Estimation and Testing of Household Labour Supply Models: Evidence from Spain

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Abstract

This paper provides an empirical contribution to the current debate about the suitability of the collective model proposed by Chiappori (1988, 1992) for analysing intrahousehold behaviour in the labour supply context. We follow Chiappori et al.(2002) and we extend the model considering differences in the education level between the two members of the couple as a potential distribution factor. Moreover, we propose a particular parametric specification for the labour supply system in order to derive the restrictions imposed by the collective setting on observed household behaviour. The empirical results show that neither the unitary model nor the collective one fits the Spanish household labour supply data.

Keywords: Household behaviour, labour supply, collective model, unitary model.

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1 *Introduction*

The choice of a framework for modelling household behaviour has become an important topic in Family Economics. This question is of interest because it shapes our understanding of the household decision variables (i.e, consumption, labour supply, household production, fertility, savings and portfolio choices) when analysing policy evaluation issues. It is accepted that such a framework must satisfy a set of requirements, namely, that (i) it embeds a structural model based on a realistic notion of a family, (ii) it is testable, and (iii) it is integrable (i.e, the structural model can be recovered uniquely from observed individual behaviour).

Traditionally, the standard consumer theory model, the so-called *unitary model*, has been used to deal with the analysis of household behaviour assuming that the family as a whole is the basic decision-making unit. Although this setting seems to be very convenient from a technical point of view, its use in the family context has been strongly criticized in the last two decades by several authors (Manser and Brown (1980), Apps and Rees (1988), Chiappori (1992), Bourguignon and Chiappori (1992), Browning and Chiappori (1998)). The main criticisms are basically two. First, it has been argued that treating the family as the representative agent violates the most elementary principle of modern microeconomic theory: the *individualism principle,* which states that each individual must be characterized by her own preferences. Second, since the unitary model considers the family as a whole, it does not allow to raise any intrahousehold related issues that might have a significant effect on each member's welfare. As a consequence of this drawback, this framework turns out to be very restrictive for performing positive and normative analysis at intrahousehold level. To overcome this limitation, various multiperson household models have been proposed in the literature. These models are all based on game theory concepts since they consider that household behaviour is the result of an interaction process among family members. However, they differ in how they model the interaction process.

In particular, we can distinguish between models that consider the interaction as a noncooperative game and those that model it using a cooperative approach. The former (Ashworth and Ulph (1981), Browning (2000)) use the standard concept of Nash equilibrium in noncooperative games and therefore assume that each household member behaves as if she were maximizing her own utility function taking the others' behaviour as given. Because the Nash equilibrium does not need to be Pareto efficient in a noncooperative context, these models do not provide the most adequate scenario for analysing family behaviour. The argument for this criticism is that Pareto efficiency appears to be a very natural property for household decisions since they are made in a context where everything is common knowledge. In this situation, it does not seem reasonable to admit the existence of feasible opportunities for improvement that have not been exploited by the members of the family. By contrast, in cooperative models, household behaviour is assumed to be the outcome of a cooperative game among the family's decision-making members. Since at least under symmetric information the outcome of these kinds of games is Pareto efficient, they provide a more suitable framework for intrahousehold analysis.

In the cooperative context, two different kinds of structural models have been proposed. On the one hand, some authors (Manser and Brown (1980), McElroy and Horney (1981)) have considered a bargaining model in which individuals, given their relative bargaining power in the family, have to reach a Pareto efficient allocation of the gains obtained from the fact of living together. In this framework, various bargaining equilibrium concepts (Nash, dictatorial, Kalai-Smorodinski) have been applied, imposing a very particular and specific structure on observed family behaviour. This gives rise to an important limitation of this model in performing empirical analysis since if the data reject the restrictions imposed on individuals' actions, it will not be possible to disentangle whether it is the specific equilibrium or the model in general that causes this rejection. On the other hand, there is an alternative approach, the so-called collective model, that was developed by Chiappori in his seminal work in 1988 and extended by several studies to analyse both consumption and labour supply behaviour.

In the collective setting, the family is considered as a group of individuals characterized by their own preferences that interact between each other when making their decisions through a certain exogenous and unobservable decision process that yields to a Pareto efficient outcome. Therefore, since the most general version of the collective model is only based on the assumption of Pareto efficiency and does not impose any additional structure on the interaction process, it provides a very attractive setting for raising questions related to what may happen within a household (intrahousehold allocation of resources, intrahousehold consumption inequality, the distribution of decision power, family formation and dissolution, etc). However, technically, the collective model is not so simple to deal with. In particular, Chiappori (1988, 1992) shows that additional assumptions have to be imposed on the nature of goods and on individual preferences for the model to satisfy the testability and integrability requirements. In this direction, various authors (Chiappori (1988, 1992), Bourguignon et al. (1995), Browning and Chiappori (1998), Chiappori and Ekeland (2002), Chiappori et al. (2002)) propose different approaches that allow the different versions of the collective model to fulfil these two requirements.

In the empirical context, several authors (Bourguignon et al. (1993), Browning et al. (1994), Fortin and Lacroix (1997), Browning and Chiappori (1998), Chiappori et al. (2002), Fernández-Val (2003)) have found evidence in favor of the collective model. Nevertheless, the choice of a framework for modelling household behaviour is still an open question and more empirical work is required to confirm that evidence. Moreover, most of these papers are focused on testing Chiappori's model in either consumption or labour supply settings, but the approach still needs to be extended to other areas of household behaviour -such as fertility, savings and portfolio choices- which to the best of our knowledge have not been explored yet. Hence, the present analysis stems from the need for a better comprehension of the validity of Chiappori's model to fit household behaviour data. In this sense, our goal is to provide an empirical contribution to this important debate in the labour supply context using Spanish data. Specifically, we adopt a parametric approach to estimate a household labour supply system and to test the restrictions on observed behaviour derived from the collective model. We use Spanish data from the European Community Household Panel (ECHP) for the period from 1994 to 1999.

For Spain, empirical evidence on the collective model is rather scarce. For consumption, Zamora (2002a) uses the collective model to estimate the intrahousehold distribution of private family expenditure for two kinds of couples: couples in which the wife does not work and couples in which the wife does work. Related to this, Zamora (2002b) also uses a collective framework to analyse the impact of female labour-force participation on the woman's bargaining power within the couple and, therefore, on the consumption of a set of goods. In both studies she uses data drawn from the Spanish Consumer Expenditure Survey (EPF) for 1990/91. Regarding labour supply decisions, Fernández-Val (2003) follows Fortin and Lacroix (1997) and estimates a household labour supply model using the ECHP for the period from 1994 to 1997. He tests the parametric restrictions derived from both the unitary and the collective settings, and finds empirical evidence in favor of the latter. Although our purpose is also to test the collective model's restrictions in a parametric context using the ECHP, the present analysis differs from that of Fernández-Val (2003) in its identification assumptions, parametric specification and estimation methodology.

In particular, in order to meet the identification and testability requirement of the collective model in a simple and robust way, we follow Chiappori et al. (2002) and consider the existence of the so-called *distribution factors*. These are variables that have an influence on family behaviour through their effect on the intrahousehold decision process but do not affect either individual preferences or the household budget constraint. Some examples that have been proposed in the literature are the sex ratio in the population, several features of the divorce laws (Chiappori et al. (2002)) and differences in incomes and ages between partners (Bourguignon et al. (1994)). In this sense, we use differences in the education level between husband and wife as a potential distribution factor. We find that this variable significantly affects each individual's labour supply decisions according to the collective model interpretation. However, our results show that Chiappori's model does not fit the Spanish data on household labour supply. This contradicts the empirical findings in Fernández-Val (2003).

The structure of the paper is as follows. In section 2, the unitary and collective theoretical models are formally developed in order to facilitate the comprehension of Chiappori's contributions. In the collective setting, we pay special attention to the assumptions that are considered to get identification of the structural model and to derive testable restrictions. In section 3 we present the parametric specification of the labour supply system proposed by Chiappori et al. (2002) and we derive the restrictions from the collective model. Section 4 contains the empirical analysis and reports the estimation results, which show that this parametric specification does not fit our data. Hence, in section 5, we propose an alternative parametric model that additionally allows us to test the unitary model. Next, each model's parametric restrictions are derived. Section 6 presents the estimation results for the unrestricted labour supply system under the new specification. Section 7 reports the tests of the restrictions derived from both the unitary and the collective models. Section 8 concludes.

2 *Theoretical Models*

This section presents the theoretical context that characterizes the family situation we are interested in. We consider a family comprising two decision-making members of working age, individual preferences are defined over consumption and labour supply[1] and there is a unique private consumption good in the economy taken as numeraire. No questions related to public consumption (children, rent or other housing expenditures), household production or participation decisions of individuals are raised in this setting.[2] Even though the importance of such issues is undoubted, we restrict our attention to the simplest version of the collective labour supply model since we focus on individuals' labour supply behaviour. Before developing such a model, we present the unitary model.

2.1 *The Unitary Model*

As we pointed out earlier, the standard consumer theory model has traditionally been applied for analysing family behaviour. In this framework, the family is treated as the basic decision unit even in the case of multiperson households. Hence, household preferences are represented by a unique, well-behaved utility function, U, that, according to our general assumptions, depends positively on household consumption, c,[3] and negatively on each individual's labour supply, h^i, $i = m, f$, where m denotes the husband and f refers to the wife. Therefore, family behaviour is the result of the following maximization problem:

[1] Household production is not considered since no data are available for the case of Spain.

[2] Based on the seminal work by Chiappori (1988, 1992), several extensions have been raised in recent years analysing important aspects related to household labor supply decisions. Chiappori et al.(2001), Fong and Zhang (2001) and Chiappori and Ekeland (2002) deal with collective labor supply models that include public consumption goods. Apps and Rees (1996), Chiappori (1997), Blundell et al.(2000) and Aronsson et al.(2001) extend the model to consider household production. Donni (2000, 2001) and Blundell et al.(2002) consider nonparticipation decisions and allow for non-convex budget sets. Finally, Mazzoco (2001) deals with intertemporal considerations in the collective context.

[3] Since most of the microdata surveys do not provide information on individual consumption and all members of the household face the same price of the unique private consumption good, we can apply Hicks' composite good theorem and assume that household's utility function depends on aggregate consumption and both individual's labor supplies.

$$\underset{\{c,h^m,h^f\}}{Max} \; U{=}U(c, h^m, h^f)$$

$$s.t \qquad w_m h^m{+}w_f h^f{+}y \geq c \tag{P1}$$

where w_i, $i = m, f$, and y are exogenous variables that represent wages and household nonlabour income, respectively. The price of the private consumption good is normalized to one since it is taken as the numeraire.

Let $h^m(w_m, w_f, y)$ and $h^f(w_m, w_f, y)$ represent the system of labour supply functions -the Marshallian labour supplies-. For both functions to be the interior solutions[4] of (P1) they have to satisfy the standard restrictions of *symmetry* and *positive definiteness* of the Slutsky matrix given by the following expressions:

Symmetry restriction:

$$s_{mf} = s_{fm} \tag{1}$$

Positive semidefiniteness:

$$s_{ii} \geq 0, \quad i = m, f \tag{2a}$$

$$s_{mm}s_{ff} - s_{mf}^2 \geq 0 \tag{2b}$$

where $s_{ij} = \frac{\partial h^i}{\partial w_j} - h^j \frac{\partial h^i}{\partial y}$, $i, j = m, f$, is the compensated substitution effect of the labour supply of member i with respect to the wage of member j.

Apart from this set of restrictions, the unitary model imposes the so-called *Income Pooling Hypothesis*. This condition states that the source of nonlabour income plays no role in the household allocation problem. If we define y_m, y_f as husband's and wife's nonlabour income, respectively, such that $y_m + y_f = y$, this hypothesis will be given by the following set of equations:

$$\frac{\partial h^i}{\partial y_j} = \frac{\partial h^i}{\partial y_i} = \frac{\partial h^i}{\partial y}, \quad i, j = m, f \tag{3}$$

which means that y_m and y_f have the same effect on each individual's labour supply.

[4]Since nonparticipation decisions are excluded from the scope of this analysis, we focus on interior solutions.

The *Income Pooling Hypothesis* has been strongly questioned in this literature since several studies have found empirical evidence against it (Altonji et al. (1989), Bourguignon et al. (1993), Fortin and Lacroix (1997), Fernández-Val (2003)). Nevertheless, we assume implicitly that this hypothesis is generally satisfied by the observed household behaviour and, therefore, we consider the household nonlabour income as a whole in the present analysis. We proceed in this way for two reasons. First, conceptually, it seems reasonable to think that individuals' nonlabour incomes are pooled within the household, specially if the couple has living together for several years. Moreover, we are really sceptical about the idea that the source of nonlabour income could be identified after several years of cohabitation in a family. Hence, the Income Pooling Hypothesis seems to be a realistic assumption to impose on intrahousehold behaviour.[5] Second, regarding the empirical analysis, the distinction between each member's nonlabour income reported by some data surveys could turn out to be artificial or fictitious since it may be influenced or distorted by fiscal incentives. As a result, this information might not reflect the real economic situation of the family concerning nonlabour income and, therefore, might not be suitable for testing the Income Pooling Hypothesis. These two points lead us to suggest that the distinction between each individual's nonlabour income should not be considered in the analysis of intrahousehold behaviour.

2.2 *The Collective Model*

The collective model was developed by Chiappori in his seminal work in 1988 to overcome the drawbacks of the unitary model. In addition, since the collective model relies on very general assumptions, it overcomes the empirical limitations of the multiperson-bargaining contexts that impose a very particular and restrictive structure on family choices. There are two basic assumptions that characterize household behaviour in the collective setting. First, the individual is the basic decision unit and is represented by her own preferences. Second, collective decisions lead to a Pareto efficient equilibrium. Therefore, the collective model describes the family as a group of two individuals with potentially different ratio-

[5] Aronsson et al.(2001) show that the income pooling hypothesis can not be rejected for Swedish data from 1984 and 1993.

nal preferences.[6] These individuals interact with each other when making their decisions through a certain exogenous and unobservable decision process that yields a Pareto efficient outcome. Hence, the family's behaviour is represented by the following maximization problem:

$$\underset{\{c^m,c^f,h^m,h^f\}}{Max} W = \mu U^m + (1-\mu)U^f$$

$$s.t \quad w_m h^m + w_f h^f + y \geq c^m + c^f \tag{P2}$$

where U^m and U^f are the individual's utility functions and μ is a weighting factor. In the most general version of the collective model, individual preferences are assumed to be altruistic. Altruism implies that each member of the couple not only cares about her own decision variables but also about those of her partner, which seems a very natural situation in the family context. Therefore, each member's preferences are represented by a utility function, $U^i = U^i(c^m, c^f, h^m, h^f)$, $i = m, f$, that is well-behaved in all its arguments. The weight component, μ, represents the importance of each member of the couple in the intrahousehold decision process. Under the collective setting, μ is a function of all the variables that affect each member's bargaining power -wages, household nonlabour income and the vector of the so-called distribution factors, s- and it is assumed to be continuously differentiable in all its arguments, $\mu(w_m, w_f, y, s) \in [0,1]$. Therefore, w_m, w_f, y and s will determine the final location of the solution on the Pareto frontier through their influence on the collective decision process. The term *distribution factor* is used in this literature (Browning and Chiappori (1998), Chiappori et al. (2002)) to denote variables that have an influence on family behaviour through their effect on the intrahousehold decision process but that do not affect either individual's preferences or the household budget constraint.[7] As we will discuss later, the role of such variables turns out to be crucial for the identification of the structural model and the possibility of deriving testable restrictions in the present context.

[6] Notice that in this analysis we only consider the existence of two decision makers in the family: the husband and the wife. Chiappori and Ekeland (2002) extend the collective model to the case in which the family is composed of a larger set of decision-making individuals. They analyse the conditions under which it is possible to get identification of this model.

[7] This concept is due to McElroy (1990), who used the term *Extra-Environmetal parameter*, EEP

Since this setting does not impose any additional assumption on the intrahousehold decision process, it provides a very natural framework for analysing family behaviour. However, its main limitation comes from the fact that the structural model is not uniquely identified under this general approach. Moreover, testable restrictions cannot be derived in a parametric context unless there are at least two distribution factors (see Bourguignon et al. (1995), Chiappori et al. (2002)). Therefore, in order to get identification of the structural model, additional assumptions are required. In particular, Chiappori (1988) assumes that individual preferences are either egoistic or caring à la Becker. If members are egoistic, they only care about their own decision variables and, therefore, $U^i = U^i(c^i, h^i)$, $i = m, f$. If preferences are caring à la Becker, each member not only cares about her own decision variables but also about her partner's welfare and, as a result, her utility will have the following form: $W^i = W^i(c^i, h^i, \widetilde{U}^j(c^j, h^j))$, $i, j = m, f$; $i \neq j$. Although assuming that preferences are caring a la Becker seems more realistic in the family context, we consider egoistic preferences in order to simplify the notation since the same results concerning the testability and integrability requirements hold under both kinds of preferences (see Chiappori (1988), (1992)).

Under this separability assumption on individuals' preferences, Chiappori (1992) shows that Pareto efficiency implies that the intrahousehold collective process can be interpreted as a two-stage process. In the first stage, both members of the couple share the household nonlabour income according to an exogenous and unobservable sharing rule that reflects each individual's bargaining power in the household. Specifically, that sharing rule is characterized by a function $\phi(w_m, w_f, y, s)$ that depends on wages, the household nonlabour income and the vector of distribution factors and represents the fraction of the nonlabour income that goes to the husband. In the second stage, once the total nonlabour income has been allocated between the individuals, each member solves her own maximization problem:

$$\underset{\{c^i, h^i\}}{Max} \;\; U^i(c^i, h^i)$$

$$s.t \qquad w_i h^i + \phi^i \geq c^i \tag{P3}$$

where $i = m, f$, $\phi^m = \phi$, and $\phi^f = y - \phi$. This interpretation relies on the Second Fundamental Welfare Theorem that states that, in the absence of externalities, any Pareto efficient allocation can be reached through a competitive equilibrium given an appropriate wealth distribution (represented by the sharing rule). Formally, Chiappori (1992) shows that, under the assumption of egoistic preferences, the sharing rule function $\phi(w_m, w_f, y, s)$ exists and the maximization problems (P2) and (P3) are equivalent. As a result, for interior solutions, labour supply functions are given by the following expressions:

$$h^m(w_m, w_f, y, s) = h^{m^*}(w_m, \phi(w_m, w_f, y, s)) \tag{4a}$$

$$h^f(w_m, w_f, y, s) = h^{f^*}(w_f, y - \phi(w_m, w_f, y, s)) \tag{4b}$$

where $h^{i^*}, i = m, f$, are the Marshallian labour supply functions that correspond to the second stage of the problem.

Under this framework, Chiappori et al. (2002) show that it is possible to derive testable restrictions on observed individuals' labour supply behaviour and to recover the sharing rule function up to an additive constant from the system (4a)-(4b). Even without distribution factors, Chiappori (1988, 1992) shows that, under the assumption of egoistic preferences, the model is identified and the testability requirement is satisfied. Furthermore, it is possible to solve the *integrability problem,* recovering the individual's utility functions and the sharing rule up to an additive constant from such observed behaviour. However, since these identification and testability results are based on second and third-order partial derivatives of the individual's labor supplies, respectively, it might not be possible to derive such restrictions for certain parametric specifications of the model. In this direction, Chiappori et al. (2002) extend the household labor supply model by allowing for distribution factors. They show that the incorporation of such variables provides a simpler and more robust method of obtaining identification and deriving testable restrictions relying on first and second-order partial derivatives of the individuals' labour supplies[8], respectively. In addition to this, it is important to point out that only one distribution factor is needed for this testability and integrability result to hold under egoistic preferences.

In our analysis, we only consider one distribution factor. In particular, we claim that the intrahousehold decision process depends on the differences in the education level be-

[8]See Browning and Chiappori (1998) and Chiappori and Ekeland (2002) for a further review of identification for different versions of the collective model.

tween the members of the couple. Although the education level of each individual may affect her own preferences, her spouse's education level does not. Thus, it is possible to treat the differences in education as a variable that affects both members' labor supply behaviour through the sharing rule but without influencing either individual preferences or the household budget constraint. A deeper explanation of the definition and the interpretation of this variable is provided in the empirical part of the analysis. Since we focus on a similar setting to that of Chiappori et al.(2002) -they consider the sex ratio and the divorce laws as distribution factors-, we follow their result, given in Proposition 1 (see Appendix A), in order to get identification and derive testable restrictions.

As Chiappori et al. (2002) state, the conditions in Proposition 1 are nonparametric since no assumptions have been imposed on the functional form of the utility functions. However, the estimation and testing of such conditions is much easier if it is performed in a parametric framework considering a particular functional form for the model. The next section presents a specific representation of the labour supply system that allows us to test the restrictions imposed by the collective setting on the observed labor supplies and to recover the underlying structural model if such restrictions are accepted.

3 *Parametric Specification*

Under the parametric approach, the choice of the particular functional form for the unrestricted labor supply system should be based on several criteria. First, it should display a certain degree of flexibility in the responses of labour supplies to changes in wages in order to provide a proper characterization of the data. Second, it should not impose the restrictions of the collective model, and these restrictions must be empirically testable. Third, it should be possible to recover a closed-form for the underlying structural model under the collective setting (both individuals' indirect utility functions and the sharing rule).

According to these requirements, as a first approximation to the problem we follow Chiappori et al. (2002) and use a semilogarithmic specification for the unrestricted labor supply system:

$$h^m = \alpha_0 + \alpha_1 \log w_m + \alpha_2 \log w_f + \alpha_3 \log w_m * \log w_f + \alpha_4 y + \alpha_5 s \tag{5a}$$

$$h^f = \beta_0 + \beta_1 \log w_m + \beta_2 \log w_f + \beta_3 \log w_m * \log w_f + \beta_4 y + \beta_5 s \tag{5b}$$

In order to derive the restrictions imposed by the collective model, we apply conditions (A1a)-(A1h) to the unrestricted parametric model (5a) and (5b). Under this framework, there is only one parametric restriction given by the following expression (see Chiappori et al. (2002) for further details):

$$\frac{\alpha_3}{\beta_3} = \frac{\alpha_5}{\beta_5} \tag{6}$$

It easy to check that this restriction comes from condition (A1f) while the rest of the conditions (A1a)-(A1h) are fulfilled trivially. As Proposition 1 states, if restriction (6) is empirically satisfied, the partial derivatives of the sharing rule can be identified and take the following form:

$$\phi_y = \frac{\alpha_4 \beta_3}{\Delta},$$

$$\phi_s = \frac{\alpha_5 \beta_3}{\Delta},$$

$$\phi_{w_m} = \frac{\alpha_3}{\Delta} \frac{\beta_1 + \beta_3 \log w_f}{w_m},$$

$$\phi_{w_f} = \frac{\beta_3}{\Delta} \frac{\alpha_2 + \alpha_3 \log w_m}{w_f}, \tag{7}$$

where $\Delta = \alpha_4 \beta_3 - \alpha_3 \beta_4$. Solving this system of partial differential equations, we obtain the following expression for the sharing rule:

$$\phi(w_m, w_f, y, s) = \frac{1}{\Delta}(\alpha_3 \beta_1 \log w_m + \alpha_2 \beta_3 \log w_f + \alpha_3 \beta_3 \log w_m \log w_f + \alpha_4 \beta_3 y + \alpha_5 \beta_3 s) + k \tag{8}$$

where k is a parameter that cannot be identified without additional assumptions and may depend on preference factors.

Moreover, following Stern (1986), we can integrate the system (4a) and (4b), assuming a semilogarithmic specification, and show that the individual's indirect utility functions are given by:

$$\upsilon^m(w_m, \phi) = \left[\frac{e^{aw_m}}{a}\right][a\phi + b\log(w_m) + c] - \left(\frac{b}{a}\right)\int_{-\infty}^{aw_m}\frac{e^t}{t}dt \tag{9a}$$

$$\upsilon^f(w_f, y-\phi) = \left[\frac{e^{dw_f}}{d}\right][d(y-\phi) + f\log(w_f) + g] - \left(\frac{f}{d}\right)\int_{-\infty}^{dw_f}\frac{e^t}{t}dt \tag{9b}$$

where the structural preferences parameters can be recovered as functions of the labour supply reduced-form parameters such that $a = \frac{\Delta}{\alpha_3}$, $b = \frac{(\alpha_1\beta_3 - \alpha_3\beta_1)}{\beta_3}$, $d = \frac{-\Delta}{\alpha_3}$, and $f = \frac{\alpha_3\beta_2 - \alpha_2\beta_3}{\alpha_3}$. The coefficients c and g are functions of preference factors and cannot be identified without additional assumptions.

Therefore, if the restrictions of the collective model are not rejected by our data, it is possible to obtain a characterization of the intrahousehold allocation process and the preferences of the individuals up to an additive constant. This characterization turns out to be a fundamental tool for family welfare analysis.

4 *Empirical Analysis*

In this section we provide the main insights concerning the main points of the empirical analysis: the data, the sample selection, the empirical model, the econometric problems that arise and the estimation methodology applied in the present analysis.

4.1 *Data and Sample Selection*

We use data from the European Community Household Panel (ECHP). This data set provides comparable statistical annual information about the labour status and welfare level of households in the EU-15 countries allowing their social and economic situation to be analysed. In particular, we select a sample of couples living in Spain for the period from 1994 to 1999. However, since income variables refer to the period prior to the interview and the remaining data refer to the current period, the last year is lost for the estimation. We do not exploit the panel structure of the data because we do not analyse intertemporal considerations.[9] Instead, we use the observations as a pooled cross-section ignoring the temporal dimension of the survey.[10] We select couples with both members aged less than 65, continuously working as employees throughout the year. We end up with a sample of 1879 couples on whom information about all the variables that we consider in the analysis is available.

4.2 *Empirical Model*

According to parametric specification (5a) and (5b), we consider the following empirical model:

$$h^m = \alpha_0 + \alpha_1 \log w_m + \alpha_2 \log w_f + \alpha_3 \log w_m * \log w_f + \alpha_4 y + \alpha_5 s + \alpha_6' z_m + \varepsilon_m \qquad (10a)$$

$$h^f = \beta_0 + \beta_1 \log w_m + \beta_2 \log w_f + \beta_3 \log w_m * \log w_f + \beta_4 y + \beta_5 s + \beta_6' z_f + \varepsilon_f \qquad (10b)$$

where z_i, $i = m, f$, is a vector of observable sociodemographic characteristics and $(\varepsilon_m, \varepsilon_f)'$ are the error terms that include individuals' unobservables and are allowed to be correlated.

The dependent variables are each member's weekly hours of work. With respect to the explanatory variables, hourly wage rates (w_m, w_f) are computed as the ratio of monthly earnings and the number of hours of work per month. Annual household nonlabour income (y) includes non-work private income (capital income, assigned property/rental income and private transfers received) and total social insurance receipts (old-age/survivors' benefits, family-related allowances, sickness/invalidity benefits, education-related allowances and any other personal benefits). All income variables have been deflacted by the annual mean of the Consumer Price Index (CPI) base 1992 and are expressed in euros. In addition to this, in order to control for observable individual heterogeneity we include in the labour supply of each member some sociodemographic characteristics such as age, age

[9] Furthermore, using the panel structure of the database would dramatically reduce the sample size to 165 observations in each year.

[10] We treat one household at different points in time as different observations. Since observations will not be serially independent, we control for autocorrelation in the estimation procedure.

squared, a set of dummies for the education level -$Educ1$ for primary schooling or without schooling, $Educ2$ for high school and $Educ3$ for graduate and postgraduate studies-[11] and two household fertility variables, the number of children less than 6 years old and the number of children between 6 and 18 years old.

As mentioned above, the distribution factor, s, that we consider in this analysis is given by a cathegorical variable that reflects the differences in education level between the members of the couple.[12] Specifically, it is defined as follows

$$s = \begin{cases} 1 & \text{if} \quad F = G \text{ and } M = P \\ 2 & '' \quad F = G \text{ and } M = H \\ 3 & '' \quad F = H \text{ and } M = P \\ 4 & '' \quad F, M = G \\ 5 & '' \quad F, M = H \\ 6 & '' \quad F, M = P \\ 7 & '' \quad F = H \text{ and } M = G \\ 8 & '' \quad F = P \text{ and } M = H \\ 9 & '' \quad F = P \text{ and } M = G \end{cases}$$

where F and M represent the highest level of education reached by the woman and the man, respectively. These variables can take three different values: G for graduate and postgraduate studies, H for high school or equivalent and P for primary schooling or no schooling. Therefore, with this particular definition of variable s,[13] we reflect not only that members' education levels may differ but also how big these differences are.[14] We claim s to be interpreted as a potential distribution factor since it seems realistic for the differences

[11] Since a constant term is included in the regression system, $Educ1$ is the default dummy.

[12] We have tried with additional variables that could be seen as potential distribution factors for Spanish couples: differences in ages, in potential unemployment spell before the first interview year and in the number of years in the current position. However, none of these were significant and they could not therefore be used as distribution factors.

[13] We must point out that the choice of a discrete variable as a distribution factor is not compatible with the requirement of continuously differentiability of the sharing rule with respect to all its arguments. The natural solution to this problem would be to use continuous information on education (i.e, number of years of schooling). Unfortunately, such information is not provided by our survey. Therefore, as Chiappori et al.(2002) states, the test of the collective restrictions is approximative.

[14] It could be argued that the order of the nine categories in s has been established in an *ad hoc* fashion. However, this order appears to be appropriate since equivalent predicted effects on individuals' labour

in education level between the members of the couple to affect the intrahousehold decision process by influencing each individual's relative bargaining power. Although the level of education is a preference factor, and therefore appears as an explanatory variable in each individual's labor supply equation, the spouse's level is not. As a result, the differences in education level can be seen as affecting the intrahousehold decision process but not individuals' preferences. Furthermore, in order for s to be a distribution factor, and given that it is increasing in the relative education level of the man, it must affect the man's labour supply negatively and the woman's labour supply positively. The interpretation is as follows: as s increases, the man's education level becomes higher relatively to his spouse's level. This implies a higher relative decision power for the man which allows him to get a larger share of the household nonlabour income. This will lead to a lower number of hours of work for the man as a result of a standard income effect assuming that leisure is a normal good. The influence of s on the woman's labor supply function will have the opposite sign following the same argument. In appendix B we present some descriptive statistics of the variables used in this analysis.

4.3 *Estimation Methodology and Empirical Results*

We start by pointing out some econometric problems that may arise in this analysis. First, wages are considered as endogenous variables since they are computed as the ratio of monthly earnings and monthly hours of work giving rise to the so-called "division bias". Moreover, potential measurement errors may arise in such reported variables and can be accumulated in the computation of hourly wage rates. In order to deal with this problem, we apply instrumental variables techniques for estimating the model. Specifically, following Fortin and Lacroix (1997) and Chiappori et al. (2002), we instrument wages using third-order polynomials in age, their interactions with the schooling dummies and, finally, the number of years the individual has been working at her current position (this variable is named *specific experience* by Fernández-Val (2003)). Even though there is no consensus in the literature about the exogeneity of household nonlabour income, children variables and experience, we treat them as exogenous given the empirical evidence for

supplies are obtained including the corresponding set of nine dummy variables in the regression system.

Spain in Fernández-Val (2003).[15]

Second, since we restrict our attention to the interior solutions of problem (P2) for both individuals' hours of work, to account for nonparticipation decisions and avoid sample selection biases we implement a two-stage Heckman correction methodology for each member. The estimation results for the Probit models are presented in Appendix C.

We estimate the system of equations (10a) and (10b) by the Generalized Method of Moments (GMM). We use the Optimal GMM estimator based on the two stage least squares residuals to account for heteroskedasticity and serial correlation in the error terms (see White (1982), Ogaki (1993), Chiappori et al. (2002), Arellano (2003)). This procedure guarantees desirable asymptotic properties, i.e, efficiency under heteroskedasticity and autocorrelation. Furthermore, distributional assumptions on the error terms are not needed.

The estimation results and the Sargan statistic for testing the overidentifying restrictions are presented in Table 1:

Table 1. Unconstrained Labor Supply Model

Semilogarithmic Specification. GMM Parameter Estimates					
	Men ($j=m$)	Women ($j=f$)		Men ($j=m$)	Women ($j=f$)
Constant	69.2**	41.45*	$Educ2_j$	2.15**	4.85**
	(6.08)	(7.04)		(0.73)	(1.53)
$\log(w_m)*\log(w_f)$	4.45*	11.87*	$Educ3_j$	2.07*	3.80
	(2.31)	(2.65)		(1.13)	(2.57)
$\log(w_m)$	-8.36**	-23.87*	$Children < 6$	0.25	-2.55**
	(3.85)	(4.36)		(0.34)	(0.68)
$\log(w_f)$	-11.64**	-14.62*	$Children618$	0.30	-1.39**
	(4.09)	(4.06)		(0.24)	(0.38)
y	0.74**	-0.22	s_{mf}	-0.53*	0.35
	(0.35)	(0.16)		(0.16)	(0.28)
Age_j	-2.89	10.96**	λ_j	-2.33	5.72**
	(2.83)	(3.37)		(2.12)	(2.19)
Age_j^2	0.35	-1.54**			
	(0.32)	(0.44)			
Sargan Test	54.95	(0.007)	Sample	1874	

Note: Standard errors for parameter estimates and p-value for Sargan Test displayed in parentheses. (*) Significant at 10%. (**) Significant at 5%. Age has been divided by 10.

First of all, it is worth pointing out that the Sargan test rejects the validity of instruments. Therefore, these parameter estimates are not consistent and cannot be used for

[15] In addition, the empirical results provided in Section 6 show that the Sargan test does not reject the exogeneity of all these variables.

inference analysis. Among the instruments used to control for the endogeneity of wages, we consider the so-called specific experience as the most likely candidate to be related to such rejection. In fact, if we do not include the specific experience as an instrument, the Sargan test does not reject the overidentifying restrictions. However, most of the variables become nonsignificant and the fit of the regression worsens considerably. A plausible explanation for the endogeneity of specific experience is that the errors in (10a) and (10b) might include additional terms in wages which have not been considered in the semilogarithmic specification of the labour supply function. If this is the case, the specific experience will be correlated with the error terms due to its strongly correlation with wages. In order to avoid this specification problem, we present an alternative functional form for the unconstrained labour supply system in the next section that fits the observed behaviour more closely.

5 *An Alternative parametric model*

Specifically, we propose the following labour supply system characterized by a quadratic specification in wages:

$$h_m = \alpha_0 + \alpha_1 w_m^2 + \alpha_2 w_f^2 + \alpha_3 w_m w_f + \alpha_4 w_m + \alpha_5 w_f + \alpha_6 y + \alpha_7 s \tag{11a}$$

$$h_f = \beta_0 + \beta_1 w_m^2 + \beta_2 w_f^2 + \beta_3 w_m w_f + \beta_4 w_m + \beta_5 w_f + \beta_6 y + \beta_7 s \tag{11b}$$

This alternative parametric model has several advantages over the semilogarithmic specification. First, it provides a larger degree of flexibility since it includes the quadratic terms in wages which play an important role in labour supply equations as it will be shown below. Second, since the quadratic form is linear in parameters, it is straightforward to estimate by linear regression and to provide a direct interpretation of wages and nonlabour income's parameters. Third, it allows to derive and test not only the collective model but also the unitary model.[16] In addition to this, it is possible to derive a closed-form for the structural model both under the collective and the unitary approaches (the household's

[16] As Chiappori et al.(2002) point out, the unitary model imposes very unrealistic restrictions on labour supply behaviour under the semilogaritmic form. Therefore, it does not make sense to test such restrictions under that specification.

indirect utility function for the unitary model and each member's indirect utility function and the sharing rule for the collective setting).

Next, we derive the restrictions and the structural model consistent with each framework.

5.1 *The Unitary Model*

As pointed out in Section 2.1, the unitary framework treats the family as the basic decision-making unit and does not allow any questions related to the intrahousehold allocation process. Therefore, its first implication on the empirical model given by (11a) and (11b) is the non-existence of distribution factors. As a result, differences in level of education will have no effect on individuals' labour choices, which means that

$$\alpha_7 = \beta_7 = 0 \tag{12}$$

Moreover, conditioning on (12), we know that (11a) and (11b) are the solution of problem (P1) if and only if the symmetry conditions of the Slutsky matrix given by (1) hold. Imposing such conditions on (11a) and (11b), we obtain the following set of restrictions:

$$\begin{aligned}
\beta_1\alpha_6 &= \alpha_1\beta_6 \\
\beta_2\alpha_6 &= \alpha_2\beta_6 \\
\beta_3\alpha_6 &= \alpha_3\beta_6 \\
\alpha_3 - \alpha_6\beta_4 &= 2\beta_1 - \alpha_4\beta_6 \\
2\alpha_2 - \alpha_6\beta_5 &= \beta_3 - \beta_6\alpha_5 \\
\alpha_5 - \alpha_6\beta_0 &= \beta_4 - \alpha_0\beta_6
\end{aligned} \tag{13}$$

If these equations are fulfilled, it is possible to recover the underlying structural model from the restricted labour supply system by solving the integrability problem. Following Stern (1986), we obtain that the household's indirect utility function takes the form

$$v(w_m, w_f, y) = e^{\theta_1 w_m + \theta_2 w_f}(y - (\theta_3 + \theta_4 w_m + \theta_5 w_f + \theta_6 w_m^2 + \theta_7 w_f^2 + \theta_8 w_m w_f)) \quad (14)$$

Applying Roy's identity on (14) ($h_i(w_m, w_f, y) = \frac{v_{w_i}}{v_y}$ $i = m, f$), we get the following restricted labour supply system:

$$h_m = -\theta_1\theta_6 w_m^2 - \theta_1\theta_7 w_f^2 - \theta_1\theta_8 w_m w_f - (\theta_1\theta_4 + 2\theta_6)w_m - (\theta_1\theta_5 + \theta_8)w_f + \theta_1 y - (\theta_1\theta_3 + \theta_4) \quad (15a)$$

$$h_f = -\theta_2\theta_6 w_m^2 - \theta_2\theta_7 w_f^2 - \theta_2\theta_8 w_m w_f - (\theta_2\theta_4 + \theta_8)w_m - (\theta_2\theta_5 + 2\theta_7)w_f + \theta_2 y - (\theta_2\theta_3 + \theta_5) \quad (15b)$$

From system (15a) and (15b), we can derive the structural parameters ($\theta_i, i = 1, ..., 8$) as functions of the reduced-form parameters ($\alpha_i, \beta_i, i = 1, ..., 6$) in (11a) and (11b) and get a full identification of individual preferences consistent with the unitary framework.

5.2 *The Collective Model*

We apply Proposition 1 in Chiappori et al. (2002) to derive the restrictions imposed by the collective framework under the new parametric specification given by (11a) and (11b):

$$A = \frac{2\alpha_2 w_f + \alpha_3 w_m + \alpha_5}{\alpha_6},$$

$$B = \frac{2\beta_1 w_m + \beta_3 w_f + \beta_4}{\beta_6},$$

$$C = \frac{\alpha_7}{\alpha_6},$$

$$D = \frac{\beta_7}{\beta_6}.$$

Then, if $C \neq D$, conditions (A1a)-(A1f) are necessary and sufficient for (11a) and (11b) to be the solution of problem (P2). As Chiappori et al. (2002) state, condition

$C \neq D$ is likely to be satisfied. On the one hand, the effect of the distribution factor has opposite signs for the man's and the woman's labour supply, so the ratio $\frac{\alpha_7}{\beta_7}$ must be negative. On the other hand, since $\frac{\alpha_6}{\beta_6}$ represents the ratio of the effect of household nonlabour income on each member's labour supply, it should be positive provided that leisure is a normal good for both individuals. Under this condition, (A1a)-(A1f) gives rise to a similar restriction to that of the semilogarithmic specification

$$\frac{\alpha_3}{\beta_3} = \frac{\alpha_7}{\beta_7} \tag{16}$$

which comes from (A1f) since the previous conditions hold trivially. Therefore, we have shown that the predictions of the collective model are robust to both parametric specifications.

In addition, if restriction (16) is satisfied, the partial derivatives of the sharing rule can be identified and take the following form:

$$\phi_y = \frac{\alpha_6 \beta_3}{\Delta},$$

$$\phi_s = \frac{\alpha_7 \beta_3}{\Delta},$$

$$\phi_{w_m} = \frac{\alpha_3}{\Delta}(2\beta_1 w_m + \beta_3 w_f + \beta_4),$$

$$\phi_{w_f} = \frac{\beta_3}{\Delta}(2\alpha_2 w_f + \alpha_3 w_m + \alpha_5), \tag{17}$$

where $\Delta = \alpha_6\beta_3 - \alpha_3\beta_6$. Solving this system, we obtain the following expression for the sharing rule:

$$\begin{aligned} \phi(w_m, w_f, y, s) \quad = \quad & \frac{1}{\Delta}(\alpha_3\beta_1 w_m^2 + \alpha_2\beta_3 w_f^2 + \alpha_3\beta_3 w_m w_f + \alpha_3\beta_4 w_m + \\ & \alpha_5\beta_3 w_f + \alpha_6\beta_3 y + \alpha_7\beta_3 s) + k \end{aligned} \tag{18}$$

where k is a parameter that cannot be identified without additional assumptions and may depend on preference factors.

Following Stern (1986), it is possible to recover (up to an additive constant) each individual's indirect utility function from the reduced-form given by (4a) and (4b) under a quadratic specification in wages

$$v^m(w_m, \phi) = e^{aw_m}(\phi - (bw_m^2 + cw_m + d)) \tag{19a}$$

$$v^f(w_f, y - \phi) = e^{fw_f}((y - \phi) - (gw_f^2 + hw_f + p)) \tag{19b}$$

where $a = \frac{\Delta}{\beta_3}$, $b = \frac{\alpha_3\beta_1 - \alpha_1\beta_3}{\Delta}$, $c = \frac{2\beta_3(\alpha_1\beta_3 - \alpha_3\beta_1)}{\Delta^2} - \frac{\alpha_4\beta_3 - \alpha_3\beta_4}{\Delta}$, $f = -\frac{\Delta}{\alpha_3}$, $g = \frac{\alpha_3\beta_2 - \alpha_2\beta_3}{\Delta}$, and $h = \frac{2\alpha_3(\beta_2\alpha_3 - \beta_3\alpha_2)}{\Delta^2} + \frac{\alpha_3\beta_5 - \beta_3\alpha_5}{\Delta}$. Since the coefficients d and p may be functions of preference factors they cannot be identified without additional assumptions.

6 *Empirical Model and Estimation Results*

Given the parametric labour supply system (11a) and (11b), the empirical model takes the following form

$$h_m = \alpha_0 + \alpha_1 w_m^2 + \alpha_2 w_f^2 + \alpha_3 w_m w_f + \alpha_4 w_m + \alpha_5 w_f + \alpha_6 y + \alpha_7 s + \alpha_8' z_m + \varepsilon_m \tag{20a}$$

$$h_f = \beta_0 + \beta_1 w_m^2 + \beta_2 w_f^2 + \beta_3 w_m w_f + \beta_4 w_m + \beta_5 w_f + \beta_6 y + \beta_7 s + \beta_8' z_f + \varepsilon_f \tag{20b}$$

where, similarly to (10a) and (10b), $z_i, i = m, f$, capture each individual's observable demographic characteristics and $(\varepsilon_m, \varepsilon_f)'$ include the unobservables. We estimate (20a) and (20b) by Optimal GMM considering the same list of instruments as in the semilogarithmic specification and controlling for sample selection problems. The estimation results are reported in Table 2:

Table 2. Unconstrained Labor Supply Model

Quadratic Specification. GMM Parameter Estimates					
	Men ($j=m$)	Women ($j=f$)		Men ($j=m$)	Women ($j=f$)
Constant	58.93**	29.42**	Age_j^2	0.14	-0.92**
	(5.74)	(7.15)		(0.35)	(0.45)
w_m^2	0.08**	0.04	$Educ2_j$	2.52**	3.76**
	(0.03)	(0.03)		(0.83)	(1.54)
w_f^2	-0.05	-0.20	$Educ3_j$	2.43**	2.70
	(0.11)	(0.15)		(1.21)	(2.61)
$w_m w_f$	0.16	0.38**	$Children < 6$	0.37	-1.62**
	(0.12)	(0.11)		(0.35)	(0.69)
w_m	-2.29**	-3.80**	$Children618$	0.20	-1.02**
	(0.89)	(0.80)		(0.26)	(0.37)
w_f	-1.40	0.94	s_{mf}	-0.55**	0.58**
	(1.05)	(1.41)		(0.18)	(0.29)
y	0.55	-0.11	λ_j	-1.12	2.73
	(0.39)	(0.17)		(2.45)	(2.28)
Age_j	-1.18	6.57*			
	(3.01)	(3.38)			
Sargan Test	40.63	(0.058)	Sample	1879	

Note: Standard errors for parameter estimates and p-value for Sargan Test displayed in parentheses. (*) Significant at 10%. (**) Significant at 5%. Age has been divided by 10.

First of all, it is important to notice that the Sargan statistic does not reject the overidentifying restrictions at the 5% level, which confirms the validity of the instruments and the consistency of the parameter estimates. Furthermore, even though quadratic terms in wages are not individually significant -except the square of the man's wage, which turns out to be significant in his own labour supply-, they are jointly significant together with the cross-term and the linear terms in both equations.

Household nonlabour income does not appear to have a significant effect on individuals' labour supply decisions whereas the effect of age is only significant for females. With respect to education level, both high school schooling and graduate studies dummy variables are significant for men with a positive sign. For women, only the dummy variable for high school is significant, and it has a positive sign. This means that females who have reached high school work more hours a week than those who only have primary schooling. However, the highest level of education does not significantly affect the number of hours of work. In addition, fertility variables only have a significant, negative effect on women's labour supply and that effect is larger for children less than six years old.

Furthermore, the coefficient estimates for the differences in education level between the members of the couple confirm the theory of the distribution factors. In particular, we obtain that this variable strongly affects both individuals' labour supplies according to the distribution factor interpretation. Hence, these estimates support the hypothesis that there are variables that may influence household decisions through their effects on the intrahousehold allocation process.

Finally, since neither of individuals' inverse Mills ratio is significant, we conclude that there are no sample selection problems.

In order to check if these results reasonably describe household labour supply behaviour in Spain, Table 3 reports some statistics of the predicted labour supply elasticities:

Table 3. Predicted Labor Supply Elasticities.

		Mean	Std. Dev	Median	Min	25 th Quantile	75^{th} Quantile	Max
	$\varepsilon^m_{w_m}$	0.001	0.205	-0.062	-0.251	-0.097	0.023	2.976
Men	$\varepsilon^m_{w_f}$	-0.116	0.106	-0.094	-1.064	-0.154	-0.063	0.581
	ε^m_y	0.005	0.018	0.0003	0	0	0.003	0.396
	$\varepsilon^f_{w_m}$	-0.163	0.216	-0.186	-0.930	-0.257	-0.096	1.818
Women	$\varepsilon^f_{w_f}$	0.140	0.250	0.114	-2.164	0.063	0.210	2.370
	ε^f_y	-0.001	0.005	-0.00007	-0.136	-0.0009	0	0

For men, wage elasticities are on average close to zero since they react slightly to changes in economic conditions in the labour market. However, even though the elasticities are not very large for women either, they reflect the fact that married women are more sensitive to wage variations than men. Furthermore, on average, both kinds of individuals work more hours when their own wages increase and reduce their labour supply when the spouse's wages increase. In addition, elasticity with respect to household nonlabour income is zero, which means that neither men's nor women's labour supply decisions are affected by changes in the nonlabour income in the household.

These results are close to the ones provided by Fernández-Val (2003), who uses the same database for Spain, although he obtains a larger own-wage elasticity for woman (0.309). This difference can be explained by the fact that we restrict our sample to couples with both members continuously working throughout the period whereas Fernández-Val (2003) extends the selection to couples in which both individuals work a positive number of hours a year. As a result, it seems reasonable to think that for such a wider sample, women are on average more sensitive to wage variations.

7 *Tests of the Unitary and Collective Models*

Given the empirical results reported in Table 3 for the unrestricted labour supply system (20a) and (20b), we perform some tests to determine whether the unitary and collective models' predictions are adequate or not for analysing Spanish household labour supply behaviour. Specifically, we test the non-existence of distribution factors (12) and the symmetry of the Slutsky matrix (1) for the unitary model, and restriction (16) for the collective approach.

Table 4 presents the statistics and the p-values for the tests of these coefficient restrictions:

Table 4. Inference Results.

Unitary Model	Statistic	P-value
No distribution Factors	12.47	(0.002)
Symmetry(1)	3.35	(0.764)
Collective Model (2)	4.62	(0.031)
Collective Model (3)	6.25	(0.012)

Note: Unitary model restrictions are tested using Wald tests. (1) We test the symmetry of the Slutsky matrix conditioning to the non-existence of distribution factors. The collective model restriction is tested using a Wald test (2) and a Pseudo-likelihood ratio test (3).

For the unitary model restrictions, we perform Wald tests. In particular, we reject the non-existence of distribution factors (the p-value takes a value of 0.002). In the present analysis, this means that the differences in education level between members are strongly significant in their labour supply choices. Therefore, this result shows evidence against the suitability of the unitary model for analysing family behaviour since it does not consider any information related to the intrahousehold allocation process. Under this situation, the result for the symmetry of the Slutsky matrix is not informative at all since we impose (12) to test it, and this restriction is rejected by the data.

For the collective model, since condition (16) is a nonlinear restriction and the Wald test is not invariant to reparameterizations,[17] we also perform a *Pseudo-likelihood ratio* test. Both tests reject the restrictions imposed by the collective model considered in the

[17] As Wooldridge (2002) states, this lack of invariance cannot be ignored since it may explain the poor finite sample properties of the Wald statistic for testing nonlinear hypothesis. For a further discussion see Gregory and Vell (1985) and Phillips and Park (1988).

present analysis at the 5% level, and therefore suggest that the collective setting does not seem to fit the empirical evidence shown by our sample.[18]

8 *Conclusions*

This paper provides an empirical contribution to the wide "unitary vs. collective" model debate that has arisen over the past 20 years in family economics. In particular, we test the parametric restrictions imposed by the collective labour supply model considering the differences in education level between the members of the couple as a potential distribution factor. To the best of our knowledge, this is the first attempt to use this kind of information on education to test this version of the labour supply model due to Chiappori. Moreover, the quadratic specification that we propose for the labour supply system also allows the restrictions imposed by the unitary model to be tested.

We conclude that our sample drawn from the Spanish version of the ECHP for the period from 1994 to 1999 clearly rejects the restriction of non-existence of distribution factors. Specifically, it is shown that the differences in education play an important role in both members' labour supply decisions according to the distribution factor interpretation. This result is in line with previous studies that indicate that the unitary model should not be used to analyse household behaviour. However, we also reject the restriction imposed by the collective model with a distribution factor. This outcome suggests that even though there are variables that can influence household behaviour through their effects on individuals' decision power, the collective setting is not adequate for modelling such intrahousehold considerations.

Furthermore, since this analysis contradicts many papers that have accepted the collective model's restrictions using different datasets (Fortin and Lacroix (1997), Bourguignon et al. (1994), Browning et al. (1998), Chiappori et al. (2002), Fernández-Val (2003)), it shows that more empirical research is needed in order to reach a definite consensus about the appropriateness of the collective model for analysing intrahousehold behaviour.

[18] In line with our results, Aronsson et al.(2001) reject both the unitary model and the collective model where household production can be traded using Swedish data from 1984 and 1993.

Appendix A

Proposition 1 (Chiappori et al. (2002)): Given the system (4a) and (4b), define $A = h^m_{w_f}/h^m_y$, $B = h^f_{w_m}/h^f_y$, $C = h^m_s/h^m_y$, $D = h^f_s/h^f_y$ whenever $h^m_y * h^f_y \neq 0$ which are observable variables that can therefore be estimated. Then, the following results hold: (i) If there exists exactly one distribution factor such that $C \neq D$, the following conditions are necessary for any pair (h^m, h^f) to be solutions of (P3) for a sharing rule ϕ :

$$\frac{\partial}{\partial s}(\frac{D}{D-C}) = \frac{\partial}{\partial y}(\frac{CD}{D-C}), \tag{A1a}$$

$$\frac{\partial}{\partial w_m}(\frac{D}{D-C}) = \frac{\partial}{\partial y}(\frac{BC}{D-C}), \tag{A1b}$$

$$\frac{\partial}{\partial w_f}(\frac{D}{D-C}) = \frac{\partial}{\partial y}(\frac{AD}{D-C}), \tag{A1c}$$

$$\frac{\partial}{\partial w_m}(\frac{CD}{D-C}) = \frac{\partial}{\partial s}(\frac{BC}{D-C}), \tag{A1d}$$

$$\frac{\partial}{\partial w_f}(\frac{CD}{D-C}) = \frac{\partial}{\partial s}(\frac{AD}{D-C}), \tag{A1e}$$

$$\frac{\partial}{\partial w_f}(\frac{BC}{D-C}) = \frac{\partial}{\partial w_m}(\frac{AD}{D-C}), \tag{A1f}$$

$$h^m_{w_m} - h^m_y(h^m + \frac{BC}{D-C})(\frac{D-C}{D}) \geq 0, \tag{A1g}$$

and

$$h^f_{w_f} - h^f_y(h^f - \frac{AD}{D-C})(-\frac{D-C}{C}) \geq 0. \tag{A1h}$$

(ii) Under the assumptions that conditions (A1a)-(A1h) hold, the partial derivatives of the sharing rule with respect to wages, nonlabour income and the distribution factor are given by

$$\phi_y = \frac{D}{D-C},$$

$$\phi_s = \frac{CD}{D-C},$$

$$\phi_{w_m} = \frac{BC}{D-C},$$

$$\phi_{w_f} = \frac{AD}{D-C}. \tag{A2}$$

Therefore, the sharing rule is defined up to an additive function $k(z)$ where z is the set of preference factors.[19]

Proof: See Appendix in Chiappori et al. (2002).

[19] In the consumption setting, Blundell et al.(2004) extend the collective model considering a consumption technology function. In that context, they show that, assuming that individual ordinal preferences do not change after marriage and provided that there exist more than three goods, the sharing rule can be nonparametrically full identified using consumption data on singles and couples. In addition, Couprie (2003) estimates a collective model of demand for leisure that includes the production of a household public good using the British Household Panel Survey for the period from 1992 to 2000. Under this setting, she shows that the sharing rule conditional to public expenditures can be identified by the woman's changes in family status (from single to married or vice versa).

Appendix B

Table 5 presents some descriptive statistics of the variables used in this analysis:

Table 5. Descriptive Statistics.

	Mean		Std. Dev.		Min		Max	
	Men	Women	Men	Women	Men	Women	Men	Women
Hours of work (1)	42.46	36.80	8.10	7.84	20	15	91	72
Hourly wage (2)	6.19	5.24	3.17	2.47	0.71	0.42	27.17	18.59
Age	40	38	0.83	0.78	21	21	64	62
Educ1	0.38	0.37	0.48	0.48	0	0	1	1
Educ2	0.27	0.24	0.44	0.42	0	0	1	1
Educ3	0.34	0.38	0.47	0.48	0	0	1	1
Years of service	10.7	9.19	6.21	6.13	0	0	19	19
Households								
Children<6	0.31		0.55		0		3	
Children6-18	0.82		0.95		0		5	
Nonlabour income (2)	443.40		1404.27		0		24951.25	
Distribution Factor	4.91		1.99		1		9	

Note: Number of observations, 1879 couples. (1) Weekly hours of work. (2) Euros.

According to the data men are, on average, older, work more hours per week and earn higher wages than women, while women are slightly more highly educated.

Appendix C

In this Appendix, we provide a brief explanation of the two-stage Heckman-type selection correction that we implement in order to avoid sample selection biases in the empirical results. In particular, we apply this method taking into account the endogeneity of wages (for further details, see Wooldridge (2002)). This procedure has two steps. First, we specify a Probit model for the participation decision of each member. Specifically, we consider that an individual participates (the dependent binary variable takes the value one) if she continuously works during the whole year. We include household nonlabour income, the fertility variables, a second-order polynomial in age, dummy variables for high school schooling and graduate studies ($Educ2, Educ3$) and their interactions with that polynomial as explanatory variables in each Probit model. Obviously, we do not include wages since they are endogenous variables in the structural equations of interest.

We estimate both Probit models using the whole sample of working and non-working couples and we compute each individual's inverse Mills ratio (the predicted λ-term). Table 6 presents the estimation results for the Probit models:

Table 6. Probit Participation models.

	Men ($j = m$)	Women ($j = f$)
Age_j	1.98**	0.95**
	(0.24)	(0.15)
Age_j^2	-0.24**	-0.15**
	(0.03)	(0.02)
Educ2_j	-1.62**	-1.75**
	(0.85)	(0.66)
Educ3_j	-5.33**	-5.37**
	(2.14)	(0.79)
$\text{Educ2}_j{*}\text{Age}_j$	0.99**	1.11**
	(0.40)	(0-34)
$\text{Educ3}_j{*}\text{Age}_j$	2.59**	3.24**
	(0.96)	(0.39)
$\text{Educ2}_j{*}\text{Age}_j^2$	-0.11**	-0.11**
	(0.05)	(0.04)
$\text{Educ3}_j{*}\text{Age}_j^2$	-0.23**	-0.36**
	(0.09)	(0.04)
y	-0.0002**	-0.00003**
	(0.0001)	(0.000007)
Children<6	-0.04	-0.39**
	(0.04)	(0.03)
Children6-18	-0.12**	-0.18**
	(0.02)	(0.02)
Constant	-2.71**	-1.95**
	(0.52)	(0.31)
R^2	0.45	0.23

Note: Standard errors displayed in parentheses. Number of observations, 10559.
(*) Significant at 10%. (**) Significant at 5%. Age has been divided by 10.

From these results, we should stress that women with children are more likely to be nonparticipants in the labour market and that household nonlabour income has a significant negative effect on the probability of being working in both equations.

Second, using the sample of continuously working couples, we estimate the empirical labour supply system including each individual's inverse Mills ratio in both the list of regressors and the list of instruments that correspond to each member's labour supply equation.

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