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Antonio Cutanda
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Juan A. Sanchis-Llopis

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VNIVERSITAT DE VALÈNCIA

Departamento de Estructura Económica (Economía Aplicada II), Facultad de Economía, Universitat de València
Avda dels Tarongers, s/n, 46022 – Valencia, Spain
Phone +34 96 382 83 49 / Fax +34 96 382 83 54
http://www.estructuraeconomica.es
e-mail: investigacion.estructura@uv.es

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INTERTEMPORAL SUBSTITUTION FOR CONSUMPTION AND LEISURE: EMPIRICAL EVIDENCE FOR SPAIN

Antonio Cutanda
Universidad de Valencia
and
Juan A. Sanchis-Llopis[1]
Universidad de Valencia and ERICES

Abstract.
In this paper we test the three first-order conditions of an intertemporal optimization model for a representative individual who chooses simultaneously for her level of consumption and leisure, assuming a separable utility function. We estimate these first order conditions separately and jointly using a Spanish pseudo-panel data set built by combining the Family Expenditure Survey and the Labour Survey for Spain over the period 1987-1997. Our results confirm previous empirical evidence as regards the elasticity of intertemporal substitution for consumption, that we estimate around 0.4/0.5, and provide an estimate for the leisure intertemporal elasticity around 0.2/0.3. Finally, we provide further evidence controlling for human capital. This allows checking that the model ignoring human capital produces biased estimates for the elasticity of intertemporal substitution for leisure.

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Corresponding author:
Antonio Cutanda Tarín
Departamento de Análisis Económico
Facultad de Economía
Avda. de los Naranjos, s/n
46022-Valencia
Phone: 96 382 82 35. Fax: 96 382 82 49
e-mail: antonio.cutanda@uv.es

1. Introduction.

The empirical research on the elasticity of intertemporal substitution for leisure using microeconomic data has traditionally produced very low estimates, as compared to the values given to this elasticity in the business cycle models (see Keane, 2011, and Chetty et al., 2011 and 2012). This discrepancy between the empirical evidence and the parameters considered in many theoretical macroeconomic models is a crucial issue in the debate within both literatures[1] and also for policy reasons (see Alan et al., 2009).[2] This has motivated a renewed attempt to reconcile both facts (see Chang and Kim, 2006, and Rogerson and Wallenius, 2009). Further, the few estimates available with aggregated data do not provided either reasonable results. See, for example, Mankiw et al. (1985) for the U.S. economy, or Cutanda (2019) for Spain using regional data.

The elasticity of intertemporal substitution for leisure measures labour supply responses to wage changes. There are different ways to obtain an estimate for this elasticity, that vary according to the assumptions adopted in its analytical derivation. In this paper, we will estimate the so-called Frisch elasticity for labour supply using Spanish microdata. The Frisch elasticity is derived from a life cycle model under the assumption that the marginal utility of wealth is constant. We consider this is one of the most accurate approaches when one aims to analyse the behaviour of labour supply along the life cycle.[3] However, the traditional methodological approach to this issue relies on estimating the intertemporal condition for leisure, ignoring that both the intertemporal labour supply and consumption decisions are taken jointly (and simultaneously) by individuals. This might be due to the modest results obtained in the

[1] As Chetty et al. (2011) point out, "micro estimates of intertemporal substitution (Frisch) elasticities are an order of magnitude smaller than the values needed to explain business cycles fluctuations in aggregate hours by preferences".

[2] As stated by Alan et al. (2009) the reasons are well known and are related to important issues such as, life-time wealth, retirement, fertility plans and other motives.

[3] The other two approaches to this concept are the Hicksian and the Marshallian elasticities. These depend on assuming that either the utility or wealth remain constant when wage is changing, respectively.

first attempts to tackle this issue (see Mankiw et al., 1985), and the lack of available statistical sources.[4]

In recent years, the traditional empirical approach for the estimation of the elasticity of intertemporal substitution for leisure has experienced a new push due to two features. First, Imai and Keane (2004) and related papers claim that previous results might suffer from a downward bias as do not consider the effect of human capital in the model. Second, there are new attempts to estimate the elasticity of intertemporal substitution for leisure, either based in the intratemporal condition between consumption and leisure, see Imai and Keane (2004) or using the intertemporal consumption Euler equation, as in Blundell et al. (1994) with an application to household labour supply, or combining both the intratemporal and intertemporal conditions, as in Attanasio et al. (2018) with an application to female labour supply. In this paper, we provide evidence on this empirical task considering the two issues raised above: first, we consider all the equations of the complete system of intertemporal optimization first-order conditions; and, second, we analyse the theoretical effect of human capital in our model to evaluate the magnitude of the hypothetical bias incurred when not considering its effect in the model. In particular, we estimate the log-linearized version of the Euler equation of the individual optimization problem, given that the estimation of their non-linear counterpart is inconsistent in the presence of the classical measurement error. Attanasio and Low (2004) and Alan et al. (2009) prove, using simulation techniques, that the elasticity of intertemporal substitution might be consistently estimated by log-linearized estimation in sufficiently large datasets. Our empirical work lies in this category as we have available a long (pseudo) panel with 41 quarters.

To jointly estimate the intertemporal labour supply and consumption decisions, implies using a data set with information on both individual consumption and labour supply. As there is not a microeconomic Spanish statistical source with these two basic pieces of information, we will combine two available data sets that provide detailed

[4] However, the joint analysis of consumption and leisure decisions is more realistic and provides better insights, as shown by recent available evidence (see Lepage-Saucier, 2016).

information for these two variables.[5] In particular, we combine the information on individual consumption and income from the Spanish Family Expenditure Survey (the *Encuesta Continua de Presupuestos Familiares*, ECPF) with information on individual labour supply from the Spanish Labour Force Survey (*Encuesta de Población Activa*, EPA). To combine these two data sets, we use pseudo-data panel techniques. We construct a synthetic panel to merge information for the different cohorts from both statistical sources based on the age of the head of the household (see Browning et al., 1985).[6] Combining these two microeconomic data sets for Spain makes it possible to empirically analyse the intertemporal substitution of leisure and consumption.

As regards the estimation results, we get reasonable estimates for the elasticity of intertemporal substitution for consumption and leisure for men, below one in both cases. In relation to consumption, we obtain an elasticity between 0.4-0.5, that is in line with Cutanda et al. (2019). However, we have to point out that our estimates are bigger than their estimates, what might be related to: i) the fact that we use more homogeneous cohorts; and, ii) we have a more appropriate definition of expenditure to analyse the intertemporal elasticity of consumption. For men's leisure we also get a sensible and statistically significant estimate for the elasticity of intertemporal substitution, between 0.2 and 0.3, a relevant result given that Cutanda (2019) obtained a non-significant estimate using Spanish regional data. Our result is comparable to the estimates obtained for other economies. See, for example, MaCurdy (1981), Altonji (1986) and Zabel (1997) or, more recently, Blundell et al. (2016).[7] One of the reasons behind the relatively lower elasticity for intertemporal substitution in Spain might be related to the high

[5] Further, the main available statistical Spanish source for labour supply does not contain information about wages or income, what explains that there is not any available estimate for the intertemporal substitution of leisure in Spain.

[6] In our approach, we follow Arellano and Meghir (1992) who combine the Labour Family Survey and the Family Expenditure Survey, although they do so only for 1983. These authors stress that the ideas relating to combining data sets have long existed in the literature. In this sense, we can underline Hartley (1958), Hartley and Hocking (1971), Maddala (1971), Jorgenson, Lau and Stoker (1982), or Bound et al. (1986), among others.

[7] Our estimate for the Frisch elasticity is slightly above the range of MaCurdy (1981) estimates (0.1-0.45) and Altonji (1986) estimates (0.08-0.54), which vary depending on the specification or the set of instruments used. Keane (2011) surveys 12 influential studies and reports an average estimate of 0.83 with a median estimate of 0.17.

persistence of the unemployment rate.[8] Further, our estimates are also comparable to Attanasio et al. (2018) estimate (0.87), for the intertemporal elasticity of US women labour's supply. Finally, within our framework, we confirm, following Imai and Keane (2004) the hypothesis that ignoring human capital produces biased estimates for the intertemporal substitution of leisure.

The rest of the paper is organised as follows. In section 2, we develop the theoretical model and discuss the main aspects related to the model. In section 3, we present the data used and how we build the pseudo-panel data set. In section 4, we report the results and in section 5 we conclude.

2. The intertemporal model.

2.1. The theoretical model.

In our theoretical approach we follow MaCurdy (1981 and 1983) who develops a basic life-cycle model of intertemporal labour supply. In this framework, it is assumed that individuals choose in each period consumption and leisure to maximize the expected life cycle utility function:

$$\underset{C_t L_t}{Max} U = E_t \sum_{i=0}^{T-t} \beta^i u\left(C_{t+i}, L_{t+i}\right) \tag{1}$$

where C_t, and L_t, are non-durable consumption and leisure, respectively.[9] In this model, U is assumed to be an intertemporally separable utility function and $u(.)$ corresponds to the utility in a specific period, assumed to be increasing and concave in its arguments. E_t is the mathematical expectations operator conditional on the information set available in period t and β is the discount rate. This maximization is subject to the usual budget constraint:

$$A_{t+i+1} = R_t\left[A_{t+i} + W_{t+i}N_{t+i} - P_{t+i}C_{t+i}\right] \tag{2}$$

[8] In the period we analyse, the Spanish average unemployment rate reached 17.19%, with a minimum value of 13.70 in the first quarter of 1991.

[9] A description of the variables used is reported in Table A.1 in the Appendix.

where A_t is the individual's financial non-human wealth; R_t is the nominal interest factor, or gross interest rate, R_t=1+r_t (where r_t is the nominal interest rate);[10] W_t is the wage per hour and N_t is the number of hours an individual works in t; and, C_t is individual real consumption in period t and P_t is the nominal price of a unit of C_t. W_t as well as P_t are assumed to be exogenous.

Assuming no legacies ($A_T=0$), the life cycle budget constraint is then given by:

$$\sum_{i=0}^{T-t} R_t^{-i} P_{t+i} C_{t+i} = A_t + \sum_{i=0}^{T-t} R_t^{-i} W_{t+i} N_{t+i} \tag{3}$$

Finally, we assume, as usual, perfect capital markets.

From above, we define the value function V, which represents the maximum utility expected from consumption and leisure by the individual in t+1:

$$V(A_{t+1}) = Max E_{t+1} \left\{ \sum_{i=1}^{T-t} \beta^i \, U(C_{t+i}, L_{t+i}) \right\} \tag{4}$$

According to the Bellman's optimality principle, our optimization problem is equivalent to this expression,

$$V(A_t) = \underset{C_t, L_t}{Max} \left\{ U(C_t, L_t) + b E_t V(A_{t+1}) \right\} \tag{5}$$

from where we get that:

$$V'(A_t) = R\beta \, E_t V'(A_{t+1}) \tag{6}$$

that allows obtaining the following first order conditions

$$\frac{W_t}{P_t} \frac{\partial u / \partial C_t}{\partial u / \partial L_t} = 1 \tag{7}$$

$$E_t \beta \frac{\partial u / \partial C_{t+1}}{\partial u / \partial C_t} \frac{P_t R_t}{P_{t+1}} = 1 \tag{8}$$

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[10] We will name R_t generically as the interest rate.

$$E_t\beta\frac{\partial u/\partial L_{t+1}}{\partial u/\partial L_t}\frac{W_t R_t}{W_{t+1}}=1 \qquad (9)$$

For an individual optimal solution, these three conditions should be satisfied simultaneously. Thus, in an optimum solution, if condition (7) holds, then it implies that, given C_t and W_t, the individual cannot be better off by increasing her consumption and reducing leisure, or vice versa. Further, if condition (8) holds, the Euler condition for consumption, it denotes that, given R_t, P_t and P_{t+1} in the optimization's path, the individual cannot increase her utility between periods t and t+1 reallocating consumption between them. Finally, satisfaction of condition (9), the Euler condition for leisure, means that, in the optimization path, and given R_t, W_t and W_{t+1}, the individual cannot increase her utility between periods t and t+1 reallocating leisure between them. Note that our approach is different to Zabel (1997), or MaCurdy (1981), who explicitly consider, and model, the marginal utility of wealth, $V(A_t)$, as a fixed effect.

It is important to note that, if (7) holds exactly in the data, one of the two remaining equations would be redundant (i.e., replacing (7) in (8), or in (9), we can obtain the other). Attanasio et al. (2018), in their simulation exercise for female labour supply, use this property and focus only on two equations: the household Euler equation for consumption and the intertemporal condition.

Further, Martínez-Granado (2005) assumes that workers cannot freely choose the hours they work. This work estimates a bigger labour supply elasticity for movers than for stayers, and concludes that the traditional estimates overestimate the elasticity for constrained workers, but underestimate it for the unconstrained ones. We cannot properly tackle this subject, as we cannot distinguish between movers and stayers in our data.

In relation to the elasticity of intertemporal substitution of leisure, Imai and Keane (2004), Wallenius (2011), Keane and Rogerson (2012) and Keane (2016), have argued recently that this elasticity should be higher than the estimated values in previous empirical literature with microeconomic data.[11][12] They point out that incorporating

[11] Kim and Lee (2007) prove that ignoring on-the-job human capital accumulation in RBC models leads to a substantial bias in the estimation of the intertemporal elasticity of substitution for leisure.

[12] These values were obtained, precisely, estimating the intertemporal first order condition of leisure (9).

human capital in the basic intertemporal optimization consumption-leisure model produces a higher value of the elasticity of intertemporal substitution of leisure. Thus, they conclude that previous estimated values are biased downwards due to this failure. However, their analysis is based in how the intratemporal condition changes when human capital is added to the model. Using this approach, Imai and Keane (2004), obtain a value of 3.82 for this parameter for the U.S. economy. Wallenius (2011), when she considers human capital, also obtains bigger estimated values for this elasticity using cohort data. These values are far for the consensus that on average the estimates for the elasticity of intertemporal substitution of leisure should be below 1, especially for certain selected groups. There are reasons to think that this elasticity is especially low for Spain. This is so as the high unemployment rate is an important disincentive to leave, or move, frequently the job.[13] Further, there is some evidence of a reduced labour supply for certain groups in Spain, such as men near the retirement age. This is related to the design of the Spanish unemployment benefits and penalties for early retirement schemes. However, this is an aspect more related to the extensive margin elasticity, see Garcia-Gomez et al. (2018). We will extend our discussion about this later.

To verify the relevance of human capital, we have modified our model to incorporate this variable, in a similar manner than the before mentioned authors. Thus, we express the value function (5) to depend on both current human capital and financial wealth, and considering that individual wages depend on previous hours worked. Incorporating these changes, equation (9), that is the condition of intertemporal substitution of leisure, has the following form:

$$\frac{\partial u}{\partial L_t} = E_t \frac{\beta R_t W_t}{W_{t+1}} \frac{\partial u}{\partial L_{t+1}} - \frac{1}{\partial K_{t+1}/\partial K_t} \frac{\partial V(A_t, K_t)}{\partial K_t} \left(\frac{R_t W_t}{W_{t+1}} \frac{1}{\partial K_{t+2}/\partial K_{t+1}} \frac{\partial K_{t+2}}{\partial L_{t+1}} - \frac{\partial K_{t+1}}{\partial L_t} \right) \tag{10}$$

[13] Evidence supporting this argument may be found in García-Mainar and Montuenga-Gómez (2003), who analyse the Spanish wage curve with regional data. They obtain a wage elasticity to unemployment, similar to other countries, although they explain the higher persistence of regional differences in Spanish unemployment by the slow wage adjustment and the high migration costs. They also find important differences in the wage curve slopes across different groups, depending on their education level, age, etc.

where K_t is human capital in period t.[14] As this equation depends on many unobservable variables, we have to make some assumptions to check if the estimation results of equation (9) might be affected by human capital. Thus, we assume that $\partial K_{t+i+1} / \partial K_{t+i} = 1$ and $\partial K_t / \partial L_{t-1} \simeq N_{t-1}$.[15] Therefore, equation (9) becomes,

$$\frac{\partial u}{\partial L_t} = E_t \frac{\beta R_t W_t}{W_{t+1}} \frac{\partial u}{\partial L_{t+1}} - \frac{\partial V(A_t, K_t)}{\partial K_t} \left(\frac{R_t W_t}{W_{t+1}} N_{t+1} - N_t \right) \tag{11}$$

an expression which, although it is a more empirically tractable expression, still depends on the "marginal utility of human capital". We will tackle this issue in the empirical section below.

Now, returning to the model without human capital, to derive the model testable expressions, we need to specify a utility function. We follow MaCurdy (1983) and Mankiw et al. (1985), who propose a generalization of the CRRA utility function, widely applied in the empirical analysis of consumption, to incorporate leisure as an additional argument (see also Cutanda, 2019). From this function, and given that we aim at testing the model with individual data, we add the effect of demographic variables (the vector θ_t) using an exponential term, as follows:[16]

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[14] The intratemporal (or static) condition, in our case equation (7), would change to $\frac{\partial u}{\partial L_t} = \frac{W_t}{P_t} \frac{\partial u}{\partial C_t} - \frac{\partial V(A_t, K_t)}{\partial K_t}$, that is the equation estimated by Imai and Keane (2004). And, the intertemporal condition for consumption, equation (8), does not change.

[15] Note that the first assumption is equivalent to considering no depreciation of human capital. We are confident that these assumptions will not be restrictive, given that we are going to consider, like most of the works in literature, a sample of men always working in a relatively short period. To be more precise, there is a short crisis period in our sample. This is the crisis for the year 1992 and the first quarter of 1993. Given the short crisis period, we consider our assumption is valid.

[16] Attanasio et al. (2005 and 2008) introduce the effect of demographic variables in a different way. They consider a utility function that depends on consumption, expressed in equivalence scale units, and not on leisure. Additionally, they introduce a discrete {0,1} female labour supply choice, as they aim to simulate female labour supply. Alternatively, the utility function in Attanasio et al. (2018) is a weighted average of consumption and female labour supply where the weights depend on demographic variables and a taste shock; nevertheless, given that their aim is to simulate female labour supply, they use previous values obtained from the estimation of a modified version of equation (7) with demographics.

$$u(C_t, L_t) = \frac{1}{1-\gamma}\left[\frac{C_t^{1-\alpha}-1}{1-\alpha} + d\,\frac{L_t^{1-\phi}-1}{1-\phi}\right]^{1-\gamma} e^{\lambda\theta t} \tag{12}$$

where γ, α, ϕ, λ and d are all parameters. Note that this utility function becomes additively separable in consumption and leisure when $\gamma = 0$, the case traditionally considered in consumption empirical analysis (see Zeldes, 1989). In this expression $1/\alpha$ is the elasticity of intertemporal substitution for consumption and $1/\phi$ is the elasticity of intertemporal substitution for leisure. Other particular cases of this utility function are a CES form, when $\alpha = \beta$, or a logarithmic utility function, when $\alpha = \beta = 1$ and $\gamma = 0$.

From the utility function (12) we log-linearize the model, imposing intratemporal separability between consumption and leisure, to obtain the empirical testable expressions using our (cohort) data set. This exercise is different to Mankiw et al. (1985), as they use nonlinear estimators with aggregate U.S. data. In our case, it is easy to check that the log-linearization of the utility function produces the following expressions:

$$\ln(C_t) = k_{os} + k_{1s}\ln(L_t) + k_{2s}\ln\left(\frac{W_t}{P_t}\right) \tag{13}$$

$$E_t \ln\left(\frac{C_{t+1}}{C_t}\right) = k_{oc} + k_{1c}E_t \ln\left(\frac{P_t R_t}{P_{t+1}}\right) + k_{2c}\Delta\theta_{t+1} \tag{14}$$

$$E_t \ln\left(\frac{L_{t+1}}{L_t}\right) = k_{ol} + k_{1l}\, E_t \ln\left(\frac{W_t R_t}{W_{t+1}}\right) + k_{2l}\Delta\theta_{t+1} \tag{15}$$

where k_{ij} (i = 0, 1 and 2, j = s, c and l) are coefficients to be estimated and dependent on parameters of the utility function. Note, in particular, two important points: first, k_{oc} and k_{ol} in (14) and (15) contain β, which should be treated as an individual fixed effect in estimation when using panel data techniques. This is not the case for k_{os} in (13) as this term does not contain β; second, if the utility function is intratemporally separable in consumption and leisure, i.e., γ=0, k_{1c} in (14) is the intertemporal elasticity of substitution for consumption and k_{1l} in (15) is the intertemporal elasticity of substitution for leisure.[17] In this setting, it is relevant to highlight that, under this utility specification, the static intratemporal equation does not depend on demographic variables. Further, when estimating the complete system of equations, it is necessary to consider some restrictions between some of the parameters.[18]

Therefore, our empirical analysis, based on expressions (13), (14) and (15), is dependent on separability assumptions.[19] When utility is assumed to be intratemporally non-separable, the static intratemporal equation does not change in a significant way with respect to the expression (13), but the expressions for the Euler conditions, expressions (14) and (15), will both depend on consumption and leisure in t and t+1.[20]

To empirically test our model implies the fulfilment of the three above first order conditions. In that sense, we need to assume no violations of the canonical model of intertemporal choice, such as, for example, liquidity constraints in the consumption equation, or involuntary unemployment in that of the labour supply.[21]

Mankiw et al. (1985) point out that despite the properties of the static intratemporal equation, it is very unlikely that this equation holds exactly in the data. Thus, this implies that it would be important to consider all the information provided by the three Euler conditions. This implies that it seems sensible to jointly estimate the three equations. However, given that one of the equations is redundant, we can jointly

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[17] Note that, alternatively, we could estimate one or another from (13), depending on how we express equation (7).

[18] In particular, k_{2s}=k_{1c}, and k_{1s}=k_{1c}/k_{1l}.

[19] It is important to note that much of the empirical analysis of aggregate consumption, based on the expression (14), also assumes separability, and, as emphasized by Mankiw et al. (1985), this weakness is aggravated by the fact that (aggregate analysis) ignores the information provided by the expression (13).

[20] An alternative utility function to the one considered here is the direct *translog* function, used by Ziliak and Kniesner (2005), although it would very much complicate the analysis.

[21] This would imply discarding households where the head is unemployed, what would have implications for the empirical sample used. There might be other individuals suffering (potentially) from liquidity constraints, such as are young individuals with low income. To avoid this problem, we also discard individuals younger than 23 years in 1987.

estimate only two equations instead of estimating the complete system, and retrieve all the relevant parameters with only these two equations.[22]

In this paper, we aim to estimate the Frisch elasticity for consumption and labour supply. Frisch elasticities are considered the most relevant in an intertemporal setting, whereas the Hicksian and Marshallian elasticities are more appropriate for a static framework.[23] Hicks elasticity provides a lower bound for Frisch elasticity (see Chetty, 2012) and, as Marshall elasticity, can be retrieved from the static intratemporal equation, while retrieving Frisch elasticity requires to use the Euler conditions. In this sense, Attanasio et al. (2018) obtain the Frisch elasticity for labour supply from an estimation of the static intratemporal equation (similar to equation 13). However, Mankiw et al. (1985) established the difference between short and long run elasticities in an intertemporal setting. Our approach is similar to this last work. Therefore, in principle, we can obtain all these elasticities, either estimating them directly, or retrieving them analytically from the obtained estimates. Keane (2011) provides a complete and updated survey of the results obtained in the literature for these different elasticities.[24]

Further, in the analysis of the effect of wage changes on labour supply, it is important to distinguish between the intensive and extensive margins.[25] The first refers to the change in hours worked in response to a wage change, while the second refers to changes in participation in the labour market. This distinction is one of the most important problems faced by this literature, given the difficulty in distinguishing, using the available statistical information, which individuals voluntarily choose not to work from those who are involuntarily unemployed. To face this problem, the common

[22] Mankiw et al. (1985) estimate jointly the three equations with aggregate data, rejecting systematically the test of overidentifying restrictions. Cutanda (2019) also tests the three equations system with regional Spanish data without obtaining a statistically significant value for the intertemporal elasticity of substitution for leisure.

[23] These elasticities have been widely analysed in studies researching the effect of changes in taxes on labour supply both in a static or in a dynamic context. See, for example, in the first case, Eklöf and Sacklén (2000) and Bloomquist et al. (2001), and in the second case, Blundell and Walker (1986), Ziliak and Kniesner (2005), and Aaronson and French (2009).

[24] See Table 6 (page 1042) where there is an exhaustive compendium of the values obtained previously for these elasticities in literature.

[25] See Rogerson and Wallenius (2009).

practice is to use sampling selection to obtain a sample of individuals who presumably will never drop from the labour market (i.e., males in certain ages, who are head of their household and always work). This is the approach we follow in this work, as considering the participation decision would be a troublesome issue in the empirical analysis (for example to analyse intertemporal female labour supply). There are very few studies addressing this issue and only very recently it has been addressed in its full complexity (see Attanasio et al., 2018). Further, Blundell et al. (2018) consider a family labour supply approach that evaluates household decisions on leisure and working time for both spouses in the presence of children. Analysing female labour participation is out of the scope of this paper, as this is a much more complex empirical exercise that we leave for future work.

2.2. The empirical specifications.

Given that the objective of this research is to estimate the equations (13), (14) and (15) using panel data techniques, we rewrite them adding an individual subscript and applying the rational expectations assumption in the usual way:

$$\ln(C_{it}) = k_{os} + k_{1s}\ln(L_{it}) + k_{2s}\ln\left(\frac{W_{it}}{P_{it}}\right) \tag{13'}$$

$$\Delta\ln(C_{it+1}) = k_{ioc} + k_{1c}\ln\left(\frac{P_{it}R_t}{P_{it+1}}\right) + k_{2c}\Delta\theta_{it+1} + \varepsilon_{ict+1} \tag{14'}$$

$$\Delta\ln(L_{it+1}) = k_{iol} + k_{1l}\ln\left(\frac{W_{it}R_t}{W_{it+1}}\right) + k_{2l}\Delta\theta_{it+1} + \varepsilon_{ilt+1} \tag{15'}$$

where ε_{ict+1} and ε_{ilt+1} are two error terms independent of all variables dated at t or before.

Given that k_{ioc} and k_{iol} are individual fixed effects that might be potentially correlated with the regressors, we will apply robust estimation techniques to account for this correlation. In particular, we apply an instrumental variables estimator, the two-step generalized method of moments, to avoid this endogeneity problem. We will test for the goodness of fit with a Hansen's test of overidentifying restrictions and for first and second order residuals' autocorrelation.

Finally, as known, expenditure and income, might be affected by measurement error, a problem that mitigates by the averaging procedure we use to build the cohorts. However, given the time span we have available (41 quarters) we consider that the intertemporal elasticities of substitution are consistently estimated (see Attanasio and Low, 2004). Further, the usual procedure to obtain data on wages (when this variable is not available in the data set) is dividing income by hours worked. However, this might be another source of measurement error (see Altonji, 1986). Thus, to prevent measurement error problems we follow Griliches and Hausman (1986), and avoid using as instruments current values of income, expenditure, interest rates, hours, wages or any variable directly related to household's income level, such as the number of income earners in the household. As regards the demographic variables, we will consider them as exogenous, what allow using them directly as instruments.

Finally, coming back to the issue of human capital, and to verify whether our estimates of equation (15') are robust to its effect, we will estimate equation (11). In this equation, as we do not have any variable in our dataset to proxy for the "marginal utility of human capital", we will assume it remains constant. We consider that this might be a reasonable assumption given that we are analysing a particular kind of human capital (the human capital acquired by workers on-the-job). Therefore, to test for the impact of human capital, we will expand equation (15') by adding as a regressor the logarithm of the expression in brackets in equation (11). This will allow checking whether the estimate of the intertemporal elasticity of substitution of leisure changes with human capital. Our approach follows the approach put forward in Keane and Rogerson (2012), and Keane (2016), and applied to the U.S. economy by Imai and Keane (2004).

3. The data.

The aim of this research is to estimate the first order intertemporal conditions of a consumption-leisure optimization program with Spanish cohort data. For this purpose, one would need a statistical source with information both on individual consumption and labour supply. The main survey with panel information on consumption for Spain is the Family Expenditure Survey (*Encuesta Continua de Presupuestos Familiares*, ECPF). However, this data set does not have information on hours worked. The only information on labour supply is whether members in a household work more or less than one third of the usual weekly working hours. These data present information on households' income, classified in different categories depending on the different sources of income. Information on income is aggregated at the household level and there is not detailed information about which member of the household earns that income.[26] As regards labour supply, we have the Spanish Survey on Labour (*Encuesta de Población Activa*, EPA). This survey is not a panel data,[27] as one cannot track individuals across time. As this is a survey focused on labour, it has not information on individual consumption, income or wages.

With the objective of combining the information available from both statistical sources, we built the same pseudo-panel, using the age of the head of the household in both surveys. Once we have the pseudo-panel in the consumption (ECPF) and labour (EPA) surveys, we combine both data sets. These two surveys have quarterly periodicity. As the first period is the first quarter of 1987 and the last one is the first quarter of 1997, we have 41 points in data.[28] The pseudo-panel we have constructed is composed by eight households of 5-year bands for the head of the household, being the minimum and maximum ages 18 and 57, respectively. However, in the empirical analysis we will only use six cohorts of five years bands of the age of household's head, being the minimum and maximum ages 23 and 52, inclusive, in 1987 (34 and 63, respectively in 1997).[29]

[26] Although it is possible to identify individual's income across appropriate sample selection, the problem we have to face is the loss of observations. The most obvious case would be the sample of households composed only by one labour income earner. This group implies a mean size along the period of analysis of 33 individuals.

[27] We do not have information about labour market flows in our data from the EPA. The EPA, at least in the version available to public, is a survey on the stocks of the Spanish labour market. Yet, at least from 1996, a year well after our sample period, the INE provides a survey on labour force flows.

[28] It is important to notice that our period includes the 1992 recession that occurred between two long expansionary phases for the Spanish economy.

[29] We have applied all the usual filters in this kind of studies. In this sense, we have discarded households with no data in expenses, income, hours of work or any other sensible variables, both in the ECPF or EPA. Also, following the usual practice, in the ECPF we have discarded all households with income in the first and last percentile of the distribution.

As regards the variables in both data sets, given that the definition and scope of the household's variables is standard in the ECPF, we have taken the variables directly from the survey. For wages, we follow the usual procedure in the literature and divide employees' income from the ECPF by the hours worked by employees in the EPA. Using this procedure implies that we might face a measurement error problem (see Keane, 2011), that we need to tackle in estimation.

In the analysis of the response of labour supply to wage changes there are different approaches in the literature. First, there are evident differences in the analysis of male or female labour supply; and, second, the analysis in an intertemporal setting is also different from the analysis in a static one.[30] In our case, given the statistical sources available in Spain, and the period considered, we cannot analyse female labour supply as it would imply reducing quite importantly our sample. Further, the fact that the ECPF only collects household's income implies that we should, in principle, consider household's labour supply in a similar manner to Blundell and Walker (1984). However, given the available sample sizes in the ECPF, it is possible to select only those households where the head of the household is a non-self-employed male and his wife or any other household member is not working. We have also discarded all households whose head declares to be unemployed or retired. Thus, with this fairly adjusted profile, we are confident enough to examine the Spanish male labour supply, which sounds sensible given the limited female participation in the labour market during the analysed period.[31]

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[30] Although there are some important attempts to integrate all these elements in the analysis. See, for example, Blundell and Walker (1984).

[31] The average size of the sample of households whose head is a labour income woman in the period is 74. We have also tried other samples. For example, we have selected married couples where both members are working, in an attempt to analyse household's labour supply, however this is not viable due to the downfall in the average cohort size (the average number of individuals in the ECPF cohorts drops between 40% and 50%.). In a second attempt, we also checked the possibility of including self-employed males in our sample. But we discarded this option, as the gain associated with the increase in the average size of the cohorts did not compensate the problems that we had to handle due to the lack of sample homogeneity. In this sense, the average size in the period of our selected sample of households whose head is a married labour income earner is 704, from which 610 have children, 61 do not have children and 33 are single.

Table 1 presents the average size of the number of individuals in the two pseudo-panels constructed in our study. The numbers we get are within the usual figures in this literature, especially in the reduced pseudo-panel. It is important to notice that the large number of periods available makes that both the youngest and oldest cohorts shrink across time. Finally, as expected, the average size of the EPA cohorts is much bigger than that of the ECPF cohorts, given the initial larger size of the EPA.

[Table 1 about here]

In what follows we describe the variables we use in estimation (see Table A.1 in the Appendix). Consumption is measured as the sum of total non-durable expenditures (expenditures in food, beverages and tobacco; gasoline, fuels and lubricants; heating, lighting and water distribution; and, transport services and mail and communications).[32] The nominal wage has been obtained dividing the head of the household's quarterly labour income in the ECPF by the effective hours declared in EPA. The quarterly leisure hours have been computed by subtracting from the total number of available hours the effective hours worked. The number of available hours is calculated as the number of days in the quarter multiplied by 16 hours. And the effective hours worked are the weekly effective hours declared in EPA multiplied by 12.

As for the price index, we calculate a Stone price index for each cohort in our sample using the expenditure categories considered. We use a nominal interest rate for the Spanish bank deposits, which is the same used in Cutanda et al. (2019). Although the nominal interest rate does not change across cohorts, the real interest rate does as we have variability in the cohort price index.

Finally, we have estimated the model by the Generalized Method of Moments and we instrument all variables that potentially might suffer either from endogeneity problems or by measurement error, using at least their second lag. Further, in all the specifications estimated, we provide the results for the Hansen's test of overidentifying restrictions and given that the fixed effects estimator might produce first order

[32] This aggregate consumption has been previously used in other studies for the Spanish economy (see Cutanda, 2002).

autocorrelation of the residuals, we have tested for the second order autocorrelation with a Cumby and Huizinga test.[33]

4. Empirical Results.

In this section we present the estimation results for the different specifications discussed in previous section. We start providing estimates for the intertemporal and intratemporal specifications estimated individually. Further, we estimate the two intertemporal specifications jointly, and the two intertemporal and the intratemporal specifications in a system of three equations. Finally, we test for the relevance of accounting for human capital when estimating the intertemporal condition for leisure.

In Table 2 we report the estimation for the intertemporal condition of non-durable consumption. We use two specifications, being the difference between them the fact that we account for education in the second one (see column 2). As it can be checked, we obtain a relatively high and statistically significant estimated value for the intertemporal elasticity of substitution for consumption (*EISC*). Our estimate, about 0.5, can be classified in the upper tail of the range of values obtained in the literature using microeconomic data for different economies, including Spain. See the survey by Thimme (2016) and Cutanda et al. (2019) for the Spanish case.

Further, in both specifications reported in Table 2, we include a constant that, according to our theoretical model, is equal to the logarithm of the discount factor multiplied by the elasticity of the intertemporal substitution. Given the estimated values for the constant in both specifications, the estimated intertemporal discount rate is very high: about 12% in the first specification (the one without the education variables); and, 16% in the wider specification. These values are in line with previously available evidence for the Spanish economy, for the period 1970-91, where aggregate consumption has been traditionally more volatile than aggregate income and highly procyclical (see Dolado et al., 1993), what can be explained by a discount factor in Spain bigger than the interest rate.

[33] We would like to note that our results stand the same estimating our specifications with demeaned data. These results are available upon request.

As regards the Hansen test for the overidentifying restrictions, the two specifications considered provide appropriate results, as we obtain in both cases a significance level above 75%. Remarkably, in the second specification, although we increase the number of covariates while maintaining the instruments set, the test is not seriously affected. We also perform a test for the second order autocorrelation, as by construction there might be autocorrelation of first order (this serial correlation most probably occurs due to the presence of individual fixed effects, among other reasons).[34] The results of the test for second order autocorrelation indicate that in both specifications we do not have this problem.

Now, focusing on the results for the other covariates, in the first specification we consider the following variables in differences: age of the head of the household and age squared (*Age head* and *Age head squared*, respectively), the number of household members (*Number of members*) and the number of adults in the household (*Number of adults*). In this specification, all demographic variables, except the number of adults, are statistically significant. The variables *Number members* and *Age head* affect positively to non-durable consumption growth, while *Age head squared* does it negatively. In the second specification, we extend this specification to include three dummy variables capturing the educational level of the head of the household (*Education level 1*, *Education level 2*, and *Education level 3*). In this specification, all previous variables maintain its statistical significance and sign. As for the education variables, none of them is statistically significant; however, including them affects, as expected, the significance of the constant. It is important to remark that our results are quite stable after including the education variables.

[Table 2 about here]

In Table 3 we report the estimation results for the intertemporal substitution of leisure (*EISL*). As for consumption, the results for the two specifications in terms of the *EISL* are quite suitable. We obtain an estimated value for this parameter for the Spanish economy about 0.25, and statistically significant in both cases. These estimates are potentially comparable to Cutanda (2019), who estimated a similar model with regional

[34] Runkle (1991) and López Salido (1993) test for the existence of fixed effects checking the significance of lagged consumption growth in the model.

Spanish data, or to Mankiw et al. (1985), with aggregate U.S. data, although in both cases they fail to get a statistically significant estimate for the intertemporal elasticity of leisure. Further, the obtained estimated values are also similar to those obtained previously for other economies (using microeconomic data) for the Frisch elasticity, and is inside the range of values obtained by Zabel (1997) for the U.S.[35]

It is important to highlight that the estimation of this parameter has been traditionally controversial. Keane (2011), after reviewing 14 previous empirical studies with microeconomic data, concludes that the estimated average value is about 0.83. However, the exclusion of two potential outlier values would reduce the average to 0.34, which gives an average much closer to our estimate. Additionally, Reichling and Whalen (2012), after reviewing the previous empirical literature for the U.S., conclude that this elasticity ranges between 0.27 and 0.53 for the U.S. We should underline that these reported values correspond to estimates using the entire working population. When they consider a more restricted sample, closer to the sample used in our study (i.e., working men aged between 25 and 54), they conclude that "most estimates…tend to be close to 0.2, but the range to estimates runs from zero to 0.8". As regards the other covariates, we do not obtain any significant effect of the demographic variables in each of the specifications, except for the variable *Educational level 3*. As pointed out above, the constant in this specification is the logarithm of the discount factor affected by the elasticity of the intertemporal substitution of leisure. The estimated values for this elasticity imply similar estimated values for the discount factor obtained in the estimation of the intertemporal condition of consumption. Finally, we should stress that the significance levels for the Hansen tests are never below 50%, however the second order auto correlation tests perform worst in this specification than those for the consumption equation.[36]

[Table 3 about here]

[35] It is compatible also with the estimates obtained by Bellou and Kaymak (2012) for the (income) elasticity of labor supply to wages for male workers, using the European Community Household Panel.

[36] We can reject the null of auto correlation for the first specification (see column 1 in Table 3). The worst performance of the second autocorrelation test for the residuals is troublesome in this case. In principle, this result could be explained by measurement error or, alternatively, by aggregation problems. Given the long-time span of our data, we consider the second reason as more feasible.

In Table 4, we present the estimation of the intratemporal (static) condition between consumption and leisure.[37] As pointed out previously, this equation does not depend on demographic variables, and thus is simpler than the two intertemporal conditions estimated above. We can use this equation to either estimate the elasticity of intertemporal substitution for consumption (EISC), when the independent variable is the logarithm of consumption, or the elasticity of intertemporal substitution for leisure (EISL), when the independent variable is the logarithm of leisure. In the model, the estimated parameter for the variable *Real wage* is the elasticity of intertemporal substitution for consumption.[38] The estimates we get (1.651 or 1.800) are remarkably different from the parameters obtained in the estimation of the intertemporal equation for consumption (see Table 1), about 0.5. This discrepancy in the estimation of the *EISC* is a good example of the difficulties in obtaining an estimation for this parameter, which justify the extensive investigation devoted to this task since the publication of the seminal paper by Hall (1988) and reviewed by Thimme (2016). Further, Mankiw et al. (1985) consider that it is very unlikely that this equation holds exactly in data. As regards the appropriability of the instrument set used, the Hansen test does not reach, in any case, 50%. Further, the residuals show in both cases auto-correlation of second order. This correlation cannot be attributed to fixed effects as they are not present in this equation. However, there might persist other reasons behind the correlation.

[Table 4 about here]

In Table 5 we estimate jointly the two intertemporal conditions for consumption and leisure integrated in a system. As mentioned, one of the equations is redundant in our model. Then, as we are primarily interested in intertemporal allocation, we leave out the intratemporal equation. As regards the intertemporal elasticities, we obtain a similar elasticity of intertemporal substitution for consumption (*EISC*) but a higher estimate for the elasticity of leisure (*EISL*), bigger than 0.3 in all cases. The constants for the intertemporal conditions of consumption and leisure are not statistically significant,

[37] We estimate this equation using two instruments sets that produced similar results.

[38] This equation is usually not considered in the estimation of the elasticity of intertemporal substitution for consumption, as compared to the extensive use of the intertemporal condition. And this might be justified by the fact that it requires much more information (for example, data on wages and on labour supply).

except in the short specification of the intertemporal condition of leisure. We get that all demographic variables are statistically significant, although in some cases we obtain a different sign as compared to the separate estimation of the intertemporal conditions. For example, the variable *Number of members* in the household has a negative impact, whereas it had a positive and significant in the single intertemporal condition for consumption (and not significant for leisure).[39] With respect to the education level dummies, we get that only one of them is statistically significant, and with a positive sign. In relation to the fit of the model, we obtain quite satisfactory significance levels for the Hansen test (over 75%). However, as there is not a formal test for the second order autocorrelation of the residuals for the entire system, we have applied the test to each equation separately, obtaining that in the short specification we do not face a problem of second order correlation, but not in the extended specification.

[Table 5 about here]

Given the discrepancy in the estimated *EISC* in Tables 2 and 5 as compared to Table 4,[40] now we report the estimates obtained using a system of three equations, where we force the *EISC* parameter to be equal across equations. These results are presented in Table 6 and are directly comparable with those reported in Table 5 (a system with the two intertemporal equations). In the estimation of the three-equation system we do not include as a covariate the logarithm of the real wage of the intratemporal condition, as this parameter is equal to the parameter of the logarithm of the real interest rate in the intertemporal condition for consumption. The estimated *EISC* in the three-equation system is closer to the estimate we get in the single intertemporal equation. Now, we get a parameter for the *EISC* about 0.89, whereas this estimate is about 0.5 in the single intertemporal equation for consumption and in the two equations system (see Tables 2 and 5, respectively) and about 1.7 in the intratemporal equation (see Table 4). Further, we get that the constant for the intertemporal consumption equation in the three-equation system is larger and statistically significant. As regards the intertemporal

[39] We think that this result in the estimation of the system of both Euler equations could be due to a composition effect, given that the estimated parameter is different in each of the equations estimated separately.

[40] These discrepancies between the estimates for the same parameter depending on the Euler equation estimated were also observed in Mankiw et al. (1985) and Cutanda (2019).

equation for leisure, we get very similar values for the *EISL*. Finally, the Hansen test performs quite well and the second order autocorrelation test provides good results for the two intertemporal equations (in those specifications in which we do not include the education variables).

Now, we turn to the research on the bias of the elasticity of intertemporal substitution of leisure, raised by Imai and Keane (2004), Wallenius (2011), Keane and Rogerson (2012) and Keane (2016). These authors argue that not incorporating human capital in the basic intertemporal optimization consumption-leisure model produces a downward biased elasticity of intertemporal substitution of leisure.

In Table 7 we report the results where we account for human capital, in order to test whether the elasticity of intertemporal substitution of leisure was estimated with a bias.[41] To perform the test requires to include as a regressor N_{t+1}, which does not belong to the agent's information set. Hence, we have estimated the model using the instrument set as in Table 3 (in columns 1 and 3 in Table 7), and adding to the set of instruments the second lag of the added regressor (in columns 2 and 4 in Table 7). From our results, we observed, as expected, that the estimated elasticity of intertemporal substitution of leisure increases significantly with respect to the estimated value reported in Table 3. Specifically, in the wider specification estimates, we get an estimated *EISL* over 0.5, a value almost doubling our previous result. Additionally, the added regressor is, jointly with the interest rate adjusted by inflation in wages, the only statistically significant variable. We find that all the other regressors are not significant in all specifications reported. Further, the constant loses its significance as compared to Table 3. Finally, although the Hansen test worsens, the test for second order autocorrelation of the residuals improves significantly.

We consider that the results obtained in this exercise give support to the hypothesis raised by Imai and Keane (2004), Wallenius (2011), Keane and Rogerson (2012) and Keane (2016). We confirm that it is important to consider the effect of human capital in individual wages to get a reliable estimate of the elasticity of intertemporal

[41] We have tried different mathematical expressions to compute the added regressor, all of them depending on the interest real rate adjusted by the inflation in wages and hours worked, but the results were very similar to presented in Table 7.

substitution for leisure.[42] We would also like to point that the estimate for the Spanish economy is still far from the estimate obtained by Imai and Keane (2004) for the U.S. economy, and from the values of this parameter used in the real business cycle literature.

5. Conclusions.

In this paper we have estimated the first order conditions of an intertemporal optimization labour supply-consumption model, both separately and jointly in a system of equations with the aim of estimating the two elasticities of intertemporal substitution (for consumption and leisure). For this purpose, we use Spanish cohort data. Given that there is not a unique statistical source with complete individual information on consumption and labour, we have combined the information of two different statistical sources, the ECPF and the EPA, in an age-based cohort sample, using pseudo-panel data techniques.

The results we obtain confirm previous empirical available evidence for the Spanish elasticity of intertemporal substitution for consumption, that we estimate about 0.4/0.5. Further, we get an estimate for the elasticity of intertemporal substitution of leisure about 0.2/0.3, that is similar to estimates obtained for other countries with similar samples (households where the head is a man who is always working). However, this estimate is far from the values traditionally used for this parameter in the real business cycle literature.

Our results show that to tackle empirically the estimation of these structural parameters is quite troublesome and complex. This is so as even assuming a standard separable utility function, the estimation of the intratemporal (static) first order condition produces different estimates to the ones obtained in the intertemporal first order condition for consumption. This should not be surprising, as the elasticity of intertemporal substitution for consumption reflects the behaviour of consumption across

[42] Nevertheless, this result might also be explained through the effect of borrowing constraints, as Domeij and Flodén (2006) or Bredemeier, Gravert and Juessen (2019). ~~Unfortunately, our data set prevents us to replicate their results, as we do not have information on household's wealth and we cannot obtain samples with the appropriate number of individuals.~~

time, whereas the static condition captures the joint labour supply-consumption decision in a single period. Therefore, the results we estimate pose interesting questions that need to be clarified in future empirical research. The different results obtained in the estimation of the equations system, compared with those obtained in each separate condition reinforce this conclusion. While the two intertemporal conditions system produce estimates for both elasticities very similar to those obtained with the separate conditions, in the three-equation system we obtain a different estimate for the elasticity of consumption (as compared to that obtained in the intertemporal condition estimated in isolation).

Finally, we have also checked whether human capital, as put forward by Imai and Keane (2004), affects the estimated intertemporal elasticity for leisure. Using a proxy approach, we verify that this parameter increases (to more than 0.5), when we consider the effect of the human capital. This result confirms the bias obtained by Imai and Keane (2004). Finally, our estimate is still far from the values traditionally used in real business cycle models.

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Table 1. Average number of individuals within each age cohort.

N. of Cohort	Age of head of house. in 1987	Age of head of house. in 1997	ECPF	EPA
1	18-22	29-33	41	622
2	23-27	34-38	94	1373
3	28-32	39-43	118	1876
4	33-37	44-48	126	1988
5	38-42	49-53	116	2133
6	43-47	54-58	82	1868
7	48-52	59-63	58	1622
8	53-57	64-68	47	1288
Mean 1-8			85	1596
Mean 2-7			99	1810

Notes:

1. In the ECPF we select only households whose head is a man and has income as employee (i.e., we discard all households whose head declares to be self-employed, unemployed or pensioner), and whose wife has not income as employee or as self-employed. In the EPA we select male households whose head declares to be an employee and whose wife declares not to be.
2. Our estimation sample is composed by cohorts 2 to 7, that are framed in the table.

Table 2. Euler equation for consumption.

	(1)	(2)
Constant	-0.052**	-0.087
	(0.026)	(0.071)
EISC	0.461**	0.564*
	(0.212)	(0.299)
Age head	0.077**	0.083**
	(0.037)	(0.039)
Age head squared	-0.001**	-0.001**
	(0.000)	(0.000)
Number of members	0.127***	0.127***
	(0.036)	(0.035)
Number of adults	-0.010	-0.009
	(0.012)	(0.013)
Education level 1	-	0.062
		(0.119)
Education level 2	-	0.011
		(0.055)
Education level 3	-	0.116
		(0.156)
N. observations	228	228
Test overidentifying restriction		
Hansen's J Chi2(1)	0.065	0.096
p-value	0.799	0.756
Cumby-Huizinga test for 2^{nd} order correlation	0.535	0.479
p-value	0.464	0.488

Notes:

1. ***, ** and * mean significant at the 1%, 5% and 10% level, respectively.
2. We instrument the interest rate in all specification using the second and third lags for this variable and the all the other covariates.

Table 3. Euler equation for leisure.

	(1)	(2)
Constant	-0.026***	-0.051***
	(0.007)	(0.015)
EISL	0.247***	0.284***
	(0.061)	(0.041)
Age head	-0.011	-0.067
	(0.037)	(0.045)
Age head squared	0.000	0.001
	(0.000)	(0.001)
Number of members	-0.010	0.032
	(0.053)	(0.048)
Number of adults	-0.004	-0.020
	(0.020)	(0.017)
Education level 1	-	0.006
		(0.048)
Education level 2	-	0.023
		(0.017)
Education level 3	-	0.102**
		(0.047)
N. observations	228	228
Test overidentifying restriction		
Hansen's J Chi2(1)	0.317	3.090
p-value	0.573	0.542
Cumby-Huizinga test for 2º order correlation	3.744	1.859
p-value	0.053	0.173

Notes:

1. ***, ** and * mean significant at the 1%, 5% and 10% level, respectively.
2. We instrument equation (1) with the second and third lags of the interest rate and the third lag of the increase in the number of members of the household and the rest of covariates. For equation (2), we add to the previous set the added covariates with respect to equation (1), and the second lag of the logarithm of the hours worked by the head of the household.

Table 4. Intratemporal (static) equation.

	(1)	(2)
Constant	-29.178***	-21.609***
	(7.985)	(6.173)
Log real wage	1.651***	1.800***
	(0.229)	(0.256)
Log leisure	4.803***	3.651***
	(1.149)	(0.849)
N. observations	228	222
Test overidentifying restriction		
Hansen's J Chi2(1)	1.768	1.439
p-value	0.413	0.487
Cumby-Huizinga test for 2º order correlation	33.567	39.334
p-value	0.000	0.000

Notes:

1. ***, ** and * mean significant at the 1%, 5% and 10% level, respectively.
2. The instrument set for equation (1) is the second and third lags of the logarithm of leisure of the head of household, the level of their age and the increase in the number of their members. For equation (2) we substitute in the previous set the third lag of the logarithm of leisure of the head of the household by their fourth lag.

Table 5. Intertemporal consumption and leisure system.

	(1)	(2)
Constant consumption	-0.081	-0.164
	(0.091)	(0.107)
EISC	0.483	0.579*
	(0.735)	(0.284)
Constant leisure	-0.059*	-0.133
	(0.020)	(0.096)
EISL	0.314***	0.332***
	(0.096)	(0.088)
Age head	2.561***	2.205***
	(0.728)	(0.530)
Age head squared	-0.029***	-0.025***
	(0.008)	(0.006)
Number of members	-0.820***	-0.656***
	(0.273)	(0.194)
Number of adults	0.097***	0.091***
	(0.021)	(0.020)
Education level 1	-	0.970**
		(0.409)
Education level 2	-	-0.146
		(0.147)
Education level 3	-	0.427
		(0.348)
N. observations	228	228
Test overidentifying restriction		
Hansen's J Chi2(1)	3.399	6.348
p-value	0.846	0.785
Cumby-Huizinga test for 2º order correlation	0.267	9.079
EQ 1 p-value	0.605	0.002
	0.238	8.486
EQ 2 p-value	0.626	0.002

Notes:

1. ***, ** and * mean significant at the 1%, 5% and 10% level, respectively.
2. For estimation of both systems of equations, we instrument equation (1) by the second and third rate of the interest rate and the rest of covariates, and in the case of equation (2) we use the same set substituting the interest rate by the real interest rate obtained with wage inflation.

Table 6. Intertemporal consumption, leisure and intratemporal equations system.

	(1)	(2)
Constant consumption	-0.129***	-0.213*
	(0.018)	(0.094)
EISC	0.885***	0.877***
	(0.074)	(0.071)
Constant leisure	-0.060***	-0.150
	(0.019)	(0.095)
EISL	0.328***	0.370***
	(0.091)	(0.086)
Age head	2.452***	2.149***
	(0.691)	(0.529)
Age head squared	-0.028***	-0.025***
	(0.008)	(0.006)
Number of members	-0.801***	-0.635***
	(0.259)	(0.193)
Number of adults	0.092***	0.082***
	(0.020)	(0.019)
Education level 1	-	0.978***
		(0.406)
Education level 2	-	-0.126
		(0.146)
Education level 3	-	0.468
		(0.342)
Constant	-15.749***	-15.603***
	(5.166)	(5.151)
Log leisure	3.124***	3.106***
	(0.758)	(0.755)
N. observations	228	228
Test overidentifying restriction		
Hansen's J Chi2(1)	8.379	11.048
p-value	0.679	0.682
Cumby-Huizinga test for 2º order correlation	0.242	8.877
EQ 1 p-value	0.622	0.003
	0.252	8.774
EQ 2 p-value	0.615	0.003
	21.650	22.008
EQ 3 p-value	0.000	0.000

Notes:

1. ***, ** and * mean significant at the 1%, 5% and 10% level, respectively.
2. The instruments set are the same as the ones reported in Table 5.

Table 7. Human capital bias in the leisure intertemporal condition for leisure.

	(1)	(2)	(3)	(4)
Constant	-0.009	-0.022**	-0.017	-0.038
	(0.007)	(0.011)	(0.015)	(0.021)
EISL	0.288**	0.347***	0.588***	0.544***
	(0.105)	(0.105)	(0.118)	(0.106)
Number of members	-0.024	0.007	0.058	0.063
	(0.033)	(0.043)	(0.052)	(0.053)
Age head	-0.011	-0.033	-0.035	-0.021
	(0.003)	(0.037)	(0.055)	(0.064)
Number of adults	0.015	-0.006	-0.032	-0.030
	(0.020)	(0.018)	(0.020)	(0.018)
Age head squared	0.000	0.000	0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.000)
Education level 1	-	-	-0.011	-0.049
			(0.054)	(0.059)
Education level 2	-	-	-0.015	-0.022
			(0.019)	(0.021)
Education level 3	-	-	0.038	0.090
			(0.038)	(0.055)
Human capital bias	-0.015**	-0.012**	-0.035***	-0.019**
	(0.007)	(0.006)	(0.010)	(0.009)
N. observations	202	180	202	180
Test overidentifying restriction				
Hansen's J Chi2(1)	1.176	1.819	8.516	4.818
p-value	0.278	0.177	0.074	0.306
Cumby Huizinga test for 2º order correlation	1.953	1.767	0.311	0.889
p-value	0.162	0.183	0.577	0.345

Notes:

1. ***, ** and * mean significant at the 1%, 5% and 10% level, respectively.
2. We instrument equation (1) by the second and third lags of the interest rate, the third lag of the increase in the number of members of the household and the rest of covariates. In the case of equation (2), we add the second lag of the human capital bias. For equation (3), the instrument set increases that of equation (1) with the second lag of the logarithm of the hours worked by the head of the household and the second lag of the proxy for human capital bias.

Appendix.

Table A.1. Variables used in the analysis.

C_{it}	Non-durable consumption.
N_{it}	Worked hours.
L_{it}	Leisure hours.
W_{it}	Wage per hour.
$W_{it}N_{it}$	Labour income.
P_{it}	Nominal price of a unit of C_{it}.
$R_{t=}1+r_t$	Nominal interest rate.
θ_{it}	This a vector of demographic variables. In particular, we include the number of members of the household, the number of adults of the household (individuals14 years old or older), and a set of educational dummies (Illiterate and/or primary education; high school; and, college).