Leisure Time and the Sectoral Composition of Employment

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Abstract

We observe the following patterns in the US economy during the period 1965-2015: (i) the rise of the service sector, (ii) the increase in leisure time, and (iii) the increase in recreational services. To show the last pattern, we measure the fraction of the value added of the service sector explained by the consumption of recreational services and we show that it increases during this period. We explain these three patterns of structural change in a multisector growth model in which leisure time increases with income. As a consequence, the consumption of recreational services increases since they are consumed during leisure time. We show that the introduction of recreational services contributes to explain the rise of the service sector, inequality in leisure, and employment differences across countries caused by differences in income taxes.

JEL classification codes: O41, O47.

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1. Introduction

We observe two important patterns of structural change during the last fifty years. The first one is the large shift in employment and production from the goods to the service sector. Figure 1 illustrates this pattern for the US economy, during the period 1965-2015. In 1965, only 55% of workers were employed in the service sector, whereas 77% were employed in this sector in 2015. Figure 1 also shows a similar pattern for the shares of value added. The recent multisector growth literature has explained these patterns of structural change as the result of income effects (Kongsamut, et al., 2001) or price effects (Acemoglu and Guerrieri, 2008; and Ngai and Pissarides, 2007). More recently, this literature has argued that the significant increase of the service sector can only be explained by combining both types of effects (Boppart, 2014; Dennis and Iscan, 2009; Foellmi and Zweimuller, 2008; and Herrendorf, et al., 2013). Herrendorf, et al. (2014) offers an exhaustive review of this literature and shows that this process of structural change is not specific to the US, but it is quite a general feature.

The second pattern is the increase in leisure time. Using survey data, Aguiar and Hurst (2007), and Ramey and Francis (2009) document that leisure time increases in the US economy during the second half of the last century.[1] This increase is also illustrated in Figure 1, where it is shown that leisure, as a fraction of total time devoted to leisure and work in the market, increases from 46% in 1965 to 54% in 2015.[2] Duernecker and Herrendorf (2018) show the same pattern in other countries.

The increase in leisure time is mainly explained by an income effect due to non-homothetic preferences (Duernecker and Herrendorf, 2018; and Restuccia and Vandenbroucke, 2013 and 2014). More recently, Aguiar, et al. (2017) argue that the introduction of new recreational activities, such as video gaming and other recreational computer activities, has reduced the labor supply of young men. Note that these

[1] There is a debate about the comparability of the data among the different waves of surveys that affects the magnitude of the increase in leisure time. However, there is a consensus that leisure has increased. Two recent examples of papers that study the evolution of leisure are Boppart and Ngai (2018) and Boppart and Krusell (2019). These papers show that in different countries working hours decreased in the 20th century, while leisure hours increased.

[2] Appendix A explains in detail the construction of the time series displayed in Figure 1. In this appendix, we show that the amount of time devoted to leisure and work in the market has remained almost constant at a value of 67 hours per week. Therefore, the increase in leisure time implies a reduction in the time devoted to work.

explanations are entirely independent of the multisectoral structure of the economy. In fact, there are few papers relating the rise of the service sector with changes in the uses of time. Examples are the papers by Buera and Kaboski (2012), Gollin, et al. (2004), Moro, et al. (2017), Ngai and Pissarides (2008), and Rogerson (2008). In these papers, the relationship between the service sector and the uses of time is based on home production and its different substitutability with the market production of the different sectors. More precisely, the reduction in home production causes the increase in the employment share of the service sector because home production is a better substitute for services than for the goods produced in the other sectors. The relationship between uses of time and the service sector is also obtained by Greenwood and Vandenbroucke (2005) and Ngai and Pissarides (2008), who introduce recreational activities that combine leisure time with durable goods produced in the manufacturing sector.[3] Again, the different substitutability of these activities with the market production of the different sectors contributes to explain the increase in the employment share of the service sector.

In this paper, we also provide a joint explanation of the increase in both the service sector and leisure time. We contribute to the aforementioned papers by assuming that individuals consume recreational services during leisure time. Therefore, the consumption of these services increases with leisure time, which introduces a mechanism that relates leisure time with the service sector.

An advantage of our approach is that we can identify the industries that provide recreational services and, therefore, we can obtain a direct measure of the effect of recreational activities on structural change.[4] To this end, we measure the fraction of the value added of the service sector explained by the consumption of recreational services. The details of the procedure followed to obtain this fraction are in Appendix A, and the results are shown in Figure 1. This figure shows that this fraction has increased

[3]Other papers in the literature have considered recreational activities. In particular, Kopecky (2011) and Vandenbroucke (2009) consider recreational activities that combine leisure time with goods to explain the reduction in working hours. More recently, Boppart and Ngai (2018) and Bridgman (2017) consider recreational activities that combine capital and leisure time to explain the rising inequality in leisure. None of these papers relates the rise of leisure time with the increase in the service sector.

[4]Table A.2 in Appendix A offers an exhaustive classification of industries that provide recreational services. These services include sport, exercise, socialize, travel, hobbies, Tv, radio, entertainment, among others.

from 5.2% in 1965 to 8.6% in 2015. This increase has a sizeable effect on sectoral composition, as it accounts for 19% of the observed increase in the service sector share of total value added.

Our purpose is to analyze the effect that recreational activities have on both the sectoral composition and the labor supply. To this end, we measure both effects using a multisector exogenous growth model. In the supply side of this model, we distinguish between two sector-specific technologies that produce goods and services. These technologies are differentiated only by the exogenous growth rate of total factor productivity (TFP). In the demand side, we assume that households obtain utility from consuming goods, non-recreational services, and recreational activities. Following Ngai and Pissarides (2007), the utility function is a constant elasticity of substitution (CES) function. Therefore, the only new feature of this model is the introduction of recreational activities. These activities are defined as another CES function relating the amount of time devoted to leisure and the consumption of recreational services. Hence, the utility function considered in this paper is a non-homothetic version of the nested CES function introduced by Sato (1967).

In this model, technological progress drives structural change through three different mechanisms: substitution, income, and recreational mechanisms. First, the substitution mechanism is due to the assumption of different growth rates of sectoral TFP. Consistent with empirical evidence, we will assume that the goods sector experiences the largest TFP growth rate, which causes the increase in the relative price of services in units of goods. As shown by Ngai and Pissarides (2007), this relative price increase contributes to explain the rise of the service sector when the elasticity of substitution of consumption goods is smaller than one.

Second, the income mechanism is due to the introduction of a minimum consumption requirement on the consumption of goods. Preferences are then non-homothetic and the income elasticity of the demand of services is larger than one. As a consequence, the employment share of the service sector increases as income grows with technological progress. Thus, the income mechanism also contributes to explain the rise of the service sector.

Third, the recreational mechanism is the new mechanism introduced in this paper.

Both leisure time and the fraction of the value added of the service sector explained by the consumption of recreational services increase when the elasticity of substitution between leisure time and recreational services is smaller than one but larger than the elasticity of substitution of consumption goods.[5] Thus, the recreational mechanism also contributes to explain the rise of the service sector when leisure time and recreational services are not strong complements, which implies that individuals can substitute between leisure time and recreational expenditures.

We simulate three different models, that are calibrated to match the patterns of structural change of the US economy in the period 1965-2015, to show that the recreational mechanism is a relevant factor explaining these patterns. The first one is our benchmark model in which individuals obtain utility from recreational activities. In the second model, we do not consider these activities, and we instead assume that individuals obtain utility directly from leisure. Finally, the third model is a standard multisector growth model without leisure. Therefore, the three mechanisms of structural change are operative only in the benchmark model. We show that the interaction among the three mechanisms accounts for almost all the observed increase of the share of employment allocated in the service sector, of leisure time and of the fraction of the value added of the service sector explained by the consumption of recreational services. In the other two models, the recreational mechanism is not operative and, hence, the increase of the service sector is explained only by the other two mechanisms. We compare the performance of these three models to conclude that the introduction of recreational activities improves substantially the performance of the model in explaining the increase of the service sector.

The substitution between leisure time and expenditure in recreational services, introduced by recreational activities, has interesting implications on leisure inequality and employment differences among countries. First, in line with Boppart and Ngai (2018) and Bridgman (2016), we analyze an extension of the basic model that introduces inequality in labor income. We show that high labor income individuals perform expenditure intensive recreational activities, whereas low labor income

[5] We distinguish between the elasticity of substitution of recreational activities (the elasticity between leisure time and recreational services) and the elasticity of substitution of consumption goods (the elasticity among recreational activities, the consumption of goods and non-recreational services).

individuals perform time intensive recreational activities. This result is consistent with the evidence in Figure 4, that shows that high labor income individuals consume a larger fraction of services in recreational activities, although they devote a smaller fraction of time to leisure.

Second, the introduction of recreational activities worsens the reduction in employment due to a labor income tax increase, because these activities increase the substitutability between leisure time and consumption expenditures. As a consequence, labor income tax differences across-countries result into larger employment differences when the recreational mechanism is considered. This result is related to Rogerson (2008), who shows that the larger labor income taxes in Europe in comparison to the US make home production larger. In his analysis, this explains that European economies exhibit both a lower level of employment and a smaller fraction of working time employed in the service sector. In contrast, in our analysis, the larger taxes make recreational activities be more time intensive in European economies. This result is consistent with evidence obtained from the comparison between US and France, a country with larger labor income taxes than in the US. In Figure 6, we show that the fraction of recreational services over total services is smaller in France than in the US, whereas the fraction of time devoted to leisure is larger. This also explains that both the level of employment and the employment share in services are smaller when taxes are larger. Hence, our paper offers a complementary explanation of the differences between Europe and US regarding both sectoral composition and uses of time.

The rest of the paper is organized as follows. Section 2 introduces the model and Section 3 characterizes the equilibrium. Section 4 solves the model numerically and obtains the main results. Section 5 introduces inequality. Section 6 studies the effect of labor income taxes on employment. Finally, Section 7 includes some concluding remarks and discusses other possible extensions of the basic model.

2. The model

We consider a two-sector exogenous growth model, where we distinguish between the service and the goods sectors. The former only produces a consumption good that can be devoted to either recreational or non-recreational activities, whereas the latter produces both a consumption and an investment good.

2.1. Firms

Each sector i produces by using the following constant returns to scale Cobb-Douglas technology:

$$Y_i = A_i \left(s_i K\right)^{\alpha} \left(u_i L\right)^{1-\alpha}, \; i = s, g, \tag{2.1}$$

where Y_i is the amount produced in sector i, $\alpha \in (0,1)$ is the capital-output elasticity, s_i is the share of total capital K devoted to sector i, u_i is the share of total employment L employed in sector i, A_i measures total factor productivity (TFP) in sector i, and the subindexes s and g amount for the services and goods sectors, respectively. Obviously, the capital and employment shares satisfy $s_g + s_s = 1$ and $u_g + u_s = 1$. We assume that TFP grows in each sector at a constant growth rate γ_i. Consistent with empirical evidence, we also assume that $\gamma_g > \gamma_s$.

Each individual has a time endowment of measure one that can devote to either leisure activities or work in the market. Let l be the amount of time an individual devotes to work, $1-l$ the amount of time devoted to leisure activities and N the constant number of individuals. Then, total employment in the economy satisfies $L = lN$. It follows that (2.1) can be rewritten in per capita terms as

$$y_i = A_i \left(s_i k\right)^{\alpha} \left(u_i l\right)^{1-\alpha}, \; i = s, g, \tag{2.2}$$

where $y_i = Y_i/N$ and $k = K/N$.

Perfect competition and perfect factors' mobility imply that each factor is paid according to its marginal productivity and that marginal productivities equalize across sectors, implying that the firms' optimization conditions are

$$r = \alpha p_i A_i \left(s_i k\right)^{\alpha-1} \left(u_i l\right)^{1-\alpha} - \delta, \tag{2.3}$$

and

$$w = (1-\alpha) p_i A_i \left(s_i k\right)^{\alpha} \left(u_i l\right)^{-\alpha}, \tag{2.4}$$

where r is the rental price of capital, w is the wage per unit of employment, p_i is the relative price and $\delta \in (0,1)$ is the depreciation rate of capital. We assume that the commodity produced in the goods sector is the numeraire and, hence, $p_g = 1$. From using (2.3) and (2.4), we obtain $s_i = u_i$ and

$$p_s = \frac{A_g}{A_s}. \tag{2.5}$$

Given the assumed ranking of TFP growth rates, the relative price of services, p_s, increases.

2.2. Individuals

The economy is populated by infinitely lived individuals characterized by the utility function $u = \int_0^\infty e^{-\rho t} \ln C dt$, where $\rho > 0$ is the subjective discount rate and C is the following composite consumption good:

$$C = \left[\eta_g \left(c_g - \overline{c}\right)^{\frac{\varepsilon-1}{\varepsilon}} + \eta_s \left[\left(1-x\right) c_s\right]^{\frac{\varepsilon-1}{\varepsilon}} + \eta_l c_l^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where c_g is the consumption of goods, c_s is the consumption of services, c_l are recreational activities, $x \in [0,1]$ is the fraction of services devoted to recreational activities, $\varepsilon > 0$ is the elasticity of substitution among the different consumption goods, $\overline{c}$ is a minimum consumption requirement and $\eta_i > 0$ measures the weight of the different consumption goods in the utility function. We assume that $\eta_g + \eta_s + \eta_l = 1$. We also assume that recreational activities depend on both leisure time and the amount consumed of recreational services, according to the following function:

$$c_l = \left[\beta \left(x c_s\right)^{\frac{\sigma-1}{\sigma}} + \left(1-\beta\right)\left(1 - l - \overline{o}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{2.6}$$

where $\sigma > 0$ is the elasticity of substitution between recreational services and leisure, $\overline{o}$ is a minimum requirement of leisure and $\beta \in [0,1]$ measures the weight of recreational services in recreational activities.[6]

[6]The parameter $\overline{o}$ is introduced to disentangle σ from the elasticity of substitution of the labor supply with respect to the wage.

Individuals decide on leisure, the value of consumption expenditures, the sectoral composition of these expenditures and the fraction of services devoted to recreational activities to maximize the utility function subject to the budget constraint $wl + rk = E + \dot{k}$, where $E = c_g + p_s c_s$ is total consumption expenditures. The solution of this maximization problem is obtained in Appendix B and it is characterized by the following equations:

$$\frac{c_g}{E} = \frac{1}{\kappa_1} + \frac{\bar{c}}{E}\left(\frac{\kappa_1 - 1}{\kappa_1}\right), \tag{2.7}$$

$$\frac{p_s c_s}{E} = \left(1 - \frac{\bar{c}}{E}\right)\left(\frac{\kappa_1 - 1}{\kappa_1}\right), \tag{2.8}$$

$$x = \frac{1}{1 + \left(\frac{\eta_s}{p_s \eta_l}\right)^{\varepsilon}\left(\frac{p_s}{\beta}\right)^{\sigma} \kappa_2^{\frac{\sigma-\varepsilon}{\sigma}}}, \tag{2.9}$$

$$1 - l = \bar{o} + \left(\frac{\eta_g}{\eta_l}\right)^{-\varepsilon}\left(\frac{w}{1-\beta}\right)^{-\sigma}\left(\frac{E - \bar{c}}{\kappa_1}\right)\kappa_2^{\frac{\varepsilon-\sigma}{\sigma}}, \tag{2.10}$$

and

$$\frac{\dot{E}}{E - \bar{c}} = r - \rho - \frac{\dot{\kappa}_3}{\kappa_3}, \tag{2.11}$$

where

$$\kappa_1 = 1 + p_s\left(p_s \frac{\eta_g}{\eta_s}\right)^{-\varepsilon} \frac{1}{1-x}, \tag{2.12}$$

$$\kappa_2 = \left(\beta^{\sigma} p_s^{1-\sigma} + (1-\beta)^{\sigma} w^{1-\sigma}\right)^{\frac{\sigma}{\sigma-1}}, \tag{2.13}$$

and

$$\kappa_3 = \frac{1 + \overline{\eta}_s p_s^{1-\varepsilon} + \overline{\eta}_l \kappa_2^{-\frac{1-\varepsilon}{\sigma}}}{\kappa_1}. \tag{2.14}$$

Equations (2.7) and (2.8) characterize the sectoral composition of consumption expenditures, while (2.9) determines the fraction of services devoted to non-recreational activities and (2.10) is the labor supply. Finally, (2.11) is the Euler condition driving the intertemporal trade-off between consuming today and in the future.[7]

[7]Equation (2.11) shows that the growth rate of consumption expenditures depends on the growth rate of κ_3 and, therefore, it depends on the growth rate of prices. Alonso-Carrera, et al. (2015) discuss when the growth of prices affects the Euler condition in multisector growth models.

3. Equilibrium

In this section, we define the equilibrium and obtain the long run values of employment, of the employment share in services, and of the fraction of services devoted to recreational activities. The first step is to obtain the employment share in services. To this end, we define per capita GDP as $Q = p_s y_s + y_g$ and, using (2.2) and (2.5), we obtain $Q = A_g k^{\alpha} l^{1-\alpha}$. We next use the market clearing condition in the service sector, $y_s = c_s$, and (2.5) and (2.8) to obtain

$$u_s = \left(\frac{\kappa_1 - 1}{\kappa_1}\right)\left(\frac{E - \bar{c}}{Q}\right). \tag{3.1}$$

Equations (2.9), (2.10) and (3.1) show that the sectoral composition and leisure time depend on the relative price, the wage and the time path of E and k.[8] We can now define a dynamic equilibrium of this economy as a path of $\{k, E, u_s, l, x, p_s, w\}_{t=0}^{\infty}$ that, given initial conditions $k(0)$, $A_g(0)$ and $A_s(0)$, satisfies the consumers' optimization conditions, the firms' optimization conditions, the market clearing conditions and $A_i = A_i(0)\, e^{-\gamma_i t}$, $i = s, g$.

The assumption of permanent bias in technological progress implies that both the relative price and the wage diverge to infinite (see 2.4 and 2.5). As a consequence, the long run equilibrium can only be attained asymptotically when the variables characterizing the sectoral composition and leisure converge to a corner solution where, depending on the value of ε and σ, they take either its minimum or its maximum possible value.[9] Given that these long-run values arise because technological progress is permanently biased towards a given sector, they inform about the direction of structural change while the process of biased technological progress is maintained. The following propositions obtain the long run values of these variables.[10]

Proposition 3.1. *The long run value of employment, l^*, satisfies: $l^* = 0$ if $\sigma < 1$ and $\varepsilon < 1$, and $l^* = 1 - \bar{o}$ otherwise.*

[8] We obtain the system of differential equations governing the time path of the variables in the online Appendix D.1.

[9] The long-run equilibrium is an asymptotic balanced growth path along which the interest rate, the ratio of capital to GDP and the variables characterizing the sectoral composition remain constant.

[10] The proof of Propositions 3.1, 3.2 and 3.3 is in the online Appendix D.2.

Since the wage and consumption expenditures increase with technological progress, using (2.10), it can be shown that employment increases and converges to its maximum value when individuals can substitute leisure for other consumption goods. This happens when either $\sigma > 1$ or $\varepsilon > 1$. Therefore, we can only explain the increase in leisure time shown in Figure 1 when $\varepsilon < 1$ and $\sigma < 1$. In what follows, we show that for these values of the elasticities of substitution the transitional dynamics implied by the model are also consistent with the other observed patterns of structural change.

Proposition 3.2. *The long run values of the sectoral composition of employment, u_s^* and u_g^*, satisfy: $u_s^* = 0$ and $u_g^* = 1$ if $\varepsilon > 1$, and $u_s^* = q^*$ and $u_g^* = 1 - q^*$ if $\varepsilon < 1$, where q^* is the long run value of the ratio E/Q.*

The result in the pervious proposition follows from using (3.1) and it was already obtained in Ngai and Pissarides (2007). As these authors explain, when the price of services increases, the employment share in this sector increases only if goods and services are complements. Therefore, the observed increases in both the price of services and in the employment share can only be jointly explained when $\varepsilon < 1$.

Proposition 3.3. *The long run value of the fraction of services devoted to non-recreational activities, x^*, satisfies: $x^* = 0$ if $\sigma < \min\{1, \varepsilon\}$, $x^* = 1$ if $\sigma \in (\varepsilon, 1)$, and $x^* = 1/\left[\beta^{\left(\frac{1-\varepsilon}{\sigma-1}\right)\sigma} (\eta_s/\eta_l)^{\varepsilon} + 1\right]$ if $\sigma > 1$.*

The result in Proposition 3.3 follows from using (2.9). Along the transition, both leisure and the consumption of services, c_s, increase when $\varepsilon < 1$ and $\sigma < 1$. However, the increase in the consumption of services is substantially larger and faster than the increase in leisure time. As a consequence, when leisure and recreational services are strong complements, $\sigma < \min\{1, \varepsilon\}$, the fraction of services devoted to recreational activities declines and converges to zero. It follows that this fraction increases only when leisure and recreational services are not strong complements, which occurs when $\sigma \in (\varepsilon, 1)$. Note that this is the empirically relevant case, as it is consistent with the evidence in Figure 1. Finally, leisure vanishes when $\sigma > 1$. Since leisure and recreational services are gross substitutes in this case, individuals still consume recreational services in the long run and, hence, $x^* < 1$.

We conclude that the equilibrium path implied by this model is compatible with the observed patterns of structural change when (i) there is complementarity among the different consumption goods ($\varepsilon < 1$) and between leisure and recreational services ($\sigma < 1$) and (ii) when the complementarity between leisure and services is weaker than the complementarity among the different consumption goods ($\sigma > \varepsilon$). The first condition is already obtained in Ngai and Pissarides (2007). The second condition is a contribution of this paper, which is necessary to explain the process of structural change between recreational and non-recreational services shown in Figure 1. These constraints on the value of the elasticities of substitution are considered in the analysis of the following sections.

4. Structural change

In this section, we study the contribution of the recreational mechanism to explain the observed patterns of structural change. To this end, we calibrate three different models. Economy I is our benchmark economy with recreational activities. In Economy II, we assume that $\beta = 0$, implying that $x = 0$ and, hence, there are no recreational services. Individuals derive utility directly from leisure. Finally, in Economy III we assume that $\eta_l = 0$, which implies that $x = 0$ and $l = 1$. This economy corresponds to a classical structural change model without leisure.

We distinguish between two groups of parameters. The first group is shown in Table 1 and consists of parameters that have a common value in the three economies. These parameters are $\gamma_g = 1.87\%$ and $\gamma_s = 1.18\%$ that are set to match the GDP growth rate and the growth rate of prices,[11] $A_g(0) = 1$ and $A_s(0) = 1.4$ that are set to obtain the initial relative price of services in units of goods, and $\alpha = 0.348$ that is set to match the average value of the labor income share.[12] Table 2 reports the rest of parameters. These parameters are jointly set in each model to attain the following targets: the values of the share of recreational services and of employment in 1965 and 2015, the value of the employment share in services in 1965, the long run values of the ratios

[11] The long run growth rate of GDP is $\gamma_g/(1-\alpha)$ and the growth rate of prices equals $\gamma_g - \gamma_s$.

[12] The initial values of A_g and of A_s depend on the base year used to construct the price indexes. In our calibration, the base year is 2005.

of investment to capital and of capital to GDP, and to minimize the root mean square error of the model's prediction with respect to investment to capital ratio for the period 1965-2015.[13] Finally, note that in this calibration we do not consider the employment share in the service sector in 2015 as a target.

We assume that initial capital is such that the initial value of capital per efficiency unit of labor equals its long-run asymptotic value.[14] This assumption implies that the transition shown in Figures 2 and 3 is mainly driven by the exogenous technological progress governing the three aforementioned mechanisms of structural change. In Economy I, shown in Figure 2, the interaction among the three mechanisms accounts for the increase in leisure time, the increase in the share of recreational services and almost all the increase in the employment share of the service sector. Figure 3 shows the other two economies. Economy II does not include the recreational mechanism. Therefore, it does not explain the increase in recreational services, but it still accounts for the increase in leisure and the increase in the employment share of the service sector. However, the performance in explaining the rise of the service sector is worse than in Economy I. Finally, in Economy III there is no leisure. Therefore, this model only explains the changes in the sectoral composition of employment. Again, the performance is worse than in Economy I.

Table 3 compares the performance of the three economies in explaining the increase of the service sector by using three different accuracy measures: relocation index, root mean square error and Akaike information criterion.[15] From this comparison, we can see that the performance of Economy I is much better, whereas the differences in the performance of Economies II and III are negligible. We can then conclude that leisure

[13]The elasticity of substitution, ε, equals 0.01. This very low elasticity is consistent with the results obtained by Herrendorf, et al. (2013), who show that this elasticity is almost zero when considering consumption value added.

[14]The model exhibits sustained growth and, hence, capital diverges to infinite. However, capital per efficiency unit, $k/(lA_g^{\frac{1}{1-\alpha}})$, converges asymptotically to a long run finite value. Given that the long run equilibrium is asymptotic, capital per efficiency unit exhibits a small transition even if it is initially set at its long run value.

[15]The relocation index was introduced by Swiecki (2017) and measures the fraction of the change in the service employment share between 1965 and 2015 explained by the model. An index of 100% means that the model explains all the change. The root mean square error measures the performance of the simulation throughout the transition. Finally, the Akaike information criterion provides a means for model selection, since it addresses the trade-off between the goodness of fit of the model and its simplicity. The preferred model is the one with the minimum value of the Akaike information criterion.

contributes to explain the rise of services only through the increase in recreational activities.

The results in this section show that the recreational mechanism contributes to explain the changes in the sectoral composition, while the transitional dynamics implied by the model are consistent with the observed evolution of leisure.[16] In the following sections, we analyze two other implications of the recreational mechanism. In Section 5, we show that this mechanism explains the evidence on inequality in recreational activities and, in Section 6, we analyze how income taxes affect the labor supply when individuals can substitute between leisure time and expenditures in recreational services.

5. Inequality in recreational activities

Figure 4 shows average leisure as a fraction of total weekly time devoted to leisure and market work when individuals are grouped by quartiles of hourly wages and the average share of recreational services in total expenditure in services by quartiles of labor income, for the US, in the period 2003-2015. This evidence is elaborated using data from the American Time Use Survey and from the Consumption Expenditure Survey. The procedure followed to obtain these data is in Appendix A. Figure 4 shows that individuals in the first quartile generally enjoy more leisure than individuals in the other quartiles and individuals in the last quartile enjoy less leisure. Average leisure in the second and third quartiles is not clearly separated, but it is above average leisure in the fourth quartile and below average leisure in the first quartile. Therefore, Figure 4 shows that leisure time declines with hourly wages, whereas the share of recreational services clearly increases.[17] This evidence suggests that individuals substitute between leisure time and recreational expenditures, since high labor income individuals choose

[16] We perform alternative quantitative exercises where we analyze the effect of recreational activities on leisure time. We conclude that the recreational mechanism also contributes to explain the time path of leisure when the transitional dynamics is consistent with the patterns of structural change.

[17] Given that the Consumption Expenditure Survey does not provide data on wages, Figure 4 groups individuals by quartiles of hourly wages to obtain average leisure and by quartiles of labor income to obtain average shares of recreational services in total expenditure in services. In the online Appendix D.3, we show that the results in Figure 4 still hold when average leisure is obtained by quartiles of labor income and the share of recreational services is obtained by quartiles of hourly wages, which we calculate from annual income from wages and an estimation of hours worked.

expenditure intensive recreational activities, whereas low labor income individuals choose more time intensive activities.

In this section, we show that the model of Section 2 is consistent with the evidence in Figure 4, when the elasticities take values in the relevant range, i.e. $\sigma \in (\varepsilon, 1)$. To this end, we introduce labor income inequality in the model of Section 2 by assuming that there is a continuum of individuals of mass N that are differentiated by efficiency units of labor.

The introduction of efficiency units of labor modifies the sectoral production functions that become:

$$Y_i = A_i \left(s_i K\right)^{\alpha} H_i^{1-\alpha},\ i = s, g. \tag{5.1}$$

Note that the only difference with respect to the production function in Section 2 is the variable H_i that amounts for total efficiency units of labor in sector i and it is defined as

$$H_i = \int_0^N u_{ij} l_j e_j dj,\ i = s, g,$$

where l_j is the amount of time an individual j devotes to work, $1 - l_j$ is the amount of time devoted to leisure activities, u_{ij} is the employment share of individual j in sector i and e_j are the efficiency units of individual j. Obviously, the capital and employment shares satisfy $s_g + s_s = 1$ and $u_{gj} + u_{sj} = 1$ for all j. The production function can be rewritten in per capita terms as

$$y_i = A_i \left(s_i k\right)^{\alpha} \left(h_i\right)^{1-\alpha},\ i = s, g, \tag{5.2}$$

where $y_i = Y_i/N$, $k = K/N$ and $h_i = H_i/N$ are the average efficiency units of employment in sector i.

The solution of the firms' optimization problem determines that the rental price of capital and the wage per efficiency unit of employment are

$$r = \alpha p_i A_i \left(s_i k\right)^{\alpha - 1} \left(h_i\right)^{1-\alpha}, \tag{5.3}$$

$$\tilde{w} = \left(1 - \alpha\right) p_i A_i \left(s_i k\right)^{\alpha} \left(h_i\right)^{-\alpha}. \tag{5.4}$$

Therefore, the wage per unit of time of individual j is $w_j = \tilde{w} e_j$. Note that the wage per efficiency unit is equal across individuals and sectors. Taking this into account and using (5.3) and (5.4), we obtain that $p_s = A_g/A_s$ and

$$\frac{s_s}{h_s} = \frac{s_g}{h_g}. \tag{5.5}$$

Let us define total efficiency units of labor in the economy as $H = H_s + H_g$ and the average efficiency units of labor as $h = h_s + h_g$. Remember that $s_s + s_g = 1$, then (5.5) rewrites as $h_s = s_s h$ and $h_g = s_g h$. Finally, from (5.3) and (5.4), we obtain $r = \alpha A_g \left(k/h\right)^{\alpha-1} - \delta$ and $\tilde{w} = \left(1-\alpha\right) A_g \left(k/h\right)^{\alpha}$. Note that the relative price, the interest rate and the wage per efficiency unit do not depend on the distribution of efficiency units.

The first order conditions (2.7)-(2.11) still characterize the solution to the consumers' problem once we take into account that wage differences also imply differences in the individual total consumption expenditures, $E_j = c_{jg} + p_s c_{js}$, that satisfy $E_j = \tilde{w} l_j e_j + r k_j - \dot{k}_j$. Therefore, we can use directly equations (2.8), (2.9) and (2.10) to study the effect of income differences on sectoral composition and leisure.

We first use (2.9) to obtain that the share of recreational services in total service expenditures of an individual j with a labor income w_j is

$$x_j = \frac{1}{1 + \left(\frac{\eta_s}{p_s \eta_l}\right)^{\varepsilon} \left(\frac{p_s}{\beta}\right)^{\sigma} \kappa_{2,j}^{\frac{\sigma-\varepsilon}{\sigma}}},$$

where $\kappa_{2,j}$ is the individual specific expression of the function κ_2 defined in (2.13). It is equal to

$$\kappa_{2j} = \left(\beta^{\sigma} p_s^{1-\sigma} + \left(1-\beta\right)^{\sigma} w_j^{1-\sigma}\right)^{\frac{\sigma}{\sigma-1}}.$$

Note that κ_{2j} decreases with the wage and x_j decreases with κ_{2j} when $\sigma \in (\varepsilon, 1)$. Therefore, x_j increases with the wage when the elasticities take values in the relevant range. Hence, high labor income individuals devote a larger fraction of their expenditure in services to recreational services, which is consistent with the evidence shown in Figure 4.

Boppart (2014) provides evidence showing that the fraction of total consumption expenditure in services increases with income.[18] This model is also consistent with this evidence. To see this, we use (2.8) to obtain the expenditure share in services of an individual with labor income w_j and total expenditures E_j :

$$\frac{p_s c_{s,j}}{E_j} = \left(1 - \frac{\bar{c}}{E_j}\right)\left(1 - \frac{1}{\kappa_{1,j}}\right),$$

where $\kappa_{1,j}$ is the individual specific expression of the function κ_1 defined in (2.12). It is equal to

$$\kappa_{1,j} = 1 + p_s \left(p_s \frac{\eta_g}{\eta_s}\right)^{-\varepsilon} \frac{1}{1 - x_j}.$$

From the former equations, it is easy to show that individuals with larger wages consume a larger fraction of expenditures in services. This result follows from two different mechanisms. On the one hand, the non-homotheticity of preferences implies that the fraction $p_s c_{s,j}/E_j$ increases with E_j. On the other hand, individuals with larger wages devote a larger fraction of services to perform recreational activities; i.e. x_j increases. This causes the increase of $\kappa_{1,j}$, which also increases the fraction $p_s c_{s,j}/E_j$. Therefore, the introduction of recreational services introduces an additional mechanism explaining the effect of income inequality on the sectoral composition.

Finally, we obtain the effect of labor income inequality on leisure. To this end, we combine (2.9) and (2.10) to get the amount of leisure of an individual j with labor income w_j and total expenditures E_j :

$$1 - l_j - \bar{o} = \left(p_s \frac{\eta_g}{\eta_s}\right)^{-\varepsilon} \left(\frac{(1-\beta)\, p_s}{w_j \beta}\right)^{\sigma} (E_j - \bar{c}) \left(\frac{x_j}{1 - x_j + p_s^{1-\varepsilon}\left(\frac{\eta_s}{\eta_g}\right)^{\varepsilon}}\right).$$

This equation shows that labor income differences affect leisure through three different effects. The first one is the substitution effect introduced by wages: a larger wage increases the opportunity cost of leisure and, hence, leisure decreases. This effect is measured by the second product in the previous expression. The second one is the

[18] Boppart (2014) also uses CEX data. There are two differences between the sample used by Boppart and ours. First, he considers household expenditures over a period of 3 months as an observation. Therefore, in one year, there are three observations per household (the last 3 months of each year are not used). In contrast, we consider household expenditures over a year as an observation. Consequently, the sample is three times larger in Boppart. Second, the period of time covered by the sample is different. Boppart (2014) considers the period 1986-2010, while we consider 2003-2015.

income effect shown in the third product of the previous expression: a larger labor income increases consumption expenditures and leisure. The last term of the previous equation shows the recreational effect. As we have explained, a larger labor income implies that a larger fraction of the expenditures in services is devoted to recreational activities; i.e. a larger x_j. Individuals then devote a larger amount of time to leisure. The net effect of labor income differences on leisure is then ambiguous and depends on the interaction among these three effects. Figure 4 shows that individuals with a larger hourly wage devote less time to leisure, which suggests that the substitution effect dominates.

At this point, it is important to outline that the evidence in Figure 4, based on quartiles of hourly wages, and the time series evidence in Figure 1 illustrate different findings. Figure 1 shows that leisure increases along time, as the economy develops and income increases. Therefore, this time series evidence suggests that the income and recreational effects dominate, which is in stark contrast with the findings obtained using the evidence based on quartiles of hourly wages. We can explain both results by taking into account that the income inequality analysis of this section only considers differences in wages resulting from different efficiency units, whereas in the time series analysis the increase in leisure along time is the consequence of TFP growth and capital accumulation that rises total income. Obviously, when we consider the growth of total income, the importance of the income and recreational effects relative to the substitution effect increases and these effects dominate the evolution of leisure time, as we have shown in the numerical analysis of Section 4. In contrast, in the following section, we show that in our calibrated economy the substitution effect dominates the evolution of leisure time when we only consider changes in wages.

6. Labor income taxes and the labor supply

In this section, we study the effect of labor income taxes on employment, GDP and sectoral composition. Duernecker and Herrendorf (2018), Prescott (2004) and Rogerson (2008) have shown that the labor supply decreases when the labor income tax increases. In fact, the effect of labor income taxes depends on the substitution between leisure and the consumption of goods. As recreational activities modify this substitution, the effect of taxes on employment is modified when these activities are introduced. To study this different impact of labor income taxes, we compare the effect of a permanent tax increase in the Economies I and II, described in Section 4. We follow Prescott (2004) and we study the consequences of increasing the effective labor income tax from the US average level, 40%, to the French average level, 59%. For the sake of simplicity, we assume that government revenue returns to individuals as a lump-sum subsidy.

We calibrate again Economies I and II so that they match the level of employment and the fraction of recreational services both in 1965 and in 2015 and the employment share in services in 1965 when taxes are at the US level. Table 4 provides the new values of the parameters.

Figure 5 shows the effects of a permanent tax increase introduced in 1965. Panel b of this figure shows that, in Economy II, where individuals directly derive utility from leisure, the tax increase rises leisure both initially and during the transition. The increase in leisure causes the initial reduction of GDP. This lower GDP reduces capital accumulation which, in turn, reduces even further employment and GDP during the transition. Figure 5 shows, in Panels (d) and (e), the employment and GDP loss due to the tax increase. Both employment and GDP loss increase during the transition from around 0.3% in 1965 to 1% in 2015, as a consequence of the reduction in capital accumulation.

Table 5 shows that in Economy I, where individuals derive utility from recreational activities, the effect on employment and GDP of the tax increase is substantially larger than in Economy II. Initially, employment and GDP decrease 1.4%. This initial reduction of GDP causes a larger reduction in capital accumulation which, in turn, implies a more significant GDP loss during the transition. Thus, in 2015, the employment loss is around 3.1%, while the GDP loss is 2.8%. Clearly, the effect of taxes on both employment and GDP is substantially larger when we take into account that individuals derive utility from leisure through the consumption of recreational activities. These activities introduce the possibility that individuals can substitute leisure time for expenditure in services. As a consequence, after the tax increase, recreational activities become more time intensive, which facilitates the increase in leisure and the reduction in working time.

This substitution is illustrated in Panel c of Figure 5 that shows that x decreases after the tax increase.

Figure 6 provides some empirical support to our findings. This figure compares the value of leisure time and of the ratio x in the two economies, US and France, that, following Prescott (2004), inspired the analysis of this section. Some words of caution are in order. First, data availability for France is limited and we can only consider a very short period of time, 2000-2009, in which we obtain only two observations of leisure for France. Second, households consumption expenditure in health and education are extremely different in these two countries, possibly as a result of a different provision by the government of these services. To keep the comparability between these two countries, the ratio x is defined in Figure 6 as expenditure in recreational services over total expenditure in services, excluding expenditure in health and education. Taking these caveats in mind, Figure 6 shows that in France, where labor income taxes are substantially larger, individuals devote a larger fraction of time to leisure and a smaller fraction of services are consumed in recreational activities. This evidence provides support to the findings of the model that imply that individuals choose a more time intensive recreational activities when labor income taxes increase.

7. Concluding remarks and extensions

This paper studies two important patterns of structural change; first, the large shift in employment and production from the goods to the service sector, and, second, the sustained increase in leisure time. We contribute to the literature on structural change by relating these two patterns. We argue that during leisure time we consume recreational services. The observed increase in leisure time then implies an increase in the consumption of these services, which introduces a mechanism explaining structural change in the sectoral composition of employment.

We construct a multi-sector exogenous growth model with sectoral biased technological change to measure the effect on structural change of this mechanism. The new feature of the model is the introduction of recreational activities, which depend on both leisure time and the consumption of recreational services. We calibrate the model and we show that it accounts for the increase in leisure time, the increase in recreational services and the changes in the sectoral composition of employment. We also show that the performance of the model in explaining the rise of the service sector worsens when recreational activities are not considered.

Recreational activities introduce a substitution between leisure time and the consumption of recreational services that has interesting implications on leisure inequality and on the effect of taxes on the labor supply. First, we provide evidence showing that high labor income individuals consume a larger fraction of services in recreational activities and devote a smaller fraction of time to leisure. We show that the model explains this evidence through the substitution between leisure time and recreational expenditures. Second, we argue that the introduction of recreational activities contributes to explain the large differences in the amount of time devoted to work between the US and European economies. Prescott (2004) and Rogerson (2008) have convincingly shown that large part of these differences can be explained by the differences in the labor income taxes. The effect of taxes on employment depends on the substitution between leisure and consumption expenditures. Since recreational activities increase this substitution, the reduction in employment due to a tax increase is larger when recreational activities are considered. Therefore, recreational activities contribute to explain employment differences across countries due to differences in labor income taxes.

During the last 50 years, other important changes in the uses of time have occurred. One of them is the reduction in the amount of time devoted to home production, which can be explained as the consequence of technological improvements in the home production technology. As explained in the introduction, many authors have argued that the reduction of home production may help to explain the rise of the service sector. A natural question then is to study how the reduction in home production has affected the changes in the sectoral composition of the service sector, mainly the fast increase of recreational services that we show in Figure 1.

To address this question would require a deep analysis of home production that is beyond the scope of this paper. In Appendix C, we provide a preliminary answer to this question by introducing home production in a very stylized manner in the model of Section 2. In particular, we assume that home production is only a substitute of non-recreational services. Using this crucial assumption, we show that an improvement in the home production technology directly increases both leisure and the fraction of services devoted to recreational activities when the elasticity of substitution between market and non-market services is larger than the elasticity of substitution among the different consumption goods. The intuition is quite immediate. This technological improvement increases the non-market production of non-recreational services and, hence, the consumption of non-recreational services increases. Two effects occur. On the one hand, if home produced services are a good substitute of market services, the amount of non-recreational services produced in the market declines. As a consequence, the fraction of market services devoted to recreational activities increases. On the other hand, the increase in non-recreational services rises the demand of recreational activities when the elasticity of substitution among the different consumption goods is small. This causes the increase in both leisure and recreational services.

Some words of caution about this result are in order. First, the analysis only considers the direct effect of a technological improvement and, hence, it disregards the general equilibrium effects associated to this improvement. Second, the result depends on the assumptions made about home production, mainly that home production is only a substitute of non-recreational services. Finally, the result crucially depends on the value of the elasticity between market and non-market services. These concerns limit the relevance of the findings obtained in Appendix C, which should be interpreted as a preliminary analysis of the effects of home production on the sectoral composition of the service sector. The preliminary results suggest that this analysis seems a promising line of future research.

Another interesting extension is to consider that during leisure time individuals consume both recreational services and recreational goods. The introduction of recreational goods seems particularly relevant for those recreational activities that take place at home, such as watching television. In the online Appendix D.5, we show that the fraction of the value added of the goods sector explained by the consumption of recreational goods has increased substantially in the period 1965-2015. In the same appendix, we solve the consumers' problem to show that the conclusions of this paper regarding the increase in leisure time and structural change in the sectoral composition are still maintained when goods are included in recreational activities.

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Tables and Figures

Table 1: Baseline Calibration for Economies I, II and III

Parameters	Values	Targets	Data
α	0.3480	Labor income share	0.652
γ_g	0.0187	GDP growth rate	0.028
γ_s	0.0118	Growth rate of relative price	0.007
A_s	1.4002	Relative price of services	0.714
A_g	1	Normalized	-

We report data of average labor income share from Penn World Table version 9.0. and the data on the GDP growth rate from Table 1.1.5 in BEA for the period 1965-2015. We compute relative price of services (level and growth rate) using value added data by industry from BEA based on the procedures presented in Herrendorf et al. (2014). Based on these calibrated parameters, the simulated average GDP growth rate in the period 1965-2015 in Economies I, II and III is 0.0258, 0.0252, and 0.029, respectively.

Table 2: Joint Calibration of Economies I, II and III

Parameters	Targets	Data	Economy I Values	Economy II Values	Economy III Values
σ	Recreational consumption (2015)	0.086	0.7130	-	-
β	Recreational consumption (1965)	0.052	0.2966	0	-
$\bar{o}$	Total employment (2015)	0.457	0.4120	0.4183	-
$\bar{\eta}_l$	Total employment (1965)	0.539	7.457	0.6079	0
$\bar{\eta}_s$	Employment in services (1965)	0.546	108.25	9.3059	9.9417
ρ	Long-run value of K/Q	2.680	0.0781	0.0824	0.0824
δ	Long-run value of I/K	0.054	0.0270	0.0227	0.0227
$\bar{c}$	Minimize RMSE of I/K	-	0.3140	0.2500	0.2500
ε	Minimize RMSE of I/K	-	0.0100	0.1200	0.0100

We calibrate jointly the parameters (β, σ, $\bar{o}$, $\bar{\eta}_l$, $\bar{\eta}_s$, ρ, δ, $\bar{c}$, ε) along with parameters in Table 1 to match the following targets: we set the values of β, $\bar{o}$, σ and $\bar{\eta}_l = \left(\eta_l/\eta_g\right)^{\varepsilon}$ to explain 100% of the total variation of employment and recreational services shares in the period 1965-2015; $\bar{\eta}_s = \left(\eta_s/\eta_g\right)^{\varepsilon}$ to match the employment share in services in 1965. We set δ and ρ to match the long-run values of the investment-capital and the capital-output ratios and we set $\bar{c}$ and ε to minimize the root-mean-square errors (RMSE) of the model's predictions with respect to the investment-capital ratio for the period 1965-2015. Long-run value of investment-capital ratio is the average value for the period 2008 to 2015, whereas the long-run value of capital-output ratio is the average value for the period 1965 to 2015. Both values are obtained from the Bureau of Economic Analysis. Based on the calibrated parameters, the average investment-capital ratio in the period 2008-2015 in Economies I, II and III is 0.0528, 0.0479 and 0.0517. The average capital-output ratio in the period 1965-2015 in Economies I, II and III is 2.54, 2.55 and 2.54, respectively.

Table 3: Performance of Economies I, II and III

Accuracy Measures	Economy I	Economy II	Economy III
Relocation index	0.9652	0.7922	0.8104
Root mean squared error	0.0067	0.0160	0.0149
Akaike information criterion	-364.26	-276.58	-284.04

Table 3 reports accurancy measures for the three models to explain the time path of the employment share in services from 1965 to 2015. The relocation index measures the fraction of the total change between 1965 and 2015 explained by the model. Both Root Mean Squared Errors and the Akaike Information Criterion are obtained by regressing actual employment share in services on simulated employment share and without a constant.

Table 4: Calibration with taxes: Economies I and II

			Economy I	Economy II
Parameters	Targets	Data	Values	Values
σ	Recreational consumption (2015)	0.086	0.8085	-
β	Recreational consumption (1965)	0.052	0.3757	0
$\bar{o}$	Total employment (2015)	0.457	0.4030	0.4187
$\bar{\eta}_l$	Total employment (1965)	0.539	8.5366	0.5810
$\bar{\eta}_s$	Employment in services (1965)	0.546	115.02	9.5436
ρ	Long-run value of K/Q	2.680	0.0795	0.0824
δ	Long-run value of I/K	0.054	0.0255	0.0227

Table 4 shows the calibrated parameters values for economies I and II when the labor income tax is equal to 40%. The values of $\bar{c}$ and ε remain as in Table 2.

Table 5: Employment and GDP loss due to a tax increase

	Economy I		Economy II	
year	Employment	GDP	Employment	GDP
1965	1.392%	1.392%	0.327%	0.327%
2015	3.133%	2.829%	1.019%	0.719%

Table 5 shows the employment and GDP loss due to the increase in the income tax from 40% to 59%.

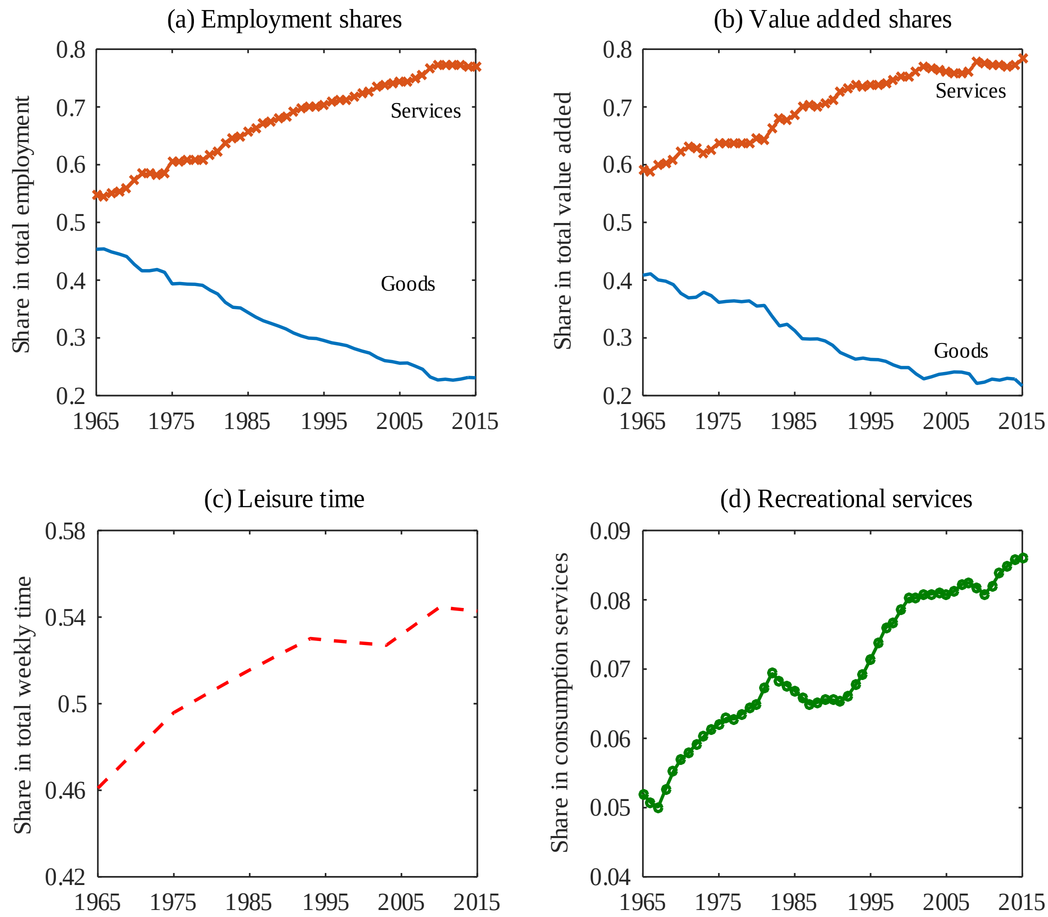

Figure 1. Patterns of Structural Change of the US economy

Source: Employment and value-added shares are obtained from Timmer et al (2015) and World Development Indicators. In Appendix A we explain the construction of leisure time and consumption of recreational services. Total weekly time refers to total time devoted to leisure and work in the market.

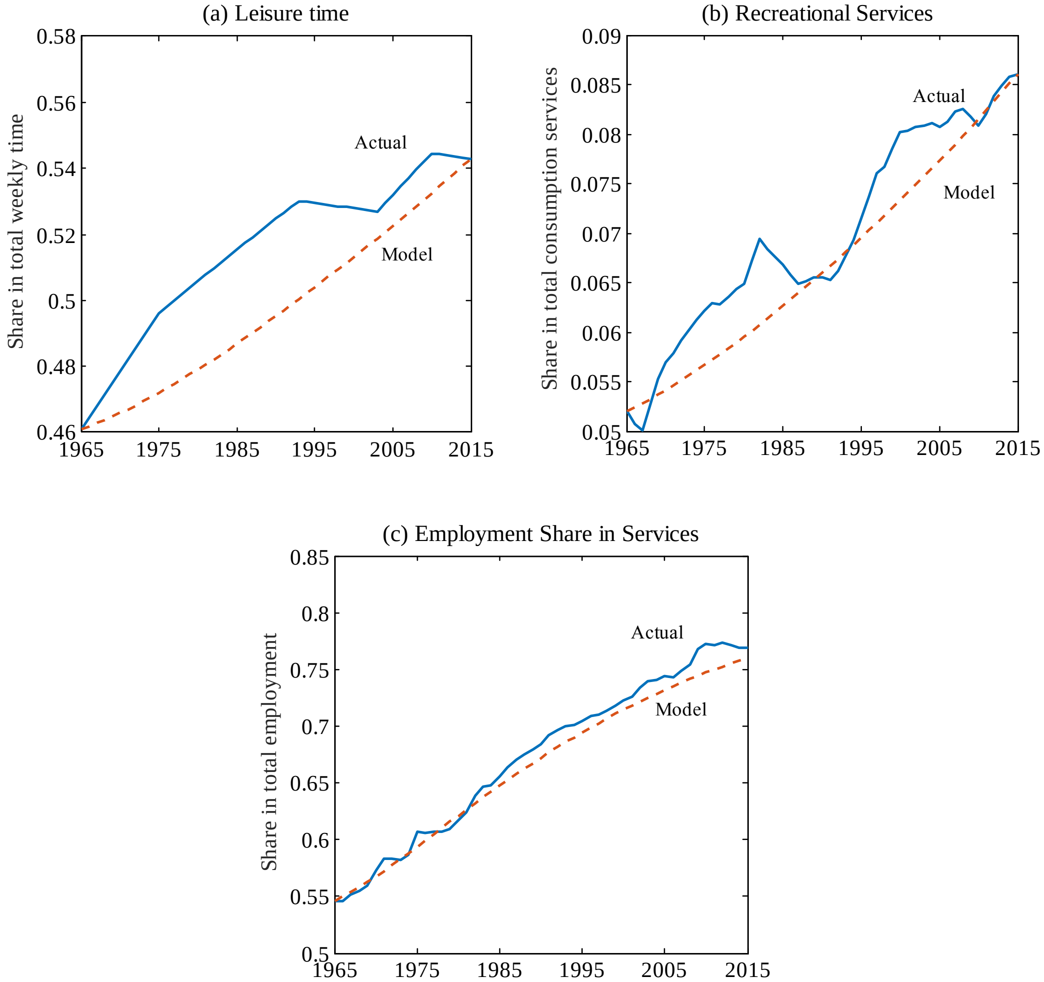

Figure 2. Numerical simulation of Economy I

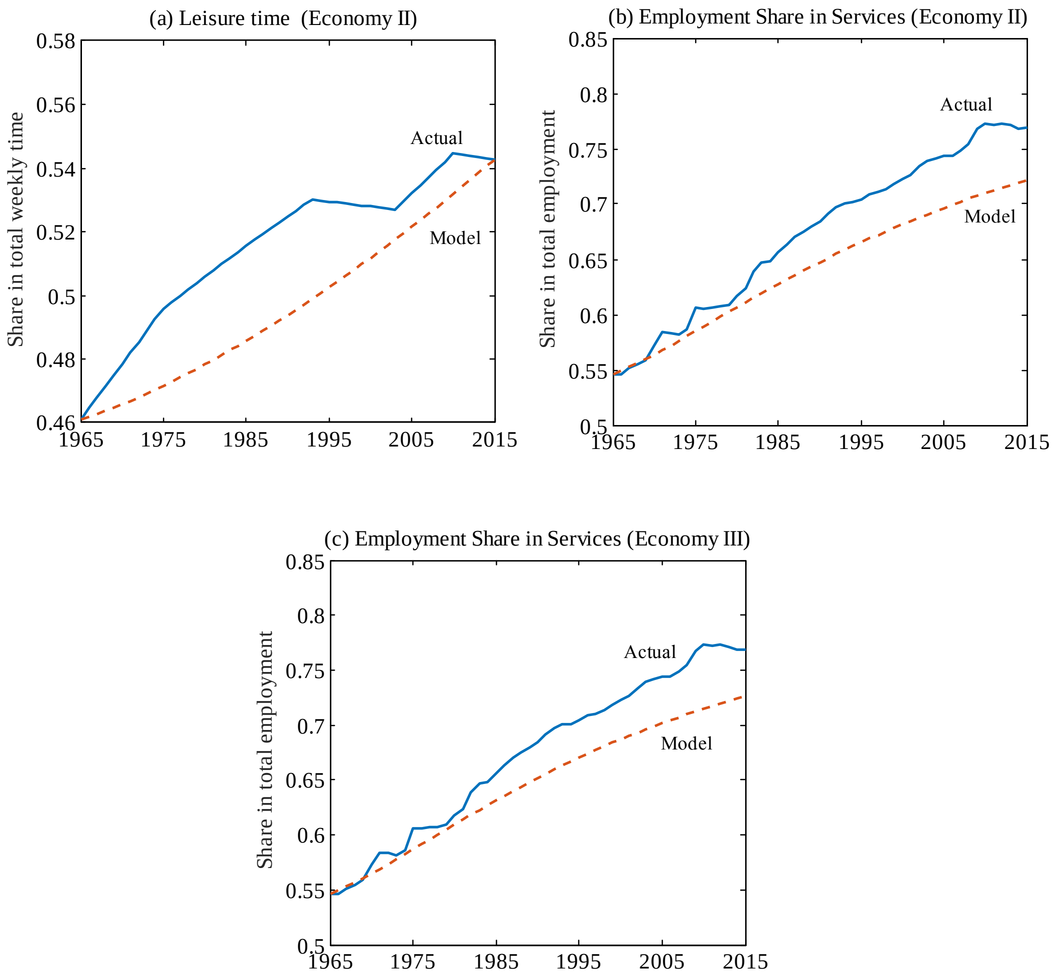

Figure 3. Numerical simulation of Economies II and III

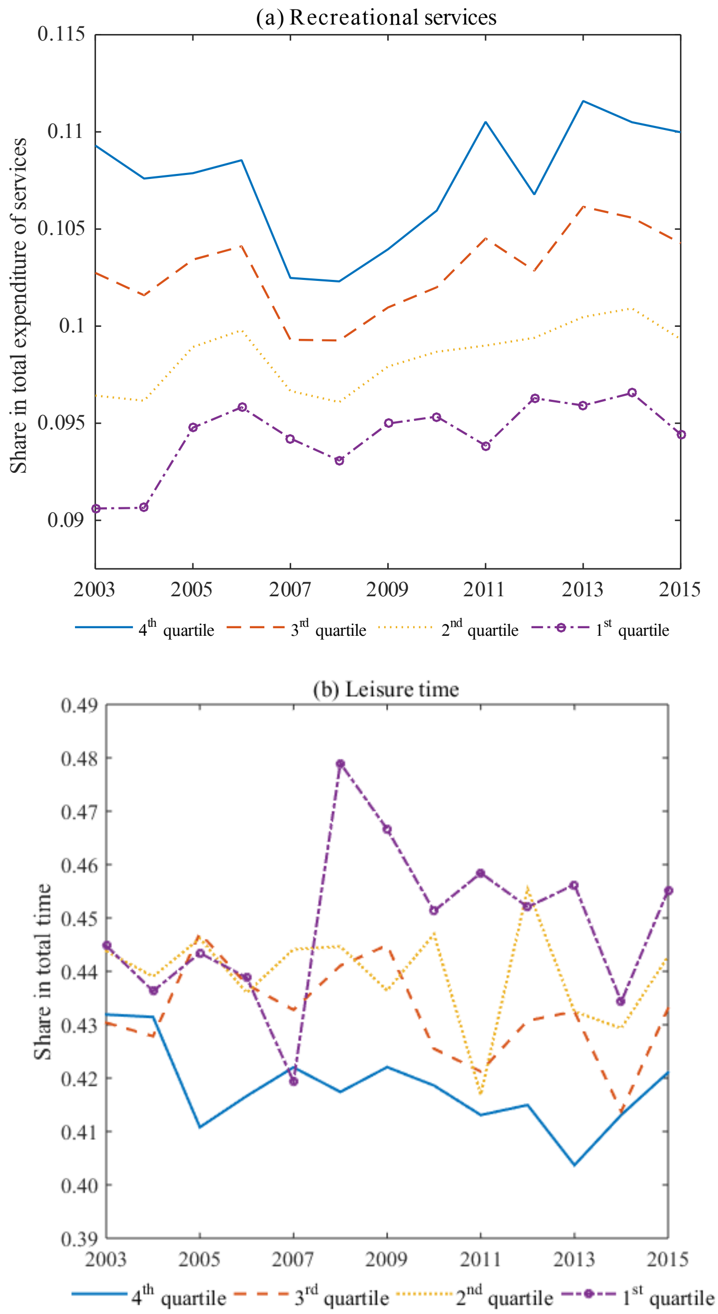

Figure 4. Inequality in recreational services and leisure time

Figure 4 shows the time path of recreational services expenditure in the US by labor income quartile and of leisure as a fraction of total time devoted to leisure and market work by quartiles of hourly wages. We use the Consumer Expenditure Survey (CEX) from the Bureau of Labor Statistics (BLS) to compute recreational expenditures (see Appendix A.3). We compute leisure and market work hours as in Aguiar and Hurst (2007) based on micro-level data from the American Time Use Survey (see Appendix A.1). Both figures show trends in inequality for the population aged between 25 and 75 or more years.

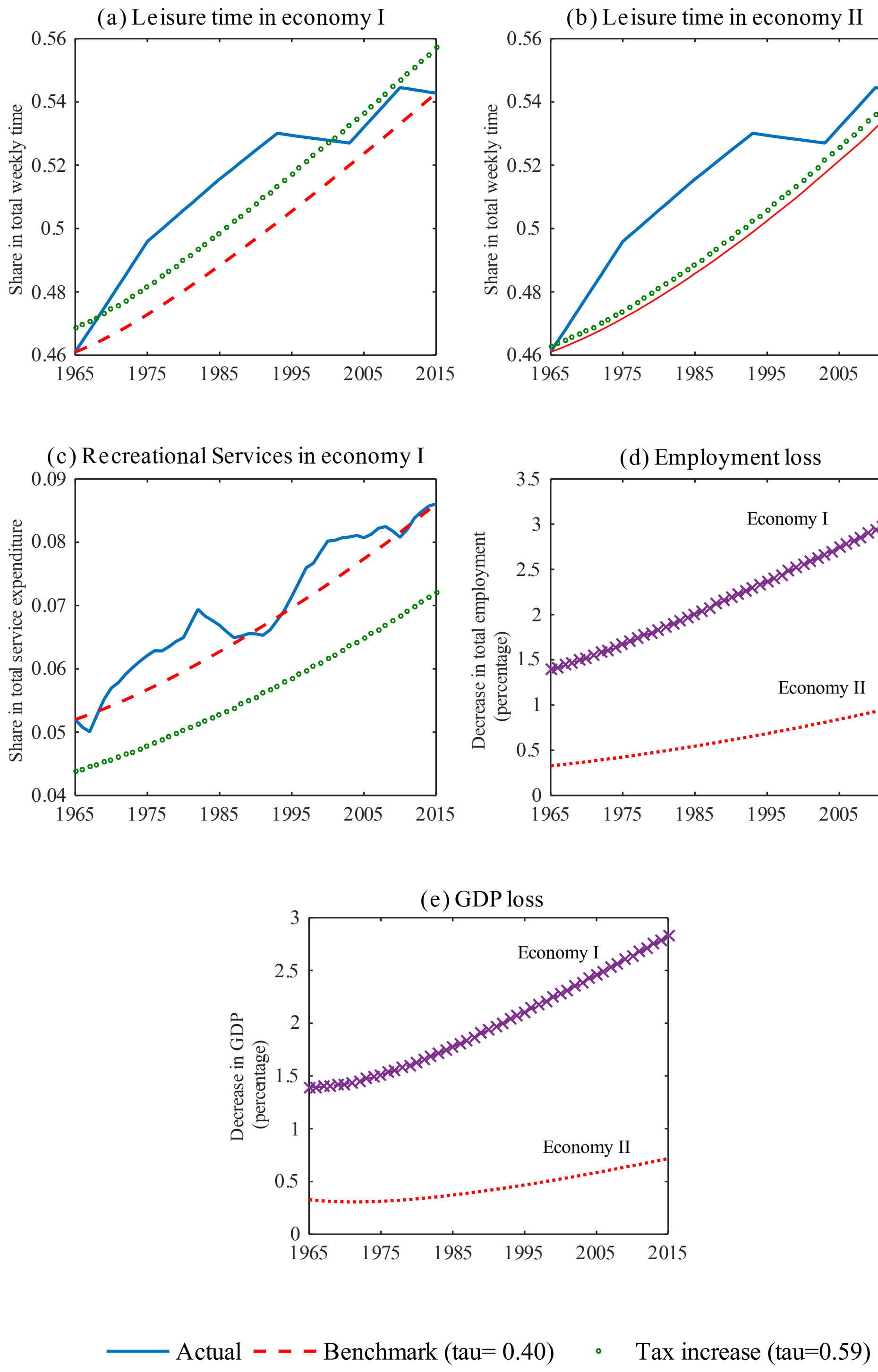

Figure 5. Effect of taxes

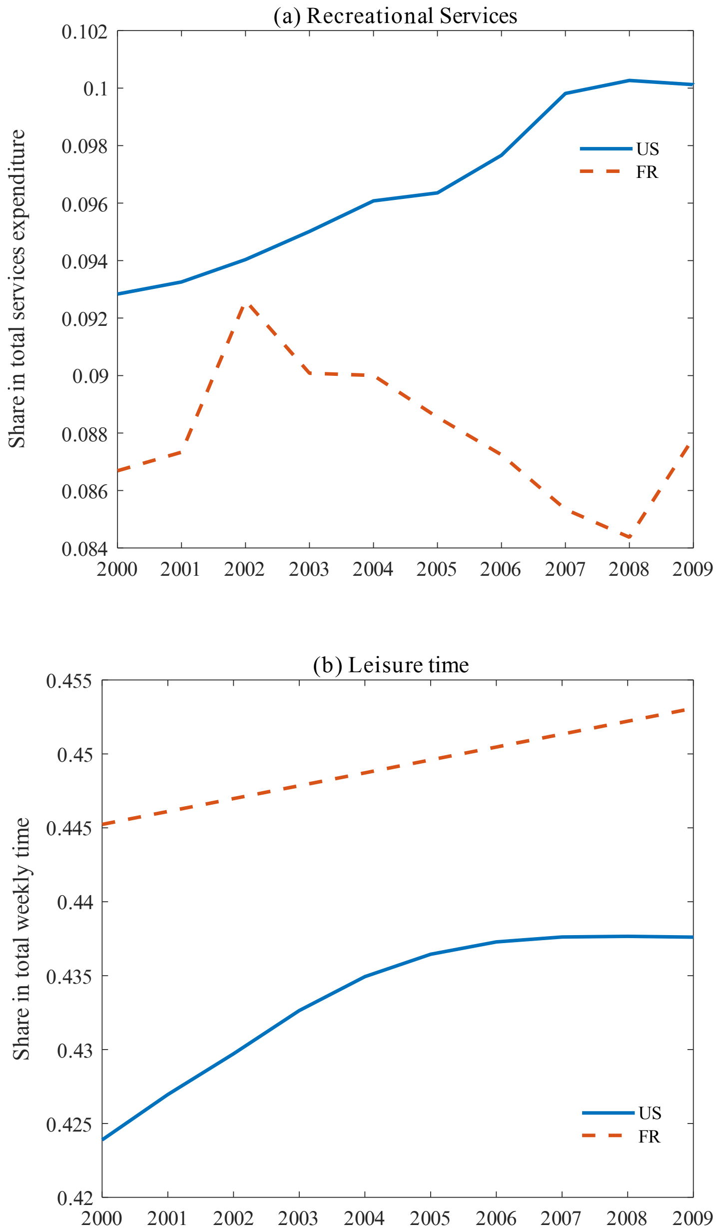

Figure 6. Cross-country differences in leisure and recreational services

Figure 6 shows the time path of recreational services expenditure, as a share of total service expenditure, and leisure time in the US and France. Recreational services expenditures are computed following the methodology in Herrendorf et al. (2013). As before, we use data from BEA for the US economy, and we use available input-output data in the World Input-Output Database (WIOD) for the French economy. We should highlight that we exclude from the computation of the recreational services share the expenditure in health and education in both countries to keep comparability between the two measures. See Appendix A.4.

A. Leisure time and recreational services

A.1. Leisure time

We construct the uses of time data as in Aguiar and Hurst (2007), who use micro-level data from the American Time Use Survey (ATUS). First, they define time devoted to work as average hours devoted to work in the main job (including time spent working at home), other jobs, plus other work-related activities such as commuting to/from work, meals/breaks at work, searching for a job and applying for unemployment benefits. Second, they define four different measures of leisure based on the type of activities realized during non-working time. The data in our paper refers to their measure *leisure 1*. This measure includes the average weekly hours devoted to sports, exercise, socialize, travel, reading, hobbies, TV, radio, entertainment, volunteering, pet care and gardening. Third, we follow Aguiar and Hurst (2007) and we control demographic changes when we compute the average hours per week spent in total market work and leisure. More precisely, we compute the average weekly hours in leisure activities and work for individuals aged between 24 and 65 years holding constant the demographic composition. To this end, we divide the sample into 72 demographic cells, as Aguiar and Hurst (2007). These cells are defined using five age groups, four education categories, two gender categories, and two categories to distinguish between individuals with and without a child.[19] Then, we compute the constant weights used for demographic adjustments by pooling together all the time use surveys and compute the percentage of the population that belongs to each demographic cell. We use these constant weights to compute the weighted mean of leisure and work in each year. Table A.1 shows the working and leisure hours for the years in which survey data is available.[20]

The ATUS reports other uses of time such as time spent on personal care, time devoted to home production and time spend on childcare. The total time devoted to these activities has been roughly constant and equal to 101 hours a week during the period 1965-2015, with the only exception of 1993. This year is not considered in

[19] The age groups are defined by individuals aged between 21-29, 30-39, 40-49, 50-59, and 60-65. The four education categories are defined by individuals with less than high school, high school, some college, and college.

[20] Since 2003, the American Time Use Survey (ATUS) is available at annual frequency.

our analysis. As a consequence, the remaining time that is devoted to either leisure or working in the market has also been roughly constant and equal to 67 hours a week. The ratio between the time devoted to leisure and the sum of the time devoted to leisure and to market work is shown in Panel c of Figure 1. This ratio exhibits an increasing trend and the year 1993 is clearly out of the trend.

Table A.1: Average hours per week devoted to market work and leisure

	1965	1975	1985	1993	2003	2010	2015
Working hours	35.96	33.77	32.62	33.29	31.78	29.98	30.12
Leisure hours	30.78	33.22	34.75	37.45	35.33	35.74	35.76

A.2. Recreational Services

We obtain the value added generated by the consumption of recreational services using the IO tables published by the Bureau of Economic Analysis (BEA) for the period 1963-2015.[21] We follow the methodology of Herrendorf et al. (2013), who compute the value added in the agricultural, manufacturing and service sectors generated by the final consumption expenditure. We extend this methodology to obtain the value added of recreational and non-recreational services. The former are identified as those services demanded by households to fulfill recreational activities that are performed by individuals during their leisure time. These activities are defined according to Aguiar and Hurst (2007) first measure of leisure, leisure 1. We then assume that these recreational activities are provided by the following industries in the IO tables: amusement, motion pictures and other recreational services; radio and TV broadcasting; communication; and hotels and lodging places. These industries cover activities that according to Aguiar and Hurst (2007) are realized during leisure time except volunteering, pet care, gardening and reading for which we cannot identify and industry in the service sector. Table A.2 provides detailed information of these industries and the codes that identify them in the IO table for each year.

We use this analysis to compute the fraction of the value added of the service sector

[21] The Bureau of Economic Analysis (BEA) publishes IO tables for the years 1963, 1967, 1972 1977, 1982, 1987, 1992, 1998. After 1998, IO tables are published annually from 1999 to 2015. To download IO tables prior to 1977, see http://www.bea.gov/industry/io_benchmark.htm. For the years after 1977, IO tables are available in http://www.bea.gov/industry/io_histsic.htm.

generated by the consumption of recreational services, which is shown in Figure 1, Panel d. It shows that this fraction follows a rising trend except in the years 1987 and 1992. Our analysis does not explain observations that are out of the trend and, therefore, we will not consider them in the analysis.

At this point, it is important to mention that we do not include industries such as restaurants and transport services, because we cannot claim households consume them only for recreational purposes. Therefore, the value of the fraction of recreational services reported in Panel d of Figure 1 is underestimated. As a consequence, we interpret the 19% of the increase in the service sector explained by recreational services, that we report in the paper, as a lower bound.

A.3. Inequality in recreational services and leisure time

Inequality in recreational services

We use the Consumer Expenditure Survey (CEX) from the Bureau of Labor Statistics (BLS) for the period 2003 to 2015 to compute recreational services expenditure by quartile of labor income. We use the annual expenditures of households to compute the share of recreational services in total services consumption expenditure. Annual consumption expenditures are computed using the Quarterly Interview Surveys and following BLS instructions. We then classify consumption expenditures into goods, non-recreational services and recreational services. We classify as recreational services those services demanded by a household to fulfill recreational activities. This classification is based on Aguiar and Hurst (2007) cataloging of recreational activities (see Table A.2).

We drop all observations with missing and non-positive income reports, and all observations with non-positive consumption expenditure reports of non-durable goods, durable goods, non-recreational and recreational services. By following these criteria, and focusing in households where the head of the household is aged between 25 and 75 or more, we obtained a database with 162,611 observations.[22] In each year, we group the observations into four income quartiles according to the total household labor income after taxes per OECD modified equivalence scale. We then compute the mean of

[22] We also carry out the same analysis by including households where the head of household in aged between 25 to 65 years old. In that case, our sample is 122,884 observations and we don't observe significant changes in the reported results in Figure 4.

the recreational services shares for each quartile and year. These means are shown in Panel a of Figure 4.[23]

At this point, it is important to clarify that the measure of recreational services in Figure 1 is not directly comparable with the measure provided in Figure 4. First, these measures are obtained from different data bases and, second and more important, the measure in Figure 1 is based on the value added component of the expenditures, whereas the measure in Figure 4 is based on the final consumption expenditure.

Inequality in leisure time

To compute inequality in leisure time, we use the ATUS database for the period 2003 to 2015. We first drop all observations with missing and non-positive income reports, and we also drop observations with individuals that are not aged between 25 and 75 or more. Following these criteria, we obtain a database with 82,036 observations. As explained in Appendix A.1, the activities included in our measure of leisure time correspond to those in the Leisure 1 measure in the paper by Aguiar and Hurst (2007). In each year, we group the observations by quartiles of hourly wages. We then compute the mean of leisure time as a fraction of time devoted to leisure and market work for each quartile and year. These means are shown in Panel b of Figure 4.[24]

A.4. Cross-country differences in recreational services and leisure time

We use the World Input-Output Database (WIOD) and the Multinational Time Use Study (MTUS) to calculate the share of recreational services in total services expenditure and the leisure time in France. These data are shown in Figure 6.

Recreational Services

We use the France data available in the WIOD and we follow the methodology of Herrendorf et al. (2013) to compute the value added in the agricultural, manufacturing and service sectors (recreational and non-recreational services) generated by the final

[23] We obtain the conditional mean of recreational service shares by running a regression of the individual recreational service shares on a constant, on the age of the household and on the square of the age. We also compute the simple mean of the recreational services shares by quartiles of labor income and we obtain the same conclusions regarding the effect of labor income on the recreational services shares.

[24] In contrast to the measure of leisure in Panel c of Figure 1, leisure time in Figure 4 is obtained without controlling for demographic changes.

consumption. We use the recreational industries in the IO tables described in Table A.2. to identify in the WIOD the industries that provide recreational services. Table A.3. provides the WIOD code and names of these industries.

There are two main differences between the measure of the share of recreational services in total service expenditures based on WIOD, that we use for France, and the one based on IO tables published by BEA, that we use for the US. The first difference refers to the level of detail. In the case of France, the WIOD table merges accommodation and food services in a unique industry. In contrast, the IO tables published by BEA, report accommodation and food services as different industries. As a consequence, household consumption expenditure in recreational services includes food services in the case of France, but not in the US. The second difference refers to households consumption expenditure in health and education. There are significant differences between US and France in households consumption expenditure in these services, that are probably due to a different provision by the government of these services. To keep the comparability, we exclude consumption expenditures in health and education when computing total consumption expenditure in services in both France and the US data.

Leisure time

We use the Multinational Time Use Study (MTUS) to compute the share in total weekly time of leisure and market work in France and the US.[25] MTUS provides a collection of time use surveys that are harmonized for compatibility across countries. We compute the average weekly hours in leisure activities (see Table A.4) and market work reported by individuals aged between 24 and 64 years holding constant the demographic composition.[26] To this end, we divide the samples of France and the US into demographic cells as we explained in Appendix A1. These cells are defined by four age groups, three education categories, two gender categories, and two categories to distinguish between individuals with and without a child. Then, we compute the

[25] For the sake of comparability with France, we compute again for the US economy the fraction of weekly time devoted to leisure using the MTUS instead of the ATUS. There are small differences, mainly explained by the fact that the number of demographic cells that can be used is different in these two data bases.

[26] We identify as market work the hours devoted to work for pay in the main job (including time spent working at home) and also in other jobs.

constant weights used for demographic adjustments by pooling together all the time use surveys and compute the percentage of the population that belongs to each of the 48 demographic cells.[27] We use these weights to compute the weighted mean of leisure and market work in each year and for each country. Finally, we calculate the share of leisure in total weekly time, in France and the US, as the ratio between leisure and the sum of leisure and market work time.

[27]For France, we use the available time use surveys of 1998 and 2009. For the US, we use the time use surveys of 1998 , and from 2003 to 2009. For those years where there is no available information, we compute the average weekly time of leisure and working time by linear interpolation. In the case of France, we interpolate annual data within 1998-2009, and for the US, we interpolate data within 1998-2003. In Figure 6, panel b, we only report data for the period 2000-2009 to maintain the same period than Panel a in Figure 6.

Table A.2: Selected industries in IO tables that provide recreational services

Year	Amusement, Motion pictures and other recreational services	Radio & TV broadcasting	Communication	Hotels and lodging places
1963 & 1967	Motion pictures (7601), Amusement and other recreation services (7602) , Businnes travel, and entertainment (8100).	6700	6600	7201
1972 & 1977	Motion pictures (7601), Amusement and other recreation services (7602).	6700	6600	7201
1982 & 1987	Motion pictures (760100), Theatrical producers, orchestras, and entertainers (760201), Bowling alleys, billiard and pool establishments (760202), Professional sports clubs and promoters (760203), Racing, including track operation (760204), Membership sports and recreation clubs (760205), Other amusement and recreation services (760206).	670000	660000	720100
1993	Motion picture services and theaters (760101), Video tape rental (760102), Theatrical producers (760201), Bowling centers (760202), Professional sports clubs and promoters (760203), Racing, including track operation (760204), Physical fitness facilities and membership sports and recreation clubs (760205).	670000	Telephone, telgraph communications, and communications services n.e.c. (660100), Cable and other pay television services (660200).	Hotels (720101), Other lodging places (720102).
2002	Motion pictures and sound recordings (5120), Performing arts, spectator sports, and museums (71A0), Amusements, gambling, and recreation (7130).	Radio and television broadcasting (5151), Cable networks and program distribution (5152).	Internet publishing and broadcasting (5161), Telecommunications (5170), Data processing services (5180), Other information services (5190).	Accommodation (7210).
2007	Motion picture and video industries (512100), Performing arts companies (711100), Spectator sports (711200), Promoters of performing arts and sports and agents for public figures (711A00), Independent artists, writers, and performers (711500), Museums, historical sites, zoos, and parks (712000), Amusement parks and arcades (713100), Gambling industries (except casino hotels) (713200), Other amusement and recreation industries (713900), Sound recording industries (512200).	Radio and television broadcasting (515100), Cable and other subscription programming (515200).	Wired telecommunications carriers (517110), Wireless telecommunications carriers (except satellite) (517210), Satellite, telecommunications resellers, and all other telecommunications (517A00), News syndicates, libraries, archives and all other information services (5191A0), Internet publishing and broadcasting and Web search portals (519130).	Accommodation (721000).
2015	Motion picture and sound recording industries (512), Performing arts, spectator sports, museums, and related activities (711AS), Amusements, gambling, and recreation industries (713).	Broadcasting and telecommunications (513).	Data processing, internet publishing, and other information services (514).	Accommodation (721).

Table A.3: WIOD industries

WIOD codes	Description
CPA I	Accommodation and food services
CPA J59-60	Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services.
CPA J61	Telecommunications services
CPA N79	Travel agency, tour operator and other reservation services and related services
CPA R90-92	Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services
CPA R93	Sporting services and amusement and recreation services
CPA S94	Services furnished by membership organizations

Table A.4: Leisure activities in MTUS

MTUS codes	Description	MTUS codes	Description
0735	General out-of-home leisure	0950	Games
0736	Attend sporting event	0951	General indoor leisure
0737	Cinema, theatre, opera, concert	0952	Art or music
0740	Party, social event, gambling	0953	Correspondence
0842	General sport or exercise	1058	Listen to radio
0845	Other outside recreation	1059	Watch TV, video, streamed film
0949	Conversation	1061	E-mail, surf internet, computing

Source: Kimberly Fisher, Jonathan Gershuny, Sarah M. Flood, Daniel Backman, and Sandra L. Hofferth. Multinational Time Use Study Extract System: Version 1.3 [dataset]. Minneapolis, MN: IPUMS, 2019. https://doi.org/10.18128/D062.V1.3

B. Solution of the consumers' problem

The Hamiltonian present value associated to the consumers' maximization problem is

$$\mathcal{H} = \ln C + \lambda \left(wl + rk - c_g - p_s c_s \right).$$

The first order conditions with respect to x, c_g, c_s, l and k are, respectively,

$$\frac{(1-x)^{-\frac{1}{\varepsilon}}}{x^{-\frac{1}{\sigma}}} c_s^{\frac{\varepsilon-\sigma}{\varepsilon\sigma}} = \left(\frac{\eta_l \beta}{\eta_s} \right) c_l^{\frac{\varepsilon-\sigma}{\varepsilon\sigma}}, \tag{B.1}$$

$$C^{\frac{1-\varepsilon}{\varepsilon}} \eta_g \left(c_g - \overline{c} \right)^{-\frac{1}{\varepsilon}} = \lambda, \tag{B.2}$$

$$C^{\frac{1-\varepsilon}{\varepsilon}} \left\{ \frac{\eta_s \left[(1-x) c_s \right]^{\frac{\varepsilon-1}{\varepsilon}} + \eta_l \beta c_l^{\frac{\varepsilon-\sigma}{\varepsilon\sigma}} \left(x c_s \right)^{\frac{\sigma-1}{\sigma}}}{c_s} \right\} = \lambda p_s, \tag{B.3}$$

$$C^{\frac{1-\varepsilon}{\varepsilon}} \eta_l c_l^{\frac{\varepsilon-\sigma}{\varepsilon\sigma}} \left(1-\beta \right) \left(1-l-\overline{o} \right)^{-\frac{1}{\sigma}} = \lambda w, \tag{B.4}$$

and

$$\dot{\lambda} = -\left(r-\rho \right) \lambda. \tag{B.5}$$

We proceed to obtain c_l, c_s, c_g, l, and x as functions of prices, wages and total consumption expenditures, E, where $E = c_g + p_s c_s$. To this end, we combine (B.1), (B.2) and (B.3) to get (2.7) and (2.8) in the main text. We next use (B.1), (B.3) and (B.4) to obtain

$$x c_s = \left(\frac{(1-\beta) p_s}{w\beta} \right)^{-\sigma} \left(1-l-\overline{o} \right). \tag{B.6}$$

We substitute (B.6) in (2.6) to get

$$c_l = \left(1-l-\overline{o} \right) \kappa_2 \left(\frac{w}{1-\beta} \right)^{\sigma}, \tag{B.7}$$

where κ_2 is defined in (2.13). From combining (B.2), (B.4), (B.7) and (2.7), we get (2.10) in the main text. We combine (B.1), (B.7), (2.8) and (2.10) to get (2.9) in the main text.

To derive the expression of the Euler condition, we first use (B.7) and (2.10) to reach

$$c_l = \left(\frac{\eta_g}{\eta_l} \right)^{-\varepsilon} \kappa_2^{\frac{\varepsilon}{\sigma}} \left(c_g - \overline{c} \right). \tag{B.8}$$

We next substitute (2.8) and (B.8) in the definition of C to obtain

$$\left(\frac{C}{c_g-\overline{c}}\right)^{\frac{\varepsilon-1}{\varepsilon}}\frac{1}{\eta_g}=1+\overline{\eta}_s p_s^{1-\varepsilon}+\overline{\eta}_l\kappa_2^{-\frac{1-\varepsilon}{\sigma}},$$

where $\overline{\eta}_s=\left(\eta_s/\eta_g\right)^{\varepsilon}$, and $\overline{\eta}_l=\left(\eta_l/\eta_g\right)^{\varepsilon}$. We rewrite (B.2) and substitute the previous relations to reach

$$\lambda=\frac{1}{\left(1+\overline{\eta}_s p_s^{1-\varepsilon}+\overline{\eta}_l\kappa_2^{-\frac{1-\varepsilon}{\sigma}}\right)\left(c_g-\overline{c}\right)}. \tag{B.9}$$

Using (2.7), we obtain

$$\frac{1}{\lambda}=\kappa_3\left(E-\overline{c}\right), \tag{B.10}$$

where κ_3 is defined in (2.14). Finally, combining (B.5) and (B.10), the Euler condition (2.11) is obtained.

C. Home production

During the last 50 years, the time devoted to home production has declined. This has been related to improvements in the home production technology. Several papers have also related the reduction in the time devoted to home production with the increase in the service sector. This relation is based on the larger substitutability of home production with services than with goods. In the concluding remarks section, we extend this analysis by discussing how the technological improvements in home production, that reduce the time devoted to home production, may affect the sectoral composition within the service sector. The purpose of this appendix is to provide a preliminary analysis of a simplified model in order to support the discussion in the concluding remarks section.

We extend the model of Section 2 to introduce home production, which is produced with the following linear production function:[28]

$$c_h=A_h u_h l, \tag{C.1}$$

where c_h is home production, u_h is the fraction of total employment, l, devoted to home production and A_h measures TFP in home production. Obviously, we assume

[28] The linear production function is obviously a simplification. Other authors like Ngai and Pissarides (2008) and Boppart and Ngai (2017) assume instead that the technology to produce at home is identical to the technology used to produce in the market.

that $u_g + u_s + u_h = 1$. The introduction of home production does not modify the firms' problem explained in Section 2 and the only change is that now from (2.3) and (2.4) we obtain that $u_g = s_g (1 - u_h)$ and $u_s = s_s (1 - u_h)$.

We modify the utility function of the model of Section 2 by introducing home production as a substitute only of non-recreational services. Rogerson (2008) assume that home production is only a substitute of services.[29] Moreover, Aguiar and Hurst (2007) account for the following activities of home production: home maintenance, outdoor cleaning, vehicle repair, gardening, among others. Note that all these activities are clear substitutes of non-recreational services, but they are not of recreational services. To introduce home production as a substitute of non-recreational services, we define the consumption of non-recreational services as

$$\tilde{c}_s = \left[\pi \left[(1 - x) c_s \right]^{\frac{\mu - 1}{\mu}} + (1 - \pi) (c_h)^{\frac{\mu - 1}{\mu}} \right]^{\frac{\mu}{\mu - 1}}, \tag{C.2}$$

where $1 - x \in [0, 1]$ is the fraction of market services that together with home production define the total amount of non-recreational services and μ is the elasticity of substitution between market and non-market services. The composite consumption good rewrites as

$$C = \left[\eta_g (c_g - \overline{c})^{\frac{\varepsilon - 1}{\varepsilon}} + \eta_s \tilde{c}_s^{\frac{\varepsilon - 1}{\varepsilon}} + \eta_l c_l^{\frac{\varepsilon - 1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon - 1}},$$

where recreational activities, c_l, are defined as in (2.6).

Individuals decide on x, u_h, l, c_s, c_g, and k to maximize the utility function subject to the budget constraint $wl (1 - u_h) + rk = E + \dot{k}$, where $E = c_g + p_s c_s$ is total consumption expenditures. The details of the solution of the consumer's problem are available in the online Appendix D.4 and, therefore, here we just provide the three main results from the consumers' problem. First, from the first order conditions with respect to x, we obtain the sectoral composition within the service sector

$$x = \frac{1}{1 + \left(\frac{\pi \eta_s}{\beta \eta_l} \right)^{\varepsilon} \Delta_{\pi}^{\frac{\varepsilon - \mu}{\mu - 1}} \Delta_{\beta}^{\frac{\sigma - \varepsilon}{\sigma - 1}}}, \tag{C.3}$$

where $\Delta_{\pi} = \pi + (1 - \pi) \left(\frac{A_h p_s}{w} \frac{1 - \pi}{\pi} \right)^{\mu - 1}$ and $\Delta_{\beta} = \beta + (1 - \beta) \left(\frac{p_s}{w} \frac{1 - \beta}{\beta} \right)^{\sigma - 1}$.

Second, combining the first order conditions with respect to l, c_g and c_s, we obtain

[29] Rogerson argues that home production of goods is not important in developed countries.

the total supply of labor

$$l = 1 - \overline{\theta} - \left(\frac{\eta_l}{\eta_g}\right)^{\varepsilon} \left(\frac{p_s}{\beta}\right)^{\sigma-\varepsilon} \left(\frac{1-\beta}{w}\right)^{\sigma} \Delta_{\beta}^{\frac{\varepsilon-\sigma}{\sigma-1}} \left(\frac{E-\overline{c}}{\Delta}\right), \tag{C.4}$$

where $\Delta = 1 + \frac{p_s}{1-x}\left(\frac{\pi\eta_s}{p_s\eta_g}\right)^{\varepsilon} \Delta_{\pi}^{\frac{\varepsilon-\mu}{\mu-1}}$.

Finally, we combine the first order conditions with respect to u_h, c_g and c_s to obtain employment in home production

$$u_h l = \left(\frac{1-\pi}{\pi}\right)^{\mu} \left(\frac{p_s}{w}\right)^{\mu} A_h^{\mu-1} \left(\frac{\pi\eta_s}{\eta_g p_s}\right)^{\varepsilon} \Delta_{\pi}^{\frac{\varepsilon-\mu}{\mu-1}} \frac{E-\overline{c}}{\Delta}. \tag{C.5}$$

From the previous expressions, it follows that both x and leisure increase with A_h if and only if $\mu > \varepsilon$. The increase in A_h increases both home production, c_h, and non-recreational activities, $\tilde{c}_s$. If home produced services are a good substitute of non-recreational services produced in the market (i.e. μ is large), the increase in home production reduces the fraction of market services devoted to non-recreational activities (x increases). Moreover, if the different consumption goods are complements (ε is small) then the increase in non-recreational services causes the increase in recreational activities, c_l. This explains that both leisure time and the fraction of market services devoted to recreational activities increase if and only if μ is large in comparison to ε, i.e. $\mu > \varepsilon$.

Finally, $u_h l$ declines with A_h when $\mu < 1$ and $\varepsilon < \mu$. On the one hand, if home production and market production are complements, $\mu < 1$, then an increase in A_h shifts employment towards the market sector. On the other hand, if recreational activities and non-recreational services are complements (ε small), then recreational activities increase and, hence, leisure increases, which causes the reduction in employment.

The former results suggest that technological improvements in home production may explain part of the increase in both leisure time and in the fraction of services devoted to recreational activities. At this point, it is important to clarify that the former analysis only considers the direct effect of the technological improvement. There are also indirect general equilibrium effects that we have not considered.[30]

[30] The increase in A_h changes the supply of labor in the market, $l(1-u_h)$, and hence it modifies the wage, which is defined by $w = (1-\alpha) A_g (k/l(1-u_h))^{\alpha}$.