Luxuries, Necessities, and the Allocation of Time*

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Abstract

We study consumption and welfare inequality by analyzing how households allocate resources—market expenditures and the value of time—to the production of activities. The share of resources allocated to an activity rises or falls with wages, classifying them into luxuries or necessities, respectively. An estimated model with non-homothetic preferences shows that the rise in consumption inequality between 2004 and 2019 was mostly due to an increase in wage dispersion, while rising prices, especially of leisure luxuries, had a significant negative effect on inequality. The distinction between luxuries and necessities amplifies the counteracting effects of wage and price on inequality.

JEL Codes: J22, E21, D11
Keywords: time allocation, consumption expenditures, luxuries, necessities, activity production, inequality

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1 Introduction

Do increases in income inequality lead to similar increases in consumption and welfare inequality? To answer this longstanding question, previous studies often equate consumption with expenditure (Krueger and Perri, 2006; Aguiar and Bils, 2015, among others). However, Becker (1965) emphasized early on that household consumption consists of activities that are produced by combining time and goods.[1] From this perspective, expenditures are a poor proxy of consumption, especially for activities that require a significant amount of time. The set of activities that households consume varies with income, and the way activities are produced responds to changes in input prices. Thus, dispersion in wages and fluctuations in prices critically influence the distribution of consumption across households and therefore shape inequality.

We propose a framework in which a household's primary resource is time, which can be allocated to produce a variety of activities and to engage in market work. In doing so, we contribute to a literature that has typically focused solely on home production (Greenwood et al., 2005; Duernecker and Herrendorf, 2018), or exclusively on leisure production (Boppart and Ngai, 2021; Kopytov et al., 2023). Time spent working generates income, enabling households to purchase market goods used to produce other activities. Thus, the total resources allocated to any activity include both the spending on market goods and the value of the time devoted to the activity, where time is valued at its opportunity cost — the wage rate. This approach allows us to define a household-level resource share as the fraction of total resources allocated to a specific activity.

Guided by Becker's (1965) view, we empirically assess how time, expenditures, and hence resource allocations across activities adjust to changes in wages. Crucial to understanding these adjustments is the distinction between luxury and necessity activities. While Aguiar and Bils (2015) classify luxuries and necessities based solely on consumption expenditures, our measure considers how resource shares allocated to an activity increase (luxuries) or decrease (necessities) with wages. Hence, our next contribution consists of empirically identifying luxury and necessity activities. This classification requires data on time use and expenditure bundles for each activity. However, activity categories in the time use and expenditure data are typically not assigned to the same set of activities. We consequently map time use and expenditures at the activity level using data from the American Time Use Survey (ATUS) and the Consumer Expenditure Survey (CEX). This mapping allows us to assign time and expenditures jointly to a particular consumption activity. Imputing time use from the ATUS to CEX households for each activity, we study the correlations of resource shares with wages. According to these correlations, we aggregate

[1] Throughout the paper, for simplicity, we refer to both market goods and services as market goods.

home and leisure activities into four categories: leisure luxuries, leisure necessities, home luxuries, and home necessities.[2]

Based on our findings, we specify a model in the spirit of Becker (1965), where utility is represented through a nested CES (constant elasticity of substitution) function. The outer CES nest is an aggregator of the four activities, while the inner nest defines a CES production function for each individual activity, using both market goods and time as inputs. The outer CES nest incorporates a fixed and activity-specific non-homothetic term that determines the luxuriousness of an activity. The inner CES nest contains activity-specific elasticities of substitution between time and goods. Both model ingredients are essential to replicate the observed correlations between time, expenditures, and resource shares with household wage levels.

We identify the model parameters by exploiting differences in the consumption of activities over time and across households. Particularly crucial for the identification of parameters are the variation in resource shares and the variation in the ratio between expenditure and time for an activity. Several key insights emerge from the estimation. First, the non-homothetic activity-specific consumption term is larger for necessities than for luxuries. Second, necessities (both leisure and home) have a combined weight of only 0.22 in the utility function, while luxuries (leisure and home) have a combined weight of 0.78. Notably, leisure luxuries and necessities have a combined weight of 0.70, reflecting the importance of leisure production in household allocations. Finally, while time and goods are mostly substitutes for the production of individual activities, the four activities are themselves complements.

Both wages and prices play a pivotal role in how households allocate resources to activities, as they influence the amount of own time and market goods used in the activity production. In the model, we simulate the responses of time use and expenditures to wage and price changes. Wage changes affect resource allocation through three effects: substitution effect across activities, substitution effect between time and goods within an activity, and income effect. Of these, the income effect is the most significant, resulting in increased resource shares in wages for luxury activities and decreased shares for necessities. Price changes also influence resource shares primarily through the two substitution effects, with the substitution effect across activities being quantitatively the most significant. Given that the estimated elasticity of substitution across activities is less than one, an increase in the goods input price of a necessity leads to an increase in its resource share and a decrease for all other activities. Conversely, for luxury activities, increases in input prices reverse these patterns because the non-homothetic consumption term has an opposite effect on the resource shares and outweighs the forces of complementarity between

[2]The distinction between home and leisure activities follows Aguiar et al. (2013).

activities. These results suggest that in response to a price increase in an activity, households will redirect their resources away from (toward) an activity if it is a luxury (necessity).

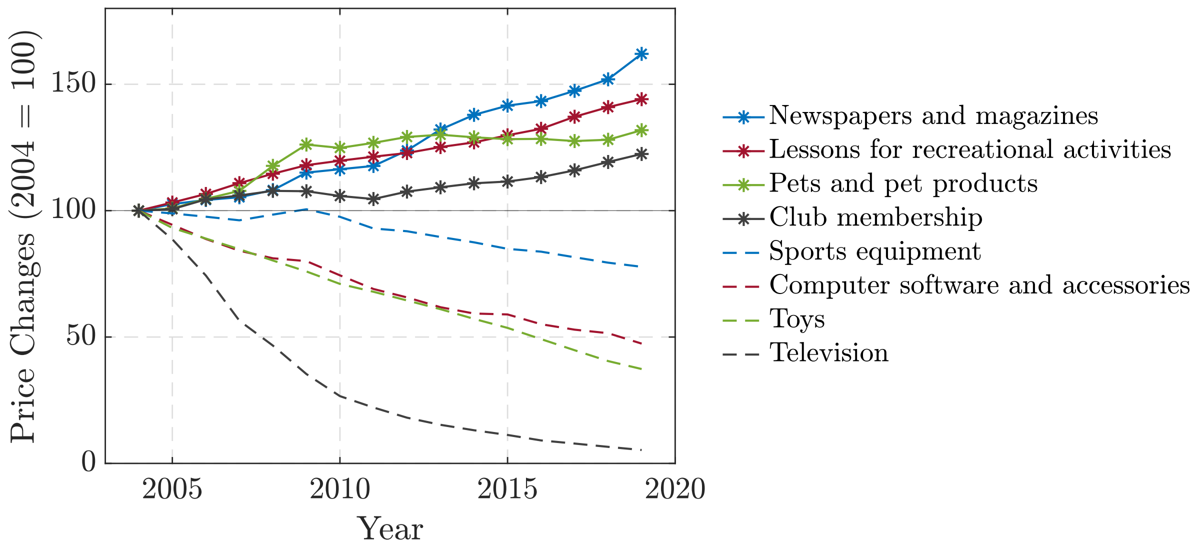
We use the model to examine the evolution of consumption and welfare inequality between 2004 and 2019. The prices of market goods, which are highly heterogeneous across households, evolved unevenly over this period (see Figure 1). For instance, while the price of TVs steadily declined, the cost of recreational activities, such as tennis lessons, increased. We construct activity-specific prices using disaggregated indices from the Consumer Price Index for 50 income percentiles, and explore the dynamics of consumption and welfare inequality by considering wage and price differences across income groups for each year. Our results reveal that consumption inequality increased by 8% overall. This total effect obscures, however, the counteracting influences of wage and price changes over the period. Holding prices constant at 2004 levels, we observe that consumption inequality would have risen by 18%. Conversely, if wages had remained at their 2004 levels, consumption inequality would have decreased by 8%. We also investigate which activity price most significantly determines the overall negative effect of price changes on consumption inequality, and find that it is primarily driven by the substantial increase in the price of leisure luxuries. Finally, the effects of wages and prices on welfare inequality mirror those on consumption inequality: Wage dispersion increased welfare inequality by 15% from 2004 to 2019, while the rise in prices decreased it by 5%, resulting in an overall increase in welfare inequality of 11%.

Lastly, we examine the extent to which the distinction between luxury and necessity activities drives the effects of wage and price changes on inequality. When removing this distinction from the model—i.e., by setting the non-homothetic activity-specific consumption term to zero—we observe a significant reduction of 23% in the impact of wages on consumption inequality, while the influence of prices declines by 63%. This notable effect arises because resource shares allocated to luxuries and necessities respond very differently to wage and price changes in the baseline model. Eliminating the distinction between these activity types results in more uniform resource allocations across households. Restricting the analysis to only luxury or necessity activities and assessing the implications for income and consumption inequality offers another means of underscoring the importance of distinguishing between luxuries and necessities. In this experiment, the model with only necessities increases consumption inequality, since necessity activities are characterized by a low degree of substitutability between time and goods. Conversely, the model with only luxuries reduces consumption inequality.

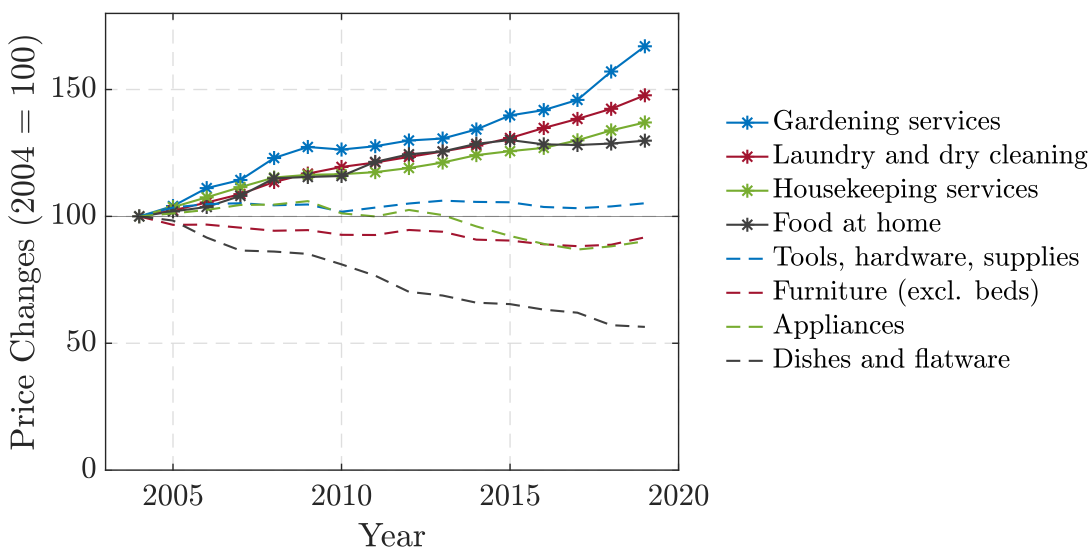
Related Literature This paper builds on a growing body of work on home production and leisure production. Aguiar et al. (2012) summarize the literature highlighting the im-

Figure 1: Prices of Goods and Services for Individual Activities

(a) Leisure Activities



(b) Home Activities



Notes: The data come from the Consumer Price Index database provided by the Bureau of Labor Statistics. Monthly data are averaged to obtain annual values using the CES sample. For leisure activities, we plot subindices SERG01, SERF03, SERB01, SERF01, SERC02, SEEE02, SERE01, and SERA01. For home activities, we plot subindices SEHP02, SEGD03, SEHP01, SAF11, SEHM01, SEHJ02, SEHK, and SEHL03.

portance of home production in business-cycle fluctuations. Greenwood et al. (2005) show that the emergence of consumer durables is a significant contributing element to the rise in female labor-force participation in the past century. Rogerson (2008), McDaniel (2011), Ngai and Pissarides (2011), Ngai and Petrongolo (2017), and Duernecker and Herrendorf (2018) find that home production is a key factor in propagating the effects of taxes and social subsidies on market labor supply.[3] Two papers on leisure production, Vandenbroucke (2009) and Kopecky (2011), observe that declining relative prices of goods inputs for leisure activities help explain employment declines over the last century.[4] Boppart and Ngai (2021) propose a model with leisure production that can generate rising average leisure time and increasing leisure inequality over time. Our measure of consumption differs from the more common use of expenditures, aligning instead with Aguiar and Hurst (2005). These authors reconcile the observed decline in expenditures at retirement with a smooth lifecycle consumption pattern, as retirees use the extra time to shop for lower price goods and services. We contribute to this literature in two ways. First, we classify home and leisure activities as luxuries or necessities. Second, we quantitatively estimate a model with both home and leisure production using data that combines time and goods at the activity level. The model allows us to analyze the effects of wage and price changes on allocations, income, and consumption inequality.

A related literature separates goods into luxuries and necessities to study their macroeconomic implications. Luxuries are typically classified as goods whose expenditure shares rise with income. In a recent paper, Aguiar et al. (2021) define leisure luxuries as activities that exhibit little diminishing returns in time. These activities therefore respond more to changes in total leisure time. Because we focus on consumption activities produced with both time and goods, our definition of luxuries and necessities is, in contrast, based on the response of the resource share allocated to an activity to changes in total available resources, which include both expenditures and time costs. Aguiar et al. (2021) identify leisure luxuries by estimating model-derived Engel curves in time, whereas we empirically classify luxuries and necessities by examining the correlation of resource shares with wages. These methodological differences mean that our empirical classification of leisure luxury activities diverges from that of Aguiar et al. (2021).

Several papers relate the demand elasticity for luxuries or necessities with the intertemporal elasticity of substitution. Browning and Crossley (2000) find that if the utility function is additively separable over time and over goods, luxuries (defined as goods with higher income elasticity of demand) also have higher within period intertemporal elasticity of

[3]See also Olovsson (2009), Ragan (2013), and Fang and Zhu (2017).

[4]Aguiar et al. (2021) and Kopytov et al. (2023) also study the effects of the decline in recreation prices on labor supply but do not use the leisure-production model.

substitution (IES). Aguiar et al. (2012) and Aguiar and Hurst (2013) extend this insight to the activity production model and find a similar relationship between the income elasticity and the IES. Even though we do not restrict the utility function to be additively separable over consumption activities and our definition of luxuries differs, in our model, luxuries likewise exhibit a higher IES than necessities.

Our paper also intersects with studies on income, consumption, and welfare inequality. Krueger and Perri (2006), Blundell et al. (2008), and Aguiar and Bils (2015) focus on changes in inequality over time and the relationship between income and consumption inequality. Attanasio and Pistaferri (2016) point out that a complete welfare analysis must go beyond aggregate categories of household expenditure and consider, in addition, the basket of goods households consume, their quality, and the value households assign to leisure. Aguiar and Bils (2015) exploit differences in expenditure shares on luxuries and necessities by income level to estimate the degree of measurement error in the CEX, their goal being to examine the time evolution of households' income and consumption levels. Boerma and Karabarbounis (2021) take the value of non-market time into account while analyzing welfare inequality in a version of the Beckerian model with home production. They find that heterogeneity in home-production efficiency raises welfare inequality because the time input in home production does not covary negatively with wages in the cross section. We complement their work by showing that in addition to productivity (market and home), the differential evolution in prices of market goods is crucial to the evolution of consumption and welfare inequality. Moreover, we contribute to the inequality literature by showing the importance of distinguishing between luxuries and necessities when analyzing inequality.

Finally, our data analysis is closely related to empirical studies on time allocation. Aguiar et al. (2012) discuss the available time use data and review recent work analyzing long-run trends in time use. We add to this research by mapping time-use and expenditure data for particular activities. We then use the mapped data to empirically classify consumption activities into luxuries and necessities. Pretnar (2024) also maps time and expenditures into different consumption activities, though his focus is not on how the existence of luxuries and necessities affects resource allocations, nor does he examine the effect of price changes in the recent evolution of income and consumption inequalities.

The rest of the paper is organized as follows. Section 2 presents the theoretical framework. Section 3 empirically classifies consumption activities into luxuries and necessities. Section 4 explains the estimation strategy, summarizes the estimation results, and discusses the model fit. Section 5 simulates the model to highlight the key model mechanisms. Section 6 analyzes the implications of wage and price changes from 2004 to 2019 for consumption and welfare inequality through the lens of our estimated model. Section

7 concludes.

2 Model

Becker (1965) introduced the seminal idea that households enjoy various consumption activities produced by combining distinct segments of time with goods. This approach to utility differs from the conventional macroeconomic perspective, which aggregates all non-market time into a single ”leisure” category and models consumption as expenditures. It also extends beyond models focused on home or leisure production that assume a single, undifferentiated type of home- or leisure-related activity. Such models imply perfect substitutability across all leisure (or home) hours in producing activities, as well as among all leisure (or home) goods. It remains, however, uncertain whether this assumption accurately reflects the allocation of time and goods across different households. Expanding the analysis to include multiple leisure (or home) activities introduces various segments of time and goods as distinct production inputs, which are no longer perfectly substitutable.

We formalize Becker (1965)'s concept by defining household utility in terms of the consumption of activities, denoted as c_j for each $j = 1, ..., n$. Each activity c_j is produced by combining time, ℓ_j, with a market good, x_j, through a CES production function. The overall household utility, $U(C)$, is then derived as a CES aggregator of all j activities:

$$U(C) = log(C), \quad C = \left(\sum_j \alpha_j (c_j - \bar{c}_j)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}, \quad 0 < \alpha_j < 1, \ \rho > 0. \tag{1}$$

The production of activity c_j is given by:

$$c_j = \left(\kappa_j x_j^{\frac{\xi_j - 1}{\xi_j}} + (1 - \kappa_j) \ell_j^{\frac{\xi_j - 1}{\xi_j}} \right)^{\frac{\xi_j}{\xi_j - 1}}, \quad 0 < \kappa_j < 1, \ \xi_j > 0. \tag{2}$$

Several sets of parameters govern the utility function. The parameter α_j assigns the relative importance of each activity j within the aggregate set of activities, while ρ captures the elasticity of substitution among consumption activities. For a given activity j, κ_j denotes the weight of goods in the activity's production, and ξ_j characterizes the activity-specific elasticity of substitution between time and goods. Given that ξ_j is activity-specific, the extent to which households are able to substitute between goods and time varies across activities, resulting in non-homothetic preferences. Non-homotheticity is further introduced through $\bar{c}_j$, a fixed activity specific consumption term that can be either positive or negative. If $\bar{c}_j$ enters utility negatively, it is equivalent to a consumption floor and implies that a minimum level of activity j will be produced and consumed. A positive $\bar{c}_j$ instead implies that households only engage in the production of activity j after a certain level of consumption has been reached. Together, ξ_j and $\bar{c}_j$ play an important role in aligning the model with allocations of time and expenditures for different home and leisure activities in the data.

2.1 Household Allocations

Each household has one unit of time, which may be allocated to the production of consumption activities or to market work. Households differ in their wages. For ease of notation, we omit the household index. Let w represent the wage rate of a household, and let p_j denote the price of goods x_j. The household's maximization problem can be solved in two steps. First, households determine the amount of goods, x_j, and time, ℓ_j, required to produce a given amount of activity, c_j, by minimizing the resources $R_j = p_j x_j + w\ell_j$ spent on the activity. In a second step, households select the set of activities to consume (c_j) to maximize utility subject to the budget constraint. Detailed conditions for the optimal allocations are provided in Appendix A.1. The resource minimization yields the following condition:

$$\frac{\partial c_j / \partial \ell_j}{\partial c_j / \partial x_j} = \frac{w}{p_j}. \tag{3}$$

Equation (3) states that households allocate time and goods to produce an activity such that the relative price of these inputs equals the marginal rate of technical substitution (MRTS), which is the ratio of the two marginal products. Given the activity production function, time and goods spent on activity j can be determined as follows:

$$\frac{\ell_j}{x_j} = \left(\frac{p_j}{w}\right)^{\xi_j} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}, \tag{4}$$

$$\frac{s_{\ell j}}{s_{xj}} = \frac{w\ell_j}{p_j x_j} = \left(\frac{p_j}{w}\right)^{(\xi_j - 1)} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}, \tag{5}$$

where $s_{xj} = \frac{p_j x_j}{R_j}$ and $s_{\ell j} = \frac{w\ell_j}{R_j}$ denote the shares of expenditure and time cost, respectively, in the production of activity j. Given that $\xi_j > 0$, an increase in wages leads to a decrease in the input ratio $\dfrac{\ell_j}{x_j}$, since higher wages encourage households to increase market hours and decrease non-market hours. Additionally, an increase in income enables households to purchase more goods x_j, thereby substituting time with goods in activity production, with the magnitude of substitution being governed by ξ_j. Similarly, a reduction in the price of goods also incentivizes households to substitute time with goods in activity production.

Since ξ_j is activity-specific, the response of allocations to wage and price changes varies by activity. A greater elasticity ξ_j implies that time and goods are more substitutable, leading to a more pronounced response in the input ratio $\frac{\ell_j}{x_j}$. Consequently, if goods and time are substitutes ($\xi_j > 1$), s_{xj} will rise with wage and fall with price p_j, while $s_{\ell j}$ will decrease with wage and increase with price p_j. Conversely, if goods and time are complements ($\xi_j < 1$), the relationships invert. Property 1 summarizes the dynamics of the CES production function:

Property 1: If $\xi_j > 1$, s_{xj} will rise with wage and fall with price p_j, while $s_{\ell j}$ will decrease with wage and increase with price p_j. If $\xi_j < 1$, the relationships invert.

$$\frac{\partial s_{xj}}{\partial p_j} < 0, \quad \frac{\partial s_{\ell j}}{\partial p_j} > 0, \quad \frac{\partial s_{xj}}{\partial w} > 0, \quad \frac{\partial s_{\ell j}}{\partial w} < 0, \quad \text{if} \quad \xi_j > 1 \tag{6}$$

$$\frac{\partial s_{xj}}{\partial p_j} > 0, \quad \frac{\partial s_{\ell j}}{\partial p_j} < 0, \quad \frac{\partial s_{xj}}{\partial w} < 0, \quad \frac{\partial s_{\ell j}}{\partial w} > 0, \quad \text{if} \quad \xi_j < 1 \tag{7}$$

Proof: See Appendix A.2.

In the second step, households maximize utility subject to the budget constraint:

$$\sum_j p_j x_j = w(1 - \sum_j \ell_j). \tag{8}$$

Defining R as the total amount of resources, the budget constraint can be rewritten as:

$$R = \sum_j R_j = \sum_j (p_j x_j + w\ell_j) = \sum_j p_j^c c_j = w, \tag{9}$$

where $p_j^c = \frac{p_j}{\frac{\partial c_j}{\partial x_j}}$ represents the implicit price of activity j. Property 2 demonstrates that increases in input prices (p_j) and wages (w) elevate the production cost of activity j and therefore raise the activity-specific price p_j^c. The price of unrelated inputs ($p_i, i \neq j$) does not impact p_j^c since these inputs are not utilized in the production of activity j.

Property 2 Activity price p_j^c increases with both p_j and w, and does not depend on p_i.

$$\frac{\partial p_j^c}{\partial w} > 0, \quad \frac{\partial p_j^c}{\partial p_j} > 0, \quad \text{and} \quad \frac{\partial p_j^c}{\partial p_i} = 0 \, \forall i \neq j \tag{10}$$

Proof: See Appendix A.2.

Let λ denote the Lagrangian multiplier associated with the budget constraint. The first order conditions, combined with Equation (3), yield:

$$\frac{\partial U}{\partial C}\frac{\partial C}{\partial c_j} = \lambda p_j^c \qquad \Rightarrow \qquad \frac{\frac{\partial C}{\partial c_j}}{\frac{\partial C}{\partial c_i}} = \frac{p_j}{p_i}\frac{\frac{\partial c_i}{\partial x_i}}{\frac{\partial c_j}{\partial x_j}}, \tag{11}$$

$$\frac{\partial U}{\partial C}\frac{\partial C}{\partial c_j} = \lambda \frac{w}{\frac{\partial c_j}{\partial \ell_j}} \qquad \Rightarrow \qquad \frac{\frac{\partial C}{\partial c_j}}{\frac{\partial C}{\partial c_i}} = \frac{\frac{\partial c_i}{\partial \ell_i}}{\frac{\partial c_j}{\partial \ell_j}}. \tag{12}$$

Both conditions suggest that households allocate expenditures (Equation 11) and time (Equation 12) across activities such that the marginal rate of substitution between activity i and j aligns with the ratio of their marginal products. Since input prices for goods differ across activities ($p_i \neq p_j$), the ratio of marginal products for goods is further adjusted by the input price ratio. Using utility and production functions for activities i and j, Equation (11) can be rewritten as:

$$\frac{(c_j - \bar{c}_j)}{(c_i - \bar{c}_i)} = \left(\frac{p_i^c \alpha_j}{p_j^c \alpha_i}\right)^\rho. \tag{13}$$

A higher value of ρ indicates greater substitutability between activities, leading to a more significant reallocation of time and goods across activities in response to wage and price changes. Combining (13) and the budget constraint, the consumption of activity j is given by:

$$c_j = \frac{\gamma_j}{p_j^c}\left(w - \sum_i p_i^c \bar{c}_i\right) + \bar{c}_j, \tag{14}$$

$$R_j = p_j^c c_j = \gamma_j \left(w - \sum_i p_i^c \bar{c}_i\right) + p_j^c \bar{c}_j, \tag{15}$$

where $0 < \gamma_j = \frac{\alpha_j^\rho (p_j^c)^{1-\rho}}{\sum_i \alpha_i^\rho (p_i^c)^{1-\rho}} < 1$ and $\sum_j \gamma_j = 1$. γ_j is a function of price p_j^c and determines the amount of resources spent on activity j. Property 3 below shows that when activities are complements ($\rho < 1$), any increase in the activity price p_j^c will require a larger allocation of resources to the activity that is becoming more expensive. Consequently, resources spent on all other activities decline. The opposite occurs when activities are substitutes ($\rho > 1$).

Property 3: If $\rho < 1$, γ_j increases with its own price and decreases with prices of other activities. If, instead, $\rho > 1$, γ_j decreases with its own price and increases with prices of other activities.

$$\begin{aligned} &\frac{\partial \gamma_j}{\partial p_j^c} > 0, \quad \frac{\partial \gamma_j}{\partial p_i^c} < 0, \quad \forall \rho < 1 \\ &\frac{\partial \gamma_j}{\partial p_j^c} < 0, \quad \frac{\partial \gamma_j}{\partial p_i^c} > 0, \quad \forall \rho > 1 \end{aligned} \tag{16}$$

Proof: See Appendix A.2.

2.2 Luxuries and Necessities in the Model

In our model, activities can be classified into luxuries and necessities based on the relationship between wages and resources. Traditionally, goods are identified as luxuries or necessities by considering the size of their expenditure elasticity. In our framework, where utility is derived from activities that combine both time and goods, luxuries and necessities are similarly differentiated based on the resource elasticity associated with an activity. This elasticity measures the percent change in resources allocated to an activity in response to a one-percent change in total resources, with both prices and wages held constant. This is formally expressed as:

$$\epsilon^j_{RR} \equiv \frac{\partial R_j}{\partial R}\frac{R}{R_j}\bigg|_{dw=0,dp=0}, \tag{17}$$

where ϵ^j_{RR} is the resource elasticity for activity j. Essentially, this elasticity captures how sensitive the allocation of resources towards an activity is relative to the change in overall resources, maintaining constant prices and wages.

Definition An activity is classified as a luxury if $\epsilon^j_{RR} > 1$, and as a necessity if $\epsilon^j_{RR} < 1$. Equivalently, holding wage w and price vector $(p_1, ...p_n)$ constant, resource share $s_{cj} \equiv \frac{R_j}{R}$ increases with total resources R for a luxury and decreases for a necessity. [5]

Define the resource elasticity of expenditures by $\epsilon^j_{xR} = \frac{\partial x_j}{\partial R}\frac{R}{x_j}$ and the resource elasticity of time inputs by $\epsilon^j_{\ell R} = \frac{\partial \ell_j}{\partial R}\frac{R}{\ell_j}$. The resource elasticity ϵ^j_{RR} can be expressed as:

$$\epsilon^j_{RR} = \left(p_j\frac{\partial x_j}{\partial R} + w\frac{\partial \ell_j}{\partial R}\right)\frac{R}{R_j} = p_j\frac{\partial x_j}{\partial R}\frac{R}{x_j}\frac{x_j}{R_j} + w\frac{\partial \ell_j}{\partial R}\frac{R}{\ell_j}\frac{\ell_j}{R_j} = \epsilon^j_{xR}s_{xj} + \epsilon^j_{\ell R}s_{\ell j}. \tag{18}$$

Equation (18) shows that the resource elasticity of activity j is a weighted average of the resource elasticity of goods and time inputs. The weights are determined by the respective share of resources allocated to goods and time for the activity.

[5] $\frac{\partial R_j}{\partial R}\frac{R}{R_j} = \frac{\partial R s_{cj}}{\partial R}\frac{R}{R_j} = \left(s_{cj} + R\frac{\partial s_{cj}}{\partial R}\right)\frac{R}{R_j} = 1 + \frac{R^2}{R_j}\frac{\partial s_{cj}}{\partial R}$. Hence $\epsilon^j_{RR} \lesseqgtr 1$ is equivalent to $\frac{\partial s_{cj}}{\partial R} \lesseqgtr 0$.

From Equation (15), the resource share of an activity j is given as follows:

$$s_{cj} = \frac{R_j}{R} = \frac{p_j^c c_j}{R} = \gamma_j + \left[p_j^c \bar{c}_j - \gamma_j \sum_i p_i^c \bar{c}_i \right] \frac{1}{R}. \tag{19}$$

Equation (19) implies that if the non-homothetic term $\bar{c}_j = 0 \, \forall j$, the resource share s_{cj} does not vary with the total amount of resources R. Thus, to generate luxuries and necessity activities, it is necessary to model the non-homothetic term $\bar{c}_j$. Moreover, since $\gamma_j < 1$, the cross-derivative of resource share s_{cj} with respect to R and $\bar{c}_j$ is negative, $\frac{\partial s_{cj}^2}{\partial R \partial \bar{c}_j} < 0$. Hence, a smaller $\bar{c}_j$ is associated with more luxurious activities.

The effects of wages and prices on resource shares for each activity depend on their effects on total resources R, activity price p_j^c, and γ_j. In the absence of activity production, the model would adopt standard non-homothetic CES preferences, where p_j^c does not depend on wages. In this case, γ_j would be invariant across wages and thus wages would influence the resource share for each activity, s_{cj}, solely through total available resources R. The introduction of activity production alters this relationship, as wages, along with the prices of goods, now influence s_{cj} not only through their effect on R but also their effect on the activity price p_j^c, and thus γ_j. Section 5 analyzes these effects in detail.

3 Luxuries and Necessities in the Data

Section 2.2 establishes that resource shares for luxury activities increase with the total available resources and decrease for necessities. Guided by this observation, this section employs U.S. data to empirically classify a variety of consumption activities into luxuries and necessities. Ideally, the dataset would include allocations of time and expenditures on a variety of consumption activities. As such data does not exist, we follow Boerma and Karabarbounis (2021) and study the association between time allocations and individual characteristics in the American Time Use Survey (ATUS). We then use this relationship to assign time allocations by activity to each household in the Consumer Expenditure Survey (CEX). The result is a unique dataset that combines time use and expenditure for each consumption activity. From Equation (9) in Section 2, total available resources are equal to the wage rate since labor income is the only source of income. In more complicated setups, other sources of income (such as government transfers) may affect total resources beyond the wage rate. Nonetheless, wages still provide a good instrument to proxy total household resources. Using the constructed data, we can thus explore the correlation between resource shares and wages and classify consumption activities as either luxury or necessity.

3.1 Data Construction

We start by mapping consumption activities between the ATUS and CEX. The ATUS records an individual's time allocation for more than one hundred activities in a twenty-four-hour period. The CEX collects data for more than six hundred different types of expenditures on market goods and services. We restrict the samples in both surveys to between 2004-2019 and consider only individuals (ATUS) or household heads (CEX) aged 21-65. We also drop observations with hourly wages that are less than 7 USD and above 300 USD. When imputing time use for households in the CEX, we restrict the sample to married households with positive household income and positive consumption expenditures.

In order to assign expenditures and time for each activity consistently across the two surveys, we start with the time-use activity categories in Aguiar et al. (2013) and group the associated consumption expenditures in the CEX into comparable categories. Appendix B details the data-construction process. Tables B.1 and B.3 describe the time use and expenditures associated with each activity. Our analysis includes four home activities and four leisure activities. Home activities comprise core home production (e.g., cooking and cleaning), homeownership activities (e.g., house maintenance), obtaining goods and services (e.g., shopping), and other care (e.g., care for an adult relative). Leisure activities consist of watching TV, socializing (e.g., parties), eating & personal care (e.g., dining out), and hobbies & entertainment (e.g., vacation).

Imputing Time Use in the CEX To assign time allocations to CEX households, we first regress time use from ATUS separately for weekdays and weekends on observable characteristics: gender, marital status, number of children, age, age squared, years of schooling, home ownership, race, and hourly wages. We also include year fixed effects and apply sample weights. The regressions are conducted separately by work status, i.e., whether or not individuals report income from working. If they report wage or salary income, we drop the lowest and highest percentile of wages in the sample.

Using the regression results, we compute weighted means of the ATUS predictions for 312 demographic cells based on gender, marital status, whether or not the household has children, 5 age groups, 4 education groups, and the individual's work status. We then construct the same set of observables in the CEX for household heads and their spouses and assign each individual the predicted mean time allocation for all activities on weekdays and weekends based on the individual's demographic cell. To check the validity of the imputation procedure, we compare average hours spent on all activities for weekdays and weekends between the ATUS and the imputation for the CEX. The imputation procedure works reasonably well, given that individuals in the ATUS spent an average of 9.63 hours per day on all non-market activities considered and the imputed time use at the individual level in the CEX yields an average of 9.68 hours for the same set of activities (see Appendix B.3 for details). Finally, we compute an individual's daily time use by assigning a weight of 5/7 to weekdays and 2/7 to weekends. Since the expenditure data from the CEX are collected monthly, we multiply daily time use by 30 days to generate a monthly allocation of time to an activity.

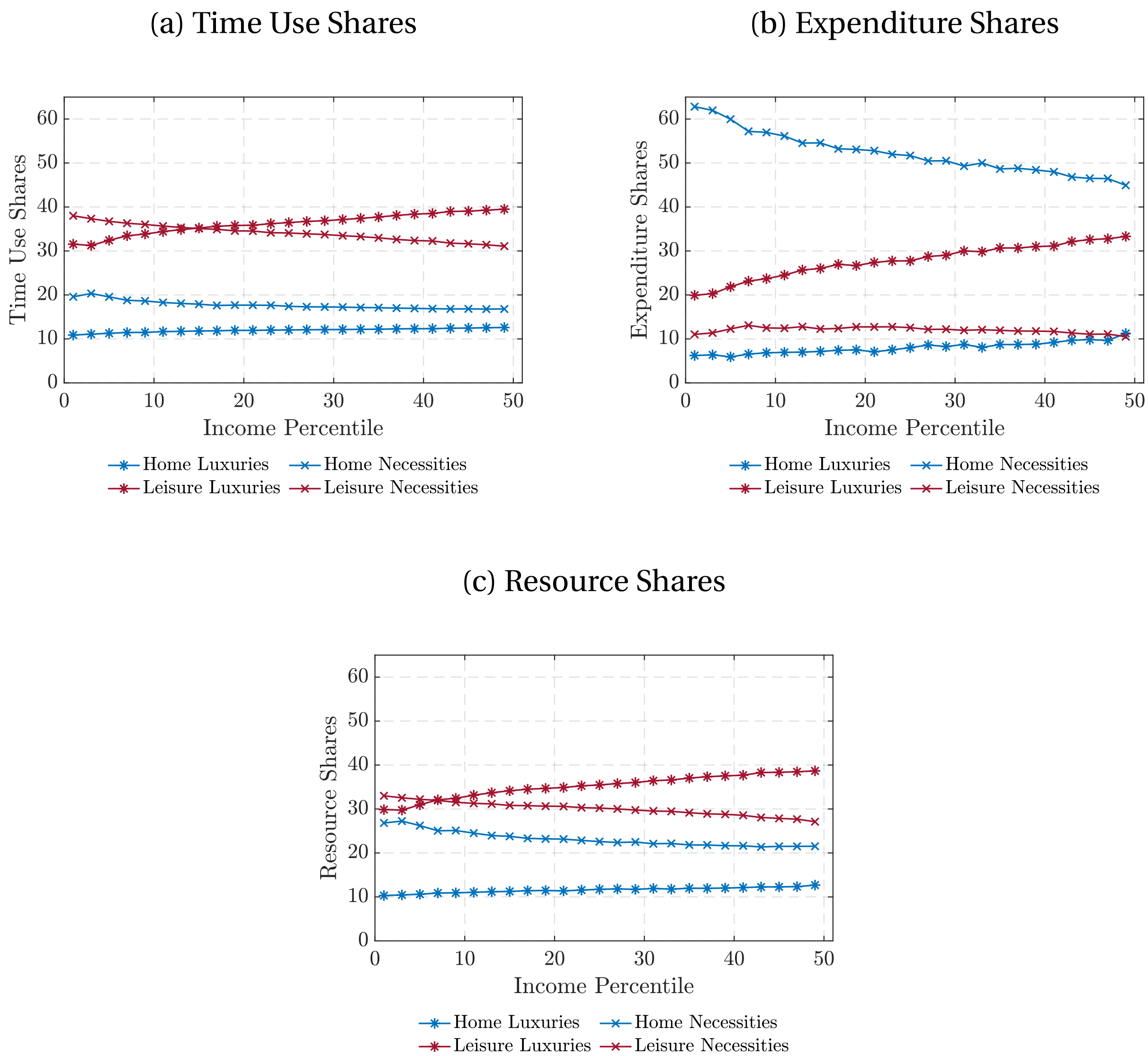
3.2 Resource Shares and Wages

We derive resources spent on an activity at the household level by summing up monthly expenditures and the cost of time. While expenditures are already expressed in dollars, we need to convert time use into comparable units. To this end, we compute time cost by multiplying hourly wages and time use spent on an activity at the individual level. For non-working individuals, we infer their wages using the Heckman correction procedure. Because expenditures in the CEX are recorded at the household level, we derive resources spent on an activity by summing up household expenditures and time costs from both spouses. The resource share of an activity is defined as the ratio of resources spent on that activity to the sum of resources spent on all activities. Figure 2 plots the resulting time, expenditure, and resource shares by income percentile. For luxuries, all three shares increase with income and the increase is significantly larger for leisure luxury than for home luxury. For necessities, the shares are either declining or flat with income; the decline in time is greater for leisure necessities, and the decline in expenditure is greater for home necessities. As a result, resource shares for both necessities decline.

We perform a two-step regression to explore the relationship between resource shares and the permanent component of wages. First, we regress hourly wages against a set of individual characteristics, including education, age, age squared, race, parental status, the number of children, and home ownership. This regression is done separately for men and women in each year. Using the results from this regression, we calculate predicted wages for each individual in our sample. We then compute the household's wage rate as the average of the predicted wages for both spouses.

Next, we regress resource shares on the natural log of household wages for each activity. Table 1 summarizes the results. Among home production activities, the shares of resources allocated to core home production and other care are declining as wages increase, while the opposite is true for obtaining goods and services and home ownership related activities. Among leisure activities, the resource shares allocated to watching TV and socializing are declining with wages, while resource shares for eating & personal care and hobbies & entertainment are increasing with wages. As shown in the table, the coefficients are all

Figure 2: Time Use, Expenditure, and Resource Shares by Income Percentile



Notes: We plot time use (Panel (a)), expenditure (Panel (b)), and resource shares (Panel (c)) in the CEX. The sample includes married households between 2004–2019. See Section 3.1 for further details on data construction and sample restrictions.

significant at the 1% level and are sizable except for other care.

Classifying Luxuries and Necessities Based on the definitions of luxury and necessity in Section 2, we classify an activity as the former if the resource share is positively correlated with wages and the latter if the correlation is negative. The regression results in Tables 1 give rise to four types of activities: (1) home luxuries, including home ownership activities and obtaining goods and services; (2) home necessities, including core home production and other care; (3) leisure luxuries, including eating & personal care and hobbies & enter-

Table 1: Resource Share Regressions

	A. Home Activities			
	(1) Core Hm	(2) Oth Care	(3) Obt Gds Svs	(4) Hm Own
Ln Wage	-5.13***	-0.15***	1.02***	1.27***
	(0.04)	(0.00)	(0.01)	(0.02)
N	83,573	83,573	83,573	83,573

	B. Leisure Activities			
	(5) Watch TV	(6) Social	(7) Eat & Pcare	(8) Hobby & Ent
Ln Wage	-4.70***	-1.11***	3.79***	5.01***
	(0.03)	(0.02)	(0.02)	(0.03)
N	83,573	83,573	83,573	83,573

Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. The table reports the results from the linear regression model. Data comes from the CEX with time use imputed based on the ATUS between 2004 and 2019. The dependent variables are the household resources spent on each activity as a fraction of total resources for the following activities: the four home activities of (1) core home production, (2) other care, (3) obtaining goods and services, and (4) homeownership activities; and the four leisure activities of (5) watching TV, (6) socializing, (7) eating & personal care, and (8) hobbies & entertainment. The independent variable is a measure of household hourly wages using predicted wages from a first-stage regression. If wages are not observed, we use the Heckman procedure to impute wages. The sample is restricted to married couples and hourly wages of less than 7 USD are dropped.

tainment; and (4) leisure necessities, including watching TV and socializing.

Note that our definition differs from the standard approach, which classifies goods as luxuries or necessities based on their expenditure elasticity. One exception is Aguiar et al. (2021), who define leisure luxuries as activities that exhibit little diminishing returns to time and therefore display larger responses to changes in total leisure time. As our definition is at the activity level, it is based on the resource elasticity.

4 Estimation

Our estimation exploits the variation in time and expenditure shares across activities and households, as well as over time. In this section, we first discuss the estimation strategy and results. We then demonstrate that the estimated model matches the data moments and can replicate the signs of the regression coefficients of resource shares on wages, as documented in the data. Finally, we show numerically that luxury activities are associated with a larger within period intertemporal elasticity of substitution (IES).

4.1 Estimation Strategy

Based on Section 3, the estimation focuses on four activities: home luxuries, home necessities, leisure luxuries, and leisure necessities. The imputation procedure yields activity-specific data moments for time use and expenditures, as well as wages for every household in the sample. Given prices of the goods inputs and household-level wages, the model described in Section 2 delivers allocations of time and expenditures for each activity. These model allocations and their relationship to household wages are then used in the estimation to minimize the distance between selected model and data moments.

There are sixteen parameters to estimate: $\{\xi_j\}_{j=1}^4$, $\{\kappa_j\}_{j=1}^4$, $\{\alpha_j\}_{j=1}^3$, $\{\bar{c}_j\}_{i=j}^4$, and ρ. The estimation targets allocations of time and expenditure shares between 2004 and 2019 for each activity and each earnings quintile, as well as household-level regressions of time-use (including market work) and expenditure shares on log wages for each of the four activities. Given wage and price variations, differences in allocations reflect the degree of substitutability between time and goods within an activity and the substitutability across activities. This implies that the allocations of resource shares and the ratio between expenditure and time cost for an activity are crucial for identifying the model parameters. Given the variations in wages and prices in the data, Equation (5) shows that the cross-section and time-series variations in the ratio between expenditure and time cost for an activity $(s_{xj}/s_{\ell j})$ identify ξ_j and κ_j associated with activity j. Similarly, given the variations in wages and prices, Equation (19) shows that the variation in resource shares across activities identifies α, ρ, and $\bar{c}_j$.

4.2 Prices

In addition to allocations and wages, information on goods prices are needed to estimate the model. We obtain prices of goods inputs from the disaggregated indices of the Consumer Price Index (CPI) published by the Bureau of Labor Statistics. Following Casey (2010), we consistently map these disaggregated indices to activity-specific expenditures. The aggregated price index for each of the four activities is derived in three steps. First, we compute expenditure shares at the household level using the most detailed level of data on expenditures available in the CEX. Second, we use these shares as weights to aggregate the corresponding CPI indices to weighted price indices for the four activities at the household level. Finally, we group the households into 50 groups every year according to their income, and for each income group, we average the CPI indices across households using the CEX sample weights in order to find the price index by year between 2004 to 2019 and for each of the four activities.

4.3 Estimation Results

Table 2 summarizes the estimated parameters with standard errors in parentheses. We obtain standard errors by bootstrapping the household-level data. Most of the standard errors are small, implying that the model parameters are precisely identified. Another way to test the estimation is to examine the curvature of the minimized objective function in the neighborhood of the estimated parameter values. As Figure C.1 in the Appendix shows, the objective function increases substantially from the minimum achieved at the parameter estimates when one parameter is changed at a time, indicating that the parameters are well identified.

Table 2: Parameter Estimates

	(1) Home Luxuries	(2) Leis Luxuries	(3) Home Necessities	(4) Leis Necessities
Elast. Time & Goods	ξ_{HL}	ξ_{LL}	ξ_{HN}	ξ_{LN}
	1.484	1.334	0.937	1.124
	(0.014)	(0.006)	(0.004)	(0.006)
Share of Goods	κ_{HL}	κ_{LL}	κ_{HN}	κ_{LN}
	0.653	0.678	0.823	0.438
	(0.010)	(0.010)	(0.010)	(0.013)
Non-homotheticity	$\bar{c}_{HL}$	$\bar{c}_{LL}$	$\bar{c}_{HN}$	$\bar{c}_{LN}$
	-0.020	-0.045	-0.002	0.022
	(0.005)	(0.013)	(0.004)	(0.000)
Utility Weights	α_{HL}	α_{LL}	α_{HN}	α_{LN}
	0.099	0.677	0.193	0.031
	(0.012)	(0.047)	(0.029)	(0.007)
Elast. b/w Activities	ρ			
	0.527			
	(0.047)			

Notes: The table reports the estimates for the preference parameters of the model described in Section 2 (bootstrapped standard errors in parentheses).

We now turn to the results of the estimation. First, consider ξ_j, the elasticity of substitution between time and goods in the production of activities. We find that time and goods are relatively substitutable. As a result, households react strongly to wage and price changes by changing the composition of inputs into their activity production. Moreover, the elasticity of substitution between goods and time differs across activities. It is larger for luxuries than for necessities. In addition, all elasticities are larger than one, except for home necessities, with an elasticity of 0.937, implying a production function close to a Cobb-Douglas form for home necessities.

Second, the weight of expenditures in the activity production, κ_j , is smallest for leisure necessities and largest for home necessities. The estimated standard errors for all κ_j's are small, implying that the share of time inputs required for every activity, 1 - κ_j, are significantly different from zero. This supports Becker's notion that households require a combination of time and goods to enjoy consumption activities. Third, the estimate for the non-homothetic term $\bar{c}_j$ is negative for luxuries and positive or negative but close to zero for necessities. These findings are consistent with the discussion in Section 2.2, where luxuries are associated with smaller $\bar{c}_j$.[6]

Not all activities are equally important in determining the overall utility of households. The weight of an activity, α_j, varies substantially. The two luxuries have a combined weight of 0.78, while the combined weight of necessities is 0.22. At the same time, leisure luxuries and leisure necessities together constitute an important component of households' utility, with a combined utility weight of 0.71. It is thus not surprising that formalizing Becker's (1965) idea beyond home production significantly alters how households allocate time and expenditures when wages or prices change.

Finally, while we observe that time and goods are fairly substitutable within an activity, activities themselves are rather complementary. The estimated elasticity of substitution across activities, ρ, is 0.53, and therefore smaller than all the estimated elasticities of substitution between time and goods, ξ_j. This suggests that it is harder for households to substitute between activities than to substitute between time and goods in the production of a single activity. Hence, much of the time and expenditure adjustments when relative prices change involve reallocating factors within activities rather than across them.

4.4 Model Fit and Identification of Parameters

To check the fit of our model, we first confront the model results with cross-sectional data on time and expenditure shares for each activity. Table 3 reports the average allocations by income quintile over the sample period. The model replicates the variation in time and expenditure shares by activity and income quintile observed in the data. We then compare the household-level regression coefficients obtained by regressing time use and

[6] Despite the relatively large standard errors for some $\bar{c}_j$, all the estimates are statistically different from zero because the parameters' distributions are non-symmetric. Appendix C.2 discusses this issue in greater depth.

expenditure shares on log wages. Table 4 summarizes the results. Panel A reports the time-use regressions and Panel B the expenditure share regressions. The coefficients from the model-based regressions are, in all cases, virtually identical to those estimated from the data.

Table 3: Model Fit – Time and Expenditure Shares

A. Time Use	Model				Data			
Income Quintile	(1) HL	(2) LL	(3) HN	(4) LN	(1) HL	(2) LL	(3) HN	(4) LN
Q1	0.110	0.333	0.190	0.378	0.113	0.326	0.193	0.368
Q2	0.118	0.353	0.179	0.349	0.118	0.353	0.179	0.350
Q3	0.122	0.369	0.174	0.335	0.120	0.365	0.174	0.340
Q4	0.124	0.380	0.171	0.325	0.122	0.378	0.171	0.329
Q5	0.125	0.392	0.169	0.313	0.125	0.392	0.168	0.315

B. Expenditure Share	Model				Data			
Income Quintile	(1) HL	(2) LL	(3) HN	(4) LN	(1) HL	(2) LL	(3) HN	(4) LN
Q1	0.060	0.219	0.593	0.128	0.064	0.221	0.594	0.121
Q2	0.074	0.263	0.541	0.122	0.073	0.259	0.544	0.124
Q3	0.082	0.287	0.513	0.118	0.079	0.284	0.513	0.124
Q4	0.089	0.307	0.489	0.115	0.087	0.306	0.488	0.119
Q5	0.096	0.324	0.469	0.111	0.099	0.327	0.464	0.110

Notes: The top panel reports the share of time for each activity in the model and in the data (averages between 2004 and 2019). The bottom panel reports expenditure shares in the model and in the data (averages between 2004 and 2019). HL is home luxury, LL is leisure luxury, HN is home necessity, and LN is leisure necessity.

To validate the model, we compare a set of non-targeted moments in the model and in the data. Panel A of Table 5 reports the regression coefficients of resource shares on log wages. We see that the estimated model can produce the positive correlations between wages and resource shares of luxuries and the negative correlations between wages and resource shares of necessities. Panels B and C of Table 5 further compare the average allocations of resource shares and the ratio between expenditure and time cost for an activity $(s_{xj}/s_{\ell j})$ by income quintile in the mode and data over the sample period. The model predicts resource shares s_{c_j} that closely match the data, though it slightly overpredicts the average resource shares of home necessities and underpredicts the average shares of leisure necessities. The model also successfully replicates the variation in these resource shares

Table 4: Correlation with Ln Wages – Data vs. Model

	(1) Home Lux	(2) Leisure Lux	(3) Home Nec	(4) Leisure Nec	(5) Market Work
			A. Time Use		
Data	1.755***	7.958***	-2.396***	-7.316***	1.715***
	(0.007)	(0.025)	(0.028)	(0.018)	(0.040)
N	83,557	83,557	83,557	83,557	83,557
Model	1.755***	7.957***	-2.396***	-7.315***	1.715***
	(0.003)	(0.006)	(0.005)	(0.005)	(0.002)
N	83,557	83,557	83,557	83,557	83,557
			B. Expenditure Shares		
Data	4.056***	11.951***	-14.074***	-1.933***	
	(0.100)	(0.149)	(0.162)	(0.075)	
N	83,557	83,557	83,557	83,557	
Model	4.052***	11.939***	-14.059***	-1.932***	
	(0.003)	(0.014)	(0.017)	(0.001)	
N	83,557	83,557	83,557	83,557	

Notes: Data regressions for the time use and expenditure shares, based on CEX data and the imputed time use from the ATUS. All data regressions follow the description in Section 3.2. Model regressions regress the simulated time and expenditure shares on the natural log of wages.

across the income quintile for each activity.

Table 5: Non-Targeted Moments – Data vs. Model

	Data				Model			
A. Regression of Resource Shares on Ln Wages								
	(1) HL	(2) LL	(3) HN	(4) LN	(1) HL	(2) LL	(3) HN	(4) LN
Coeff.	2.29***	8.80***	-5.28***	-5.81***	4.43***	15.89***	-10.28***	-8.32***
Std. Error	(0.03)	(0.04)	(0.04)	(0.02)	(0.00)	(0.01)	(0.02)	(0.01)
B. Resource Shares s_{cj} by Quintile								
	(1) HL	(2) LL	(3) HN	(4) LN	(1) HL	(2) LL	(3) HN	(4) LN
Q1	0.107	0.311	0.254	0.327	0.094	0.288	0.323	0.295
Q2	0.114	0.341	0.232	0.314	0.104	0.324	0.300	0.273
Q3	0.117	0.356	0.222	0.306	0.108	0.342	0.288	0.262
Q4	0.120	0.371	0.214	0.296	0.112	0.356	0.279	0.253
Q5	0.124	0.385	0.210	0.281	0.115	0.368	0.273	0.243
C. s_{xj}/s_{lj} by Quintile								
	(1) HL	(2) LL	(3) HN	(4) LN	(1) HL	(2) LL	(3) HN	(4) LN
Q1	0.142	0.150	0.610	0.064	0.104	0.130	0.596	0.065
Q2	0.144	0.152	0.548	0.065	0.120	0.143	0.580	0.067
Q3	0.165	0.159	0.514	0.064	0.131	0.151	0.567	0.068
Q4	0.169	0.164	0.490	0.063	0.141	0.158	0.555	0.069
Q5	0.192	0.177	0.502	0.063	0.150	0.162	0.543	0.070

Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Data regressions for the time use, expenditure shares, and resource shares are based on CEX data and the imputed time use from the ATUS. All data regressions follow the description in Section 3.2. Model regressions regress the simulated time and expenditure shares on the natural log of wages.

4.5 Luxuries, Necessities, and the IES

Browning and Crossley (2000) and Aguiar et al. (2012) show that luxuries have higher within period intertemporal elasticity of substitution (in absolute terms) if the utility function is additively separable over time and over consumption goods or activities. Since we do not impose separability of activities in the utility function, it is unclear whether luxuries have a higher intertemporal elasticity of substitution (IES) in our model. To explore the relationship between the IES and the luxuriousness of an activity, Table 6 calculates the within period IES numerically in our model, where the IES for activity j is defined as in Aguiar et al. (2012) for different income quintiles:

$$IES_j = -\frac{\partial U/\partial c_j}{c_j \partial^2 U/\partial^2 c_j}. \tag{20}$$

The table calculates the IES by income quintile for each of the four activities and shows that, indeed, luxuries have higher IES in our model. The two luxury activities have an IES well above one, while necessities have an IES well below one. In fact, the IES for leisure necessities is only about one-fifth that of leisure luxuries.

Table 6: Intertemporal Elasticity of Substitution

	(1) Home Luxuries	(2) Leis Luxuries	(3) Home Necessities	(4) Leis Necessities
Q1	1.489	1.816	0.650	0.267
Q2	1.300	1.561	0.642	0.273
Q3	1.211	1.453	0.638	0.277
Q4	1.140	1.363	0.634	0.282
Q5	1.081	1.291	0.631	0.287

Notes: The table reports the means (across years) of the estimated intertemporal elasticity of substitution computed according to (20). For each year and income quintile we calculate the IES for each activity using the estimated values of the parameters and the model-implied allocations of expenditures and time use.

5 Model Mechanisms

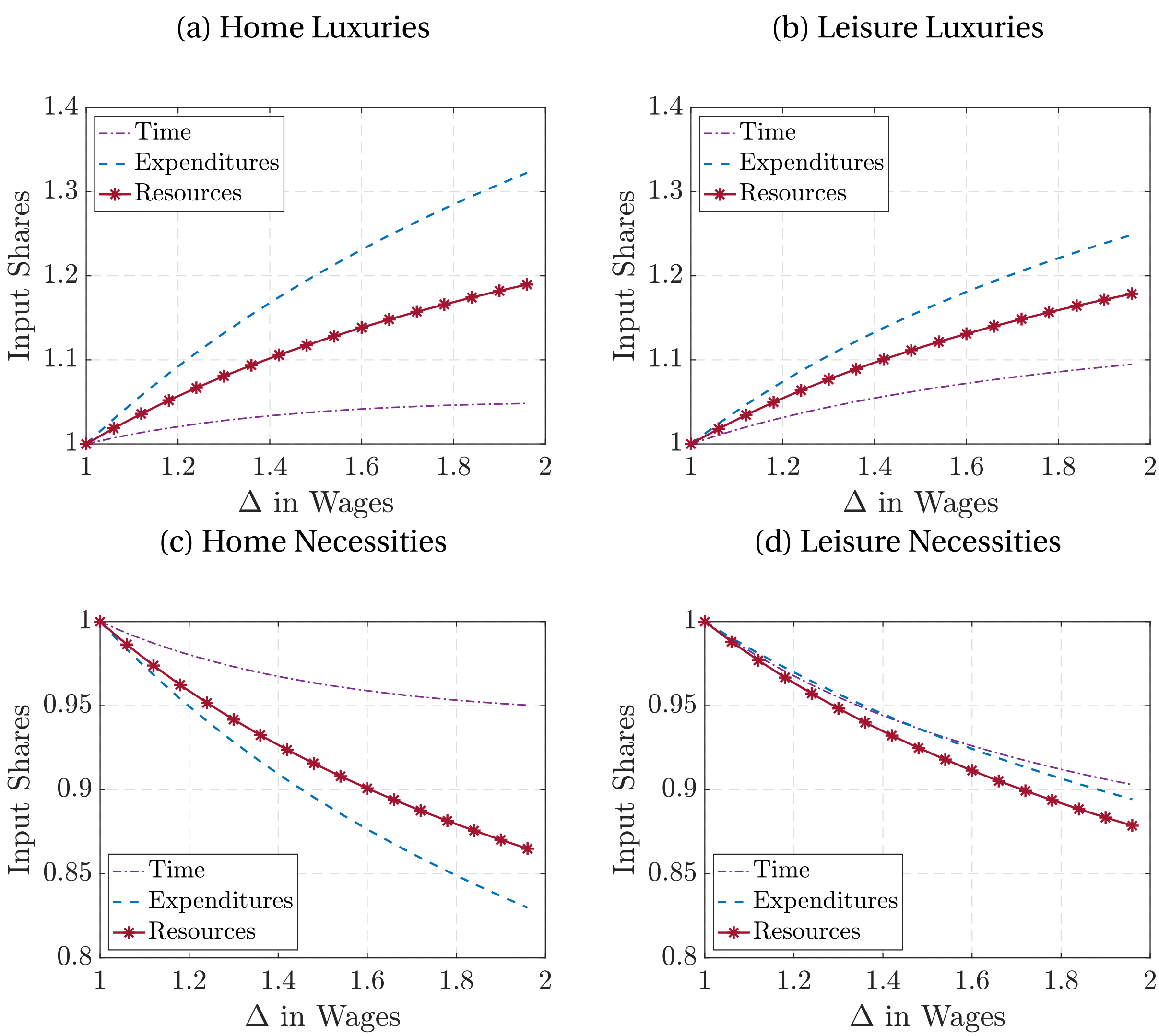
This section explores the mechanisms underlying our model by assessing the effects of changes in wages and prices on the allocations of time, expenditures, and resource shares across activities. Specifically, we simulate changes in these allocations in response to wage or price fluctuations and compare the outcomes to a baseline scenario where the wage is set to the average wage in our sample and prices for goods inputs are maintained at their average levels over the period of 2004 to 2019.

5.1 Response of Input Shares to Wage Changes

Figure 3 illustrates the simulation results for each activity when wages increase. It plots the input shares of each activity for expenditures, time, and total resources $\left(\frac{p_j x_j}{\sum_j p_j x_j}, \frac{w\ell_j}{\sum_j w\ell_j}, s_{cj}\right)$ relative to the baseline. All three shares increase for luxury activities with rising wages.

Conversely, for necessities, wage increases lead to decreases in all input shares. Overall, the decline in time allocated to necessities slightly outweighs the increase in time allocated to luxuries, resulting in a rise in market hours due to the increase in wages.

Figure 3: Response of Input Shares to Wage Changes



Notes: This figure plots the percent changes in expenditure, time, and resource shares in response to wage increases relative to the baseline where wage is set to the average wage in our sample and prices for market goods are kept at their average levels over the sample period.

The intuition behind this result is illustrated by Equations (21) and (22), which decompose the wage effects on expenditures and time into three components: the substitution effect across activities, the substitution effect between time and goods within an activity, and the income effect.

$$\frac{\partial p_j x_j}{\partial w} = \frac{\partial \left(s_{cj} w s_{xj}\right)}{\partial w} = \underbrace{w s_{xj} \sum_s \frac{\partial s_{cj}}{\partial p_s^c} \frac{\partial p_s^c}{\partial w}}_{\text{subs. across activities}} + \underbrace{s_{cj} w \frac{\partial s_{xj}}{\partial w}}_{\text{subs. across goods and time}} + \underbrace{s_{xj} \left(w \frac{\partial s_{cj}}{\partial w} + s_{cj}\right)}_{\text{income effect}} \tag{21}$$

$$\frac{\partial w \ell_j}{\partial w} = \frac{\partial \left(s_{cj} w s_{\ell j}\right)}{\partial w} = \underbrace{w s_{\ell j} \sum_s \frac{\partial s_{cj}}{\partial p_s^c} \frac{\partial p_s^c}{\partial w}}_{\text{subs. across activities}} + \underbrace{s_{cj} w \frac{\partial s_{\ell j}}{\partial w}}_{\text{subs. across goods and time}} + \underbrace{s_{\ell j} \left(w \frac{\partial s_{cj}}{\partial w} + s_{cj}\right)}_{\text{income effect}} \tag{22}$$

The first term describes the substitution effect across activities. As illustrated by Property 2, an increase in w raises the activity price p_j^c. This increase is more pronounced for activities where time is a relatively more important input (indicated by a smaller κ_j), making such activities costlier to consume. In response, households substitute away from activities with smaller κ_j. The estimation shows that leisure necessities have the smallest κ_j, while home necessities have the largest κ_j. This leads to a decline in the resource shares for leisure necessities and an increase for home necessities as wages rise. However, this substitution alone cannot fully explain the patterns of resource shares shown in Figure 3, where resource shares decline for both types of necessities.

The second term describes the substitution effect between goods and time in the production of an activity. As wages increase, households substitute time with goods in the production of each activity. The magnitude of this substitution is governed by the elasticity of substitution ξ_j, where a larger ξ_j leads to a more pronounced shift from time inputs to goods inputs as wages rise. As outlined in Property 1, when goods and time are substitutes $\xi_j > 1$, an increase in w leads to an increase in expenditure share (s_{xj}) and a decrease in time-cost share ($s_{\ell j}$). Conversely, when goods and time are complements ($\xi_j < 1$), the effect is reversed. The estimated ξ_j is larger for luxuries than for necessities, resulting in a stronger substitution from time to goods for luxuries. This substitution effect, as wage increases, results in a decline in the share of time spent on luxuries $\left(\frac{w\ell_j}{\sum_j w\ell_j}\right)$, suggesting that this effect alone cannot explain increases in this share for luxuries, as depicted in Figure 3.

The last terms in Equations (21) and (22) describe the income effect, which raises consumption of all activities. By definition, the income effect on luxuries is more pronounced. This results in larger increases in expenditure and time cost for luxuries, thereby raising their expenditure share, time-cost share, and resource share, while reducing these shares for necessities. These results are consistent with the patterns shown in Figure 3, suggesting that among the three components of wage effect, the income effect is the primary driver of the changes in input shares in response to wage variations. The size of the income effect is related to the luxuriousness of an activity, which is closely related to the size of $\bar{c}_j$.

5.2 Response of Input Shares to Goods Price Changes

The effect of goods input prices p_j on input shares depends on whether the price change is for a luxury or a necessity, and whether it affects the input of an activity itself or the inputs of other activities. To understand these effects, Figures 4 and 5 plot changes in time, expenditure, and resource shares following an increase in the goods input price of a home necessity and a leisure luxury, respectively. An increase in the price of a home necessity leads to reductions in time, expenditure, and resource shares for all other activities, while input shares for the home necessity itself increase. Appendix Figure D.3 confirms similar patterns for leisure necessities. Conversely, an increase in the price of a luxury activity produces the opposite effect. Figure 5 and Appendix Figure D.4 demonstrate that expenditure and resource shares decrease in response to an own price increase, while time input shares rise. Input shares of all other activities rise in response to a luxury price increase.

The quantitative effect of price changes on expenditure and time input shares is governed by two substitution effects: (i) that across activities, and (ii) that between time and goods within an activity. These effects vary across activities since the response to a price change is determined by both the activity-specific non-homothetic term $\bar{c}_j$ and the elasticity of substitution ξ_j. Equations (23) and (24) decompose the own price effects into these two substitution effects:

$$\frac{\partial p_j x_j}{\partial p_j} = \frac{\partial \left(p_j^c c_j s_{xj}\right)}{\partial p_j} = \underbrace{s_{xj}\left(\frac{\partial p_j^c c_j}{\partial p_j^c}\frac{\partial p_j^c}{\partial p_j}\right)}_{\text{subs. across activities}} + \underbrace{p_j^c c_j\left(\frac{\partial s_{xj}}{\partial p_j}\right)}_{\text{subs. across goods and time}}, \tag{23}$$

$$\frac{\partial w\ell_j}{\partial p_j} = \frac{\partial \left(p_j^c c_j s_{\ell j}\right)}{\partial p_j} = \underbrace{s_{\ell j}\frac{\partial p_j^c c_j}{\partial p_j^c}\frac{\partial p_j^c}{\partial p_j}}_{\text{subs. across activities}} + \underbrace{p_j^c c_j\frac{\partial s_{\ell j}}{\partial p_j}}_{\text{subs. across goods and time}}. \tag{24}$$

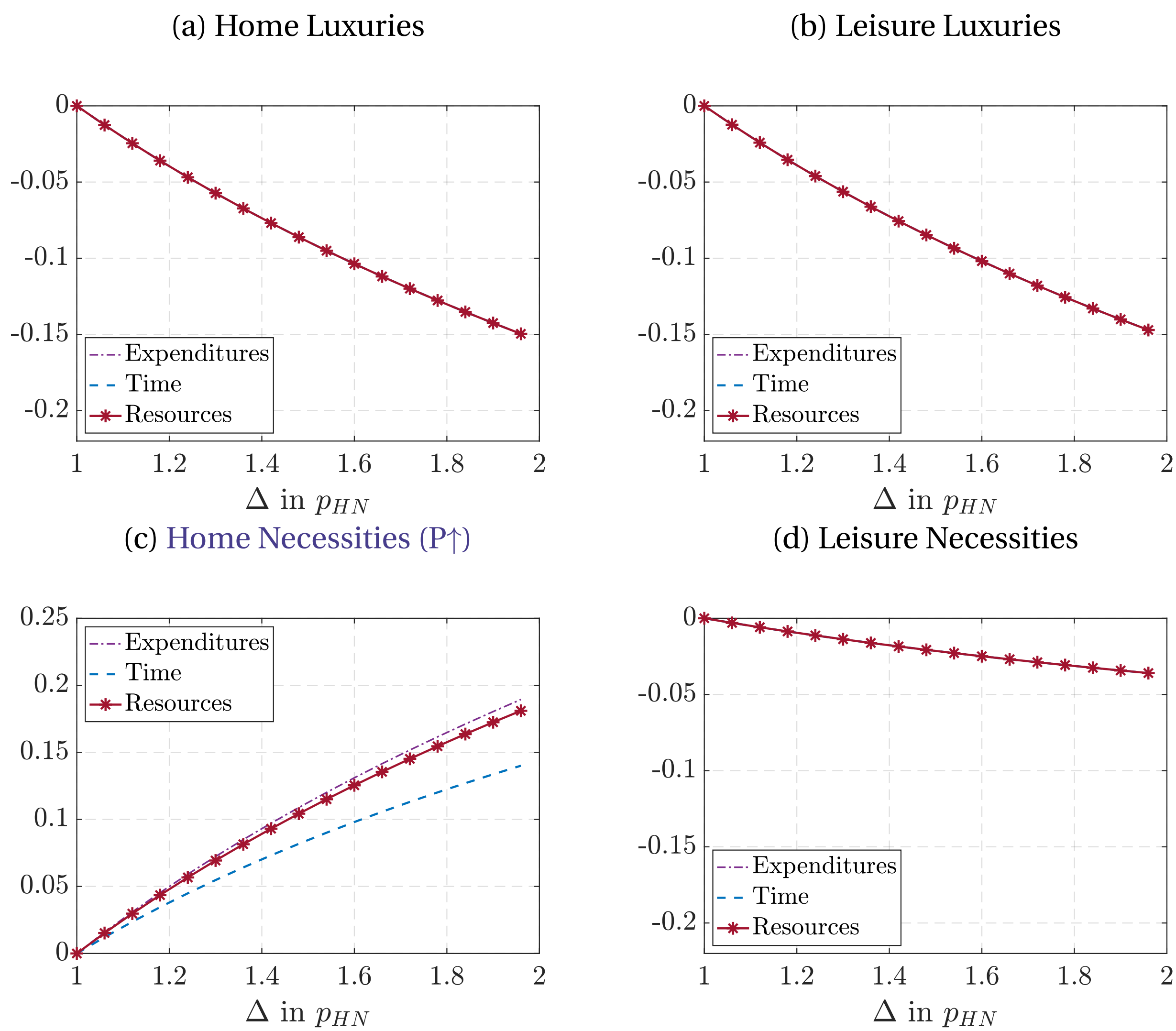
Let us first consider the changes in time and expenditure input shares resulting from an increase in the price of a necessity. According to Property 1, when time and goods are substitutes $\xi_j > 1$, an increase in p_j leads to substitution from x_j to ℓ_j, resulting in a decline in the expenditure share $\left(\frac{\partial s_{xj}}{\partial p_j} < 0\right)$ and an increase in the time-cost share $\left(\frac{\partial s_{\ell j}}{\partial p_j} > 0\right)$. Conversely, when time and goods are complements $\xi_j < 1$, the effects are reversed. For a home necessity, where the estimated ξ_j is close to one, there is little substitution from goods to time and thus both s_{xj} and $s_{\ell j}$ remain relatively constant in response to its own price increase. Therefore, the own price effects on both expenditure and time inputs for home necessity are mostly determined by the substitution effects across activities.

The substitution across activities is, in turn, determined by the response of resources spent on an activity j, $p_j^c c_j$, as well as the resources spent on all other activities, $p_i^c c_i$, when the price, p^c_j, changes:

$$\frac{\partial p^c_j c_j}{\partial p^c_j} = \frac{\partial \gamma_j}{\partial p^c_j}\left(w - \sum_s p^c_s \bar{c}_s\right) + (1-\gamma_j)\bar{c}_j \tag{25}$$

$$\frac{\partial p^c_i c_i}{\partial p^c_j} = \frac{\partial \gamma_i}{\partial p^c_j}\left(w - \sum_s p^c_s \bar{c}_s\right) - \gamma_i \bar{c}_j. \tag{26}$$

Figure 4: Response of Input Shares to a Change in the Home-Necessity Price



Notes: This figure plots the percent changes in the levels of expenditure, time cost, and resource to changes in home-necessity price relative to the baseline where wage is set to the average wage in our sample and prices for goods inputs are kept at their average levels in our sample period.

Equations (25) and (26) show that the substitution effect across activities is determined by γ_j, which is a price index of all activities. When activities are complements ($\rho < 1$), Property 3 shows that γ_j increases as the own price p^c_j rises, $\frac{\partial \gamma_j}{\partial p^c_j} > 0$, and decreases when the prices of all other activities increase, $\frac{\partial \gamma_j}{\partial p_i^c} < 0$. Suppose the non-homothetic term $\bar{c}_j$ is zero. Equations (25) and (26) then imply that the substitution effect shifts resources towards activity j when p_j^c increases, i.e., $\frac{\partial p_j^c c_j}{\partial p_j^c} > 0$. This substitution increases both expenditure and time costs spent on activity j, thereby reducing them for all other activities. For necessities, the estimated $\bar{c}_j$ is either close to zero or positive, which increases the substitution across activities and thus reinforces the reallocation of resources towards activity j.[7] Hence, an increase in a necessity price increases the time, expenditure, and resource shares of the necessity itself and reduces these shares for all other activities.

For luxuries, the overall effect of a price increase is determined by a combination of the substitution effect between time and goods within an activity, and the substitution effect across activities. Recall that for necessities, this former effect was approximately zero. However, for luxuries, the estimated ξ_j is significantly larger than one, implying more substitutability between time and goods in the activity production. Property 1 then indicates that for an increase of the own goods input price, p_j, households respond by increasing the share of time inputs, $s_{\ell j}$, and reducing the expenditure input share, s_{xj}. Figure 5, Panel (b), and Figure D.4, Panel (a), confirm this result for leisure and home luxuries.

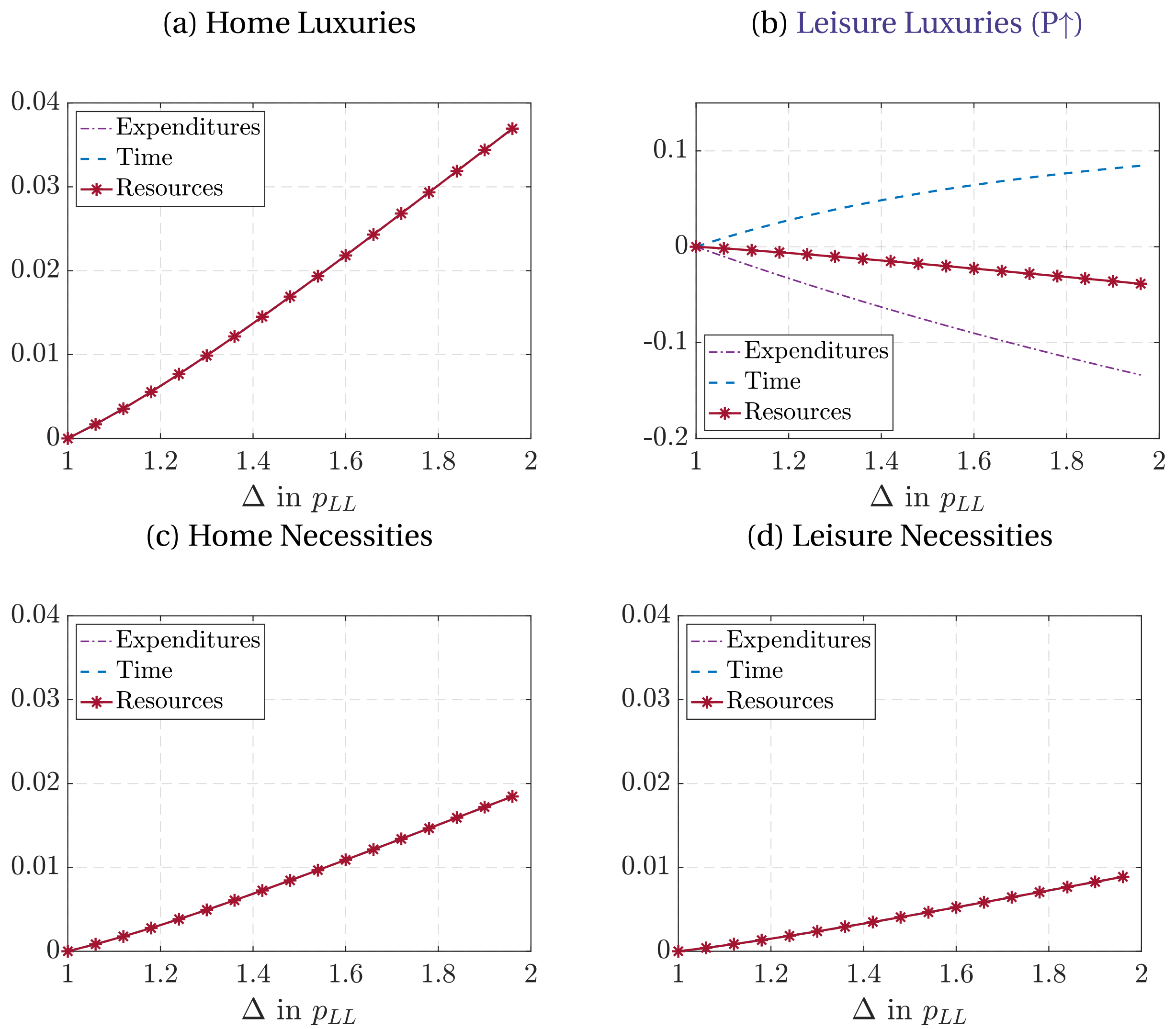
Furthermore, for luxuries, the substitution effect across activities generates the opposite effect compared to necessities. The effect is determined by the estimated $\bar{c}_j$, which is negative for luxuries. According to Equations (25) and (26), when the goods input price increases for a luxury, the negative $\bar{c}_j$ leads to a decrease in the resource share for this luxury itself, while increasing the resource shares for all other activities. This response contrasts with that observed for necessities, underscoring the importance of modeling both luxuries and necessities.

Finally, Figure 6 captures the duality between luxuries and necessities by plotting the responses of resource shares to individual price changes. We see that the resource share of a luxury activity declines when its own price increases, while resource shares for all other activities increase. Overall, the reallocation across activities is relatively small. In contrast, when the goods input price of a necessity increases, its resource share increases as well, while the resource shares of all other activities decline. The reallocation of resources across activities is particularly strong for necessities.

In summary, luxuries and necessities exhibit distinct responses to changes in (i) wages and (ii) prices. First, as wages increase, resource shares for luxury activities rise, while those for necessity activities decline. This wage effect can be decomposed into three key components: the substitution effect across activities, the substitution effect between time and goods within an activity, and the income effect, with this last effect being the most

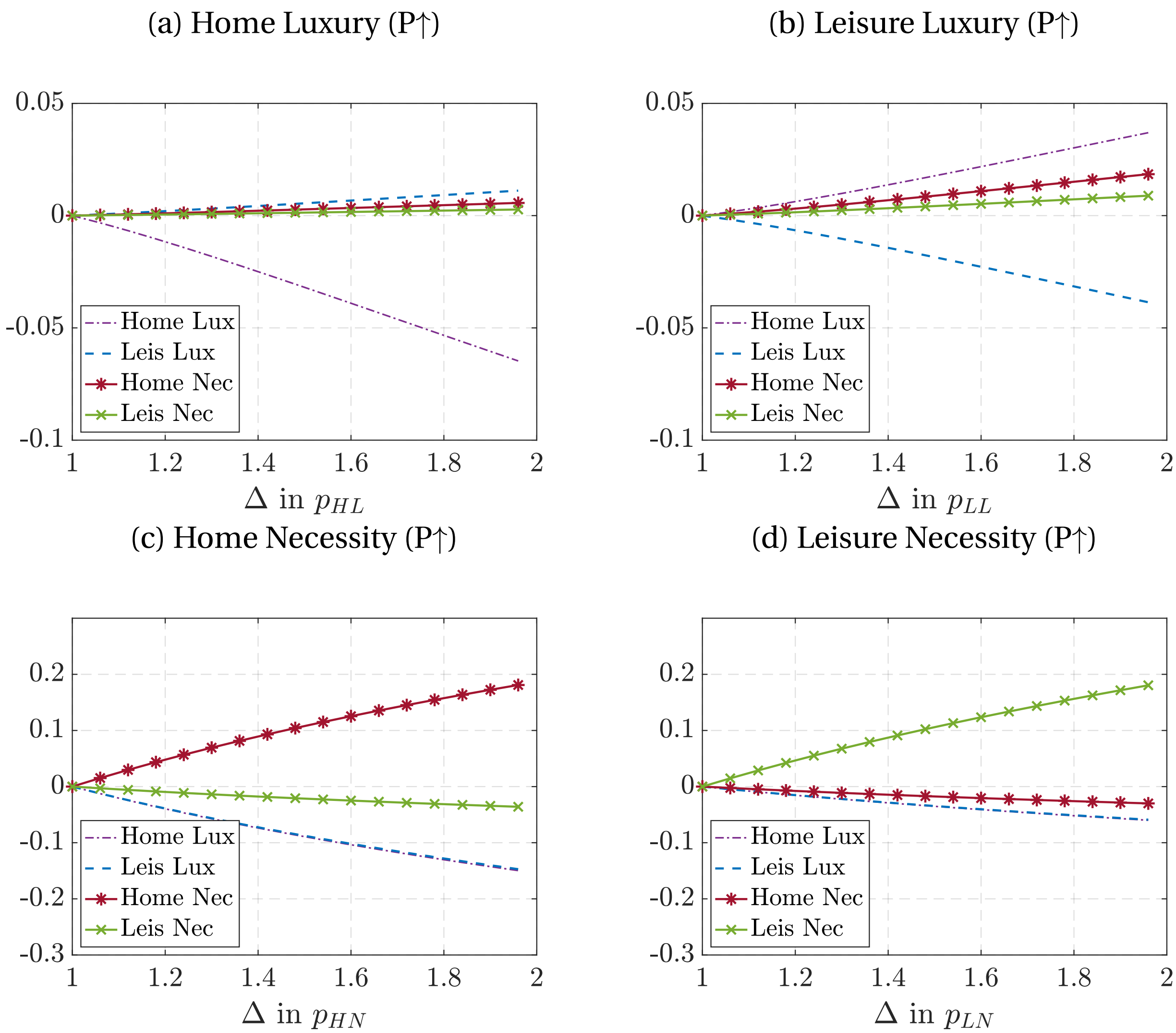
[7]The price effect on the allocation of time ℓ_j is the same as on time costs since wage is held constant in the price experiments.

Figure 5: Response of Input Shares to a Change in the Leisure-Luxury Price



Notes: This figure plots the percent changes in the levels of expenditure, time cost, and resource to changes in leisure-luxury price relative to the baseline where wage is set to the average wage in our sample and prices for goods inputs are kept at their average levels in our sample period.

Figure 6: Response of Resource Shares to Price Changes



Notes: This figure plots the percent changes in resource shares to changes in prices relative to the baseline where wage is set to the average wage in our sample and prices for goods inputs are kept at their average levels in our sample period. Each panel represents the price change of an activity as indicated.

important in explaining the observed changes in input shares. Second, the impact of price changes varies as well between luxuries and necessities. An increase in the goods input price of a luxury activity affects input shares through a combination of two substitution effects, leading to a decrease in the resource share for that activity while increasing the share for all other activities. Conversely, when the input price for a necessity activity increases, the resulting pattern is mainly driven by the substitution effect across activities. These dynamics highlight the importance of distinguishing between luxuries and necessities when analyzing how households adjust their consumption to wage and price changes.

6 Luxuries, Necessities, and Inequality

In Section 5, we demonstrated that changes in wages and goods prices prompt households to reallocate time and expenditures among various activities. This reallocation shifts the distribution of income and consumption activities across households. In this section, we use the model to examine how the evolution of wages and prices from 2004 to 2019 affected income, consumption, and welfare inequality.

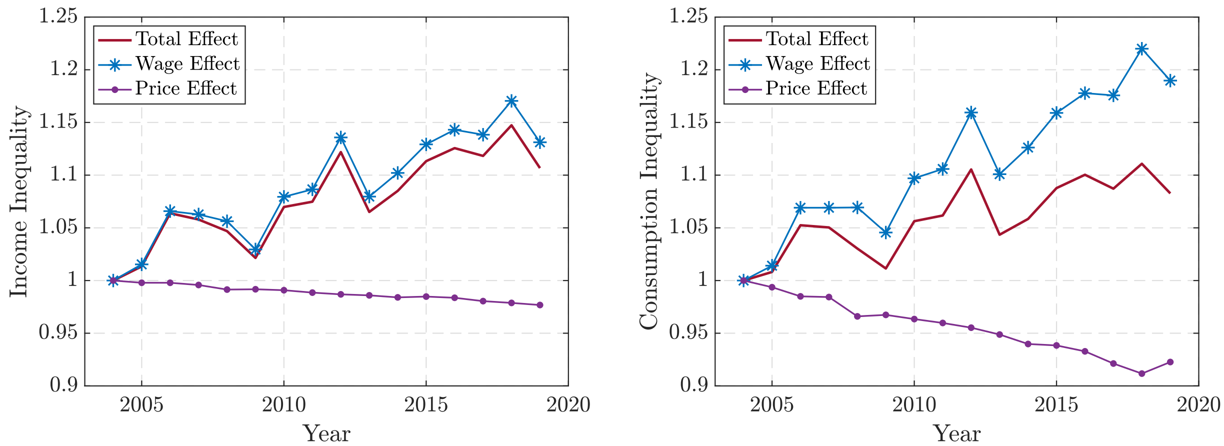
6.1 Income and Consumption Inequality

We first examine the evolution of income and consumption inequality by simulating the model with the entire distribution of predicted wages for all households in the CEX sample as well as goods input prices by income group, as constructed in Section 4. There are 50 prices for each goods inputs in every year, capturing the variation in input prices across income levels. Income inequality is measured by the standard deviation of the natural log of income. Consumption is measured by the amount of the consumption composite of all activities that households consume. Consumption inequality is then measured by the standard deviation of the natural log of the consumption composite. The line “Total Effect” in Figure 7 illustrates the evolution of income and consumption inequality over the sample period, with values in 2004 normalized to one. Both income and consumption inequality increased during this period, with income inequality rising by 11% and consumption inequality by 8%.

Wage Effect Figure 7 decomposes the total increase in income and consumption inequality into effects stemming from changes in wages and prices. The impact of wage changes over the sample period is assessed by simulating the model using the distribution of predicted wages from the CEX sample, while keeping activity prices fixed at their 2004 values.

Figure 7: Income and Consumption Inequality between 2004 and 2019

(a) Income Inequality (b) Consumption Inequality



Notes: This figure plots income and consumption inequality using the distribution of predicted wages for the CEX households. Activity-specific prices are constructed as described in Section 4. Income inequality is defined as the standard deviation of the natural log of income. Similarly, consumption inequality is the standard deviation of the natural log of the consumption composite. The values in 2004 are normalized to one.

Given that the dispersion in wages widened between 2004 and 2019, these changes resulted in increased income inequality. In fact, a comparison between the total effect and the wage effect in Figure 7(a) reveals that almost all the increase in income inequality can be attributed to the rising wage dispersion.

The rise in wage dispersion also exacerbates consumption inequality, with an increase of 18%—more than double the overall rise in consumption inequality. The influence of wage dispersion on consumption inequality operates through two channels. The first is standard: the larger the wage inequality, the greater the consumption inequality. The second channel, unique to our model, highlights how the distinction between luxury and necessity activities amplifies the effect of increased wage dispersion on consumption inequality. We discuss this novel mechanism in greater detail in Section 6.2.

Price Effect To explore the impact of price fluctuations, we simulate the model with time-varying prices while keeping wages fixed at their 2004 distribution. This evolution of prices tends to reduce income inequality by decreasing the dispersion in hours worked, although the quantitative impact is small compared to that of wages. Conversely, the effect of prices on consumption inequality is substantial and negative. The magnitude of this price effect is 8%, which is about the same as the total changes in consumption inequality over this period, but it moves in the opposite direction. Overall, the positive effect of rising wages outweighs the negative effect of fluctuating prices, leading to an increase in consumption inequality.

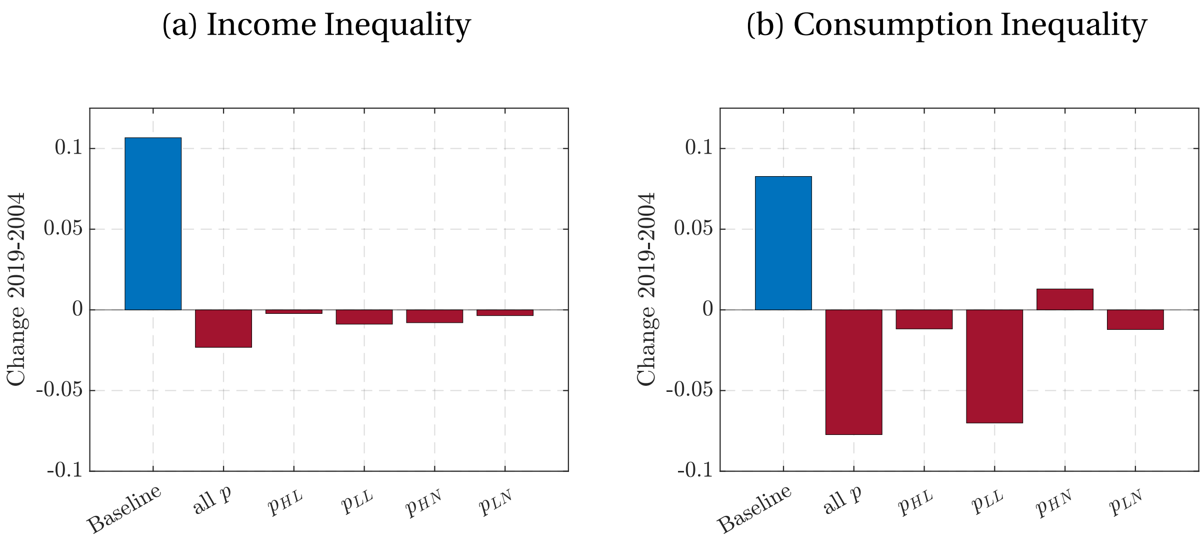
Figure 8 examines the significant role that individual activity prices play in generating the negative price effect on income and consumption inequality. When simulating the model with one price varying at a time, and holding all other prices and wages fixed at their 2004 distribution, the increase in the leisure luxury price significantly reduces consumption inequality. The magnitude of this reduction is roughly equivalent to the overall price effect observed. Over the sample period, the price of luxury leisure increased the most, the average price increase even exceeding the increase in the average wage. This price increase led households—especially wealthier ones, that consume larger amounts of luxury leisure—to cut back on their consumption of the activity (Figure 5). Hence, the consumption of activity bundles between rich and poor households converge and consumption inequality declines.

In the analysis, we assume all households in a given income percentile face the same goods input prices. However, households may encounter different prices due to variations in the type or quality of goods used to produce the same activity. For example, given the same income, some households may be more likely to dine at fine restaurants, whereas others opt for consuming fast food. Recent studies utilizing scanner data have revealed significant price dispersion for comparable goods. This dispersion is evident across different stores and even within the same store over short periods, often influenced by sales and discounts (see, for example, Aguiar and Hurst (2007), Kaplan and Menzio (2015), or Pytka (2024)). Introducing this kind of price heterogeneity into our model is likely to strengthen the effects of price variations on consumption inequality.

6.2 The Importance of Luxuries and Necessities

Parameter Restrictions Luxuries and necessities respond differently to wage and price changes, and this is driven by the size of the activity-specific non-homothetic term $\bar{c}_j$. To evaluate the importance of modeling both activity types, we simulate a version of the model that sets $\bar{c}_j = 0 \, \forall j$, while keeping all other parameters at their baseline values, thus removing the distinction between luxuries and necessities entirely. Figure 9 compares the percentage change in income and consumption inequality from 2004 to 2019 between this restricted model and the baseline. Although the overall difference in the total effect appears relatively small, this belies the fact that the effects of wage and price changes are substantially more pronounced in the baseline model. Since the wage and price effects offset each other due to their opposing signs, the total effect on income and consumption inequality remains relatively similar between the two models.

Figure 8: Impact of Individual Price on Inequality



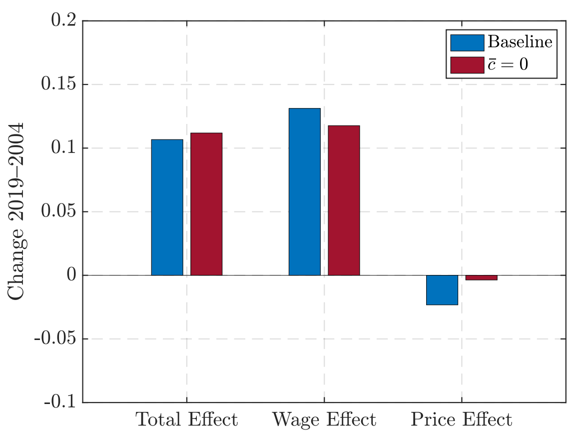
Notes: We compute the percentage change in income and consumption inequality between 2004 and 2019 in the baseline model where wage and all prices evolve as in the data. The first counterfactual experiment keeps the 2004 wage distribution, but varies all prices. The following counterfactual experiments keep the 2004 wages, vary only one price, and recompute the percentage change in income and consumption inequality between 2019 and 2004. p_{HL} is the home luxury price, p_{LL} is the leisure luxury price, p_{HN} is the home necessity price, and p_{LN} is the leisure necessity price.

The offsetting effects of wage and price changes are particularly pronounced for consumption inequality. Panel (b) of Figure 9 shows that in the restricted model, consumption inequality increases by about 1.4 percentage points compared to the baseline, representing a 14.5% increase in consumption inequality. The total effect can be further decomposed into the wage and price effects. The wage effect on consumption inequality is 4.4 percentage points smaller in the restricted model, corresponding to a 23.2% reduction relative to the baseline. Similarly, the price effect is reduced by 4.9 percentage points, indicating a 63.4% reduction. Given the substantial reduction of the price effect in the restricted model, the total effect on consumption inequality increases when $\bar{c}_j = 0$ is assumed.

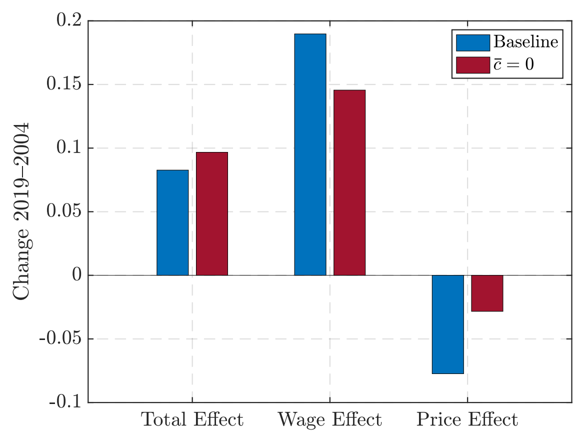
To understand why the impacts of wages and prices on consumption inequality are more pronounced in the baseline model, recall the different mechanisms discussed in Section 5. On the one hand, the response of input shares to wage changes is determined by the income effect, whose magnitude is closely linked to $\bar{c}_j$. With $\bar{c}_j = 0$, the income effect is muted, resulting in less variation in resource shares in response to wage changes and therefore generating smaller effects of wages on consumption inequality. On the other hand, the response of input shares to price changes is influenced by the substitution effect between time and goods within an activity, as well as the substitution across activities. $\bar{c}_j$ affects the magnitude of the substitution effect across activities. A positive $\bar{c}_j$ (associated with necessities) amplifies the substitution effect across activities, whereas a negative $\bar{c}_j$ (associated with luxuries) reduces it. Hence, the price effect on consumption inequality in the restricted model relative to the baseline is ex-ante unclear and remains a quantitative question. Figure 9 shows that the price effect is smaller in absolute terms when $\bar{c}_j = 0$, implying less reallocation of resources across activities. Thus, distinguishing between luxuries and necessities amplifies the impact of both wage and price changes on consumption inequality.

Figure 9: Parameter restrictions: $\bar{c} = 0$

(a) Income Inequality



(b) Consumption Inequality



Notes: This figure plots the percentage change in income and consumption inequality between 2004 and 2019 in the baseline model and the counterfactual case of $\bar{c}_j = 0 \; \forall j$. HL is home luxury, LL is leisure luxury, HN is home necessity, and LN is leisure necessity.

Effect of Activity Types on Inequality To further explore the impact of luxuries and necessities on inequality, we modify the model to include only luxuries or necessities. We adjust the utility weights, α_i, in each version of the two-activity model to ensure they sum to one, while keeping all other parameters at their baseline values. Figure 10 plots the percentage change in the inequality measure over the sample period for the baseline model and each version of the two-activity model. Panel (a) of Figure 10 shows that income inequality remains largely unchanged when only luxuries or necessities are included.

Panel (b) of Figure 10 shows that including only luxuries or necessities has, however, sizeable effects on consumption inequality. Specifically, the two-activity model with only necessities increases consumption inequality by 2.0 percentage points, which translates to an increase of 24.1% from the baseline four-activity model. In contrast, the model with only luxuries results in a decline of consumption inequality by 1.0 percentage point or

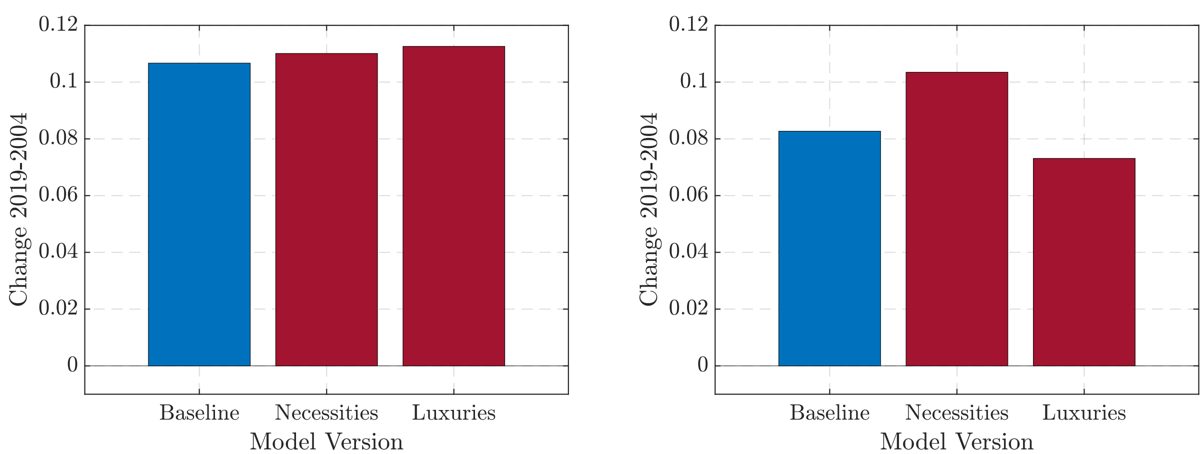
12.0% relative to the baseline.

The quantitative effects on consumption inequality arise due to the heterogeneity in ξ_j across activities. Excluding an activity with high ξ_j reduces the overall substitutability of time and goods among the remaining activities, thus restricting households' ability to reallocate resources in response to wage or price changes, which in turn increases consumption inequality. Conversely, excluding an activity with a low ξ_j reduces consumption inequality by allowing greater flexibility in resource allocation. Both home and leisure luxuries are characterized by a high ξ_j. Removing them implies that households can only allocate resources to the two necessities characterized by a low substitutability between time and goods, leading to an increase in consumption inequality. In contrast, the model with only luxuries improves households' ability to reallocate resources, thereby reducing consumption inequality.

Figure 10: Models with only Necessities or Luxuries

(a) Income Inequality

(b) Consumption Inequality



Notes: Each counterfactual case reduces the model to a two-activity model by excluding the consumption of either luxury or necessity activities and re-normalizing the α_j of the two remaining activities such that they sum to one. This figure plots the percentage change in income and consumption inequality between 2004 and 2019 in the baseline model with four activities and in each of the two-activity models. "Necessities" indicates the model with only necessities and "Luxuries" the model with only luxuries.

6.3 Welfare Inequality

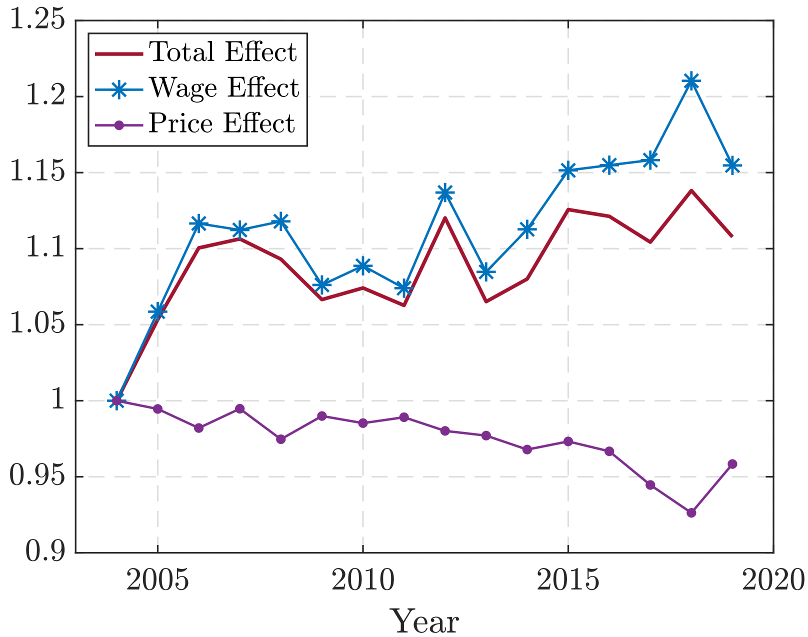
Finally, we assess the model implications for the evolution of welfare inequality over the sample period. Specifically, we organize households in the CEX into 50 income groups in each year. For an average household within each income group and year, we calculate the hypothetical wage in 2004 that, given 2004 prices, would allow the household to achieve the same utility as it would when faced with the prices and wages of any other year. This is done by setting the hypothetical wage for the g^{th} wage percentile, w'_{gt}, such that $U(w'_{gt}, \vec{P}_{2004}) = U(w_{gt}, \vec{P}_t)$, where t spans the years $t = 2004, ..., 2019$, w_{gt} represents the average wage for the g^{th} wage percentile in year t, and $\vec{P}_t$ is the vector of goods inputs prices for that year.

The change in welfare inequality between year t and 2004 can be assessed by comparing the dispersion in the hypothetical wages, w'_{gt}, with the dispersion of the actual wages observed in 2004. Specifically, a greater dispersion in w'_{gt} would indicate that a more dispersed wage distribution would be necessary for households facing 2004 prices to achieve the same utility as their counterparts in the same wage percentile in year t. This also implies greater welfare inequality in year t compared to 2004. Figure 11 plots our measure of welfare inequality: the standard deviation of $log(w'_{gt})$ normalized by the standard deviation of $log(w_{2004})$. We observe that this measure of welfare inequality increased by 10.8% over the sample period (i.e., "Total Effect" in Figure 11), and its evolution mirrors that of the consumption inequality depicted in Figure 7.

We can further decompose the change in welfare inequality into the contributions of wages and prices, similar to the decomposition for income and consumption inequality. For wages, we measure the impact by holding prices constant at 2004 values. This analysis uses a hypothetical wage that satisfies $U(w'_{gt}, \vec{P}_{2004}) = U(w_{gt}, \vec{P}_{2004})$, which implies that $w'_{gt} = w_{gt}$ in this case. Hence, the contribution of wage changes to welfare inequality is quantified by the observed changes in the dispersion of actual wages over time. Similarly, the contribution of prices is assessed by holding wages constant at 2004 values. This requires a hypothetical wage that satisfies $U(w'_{gt}, \vec{P}_{2004}) = U(w_{g2004}, \vec{P}_t)$. This approach isolates the impact of price changes by comparing the utility a household would have at 2004 wage levels across different price levels over the years.

Figure 11 shows that during the sample period, the evolution of wages led to an increase in welfare inequality, while changes in prices worked in the opposite direction. These dynamics mirror the effects that wage and price changes have on consumption inequality. In comparing Figures 7 and 11, we observe that consumption inequality rose by 8% over the sample period, whereas welfare inequality increased by 10.8%. However, the magnitude of the impacts of wage and price changes on welfare inequality is not as pronounced as on consumption inequality. Specifically, wage changes contributed to a 15.5% increase in welfare inequality from 2004 to 2019, whereas price changes reduced it by 4.2%. As observed with consumption inequality, the wage effect remains the dominant factor influencing welfare inequality.

Figure 11: Welfare Inequality



Notes: This figure plots the welfare inequality over the sample period, with the values in 2004 normalized to one. Refer back to the text for an explanation of how welfare and welfare inequality are measured.

7 Conclusion

In this paper, we develop a model inspired by Becker (1965), in which households derive utility from different consumption activities by combining time and goods. To estimate the model, we integrate detailed activity-level data on time use and consumption expenditures, assigning them to specific consumption activities. We categorize activities into luxuries and necessities based on how resource shares—defined as the sum of expenditures and time costs—respond to wage changes. Luxuries are activities where resource shares increase with wages, while necessities are those where resource shares decrease.

By exploiting variations in the allocation of expenditures and time across households and over time, we assess the impact of wage and price changes on consumption and welfare inequality from 2004 to 2019. Our findings indicate that increasing wage dispersion heightened inequality, whereas rising prices mitigated it. Yet, the overall effect of wage increases outweighed the dampening impact of price increases, resulting in a net increase in both consumption and welfare inequality. Distinguishing between luxury and necessity activities makes this dynamic particularly pronounced. Indeed, resources allocated to luxuries and necessities respond differently to wage and price changes, thereby altering overall inequality outcomes.

Our parsimonious model formalizes Becker's (1965) concept to study how changes in wages and activity prices affect allocations and welfare. There are numerous potential extensions to this analysis. For instance, our model's rich structure would allow to analyze significant shifts in time and expenditure allocations among activities pre- and post-retirement. Another direction would be to explore how different household compositions (e.g., the presence of children) influence allocations, particularly when the necessity for home-based activities increases. These questions offer promising avenues for future research.

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Online Appendix (Not for Publication)

A Model Appendix

A.1 Model Solution

The household's maximization problem can be solved in two steps. In the first step the household chooses x_i and ℓ_j to produce a given amount of c_j by minimizing the resources $R_j = p_j x_j + w\ell_i$ spent on activity j.

$$\min_{x_j,\ell_j} R_j = p_j x_j + w\ell_j$$

$$s.t. \qquad c_j = \left(\kappa_j x_j^{\frac{\xi_j-1}{\xi_j}} + (1-\kappa_j)\ell_j^{\frac{\xi_j-1}{\xi_j}}\right)^{\frac{\xi_j}{\xi_j-1}}.$$

The first order conditions give:

$$\frac{\ell_j}{x_j} = \left(\frac{p_j}{w}\right)^{\xi_j}\left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}. \tag{A.27}$$

Simple manipulation of the definition of c_j gives

$$c_j = x_j \kappa_j^{\frac{\xi_j}{\xi_j-1}}\left[1 + \frac{1-\kappa_j}{\kappa_j}\left(\frac{\ell_j}{x_j}\right)^{\frac{\xi_j-1}{\xi_j}}\right]^{\frac{\xi_j}{\xi_j-1}}. \tag{A.28}$$

Plugging Equation (A.27) into the above Equation gives

$$c_j = x_j \kappa_j^{\frac{\xi_j}{\xi_j-1}}\left[1 + \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}\left(\frac{p_j}{w}\right)^{\xi_j-1}\right]^{\frac{\xi_j}{\xi_j-1}}. \tag{A.29}$$

Define $M_j \equiv \kappa_j^{\frac{\xi_j}{\xi_j-1}}\left[1 + \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}\left(\frac{p_j}{w}\right)^{\xi_j-1}\right]^{\frac{\xi_j}{\xi_j-1}}$. Therefore,

$$x_j = \frac{c_j}{M_j}, \quad \text{and} \quad \ell_j = \left(\frac{p_j}{w}\right)^{\xi_j}\left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}\frac{c_j}{M_j}. \tag{A.30}$$

Hence, we can write the budget constraint as follows:

$$\sum_j \left[p_j \frac{c_j}{M_j} + w\left(\frac{p_j}{w}\right)^{\xi_j}\left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}\frac{c_j}{M_j}\right] = \sum_j \left[p_j \frac{c_j}{M_j}\left(1 + \left(\frac{p_j}{w}\right)^{\xi_j-1}\left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}\right)\right] = w. \tag{A.31}$$

Simple manipulation yields:

$$\sum_j \left[p_j \frac{c_j}{M_j} \left(1 + \left(\frac{p_j}{w}\right)^{\xi_j - 1} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} \right) \right] = \sum_j \frac{p_j}{\kappa_j M_j^{\frac{1}{\xi_j}}} c_i = \sum_j \frac{p_j}{\frac{\partial c_j}{\partial x_j}} c_j = w. \tag{A.32}$$

Let $p_j^c = \frac{p_j}{\kappa_j} M_j^{-\frac{1}{\xi_j}} = \frac{p_j}{\frac{\partial c_j}{\partial x_j}}$ be the shadow price of c_j. We have

$$R = \sum_j p_j^c c_j = w. \tag{A.33}$$

Hence, the household's problem can be transformed to maximize utility subject to the budget constraint (A.33):

$$\begin{aligned} \max U(c_1, ...c_n) &= log\left(\sum_j \alpha_j (c_j - \bar{c}_j)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \\ s.t. \quad R = \sum_j p_j^c c_j &= w. \end{aligned}$$

From the FOCs:

$$\frac{\alpha_i (c_i - \bar{c}_i)^{-\frac{1}{\rho}}}{\alpha_j (c_j - \bar{c}_j)^{-\frac{1}{\rho}}} = \frac{p_i^c}{p_j^c}. \tag{A.34}$$

$$c_i = \left(\frac{p_j^c \alpha_i}{p_i^c \alpha_j}\right)^{\rho} (c_j - \bar{c}_j) + \bar{c}_i \tag{A.35}$$

Plug the above equation into the budget constraint (A.33):

$$\sum_i p_i^c \left[\left(\frac{p_j^c \alpha_i}{p_i^c \alpha_j}\right)^{\rho} (c_j - \bar{c}_j) + \bar{c}_i \right] = R. \tag{A.36}$$

$$c_j = \frac{R - \sum_i p_i^c \bar{c}_i}{\sum_i p_i^c \left(\frac{p_j^c \alpha_i}{p_i^c \alpha_j}\right)^{\rho}} + \bar{c}_j = \frac{R - \sum_i p_i^c \bar{c}_i}{\left(\frac{p_j^c}{\alpha_j}\right)^{\rho} \sum_i \alpha_i^{\rho} (p_i^c)^{1-\rho}} + \bar{c}_j = \frac{\gamma_j}{p_j^c} \left(R - \sum_i p_i^c \bar{c}_i \right) + \bar{c}_j, \tag{A.37}$$

$$p_j^c c_j = \frac{\alpha_j^{\rho} (p_j^c)^{1-\rho}}{\sum_i \alpha_i^{\rho} (p_i^c)^{1-\rho}} (R - \sum_i p_i^c \bar{c}_i) + p_j^c \bar{c}_j = \gamma_j (R - \sum_i p_i^c \bar{c}_i) + p_j^c \bar{c}_j, \tag{A.38}$$

where $\gamma_j = \frac{\alpha_j^{\rho} (p_j^c)^{1-\rho}}{\sum_i \alpha_i^{\rho} (p_i^c)^{1-\rho}}$ and $\sum_j \gamma_j = 1$.

$$s_{cj} = \frac{p_j^c c_j}{R} = \gamma_j + \left(p_j^c \bar{c}_j - \gamma_j \sum_i p_i^c \bar{c}_i \right) \frac{1}{R} \tag{A.39}$$

A.2 Model Properties 1–3

Property 1: If $\xi_j > 1$, s_{xj} will rise with wage and fall with price p_j, while $s_{\ell j}$ will decrease with wage and increase with price p_j. If $\xi_j < 1$, the relationships invert.

$$\frac{\partial s_{xj}}{\partial p_j} < 0, \quad \frac{\partial s_{\ell j}}{\partial p_j} > 0, \quad \frac{\partial s_{xj}}{\partial w} > 0, \quad \frac{\partial s_{\ell j}}{\partial w} < 0, \quad \text{if} \quad \xi_j > 1 \tag{A.40}$$

$$\frac{\partial s_{xj}}{\partial p_j} > 0, \quad \frac{\partial s_{\ell j}}{\partial p_j} < 0, \quad \frac{\partial s_{xj}}{\partial w} < 0, \quad \frac{\partial s_{\ell j}}{\partial w} > 0, \quad \text{if} \quad \xi_j < 1 \tag{A.41}$$

Proof: Using Equation (A.27), we have

$$\frac{s_{\ell j}}{s_{xj}} = \frac{w\ell_j}{p_j x_j} = \left(\frac{p_j}{w}\right)^{(\xi_j - 1)} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}. \tag{A.42}$$

From equation (A.33),

$$p_j x_j + w\ell_j = p_j^c c_j. \tag{A.43}$$

$$\frac{p_j x_j}{p_j^c c_j} + \frac{w\ell_j}{p_j^c c_j} = 1; \quad s_{xj} + s_{\ell j} = 1. \tag{A.44}$$

Combining the above equations gives:

$$s_{xj} = \frac{1}{1 + \left(\frac{p_j}{w}\right)^{(\xi_j-1)} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j}} = \kappa_j M_j^{\frac{1-\xi_j}{\xi_j}} \tag{A.45}$$

$$s_{\ell j} = 1 - \kappa_j M_j^{\frac{1-\xi_j}{\xi_j}}. \tag{A.46}$$

$$\begin{aligned} \frac{\partial s_{xj}}{\partial p_j} &= \kappa_i \frac{1-\xi_j}{\xi_j} M_j^{\frac{1-2\xi_j}{\xi_j}} \frac{\partial M_j}{\partial p_j} = \kappa_j \frac{1-\xi_j}{\xi_j} M_j^{\frac{1-2\xi_j}{\xi_j}} \left[\kappa_j \xi_j M_j^{\frac{1}{\xi_j}} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} w^{1-\xi_j} p_j^{\xi_j - 2}\right] \\ &= \kappa_j^2 (1-\xi_j) \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} M_j^{\frac{2-2\xi_j}{\xi_j}} w^{1-\xi_j} p_j^{\xi_j-2} \end{aligned} \tag{A.47}$$

$$\begin{aligned} \frac{\partial s_{xj}}{\partial w} &= \kappa_j \frac{1-\xi_j}{\xi_j} M_j^{\frac{1-2\xi_j}{\xi_j}} \frac{\partial M_j}{\partial w} = \kappa_j \frac{1-\xi_j}{\xi_j} M_j^{\frac{1-2\xi_j}{\xi_j}} \left[-\kappa_j \xi_j M_j^{\frac{1}{\xi_j}} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} w^{-\xi_j} p_j^{\xi_j - 1}\right] \\ &= -\kappa_j^2 (1-\xi_j) \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} M_j^{\frac{2-2\xi_j}{\xi_j}} w^{-\xi_j} p_j^{\xi_j-1} \end{aligned} \tag{A.48}$$

Property 2: Activity price p_j^c increases with both p_j and w, and does not depend on p_i.

$$\frac{\partial p_j^c}{\partial w} > 0, \quad \frac{\partial p_j^c}{\partial p_j} > 0, \quad \text{and} \quad \frac{\partial p_j^c}{\partial p_i} = 0 \, \forall i \neq j \tag{A.49}$$

Proof: Note that p_j^c is not a function of p_i for $i \neq j$. Hence $\frac{\partial p_j^c}{\partial p_i} = 0$.

$$\begin{aligned}
\frac{\partial p_j^c}{\partial p_j} &= \frac{1}{\kappa_j} M_j^{-\frac{1}{\xi_j}} - \frac{p_j}{\kappa_j}\frac{1}{\xi_j} M_j^{-\frac{1}{\xi_j}-1} \frac{\partial M_j}{\partial p_j} \\
&= \frac{1}{\kappa_j} M_j^{-\frac{1}{\xi_j}} - \frac{p_j}{\kappa_j}\frac{1}{\xi_j} M_j^{-\frac{1}{\xi_j}-1} \left[\kappa_j \xi_j M_j^{\frac{1}{\xi_j}} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} w^{1-\xi_j} p_j^{\xi_j - 2}\right] \\
&= \frac{1}{\kappa_j} M_j^{-\frac{1}{\xi_j}} - M_j^{-1} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} \left(\frac{p_j}{w}\right)^{\xi_j - 1} \\
&= \frac{1}{\kappa_j} M_j^{-\frac{1}{\xi_j}} \left[1 - \kappa_j M_j^{\frac{1-\xi_j}{\xi_j}} \left(\frac{1}{\kappa_j} M_j^{\frac{\xi_j - 1}{\xi_j}} - 1\right)\right] \\
&= M_j^{-1} > 0
\end{aligned} \tag{A.50}$$

$$\begin{aligned}
\frac{\partial p_j^c}{\partial w} &= -\frac{p_j}{\kappa_j}\frac{1}{\xi_j} M_j^{-\frac{1}{\xi_j}-1} \frac{\partial M_j}{\partial w} \\
&= -\frac{p_j}{\kappa_j}\frac{1}{\xi_j} M_j^{-\frac{1}{\xi_j}-1} \left[-\kappa_j \xi_j M_j^{\frac{1}{\xi_j}} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} w^{-\xi_j} p_j^{\xi_j - 1}\right] \\
&= M_j^{-1} \left(\frac{1-\kappa_j}{\kappa_j}\right)^{\xi_j} \left(\frac{p_j}{w}\right)^{\xi_j} > 0
\end{aligned} \tag{A.51}$$

Property 3: If $\rho < 1$, γ_j increases with its own price and decreases with prices of other activities. Instead, if $\rho > 1$, γ_j decreases with its own price and increases with prices of other activities.

$$\begin{aligned}
&\frac{\partial \gamma_j}{\partial p_j^c} > 0, \quad \frac{\partial \gamma_j}{\partial p_i^c} < 0, \quad \forall \rho < 1 \\
&\frac{\partial \gamma_j}{\partial p_j^c} < 0, \quad \frac{\partial \gamma_j}{\partial p_i^c} > 0, \quad \forall \rho > 1
\end{aligned} \tag{A.52}$$

Proof:

$$\frac{\partial \gamma_j}{\partial p_i^c} = -\frac{\alpha_j^\rho (p_j^c)^{1-\rho} \alpha_i^\rho (p_i^c)^{-\rho}(1-\rho)}{[\sum_s \alpha_s^\rho (p_s^c)^{1-\rho}]^2} = -\frac{\gamma_j \gamma_i (1-\rho)}{p_i^c}. \tag{A.53}$$

$$
\begin{aligned}
\frac{\partial \gamma_j}{\partial p_j^c} &= \frac{\alpha_j^\rho (p_j^c)^{-\rho}(1-\rho)(\sum_s \alpha_s^\rho (p_s^c)^{1-\rho}) - \alpha_j^\rho (p_j^c)^{1-\rho}\alpha_j^\rho (p_j^c)^{-\rho}(1-\rho)}{[\sum_s \alpha_s^\rho (p_s^c)^{1-\rho}]^2} \\
&= \left((1-\rho)\frac{\gamma_j}{p_j^c} - (1-\rho)\frac{\gamma_j^2}{p_j^c} \right) \\
&= (1-\rho)\frac{\gamma_j}{p_j^c}(1-\gamma_j). \qquad \text{(A.54)}
\end{aligned}
$$

B Data for Estimation

B.1 American Time Use Survey 2004–19

Following Aguiar et al. (2013), we divided the total time for every individual surveyed in the American Time Use Survey (ATUS) into nine categories. These categories can be aggregated into three main time-use categories: market work, home activities, and leisure activities. Home activities include core home production, homeownership activities, obtaining goods and services, and caring for others. Leisure activities include watching TV, socializing, eating and personal care, and hobbies and entertainment.

Table B.2 summarizes the underlying ATUS activity codes for these categories. The ATUS indicates whether a time diary was recorded on a weekday or on a weekend or holiday. To obtain a representative estimate of the weekly hours allocated to one activity, we weighted weekday records by 5/7 and weekend or holiday records by 2/7.

B.2 Consumer Expenditure Survey 2004–19

The Consumer Expenditure Survey (CEX) consists of two components with separate questionnaires and independent samples. We used the interview-panel survey in which consumer units (CU) are interviewed once every three months over five consecutive quarters. The survey therefore records consumption expenditures for every CU over one year. The data for the interview panel are 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, and the earnings of the reference person and their spouse. Income data are collected during the second and fifth interviews. We used information collected in the fifth interview to approximate labor income and the work status of the CU. We defined a the reference person or spouse as working if they report positive salary income.

Sample Selection We restrict the samples in both surveys between 2004-2019 and only consider individuals aged 21-65. In the ATUS, we exclude students, disabled, and retirees. We drop all interviewees who did not fill out a complete time use diary and who do not

Table B.1: ATUS 2004-19 Categorization

Activity	Description of Activities
1. Market Work	Working, Work-Related Activities, Work and Work-Related Activities n.e.c., Travel Related to Working, Travel Related to Work-Related Activities, Travel Related to Work n.e.c.
2. Home Activities	
2.1 Core Home Production	Housework, Food & Drink Prep., Presentation & Clean-up, Interior Maintenance, Repair & Decoration, Vehicles, Appliances, Tools, Toys, Household Management, Travel Related to Household Activities
2.2 Homeownership Activities	Interior Maintenance; Repair & Decoration, Exterior Maintenance; Repair & Decoration; Lawn, Garden & Houseplants; Travel Related to Exterior Maintenance; Repair & Decoration; Travel Related to Lawn, Garden & Houseplant Care
2.3 Obtaining Goods & Services	Consumer Purchases, Professional & Personal-Care Services, Household Services, Government Services & Civic Obligations, Travel Related to Consumer Purchases, Travel Related to Using Professional and Personal-Care Services, Travel Related to Using Household Services, Travel Related to Using Govt Services & Civic Obligations
2.4 Others Care	Caring for Household (HH) Adults, Helping Household Adults, Caring for & Helping HH Members, n.e.c., Caring for Non-HH Adults, Helping Non-HH Adults, Caring for & Helping Non-HH Members, n.e.c., Travel Related to Caring for HH Adults, Travel Related to Helping HH Adults, Travel Related to Caring for & Helping HH Members, Travel Related to Caring for Non-HH Adults, Travel Related to Helping Non-HH Adults, Travel Related to Caring for & Helping Non-HH Members, n.e.c.
3. Leisure Activities	
3.1 Watching TV	Television and Movies (not Religious), Television (Religious)
3.2 Socializing	Socializing and Communicating, Attending or Hosting Social Events, Playing Games, Waiting Assoc. with Socializing & Communicating, Waiting Assoc. with Attending/Hosting Social Events, Telephone Calls, Travel Related to Socializing and Communicating, Travel Related to Attending or Hosting Social Events, Travel Related to Telephone Calls
3.3 Eating and Personal Care	Grooming, Personal Activities, Personal-Care Emergencies, Personal Care, n.e.c., Eating and Drinking, Travel Related to Personal Care, Travel Related to Eating and Drinking
3.4 Hobbies and Entertainment	Animals and Pets; HH & Personal Mail & Messages (except E-mail); HH & Personal E-mail and Messages; Relaxing and Leisure; Arts and Entertainment (Other than Sports); Waiting Associated with Socializing, Relaxing, and Leisure; Socializing, Relaxing, and Leisure, n.e.c.; Sports, Exercise, and Recreation; Travel Related to Care for Animals and Pets (not Vet Care); Travel Related to Relaxing and Leisure; Travel Related to Sports, Exercise, & Recreation

Table B.2: ATUS 2004-19 Categorization: Activity Codes

Activity	ATUS Activity Code
1. Home Activities	
1.1 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
1.2 Homeownership Activities	02-03-01, 02-04, 02-05, 18-02-04, 18-02-05
1.3 Obtaining Goods and Services	07, 08 (excl. 08-04), 09,10, 18-07, 18-08 (excl. 18-08-04), 18-09, 18-10
1.4 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
2. Leisure Activities	
2.1 Watching TV	12-03-03, 12-03-04
2.2 Socializing	12-01, 12-02, 12-03-07, 12-05-01, 12-05-02, 16, 18-12-01, 18-12-02, 18-16
2.3 Eating and Personal Care	01-02, 01-04, 01-05, 01-99, 11, 18-01, 18-11
2.4 Hobbies 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

report any of the following information: age, education, race, number of children, or home ownership. These restrictions leave us with 138,883 individuals surveyed between 2004 and 2019. We further drop observations with hourly wages less than USD 5 and above USD 300, following Boerma and Karabarbounis (2021).

In the CEX, we only include married households with positive household income and positive consumption expenditures. We construct hourly wages for head and spouse by dividing annual income by weeks worked multiplied by usual hours worked per week. We exclude hourly wages of less than USD 5 and more than 300 USD for the head or the spouse. We also drop observations with missing weekly hours. Further restricting the sample to married couples yields 84,446 observations between 2004 and 2019.

Table B.3: CEX 2004-19 Categorization

Activity	Description of 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. Home Activities	

2.1 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; nonpermanent carpet squares; blinds; clocks; lamps; decorative items; kitchen utensils; household services; rental of furniture; rental of household and office equipment for nonbusiness 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 nonbusiness use)
2.2 Homeownership	Maintenance, repairs, and other expenses (excl. homeowner's insurance, parking, and management fees); floor coverings (excl. nonpermanent carpet squares); installed and noninstalled wall-to-wall carpeting; building an attic, installing a pool, or finishing a basement
2.3 Obtaining Goods and Services	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
2.4 Other Care	Care for invalids or elderly persons; adult-care centers; care in nursing home (net outlay)
3. Leisure	
3.1 Watching TV	Cable services; TVs; video streaming; satellite dishes; repair, rental, and installation of TV and satellite equipment
3.2 Socializing	Catered affairs; live entertainment; party supplies; telephone services and devices; watches; jewelry; dating services
3.3 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
3.4 Hobbies 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 campers, boats, or aircraft; reading (excl. encyclopedias); miscellaneous entertainment outlays; pets, toys, and playground equipment; musical instruments; photographic equipment; event fees and admission; computers and software for nonbusiness use; tobacco and smoking supplies

Table B.4: CEX 2004-19 UCC codes

Activity	Universal Classification Codes (UCCs)

1. Home Activities	
1.1 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
1.2 Homeownership	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
1.3 Obtaining Goods and Services	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
1.4 Other Care	340906 340910 570220
2. Leisure Activities	
2.1 Watching TV	270310 310110 310120 310130 310140 310240 310334 340610 340902 690320 690330

2.2 Socializing	190902 270101 270102 270103 270104 270105 320232 430110 430120 680310 680320 680904 690210
2.3 Eating and Personal Care	640130 640420 650110 650210 650310 650900 190903 190904 200900 790310 790320 790330 790410 790420
2.4 Hobbies 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

Notes: UCCs change across survey waves. In every quarter, some UCCs might be discontinued while new ones might be added to the survey. In addition, new UCCs might not be represented in all quarters. This table reports the UCCs for all survey waves combined.

B.3 Time Use Imputation in the CEX

Table B.5: Time Use: Actual (ATUS) versus Imputed (CEX)

Activity	Actual Daily Hours (ATUS)	Imputed Daily Hours (CEX)	Difference
	A. Time Use on Weekdays		
Core Home Production	1.4926	1.4616	0.0310
Home Ownership	0.2615	0.2817	-0.0202
Obtaining Goods & Services	0.6298	0.6333	-0.0035
Other Care	0.2010	0.1984	0.0026
Watching TV	2.3369	2.3517	-0.0148
Socializing	0.8438	0.8704	-0.0266
Eating & Personal Care	1.7797	1.7966	-0.0169
Hobbies & Entertainment	1.2702	1.2767	-0.0065
	B. Time Use on Weekends		
Core Home Production	1.8117	1.7911	0.0206
Home Ownership	0.4511	0.4701	-0.0190
Obtaining Goods & Services	0.9151	0.9020	0.0131
Other Care	0.2087	0.2174	-0.0087
Watching TV	3.1178	3.1728	-0.0550
Socializing	1.5074	1.4916	0.0158
Eating & Personal Care	1.9399	1.9317	0.0082
Hobbies & Entertainment	1.5849	1.6179	-0.0330
Average Daily Hours	9.5930	9.6488	-0.0070

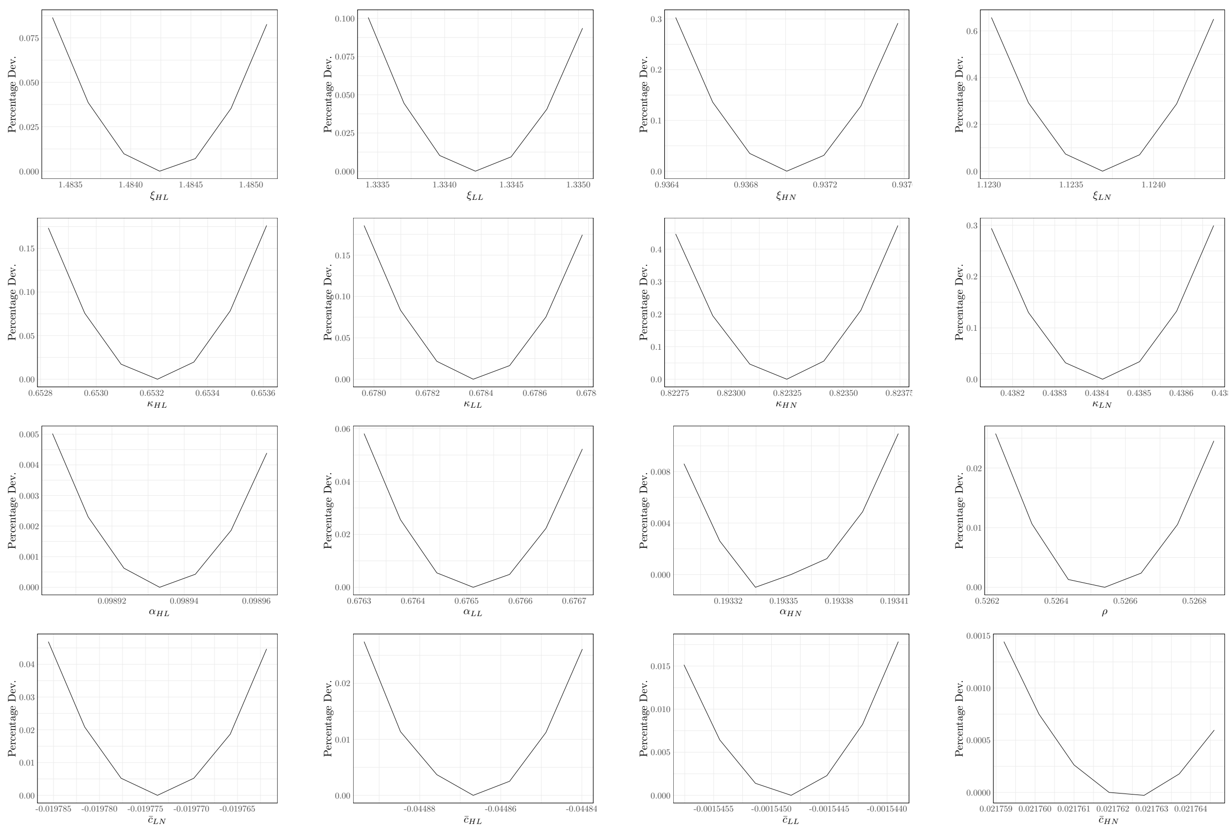
The table reports the average daily time use in the ATUS and the average time use for each activity after imputing time use in the CEX data. Average Daily Hours weight weekday time use with 5/7 and weekend observations with 2/7 to reflect the distribution of days in a representative week.

C Estimation

C.1 Identification of Parameters

The estimation problem described in the main text is highly non-linear. As a result, formal proof of identification in this type of framework is difficult. To give a sense of the behavior of the objective function around the minimum, and to at least examine whether there are apparent flat regions that could threaten identification, we take the following heuristic approach. We examine changes in the objective function in a neighborhood of the estimated parameter values changing one parameter at the time. Figure C.1 shows the sixteen plots (one for each parameter), where each plot shows the percentage deviation in the objective function value.

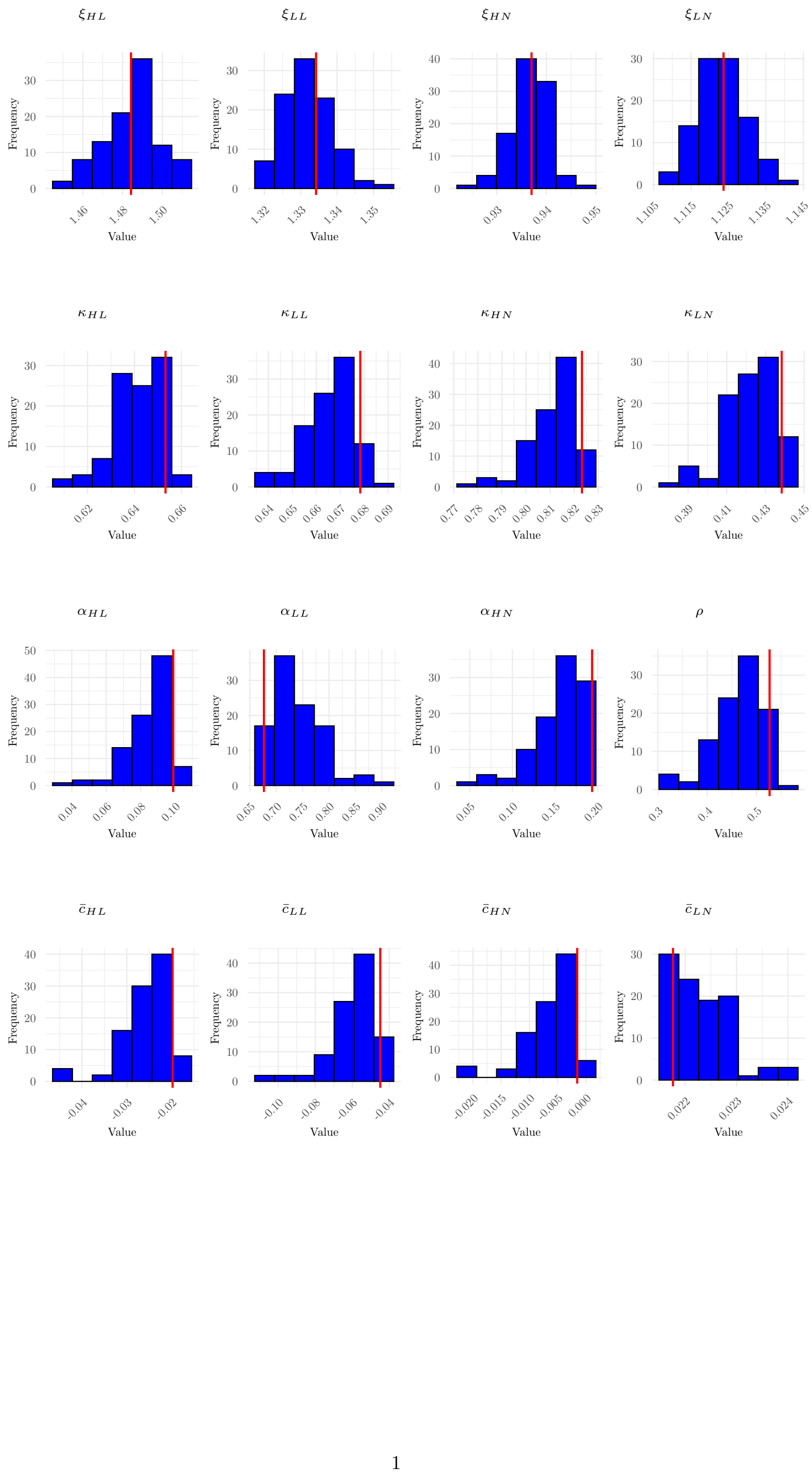
Figure C.1: Identification of Parameters



C.2 Distributions of Parameter Estimates

While most estimated parameters' standard errors are small relative to their estimated values, the standard errors for the non-homothetic terms $\bar{c}_j$ are the exception. For example, the estimated value of $\bar{c}_{LL}$ is -0.018 and the standard error is 0.019. If the estimate distribution was approximately normal, this would imply that that little would be lost by setting this parameter to zero. However, the boostrapped distributions are non-symmetric with a high skewness. Figure C.2 shows a histogram of the bootstrapped draws for each parameter estimate. Each plot includes the estimates shown on Table 2 (vertical red lines). As is evident from the plots, few parameter distributions are symmetric. Most of them are either left- or right-skewed. This makes inference about distance from zero based on standard errors only misleading. For example, the draws of the parameter $\bar{c}_{LL}$ are virtually all less than zero, but with the standard error (the standard deviation of the distribution) large relative to the value estimated with the original data.

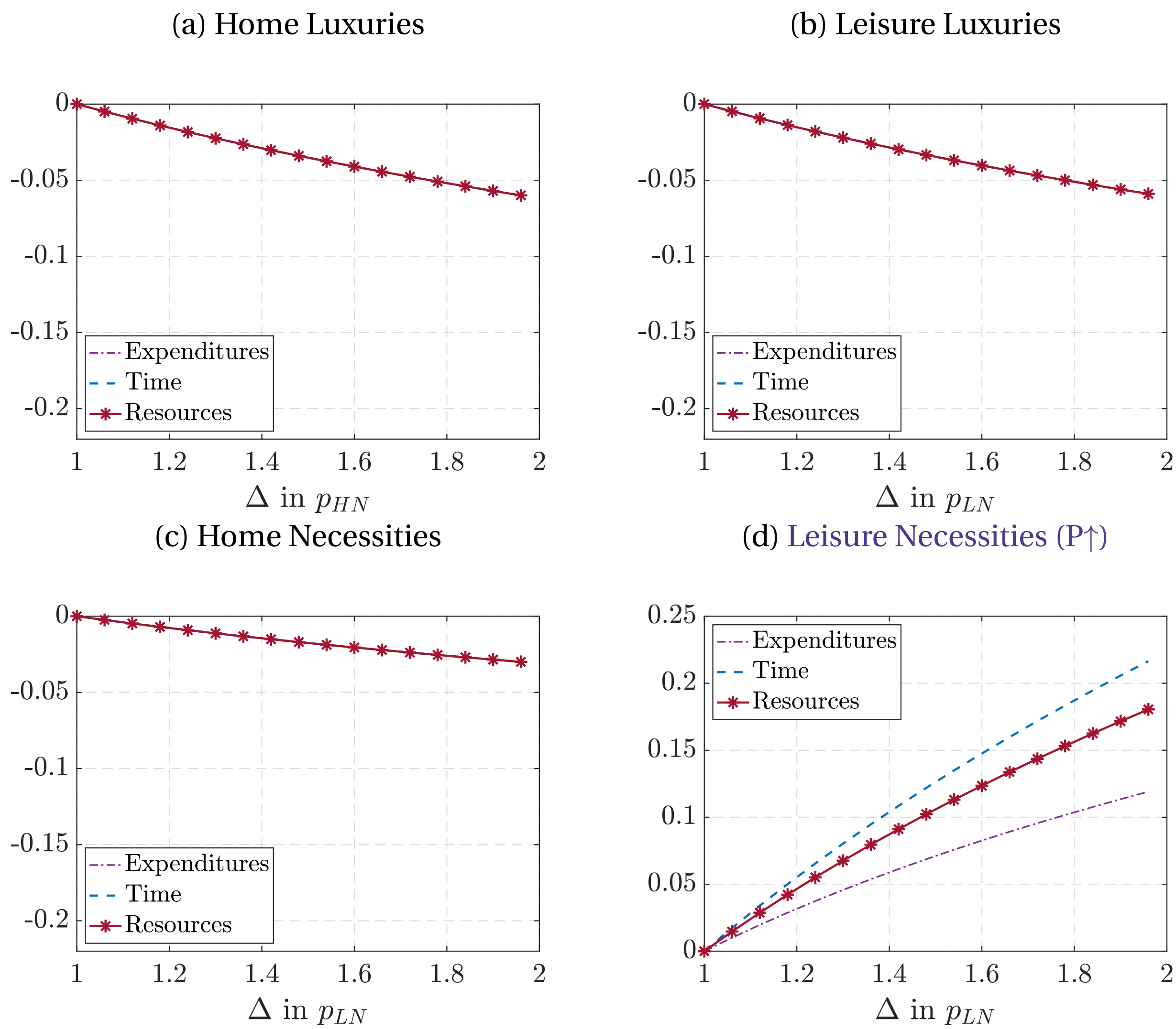
Figure C.2: Distribution of Parameter Estimates



Notes: Each plot displays the a histogram of the bootstrapped draws for each of the model's structural parameters. Each plot includes a vertical red line at the value of the estimated parameter.

D Model Experiments

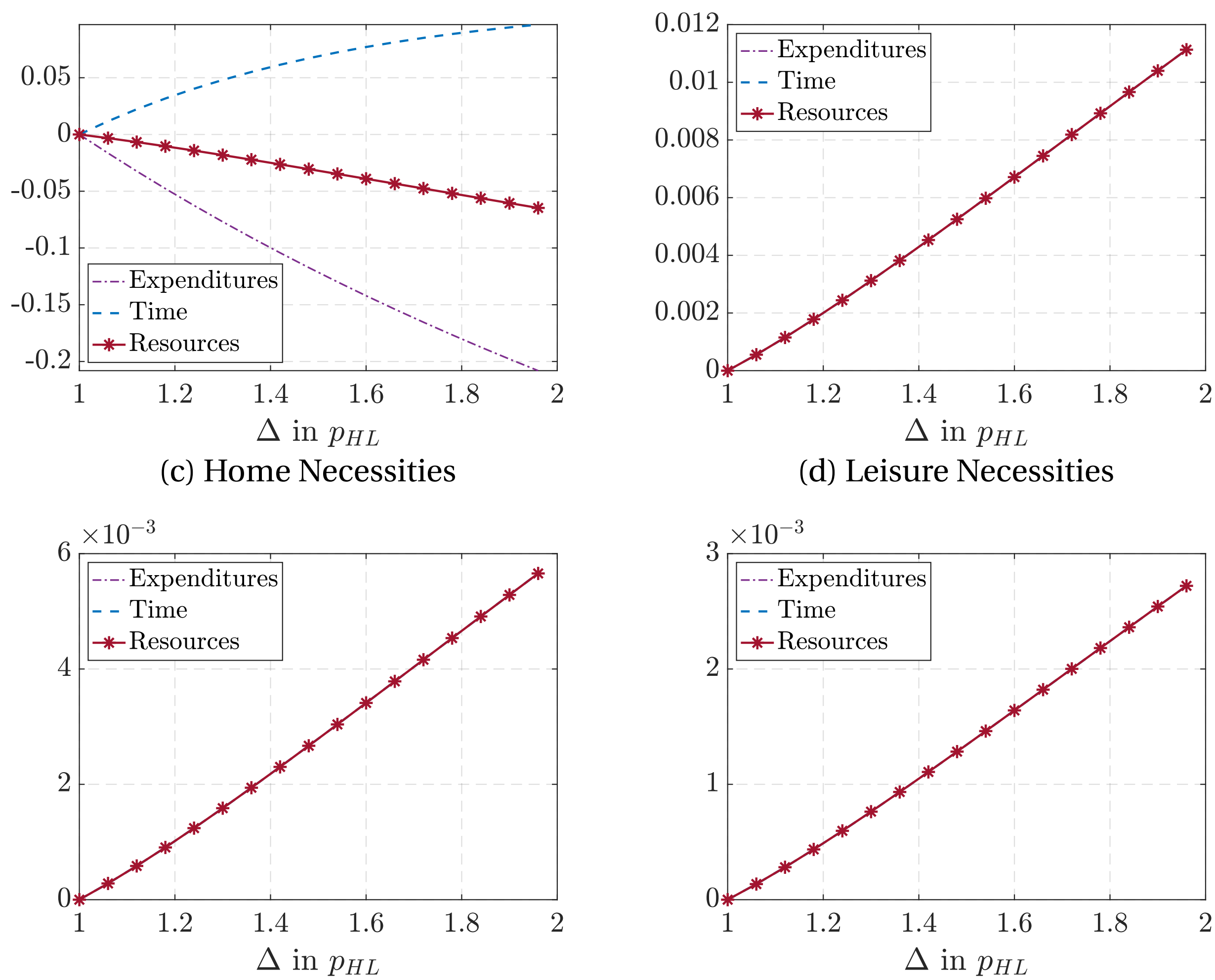
Figure D.3: Response of Input Shares to a Change in Leisure-Necessity Price



Notes: This figure plots the percent changes in the levels of expenditure, time cost, and resource to changes in leisure-necessity price relative to the baseline where wage is set to be the average wage in our sample and prices for goods inputs are kept at their average levels in our sample period.

Figure D.4: Response of Input Shares to a Change in the in Home-Luxury Price

(a) Home Luxuries (P↑) (b) Leisure Luxuries (c) Home Necessities (d) Leisure Necessities



Notes: This figure plots the percent changes in the levels of expenditure, time cost, and resource to changes in home-luxury price relative to the baseline where wage is set to be the average wage in our sample and prices for goods inputs are kept at their average levels in our sample period.