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by

Antonio Cutanda

and

Juan A. Sanchis-Llopis

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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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HUMAN CAPITAL AND THE INTERTEMPORAL SUBSTITUTION FOR LEISURE: EMPIRICAL EVIDENCE FOR SPAIN

Antonio Cutanda
Universidad de Valencia, Valencia, Spain
Universidad de Valencia, Valencia, Spain ORCID number: 0000-0003-2066-4632
and
Juan A. Sanchis-Llopis
Universidad de Valencia and ERICES, Valencia, Spain ORCID number: 0000-0001-9664-4668

Abstract.
In this paper we provide the first estimate for the intertemporal substitution for leisure in Spain. Further, we will study whether human capital accumulation affects this key elasticity. For this purpose, we estimate the equation for the intertemporal substitution without accounting for human capital and introducing it. We build a pseudo-panel data set combining the Spanish Family Expenditure Survey and the Labour Survey over the period 1987-1997. From our results the estimate of the intertemporal elasticity of leisure is about 0.25, that is comparable to estimates found for other economies. Further, considering the effect of human capital significantly increases the estimated elasticity of intertemporal substitution for leisure, obtaining an estimate about 0.5, what confirms the existence of a bias if we do not consider human capital. Finally, this bias is larger for the younger cohorts than for the older ones.

Keywords: Euler equation, Instrumental variables, Intertemporal Substitution for leisure, Panel data.
JEL Code: C33, C36, E24, J22

Corresponding author:
Juan A. Sanchis Llopis
Departamento de Estructura Económica Facultad de Economía
Avda. de los Naranjos, s/n
46022-V alencia
Phone: 96 382 83 50. Fax: 96 382 83 54 e-mail: sanchisl@uv.es

DECLARATIONS

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Conflicts of interest/Competing interests

The authors declare that they have no conflict of interest.

Availability of data and material

All the data used in this study are publicly available in the following page webs of Spanish public entities:

https://www.ine.es/, for the ECPF and the EPA.

https://www.bde.es/bde/es/, for the interest rate used.

Code Availability

Not applicable

1. Introduction.

The microeconomic empirical research on the elasticity of intertemporal substitution for leisure has usually produced very low estimates, as compared to the values used for this elasticity in macroeconomic models calibrations of the (Keane 2011; Chetty et al. 2011 and 2013). This discrepancy between the empirical evidence and the parameters considered in many theoretical (and simulated) macroeconomic models is a relevant question in the debate within both literatures and also for policy purposes.[1] This motivated a renewed interest to reconcile both facts (Chang and Kim 2006; Rogerson and Wallenius 2009). Further, the few available estimates using aggregate data do not provide consistent results (Mankiw et al. 1985, for the US economy, or Cutanda 2019, for Spain using regional data).

The elasticity of intertemporal substitution for leisure is a key determinant for the internal organization of labour within a firm as it measures labour supply responses to wage changes. There are different ways to obtain an estimate for this elasticity that vary according to the assumptions assumed in its analytical derivation. In this paper, we will estimate the Frisch elasticity for labour supply using Spanish microdata, using the intertemporal condition of the optimization, instead of the intratemporal condition. Frisch elasticities are derived using life cycle models under the assumption that the marginal utility of wealth is constant. We consider this is the most accurate approach to analyse the behaviour of labour supply along the life cycle.[2]

The traditional empirical approach for the estimation of the elasticity of intertemporal substitution for leisure has experienced an impulse due to two facts. First, Shaw (1989), Imai and Keane (2004), Keane (2016) and related papers, claim that previous results might suffer from a downward bias as do not consider the effect of human capital. Second, there are new attempts to estimate this elasticity, see for example Imai and Keane, 2004, or Bredemeir et al., (2019). Finally, there exists a continuous interest

[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] There are two further approaches to this concept: the Hicksian and the Marshallian elasticities. However, these depend on assuming that either the utility or wealth remain constant when wage is changing, respectively.

to study the effect of taxes on labour supply, with the aim of explaining the different behaviour of the US and the European labour markets (see, for example, Silva, 2008).[3]

In this paper, we provide the first estimate of the elasticity for Spain using micro data and we add new evidence for the elasticity of intertemporal substitution for leisure in Spain using a pseudo-panel data set for 41 quarters (see Browning et al. 1985) obtained combining the information from the Spanish Family Expenditure Survey (the *Encuesta Continua de Presupuestos Familiares*, ECPF), that provides information on individual consumption and income, with information on individual labour supply from the Spanish Labour Force Survey (*Encuesta de Población Activa*, EPA). We build this data set given that there does not exist a microeconomic survey gathering all this information in Spain,[4] up to 2002.[5] This explains the scarce estimates for this parameter in Spain. In our study, we estimate the log-linearized version of the Euler equation of leisure for the individual optimization problem.[6] Attanasio and Low (2004) and Alan et al. (2009) establish, using simulation techniques, that the elasticity of intertemporal substitution of consumption might be consistently estimated by log-linearized estimation procedures using sufficiently large datasets. We consider that our empirical work lies in this category as we use a long (pseudo) panel.

A further contribution of our paper is to study the effect of human capital to evaluate the bias incurred when not considering it, following. It is important noticing, that we will analyse this effect through the intertemporal equation of optimization, instead of the intratemporal equation. As discussed in Shaw (1989) and Imai and Keane (2004), as wages increase over the life-cycle individuals have incentives to increase their labour supply (by the substitution effect), while the diminishing returns of human capital produces the reverse effect. Therefore, the combined result of these effects is to flatten the labour supply curve, what explains that estimation of the intertemporal elasticity of

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[3] See the influential survey by Keane (2011) on the empirical labour supply research.

[4] In 1998, the methodology of the ECPF experienced an important change, as household income was reported as intervals. The lack of the real value of income makes matching unfeasible after 1998.

[5] The Survey of Household Finances (*Encuesta Financiera de las Familias*, EFF), launched in 2002, provides information on household income, although this survey has been designed to study individual savings and wealth. The sample design of the EFF is less appropriated to study the intertemporal behavior of consumption and leisure as it oversamples the wealthier households. Additionally, it does not record income and consumption as the needed detailed level.

[6] See, for example, Bredemeier et al. (2019) and Cutanda et al. (2020).

leisure ignoring human capital is downward biased. However, differently to these works, that use the intratemporal condition, our analysis is based on the intertemporal first order condition for leisure of the optimization program. We consider that the intratemporal equation might have serious drawbacks, as it relates only variables dated in the same period to estimate a life-cycle parameter that determines how individuals choose leisure (or work) across different periods.

As regards the estimation results, we get reasonable estimates for the elasticity of intertemporal substitution for leisure using a sample of working men, between 0.25 and 0.28. These results are comparable to the estimates obtained for other economies (MaCurdy 1981; Altonji 1986; and, Blundell et al. 2016).[7] Our results are Further, these are relevant results given the controversy in the values traditionally used for this parameter in business cycle macroeconomic models.[8] One of the reasons behind the relatively lower aggregate elasticity for intertemporal substitution in Spain might be related to the high persistence of the unemployment rate and the high rate of temporary workers.[9] Within our framework we consider the effect of human capital on the elasticity of intertemporal substitution for leisure, finding that the estimated elasticity increases when we account for human capital.

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 and the empirical specifications.

[7] Cutanda (2019), obtained a non-significant estimate for this elasticity using Spanish regional data.

[8] Keane (2011) surveys 12 influential studies and reports an average estimate of 0.83 with a median estimate of 0.17, although these numbers are upward biased due to, at least, a clear outlier. More importantly, Chetty et al. (2013) conclude, from an exhaustive meta-analysis of fifteen empirical studies, that the mean intertemporal elasticity of leisure is around 0.25.

[9] In the period we analyse, the Spanish unemployment and temporary average rates reached 17.19% and 30.17%, respectively. The Portuguese job market shows a similar behaviour as described by Cabral (2005). It is expected that temporal workers restrict their intertemporal substitution of leisure, what might explain, at least partially, the lower estimated we obtain.

In this section, we describe the life-cycle model for an individual agent choosing rationally her optimal life-cycle path for leisure and consumption. Our approach follows MaCurdy (1981 and 1983) who develops a basic life-cycle model for intertemporal labour supply, and Shaw (1989) and Imai and Keane (2004), who modify the basic model to incorporate human capital. In this framework, individuals choose in each period *t* leisure and consumption to maximize their expected life cycle utility function over the working horizon *T*:

$$\underset{C_t, L_t}{\text{Max}}\, U = E_t \sum_{\tau=t}^{T} \beta^{\tau}\, u(L_\tau, C_\tau) \tag{1}$$

where and L_τ and C_τ, are leisure and non-durable consumption, respectively. In this model, the utility function U is assumed to be intra and intertemporally separable, 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 intertemporal budget constraint:

$$A_{t+1} = R_t[A_t + W_t N_t - P_t C_t] \tag{2}$$

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 at time t; $N_t = L^* - L_t$ is the number of hours an individual works at time t, being L^* the total number of hours of each period; C_t is the individual real consumption at period t; and, P_t is the nominal price of a unit of C_t at time t, that we assume exogenous.

Following Shaw (1989) and Imai and Keane (2004), we assume that the observed wage is the product of the human capital stock, K_t, times the rental rate for a unit of this stock, R_t^K:

$$W_t = R_t^K K_t \tag{3}$$

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

The rental rate R_t^K is the market price of services for a unit of human capital. We assume a perfect market for human capital. Hence, in any period *t*, all agents face the same rental rate.

From (3), Shaw (1989) considers the wage as an endogenous variable, given that individuals can modify their wage through changes in their human capital. Thus, she assumes that the individual's value function depends on the stock of assets, the wage rate and the rental value of human capital, and not on the value of the human capital stock. Shaw (1989) proposes this value function as she is interested in the life-cycle human capital accumulation process.[11] Differently, Imai and Keane (2004) consider that the value function depends both on the human capital stock and on the stock of the assets. They specify the value function in that way given that their main interest lies on the individual's intertemporal allocation of consumption and leisure along the life-cycle. In any case, both studies assume that the individual's human capital investment function is limited to *learning-by-doing.*

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

$$\sum_{j=0}^{T-t} R_t^{-j} P_{t+j} C_{t+j} = A_t + \sum_{j=0}^{T-t} R_t^{-j} W_{t+j} N_{t+j} \tag{4}$$

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

Following Imai and Keane (2004), we assume that the stock of human capital evolves according to their accumulation rule $g(.)$, that depends on the labour supply hours, the current human capital, and a multiplicative wage shock $\varepsilon_{W,t+1}$:

$$K_{t+1} = g(N_t, K_t)\varepsilon_{W,t+1} \tag{5}$$

[11] In Shaw (1989) human capital develops in a learning-by-doing process, therefore there is no difference between the potential wage and the observed wage. This assumption is necessary to estimate a closed-form solution of the intra or intertemporal equations of (leisure). However, we think it is not plausible using Shaw (1989) solution in the Spanish case, due to the high unemployment rates suffered in the recent years.

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

$$V_{t+1}(A_{t+1}, K_{t+1}) = MaxE_{t+1}\left\{\sum_{j=1}^{T-t} \beta^j\, u\left(C_{t+j}, L_{t+j}\right)\right\} \tag{6}$$

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

$$V_t(A_t, K_t) = \max_{C_t, L_t}\left\{u(C_t, L_t) + \beta E_t V_{t+1}\left(A_{t+1}, g(N_t, K_t)\varepsilon_{W,t+1}\right)\right\} \tag{7}$$

from where we get the first order condition for leisure (see Shaw, 1989), given by:

$$\frac{\partial u}{\partial L_t} = \beta R_t W_t E_t \frac{\partial V_{t+1}}{\partial A_{t+1}} + \beta E_t \frac{\partial V_{t+1}}{\partial K_{t+1}} \frac{\partial K_{t+1}}{\partial L_t} \tag{8}$$

where:

$$\frac{\partial V_t}{\partial A_t} = R_t \beta E_t \frac{\partial V_{t+1}}{\partial A_{t+1}} \tag{9}$$

$$\frac{\partial V_t}{\partial K_t} = \beta E_t \frac{\partial V_{t+1}}{\partial K_{t+1}} \frac{\partial K_{t+1}}{\partial K_t} \tag{10}$$

It is important noting that that expressions (8) and (10) depend on the particular accumulation rule for human capital, defined in expression (5). Further, expression (8), the intertemporal equation for leisure, has an extra term (as compared to the standard expression with non-human capital) that depends on the derivative of the value function with respect to the human capital stock. This term reflects the discounted increase in welfare for all future periods associated to human capital accumulation. As Imai and Keane (2004) point out "if we only allow for the substitution effect and not the human capital effect, the i.e.s. is identified primarily from the covariation of the wages and hours over the life cycle. Then, we will falsely conclude that the i.e.s. is low, simply because labour supply remains roughly constant over the life cycle even though wages increase". Therefore, if there is human capital accumulation, ignoring this term in the empirical model might produce biased estimates for the elasticity of intertemporal substitution of leisure. A corollary of this result is that the bias in the estimation of the elasticity of intertemporal substitution for leisure will decrease with age, given that the second term in the right-hand side of expression (8) would be larger for younger workers, see Shaw (1989).

Both, Shaw (1989) and Imai and Keane (2004), consider the intratemporal equation in their analysis. This condition allows analysing the relationship between consumption and leisure in the same time period but we consider this might be less appropriate to study the intertemporal substitution of leisure between periods. Thus, differently to them, we research the effect of human capital accumulation in the intertemporal equation of leisure, expression (9), as this seems to be the appropriate framework, given that it relates the values of the variables of interest in different time periods. However, this is troublesome, as this expression depends on the human capital accumulation rule. To solve this drawback, we will assume the following expression for the accumulation rule defined in (5):

$$K_{t+1} = (1-\delta)K_t + \frac{1}{\alpha}N_t^{\alpha} = (1-\delta)K_t + \frac{1}{\alpha}(L^* - L_t)^{\alpha} \tag{11}$$

where δ is the yearly depreciation rate for human capital and $\frac{1}{\alpha}N_t^{\alpha}$ is the particular production function we assume for human capital, being α a positive parameter. This expression is not very different from those assumed by Shaw (1989) and Imai and Keane (2004), although they propose highly complicated functions.

In order to obtain a testable expression for the intertemporal equation for leisure, we take condition (7) and apply the envelope conditions (9) and (10). After rearranging terms, we obtain the following expression for the intertemporal condition of leisure:

$$\frac{\partial u}{\partial L_t} = E_t\left[\frac{\beta W_t R_t}{W_{t+1}}\frac{\partial u}{\partial L_{t+1}} - \frac{1}{\partial K_{t+1}/\partial K_t}\frac{\partial V_t}{\partial K_t}\left(\frac{W_t R_t}{W_{t+1}}\frac{1}{\partial K_{t+2}/\partial K_{t+1}}\frac{\partial K_{t+2}}{\partial L_{t+1}} - \frac{\partial K_{t+1}}{\partial L_t}\right)\right] \tag{12}$$

As this expression depends on many unobservable variables, we have to make some assumptions in the empirical analysis. Thus, we assume that $\partial K_{t+j+1}/\partial K_{t+j} = 1$ and $\partial K_t/\partial N_{t-1} = -\partial K_t/\partial L_{t-1} \cong N_{t-1}$. Note from (11) that the first assumption is equivalent to assume no depreciation of human capital and the second implies to assume α=2. We consider these assumptions are not very restrictive, given that in our empirical work we use a sample of men always working in a relatively short period, as most of the studies in the literature. Further, our assumptions will also affect the "marginal utility of human capital", as it is given by expression (10).

Therefore, under these assumptions, equation (12) becomes,

$$\frac{\partial u}{\partial L_t} = E_t\left[\frac{\beta W_t R t_t}{W_{t+1}}\frac{\partial u}{\partial L_{t+1}} + \frac{\partial V_t}{\partial K_t}\left(\frac{W_t R_t}{W_{t+1}} N_{t+1} - N_t\right)\right] \tag{13}$$

This expression is empirically more tractable; however, it still depends on the "marginal utility of human capital", that is unobservable. This expression will be used to check if the elasticity of intertemporal substitution, estimated with the standard form in the literature,[12] changes when we consider the accumulation of human capital, that will consider expression (13) with all the components. To this end, in the empirical exercise we will assume that "marginal utility of human capital" does not change when individuals decide about their allocation of leisure between periods.

3. Empirical specifications and estimation.

We need to specify a utility function to derive a testable model. We follow MaCurdy (1983), Mankiw et al. (1985) and Imai and Keane (2004), who propose a generalization of the CRRA utility function, widely applied in the empirical analysis of leisure and consumption. From this function, and given that we test the model with individual data, we add the effect of demographic variables (the vector θ_t) using an exponential term, as follows:

$$\mathrm{u}(C_t, L_t) = \frac{1}{1-\gamma}\left[d\,\frac{L_t^{1-\phi}-1}{1-\phi} + \frac{C_t^{1-\alpha}-1}{1-\alpha}\right]^{1-\gamma} e^{\lambda\theta t} \tag{14}$$

where γ, ϕ, α, λ and d are parameters to be estimated. This utility function becomes additively separable in leisure and consumption when $\gamma = 0$, which is the case traditionally considered in the empirical analysis of consumption (Zeldes 1989). In expression (14),

[12] The standard method to estimate the elasticity of intertemporal substitution for leisure consists in estimating only the first term in the right side of expression (13).

$1/\phi$ is the elasticity of intertemporal substitution for leisure and $1/\alpha$ is the elasticity of intertemporal substitution for consumption.

Using the above utility function (14) in the separable case, we take logs in the first order condition (13) to obtain the empirical testable expression without human capital (i.e., ignoring the second term of the right-hand side). We estimate this expression using (cohort) data. Our empirical approach is different to Mankiw et al. (1985), as they use nonlinear estimators with aggregate US data. After taking logs, we rewrite the equation adding an individual subscript and applying the rational expectations assumption in the usual way:

$$\Delta ln(L_{it+1}) = k_o + k_1 ln\left(\frac{W_{it}R_t}{W_{it+1}}\right) + k_2\Delta\theta_{it+1} + \varepsilon_{it+1} \tag{15}$$

where ε_{it+1} is an error term independent of all variables dated in *t* or before. Our empirical model is static given that the dependent variable in equation (15) is the growth rate of leisure (see Zeldes, 1989, and Runkle, 1991, for a similar approach for consumption). Further, all time invariant demographic variables vanish as the vector of demographic variables (θ_{it}) enters in the specification in first differences. Finally, the reduced form expressions for the coefficients in expression (15) are: $k_o = \frac{1}{\phi} ln\beta$ and $k_1 = k_2 = \frac{1}{\phi}$. It is important to note that k_1 is the intertemporal elasticity of substitution for leisure if the utility function is intratemporally separable in leisure and consumption, i.e., when γ=0. Otherwise, the expression for the Euler condition, expression (15), will depend on both consumption and leisure in *t* and *t*+1.

According to equation (15), we will estimate the Frisch elasticity for labour supply, as it is considered the relevant one in an intertemporal setting, whereas the Hicksian and Marshallian elasticities are more appropriate for a static framework. Hicks elasticity provides a lower bound for Frisch elasticity (Chetty 2012) and, as Marshall elasticity, can be retrieved from the static intratemporal equation, while retrieving Frisch elasticity requires to use the Euler condition. Shaw (1989) and Imai and Keane (2004) obtain the Frisch elasticity for labour supply from an estimation of the static intratemporal equation. Mankiw et al. (1985) established the difference between short and long run elasticities in an intertemporal setting. Keane (2011) provides a complete and updated survey of the results obtained in the literature for these different elasticities.[13]

Turning to the effect of human capital, once we estimate equation (15) without human capital, to verify whether the obtained estimates are robust to its effect, we will estimate equation (13). This equation, will depend on the "marginal utility of human capital", that is unobservable. Thus, we will assume that it remains constant, as we have no variable to proxy for it in our dataset. We consider this is a reasonable assumption provided that we are analysing a particular kind of human capital (that one 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 second term in expression (13). This will allow checking whether the estimated intertemporal elasticity of substitution of leisure changes with human capital. This approach follows the procedure put forward in Keane and Rogerson (2012), and Keane (2016), and applied to the US by Imai and Keane (2004).

We need to remark some relevant points for the estimation of equation (15). First, to empirically test our model implies the fulfilment of the first order condition (15). Therefore, we need to assume no violations of the canonical model of intertemporal choice, such as, for example, involuntary unemployment.[14] Second, we will treat the variable k_o as an individual fixed effect, given that this term includes the unobservable discount rate, that might be potentially correlated with the regressors.[15] We will apply robust estimation techniques to account for this correlation: the two-step generalized method of moments (GMM).[16] Further, we will include a constant term in the specification, that could be interpreted as the *autonomous* discount rate, common to all

[13] See Table 6 (page 1042) in Keane (2011), where there is an exhaustive compendium of the values obtained for these elasticities in literature.

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

[15] Imai and Keane (2004) do not allow for unobserved heterogeneity, although they recognize persistence in wages, assets and hours. Further, Shaw (1989) only introduces individual heterogeneity in equation (3), i.e., the process determining wages.

[16] We have estimated the model by using the *gmm* Stata command.

the individuals in the economy. Finally, in the empirical analysis, we will test for the goodness of fit with a Hansen's test of overidentifying restrictions.

A further point to consider is that income might be (potentially) affected by measurement error. However, given the time span we have available (41 quarters) we consider that the intertemporal elasticity of substitution is consistently estimated (Attanasio and Low 2004). Further, the usual procedure to obtain data on wages (in dataset where it is not available) is dividing income by hours worked, what might be another source of measurement error (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. However, we assume that the error term is first-order auto-correlated, what implies that we can use the second or further lags of these variables as instruments. As regards the demographic variables, we will consider them as exogenous, what allows using them directly (or lagged) as instruments.

Finally, in the analysis of the effect of wage changes on labour supply, it is important to distinguish between the intensive and extensive margins (Rogerson and Wallenius, 2009). The first refers to the change in hours worked in response to a wage changes, while the second refers to changes in labour market participation. This is a key issue in this literature, given the difficulty in distinguishing between individuals who voluntarily choose not to work and those involuntarily unemployed, using the available statistical information. The common practice to face this problem is using sampling selection procedures to obtain a sample of individuals who a priori will not drop from the labour market (i.e., males in a range of ages head of their household and always working). We follow this approach, as explicitly considering the participation decision would be a troublesome issue in the empirical analysis.[17] 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.

[17] There are few studies addressing this issue, especially with pseudo-panel data. See Blundell et al. (2018).

4. The data.

In this research we estimate the first order intertemporal condition for leisure using Spanish cohort data. In order to do so, we need a data set with information both on individual income and hours worked (or wages). 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 or wages. The only information on labour supply is whether any member in the household works more or less than one third of the usual weekly working hours. These data provide 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.[18] As regards labour supply, we have the Spanish Labour Survey (*Encuesta de Población Activa*, EPA). This survey is not a panel data set, as one cannot track individuals across time. As this is a labour data survey, it provides no information on individual income or wages.

To combine the information available in these statistical sources, we construct the same pseudo-panel, using the age of the head of the household, in both surveys. Once we have the pseudo-panel in the income and consumption (ECPF) and labour (EPA) surveys, we merge both data sets. It is important to bear in mind that these surveys are representative in the period analysed for the behaviour of Spanish consumption labour supply, respectively. Thus, combining these two we will assure the representativeness of the resulting one. To build the pseudo-panel, we select in both surveys only those households with a male (not retired) being the only member receiving labour income By applying this selection criteria, we guarantee that we can merge the labour income declared by these males in the ECPF with the hours declared (by the same males) in the EPA.[19] These two surveys have quarterly periodicity. As the first period is the first quarter

[18] 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 selection would be the sample of households composed only by one labour income earner.

[19] Lugilde et al. (2018) also discuss the lack of Spanish data for the jointly analysis of consumption and labour supply of the household.

of 1987 and the last one is the first quarter of 1997, we have 41 points in data.[20] 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 for the age of the head of the household, being the minimum and maximum ages 23 and 52, inclusive, in 1987 (34 and 63, respectively in 1997).[21] 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.

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;[22] we have also discarded all households whose head declares to be unemployed or retired. Thus, with this fairly adjusted profile, we consider we are able to examine the Spanish male labour supply, which sounds sensible given the limited female participation in the labour market during the analysed period.[23]

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 (cohorts 2 to 7). We had to apply a quite

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

[21] We have applied all the usual filters in this kind of studies. Thus, 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 withdrawn all households with income in the first and last percentile of the distribution.

[22] Also, and for similar reasons, Lugilde et al. (2018) restrict their sample to households where the reference person is an employee, although they do not impose any requirement on the labour status of the partner. However, we are aware of the relevance of the household perspective for labour decisions (see for example, Blundell et al. 2016 and 2018).

[23] The average size of the sample of households whose head is a labour income woman in the period is 74.

strict sample selection criteria to assure that we properly calculate the wages we use in our empirical approach.[24]

[Table 1 about here]

In what follows we describe the variables we use in estimation (see Table A.1 in the Appendix for a description of these variables). The nominal wage has been obtained dividing the head of the household's quarterly labour income, obtained from the ECPF, by the effective hours declared in the EPA. The quarterly leisure hours have been computed by subtracting the effective hours worked from the total number of available hours. 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 the EPA multiplied by 12.

We use a nominal interest rate for the Spanish bank deposits, following Cutanda et al. (2020). As for the price index, needed to obtain the real interest rate, we calculate a Stone price index for each cohort in the sample using the non-durable expenditure. So, although the nominal interest rate does not change across cohorts, the real interest rate does as we have variability in the cohort price index.

5. Results.

In this section we present the estimation results for the intertemporal elasticity of leisure using the different specifications discussed above. We start providing estimates for the intertemporal specification not considering the effect of human capital. And second, we estimate the same intertemporal condition including the effect of human capital, what will allow testing for the relevance of for human capital on the intertemporal elasticity of leisure. Finally, we will check whether the impact of human capital varies across different age groups.

[24] This selection issue is quite standard in this literature. For example, the sample used in MaCurdy (1983) has 121 individuals, and in Blundell and Walker (1986) it amounts to 1378 individuals. These sample numbers could suggest to tackle some sort of the sample selection correction. However, Keane (2011) points out that it is common in this literature "to ignore selection on the grounds that the large majority on adult non-retired do participate in the labour market".

In Table 2 we report the estimation results for the intertemporal substitution of leisure (*EISL*) for Spain. We use two specifications, being the difference between them the fact that we add three education variables in the second one (see column 2). The results reported for the two specifications estimated are quite suitable, in terms of the *EISL*. We obtain an estimated value for this parameter between 0.25-0.28, being statistically significant in both specifications reported. These estimates are potentially comparable to Cutanda (2019), who estimated a similar model with regional Spanish data, or to Mankiw et al. (1985), with aggregate US data, although in both cases they fail to obtain a statistically significant estimate for the *EISL*. Further, the values we find are also similar to those obtained (using microeconomic data) for other economies for the Frisch elasticity, as we will discuss below.

It is important to stress that the estimation of this parameter has been traditionally controversial. Keane (2011), after reviewing 14 empirical studies that use microeconomic data, concludes that the estimated average value for the *EISL* is about 0.83. However, the exclusion of two potential outlier values would reduce the average to 0.34, which provides a value much closer to our estimates. Additionally, Reichling and Whalen (2012), in a revision of the empirical literature, conclude that this elasticity ranges between 0.27 and 0.53 for the US. It is important to 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 of estimates runs from zero to 0.8”.

As regards the other covariates, we do not obtain a significant effect of the demographic variables in any of the specifications, except for the variable *College*. Finally, the Hansen test for the overidentifying restrictions in the two specifications considered provide appropriate results, as we obtain in both cases a significance level above 50%.

[Table 2 about here]

The second empirical question in this research consists on checking for the existence of a bias in the estimation of the *EISL*, as claimed by Shaw (1989), 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 3 below, we report the results accounting for human capital, in order to test whether the *EISL* is estimated with a bias. To perform the test requires including an extra regressor to proxy for the last term in expression (11), that depends on N_{t+1} (the hours worked).[25] This regressor, after assuming that the "marginal utility of human capital" is constant, is specifically $log\left(\frac{W_t R_t}{W_{t+1}} N_{t+1} - N_t\right)$.[26] We have estimated the model using the same instrument set as the one reported in Table 2.[27]

From our results, we observe, as expected, that the estimated *EISL* increases significantly with respect to the estimated values reported in Table 2. Specifically, in the wider specification estimates, we get an estimated *EISL* above 0.5, that almost doubles 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, we also get that the constant loses its significance, as compared to Table 2. Finally, although the Hansen test worsens somehow, we still get acceptable values (above 0.27).

Finally, we study whether the bias varies for different age groups. To this end, we separate the sample in two groups: the younger cohorts (cohorts 2 and 3 in Table 1) and the rest. In Table 4 we present these estimates: in column (1), we present the estimation results for the younger cohorts; and, in column (2) the estimates for the rest of cohorts. As it can be checked, the *EISL* is slightly larger for the young cohorts (and the contrary occurs for the older cohorts), as compared to the estimated parameter with the total sample. In columns (3) and (4) we provide the estimates accounting for human capital for

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[25] We have tried different mathematical expressions to compute the added regressor, all of them depending on the real interest rate adjusted by the inflation in wages and hours worked, but the results are very similar to those presented in Table 3.

[26] This extra regressor is called *Human capital bias* in Table 3. This term includes variables that would only be statistically significant if human capital is relevant.

[27] Adding the human capital variable implies that we lose some observations. However, we have checked that the results in Table 2 do not change when we use the same number of observations used to produce the results reported in Table 3.

the young and old cohorts, respectively. The inclusion of human capital implies that the estimates for the *EISL* are larger (as compared to the values in columns 1 and 2). Further, we also observe that the bias is larger for the young than for the old cohorts, according to the theoretical model.

We consider that the results obtained splitting the sample by age groups give support to the hypothesis raised by Imai and Keane (2004), Wallenius (2011), Keane and Rogerson (2012) and Keane (2016). Therefore, we confirm that it is important to account for the effect of human capital in individual wages to get a reliable estimate of the elasticity of intertemporal substitution for leisure.[28] However, we would like to point that the estimate for the Spanish economy is still far from the estimate obtained by Imai and Keane (2004) for the US economy, and from the values of this parameter used in most of the studies within the real business cycle literature.

5. Conclusions.

In this paper we have estimated the first order conditions of an intertemporal optimization labour and consumption model, aiming at estimating the elasticity of intertemporal substitution of leisure. This elasticity is a key parameter as it measures labour supply responses to wage changes. For this purpose, we use a Spanish cohort data set constructed by combining the information of two different statistical sources, the ECPF and the EPA.

To our knowledge, this is one of the first attempts to estimate this parameter using Spanish microeconomic data. We get an estimate for the *EISL* about 0.2/0.3, that is similar to values estimated in other countries with similar samples (households where the head is a man always working). These results confirm that there is scope to modify the Spanish consumption and employment behaviour by changing the relative intertemporal prices and wages through fiscal policy, confirming the results in Silva (2008).

[28] Nevertheless, this result might also be explained through the effect of borrowing constraints, as put forward by Domeij and Flodén (2006) or Bredemeier et al. (2019).

In our empirical exercise, we have also checked whether human capital, as put forward by Shaw (1989) and 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 human capital. This result confirms the bias obtained by Imai and Keane (2004). Additionally, we confirm a bigger bias in the estimation of the elasticity for younger individuals.

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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 leisure.

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

	(1)	(2)
Constant (k_{ol})	-0.026***	-0.051***
	(0.007)	(0.015)
EISL (k_{1l})	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)
Pre-school and/or primary education	-	0.006
		(0.048)
High School	-	0.023
		(0.017)
College	-	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

Notes:

1. We instrument specification (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 specification (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 3. Human capital bias in the intertemporal condition for leisure.

$$\Delta ln(L_{it+1}) = k_{ol} + k_{1l} ln\left(\frac{W_{it}R_t}{W_{it+1}}\right) + k_{2l}\Delta\theta_{it+1} + k_{3l} ln\left(\frac{W_{it}R_t}{W_{it+1}} N_{t+1} - N_t\right) + \varepsilon_{ilt+1}$$

	(1)	(2)	(3)	(4)
Constant (k_{ol})	-0.009	-0.017**	-0.018	-0.038
	(0.005)	(0.006)	(0.014)	(0.014)
EISL (k_{1l})	0.371**	0.316***	0.562**	0.443***
	(0.105)	(0.078)	(0.110)	(0.062)
Number of members	-0.039	-0.026	0.026	0.027
	(0.049)	(0.045)	(0.054)	(0.048)
Age head	-0.012	-0.012	-0.060	-0.053
	(0.033)	(0.032)	(0.044)	(0.040)
Number of adults	0.009	0.003	-0.016	-0.016
	(0.018)	(0.017)	(0.020)	(0.017)
Age head squared	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Pre-school and/or primary education	-	-	-0.010	0.004
			(0.045)	(0.045)
High School	-	-	0.005	0.015
			(0.019)	(0.016)
College	-	-	0.056	0.086
			(0.041)	(0.042)
Human capital bias (k_{3l})	-0.023**	-0.012**	-0.038***	-0.019**
	(0.008)	(0.005)	(0.010)	(0.005)
Bias	0.50	0.28	0.98	0.56
N. observations	228	228	228	228
Test overidentifying restriction				
Hansen's J Chi2(1)	0.309	0.338	5.083	2.351
p-value	0.577	0.560	0.278	0.671

Notes:

1. We instrument specification (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 specification (2), we add the second lag of the human capital bias. For specification (3), the instrument set increases that of specification (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.
2. The bias is calculated as the percentage change of the *EISL* in this table with respect to the corresponding value in Table 2.

Table 4. Human capital bias in the intertemporal condition for leisure.

$$\Delta ln(L_{it+1}) = k_{ol} + k_{1l} ln\left(\frac{W_{it}R_t}{W_{it+1}}\right) + k_{2l}\Delta\theta_{it+1} + k_{3l} ln\left(\frac{W_{it}R_t}{W_{it+1}} N_{t+1} - N_t\right) + \varepsilon_{ilt+1}$$

	(1)	(2)	(3)	(4)
Constant (k_{ol})	-0.031	-0.022***	-0.028	-0.006
	(0.025)	(0.007)	(0.022)	(0.006)
EISL (k_{1l})	0.286*	0.208***	0.641*	0.316***
	(0.187)	(0.061)	(0.421)	(0.120)
Number of members	0.081	-0.066	0.067	-0.109
	(0.102)	(0.069)	(0.088)	(0.081)
Age head	-0.122	-0.015	0.014	0.001
	(0.112)	(0.053)	(0.141)	(0.049)
Number of adults	-0.030	0.008	-0.021	0.029
	(0.033)	(0.027)	(0.031)	(0.030)
Age head squared	0.002	-0.001	-0.001	-0.001
	(0.002)	(0.001)	(0.002)	(0.001)
Human capital bias (k_{3l})	-	-	-0.038	-0.020**
			(0.027)	(0.010)
Bias			1.24	0.52
N. observations	76	152	76	152
Test overidentifying restriction				
Hansen's J Chi2(1)	1.490	0.006	0.083	0.079
p-value	0.222	0.936	0.772	0.778

Notes:

1. Columns (1) and (3) use in estimation only the two younger cohorts, i.e., cohorts 2 and 3 in Table 1. Columns (2) and (4) use in estimation only the four older cohorts, i.e., cohorts 4 to 7 in Table 1.
2. We instrument columns (1) and (2) 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 columns (3) and (4), we add the second lag of the human capital bias.
3. The *EISL* in columns (1) and (3) are statistically significant at 15%.

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 is a vector of demographic variables. In particular, we include the number of members of the household, the number of adults of the household (individuals 14 years old or older), and a set of educational dummies (pre-school and/or elementary education; high school; and, college). The omitted educational category is middle school.