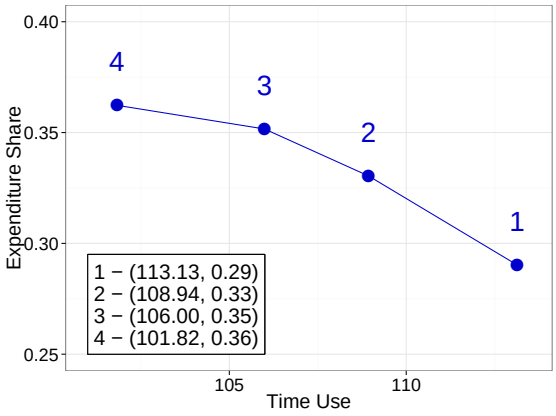
Figure 1: Major Consumption Activities by Education



(a) Market Work



(b) Non-Market Work



(c) Leisure

Notes: Households are grouped into four education categories: 1 - <HS, 2 - HS, 3 - SC, 4 - Col. Time use respondents are classified according to their individual education type. Households in the CE are grouped depending on the education of the reference person. Consumption expenditures are expressed as a fraction of core expenditures.

larger opportunity cost of time and spend less time on activities outside the market compared to low educated households. However, clear cross-sectional differences emerge in the way households combine expenditures to produce non-market and leisure activities.

Households spend at least half of their core activity budget on non-market work activities, with highly educated households allocating a smaller fraction of their budget to these activities. Both time and expenditures are simultaneously declining in education.[7] Notice that the ratio of time to expenditure inputs is roughly constant in the cross-section. This pattern is driven by the largest activity

[7]Recall that we classify all types of expenditures that may increase the value of a house as investment expenditures. Hence the fact that highly educated households are likely to purchase a bigger house does not affect the time to expenditure allocations for non-market work in our setup.

component of non-market work: core home production. Figure B.1 breaks down non-market work activities into core home production and other non-market work activities, such as obtaining goods and services and other care. It shows that the relationship of between time and expenditure allocations is driven by core home production activities. The variation in time and expenditure allocations for other non-market work activities is very small.

Leisure production follows a very different pattern. Expenditures are increasing in education, while time allocated to leisure activities is declining. This suggest that households substitute time and expenditures at a higher rate compared to non-market to activities. This might seem surprising at first. Figure B.2 provides a breakdown of the allocations into different subcategories of leisure activities. The differences in time allocation between high and low educated households is mainly driven by two activities: sleep and watching TV. Low educated households spend ten hours more per week watching TV and sleep close to seven hours more. Both activities are associated with hardly any expenditure inputs. The fact that leisure expenditures are increasing in education is driven by two activities: hobbies and entertainment, and eating out and personal care. Highly educated households spent 10% more of their core budget on these activities. Taken together, these facts explain why highly educated households spend less time but a larger fraction of their budget on leisure activities.

We perform several robustness checks. First, we split the 2003–2014 sample into two subperiods, 2003–2007 and 2008–2014. Splitting the sample does not affect our results. Next, instead of grouping households by education, we split them by income quartiles. Figure B.3, B.4 and B.5 show the results when we split households along income quartiles. Even though all results go through, we lose a few observations since the variable for household income contains a lot of missing observations in the ATUS. Thus, we choose the education classification for the estimation.

3 Structural Framework

Becker (1965) emphasizes the idea that many different types of time use and many different types of consumption goods can be combined in different ways to provide utility. Hence, his notion of utility is far more general than the majority of models used in economics today in which a single observable wage rate is associated with the individual's time. Becker (1965) emphasizes that different types of activities should have different shadow prices.

3.1 Beckerian Utility

We formalize this notion in a nested CES production function with time use and consumption expenditures for each activity as inputs, aggregated by another CES production function. This parsimonious way of modeling the production of activities gives us the most flexibility with respect to the way in which time use and consump-tion expenditures are combined. For example, one can imagine that in order to enjoy a hobby, such as playing golf, time and expenditures are less substitutable than the utility derived from a clean home, a consumption activity that can either be produced by using one's time or through paying the cost of a cleaning service.

Let consumption activity i be produced by merging time inputs (l_i) and consumption expenditures (x_i). We refer to c_i as the amount of activity i that a household enjoys. Households maximize

$$\max_{\{c_i\}_{i=1}^n} u(c_i) = \log\left\{\left(\sum_i \alpha_i c_i^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}\right\}, \quad \text{where}$$

$$c_i = \left(\kappa_i x_i^{\frac{\xi_i-1}{\xi_i}} + (1-\kappa_i)\ell_i^{\frac{\xi_i-1}{\xi_i}}\right)^{\frac{\xi_i}{\xi_i-1}}.$$

Four sets of parameters govern the production of consumption activities in this framework. First, the share parameters, $\{\alpha_i\}$, determine the relative weights of every activity in the total set of activities a household engages in. ρ captures the elasticity of substitution between these consumption activities. For a given activity i, $\{\kappa_i\}$ determines the weight of expenditures in the production this activity. Finally, the elasticities of substitution between consumption expenditures and time are given by $\{\xi_i\}$.

In the consumer expenditure data, we find that all consumption expenditures related to market work are, on average, close to zero. Thus, market work is the only activity in our setup that only involves time as input. Each household has one unit of time that can be allocated either to producing activities or market work. The budget constraint for a household of education receives wage w from market work is given by:[8]

$$\sum_i p_i x_i = w(1 - \sum_i \ell_i).$$

The optimal input ratio of time to expenditures for activity i is given by:

$$\frac{\ell_i}{x_i} = \left(\frac{p_i}{w}\right)^{\xi_i}\left(\frac{1-\kappa_i}{\kappa_i}\right)^{\xi_i}. \tag{1}$$

[8]To simplify the exposition, we drop subscripts j, indicating variation in wages and optimal allocations across education groups, in this section. Refer to Appendix C.1 for the full problem.

Note that the optimal ratio of time to expenditures is determined by the price ratio of both inputs $\frac{p_i}{w}$ and input shares κ_i, resulting in different shadow prices for every activity i. Notice that an elasticity of substitution of $\xi_i \to \infty$ would imply that time and expenditure inputs l_i and x_i are perfectly substitutable. Similarly, an elasticity of substitution between consumption activities of $\rho \to \infty$ implies that consumption activities, such as market work and leisure, are perfect substitutes. This assumption is inherent in an additive separable utility framework.

3.2 Comparison to Additive Separable Utility

We compare our results derived from the Beckerian framework to a flexible version of the standard utility framework. The key difference is that the standard framework does not posit that both time and expenditure inputs are needed to derive utility from consumption. Thus, utility is simply a combination of time and expenditures. Even though the most common version of utility treats time and expenditures as additive separable, we choose a CES utility function that nests this special case.

Households therefore solve:

$$\max_{c^s} u(c^s) = \log\left\{\left(\phi(x^s)^{\frac{\sigma-1}{\sigma}} + (1-\phi)(\ell^s)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}\right\}$$

where the superscript s stands for *standard* utility. The budget constraint is:

$$x^s = w(1-\ell^s)$$

In the standard framework, the optimal allocation between time and expenditures is summarized by:

$$\frac{\ell^s}{x^s} = \left(\frac{1}{w}\right)^{\sigma}\left(\frac{1-\phi}{\phi}\right)^{\sigma} \tag{2}$$

Hence, there is only one shadow price determined by two parameters: ϕ, the relative importance given by the household to market expenditures, and σ, the elasticity of substitution between total expenditures and total time.

When comparing this optimal input ratio to the one derived in the Beckerian framework, one might argue that the variation in time and expenditure allocations is simply driven by differences in expenditure prices p_i instead of the parameters governing activity production $\{\xi_i, \kappa_i\}$. If this was the case, a simple extension of the standard model that allows expenditures to be decomposed into different categories with different prices should yield very similar results to the Beckerian framework. We refer to this extension as standard utility with *multiple goods*:

$$\max_{c^m} u(c^m) = \log\left\{\left(\phi(X^m)^{\frac{\sigma-1}{\sigma}} + (1-\phi)(\ell^m)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}\right\}, \quad \text{where}$$

$$X^m = \left(\sum_i \mu_i (x_i^m)^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}$$

subject to

$$\sum_i p_i x_i^m = w(1-\ell^m).$$

The optimal input ratio now accounts for the variation in expenditure prices:

$$\frac{\ell^m}{x_i^m} = \left(\frac{p_i}{w}\right)^{\sigma} \left(\frac{1-\phi}{\phi}\right)^{\sigma} \tag{3}$$

Notice that if the degree of substitutability between time and expenditures is homogeneous across activities, i.e. $\xi_i = \sigma$, and input shares are the same, $\kappa_i = \phi$, the multiple goods framework should be able to fully capture the cross-sectional variation in time and expenditure allocations in the data.

In the remainder of the paper we compare results derived from the Beckerian and the multiple goods framework, while results for the standard framework are provided in the Appendix. Specifically, we will show that the multiple goods model with constant substitutability between time and expenditures and constant input shares cannot account for the cross-sectional variation in time and expenditure allocations in the data.

3.3 Comparison to Utility with Home or Leisure Production

A growing literature on home production and leisure production has started to relax the assumption of additive separability. However, to our knowledge, home and leisure production have only been treated separately in the literature. To understand whether our results hinge on the fact that we allow time and expenditure to be combined differently across various activities, we estimate a model that includes leisure production or home production only.

Let $i = \{h, l\}$ denote the model with home and leisure production, respectively. Households derive utility from consumption expenditures X^{-i} not associated with consumption activity i. Utility derived from activity i, n_i, is a combination of time l^i and expenditures x^i allocated to this activity. Households maximize

$$\max_{c^i} u(c^i) = \log\left\{\left(\phi_i (X^{-i})^{\frac{\sigma_i-1}{\sigma_i}} + (1-\phi_i)(n^i)^{\frac{\sigma_i-1}{\sigma_i}}\right)^{\frac{\sigma_i}{\sigma_i-1}}\right\}, \quad \text{where}$$

$$n^i = \left(\mu_i (x^i)^{\frac{\eta_i-1}{\eta_i}} + (1-\mu_i)(l^i)^{\frac{\eta_i-1}{\eta_i}}\right)^{\frac{\eta_i}{\eta_i-1}}.$$

4 Estimation

We combine data from the American Time Use Survey (ATUS) and from the Consumer Expenditure Survey (CEX) to construct a pseudo-panel of households grouped according to education, income, and age, that spans for 11 years. For each household-type, we obtain data of expenditures and time uses for a common set of consumption activities. Our point of departure is the set of time-use activities proposed by Aguiar et al. (2013), who classify time allocation to market work, non-market work, and leisure (and sub-categories therein). We take those categories as given and map each expenditure group in the CEX to one of the time-use categories. By doing so, we create consistent categories of activities which have associated with a level of time use and an expenditure amount.

The activities considered in the estimation are Non-Market Work, Child Care, Watching TV, Socializing, Eating and Personal Care, and Hobby and Entertainment. We choose not to include Sleeping and the category of Other because the simple structural framework proposed can not capture the biological, educational, and medical decisions of households. The cross-section of households are divided according to their educational attainment. The reason to use education rather than income to obtain the cross-sectional heterogeneity is mainly sample size. We lose a substantial amount of observations because there is much missing income data in the ATUS.

In addition to the time use and expenditure data discussed, we use data on household wages across education groups and prices of market inputs across activities between 2003 and 2014. We use the Current Population Survey (CPS) to construct household wages by education level. The wage is calculated as the ratio between total household income and total household working hours.

We assume all households face the same price and use the Consumer Price Index (CPI), obtained from the BLS, to construct relative prices between market goods. During the 2000s, the expenditure categories in the CPI and CEX are consistent, and therefore the CPI data can be aggregated into our activity categories

using expenditure weights constructed from the CEX.[9][10] Specifically, we first construct the share of expenditures for each household by the detailed CEX categories and then use the shares to aggregate the corresponding CPI indices to a weighted price for each activity at the household level. Finally, we average across households using CEX sample weights to find the aggregate price for an activity in a given year. The Appendix provides details of the construction of wages and prices.

We use a minimum-distance estimator to estimate the model's parameters. Given prices and wages for the four education groups, for all combinations of parameter values, we can calculate optimal allocations for a household of a given education level for each year in our sample. These allocations - for time and expenditure shares- are the moments the estimation procedure targets. Specifically, the targets include allocations of time use and expenditure shares from 2003 to 2014 for each of the education groups and each of the activity categories. The dimension of the vector for time and expenditure share is 288 each.[11] The number of parameters to estimate is 18.[12] The standard errors are obtained by boostrapping the individual-level data sets. Although we use both time series and cross-sectional data for estimating the parameters, the cross-sectional distribution helps identify parameters better than the time series.

Similarly, given wages by education, we estimate the "standard" preference by minimizing the distance between data and model implication on market hours by education and over years. The number of parameters is 2 and the number of moments is 48.

4.1 Estimation Results

Table 2 summarizes the estimation results with standard errors in parenthesis. The top panel shows the estimates for the Beckerian utility parameters and the two bottom panels the ones for "standard" preferences with and without multiple goods.

Recall that the parameters that govern the elasticity of substitution between time and expenditures are ξ_i in the Beckerian framework and σ^m and σ^s in the multiple goods and standard utility framework respectively. Define the substitu-

[9] We follow Casey (2010) to construct consistent categories between the CPI and CEX.

[10] We choose not to use data before the 2000s because prior to the 1998 revision CPI is not linked to CEX. The number of CPI categories before the revision is much smaller and one category may cover more than one activity according to our classification. Consequently, constructing consistent price series for the activities is not easy.

[11] The dimension is the product of the 12 years of data, 6 activities, and 4 education groups.

[12] For each activity, we estimate a share of market input and an elasticity of substitution between market inputs and time (12 parameters). We estimate the share of the activity in total consumption, but there are only 5 independent parameters because the sum of all 6 equals one. Finally, we also estimate an elasticity of substitution across activities.

Table 2: Parameter Estimates

	(1) Child	(2) Non-market	(3) TV	(4) Social	(5) Eat & Pcare	(6) Hobby
A. Beckerian Utility						
ξ	2.286	1.100	2.080	1.339	1.975	2.066
	(0.027)	(0.020)	(0.024)	(0.013)	(0.015)	(0.018)
κ	0.109	0.518	0.122	0.207	0.184	0.183
	(0.001)	(0.011)	(0.000)	(0.003)	(0.001)	(0.001)
α	0.080	0.284	0.197	0.113	0.179	0.146
	(0.002)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)
ρ	1.399					
	(0.027)					
B. Standard Utility With Multiple Goods						
μ	0.025	0.556	0.055	0.087	0.143	0.134
	(0.001)	(0.004)	(0.001)	(0.000)	(0.001)	(0.001)
η	1.128					
	(0.012)					
σ^m	1.255					
	(0.017)					
ϕ^m	0.351					
	(0.002)					
C. Standard Utility						
σ^s	1.252					
	(0.017)					
ϕ^s	0.287					
	(0.005)					

Notes: Estimation with unique expenditure prices.

tion parameter $s = \frac{\gamma - 1}{\gamma}$, where $\gamma \in \{\xi_i, \sigma_m, \sigma_s\}$. A substitution parameter of $s = 1$ implies that time and expenditure are perfect substitutes. Unless the expenditure price equals the shadow price of time, this would imply that households exclusively use either time or expenditures to produce consumption activities. In this case, an additive separable utility framework as used in most macroeconomic models would be successful in capturing the cross-sectional variation in time and expenditure allocations. However, as evident from table 3, the substitution parameters are far below one across all models. For the standard utility framework with a single good (σ^s) and with multiple goods (σ^m), we find a substitution parameter of $s = 0.2$. This value is much closer to the case of Cobb-Douglas ($s = 0$) and suggests that the optimal ratio of time and expenditures is closely determined by the input price ratio. In particular, it reinforces the notion that households require both time and expenditures to enjoy consumption activities and that these two inputs cannot be substituted perfectly.

Notice that the substitution parameter σ implied by the standard framework with and without multiple goods is identical, suggesting that price and wage

Table 3: Substitution Parameter

	σ^s	σ^m	(1) ξ_{cc}	(2) ξ_{nm}	(3) ξ_{tv}	(4) ξ_{sc}	(5) ξ_{pc}	(6) ξ_{ho}
s	0.20	0.20	0.56	0.09	0.52	0.25	0.49	0.52

changes will have very similar effects across the two frameworks. This constant substitution parameter masks large heterogeneity in the substitutability of expenditures and time across consumption activities. The Beckerian framework suggests a much larger degree of substitutability between time use and expenditures, except for the case of non-market work. The substitutability parameter is close to zero, implying that the ratio of time to expenditures is nearly constant for non-market work consumption activities. Almost all other substitution parameters are signifi-cantly larger and close to 0.5, implying an elasticity of substitution around 2. Thus, changes in the price to wage ratio for these activities will translate into much larger changes in the ratio of time to expenditure inputs.

The share parameters for home production and leisure vary in interesting ways as well. While the share parameter κ for expenditures in the production function for non-market work is close to 0.5, the share parameter is significantly smaller and below 0.2 for most leisure activities. Table D.5 reports the estimation results when we allow expenditures for activities to vary across education groups. Notice that the parameter estimates do not vary significantly from the estimates presented in Table 2. Thus we focus on results from the model estimated with activity prices that do not vary by education type.

4.2 Model Fit

Tables 4 and 5 show that the model replicates variation in time and expenditure allocations in the cross-section, with two exceptions. First, the model predicts a rather constant allocation of time to non-market work, while we see observe non-market time declining with education in the data. The second exceptions concerns the category Hobby and Entertainment. In the data, higher education is associated with more time devoted to this consumption activity. The model, however, implies a declining time allocation as education rises.

In addition, the model has a difficult time matching the inverted-U shape of the expenditure share allocation to TV Watching and the U shape of time allocated Child Care. Chiefly because the small differences across education groups and the small representation of TV in total expenditure and Child Care in total time use.

Table 4: Model Fit – Expenditure

Expenditure Share – Data						
Educ	Child	Non-market	TV	Social	Eat & Pcare	Hobby & Ent
1	0.011	0.674	0.039	0.085	0.099	0.091
2	0.015	0.614	0.045	0.085	0.119	0.122
3	0.020	0.577	0.042	0.084	0.141	0.136
4	0.027	0.549	0.037	0.076	0.162	0.149
Expenditure Share – Model						
Educ	Child	Non-market	TV	Social	Eat & Pcare	Hobby & Ent
1	0.013	0.655	0.031	0.087	0.107	0.107
2	0.017	0.617	0.038	0.083	0.124	0.120
3	0.018	0.599	0.042	0.082	0.132	0.126
4	0.025	0.544	0.054	0.076	0.156	0.143

Table 5: Model Fit – Time

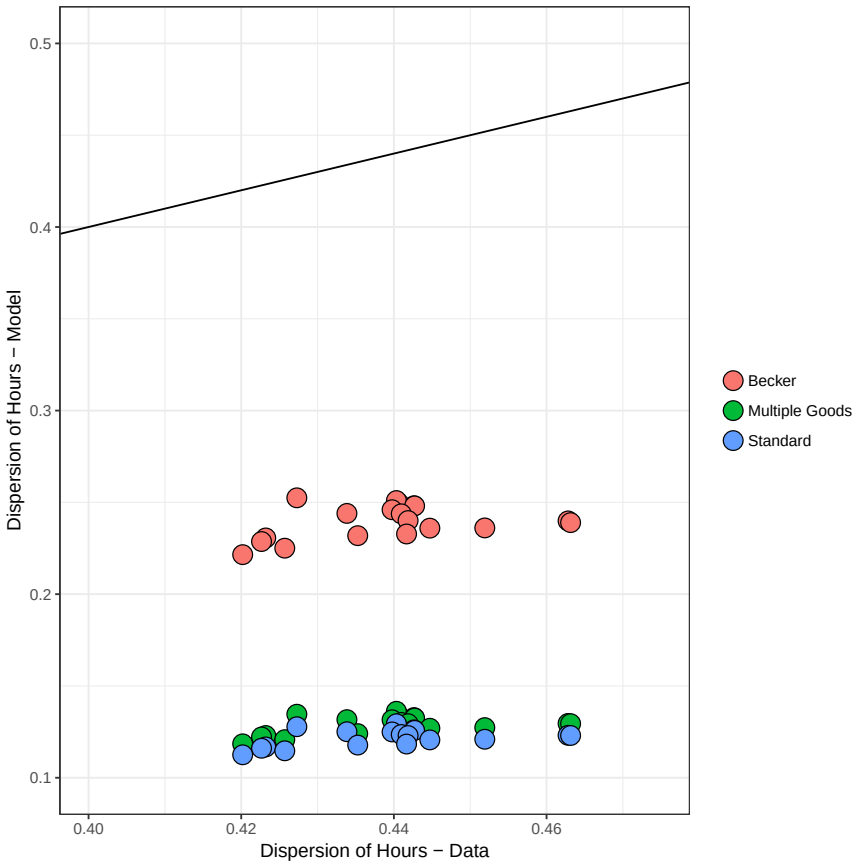
Time – Data						
Educ	Child	Non-market	TV	Social	Eat & Pcare	Hobby & Ent
1	0.047	0.173	0.203	0.064	0.102	0.069
2	0.040	0.165	0.181	0.066	0.112	0.078
3	0.042	0.160	0.148	0.067	0.119	0.085
4	0.051	0.153	0.114	0.061	0.129	0.094
Time – Model						
Educ	Child	Non-market	TV	Social	Eat & Pcare	Hobby & Ent
1	0.049	0.163	0.173	0.067	0.130	0.093
2	0.047	0.164	0.166	0.066	0.120	0.085
3	0.045	0.164	0.162	0.065	0.115	0.081
4	0.040	0.164	0.149	0.062	0.097	0.068

5 Results

5.1 Dispersion in Hours Worked

Figure 2 summarizes our main result. An additive separable framework, in which time and expenditures are perfectly substitutable, generates 30% of the dispersion of hours worked that we see in the data. The difference in hours dispersion in the standard framework and the model with multiple goods is negligible. Hours dispersion in the Beckerian framework is almost twice as large. Hours dispersion is on average 0.24 or 55% of the dispersion in the data. This finding suggests that the time and expenditures are far less than perfectly substitutable. A framework that takes this notion seriously can generate dispersion in hours work much closer to what we observe in the data.

Figure 2: Dispersion in Hours Worked: Models and Data



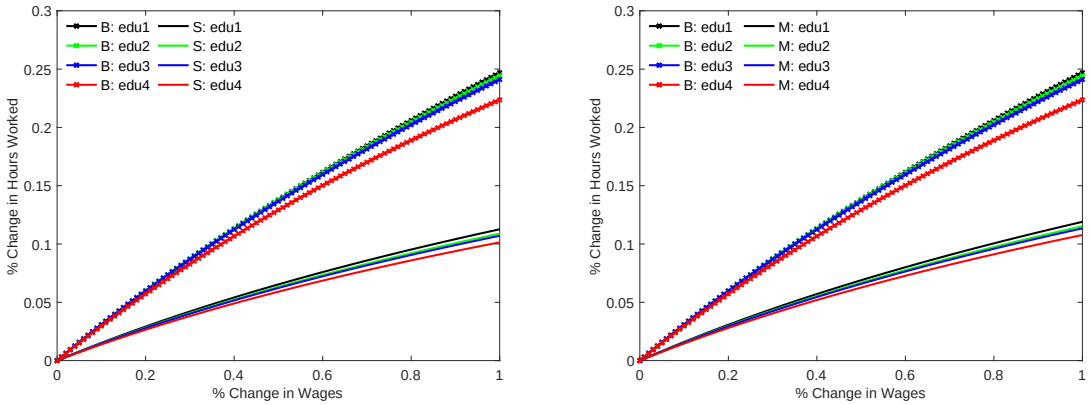
Notes: The black line corresponds to the 45-degree line.

5.2 Hours Worked and the Shadow Price of Time

To shed light on the mechanism that generates a higher dispersion of hours worked in the Beckerian framework, we perform two experiments. We change the shadow price of time for consumption activities in the Becker model and the standard model and compare the response in hours worked across the two frameworks. Notice that the shadow price of time is not the same across the two models. In the standard framework, there is only a single shadow price of time determined by the wage rate. Thus, our first experiment records changes in hours worked for a given decline in wages. Note that we choose wages in the standard framework to match the allocation of hours worked in the Beckerian framework in the baseline. Figure 3 compares the response to wage changes in the Becker model to the multiple goods model and the standard model. The responses are virtually identical if we perform the experiment with estimates derived from a model with education-specific activity prices. Figure E.6 shows the results.

The horizontal axis shows the percentage drop in wages, while the vertical axis displays the corresponding percentage change in hours worked. The baseline case

Figure 3: Response of Hours Worked to a Percentage Wage Change



(a) Becker vs. Standard

(b) Becker vs. Multiple Goods

Notes: We use parameter estimates from the model with unique prices. 'B' denotes the Beckerian framework, 'S' refers to the standard framework and 'M' to the model with multiple goods.

corresponds to the origin. We plot responses in hours worked for each education group. The response of hours worked to a change in wages is more pronounced with Beckerian preferences than with standard preferences or multiple goods preferences. While time and expenditures within a given activity are less substitutable in the Beckerian framework, the substitution parameter is almost twice as large as in the standard or multiple goods framework: 0.29 versus 0.17. This leads to much large responses in hours worked.

One caveat of the simple exercise above is that the same percentage change in wages results in different shadow prices of time across the frameworks. While the standard framework has one shadow price of time pinned down by wages, the shadow prices of time in the Beckerian framework vary across consumption activities. Wage changes can result in an aggregate change in the shadow price of time that is very different relative to the standard model. We therefore construct a measure for the relative wage that allows us to compare the effects on hours worked in a more systematic way.

We start with the Beckerian preferences and rewrite the budget constraint as follows:

$$C_j \sum_{i=1}^{6} \frac{p_i}{M_{ij} G_{ij}} = w_j (1 - \sum_{i=1}^{6} l_{ij}). \tag{4}$$

The variables M_{ij} and G_{ij} are functions of parameters, wages, prices and allocations (see Appendix C.2). We define the relative price P_j as the sum of prices of goods p_i weighted by the factor $\frac{1}{M_{ij} G_{ij}}$:

$$C_j P_j = w_j(1 - \sum_{i=1}^{6} l_{ij}). \tag{5}$$

Hence, for each education category j the left hand side represents total expenditures: an aggregate measure of consumption C_j multiplied by an aggregate price index P_j.

In a similar manner, we can rewrite the budget constraint for the standard preferences as,

$$C_j^s \frac{1}{Q_j^s} = w_j^s(1 - l_j^s), \tag{6}$$

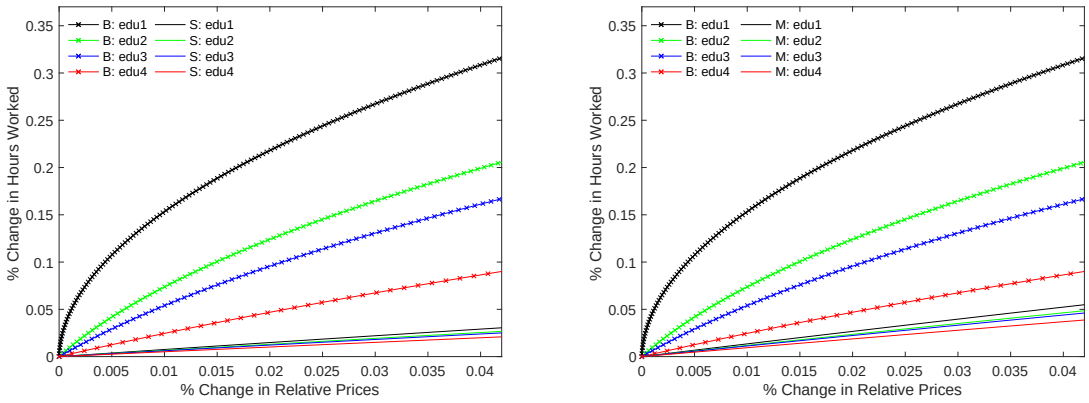
where Q_j^s is a function of parameters and the wage of group j. Defining P_j^s to be $\frac{1}{Q_j^s}$, we rewrite the constraint in a similar way as with the Beckerian preferences:

$$C_j^s P_j^s = w_j^s(1 - l_j^s). \tag{7}$$

For a more apt comparison across the two models, we now impose the same relative wage change, w/P, across models. To do so, we start by computing the change in relative wage w/P for a given change in w in the Beckerian model. Next, we find the change in w that is needed in the standard and multiple goods model to generate the same change in relative wage w/p. We repeat this exercise for wage changes in the range of 0 to 60% and for each education group. The results of this experiment are shown in Figure 4. As in the previous exercise, the change in hours worked due to the same change in relative prices is rather similar between the standard and the multiple goods model. In addition, there is little heterogeneity in the response across education groups. The Beckerian framework, on the other hand, predicts large differences in the way households of different education types respond to a change in relative prices. The response is largest for less than high school educated households and smallest for households with at least a college education. As a result, the Beckerian framework generates a much larger cross-sectional dispersion in hours worked for a given set of wages than the standard or multiple goods model.

The results are qualitatively similar once we control for education-specific prices (see Figure E.7), even though the response in hours worked is slightly lower in the Beckerian framework. However, the pronounced differences across education groups remains.

Figure 4: Response of Hours Worked to a Change in Relative Wage



(a) Becker vs. Standard

(b) Becker vs. Multiple Goods

Notes: We use parameter estimates from the model with unique prices. 'B' denotes the Beckerian framework, 'S' refers to the standard framework and 'M' to the model with multiple goods.

6 Conclusion

We provide a novel framework for analyzing how households respond to income shocks by formalizing Becker (1965)'s notion that households derive utility by combining time and expenditures. By allowing the degree of substitutability of time and expenditures to vary across consumption activities, we show that a simple static model can match the cross-sectional variation in time and expenditure allocation patterns. The framework generates dispersion in hours worked that is twice as large as compared to a framework with constant substitutability and accounts for more than 50% of the variation in the data. Our results emphasize that accounting for variations in the shadow price of time are key for explaining dispersion of hours worked in the cross-section.

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Appendix (not for publication)

A Definition of Consumption Activities

The individual data from the American Time Use Survey (ATUS) and the Consumer Expenditure Survey (CES) cannot be linked at the micro-level. We therefore impose a common structure onto both surveys to compare the time spent on household activities with their associated expenditures. First, we limit the sample in both surveys to reference persons between 21 and 65 years of age. In doing so, we try to exclude students as well as retirees, whose time allocation decisions have a strong intertemporal component to it. Second, we restrict the sample to people who are “in the labor force". In the ATUS, this includes the employed, people absent from work, as well as unemployed people either on layoff or looking for a job. The CES only reports the number of weeks the reference person or the spouse have worked within the last 12 months. If either the reference person or the spouse report to have worked at least one week, we include them in our sample.

The time use categories proposed by Aguiar and Hurst (2007) provide a natural starting point for our analysis. Three major categories account for 93% - 96% of the total time use and for 79% - 89% of total expenditures: “Market Work", “Non-market work" and “Leisure". “Non-market work" activities include home production, home ownership activities, obtaining goods and services as well as care for others. “Leisure" summarizes time spent watching TV, socializing, sleeping, eating and personal care, and hobby and entertainment. The categories “Child Care" and “Other" play a negligible role in the overall time allocation and account for at most 20% of total expenditures. The bulk of these expenditures can be attributed to education or own medical care.

To compare results across surveys, we define consumption expenditure categories that match the time use categories as closely as possible. With the exception of “Other Income-generating Activities" and “Job Search", we are able to define an expenditure category for every time use category. The CES also collects information on the purchase and sale of assets. We group information about investments into housing or the usage and purchase of vehicles into five additional categories. These expenditures are reported separately, as they cannot be linked to a particular activity. Notice that the additional expenditure categories only contain outlays related to the acquisition of new assets. Expenditures associated with the maintenance or repair of goods, that the CU already owns, are matched with a corresponding time use category.

Table A.1 summarizes and contrasts the categories for both surveys.

Category	Time Use Surveys	CES
I. Matched Time Use and Expenditure categories		
Total Market Work	Market Work Other Income-Generating Activities Job Search	Market Work
Child Care	Child Care	Child Care
Non-market Work	Core Home Production Home Ownership Obtaining goods and services Other Care	Core Home Production Home Ownership Obtaining goods and services Other Care
Leisure	Watching TV Socializing Sleep Eating and Personal Care Hobby and Entertainment	Watching TV Socializing Sleep Eating and Personal Care Hobby and Entertainment
Other	Education Civic Own Medical Unclassified	Education Own Medical
II. Additional Expenditure categories		
		Transportation Ownership Transportation Usage Housing Home Investment Real Home Investment Financial

Table A.1: **Comparison of categories across surveys**

A.1 American Time Use Survey 2003-2014

Following Aguiar, Hurst and Karabarbounis (2013), we divide the total time for every individual in the American Time Use Survey into 17 categories. These categories can be aggregated into three major time use categories: “Market Work", “Non-market Work" and “Leisure". Individuals allocate less than 7% of their time to “Child Care" and “Other" activities. The ATUS indicates whether a time diary was recorded on a weekday or a weekend (or holiday). o obtain a representative estimate of the weekly time allocated to one activity, we weight weekday records by $\frac{5}{7}$ and weekend or holiday records by $\frac{2}{7}$. Table A.2 documents the underlying ATUS activity codes for every category.

The ATUS data can be supplemented with information from the Current Population Survey (CPS). A subset of households interviewed in the CPS are selected to participate in the ATUS. If a household is selected, one individual keeps a time diary. We combine the time use data with information on household earnings from the CPS. However, the CPS interview is conducted two to five months prior to the

ATUS interview and, in some cases, might not reflect current household earnings.

Category	**ATUS activity code**
Market Work	05-01, 05-02, 05-99, 18-05-01, 18-05-02, 18-05-99
Other Income-Generating Activities	05-03, 18-05-03
Job Search	05-04, 18-05-04
Child Care	03-01, 03-02, 03-03, 04-01, 04-02, 04-03, 18-03-01, 18-03-02, 18-03-03, 18-04-01, 18-04-02, 18-04-03
Core Home Production	02-01, 02-02, 02-03 (excl. 02-03-01), 02-07, 02-08, 02-09 (excl. 02-09-03), 02-09-04, 02-99, 18-02-01, 18-02-02, 18-02-03, 18-02-07, 18-02-08, 18-02-09, 18-02-99
Home Ownership Activities	02-03-01, 02-04, 02-05, 18-02-04, 18-02-05
Obtaining Goods and Services	07, 08 (excl. 08-04), 09,10, 18-07, 18-08 (excl. 18-08-04), 18-09, 18-10
Others Care	03-04, 03-05, 03-99, 04-04, 04-05, 04-99, 18-03-04, 18-03-05, 18-03-99, 18-04-04, 18-04-05, 18-04-99
TV Watching	12-03-03, 12-03-04
Socializing	12-01, 12-02, 12-03-07, 12-05-01, 12-05-02, 16, 18-12-01, 18-12-02, 18-16
Sleep	01-01
Eating and Personal Care	01-02, 01-04, 01-05, 01-99, 11, 18-01, 18-11
Hobby and Entertainment	02-06, 02-09-03, 02-09-04, 12-03 (excl. 12-03-03 and 12-03-04), 12-03-07, 12-04, 12-05 (excl. 12-05-01 and 12-05-02), 12-99, 13, 18-02-06, 18-12 (excl. 18-12-01 and 18-12-02), 18-13
Education	06, 18-06
Civic	14, 15, 18-14, 18-15
Own Medical	01-03, 08-04, 18-08-04
Unclassified	50, 18-18, 18-19

Table A.2: **ATUS 2003-14 categorization**

A.2 Consumer Expenditure Survey

The Consumer Expenditure Survey consists of two components with separate questionnaires and independent samples. We use the Interview panel survey in which Consumer Units (CU) are interviewed once every three month over five consecutive quarters. The survey therefore records consumption expenditures for every CU over the period of one year. The data for the Interview panel is released in eight major data files for each wave separately. For this study, we make use of the FMLI and MTBI files.

To select households into our sample, we use the FMLI files which contain CU characteristics, CU income as well as earnings of the reference person and the spouse. Income data are collected on an annual basis during the second and the fifth interview only. We therefore use information from the fifth interview to

approximate labor income as well as the labor force status of the CU. We define a CU to be “in the labor force" if the reference person or the spouse report in their fifth interview that they worked at least one week during the last 12 months. If the information from the fifth interview is missing, we use the information from the second interview. Only CUs that report to be “in the labor force" are part of this study.

The CES releases detailed expenditure information in its MTBI files. Consumption and investment expenditures are organized by Universal Classification Codes (UCCs). The files contain approximately 600 different UCCs, with one record for every purchase of the CU in a given month. We re-classify these codes by expenditure purpose to construct 14 consumption expenditure categories and four investment categories. The Bureau of Labor Statistics (BLS) provides summary level variables that aggregate a certain set of UCCs. These summary variables serve as a guideline for our expenditure categories. For every summary variable, we check the underlying UCCs and, if necessary, refine the categorization. Table A.3 provides a description of the expenditures associated with each category, while table A.4 documents the corresponding UCCs.

Our derived consumption expenditure measures differ from the ones computed by the Bureau of Labor Statistics (BLS) along certain dimensions. First, we ignore any of the expenditures reported in the ITBI files. The BLS accounts for cash contributions for person in the CU (UCC 800801), gifts, contributions to charity and other organizations as well as any kind of deduction (UCC 800810-800940). Since to goal of our analysis is to match consumption expenditures to activities, we abstract from these expenditures entirely. Second, the BLS defines any investments into housing as changes in household assets. The associated expenditures are not included in total consumption expenditures. In contrast, we include a subset of these reported expenditures into our investment categories 20 and 21. Due to these differences, our derived measures for total consumption expenditures deviates from the BLS provided measure.

The expenditure categories without a time-use counterpart (category 17 to 21) can contain UCCs that represent movements in asset positions. This is typically the case for category 20 and 21, which capture real and financial investment into housing.

CES Category	**Description of variables**
I. Expenditures	
1. Market Work	Office furniture for home use; suits and uniforms for men and women; personal digital assistants; meals received as pay; occupational expenses

2. Child Care	Infant's equipment; babysitting and child day care; school books for day care centers and nursery schools; school meals for preschool and school age children
3. Core Home Production	Utilities, fuels and public services (excl. telephone services); household textiles (excl. bedroom linens); furniture (excl. mattresses and new springs); major appliances; small appliances; non-permanent carpet squares; blinds; clocks; lamps; decorative items; kitchen utensils; household services; rental of furniture; rental of household and office equipment for non-business use; management fees; other apparel products and services (excl. watches and jewelry, clothing rental); food at home (excl. food or board at school); other household expenses (excl. computers and software for non-business use)
4. Home Ownership	Maintenance, repairs and other expenses (excl. homeowner's insurance, parking and management fees); floor coverings (excl. non-permanent carpet squares); installed and non-installed wall-to-wall carpeting; building an attic, a pool or finishing the basement
5. Clothing	Clothing for men and women (excl. suits and uniforms, nightwear, sports coats, active sportswear, other sportswear and costumes); clothing for boys and girls (excl. nightwear, active sportswear and costumes); clothing for children (excl. sleeping garments); footwear; clothing rental
6. Other Care	Care for invalids or elderly persons; adult care centers; care in nursing home (net outlay)
7. TV	Cable services; TVs; video streaming; satellite dishes; repair, rental and installation of TV and satellite equipment
8. Socializing	Catered affairs; live entertainment; party supplies; telephone services and devices; watches; jewelry; dating services
9. Sleep	Bedroom linens; mattresses and new springs; nightwear
10. Eating and Personal Care	Personal care appliances and services; rental and repair of personal care appliances; food and beverages during out-of-town trips; alcoholic beverages; dining out at restaurants
11. Hobby and Entertainment	Trip expenditures on lodging; satellite radio services; video, radio and sound equipment; records, CDs, videos and audio tapes; streaming audio files; outdoor equipment; sport coats, sportswear and costumes; travel items; rental or purchase of trailer-type camper, boat or aircraft; reading (excl. encyclopedia); miscellaneous entertainment outlays; pets, toys and playground equipment; musical instruments; photographic equipment; event fees and admission; computers and software for non-business use; tobacco and smoking supplies

12. Education	Food or board at school; housing at school; private school bus; educational expenses such as tuition and school books (excl. books for day care center); encyclopedia; test prep and tutoring services; support for college students
13. Own Medical	prescription drugs; health insurance; medical services (excl. care in nursing home); medical supplies
14. Transportation Usage	Gasoline and motor oil, maintenance and repairs and vehicle insurance for any type of vehicle; public transportation; vehicle registration; driver's license; vehicle inspection; auto and truck or van rental; lease charges; parking fees; tolls; vehicle equipment and services; GPS; automobile club membership
II. Investments	
15. Transportation Ownership	Outlays for new, used and other vehicle purchases; outlays for motored and non-motored recreational vehicles
16. Housing	Rent of dwelling; ground rent; fire and extended coverage insurance; homeowners' insurance; property taxes; mortgage interest; parking; rent as pay
17. Home Investment Real	Original carpeting; addition, alteration or new construction of dwellings; New dishwasher, garbage disposal or range hood; Management, security, parking; special assessment fees
18. Home Investment Financial	Closing costs, special mortgage payments; reduction of mortgage principal; reduction of principal on home equity loan; special assessment for roads, streets

Table A.3: **Definition of CES categories**

CES Category	**Universal Classification Codes (UCCs)**
I. Expenditures	
1. Market Work	320901 360110 360901 380510 380902 690115 800700 900002
2. Child Care	320130 340211 340212 660901 670310 660900 790430

3. Core Home Production	230117 230118 250111 250112 250113 250114 250211 250212 250213 250214 250221 250222 250223 250224 250901 250902 250903 250904 250911 250912 250913 250914 260111 260112 260113 260114 260211 260212 260213 260214 270211 270212 270213 270214 270411 270412 270413 270414 270901 270902 270903 270904 280110 280130 280210 280220 280230 280900 290120 290210 290310 290320 290410 290420 290430 290440 300111 300112 300211 300212 300221 300222 300311 300312 300321 300322 300331 300332 300411 300412 320110 320111 320120 320210 320220 320231 320233 320310 320320 320330 320340 320350 320360 320370 320420 320511 320512 320521 320522 320902 320903 320904 340310 340420 340510 340520 340530 340620 340630 340901 340903 340904 340907 340908 340911 340912 340914 340915 420110 420120 440110 440120 440130 440150 440210 440900 690220 690241 690242 690243 690244 690245 790210 790230 990900
4. Home Ownership	230112 230113 230114 230115 230121 230122 230123 230131 230132 230133 230134 230141 230142 230150 230151 230152 230901 230902 240111 240112 240113 240121 240122 240123 240211 240212 240213 240214 240221 240222 240223 240311 240312 240313 240321 240322 240323 320161 320162 320163 320410 320611 320612 320613 320621 320622 320623 320631 320632 320633 330511 340410 790690 990920 990930 990940 990950
5. Clothing	360210 360311 360312 360330 360340 360410 360511 360512 360513 370110 370120 370130 370211 370213 370220 370311 370312 370313 370314 370903 380110 380210 380311 380312 380313 380320 380331 380332 380333 380420 380430 380901 390110 390120 390210 390221 390222 390223 390321 390322 390901 400110 400210 400220 400310 410110 410120 410130 410901 440140
6. Other Care	340906 340910 570220
7. TV	270310 310110 310120 310130 310140 310240 310334 340610 340902 690320 690330
8. Socializing	190902 270101 270102 270103 270104 270105 320232 430110 430120 680310 680320 680904 690210
9. Sleep	280120 290110 360320 370212 380410 390310 410140
10. Eating and Personal Care	640130 640420 650110 650210 650310 650900 190903 190904 200900 790310 790320 790330 790410 790420

11. Hobby and Entertainment	210210 270311 310210 310220 310230 310311 310312 310313 310314 310320 310330 310333 310340 310341 310342 310350 320150 340905 360120 360350 360902 370902 370904 380340 380903 390230 390902 430130 520901 520902 520903 520904 520905 520906 520907 590111 590112 590211 590212 590220 590230 590310 590410 600110 600121 600122 600127 600128 600132 600138 600141 600142 600143 600144 600210 600310 600410 600420 600430 600901 600902 610110 610120 610130 610140 610210 610230 610320 610900 620111 620115 620121 620122 620211 620212 620221 620222 620310 620320 620330 620410 620420 620903 620904 620905 620906 620908 620909 620912 620916 620919 620921 620922 620926 620930 630110 630210 680905 690111 690112 690113 690114 690116 690310 690340 690350 690230
12. Education	190901 210310 530902 660110 660210 660310 660410 660902 670110 670210 670410 670901 670902 670903 800804
13. Own Medical	540000 550110 550320 550330 550340 560110 560210 560310 560330 560400 570110 570111 570210 570230 570240 570901 570903 580111 580112 580113 580114 580311 580312 580400 580901 580903 580904 580905 580906 580907
14. Transportation Usage	450311 450411 470111 470112 470113 470211 470212 470220 480110 480213 480214 490110 490211 490212 490221 490231 490232 490311 490312 490313 490314 490318 490319 490411 490412 490413 490501 490502 490900 500110 520110 520111 520112 520310 520410 520511 520512 520521 520522 520531 520532 520542 530110 530210 530311 530312 530411 530412 530510 530901 480212 480215 520541 520550 520560 620113
II. Investments	
15. Transportation Ownership	870101 870102 870103 870104 870201 870202 870203 870204 870301 870302 870303 870304 870401 870402 870403 870404 870501 870502 870503 870504 870605 870606 870607 870608 870701 870702 870703 870704 870801 870802 870803 870804
16. Housing	210110 210901 210902 220111 220112 220121 220122 220211 220212 220311 220312 220901 220902 350110 800710
17. Home Investment Real	220511 220512 220513 220611 220612 220615 220616 220614 790600 790610 790611 790620 790630 790640
18. Home Investment Financial	790730 790910* 790920* 790940* 810301 810302 830101* 830102* 830201* 830202* 830203* 830204* 840101 840102 880120* 880220* 880320*

Table A.4: **CES categorization**

Notes: UCCs change across survey waves. In every quarter, UCCs might be discontinued while new ones are potentially added to the survey. In addition, new UCCs may not be represented in all quarters. This table reports the UCCs for all survey waves combined. We exclude UCC 790220 (Food and nonalcoholic beverage purchases at grocery stores) as it is a subset of UCC 790210 (Total purchases at grocery stores). We also exclude UCC 790240 (Average food and non-alcoholic beverage expenses) to avoid double counting of expenditures. To approximate expenditures related to the purchase of vehicles, we use UCCs 870101-870804. Since UCCs 450110-460908 also report costs associated with vehicle acquisitions, we drop them. A small set of expenditures are reported as negative values. The associated UCCs are indicated with a star. Hence, all expenditures in category 18 are converted to negative values such that expenses do not cancel out when being summed up.

A.3 Linking the results from both surveys

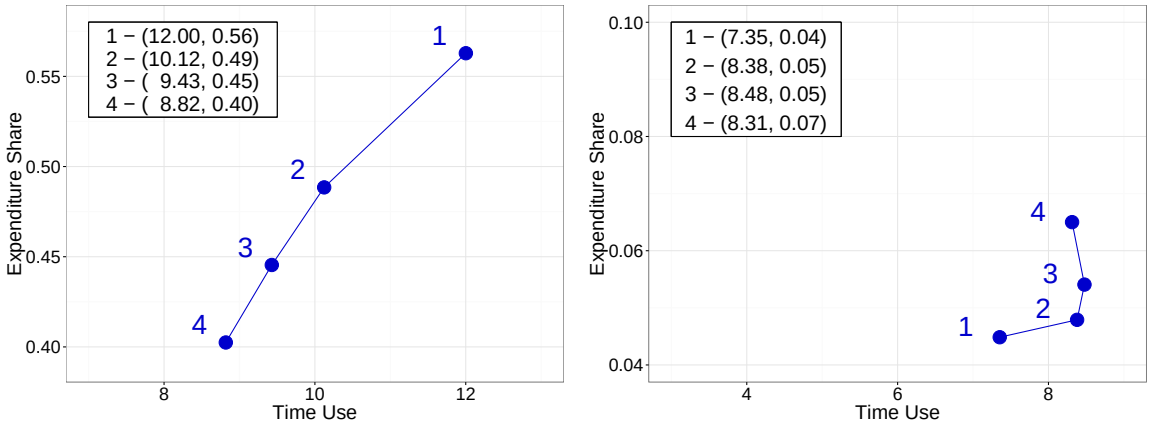
We compare the time allocated to a particular activity and the associated expenditures by partitioning the data of both surveys along the same dimensions. First, we split both samples into five age groups: 21-29, 30-39, 40-49, 50-59, 60-65. The CES reports the age of the reference person in the FMLI files. We merge the data with the MTBI files to compute average expenditures within each age group. In the ATUS, we use the age of the reference person.

Next, we structure the data according to the highest level of educational attainment: less than high school, high school, some college, bachelor, master or doctorate. In both the ATUS and the CES, the highest level of educational attainment of the reference person determines which education bin the CU is assigned to.

Third, we partition the data by household income. In the ATUS, the combined income of all family members during the last 12 month is reported in bins and not as a continuous variable. We therefore use a two step procedure to create four income groups. We limit household income to four groups because the Time Use survey in 1985 divides income into four income groups only. Notice that the 1990 Time Use survey does not report information on household income at all. We eliminate this survey from the part of the analysis that requires household income information. To construct income groups, we first use the continuous information on family income before taxes from the CEX to construct the 25th, 50th and 75th income percentile in each survey year, accounting for survey weights.

Following Aguiar and Hurst (2007), we construct constant population weights to account for changes in the demographic composition of the population between 1960 and 2010. First, we pool data from all survey years for each survey. Then, we divide both surveys into 36 demographic cells using five age groups (21-29, 30-39, 40-49, 50-59, 60-65), four education groups (Less than high school, High school,

Figure B.1: Non-Market Work by Education



(a) Core Home Production (b) Other Non-Market Work

Notes: Households are grouped into four education categories: 1 - <HS, 2 - HS, 3 - SC, 4 - Col. Time use respondents are classified according to their individual education type. Households in the CE are grouped depending on the education of the reference person. Consumption expenditures are expressed as a fraction of core expenditures.

Some college, College and above) and whether or not a child lives in the household. Due to the limited number of observations of households that have a child present at the age of 60-65, we do not distinguish these households with respect to the presence of a child. The ATUS interviews one individual of each household, so we simply use the respondent's information to create the demographic cells. The CEX reports expenditures at the household level. We apply the OECD equivalence scale (Oxford scale) to the CEX data to derive the expenditures for an average adult in the household. Next, we create 36 demographic cells according to the characteristics outlined above.

B Additional Data Facts

C Model Solution

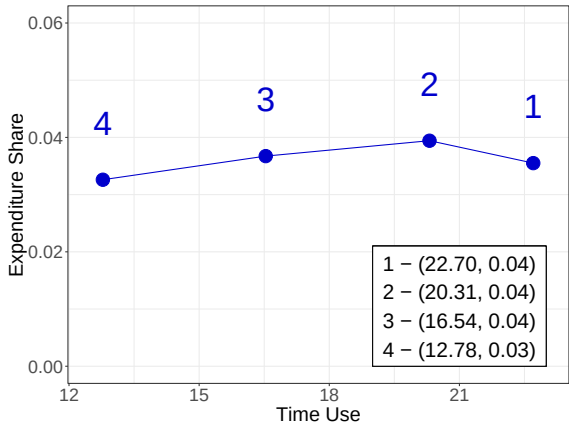
C.1 Beckerian Preferences

The utility function is $U(C_j) = log(C_j)$, where

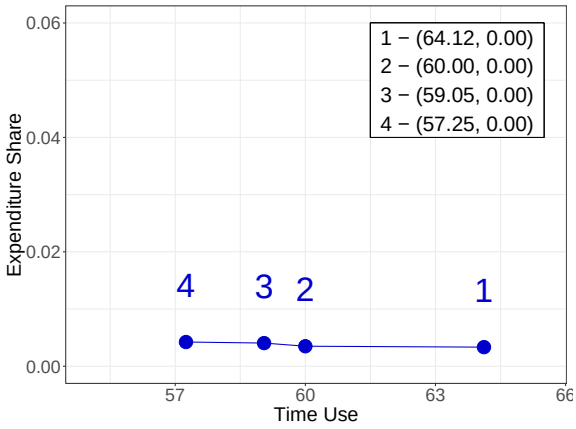
$$C_j = \left(\sum_i \alpha_i c_{ij}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \tag{8}$$

$$c_{ij} = \left(\kappa_i x_{ij}^{\frac{\xi_i-1}{\xi_i}} + (1-\kappa_i) \ell_{ij}^{\frac{\xi_i-1}{\xi_i}} \right)^{\frac{\xi_i}{\xi_i-1}} \tag{9}$$

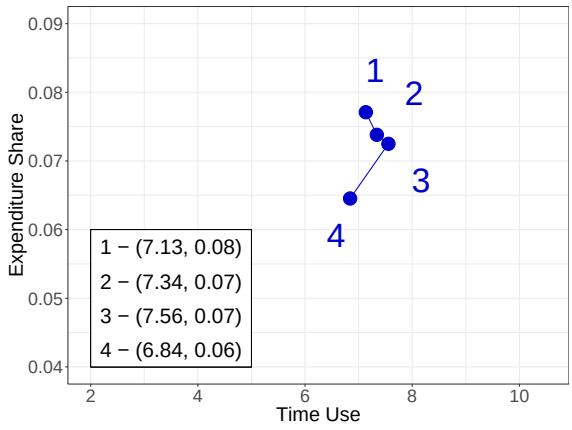
Figure B.2: Leisure Categories By Education



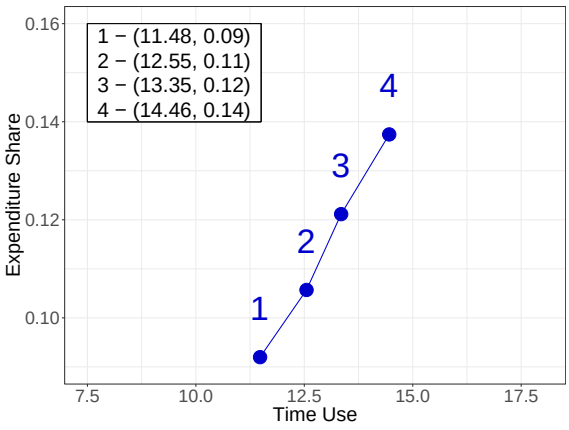
(a) Watching TV



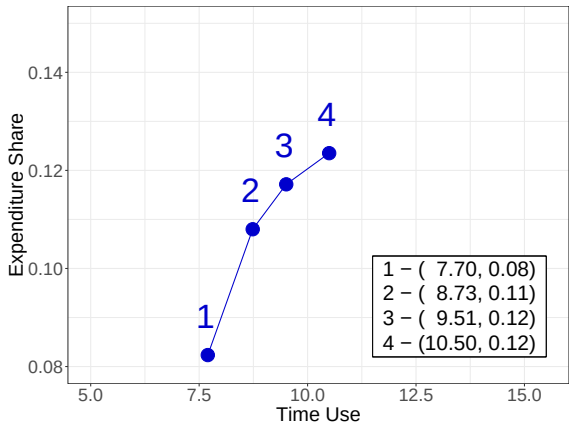
(b) Sleep



(c) Socializing

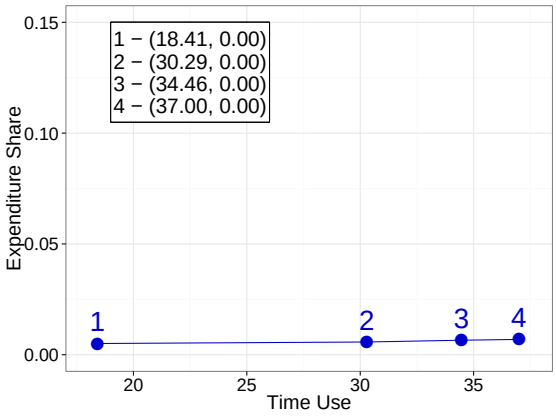


(d) Eating and Personal Care

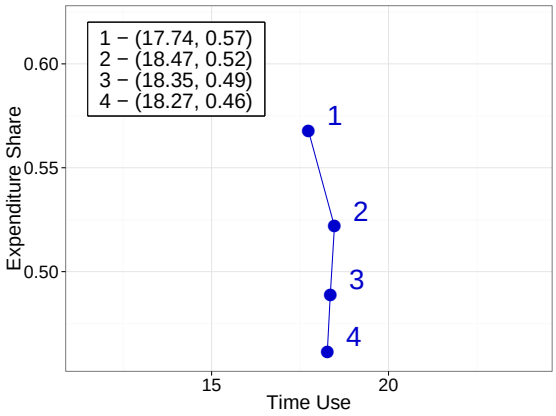


(e) Hobby and Entertainment

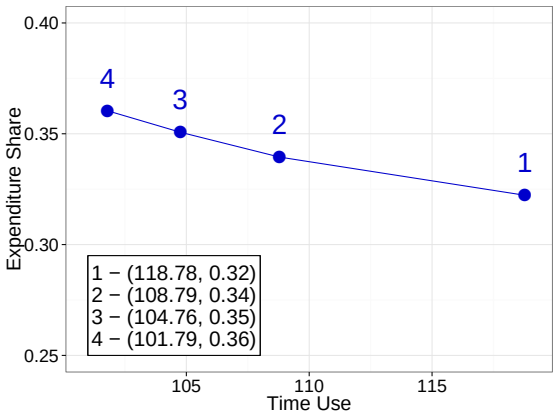
Figure B.3: Major Categories by Income



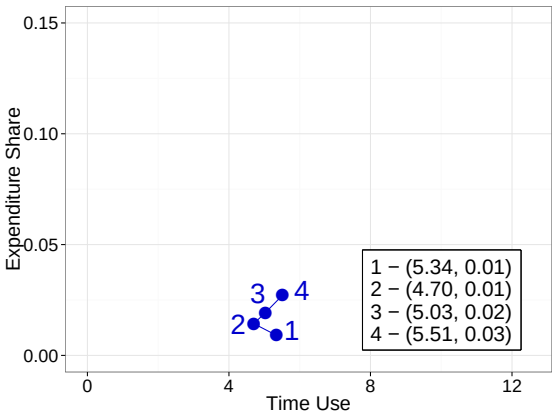
(a) Market Work



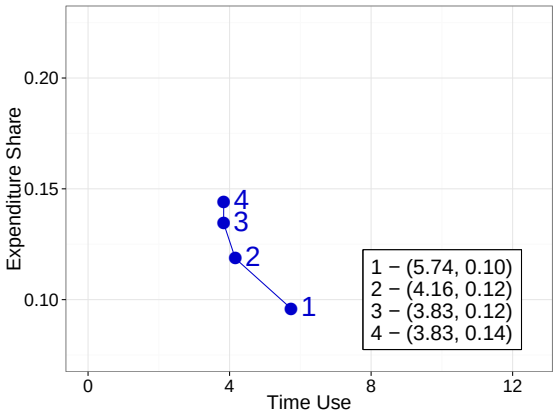
(b) Non-Market Work



(c) Leisure

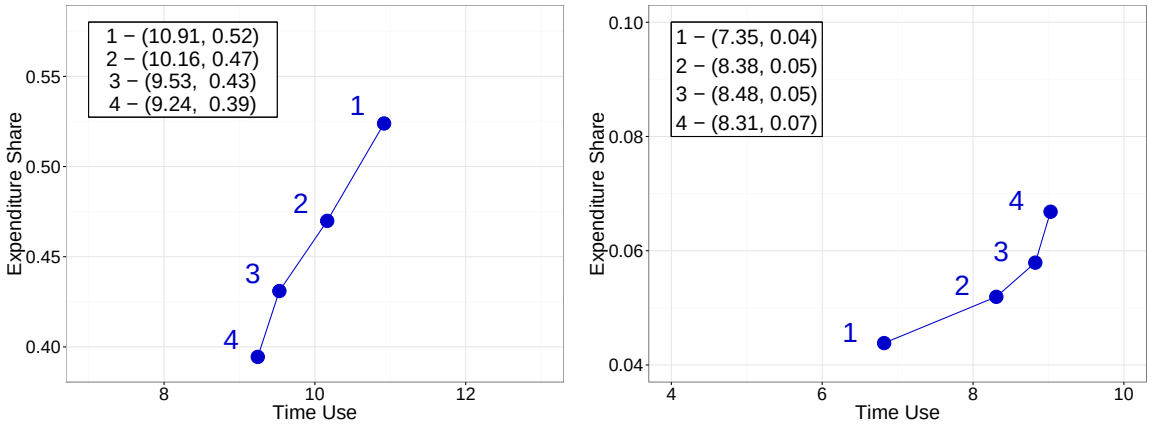


(d) Childcare



(e) Other

Figure B.4: Non-Market Work Categories by Income



(a) Core Home Production (b) Other Non-Market Work

The budget constraint is:

$$\sum_i p_{ij} x_{ij} = w_j (1 - \sum_i \ell_{ij}). \tag{10}$$

Each type of household maximizes utility subject to the budget constraint. Let λ_j be the lagrangian multiplier. The F.O.Cs are as follows:

$$\frac{\partial U}{\partial c_{ij}} \frac{\partial c_{ij}}{\partial x_{ij}} = \lambda_j p_{ij} \tag{11}$$

$$\frac{\partial U}{\partial c_{ij}} \frac{\partial c_{ij}}{\partial \ell_{ij}} = \lambda_j w_j \tag{12}$$

Taking the ratio between these two equations gives:

$$\frac{\ell_{ij}}{x_{ij}} = \left(\frac{p_{ij}}{w_j}\right)^{\xi_i} \left(\frac{1-\kappa_i}{\kappa_i}\right)^{\xi_i}. \tag{13}$$

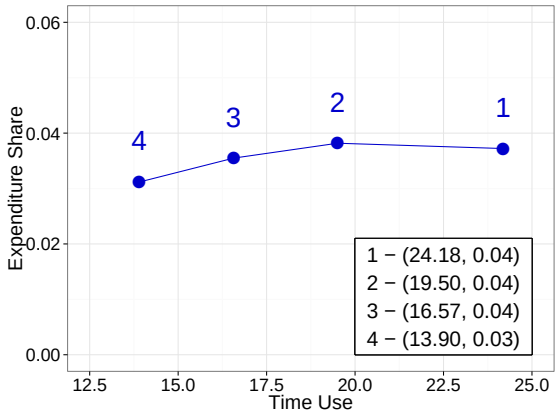
Simple manipulations of the definition of c_{ij} gives:

$$c_{ij} = x_{ij} \kappa_i^{\frac{\xi_i}{\xi_i - 1}} \left(1 + \frac{1-\kappa_i}{\kappa_i} \left(\frac{\ell_{ij}}{x_{ij}}\right)^{\frac{\xi_i - 1}{\xi_i}}\right)^{\frac{\xi_i}{\xi_i - 1}}. \tag{14}$$

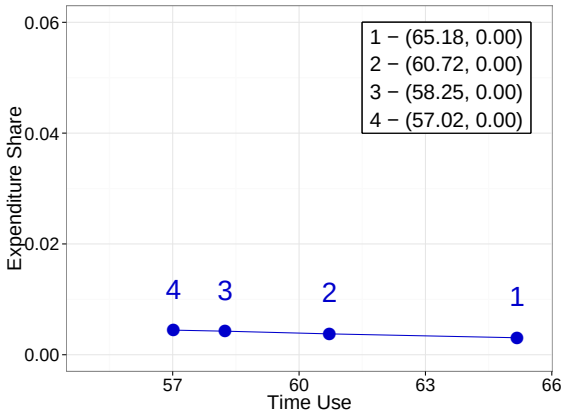
Plugging equation 13 into the above equation gives:

$$c_{ij} = x_{ij} \kappa_i^{\frac{\xi_i}{\xi_i - 1}} \left(1 + \left(\frac{1-\kappa_i}{\kappa_i}\right)^{\xi_i} \left(\frac{p_{ij}}{w_j}\right)^{\xi_i - 1}\right)^{\frac{\xi_i}{\xi_i - 1}} \tag{15}$$

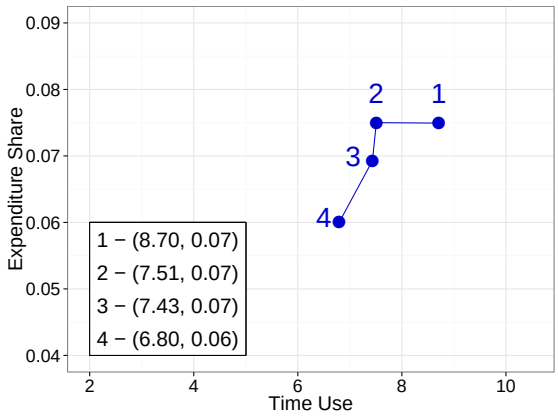
Figure B.5: Leisure Categories By Income



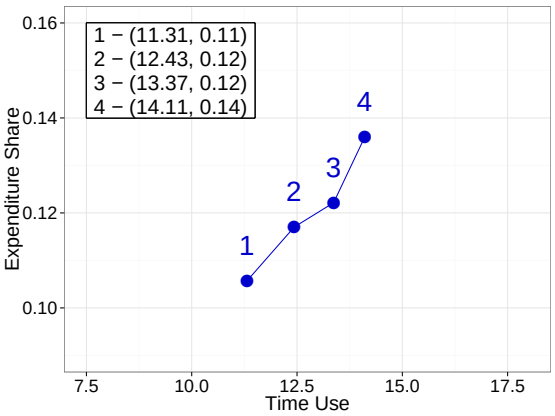
(a) Watching TV



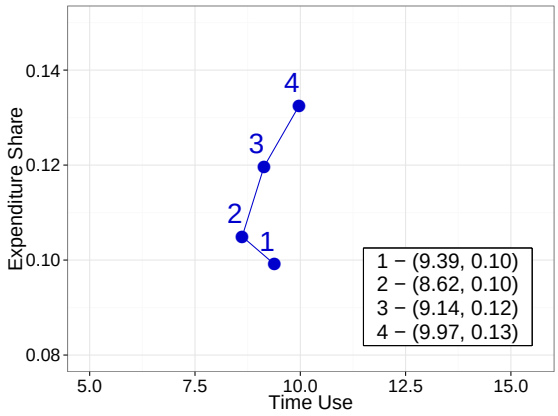
(b) Sleep



(c) Socializing



(d) Eating and Personal Care



(e) Hobby and Entertainment

Define $M_{ij} = \kappa_i^{\frac{\zeta_i}{\zeta_i-1}} \left(1 + (\frac{1-\kappa_i}{\kappa_i})^{\zeta_i} (\frac{p_{ij}}{w_j})^{\zeta_i - 1}\right)^{\frac{\zeta_i}{\zeta_i-1}}$. We have $c_{ij} = M_{ij} x_{ij}$.

From equation 11, we can derive the following equation between activity i and activity 1:

$$\frac{\frac{\partial U}{\partial c_{1j}} \frac{\partial c_{1j}}{\partial x_{1j}}}{\frac{\partial U}{\partial c_{ij}} \frac{\partial c_{ij}}{\partial x_{ij}}} = \frac{p_{1j}}{p_{ij}}. \tag{16}$$

Plugging in the partial derivatives gives:

$$\frac{\alpha_1 c_{1j}^{\frac{-1}{\rho}} (\frac{c_{1j}}{x_{1j}})^{\frac{1}{\zeta_1}} \kappa_1}{\alpha_i c_{ij}^{\frac{-1}{\rho}} (\frac{c_{ij}}{x_{ij}})^{\frac{1}{\zeta_i}} \kappa_i} = \frac{p_{1j}}{p_{ij}}. \tag{17}$$

Plugging $c_{ij} = M_{ij} x_{ij}$ into the above equation gives:

$$\frac{x_{ij}}{x_{1j}} = \left(\frac{p_{1j}}{p_{ij}}\right)^{\rho} \left(\frac{\alpha_i \kappa_i}{\alpha_1 \kappa_1}\right)^{\rho} \frac{M_{ij}^{\frac{\rho-\zeta_i}{\zeta_i}}}{M_{1j}^{\frac{\rho-\zeta_1}{\zeta_1}}}. \tag{18}$$

Define $N_{i1j} = \left(\frac{p_{1j}}{p_{ij}}\right)^{\rho} \left(\frac{\alpha_i \kappa_i}{\alpha_1 \kappa_1}\right)^{\rho} \frac{M_{ij}^{\frac{\rho-\zeta_i}{\zeta_i}}}{M_{1j}^{\frac{\rho-\zeta_1}{\zeta_1}}}$. Then, $x_{ij} = N_{i1j} x_{1j}$. This and equations (13) give ℓ_{ij} as a function of x_{1j}:

$$\ell_{ij} = \left(\frac{p_{ij}}{w_j}\right)^{\zeta_i} \left(\frac{1-\kappa_i}{\kappa_i}\right)^{\zeta_i} N_{i1j} x_{1j}. \tag{19}$$

The budget constraint can be rewritten as follows:

$$x_{1j} \sum_i p_{ij} \frac{x_{ij}}{x_{1j}} = w_j \left(1 - \sum_i \ell_{ij}\right). \tag{20}$$

$$x_{1j} \sum_i p_{ij} N_{i1j} = w_j \left[1 - \sum_i \left(\frac{p_{ij}}{w_j}\right)^{\zeta_i} \left(\frac{1-\kappa_i}{\kappa_i}\right)^{\zeta_i} N_{i1j} x_{1j}\right]. \tag{21}$$

Solve x_{1j} from the above equation gives:

$$x_{1j} = \frac{w_j}{\sum_i p_{ij} N_{i1j} + w_j \sum_i \left(\frac{p_{ij}}{w_j}\right)^{\zeta_i} \left(\frac{1-\kappa_i}{\kappa_i}\right)^{\zeta_i} N_{i1j}} \tag{22}$$

C.2 Deriving the Aggregate Price

Using $c_{ij} = M_{ij}x_{ij}$ and (18):

$$\frac{c_{ij}}{c_{1j}} = \left(\frac{p_{1j}}{p_{ij}}\right)^{\rho} \left(\frac{\alpha_i\kappa_i}{\alpha_1\kappa_1}\right)^{\rho} \frac{M_{ij}^{\frac{\rho}{\xi_i}}}{M_{1j}^{\frac{\rho}{\xi_1}}}. \tag{23}$$

The ratio for consumption between any two activities will have a similar form as (23). C_j can be rewritten as follows:

$$C_j = \left[\alpha_1 c_{1j}^{\frac{\rho-1}{\rho}} \sum_i \frac{\alpha_i}{\alpha_1}\left(\frac{c_{ij}}{c_{1j}}\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}} \tag{24}$$

Using (23), C_j can be further rewritten as:

$$C_j = \alpha_1^{\frac{\rho}{\rho-1}} \left[\sum_i \left(\frac{\alpha_i}{\alpha_1}\right)^{\rho} \left(\frac{p_{1j}\kappa_i M_{ij}^{\frac{1}{\xi_i}}}{p_{ij}\kappa_1 M_{1j}^{\frac{1}{\xi_1}}}\right)^{\rho-1}\right]^{\frac{\rho}{\rho-1}} c_{1j}. \tag{25}$$

Let $G_{1j} = \alpha_1^{\frac{\rho}{\rho-1}} \left[\sum_i \left(\frac{\alpha_i}{\alpha_1}\right)^{\rho} \left(\frac{p_{1j}\kappa_i M_{ij}^{\frac{1}{\xi_i}}}{p_{ij}\kappa_1 M_{1j}^{\frac{1}{\xi_1}}}\right)^{\rho-1}\right]^{\frac{\rho}{\rho-1}}$. We have $C_j = G_{1j}c_{1j}$. Similarly $C_j = G_{ij}c_{ij}$ where G_{ij} has a similar form as G_{1j}.

Using $C_j = G_{ij}c_{ij}$ and $c_{ij} = M_{ij}x_{ij}$, the budget constraint can be written as

$$\sum_i p_{ij}x_{ij} \equiv \sum_i p_{ij}\frac{C_j}{M_{ij}G_{ij}} = w_j(1 - \sum_i \ell_{ij}). \tag{26}$$

$$C_j \sum_i \frac{p_{ij}}{M_{ij}G_{ij}} = w_j(1 - \sum_i \ell_{ij}). \tag{27}$$

Define the aggregate price $P_j = \sum_i \frac{p_{ij}}{M_{ij}G_{ij}}$. Because M_{ij} depends on the wage rate of education group j, P_j will also be education specific.

C.3 Standard Preferences – CES

The utility function is $U(C_j^s) = log(C_j^s)$, where

$$C_j^s = \left(\phi(x_j^s)^{\frac{\sigma-1}{\sigma}} + (1-\phi)(\ell_j^s)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{28}$$

Normalize the price of x_j^s to one. The budget constraint is

$$x_j^s = w_j(1 - \ell_j^s) \tag{29}$$

Let λ_j^s be the lagrange multiplier. The first order conditions are:

$$(C_j^s)^{\frac{1}{\sigma}}\phi(x_j^s)^{-\frac{1}{\sigma}} = \lambda_j^s \tag{30}$$

$$(C_j^s)^{\frac{1}{\sigma}}(1-\phi)(\ell_j^s)^{-\frac{1}{\sigma}} = \lambda_j^s w_j \tag{31}$$

The ratio between these two equations gives:

$$\frac{\ell_j^s}{x_j^s} = \left(\frac{1}{w_j}\right)^{\sigma}\left(\frac{1-\phi}{\phi}\right)^{\sigma} \tag{32}$$

Plug equation (32) into the budget constraint gives:

$$x_j^s = \frac{w_j}{1+(w_j)^{1-\sigma}\left(\frac{1-\phi}{\phi}\right)^{\sigma}} \tag{33}$$

C.4 Deriving the Aggregate Price

Plug equation (32) into the definition of C_j^s:

$$C_j^s = \phi^{\frac{\sigma}{\sigma-1}}\left[1+\left(\frac{1-\phi}{\phi}\right)^{\sigma}\left(\frac{1}{w_j}\right)^{\sigma-1}\right]^{\frac{\sigma}{\sigma-1}} x_j^s \tag{34}$$

Define $Q_j^s = \phi^{\frac{\sigma}{\sigma-1}}\left[1+\left(\frac{1-\phi}{\phi}\right)^{\sigma}\left(\frac{1}{w_j}\right)^{\sigma-1}\right]^{\frac{\sigma}{\sigma-1}}$. Then, $C_j^s = Q_j^s x_j^s$. Define $P_j^s = \frac{1}{Q_j^s}$. We can then rewrite the budget constraint as:

$$P_j^s C_j^s = \frac{C_j^s}{Q_j^s} = x_j^s = w_j(1-\ell_j^s) \tag{35}$$

C.5 Standard Preferences with Multiple Goods – CES

The utility function is $U(C_j^s) = log(C_j^s)$, where

$$C_j^s = \left(\phi(X_j^s)^{\frac{\sigma-1}{\sigma}} + (1-\phi)(\ell_j^s)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{36}$$

$$X_j^s = \left(\sum_i \mu_i (x_{ij}^s)^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}} \tag{37}$$

The budget constraint is:

$$\sum_i p_{ij} x_{ij}^s = w_j(1-\ell_j^s). \tag{38}$$

Let λ_j^s be the lagrange multiplier. The first order conditions are given by:

$$\frac{\partial U}{C_j^s}\frac{\partial C_j^s}{\partial X_j^s}\frac{\partial X_j^s}{\partial x_{ij}^s} = \lambda_j^s p_{ij} \tag{39}$$

$$\frac{\partial U}{C_j^s}\frac{\partial C_j^s}{\partial \ell_j^s} = \lambda_j^s w_j \tag{40}$$

Using (39) between activity i and activity 1, $\frac{x_{ij}^s}{x_{1j}^s}$ can be derived as follows.

$$\frac{\frac{\partial X_j^s}{\partial x_{1j}^s}}{\frac{\partial X_j^s}{\partial x_{ij}^s}} = \frac{\mu_1 (x_{1j}^s)^{-\frac{1}{\eta}}}{\mu_i (x_{ij}^s)^{-\frac{1}{\eta}}} = \frac{p_{1j}}{p_{ij}}, \tag{41}$$

$$\frac{x_{ij}^s}{x_{1j}^s} = \left(\frac{p_{1j}}{p_{ij}}\right)^{\eta}\left(\frac{\mu_i}{\mu_1}\right)^{\eta}. \tag{42}$$

Plugging (42) into the expression for X_j^s gives:

$$X_j^s = \mu_1^{\frac{\eta}{\eta-1}}\left[\sum_i \left(\frac{\mu_i}{\mu_1}\right)^{\eta}\left(\frac{p_{1j}}{p_{ij}}\right)^{\eta-1}\right]^{\frac{\eta}{\eta-1}} x_{1j}^s. \tag{43}$$

Define $M_j^s = \mu_1^{\frac{\eta}{\eta-1}}\left[\sum_i \left(\frac{\mu_i}{\mu_1}\right)^{\eta}\left(\frac{p_{1j}}{p_{ij}}\right)^{\eta-1}\right]^{\frac{\eta}{\eta-1}}$. Hence $X_j^s = M_j^s x_{1j}^s$.

Taking ratio between (39) for activity 1 and (40) gives:

$$\frac{\frac{\partial C_j^s}{\partial X_j^s}\frac{\partial X_j^s}{\partial x_{1j}^s}}{\frac{\partial C_j^s}{\partial \ell_j^s}} = \frac{\phi (X_j^s)^{-\frac{1}{\sigma}}\mu_1\left(\frac{X_j^s}{x_{1j}^s}\right)^{\frac{1}{\eta}}}{(1-\phi)(\ell_j^s)^{-\frac{1}{\sigma}}} = \frac{p_{1j}}{w_j}, \tag{44}$$

$$\ell_j^s = \left(\frac{p_{1j}}{w_j}\right)^{\sigma}\left(\frac{1-\phi}{\phi\mu_1}\right)^{\sigma}(M_j^s)^{\frac{\eta-\sigma}{\eta}} x_{1j}^s. \tag{45}$$

Plugging (42) and (45) into the budget constraint gives:

$$x_{1j}^s = \frac{w_j}{w_j\left(\frac{p_{1j}}{w_j}\right)^{\sigma}\left(\frac{1-\phi}{\phi\mu_1}\right)^{\sigma}(M_j^s)^{\frac{\eta-\sigma}{\eta}} + \sum_i p_{ij}\left(\frac{p_{1j}}{p_{ij}}\right)^{\eta}\left(\frac{\mu_i}{\mu_1}\right)^{\eta}}. \tag{46}$$

C.6 Derive the Aggregate Price

Plugging (45) and $X_j^s = M_j^s x_{1j}^s$ into the expression for C_j^s gives:

$$C_j^s = \phi^{\frac{\sigma}{\sigma-1}} \left[1 + \left(\frac{1-\phi}{\phi} \right)^{\sigma} \mu_1^{1-\sigma} \left(\frac{p_{1j}}{w_j} \right)^{\sigma-1} (M_j^s)^{\frac{1-\sigma}{\eta}} \right]^{\frac{\sigma}{\sigma-1}} M_j^s x_{1j}^s. \tag{47}$$

Define $G_j^s = \phi^{\frac{\sigma}{\sigma-1}} \left[1 + \left(\frac{1-\phi}{\phi} \right)^{\sigma} \mu_1^{1-\sigma} \left(\frac{p_{1j}}{w_j} \right)^{\sigma-1} (M_j^s)^{\frac{1-\sigma}{\eta}} \right]^{\frac{\sigma}{\sigma-1}} M_j^s$. Hence $x_{1j}^s = \frac{C_j^s}{G_j^s}$ and $x_{ij}^s = \frac{C_j^s}{G_j^s} \left(\frac{p_{1j}}{p_{ij}} \right)^{\eta} \left(\frac{\mu_i}{\mu_1} \right)^{\eta}$. The budget constraint can then be rewritten as:

$$C_j^s \sum_i \frac{p_{ij}}{G_j^s} \left(\frac{p_{1j}}{p_{ij}} \right)^{\eta} \left(\frac{\mu_i}{\mu_1} \right)^{\eta} = w_j (1 - \ell_j^s). \tag{48}$$

Define the aggregate price as $P_j^s = \sum_i \frac{p_{ij}}{G_j^s} \left(\frac{p_{1j}}{p_{ij}} \right)^{\eta} \left(\frac{\mu_i}{\mu_1} \right)^{\eta}$.

D Parameter Estimates

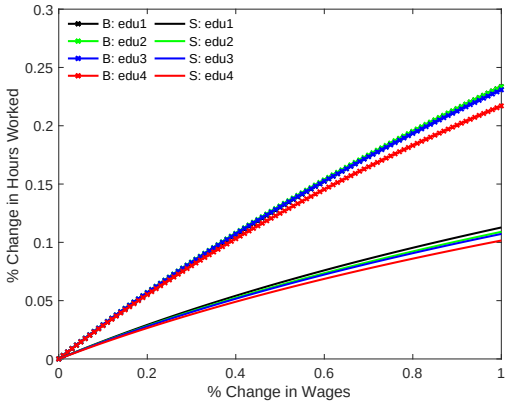
Table D.5: Parameter Estimates

	Child	Non-market	TV	Social	Eat & Pcare	Hobby
A. Beckerian Utility						
ξ	2.368	1.086	2.049	1.337	1.986	1.974
	(0.030)	(0.019)	(0.024)	(0.013)	(0.016)	(0.016)
κ	0.108	0.525	0.122	0.208	0.183	0.189
	(0.001)	(0.011)	(0.000)	(0.003)	(0.001)	(0.001)
α	0.076	0.295	0.195	0.111	0.178	0.144
	(0.002)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)
ρ	1.331					
	(0.025)					
B. Standard Utility With Multiple Goods						
μ	0.006	0.747	0.013	0.063	0.085	0.087
	(0.000)	(0.007)	(0.001)	(0.001)	(0.002)	(0.002)
η	0.706					
	(0.011)					
σ^m	1.247					
	(0.016)					
ϕ^m	0.342					
	(0.002)					
C. Standard Utility						
σ^s	1.252					
	(0.017)					
ϕ^s	0.287					
	(0.005)					

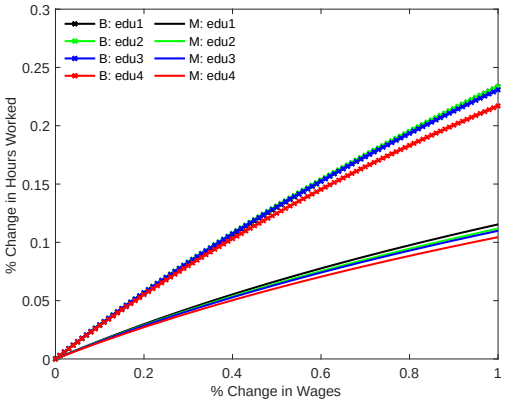
Notes: Estimation with education-specific prices.

E Experiments

Figure E.6: Response of Hours Worked to a Percentage Wage Change



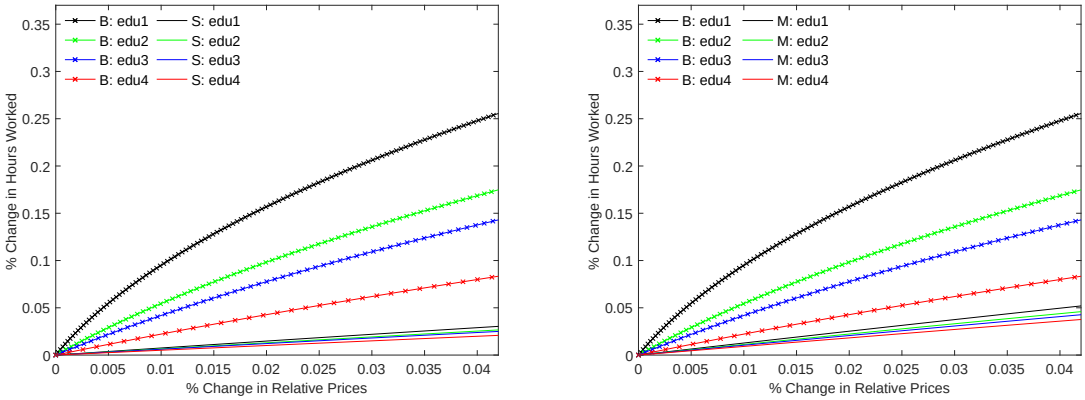
(a) Becker vs. Standard Model



(b) Becker vs. Multiple Goods Model

Notes: To make the comparison more fitting, for the baseline case we choose wages in the standard preferences to match the market time allocation of the Beckerian preferences. We use parameter estimates from the model with education-specific prices. 'B' denotes the Beckerian framework, 'S' refers to the standard framework and 'M' to the model with multiple goods.

Figure E.7: Response of Hours Worked to a Change in Relative Wage



(a) Becker vs. Standard Model

(b) Becker vs. Multiple Goods Model

Notes: We use parameter estimates from the model with education-specific prices. 'B' denotes the Beckerian framework, 'S' refers to the standard framework and 'M' to the model with multiple goods.