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Housing and labor decisions of households

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Abstract In this paper, we analyze the relationship between the demand for housing and the family employment. To do so, we develop an economic model and use a sample of Spanish households to analyze the housing tenure choice (ownership or rental of the house) and the demand for housing in relation to family labor decisions. We have gone beyond previous studies by incorporating the discrete decisions of tenure choice and the participation of women in the labor market, proving that these decisions are interrelated and broadening the scope of our findings and conclusions. We obtained an important description of the effect of economic factors on housing and labor decisions and demonstrated that a change in a family's employment decisions affects housing decisions and vice versa. In addition, we determined to what extent housing and labor decisions are affected by changes in the wife's educational level and changes in family composition. Our findings show that the labor decisions have more sensitivity than housing decisions to these changes.

Keywords Housing tenure · Housing demand · Family labor supply · Female participation in the labor market

JEL Classification J22 · J29 · R21 · R29

1 Introduction

Housing and labor markets are strongly related. The influence of the labor decisions on the housing market is related to the effect that permanent or long-term income has on decisions of households about housing. On the other hand, housing market

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decisions have important effects on social well-being, in addition to notable macroeconomic implications, such as effects on the geographic mobility of workers.

In the present study, we focused on the decisions that a household makes in relation to housing and the family labor supply decisions of the spouses. In a family unit (i.e., a household), there is a strong relationship between the labor decisions of partners and their consumption decisions, especially in terms of housing consumption (because a house is typically the most expensive investment that a couple ever makes). Understanding these relationships would help to predict the household's behavior in the face of possible changes in employment of either partner or housing-related changes.

Many papers in the econometric literature have analyzed housing decisions. They have primarily focused on tenure choice (i.e., ownership or rental of the house) and the demand for housing services (Lee and Trost 1978; Goodman 1988; Ermisch et al. 1996), though some have introduced other important aspects, such as mobility (Edin and Englund 1991; Goodman 2002), geographic location (Rapaport 1997), or a focus on the young (Haurin et al. 1994).

Regarding labor markets, Grossbard-Shechtman (1984), Hausman and Ruud (1984), Blundell and Walker (1986), Browning and Meghir (1991), Fortin (1995), and Chiappori (2011) analyzed a family's labor supply decisions by accounting for the interdependence of spouses. Duguet and Simonnet (2007) explicitly consider the role of simultaneous within-couple decisions to participate in labor market in France.

Some authors have linked the housing market with the labor market, such as Deutsch et al. (2001), who used Austrian information to study the labor supply for men and women and who related this to income uncertainties, degrees of personal skill required by the job, tenure type, and housing cost, among other factors. Henley (1998) developed residential duration models by accounting for changes in labor market conditions in the UK.

Kohlhase (1986) jointly analyzed housing consumption and spousal work and leisure hours using US data. Assadian and Ondrich (1993) also analyzed the simultaneous determination of housing consumption and the labor supply of spouses, together with the residential location, in the city of Bogotá.

In this paper, we extended this previous research by performing a cross-sectional analysis of a sample of Spanish households from 2000 obtained from the *European Community Household Panel,* ECHP (http://www.ine.es/). We jointly estimated a model composed of five equations: the first two describe discrete decisions related to housing tenure and a woman's participation in the labor market, and the other equations describe housing demand (housing units) and the labor supply of each partner (number of hours the partner is willing to work). Our analysis advances the study of relationships between housing and labor markets by providing insights into the behavior of households that must jointly face labor and housing decisions, and will provide useful information for improving policies related to labor and housing markets.

Our findings show that economic factors determine both housing and labor decisions. To quantify the weight of these factors and their impact on the demand for housing and family labor supply, we have calculated conditional elasticities according to the method of Goodman (2002), by considering the direct effects of each variable on the relevant decisions and the indirect effects of each variable that result from the simultaneity of the model's equations.

Unlike in previous studies, we have incorporated housing tenure choice and the woman's decision to participate in the labor market in the model. On the one hand, the inclusion of these decisions in the model let us correct for the potential selection bias that arises from these decisions when analyzing the demand for housing and the labor supply of the two partners. On the other hand, incorporating these discrete decisions in the model provides a tool for studying the relationship between them. In this way, we can predict how a woman's decision to participate in the labor market is affected by a change in housing tenure choice and vice versa. A woman's decision about whether to enter the labor market is an important criterion in any study of Spanish housing and labor decisions, because Spain is still a traditional country, with a woman's primary role after marriage being seen as taking care of the family. Thus, women have entered the labor market in significant numbers later than they have in other developed countries.

Our results show the interdependence of the two discrete decisions. Moreover, we determined that the probability of a woman participating in the labor market is strongly affected when a household changes its housing tenure (a rate of change of 17.91 %). Nevertheless, if the woman goes from unemployed to joining the labor force, the probability of owning the house that the spouses occupy does not change greatly (less than 2 %). This can be explained by the high rate of home ownership in Spain (nearly 90 %), which makes these variations negligible.

We have also studied the impact that changes in household structure and changes in the characteristics of the family members have on these decisions. A relevant characteristic of the individuals is their level of education, since, in recent years, the educational level achieved by individuals in Spain, and particularly women, has increased, and this change can substantially modify proposed decisions. Moreover, the need for housing and the family involvement in the labor market will vary depending on whether the household has children and whether the children are young or mature.

Because the impact of an individual variable on the probabilities of alternative choices cannot be determined only by that variable's coefficient, we will determine how changes in these household characteristics affect decisions by considering several types of household that are defined according the educational level of the woman and the family composition. We will demonstrate that both characteristics greatly influence the woman's participation in the labor market. In particular, our results indicate that if the woman has studied at the university level, it is more likely that she will participate in the labor market and that the occupants will own their house (with a probability between 0.70 and 0.80). In addition, the presence of children (young or mature) decreases the woman's probability of participation in the labor market.

In Section 2, we present the econometric model we have used in our analysis. Section 3 describes the data sources and the variables used in our analysis. Section 4 presents the results we obtained and discusses their meaning. Section 5 concludes the paper by presenting our key findings.

2 Model and econometric specifications

To explain the behavior of households that must face housing and labor decisions, we developed a model based on consumer theory. The model considers the complex

background of the relationships that determine the labor behavior of both spouses as well as their decisions regarding the household's consumption. In this approach, we assume that the household chooses the leisure consumption by the husband, L_{M}, as well as the wife's leisure consumption, L_{W}, their housing consumption, D, and the consumption of other goods and services, S, by maximizing the following utility function: $U = U\,(D, S, L_{\mathrm{M}}, L_{\mathrm{W}})$.

To optimize leisure consumption, as well as the consumption of housing and other goods, the household first maximizes its utility under each of the following alternative situations: owner-occupied and both spouses participate in the labor market (1,1); owner-occupied and the woman does not participate in the labor market (1,0); tenant and both spouses participate in the labor market (0,1); and tenant and the woman does not participate in the labor market (0,0). The maximization is subject to the following budgetary constraints:

$$\begin{aligned} Y = {} & S + T[J(p_O D + w_M L_M + w_W L_W) + (1 - J)(p_O D + w_M L_M)] \\ & + (1 - T)[J(p_{\mathrm{R}} D + w_{\mathrm{M}} L_{\mathrm{M}} + w_{\mathrm{W}} L_{\mathrm{W}}) + (1 - J)\,(p_{\mathrm{R}} D + w_{\mathrm{M}} L_{\mathrm{M}})] \end{aligned}$$

in which Y is the total income of the household, defined as the sum of the non-labor income (the capital and property incomes, private transfers, and social benefits) and the labor income; T and J are dummy variables that indicate the decisions "to live in an owner-occupied home" and "the woman participates in the labor market", respectively; p_{O} and p_{R} are the prices of the housing associated with each tenure regime (ownership or rental), and w_{M} and w_{W} are the husband's and wife's corresponding hourly wages.

The maximum levels of utility for every alternative can be represented using indirect utility functions for each of the four alternative situations described earlier in this section:

$$\begin{aligned} V_{11} &= V_{11}(Y, S, p_{\mathrm{O}}, w_{\mathrm{M}}, w_{\mathrm{W}}, \mathbf{X}) \\ V_{10} &= V_{10}(Y, S, p_{\mathrm{O}}, w_{\mathrm{M}}, \mathbf{X}) \\ V_{01} &= V_{01}(Y, S, p_{\mathrm{R}}, w_{\mathrm{M}}, w_{\mathrm{W}}, \mathbf{X}) \\ V_{00} &= V_{00}(Y, S, p_{\mathrm{R}}, w_{\mathrm{M}}, \mathbf{X}) \end{aligned}$$

where $\mathbf{X}$ is a vector that represents the socio-demographic characteristics of the household. The household compares the maximum levels of utility associated with every possible situation and chooses the one that offers the highest utility.

From this indirect utility function and applying Roy's identity, we determine the corresponding housing demand and the husband's and wife's demands for leisure and work hours.

To empirically contrast the behavior of households, we developed a model based on simultaneous equations because the man's working hours are included in the equation that describes the woman's labor supply (and vice versa) and in the housing demand, and in turn, the housing demand appears in both equations for the labor supply. The model is composed of five equations: the first two represent the discrete decisions of tenure choice (owner-occupier versus tenant) and whether or not the woman participates in the labor market, the third describes the

demand for housing (housing units), and the last two are the labor supply equations (number of working hours for the husband and wife). Here, we assume that the man always participates in the labor market and that the woman must decide whether or not to participate in the labor market. We consider an individual to be participating in the labor market when the individual is performing a job for which they receive remuneration.

We consider a bivariate probit model, defined using two latent variables, to model two discrete decisions:

$$I_{\mathrm{T}}^{*} = \mathbf{Z}_{\mathrm{T}}'\delta_{\mathrm{T}} + \upsilon_{\mathrm{T}}$$

$$I_{\mathrm{P}}^{*} = \mathbf{Z}_{\mathrm{P}}'\delta_{\mathrm{P}} + \upsilon_{\mathrm{P}}$$

These variables are not directly observable, but we can observe their dichotomous effect through the variable I_{T} (where "T" represents "tenure"), which takes the value 1 if the household chooses to be an owner-occupier and 0 if it decides to rent, and the variable I_{P} (where "P" represents "participation"), which equals 1 if the woman participates in the labor market and 0 if she does not:

$$I_{\mathrm{T}} = \begin{cases} 1 & \text{if} \quad I_{\mathrm{T}}^{*} = \mathbf{Z}'_{\mathrm{T}}\delta_{\mathrm{T}} + \upsilon_{\mathrm{T}} \geq 0 \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

$$I_{\mathrm{P}} = \begin{cases} 1 & \text{if} \quad I_{\mathrm{P}}^{*} = \mathbf{Z}'_{\mathrm{P}}\delta_{\mathrm{P}} + \upsilon_{\mathrm{P}} \geq 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

where $\mathbf{Z}_{\mathrm{T}}$ and $\mathbf{Z}_{\mathrm{P}}$ are vectors of the demographic and economic characteristics of the household and $(\upsilon_{\mathrm{T}}, \upsilon_{\mathrm{P}})$ is the random component of the tenure and participation bivariate model. Here, we assume that the random term follows a bivariate normal distribution with the correlation coefficient ρ.

Next, the demand for housing and the labor supply of both spouses are modeled using a log-linear specification:

$$\ln D = \alpha_0 + \boldsymbol{\alpha}_1\mathbf{X}_{\mathrm{D}} + \alpha_2 Y_{\mathrm{NL}} + \alpha_3 p_k + \alpha_4 w_{\mathrm{M}} + \alpha_5 w_{\mathrm{W}} + \alpha_6 \ln h_{\mathrm{M}} + \alpha_7 \ln h_{\mathrm{W}} + \varepsilon_{\mathrm{D}} \tag{3}$$

$$\ln h_{\mathrm{M}} = \beta_0 + \boldsymbol{\beta}_1\mathbf{X}_{\mathrm{M}} + \beta_2 Y_{\mathrm{NL}} + \beta_3 p_k + \beta_4 w_{\mathrm{M}} + \beta_5 w_{\mathrm{W}} + \beta_6 \ln D + \beta_7 \ln h_{\mathrm{W}} + \varepsilon_{\mathrm{M}} \tag{4}$$

$$\ln h_{\mathrm{W}} = \gamma_0 + \boldsymbol{\gamma}_1\mathbf{X}_{\mathrm{W}} + \gamma_2 Y_{\mathrm{NL}} + \gamma_3 p_k + \gamma_4 w_{\mathrm{M}} + \gamma_5 w_{\mathrm{W}} + \gamma_6 \ln D + \gamma_7 \ln h_{\mathrm{M}} + \varepsilon_{\mathrm{W}} \tag{5}$$

where $k = \mathrm{O}$ indicates that the dwelling is owned and $k = \mathrm{R}$ rented; h_{M} and h_{W} are the working hours of the husband and the wife, respectively; $\mathbf{X}_{\mathrm{D}}$, $\mathbf{X}_{\mathrm{M}}$, and $\mathbf{X}_{\mathrm{W}}$ are vectors of the socio-demographic characteristics of the household in the respective equations; Y_{NL} is the non-labor income of the household; p_k is the price of the housing; and w_{M} and w_{W} are the corresponding hourly wages of the husband and wife.

The joint model is represented by Eqs. (1)–(5). To simultaneously analyze these decisions, we assume that the random disturbances $(\upsilon_{\mathrm{T}}, \upsilon_{\mathrm{P}}, \varepsilon_{\mathrm{D}}, \varepsilon_{\mathrm{M}}, \varepsilon_{\mathrm{W}})$ follow a

multivariate normal distribution with a null vector of means and a covariance matrix that considers the correlation between the abovementioned random disturbances.

The model is estimated in two stages. In the first stage, we estimate the bivariate probit model using the maximum-likelihood method.[1] In the second stage, housing demand and labor supply equations are estimated using a three-stage least-squares analysis given the simultaneous nature of the equations, and we incorporate two factors to control for selection effects obtained from estimation of the bivariate probit model. These variables, λ_T and λ_P, allow us to correct for the possible sample selection bias associated with the tenure choice and the woman's labor market participation decision, respectively (the analytic expressions to calculate these variables λ_T and λ_P are in "Appendix 1"). This is an extension of Heckman's method, which was designed to estimate a regression model with sample selection in order to avoid inconsistent estimation of parameters of the model (Heckman 1979).

Since the percentage of tenants in Spain is low (11.5 % according to the Population and Housings Census of 2001, http://www.ine.es/), the decisions related to the demand for housing and the labor supply was analyzed only for owner-occupiers.

Thus, in the second stage, if the woman participates in the labor market, we estimate the following three equations for owner-occupiers:

$$\ln D = \alpha_0' + \boldsymbol{\alpha}_1' \mathbf{X}_D + \alpha_2' Y_{NL} + \alpha_3' p_O + \alpha_4' w_M + \alpha_5' w_W + \alpha_6' \ln h_M + \alpha_7' \ln h_W + \alpha_8' \lambda_T + \alpha_9' \lambda_P + \varepsilon_D \quad (3')$$

$$\ln h_M = \beta_0' + \boldsymbol{\beta}_1' \mathbf{X}_M + \beta_2' Y_{NL} + \beta_3' p_O + \beta_4' w_M + \beta_5' w_W + \beta_6' \ln D + \beta_7' \ln h_W + \beta_8' \lambda_T + \beta_9' \lambda_P + \varepsilon_M \quad (4')$$

$$\ln h_W = \gamma_0' + \boldsymbol{\gamma}_1' \mathbf{X}_W + \gamma_2' Y_{NL} + \gamma_3' p_O + \gamma_4' w_M + \gamma_5' w_W + \gamma_6' \ln D + \gamma_7' \ln h_M + \gamma_8' \lambda_T + \gamma_9' \lambda_P + \varepsilon_W \quad (5')$$

When the woman does not participate in the labor market, in the second stage we estimate the following two equations for owner-occupiers:

$$\ln D = \alpha_0'' + \boldsymbol{\alpha}_1'' \mathbf{X}_D + \alpha_2'' Y_{NL} + \alpha_3'' p_O + \alpha_4'' w_M + \alpha_6'' \ln h_M + \alpha_8'' \lambda_T + \alpha_9'' \lambda_P + \varepsilon_D \quad (3'')$$

$$\ln h_M = \beta_0'' + \boldsymbol{\beta}_1'' \mathbf{X}_M + \beta_2'' Y_{NL} + \beta_3'' p_O + \beta_4'' w_M + \beta_6'' \ln D + \beta_8'' \lambda_T + \beta_9'' \lambda_P + \varepsilon_M \quad (4'')$$

The estimation of the model was done with the econometric program LIMDEP 8.0 (http://www.limdep.com/), which has implemented this estimation technique, and the software incorporates the corresponding standard error correction. It is also possible to perform the estimation using a full-information maximum-likelihood approach, although with a great computational effort.

[1] The decisions related to housing tenure and participation in the labor market can be estimated separately using two independent univariate probit models. However, joint estimation offers more efficiency, since it accounts for the possibility of a correlation between the disturbances υ_T and υ_P.

3 Source of data and variables

We used the 2000 extended wave in the ECHP (source: Spanish Statistics Office, http://www.ine.es/), to perform a cross-sectional analysis using Spanish data. This wave includes a greater number of households than the other waves as well as a greater number of variables. Specifically we dispose in this extended wave the Comunidad Autónoma (Spanish disaggregation regional) where the household resides, a variable necessary to construct the housing hedonic price. This additional information does not allow us combine the 2000 extended wave with the other waves of ECHP, therefore we conducted a cross-section analysis rather than a panel data analysis.

We considered only households that are owner-occupiers or tenants of a dwelling, that were formed by a couple (with or without children), in which both spouses were young enough to be of working age (under 65 years), and in which the husband was working and receiving remuneration. We chose 65 as the cutoff age because in Spain, this is the official retirement age and we wanted to focus on decisions made during an individual's working life. It is also necessary for the household to have declared earned income and to have provided information on all relevant variables used in our analysis. After this selection process, our final sample was 5,821 households.

The dependent variables for the bivariate probit model are the regime of tenure (owner-occupier or tenant) and the woman's participation (or not) in the labor market. The demand for housing was constructed as the monthly imputed rent that the household reported in the survey[2] divided by the regional housing price (the construction of the hedonic housing price is detailed in "Appendix 2"). This variable demand for housing was defined just for home owners, the only ones households used in the analysis of housing demand and labor supply. The dependent variables of labor supply for men and women were the number of weekly working hours per individual. These three variables are log-transformed to account for the log-linear form of our model.

Table 1 summarizes the variables used in the model and Table 2 provides the corresponding descriptive statistics.

In the tenure choice equation, we considered the age and the educational level of both members of the couple as explanatory variables. The educational level was introduced using three dummy variables, one each for the following educational levels: primary studies as the maximum, secondary studies, and university studies. In addition, we included the family composition: a couple without children, a couple with children younger than 16 years, and a couple with at least one child older than 16 years. As economic factors, we considered the current income of the household (used as a proxy for permanent income because the available information did not allow us to produce a satisfactory estimate of permanent income)[3] and the two regional

[2] Sonstelie and Portney (1980), Linneman (1980) and Kohlhase (1986) all agree that imputed rent rather than house value should be used in studies of housing demand. Barrios and Rodríguez (2007) use it with Spanish data.

[3] Authors such as Gyourko and Linneman (1996), Börsch-Supan and Pitkin (1988), Henderson and Ioannides (1986), and Tu and Goldfinch (1996) have used current income in their studies instead of permanent income because they believed it was inappropriate to use an unreliable estimate of permanent income; instead, they recommended using a good measure of the current income to reflect the effects of

hedonic housing prices, the purchase price and the rental price (see "Appendix 2"). Under the assumption that housing prices vary with population density and size of town, we also captured price effects using a series of dummy variables (*size1* to *size4*) that describe the size of the town in which the residence is located.[4]

To account for the decision of woman to participate in the labor market, we considered her age and her highest education level, the household composition, and whether she was required to care for children or elderly or needy adults. The two latter variables attempt to capture the commitment of women to caring for their family's members. This is particularly important in Spain, because this has traditionally been the woman's role. We also included the size of the town where the residence was located to reflect possible sociological differences, and used two economic variables, the non-labor income of the household and the husband's hourly wage. The latter variable was calculated as the ratio of monthly income that the individual receives from work to the monthly hours worked.[5] To avoid possible endogeneity of hourly wages in the model, we estimated a wage equation using Heckman's method (Fernández-Val 2003). "Appendix 3" shows the details of this analysis. Also, in woman's participation equation, we included dummies of region in which household residence is located to gather differences in cost of living and the idiosyncratic characteristics of the labor market across regions.

The exogenous variables chosen for use in the housing demand equation were the age and the educational level attained by both members of the couple, the family composition, dummy variables for the size of town in which the residence was located, the non-labor income of the household, the hourly wage of each spouse, and the housing price.

In the labor supply equations, we considered the age and the educational level of the individual, the family composition, whether the individual had to care for children or needy adults, a dummy variable indicating whether the individual was performing tasks with a high skill level qualification, the purchase price of housing, the region dummy variables and the non-labor income of household. Furthermore, we included the hourly wage of each spouse in both equations.

4 Results

4.1 Bivariate probit model

Table 3 summarizes the results of the bivariate probit model estimation and the associated Wald tests. We found that the correlation coefficient (ρ) across the error

Footnote 3 continued
the life cycle by combining the variables of age and level of education with the current income. Gyourko and Linneman (1996) have also pointed out that even if the current income is an imperfect indicator of accumulated wealth, it nonetheless reflects the household's ability to make mortgage payments.

[4] Dummy variables for the autonomous region haven't been introduced into the housing equations given their collinearity with housing hedonic prices.

[5] Specifically, we used the labor income received by the individuals who work as employees in the previous month to the interview and the variable "hours of work", which includes the hours worked in the week preceding the interview.

Table 1 Description of variables

Variable	Definition
Dependent	
Tenure	Owner-occupier = 1; tenant = 0
Participation	Woman participates in the labor market = 1; if not = 0
Demand	Housing units demanded by household (log-transformed)
Labor supply[a]	Number of weekly working hours per individual (log-transformed)
Independent	
Age[a]	Age of individual
Age2[a]	Individual's squared age
Primary[a]	Without any education or with a primary school education = 1; if not = 0 (reference variable)
Secondary[a]	Secondary school education = 1; if not = 0
University[a]	University education = 1; if not = 0
Couple0	Couple without children = 1; if not = 0 (reference variable)
Couple1	Couple with children aged less than 16 years = 1; if not = 0
Couple2	Couple with at least one child older than 16 years = 1; if not = 0
Care[a]	If the individual has to care for children or needy adults = 1; if not = 0
High_Skill[a,b]	If the individual performs tasks that require high qualifications in their job = 1; if not = 0
Income	Current income of the household (log-transformed)
Inc_nolabor	Non-labor income of the household (log-transformed)
Wage[a]	Hourly wage (log-transformed)
Oprice	Purchase price of housing (log-transformed)
Rprice	Rental price of housing (log-transformed)
Size1	If household resides in a town with less than 10,000 inhabitants = 1; if not = 0
Size2	If the household resides in a town between 10,001 and 50,000 inhabitants = 1, if not = 0
Size3	If household resides in a town with more than 50,001 inhabitants, but not a provincial capital = 1; if not = 0
Size4	Provincial capital (central cities) (reference variable)
North-west	If household resides in Galicia, Asturias or Cantabria = 1; if not = 0
North-east	If household resides in Navarra, Aragón, País Vasco or La Rioja = 1; if not = 0
Center	If household resides in Castilla-León, Castilla-La Mancha or Extremadura = 1; if not = 0
East	If household resides in Cataluña, Valencia or Baleares = 1; if not = 0
South	If household resides in Andalucía, Murcia or Ceuta-Melilla = 1; if not = 0
Madrid	If household resides in Madrid = 1; if not = 0
Canary Islands	If household resides in Canarias = 1; if not = 0 (reference variable)

[a] Represents either a man (_M) or a woman (_W), depending on the case

[b] We consider that a job requires high skill if it belongs to Great Group 1, 2, or 3 of the National Classification of Occupations NCO-94 (http://www.ine.es/) (executives, technical personnel, and professionals), corresponding to codes 11, 12, 13, 21, 22, 23, 24, 31, 32, 33, and 34 of the International Classification of Occupations ISCO88

Table 2 Means and standard deviations for the variables

Variables	Global sample		Owner and one wage earner		Owner and two wage earners	
	Mean	SD	Mean	SD	Mean	SD
Tenure	0.9074	0.2899				
Participation	0.4288	0.4949				
Demand			1.12	0.58	1.29	0.70
Hours_M			44.83	9.64	44.64	10.42
Hours_W					36.72	11.57
Age_M	43.98	9.66	45.81	9.68	42.43	9.07
Age_W	41.56	9.49	43.39	9.65	40.09	8.67
Primary_M	0.6298	0.4829	0.7125	0.4527	0.5164	0.4998
Secondary_M	0.2006	0.4005	0.1819	0.3858	0.2309	0.4215
University_M	0.1695	0.3753	0.1056	0.3074	0.2527	0.4347
Primary_W	0.6659	0.4717	0.7981	0.4015	0.4945	0.5001
Secondary_W	0.1762	0.3811	0.1441	0.3513	0.2161	0.4116
University_W	0.1579	0.3646	0.0578	0.2335	0.2894	0.4536
Couple0	0.1713	0.3768	0.1264	0.3323	0.2117	0.4086
Couple1	0.4314	0.4953	0.4129	0.4924	0.4487	0.4975
Couple2	0.3973	0.4894	0.4607	0.4985	0.3396	0.4737
Care_M	0.2060	0.4044	0.1504	0.3576	0.2785	0.4484
Care_W	0.5241	0.4995	0.5319	0.4991	0.5085	0.5000
High_Skill_M	0.3195	0.4663	0.2671	0.4425	0.3998	0.4900
High_Skill_W					0.3413	0.4743
Income[a]	22,082.8	13,625.5	18,756.1	10,984.5	27,183.3	15,365.6
Inc_nolabor[a]	1,485.0	3,242.2	1,588.1	3,317.6	1,425.7	3,295.7
Wage_M[b]	7.04	1.95	6.73	1.70	7.50	2.18
Wage_W[b]					5.83	2.21
Oprice[a]	4,030.49	708.43	3,993.86	699.08	4,062.65	720.40
Rprice[a]	1,540.09	644.42	1,495.87	638.51	1,606.06	644.78
Size1	0.2273	0.4191	0.2574	0.4373	0.2030	0.4023
Size2	0.2311	0.4215	0.2374	0.4255	0.2300	0.4209
Size3	0.1694	0.3751	0.1812	0.3853	0.1536	0.3607
Size4	0.3723	0.4834	0.3240	0.4681	0.4133	0.4925
North-west	0.1318	0.3383	0.1230	0.3285	0.1397	0.3467
North-east	0.1606	0.3672	0.1578	0.3646	0.1772	0.3819
Center	0.1730	0.3783	0.1949	0.3962	0.1458	0.3530
East	0.2178	0.4128	0.1912	0.3933	0.2475	0.4316
South	0.1797	0.3840	0.2100	0.4073	0.1493	0.3564
Madrid	0.0811	0.2730	0.0735	0.2611	0.0903	0.2867
Canary Island	0.0560	0.2300	0.0495	0.2169	0.0502	0.2184
Sample size	5,821		2,991		2,291	

[a] In €; [b] €/hour

Table 3 Estimates of the bivariate probit model for housing tenure and the woman's participation in labor market decisions

Variable	Tenure		Variable	Woman's participation	
	Coefficient	*t*-statistic		Coefficient	*t*-statistic
Constant	−0.5837	−0.460	*Constant*	−1.4187	−4.206**
Age_M	−0.0216	−0.714	*Age_W*	0.0705	4.148**
Age2_M	0.0001	0.431	*Age2_W*	−0.0011	−5.572**
Age_W	0.0979	3.252**	*Secondary_W*	0.4037	8.174**
Age2_W	−0.0008	−2.139*	*University_W*	1.0684	17.989**
Secondary_M	0.1201	1.810	*Couple1*	−0.2600	−4.072**
University_M	−0.0565	−0.679	*Couple2*	−0.3007	−5.101**
Secondary_W	0.0405	0.601	*Care_W*	−0.2438	−5.081**
University_W	0.0629	0.698	*Wage_M*	0.2055	2.057*
Couple1	0.1781	2.647**	*Inc_nolabor*	0.0139	1.627
Couple2	0.0898	1.112	*Size1*	−0.0576	−1.134
Income	0.2383	5.067**	*Size2*	−0.0073	−0.151
Oprice	−0.3874	−2.628**	*Size3*	−0.1558	−2.862**
Rprice	0.0719	1.202	*North-west*	0.0818	0.936
Size1	0.4014	5.725**	*North-east*	0.0104	0.117
Size2	0.2933	4.539**	*Center*	−0.1499	−1.732
Size3	0.1774	2.638**	*East*	0.1767	2.098*
			South	−0.2092	−2.449*
			Madrid	0.0016	0.016
ρ	0.0889	2.862**			
Sample size	5,821				

Variable	Wald statistic	*df*	*p*	Variable	Wald statistic	*df*	*p*
Age_M	1.929	2	0.381	*Age_W*	120.597	2	<0.001
Age_W	30.631	2	<0.001	*Education_W*	337.977	2	<0.001
Education_M	5.414	2	0.067	*Family composition*	26.957	2	<0.001
Education_W	0.677	2	0.713	*Size of town*	9.871	3	0.020
Family composition	7.393	2	0.025	*Region*	57.702	5	<0.001
Size of town	42.038	3	<0.001				

** Significant at 1 %; * significant at 5 %

terms in the equations for tenure and for participation of woman in the labor market was significant and positive.

The marginal effects of the covariates on the conditional probabilities involved in the bivariate probit model are in "Appendix 4".

4.1.1 Tenure regime

In the estimation of tenure choice (Table 3), we found that of the variables that described the characteristics of the spouses, only the age of the woman was

determinant (Wald test). The likelihood of home ownership increases with the age of the woman until she reaches the age of 62, and then decreases. Also, family composition was significant (Wald test) and its estimated coefficients indicated that households with young children are more likely to be owner-occupiers than other types of households.

The current income was also a significant factor. The wealthier households had a higher probability of being owner-occupiers. This shows that the households that are most inclined to acquire a dwelling are those that have attained a level of income that lets them save enough money to cover the capital amortization and interest costs of a mortgage.

The purchase price exerted a significant negative influence, which indicates that if it increases, the probability of being an owner-occupier decreases. The rental price wasn't a determinant factor in housing tenure choice. The estimated coefficients for the size of town in which the residence was located were positive and decreased with increasing town size; the likelihood to being owner-occupier therefore decreases in larger towns because of the higher housing prices.

4.1.2 Participation of the woman in the labor market

In the equation for participation of women in the labor market (Table 3), we found a negative parabolic relationship for the woman's age, indicating that the participation of a woman in the labor market increases with her age, up to a maximum of about 32 years old, and then decreases. This might be explained by the fact that, after a certain age, women tend to leave the labor market to care for their family.

Educational level was the most influential characteristic in this decision, confirming that the recent change in the educational profile in Spain (i.e., increased educational achievements by women) is one of the main factors that explain the increased economic activity of women. The probability that a woman will participate in the labor market increases with her educational level.

The family composition and whether the woman cares for children or elderly relatives (*care_W*) also affected the woman's decision to participate in the labor force, and the estimated negative coefficients show that a woman burdened with the responsibility to care for her family has a lower probability of working outside of the house. This result can be explained by the traditional role of the woman in a Spanish family: if there are more members in the household, then the woman must dedicate more time to maintenance of the household and to non-remunerated domestic activities.

Among the economic variables, the husband's hourly wage significantly affected a woman's likelihood of participating in the labor market. If the husband's hourly wage increases, the likelihood that the woman will enter the labor market increases.

Variables indicating the size of the town and the region of residence were determinant (Wald test). We can say that women residing in capital cities and in East of Spain are more prone to participate in the labor market.

4.2 Housing demand and family labor supply

Tables 4 and 5 summarize the results of our estimation of the equations for housing demand and family labor supply, respectively, for owner-occupiers. The double

Table 4 Housing demand of owner-occupiers

Variable	One wage earner		Two wage earners	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Constant	−1.6,310	−2.212*	−3.6611	−3.994**
Age_M	−0.0423	−3.522**	−0.0040	−0.309
Age2_M	0.0005	3.806**	0.0001	0.361
Age_W	−0.0339	−3.353**	−0.0332	−2.456*
Age2_W	0.0002	2.098*	0.0003	1.839
Secondary_M	−0.1550	−4.214**	−0.0253	−0.671
University_M	−0.1947	−2.731**	0.0038	0.051
Secondary_W	0.0789	3.304**	0.0334	1.170
University_W	0.1595	2.572*	0.0515	0.908
Couple1	−0.0879	−2.340*	−0.0421	−1.080
Couple2	−0.0013	−0.040	0.0302	0.781
Size1	−0.3428	−9.669**	−0.1879	−4.924**
Size2	−0.2284	−8.431**	−0.1464	−4.610**
Size3	−0.1772	−7.762**	−0.1061	−4.386**
Inc_nolabor	0.0041	1.027	0.0172	3.369**
Wage_M	0.9365	7.398**	0.5872	4.400**
Wage_W			0.3962	5.458**
Oprice	−0.2582	−4.712**	−0.4258	−6.128**
Hours_M	1.1787	8.114**	1.0797	7.118**
Hours_W			0.6446	4.564**
λ_T	−1.4446	−6.561**	−0.5298	−1.634
λ_P	0.0593	0.927	0.2126	3.535**
Sample size	2,991		2,291	

Variable	Wald statistic	*df*	*p*	Wald statistic	*df*	*p*
Age_M	16.232	2	<0.001	0.204	2	0.903
Age_W	35.513	2	<0.001	15.126	2	<0.001
Education_M	18.266	2	<0.001	1.697	2	0.428
Education_W	10.936	2	0.042	1.474	2	0.478
Family composition	14.920	2	<0.001	8.069	2	0.018
Size of town	95.041	3	<0.001	25.759	3	<0.001

Standard errors are corrected for selection

** Significant at 1 %; * significant at 5 %

correction of the selection bias associated with the tenure choice and the participation of the woman in the labor market is adequate, since the variables that gather these effects, λ_T and λ_P, were jointly significant. The value of Wald test for the four variables associated with selection bias for the sample with one wage earner is 61.72 ($p < 0.001$) and the value of Wald test for the six selection bias variables for the sample with two wage earners is 55.54 ($p < 0.001$).

Table 5 Family labor supply of owner-occupiers

Variable	Man: one wage earner		Man: two wage earners		Woman: two wage earners	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Constant	4.4724	14.265**	5.5458	9.694**	5.1913	5.124**
Age[a]	0.0580	9.093**	0.0185	2.009*	−0.0037	−0.349
Age2[a]	−0.0006	−8.996**	−0.0002	−1.831	0.0001	0.165
Secondary[a]	0.2182	8.011**	0.0732	2.008*	−0.0243	−0.761
University[a]	0.4731	8.983**	0.1711	2.217*	−0.0471	−0.670
Couple1	−0.0131	−0.829	−0.0403	−1.419	−0.0798	−2.279*
Couple2	−0.0434	−2.921**	−0.0638	−2.036*	−0.1038	−2.781**
Care[a]	−0.0115	−1.436	−0.0150	−1.859	−0.0353	−1.707
High_Skill[a]	0.0488	5.836**	0.0259	2.942**	0.0068	0.480
Inc_nolabor	−0.0029	−1.467	−0.0142	−3.513**	−0.0149	−2.814**
Wage_M	−1.0914	−11.159**	−0.7064	−4.703**	−0.3671	−4.221**
Wage_W			−0.3204	−7.298**	−0.2506	−2.495*
Demand	0.2272	5.392**	0.5758	7.627**	0.6218	5.520**
Oprice	−0.0154	−0.391	0.2791	4.257**	0.3335	3.729**
Hours_M					−0.7371	−3.264**
Hours_W			−0.6849	−6.387**		
North-west	−0.0199	−1.245	−0.0445	−1.699	−0.0214	−0.465
North-east	0.1172	5.497**	−0.0023	−0.075	−0.0829	−1.910
Center	−0.0344	−2.154*	−0.0734	−2.674**	−0.0827	−1.757
East	0.0957	4.548**	0.0093	0.316	−0.0304	−0.716
South	−0.0583	−3.947**	−0.0749	−2.884**	−0.0689	−1.489
Madrid	0.1593	7.166**	0.0336	1.131	−0.0329	−0.735
λ_T	0.1301	1.808	−0.5438	−4.053**	−0.8518	−4.901**
λ_P	0.0395	2.129*	−0.1234	−3.368**	−0.1017	−1.378
Sample size	2,991		2,291		2,291	

Variable	Wald statistic	*df*	*p*	Wald statistic	*df*	*p*	Wald statistic	*df*	*p*
Age_M	82.702	2	<0.001	5.629	2	0.059			
Age_W							1.112	2	0.573
Education_M	80.754	2	<0.001	5.151	2	0.076			
Education_W							0.585	2	0.746
Family Composition	12.706	2	0.002	4.231	2	0.121	7.859	2	0.020
Region	92.030	5	<0.001	11.740	5	0.068	7.059	5	0.315

Standard errors are corrected for selection

Estimates of correlation between random disturbances of housing demand and family labor supply equations for one earner is $\hat{\rho}_{D,M} = -0.82$, and for two earners are $\hat{\rho}_{D,M} = -0.96$, $\hat{\rho}_{D,W} = -0.92$, and $\hat{\rho}_{M,W} = 0.97$

** Significant at 1 %; * significant at 5 %

[a] Represents either man (_M) or woman (_W)

Our results (Tables 4 and 5) show that the housing demand is determined by the family labor supply and vice versa. This confirms that decisions regarding the hours worked and housing consumption are interdependent choices. We also observed that

the demanded housing units (Table 4) increases when the man, the woman, or both increase their working hours. In turn, the quantity of housing demanded by the household had a positive effect on the family labor supply (Table 5); that is, the greater the demand, the higher the number of working hours. Both spouses (or only the man if the woman did not participate in the labor market) increase their working hours so they can afford the expenses caused by the increased housing demand.

With regard to the relationship between the household labor supply (Table 5), the number of hours worked by one spouse has an important negative effect on the number of hours worked by the other spouse when both are employed. Thus, if the wife or husband increases their working day, the other spouse typically decreases their working day.

4.2.1 Housing demand

In Table 4, we see that of the characteristics of individuals, in the case of two earners, only the age of the woman were a determining factor and showed a positive parabolic relation.

For one wage earner, the age and the educational level of both partners were influential (Wald test). We found a positive parabolic relationship for the partners' age. And the household had a greater demand for housing when the husband had a primary education and the wife had a university education.

The family composition was significant whether there were one or two wage earners (Wald test) and the estimated coefficients indicate that a household will demand fewer housing units when young children are present. The town size was also significant and the coefficients were increasingly negative (i.e., demand increased with increasing town size). Households living in a big town may demand for a higher number of housing units (houses and neighborhoods with a higher provision of amenities and services, etc.).

Two economic variables (hourly wages and housing purchase price) were significant whether one or two spouses participated in the labor market, whereas non-labor income was significant only when there were two wage earners. An increase in the individual's hourly wage or in the non-labor income resulted in a higher demand for housing. The estimated coefficient for house prices was negative. That is, if the price increases, the household diminishes its housing demand.

To quantify some of these impacts, we calculated the conditional demand elasticities following the methods of Greene (2000) and Goodman (2002). These elasticities are determined by the direct effect of a variable measured by the corresponding estimated coefficient, plus an indirect effect due, on the one hand, to the presence of this variable in the correction factors for selection bias (λ_T and λ_P) that originated in the bivariate probit model and, on the other hand, to their simultaneity with the labor supply equations.

We defined the price elasticity as the effect that a 1 % increase in price would have on the housing demand. To obtain this elasticity, we calculated, for every household, the difference between the housing demand with and without the increased price:

Table 6 Conditional housing demand elasticities

Variables	One wage earner	Two wage earners
Price	−0.5198	−0.5556
Wage_M	−0.4938	−0.5226
Wage_W		0.1268

$$\left[\alpha \mathrm{X}^{(p=1.01p_0)} + \alpha_{\mathrm{T}}\lambda_{\mathrm{T}}^{(p=1.01p_0)} + \alpha_{\mathrm{T}}\lambda_{\mathrm{P}}^{(p=1.01p_0)}\right] - \left[\alpha \mathrm{X}^{(p=p_0)} + \alpha_{\mathrm{T}}\lambda_{\mathrm{T}}^{(p=p_0)} + \alpha_{\mathrm{P}}\lambda_{\mathrm{P}}^{(p=p_0)}\right]$$

where the vector **X** gathers all the explanatory variables (exogenous and endogenous) from the demand equation, $\boldsymbol{\alpha}$ is their vector of coefficients (in reduced form), p and p_0 represent the new and original prices (respectively), and α_{T} and α_{P} are the coefficients of the selection bias variables. In this approach, price elasticity is obtained by averaging these individual elasticities. From the above definition of the elasticity, we can see that the sign and magnitude of these elasticities may be different than those corresponding to the direct effect associated with the estimated coefficient (see Greene 2000, and Goodman 2002). Table 6 shows the conditional price elasticities of housing demand. We found that the demand for housing exhibits an inelastic response to variations in the housing price in the two subsamples that we considered (one or two wage earners) and had similar values for both subsamples. The demand for housing was also inelastic with respect to hourly wages. We found that the values of hourly wage elasticities were lower than those for the price of housing with both one and two wage earners, especially for woman's wage, which moreover is positive.

4.2.2 Labor supply

The estimated labor supply equations (Table 5) show that for variables that describe the characteristics of the individual, age and educational level of individual affected the labor supply by the man only when he was the sole wage earner. The age showed a negative parabolic relationship, indicating that the length of the man's working day increases with his age up to a maximum about 50 years and then decreases; and men with university education have larger working day. Family composition was significant for women and for men only when he was the sole wage earner. Their negative estimated coefficients indicate that the presence of children in the household makes individuals want to reduce their working hours. Jobs that required a high skill level showed a positive influence on the man's labor supply, indicating that men with jobs that require high qualifications work more hours. The region where residence is located, affected the labor supply of the husband when there is one earner wage, and we see that in Madrid the individuals are working more hours.

For the economic variables, we found that hourly wages were significant and had a negative sign. This result was unexpected, but could be due to the fact that the joint estimation of the family labor supply and housing demand can lead the coefficients of some variables to differ from their habitual values based on

Table 7 Conditional labor supply elasticities

Variables	Man		Woman
	One wage earner	Two wage earners	Two wage earners
Wage_M	−1.2033	−1.0556	0.1026
Wage_W		−0.2606	0.0215

individual estimates of the labor supply. Our result could also indicate that with higher wages, the household can reach the same level of income even if the husband or the wife is working fewer hours. This may reflect the fact that in Spain, the family is valued more highly than extra income. Non-labor income and housing price had a significant influence (negative and positive, respectively) on the determination of the working hours in two-income families.

We determined the conditional elasticity of wages for the labor supply based on the direct effect of hourly wages in the corresponding equation, plus an indirect effect due to simultaneity across the housing demand and labor supply equations, and due to the presence of the man's wages in the bivariate probit model. Table 7 shows these conditional wage elasticities, and reveals different behavior between men and women.

Whereas men had a negative elasticity with regard to their own wage and its magnitude was over 1 whether or not their wife participated in the labor market, women had a positive elasticity and one that was of lower magnitude than that of the men. On the other hand, when both spouses were employed, the cross-elasticity was negative for the labor supply of men and positive for the labor supply of women.

4.3 Predicted changes in housing and labor supply decisions

To improve our understanding of the relationships between the housing and labor markets, we analyzed how housing decisions were affected by a family labor supply changes and vice versa.

We assessed the change in the probability of being an owner-occupier when the wife becomes employed, and the variation in the probability of participation of women in the labor market that is produced when the household changes from a renter to an owner-occupier. To do so, we quantified these changes from the conditional probabilities using equations (6) and (7):

$$\begin{aligned} &P(\text{owner/woman participates}) - P(\text{owner/woman does not participate}) \\ &\quad = P_{O/P} - P_{O/NP} \end{aligned} \tag{6}$$

$$P(\text{woman participates/owner}) - P(\text{woman participates/tenant}) = P_{P/O} - P_{P/T} \tag{7}$$

In addition, since the educational achievements of women have significantly increased in recent years and the emergence of new family structures has changed the distribution of family types, we assessed whether the level of education of women and the family composition affected these changes in probability. To account for these various possibilities, we defined nine reference households using a combination of

three educational levels (no more than primary education, secondary education, and university education) and three types of family composition (childless couple, a couple with children under the age of 16 years, and a couple with at least one child over the age of 16 years). In addition, we analyzed the behavior of the average household.

First, we will calculate the predicted joint probabilities of the four alternative choices. The predicted probabilities are calculated using the bivariate probit model estimates (Table 3), with the explanatory variables evaluated based on their corresponding mean values. The resulting probabilities are summarized in Table 8. We can observe that for the average household, the greatest probability is P_{10}, which corresponds to an owner-occupier and a woman who doesn't participate in the labor market, followed by P_{11}, which corresponds to an owner-occupier and a woman who participates. When we consider the nine types of households, we observe the same situation if the woman has only a primary education. However, with a secondary or university education, the greatest probability is always P_{11}, and the difference from the other probabilities is particularly large if the woman has a university education. On the other hand, the presence of children in a household decreases the probability that the woman will participate in the labor market.

From these predicted probabilities, we can obtain the conditional probabilities and the corresponding values of equations (6) and (7) for each type of household (Table 9). The change in the probability of ownership when the woman changes from not participating to participating in the labor market, $P_{O/P} - P_{O/NP}$, is positive but small for all 10 reference households; the reason. lies in the fact that in Spain, the rate of ownership is very large (nearly 90 %), which makes the variations small. For the average household, participation of the woman in the labor market represents an increase of 1.84 points, which equals a rate of change of 1.99 %. These results are quite similar to those for the other nine reference households. At a given education level, the smallest increments were for couples with mature children.

When we analyzed the variations in the probability that a woman would participate in the labor market when the household changes from tenant to owner,

Table 8 Predicted probabilities according to household type

Reference household	Children	Woman's education	P_{11}	P_{10}	P_{01}	P_{00}
Average			0.4485	0.4843	0.0274	0.0398
Type 1	None	Primary	0.4507	0.4682	0.0340	0.0471
Type 2	<16 years	Primary	0.3294	0.5872	0.0246	0.0588
Type 3	>16 years	Primary	0.2895	0.6534	0.0139	0.0432
Type 4	None	Secondary	0.6291	0.2415	0.0860	0.0434
Type 5	<16 years	Secondary	0.4940	0.4260	0.0372	0.0428
Type 6	>16 years	Secondary	0.4885	0.4588	0.0231	0.0295
Type 7	None	University	0.7939	0.0889	0.1016	0.0156
Type 8	<16 years	University	0.7330	0.2034	0.0461	0.0175
Type 9	>16 years	University	0.7075	0.2443	0.0327	0.0155

P_{11} = P(owner and woman participates) P_{10} = P(owner and woman does not participate)

P_{01} = P(tenant and woman participates) P_{00} = P(tenant and woman does not participate)

Table 9 Variations in the probabilities due to changes in the housing and labor supply decisions

Reference household	Children	Woman's education	$P_{O/P} - P_{O/NP}$ (variation rate)	$P_{P/O} - P_{P/T}$ (variation rate)
Average			0.0184 (1.99 %)	0.0730 (17.91 %)
Type 1	None	Primary	0.0212 (2.34 %)	0.0711 (16.97 %)
Type 2	<16 years	Primary	0.0216 (2.38 %)	0.0647 (21.96 %)
Type 3	>16 years	Primary	0.0162 (1.73 %)	0.0636 (26.13 %)
Type 4	None	Secondary	0.0321 (3.79 %)	0.0581 (8.75 %)
Type 5	<16 years	Secondary	0.0212 (2.33 %)	0.0717 (15.41 %)
Type 6	>16 years	Secondary	0.0152 (1.62 %)	0.0763 (17.37 %)
Type 7	None	University	0.0362 (4.26 %)	0.0328 (3.78 %)
Type 8	<16 years	University	0.0201 (2.18 %)	0.0581 (8.02 %)
Type 9	>16 years	University	0.0157 (1.67 %)	0.0658 (9.72 %)

$P_{O/NP}$ = P(owner/woman does not participates) $P_{O/P}$ = P(owner/woman participates)

$P_{P/T}$ = P(woman participates/tenant) $P_{P/O}$ = P(woman participates/owner)

$P_{P/O} - P_{P/T}$, the probability for the average household increased by 7.30 points (a rate of change of 17.91 %). This result indicates that a woman is more likely to join the labor market when the household buys their residence, possibly because the high costs of purchasing a dwelling can force the woman to enter the labor market so she can help her spouse cover the housing expenses. For the other nine reference households, we observed that when a woman has only a primary education, the rate of variation far exceeds 20 % in the presence of children, whether young or mature. With a higher level of education, the rates of change are lower than that for the average household. The increase in the probability that the woman will participate in the labor market for a childless household in which the wife has a university education is especially small (a rate of change of 3.78 %).

For the average owner-occupier household, we quantified the difference in housing demand and in the number of hours worked by the man when the woman changes from not participating to participating in the labor market. From the coefficients in Tables 4 and 5, we can calculate that the housing demand is 1.01 units of housing if only the man participates in the labor market, but this increases to 1.16 units of housing if the woman also participates, which represents an increase of 15.2 %. Moreover, the husband's working day remains practically the same, irrespective of his wife's employment status: men work an average of 43.89 h per week when they are the sole wage earner, versus 43.53 h when the woman is also employed.

These results indicate that a change in housing tenure has a strong impact on the probability of a woman's participation in the labor market; this may be because the high costs of purchasing a dwelling can force women to become workers. However, although the change in employment status of women has little impact on the likelihood of being an owner-occupier, the presence of two wage earners changes the quantity of housing demanded when the household has already decided to buy its dwelling. This result could indicate that families in which both partners participate in the labor market can afford to spend more on housing.

5 Conclusions

Our study showed that Spanish households make joint decisions about housing and family labor status. In our econometric model, unlike in most previous studies, we have incorporated equations that describe the housing tenure choice and the woman's decision to participate in the labor market, and our analysis shows that these discrete decisions are interrelated and each influences the household's demand for housing and family labor supply.

Like Kohlhase (1986) for the US and Assadian and Ondrich (1993) for the city of Bogotá, we found that housing demand and family labor supply decisions are interdependent. If one individual (husband or wife) increases their working hours, the household increases its housing demand, likely because it has greater economic capacity. Conversely, when the housing demand grows, there is an increase in labor supply by the spouses.

Economic factors were fundamental drivers of housing decisions. Households with a high income (whether from labor or non-labor income) tended to be owner-occupiers and to increase their demanded housing units. The estimated conditional elasticity indicates that the demand for housing responds inelastically to changes in prices.

With regard to labor decisions, we found a strong influence of the characteristics of women on the decision to participate in the labor market. In terms of the labor supply, we found that the number of hours worked by a spouse negatively affected the other spouse's labor supply, indicating that when one spouse increases their working day, the other spouse decreases their working day.

We also found that if a household changes their housing tenure from being tenants to becoming owner-occupiers, the participation of women in the labor market increases significantly, and that owner-occupiers with two wage earners will demand more housing units.

Our analysis of the effects of changes on the tenure choice and on the woman's decision to participate in the labor market for the reference households revealed that the trend towards ownership increases with the presence of children, probably due to the sense of stability provided by ownership, which is something that all families with children aim to achieve. On the other hand, we found that as the wife's education level increased, the likelihood that she would enter the labor market increased greatly. If we take into account the family composition, we found a significant increase in the probability that the woman would not participate in the labor market if the family grows (in size and age), which confirms that in Spain, the main role of many women is still to be in charge of the house.

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Appendix 1: Sample selection variables from the bivariate probit model

The expressions for the λ terms calculated from the bivariate probit (determined from the user manual and the help file of LIMDEP) associated with each alternative scenario are as follows:

for the sample with two wage earners

$$\lambda_{\mathrm{T}} = \frac{\phi\left(\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}\right)\Phi\left(\frac{\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}-\hat{\rho}\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}}{\sqrt{1-\hat{\rho}^2}}\right)}{\Phi_{\mathrm{b}}\left(\frac{\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}-\hat{\rho}\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}}{\sqrt{1-\hat{\rho}^2}}, \frac{\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}-\hat{\rho}\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}}{\sqrt{1-\hat{\rho}^2}} / \hat{\rho}\right)}$$

$$\lambda_{\mathrm{P}} = \frac{\phi\left(\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}\right)\Phi\left(\frac{\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}-\hat{\rho}\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}}{\sqrt{1-\hat{\rho}^2}}\right)}{\Phi_{\mathrm{b}}\left(\frac{\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}-\hat{\rho}\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}}{\sqrt{1-\hat{\rho}^2}}, \frac{\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}-\hat{\rho}\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}}{\sqrt{1-\hat{\rho}^2}} / \hat{\rho}\right)}$$

for the sample with one wage earner

$$\lambda_{\mathrm{T}} = \frac{\phi\left(\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}\right)\Phi\left(\frac{\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}-\hat{\rho}\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}}{\sqrt{1-\hat{\rho}^2}}\right)}{\Phi_{\mathrm{b}}\left(\frac{-\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}-\hat{\rho}\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}}{\sqrt{1-\hat{\rho}^2}}, \frac{\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}-\hat{\rho}\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}}{\sqrt{1-\hat{\rho}^2}} / -\hat{\rho}\right)}$$

$$\lambda_{\mathrm{P}} = \frac{\phi\left(\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}\right)\Phi\left(\frac{\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}-\hat{\rho}\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}}{\sqrt{1-\hat{\rho}^2}}\right)}{\Phi_{\mathrm{b}}\left(\frac{-\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}-\hat{\rho}\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}}{\sqrt{1-\hat{\rho}^2}}, \frac{\mathbf{Z}'_{\mathrm{T}}\hat{\delta}_{\mathrm{T}}-\hat{\rho}\mathbf{Z}'_{\mathrm{P}}\hat{\delta}_{\mathrm{P}}}{\sqrt{1-\hat{\rho}^2}} / -\hat{\rho}\right)}$$

In these expressions, ϕ and Φ are the density function and the cumulative probability function with a normal distribution, and Φ_{b} refers to the bivariate normal distribution; $\hat{\delta}_{\mathrm{T}}$ and $\hat{\delta}_{\mathrm{P}}$ are the estimated coefficients of bivariate probit model, defined by equations (1) and (2); and $\hat{\rho}$ is the estimated correlation coefficient between the random terms of these equations.

Appendix 2: Estimation of hedonic housing prices

Following the approach of Goodman (2002) and Barrios and Rodríguez (2007), we obtained the regional housing prices by estimating the following hedonic price equations for each of the 17 Spanish regions (Comunidades Autónomas in Spain):

$$\ln p_{\mathrm{O}i} = \boldsymbol{\delta}'_{\mathrm{O}}\mathbf{X}_{\mathrm{O}i} + u_{\mathrm{O}i} \quad \text{for owner} - \text{occupiers} \quad i = 1, \ldots, n_{\mathrm{O}} \tag{8}$$

$$\ln p_{\mathrm{R}j} = \boldsymbol{\delta}'_{\mathrm{R}}\mathbf{X}_{\mathrm{R}j} + u_{\mathrm{R}j} \quad \text{for tenants} \quad j = 1, \ldots, n_R \tag{9}$$

where $p_{\mathrm{O}i}$ and $p_{\mathrm{R}j}$ are the monthly imputed rent self-reported by owner-occupiers and the current rent paid by tenants, respectively; $\mathbf{X}_{\mathrm{O}i}$ and $\mathbf{X}_{\mathrm{R}j}$ are vectors for the characteristics of housing and the environment for owner-occupiers and renters, respectively; $u_{\mathrm{O}i}$ and $u_{\mathrm{R}j}$ are the corresponding random disturbances; and n_{O} and n_{R} are the number of owner-occupiers and renters, respectively.

To calculate the regional housing prices, we defined a standard dwelling based on the average of the explanatory variables using the total sample. Table 10 defines the explanatory variables, their descriptive statistics, and the standard dwelling resulting from these values. For each Spanish region, we calculated the purchase housing

Table 10 Descriptive statistics of housing characteristics

Housing characteristics	Mean	SD	Standard dwelling
Building type: Building is single-family = 1; multi-family = 0	0.3860	0.4868	0
Years: years in the dwelling	14.10	7.66	14
Rooms: Total number of rooms (without kitchen)	4.30	1.15	4
Rooms2: Squared of rooms	19.81	11.58	16
Heating: If there is a heating system = 1; if not = 0	0.4550	0.4980	0
Garden: If there is a garden or terrace = 1; if not = 0	0.7484	0.4339	1
Noise: If there is noise = 1; if not = 0	0.2429	0.4288	0
Wetlands: If there is wetlands = 1; if not = 0	0.1275	0.3336	0
Delinquency: If there is delinquency in the neighborhood = 1; if not = 0	0.1129	0.3164	0
Contamination: If there is contamination in the neighborhood = 1; if not = 0	0.0819	0.2742	0
Light: If the house has problems of daylight = 1; if not = 0	0.1062	0.3081	0
Size1: If household resides in a town with less than 10,000 inhabitants = 1; if not = 0	0.2503	0.4332	0
Size2: If the household resides in a town between 10,001 and 50,000 inhabitants = 1, if not = 0	0.2207	0.4147	0
Size3: If household resides in a town with more than 50,001 inhabitants, but not a provincial capital = 1; if not = 0	0.1535	0.3605	0
Size4: Provincial capital (central cities)	0.3755	0.4843	1

Table 11 Hedonic price indices by regions within Spain (in logarithm)

Variables	Owning	Renting
Andalucía	13.3834	11.9168
Aragón	13.2818	12.2293
Asturias	13.1309	12.1391
Baleares	13.4816	12.7930
Canarias	13.5490	11.6546
Cantabria	13.5739	12.7891
Castilla_León	13.0822	12.0479
Castilla Mancha	13.3082	12.5617
Cataluña	13.5847	12.9743
Comunidad Valenciana	13.3150	12.3461
Extremadura	13.3081	11.5468
Galicia	13.2261	12.6311
Madrid	13.7070	12.4037
Murcia	13.3999	12.1139
Navarra	13.5075	13.2356
País Vasco	13.6410	13.0843
La Rioja	13.3924	12.5309

price and the rental housing price for this standard dwelling according to the corresponding estimated Eqs. (8) and (9), respectively. Table 11 summarizes these regional housing prices.

Appendix 3: Estimation of hourly wages

In this study, we defined the hourly wage as the ratio of the monthly income that the individual received from work to the monthly hours worked. The ECPH offers the "current monthly labor income" variable and the "hours worked during the last week" variable. Thus, we constructed the monthly hours worked as the product of the weekly hours worked and the number of weeks in a month. Given this approach, the "hourly wage" variable may be endogenous to the decisions related to the labor supply.

To solve this problem of endogeneity, we estimated the hourly wage of an individual as a function of their observable characteristics following the method of

Table 12 Estimates of participation and the hourly wage equations for men

Variable	Men's participation		Variable	Hourly wage	
	Coefficient	*t*-statistic		Coefficient	*t*-statistic
Constant	1.9410	−3.080**	*Constant*	0.6404	6.199**
Age	0.0725	2.496*	*Age*	0.0443	9.340**
Age2	−0.0009	−2.888**	*Age2*	−0.0004	−7.837**
Secondary	0.2593	2.646**	*Secondary*	0.2405	17.277**
University	0.4958	4.683**	*University*	0.5237	33.917**
Couple1	0.2829	2.654**	*Sector*	0.0837	6.197**
Couple2	0.0217	0.218	*Size1*	−0.0846	−5.574**
Care	−0.3941	−4.188**	*Size2*	−0.0674	−4.712**
Wage_W	−0.4687	−11.769**	*Size3*	−0.0132	−0.847
Inc_nolabor	−0.2087	−12.604**	*North-west*	0.0145	0.544
Size1	−0.0544	−0.581	*North-east*	0.1781	6.851**
Size2	−0.0219	−0.245	*Center*	−0.0028	−0.108
Size3	0.1452	1.360	*East*	0.1526	6.154**
North-west	−0.0970	−0.638	*South*	0.0019	0.077
North-east	0.2529	1.587	*Madrid*	0.1400	4.876**
Center	0.3155	1.950	λ	0.0001	0.001
East	0.0701	0.482			
South	−0.0593	−0.394			
Madrid	0.2554	1.359			
Sample size	6,072		*Sample size*	4,436	

Standard errors in hourly wage equation are corrected for selection

** Significant at 1 %; * significant at 5 %

Fernández-Val (2003). We performed this estimation separately for men and women. We considered all individuals who were members of a couple and who were of working age (i.e., younger than 65 years based on the Spanish definition). The estimation procedure followed is the Heckman's two-stage procedure (Heckman 1979), which corrects for the selection bias associated with the participation of the individual in the labor market.

In the regression used to calculate wages (second stage of the procedure), the dependent variable was the log-transformed hourly wage and the explanatory variables considered were the age and the educational level attained by the individual and whether they were employed in the public sector (sector = 1) or the private sector (sector = 0), and a series of dummy variables that represented the size of the town and the region in which the individual resides to account for regional economic inequalities. The estimates of participation and hourly wage for men and women using this approach are summarized in Tables 12 and 13. We estimated these wages for individuals who were working as employees, rather than for self-employed individuals, as is the usual practice in the labor market literature.

Table 13 Estimates of participation and the hourly wage equations for women

Variable	Women's participation		Variable	Hourly wage	
	Coefficient	*t*-statistic		Coefficient	*t*-statistic
Constant	−1.0473	−3.237**	*Constant*	0.1889	0.990
Age	0.0771	4.854**	*Age*	0.0467	5.200**
Age2	−0.0012	−6.207**	*Age2*	−0.0006	−5.259**
Secondary	0.4363	9.451**	*Secondary*	0.3392	10.706**
University	1.1630	22.047**	*University*	0.7863	16.206**
Couple1	−0.2458	−3.915**	*Sector*	0.2926	12.878**
Couple2	−0.2762	−4.847**	*Size1*	−0.1068	−3.711**
Care	−0.2637	−5.612**	*Size2*	−0.0398	−1.523
Wage_M	−0.1775	−9.342**	*Size3*	−0.0162	−0.537
Inc_nolabor	0.0384	4.679**	*North-west*	−0.1422	−2.862**
Size1	−0.1464	−3.083**	*North-east*	0.0344	0.723
Size2	−0.0587	−1.274	*Center*	−0.1359	−2.777**
Size3	−0.1747	−3.365**	*East*	0.0769	1.680
North-west	0.1272	1.493	*South*	−0.1416	−2.948**
North-east	0.0854	1.017	*Madrid*	0.0272	0.519
Center	−0.1484	−1.775	λ	0.3756	5.926**
East	0.2451	3.052**			
South	−0.1493	−1.818			
Madrid	0.0751	0.788			
Sample size	6,080		*Sample size*	2,304	

Standard errors in hourly wage equation are corrected for selection

** Significant at 1 %; * significant at 5 %

Table 14 Marginal effects for conditionated probabilities (provided by LIMDEP 8.0)

Variables	P(tenure/participation = 1)		P(tenure/participation = 0)		P(participation/tenure = 1)		P(participation/tenure = 0)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Age_M	−0.0028	−0.714	−0.0035	−0.714	0.0269	4.022	0.0006	0.695
Age2_M	0.0001	0.431	0.0001	0.431	−0.0004	−5.488	−0.0001	−0.426
Age_W	0.0124	3.058	0.0153	3.112	0.0002	0.693	0.0238	3.618
Age2_W	−0.0001	−1.941	−0.0001	−1.982	−0.0001	−0.425	−0.0004	−5.146
Secondary_M	0.0151	1.907	0.0186	1.894	−0.0010	−1.551	−0.0034	−1.526
University_M	−0.0077	−0.659	−0.0094	−0.663	0.0005	0.657	0.0016	0.672
Secondary_W	0.0022	0.249	0.0030	0.277	0.1596	8.238	0.1554	7.967
University_W	0.0007	0.059	0.0001	0.006	0.3999	21.162	0.4064	19.618
Couple1	0.0254	2.934	0.0307	2.861	−0.1032	−4.169	−0.1018	−4.326
Couple2	0.0142	1.366	0.0169	1.314	−0.1179	−5.210	−0.1139	−5.312
Care_W	0.0198	2.714	0.0020	2.394	−0.0958	−5.101	−0.0917	−5.061
Income[a]	0.0317	4.753	0.0388	5.188	−0.0021	−2.757	−0.0067	−2.863
Inc_nolabor	−0.0001	−1.439	−0.0001	−1.384	0.0055	1.627	0.0052	1.628
Wage_M	−0.0017	−1.726	−0.0017	−1.636	0.0808	2.057	0.0773	2.055
Oprice	−0.0516	−2.609	−0.0631	−2.630	0.0034	1.961	0.0109	2.002
Rprice	0.0096	1.196	0.0117	1.202	−0.0006	−1.123	−0.0020	−1.132
Size1	0.0459	6.562	0.0569	6.704	−0.0257	−1.296	−0.0328	−1.728
Size2	0.0348	5.011	0.0431	5.018	−0.0052	−0.276	−0.0111	−0.600
Size3	0.0227	3.040	0.0278	2.957	−0.0620	−2.973	−0.0622	−3.181
North-west	−0.0007	−0.913	−0.0007	−0.884	0.0323	0.932	0.0311	0.926
North-east	−0.0001	−0.117	−0.0001	−0.117	0.0410	0.117	0.0039	0.117
Center	0.0012	1.485	0.0012	1.454	−0.0584	−1.754	−0.0553	−1.772
East	−0.0014	−1.802	−0.0015	−1.669	0.0700	2.090	0.0675	2.067

Table 14 continued

Variables	P(tenure/participation = 1)		P(tenure/participation = 0)		P(participation/tenure = 1)		P(participation/tenure = 0)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
South	0.0017	1.864	0.0017	1.784	−0.0810	−2.497	−0.0765	−2.535
Madrid	−0.0001	−0.016	−0.0001	−0.016	0.0006	0.016	0.0006	0.016

Most of the independent variables were statistically significant and produced the expected results in both wage equations. The variable that accounted for the selection bias due to participation or not in the labor market, λ, was significant for women but not for men.

From these estimated wage coefficients, we calculated the potential hourly wage associated with each individual according to their characteristics, both for individuals who work as employed and for self-employed individuals.

Appendix 4: Marginal effects of bivariate probit model

Although the marginal effects of the bivariate probit model can be calculated at different levels (Greene 1996; Christofides et al. 1997), we agree with Greene (1996) that a natural step is to consider the marginal effects of the covariates on conditional probabilities. Table 14 shows these conditional marginal effects.

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