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Who bears the full cost of children? Evidence from a collective demand system

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Abstract This paper measures how the costs of children are shared between the father and the mother by estimating a gender-specific demand system related to the demand for market goods, household products and leisure within a collective approach. The estimates illustrate how the intra-household distribution of resources varies across households with and without children and how wages and non-labor income affect the allocation rule in both single-earner and double-earner households. In the presence of a child, both parents, but mothers especially, increase their involvement in home production at the expense of the enjoyment of leisure. This commitment decreases as the child gets older. In general, mothers control less than half of the household resources, while they bear more than half of the cost of maintaining a child.

Keywords Cost of children · Collective demand system · Intra-household allocation · Household production · Full income · Sharing rule

JEL Classification D12 · D13 · J22

1 Introduction

This paper measures the costs of children taking into account both consumption expenditures and time costs (Apps and Rees 2002, 2009; Bradbury 1994, 2004a, b, c, 2008;

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Koulovatianos et al. 2009) and determines how the full cost of a child is shared between the mother and the father. To do so, we estimate the rule governing the allocation of resources within households with and without children deriving and estimating a gender-specific complete demand system consistent with a collective household model with household production (Apps and Rees 2002; Aronsson et al. 2001; Rapoport and Sofer 2004; Bourguignon and Chiuri 2005; Blundell et al. 2005; Rapoport et al. 2011).

Differently from traditional equivalence scales that are based only on information related to the consumption of market goods, in the present application we adopt a broaden definition of the cost of a child and include also the consumption of non-market goods produced by the household and the consumption of parental time devoted to childcare. Considering that the objective of the study is the estimation of the proportion of the full costs of children borne by each spouse, it is improper to model the household as unitary where resources are equally distributed across family members (Bourguignon 1999). Following the initial work of Apps and Rees (1996), we model individual preferences for leisure, household products and market goods using a system of gender-specific demand equations. We extend their model by incorporating the sharing rule summarizing transfers between couple's members within a structural estimation (Browning et al. 2014; Arias et al. 2004).

We exploit the estimated information about the intra-household distribution of resources to measure how full costs of children are distributed between mother and father and to determine each parent's contribution in terms of both goods and time. This decomposition exercise represents an original contribution to both the literature of collective household models and the literature of traditional equivalence scales. It offers useful information for the design of effective policies favouring the coordination of family and labor activities.

As in Apps and Rees (1996, 2002), we recognize differences in household types according to the labor market participation of the female that may significantly affect how household resources of time and income are allocated to children. To facilitate comparisons, we follow these authors and distinguish a traditional family, where the woman is a full-time housewife, and a non-traditional family, where the female is prevalently employed in the labor market. We present the results of the application to Italian household data based on this policy-relevant distinction.

In general, this study represents an effort in line with Phipps' exhortation (1997) to reconcile the literature on decision making within families and the literature on the estimation of equivalence scales similar to the research endeavor undertaken by Browning et al. (2013). The collective specification of a complete gender specific demand system and its application to the estimation of the sharing of the full cost of children between parents are original contributions of the present study. The estimated sharing rule is robust because most of its parameters are statistically significant.

The next section presents the derivation of a gender-specific demand system derived from a collective decision model of the family incorporating household production. The Sect. 3 is devoted to the econometric specification of the individual demand systems and the associated sharing rule between husband and wife. The method adopted to describe how the full cost of a child is shared within the couple is presented in Sect. 4. The Italian household-level data used in the analysis are described in Sect. 5. The subsequent section reports the results. Section 7 concludes.

2 The model: a gender-specific demand system within a collective model with household production

We consider the household as both a production and a consumption unit. We characterize household production by assuming that the domestic good x_z is produced at home using a strictly increasing, at least twice-differentiable, and concave technology $g(h^1, h^2; d)$ which depends on time spent on household production activities by each member of the couple h^i, and a vector of exogenous characteristics $d = d\{d_s, d_{-s}\}$ which is composed by the sub-vectors of house characteristics d_s, such as size and number of bathrooms, and demographic characteristics of the household d_{-s} including all other exogenous characteristics pertaining to household members,[1]

$$x_z = g\left(h^1, h^2; d_s, d_{-s}\right).$$

In our setup, household production x_z, a highly composite good, is not observable in its single components and is not sold in the market outside the household, but exchanged in the home market at an implicit price p_z that varies across households. It is the same for both members as a result of the efficiency assumption. The price of domestic production can be evaluated at the market price of the equivalent service price that is exogenous to the household (Jenkins and O'Leary 1994, 1995, 1996).[2] Alternatively, it can be estimated on the basis of information endogenous to the household. Aggregate household production is privately consumed so that $x_z = x_z^1 + x_z^2$. The notation 1 and 2 refers to husband and wife, respectively.[3] We do not distinguish between different household products, such as household chores and childcare, and we do not observe market-purchased inputs used in production. Nor we account for different household activities. As a consequence, we cannot separate individual contributions to household production and thus define individual-specific cost functions. The adopted technological relationship describing household production assumes that (a) there is absence of joint production (Pollak and Watcher 1975; Graham and Green 1984; Kerkhofs and Kooreman 2003) in the sense that home production time is not a direct source of utility as leisure and is spent in one activity at a time, (b) time used both in home production and market activities is equally productive, and (c) returns to scale are constant.

[1] Note that the household technology includes the full set of exogenous characteristics, while the utility function only hosts the demographic characteristics of the household members.

[2] The market approach is plausible when the domestic production is marketable, as it is the case of agricultural households or household–enterprises, or when it can be substituted with goods and services bought on an outside market at a given price. For example, meals can be taken at home or at a restaurant, a home-made cake has its perfect substitute in a pastry shop, a maid can be hired to clean the house, and so on. In this case, the market price of the equivalent service determines the trade-off between internal production and outside trade. This method requires a distinction between different types of domestic work and the evaluation of each one to the corresponding price of market specialists. Because information on the prices of specific household activities was not available, we could not apply this approach to our analysis.

[3] The superscript notation is associated with endogenous variables, while subscripts index exogenous variables.

In line with these assumptions, in the first stage, we determine the optimal allocation of time spent by each member in household production by minimizing

$$\underset{h^1,h^2}{\text{Min}} \left\{ w_1 h^1 + w_2 h^2 \;\middle|\; g\left(h^1, h^2; d\right) \geq x_z \right\}$$

to obtain the cost function $C_z(w_1, w_2, x_z; d)$. Because the domestic production technology is assumed to exhibit constant returns to scale, the cost function is homothetic $C_z(w_1, w_2, x_z; d) = c_z(w_1, w_2; d)x_z$. Then, the household-specific imputed price of the domestic good p_z is endogenously determined as (Gronau 1973; Apps and Rees 1996, 2002):

$$\frac{\partial C_z(w_1, w_2, x_z; d)}{\partial x_z} = p_z = c_z(w_1, w_2; d)$$

and corresponds to the unit cost function $c_z(w_1, w_2; d)$.[4] At equilibrium, profit from household production is zero and is, therefore, irrelevant to learn how profits from household production are shared within the household.

Consumption and production decisions are separable, in the sense that production allocation decisions do not affect consumption choices, because of the constant returns to scale technology (Chiappori 1997; Rapoport and Sofer 2004; Pollak 2011). As a result, we can describe the household economy within a collective approach treating the consumption and production decision spheres as separate. Unlike the traditional approach, which considers the household as the basic decision unit with a joint preference structure, collective models describe the household as a group of individuals each of whom is characterized by specific preferences and investigate how the decision process is influenced by prices, incomes and other exogenous factors. We assume that each adult member of the household obtains utility from the private consumption of a composite good x_m, a composite home-produced good x_z and leisure l. Leisure is time that is devoted neither to work in the market nor to work at home. Utility also depends on individual exogenous characteristics d_{-s} to account for heterogeneity in behavior. Each member of the household maximizes egoistic preferences, in the sense that their utility only depends on their own consumption and leisure and not on the other spouse's utility, as shown by the following program:

$$\text{Max}\, \mu\; U^1\left(x_m^1, x_z^1, l^1; d_{-s}\right) + \;(1-\mu)\; U^2\left(x_m^2, x_z^2, l^2; d_{-s}\right) \tag{1}$$

subject to:

[4] Because the level of the household product cannot be observed, the assumption of homotheticity (or constant return to scale) is a maintained hypothesis in collective models with household production (Apps and Rees 2002; Rapoport et al. 2011). See also Pollak and Watcher's (1975) and Pollak (2011) discussion of the issue of constant return to scale in household production.

$$\sum_{i=1}^{2} p_m x_m^i + \sum_{i=1}^{2} p_z x_z^i + \sum_{i=1}^{2} w_i l^i \leq \sum_{i=1}^{2} w_i (T - h_i) + \sum_{i=1}^{2} y_i + p_z g(h_1, h_2; d),$$
$$l^i = T - o^i - h_i,$$
$$x_m^i \geq 0, \quad x_z^i \geq 0, \quad o^i \geq 0, \quad h_i \geq 0, \quad 0 \leq l^i \leq T - o^i - h_i,$$

where $\mu = \mu\,(w_1, w_2, y_1, y_2, p_m, d_{-s}, \gamma)$ is the implicit Pareto weight of each member's utility in the collective decision process. It is a continuously differentiable function of the model's exogenous variables: individual wages w_i, non-labor incomes y_i, prices p_m, individual exogenous attributes d_{-s} shifting both preferences and weight, and distribution factors γ affecting only the Pareto weight (Browning et al. 2006). Note that the Pareto weight does not depend on p_z, because p_z is a function of w_1, w_2, d which are already present in μ (Rapoport and Sofer 2004; Kalugina et al. 2009). The assumption of constant returns to scale of the production technology and separability of the production and consumption decision spheres ensure that equilibrium prices $p_z(w_1, w_2, d)$ are independent of both distribution factors γ and exogenous non-labor income y. For the same reasons, the Pareto weight is independent of house characteristics d_s that belong to the production sphere only.[5] In a bargaining perspective, the weight $\mu \in [0,\ 1]$ describes the distribution of power within the household (Chiappori 1992; Browning and Chiappori 1998; Donni 2003).

The household budget constraint is expressed in terms of the household full income given by the sum of individual earnings evaluated at his/her own market wage, the sum of non-labor income specific for each agent, y_i, and the amount of the domestic good. T is total time endowment excluding time devoted to rest. It is allocated to market activities o^i, household production h_i and privately consumed leisure l^i. Given the assumption that the household production exhibits constant returns to scale, the full-income constraint can be rewritten as:

$$\sum_i p_m x_m^i + \sum_i p_z x_z^i \leq \sum_i w_i (o^i + h_i) + \sum_i y_i$$

where household income is given by the sum of the returns from labor supplied both outside and inside the household and non-wage income y_i specific for each agent.

Assuming that agents are egoistic and recalling that consumption is purely private in our model, Pareto efficiency implies that program in (1) can be decentralized as a second-stage maximization problem of a single household member facing the own budget constraint:

$$\begin{aligned} &\text{Max} \ \left\{ U^i \left(x_m^i, x_z^i, l^i; d_{-s} \right) \right\} \\ &\text{s.t.} \quad p_m x_m^i + p_z x_z^i \leq w_i (o^i + h_i) + \phi_i \left(p_m, w_1, w_2, y_1, y_2, \gamma, d_{-s} \right), \end{aligned} \tag{2}$$

[5] Rapoport et al. (2011), in analogy with the distribution factors affecting the distribution rule but not preferences, term such production characteristics "pure production factors" because affect the production technology only, leaving preferences unchanged.

where $\phi_1(.) = \phi$ and $\phi_2(.) = Y - \phi$ with $Y = \sum_i y_i$. The sharing rule ϕ summarizes transfers between couple's members as a function of exogenous variables affecting the distribution of bargaining power and resources within the household. It can be shown that the sharing rule ϕ is a monotonic transformation of the Pareto weight μ (Chiappori 1988, 1992; Browning et al. 2013, 2014).

The intra-household allocation rule is not directly observable and must be deduced from the information available on assignable goods. The collective approach makes no assumption about the decision process. It only requires that the outcome of the decision process is Pareto efficient. Decisions take place as if they were made within a two-stage budgeting process. Total household income is allocated to single members according to a predetermined sharing rule, which defines the intra-household distribution of income. Then, each member chooses the preferred utility-maximizing bundle of goods and leisure facing an individual budget constraint.

Individual demand functions $x^i_{m,z,l}(p_m, p_z, w_1, w_2, y_1, y_2, \gamma, d_{-s})$ can be derived as a solution of program (2):

$$
\begin{aligned}
x^1_m(.) &= \tilde{x}^1_m(p_m, p_z, w_1, \phi_1(p_m, w_1, w_2, y_1, y_2, \gamma, d_{-s}); d_{-s}) \\
x^2_m(.) &= \tilde{x}^2_m(p_m, p_z, w_2, \phi_2(p_m, w_1, w_2, y_1, y_2, \gamma, d_{-s}); d_{-s}) \\
x^1_z(.) &= \tilde{x}^1_z(p_m, p_z, w_1, \phi_1(p_m, w_1, w_2, y_1, y_2, \gamma, d_{-s}); d_{-s}) \\
x^2_z(.) &= \tilde{x}^2_z(p_m, p_z, w_2, \phi_2(p_m, w_1, w_2, y_1, y_2, \gamma, d_{-s}); d_{-s}) \\
x^1_l(.) &= \tilde{x}^1_l(p_m, p_z, w_1, \phi_1(p_m, w_1, w_2, y_1, y_2, \gamma, d_{-s}); d_{-s}) \\
x^2_l(.) &= \tilde{x}^2_l(p_m, p_z, w_2, \phi_2(p_m, w_1, w_2, y_1, y_2, \gamma, d_{-s}); d_{-s})
\end{aligned}
$$

The system of equations is a gender-specific demand system incorporating the sharing rule in structural form. This is in fact the main difference with Apps and Rees (1996). Note further that (a) y_i and the spouse's wage act as distribution factors γ because they affect the sharing rule but not preferences, (b) the price of the market good p_m can be normalized to one as in Apps and Rees (1996), and (c) the shadow price $p_z(w_1, w_2, d)$ of the domestic good is not included in the sharing rule as for the Pareto weight (Rapoport and Sofer 2004; Kalugina et al. 2009).

3 Econometric specification and estimation

The chosen structure of preferences is based on the Gorman polar form[6] linear in individual full income ϕ_i which is demographically transformed using the translating technique (Barten 1964; Pollak and Wales 1981; Lewbel 1985). The associated indirect utility functions for individual $i = 1, 2$ are:

[6] It is interesting to note that the indirect utility function with a Gorman polar form implies a unitary model and the pooling of incomes because the aggregate demand behaves as if it were the demand of a single consumer (Bergstrom 1997:10). As pointed out by Bergstrom himself (1997: 10), in the case of a translation, utilities may be different for different people. The indirect utility described in Eq. (3) incorporates both translating and scaling of the income term.

$$V^i(p_i, \phi_i; d_{-s}) = \frac{\ln \phi_i(p_{l_1}, p_{l_2}, y_1, y_2, d_{-s}) - \ln \wp_i^T(d_{-s}, p_i) - \ln A_i(p_i)}{B_i(p_i)} \quad (3)$$

where $\ln \wp_i^T(d_{-s}, p_i) = \sum_k t_k^i(d_{-s}) \ln(p_{i_k})$, for $k = m, z, l$, is the gender-specific fixed cost component associated with the demographic characteristics, and for notational convenience, we pose $p_l = w$. The function $t_k^i(d_{-s})$ is the kth translating demographic function specified as $t_k^i(d_{-s}) = \Sigma_n \tau_{kn}^i \ln(d_{-s}^n)$, where $n = 1, \ldots, N$ indexes the household characteristics "number of children" by age class and the squared total number of children. The price indexes $A_i(p)$ and $B_i(p)$ take the translog and Cobb-Douglas form, respectively:

$$\ln A_i(p_i) = \alpha^i{}_0 + \sum_k \alpha^i{}_k \ln p_{i_k} + 0.5 \sum_k \sum_r v_{kr}^i \ln p_{i_k} \ln p_{i_r} \text{ for } r = k = m, z, l \quad (4)$$

$$B_i(p_i) = \beta_0 \prod_k p_k^{\beta_k^i} \quad (5)$$

Roy's identity yields the following system of share equations:

$$s_k^i = \alpha_k^i + t^i{}_k(d_{-s}) + \sum_r v^i{}_{kr} \ln p_{i_r} + \beta_k^i \ln\left(\frac{\phi_i^*(\cdot)}{A_i(p)}\right) \quad (6)$$

where $s_k^i = p_{i_k} x_k^i / Y^i$ and $\phi_i^* = \phi_i - \ln \wp_i^T(d_{-s}, p_i) = \phi_i^* = \phi_i - \sum_k t_k^i(d_{-s}) \ln(p_{i_k})$. The function $\phi_i(.)$ is the sharing rule with the following form:

$$\begin{aligned} \phi_1(w_1, w_2, y_1, y_2, d_{-s}) &= Y_1 m(w_1, w_2, y_1, y_2, d_{-s}) = Y_1(w_1^{\theta_1} w_2^{\theta_2} y_1^{\eta_1} y_2^{\eta_2} d_{-s}^{\nu}) \\ \phi_2(w_1, w_2, y_1, y_2, d_{-s}) &= Y - \phi_1(w_1, w_2, y_1, y_2, d_{-s}) \end{aligned} \quad (7)$$

where the function $m(w_1, w_2, y_1, y_2, d_{-s})$ has as arguments information about the own and other agent's wages, non-labor income and demographic characteristics. The chosen functional form is exponential, but linear in the logarithms.[7] Note that the $m(\cdot)$ function acts as a scaling function of personal full income capturing the size of the intra-household transfers. The sharing rule for the other agent is given by $\phi_2 = Y - \phi_1 = Y_1 + Y_2 - Y_1 m(\cdot) = Y_2 + Y_1(1 - m(\cdot))$. Therefore, the sum shared between individuals 1 and 2 is $Y_1(1 - m(\cdot))$. The amount $Y_1(m(\cdot) - 1)$ offered by individual 1 corresponds to the amount received $Y_1(1 - m(\cdot))$ by the partner. The variables that are positively correlated with the bargaining power of one spouse should positively affect the own consumption share. This specification of the distribution function explains how the transfers between wives and husbands are realized. Note that $0 < m \leq Y/Y_1$. If $m = 1$, then $\phi_1 = Y_1$ and if $m = Y/Y_1$, then $\phi_2 = 0$

[7] The functional form of the sharing rule is linear in the logarithms as it is implicitly assumed by Chiappori, Fortin and Lacroix (2002, eq. 10). Our functional form does not include interaction terms because not necessary for identification (Menon and Perali 2012) and implements the condition of income independence of the sharing rule also adopted by the identification strategy of Dunbar et al. (2013) and shown to be empirically robust in Menon et al. (2012).

and $\phi_1 = Y$. The range of the modifying function $m(.)$ describes the direction of the intra-household transfer: If $m(.)$ is less than one, then the wife receives the transfer; the recipient is the husband otherwise. The modifying function $0 < m \leq Y/Y_1$ can also be seen as an index function correcting Y_1 which is observed with error given the incomplete information about all possible assignable goods in the household (Menon and Perali 2012).

The estimation technique of the sharing rule is based on an analogy borrowed from the literature of modifying functions used to incorporate demographic and other exogenous effects into demand systems (Pollak and Wales 1981; Lewbel 1985; Perali 2003) and from studies estimating household technologies (Bollino et al. 2000; Browning et al. 2013; Dunbar et al. 2013). The approach proposed in this paper to estimate the sharing rule is similar to the method adopted by Browning et al. (1994) where the estimation of the structural form, which is nonlinear in the parameters, is conducted directly given a specific parametric functional form of the sharing rule. This technique is simpler than the econometric strategy followed by Chiappori et al. (2002) which recovers the sharing rule indirectly by first estimating the linear reduced form and then applying, in the second stage, the theoretical restrictions identifying the parameters of the sharing rule.

Like sharing rules, demographic functions are not observable (Goldberger 1972). When demographically modifying functions interact with exogenous prices, often called Barten prices, or income, as in Lewbel (1985: Theorem 8) and in the present case,[8] it is possible to identify the demographic parameters of interest provided that there is sufficient information in the data. Arias et al. (2004) and Menon and Perali (2012) show that the parameters of the sharing rule, where individual full incomes are modified by an income scaling function, such as $m(.)$, are identifiable.

We assume that the household cost function takes the translog functional form. The unit cost function can be recovered from the estimates of the share equations associated with the cost of time allocated to household production by each member of the couple as follows:

$$\begin{cases} \ln C_z(w_1, w_2; d_{-s}) = a_0 + \sum_i a(d_{-s}) \ln w_i + 0.5 \sum_i \sum_j a_{ij} \ln w_i \ln w_j \\ \frac{\partial \ln C_z(w_1, w_2; d_{-s})}{\partial \ln w_i} = \frac{w_i h_i}{\sum_i w_i h_i} = a_i(d_{-s}) + \sum_j a_{ij} \ln w_j \quad i, j = 1, 2 \end{cases} . \tag{8}$$

where $a_i(d_{-s}) = a_{00} + \sum_{k_{-s}} a_{k_{-s}} d_{k_{-s}}; k_{-s} = 1, \ldots, K_{-s}$. The price of the domestic good has been computed as the exponent of the unit cost function:

$$p_z = \exp\left(a_0 + \sum_i a_i(d_{-s}) \ln w_i + 0.5 \sum_i \sum_j a_{ij} \ln w_i \ln w_j \right), \tag{9}$$

where w_1 is the husband exogenous wage , w_2 is the wife potential wage when unemployed, and d_{-s} includes individual attributes. The subset d_s of characteristics of the

[8] In the present context, the sharing rule can be thought as the analogous of a demographic function that instead of scaling prices as in the Barten (1964) tradition, scales income.

house, such as size, number of bathrooms and other characteristics, has been used to instrument the female wage for traditional household.

The econometric execution develops in the following steps:

1. estimation of the potential wage for non working women of traditional households;
2. estimation of the household production technology jointly as in Eq. (8) by maximum likelihood with symmetry and linear homogeneity as maintained hypotheses and derivation of the shadow price of the domestic good p_z as in Eq. (9);
3. joint estimation of the gender-specific demand system described in Eq. (6).

The stochastic disturbances added to each equation are meant to capture measurement errors as well as unobserved heterogeneity in tastes for different goods and assumed to be jointly and normally distributed across equation. The restrictions across gender-specific sub-systems of equations generated by the sharing rule explain the relation across the error components of each equation in the system. Given the cross-sectional nature of the data and the structure of the model, the error terms are heteroscedastic. This feature has been corrected computing a White consistent error variance-covariance matrix. Therefore, the parameters of the gender-specific sub-system of equations in Eq. (6) are estimated jointly using a generalized least square estimator which corresponds to the iterative version of the SUR estimator. In this study, the omitted equations are the consumption equations for both genders. The iterative SUR estimator guarantees that the results are invariant to the omitted equation, which, in our case, is the consumption good equation.

4 The sharing of the full cost of children

The full cost of a child is composed by the value of market goods, the value of non-market goods and the value of time devoted to child care (Bradbury 2004b, 2008). In turn, the full cost of a child is made up of a need component, given by the costs for the necessary goods and a minimal level of parental time, and the cost for goods and time that are not necessary. In fact, Bradbury (2004a, 2008) distinguishes the cost of maintaining a child associated with the child needs corresponding to the concept of equivalence scale from the "price" of a child associated with the cost of rearing a child. This distinction is important because the need component may not vary significantly with income (Lewbel 1989; Blackorby and Donaldson 1991), while the full cost does. In this study, we are mainly concerned with the need component of the full cost of children.[9] Knowledge of the rule governing the allocation of resources within a household further allows us to estimate how much of the full cost of a child is borne by

[9] Pollak and Wales (1979) show that equivalence scales suffer from a fundamental identification problem and criticize the possibility of meaningful welfare comparisons. For a recent discussion of these issues in the context of needs based equivalence scales, we refer to the paper by Menon and Perali (2010). Indifference scales introduced by Lewbel (2004) and later further developed also in Dunbar et al. (2013) and Browning et al. (2013) are defined as the lowest cost for, say, a woman living alone to attain the same indifference curve she attained living with the spouse. Indifference scales do solve the identification problem without having to resort to often-untestable assumptions regarding comparability of utility across individuals. Indeed, indifference scales implement interpersonal not inter-household comparisons and are not informative about the cost of children.

each parent. The collective approach is used here to derive the individual cost functions and to separate, within each individual cost function, the single cost components due to market, domestic and time consumption.

To accomplish this task, we construct the full cost of a child as a cost of characteristic index (Lewbel 1997; Ebert and Moyes 2003, 2009) based on the full costs of maintaining a child borne by each household member, that is, total expenses required to purchase market goods, services and time. In this framework, we define the share of the cost of maintaining a child as the increase in each member's full income required to maintain the individual welfare that he or she could attain when living in a childless couple (Pollak and Wales 1992). From the indirect utility function described in Eq. (3), we derive the cost functions for each member of the couple:

$$\ln C_1(u_1, p; d) = \ln \phi_1(\cdot) = \ln A_1(p) + \ln u_1 B_1(p) + \ln \wp_1{}^T(p, d) \tag{10}$$

$$\begin{aligned} \ln\ C_2(u_2, p; d) &= \ln \phi_2(\cdot) = \ln(Y - \phi_1(\cdot)) \\ &= \ln A_2(p) + \ln u_2 B_2(p) + \ln \wp_2^T(p, d) \end{aligned} \tag{11}$$

corresponding to the level of individual full income scaled to account for the transfer realized through the intra-household distribution process. As for conventional equivalence scales, we define the cost of maintaining a child as the relative cost associated with the characteristic "presence of a child" in the comparison household f:

$$M(d^f_{-s}, d^r_{-s}; u_1, u_2, p) = \frac{C^f(u, p; d^f_{-s})}{C^r(u, p; d^r_{-s})} = \frac{C^f\left(C_1(u_1, p; d^f_{-s}) + C_2(u_2, p; d^f_{-s})\right)}{C^r\left(C_1(u_1, p; d^r_{-s}) + C_2(u_2, p; d^r_{-s})\right)} \tag{12}$$

where the demographic profile $j = f, r$ of the reference household r and the comparison household f differ only for the attribute associated with the presence of an extra-child. The translating demographic modification of the adopted demand system generates equivalence scales that are exact by construction (Blackorby and Donaldson 1991) or independent of the base income (IB), or utility level, chosen for comparison (Lewbel 1989). IB preferences are separable in u and d as follows:

$$\begin{aligned} &C^j\left(C_1^j\left(u_1, p; d^j_{-s}\right) + C_2^j(u_2, p; d^j_{-s})\right) \\ &= C_j\left(C_1^{*j}(u_1, p)\wp_1^{Tj}\left(p, d^j_{-s}\right) + C_2^{*j}(u_2, p)\wp_2^{Tj}\left(p, d^j_{-s}\right)\right) \quad for\ j = f, r \\ &\text{and} \\ &C_i^{*f}(u_1, p) = C_i^{*r}(u_i, p). \end{aligned} \tag{13}$$

Engel curves associated with this structure are linear in income and parallel as family size increases. The horizontal difference between two parallel curves is the cost of a child that stays constant as income increases. The implied cost of living index (12) can then be decomposed in the following way:

$$M(d^f_{-s}, d^r_{-s}; u_1, u_2, p) = \frac{\left(C^{*f}_1(u_1, p)\wp_1^{T_f} + C^{*f}_2(u_2, p)\wp_2^{T_f}\right)}{\left(C^{*r}_1(u_1, p) + C^{*r}_2(u_2, p)\right)}$$
$$= \frac{C^{*f}_1(u_1, p)}{\left(C^{*r}_1(u_1, p) + C^{*r}_2(u_2, p)\right)}\wp_1^{T_f} + \frac{C^{*f}_2(u_2, p)}{\left(C^{*r}_1(u_1, p) + C^{*r}_2(u_2, p)\right)}\wp_2^{T_f}. \quad (14)$$

For the chosen structure of preferences described in Eqs. (10) and (11), the total cost of a child is the weighted sum of the separable demographic components $\wp_1^T$ and $\wp_2^T$ for the comparison household f, where the weights are the relative contributions of each parent to the full household costs. Note that the term $\wp_i^{\mathrm{Tr}}$ is equal to 1 for the reference family being a couple without children.

The relative contribution of each parent to the full cost of children can be computed as the ratio between the difference of the cost borne by each parent of the household with children and the cost incurred by the member of a childless couple of the same gender to the full costs of a child computed as the difference in the two full-income levels:

$$D\left(d^f_{-s}, d^r_{-s}; u_i, p\right) = \frac{\left(C^{*f}_i(u_i, p)\wp_1^{T_f} - C^{*r}_i(u_i, p)\right)}{\left(C^{*f}_1(u_1, p)\wp_i^{T_f} + C^{*f}_2(u_2, p)\wp_i^{T_f}\right) - \left(C^{*r}_1(u_1, p) + C^{*r}_2(u_2, p)\right)}. \quad (15)$$

The presence of a child increases the time spent on household production activities, including childcare, at the expense of the consumption of leisure. This implies a transfer of time from leisure to the household production of child care activities. Because of the adding up restriction of the complete demand system (Eq. 6), demographic parameters capturing fixed costs sum to zero, $\sum_k t^i_k = \sum_k \sum_n \tau^i_{kn} \ln(d^n_{-s}) = 0 \rightarrow \sum_k \tau^i_{kn} = 0$. As a consequence, a cost increase of the market x and household z components must be matched by a reduction in the leisure l component leaving the cost of a child almost unchanged. To avoid this, we compute Eqs. (14) and (15) accounting only for the full cost a child associated with the market goods and household products dropping the leisure component of $\wp_i^T$. Therefore, we present the full cost of a child without recognizing the "market" compensation for the associated loss of rest, but accounting only for the additional direct cost associated with the market evaluation of the time transferred from the leisure endowment to household production and child care activities.

In order to better understand how the composition of goods and time changes as the child grows older, we decompose the full costs incurred by each parent in terms of the single components using the definition of the translating term $\wp_i^T$ as follows:

$$M^i(d^{n^f}_{-s}, d^{n^r}_{-s}; p) = \frac{C^{*f}_i(u_i, p)\wp_i^{T_f}}{C^{*r}_i(u_i, p)\wp_i^{T_r}} = \frac{\wp_i^{T_f}}{\wp_i^{T_r}} = \wp_i^{T_f} = \prod_k p_k^{\tau^i_k d^{n^f}_{-s}} = \prod_k M^i_k$$
$$= \left(p_m^{\tau^i_{xn} d^{n^f}_{-s}}\right)\left(p_z^{\tau^i_{zn} d^{n^f}_{-s}}\right)\left(p_l^{\tau^i_{ln} d^{n^f}_{-s}}\right), \quad (16)$$

given that $\wp_i^{T_f} = 1$ for $d_{-s}^{n^r} = 0, k = x, z, l$ and $i = 1, 2$. The term $M_k^i = p_k^{\tau^i d_{-s}}$ can be interpreted as a good specific p-dependent cost index of the characteristic "presence of a child." The demographic parameter τ_{kn}^i describes how each parent substitutes goods x_m, x_z and x_l in response to the presence of a child of different age. Inspection of Eq. (16) reveals that the equivalence scale is independent of u. The fixed cost $\wp_i^{T_f}$ is the committed consumption associated with the presence of a child whose composition varies as the age of the child changes.

5 Data

The empirical analysis is based on a subsample of the 1995 Bank of Italy Survey on Household Income and Wealth (SHIW). The survey reports data on hours of market work, earnings, non-labor incomes and demographic characteristics specific to each family member. The survey also records information about aggregate food consumption and total expenditure, but does not contain information on the allocation of time to different non-market uses. As it is conventional in the literature,[10] we gather information on hours of domestic working time and leisure, necessary to estimate the household production technology and to identify the collective model from the 1989 nation-wide ISTAT Time Budget Survey (TBS).

The survey records time use by means of interviews and daily dairy during different days of the week, by distinguishing between weekdays and weekend days, for each individual in the family more than 3 years old. The time endowment of 16 h/day, that is, 112 h a week, net of the time for rest and personal care of 8 h, is distributed between market and non-market time. Non-market time is then divided between pure leisure and domestic time that includes a number of specific activities such as household chores, direct involvement in childcare, shopping and house administration.

The integration of the statistical information available in different data sets can be implemented by means of imputation procedures (Singh et al. 1993; D'Orazio et al. 2006; Gallezzoni et al. 2008).[11] Data on time use have been matched with the Bank of Italy income survey using regression techniques applied to complementary surveys. The statistical matching is described in detail in Addabbo and Caiumi (2003).[12] The adopted procedure is based on the estimation of unpaid work equations by type (housework, childcare, shopping and house administration), gender and days of the

[10] See, for example, Apps and Rees (2002).

[11] The absence of comprehensive data sets including information about "who does what and when" and who consumes what in the family poses considerable challenges in terms of extra modeling effort and identifying assumptions. More comprehensive data are indeed to be collected, possibly within the same survey, to obtain more complete and robust answers to the research questions considered here.

[12] The linking procedure may modify the original properties of the source data sets. Because of imputation, measurement errors due to the exclusion of unmatched units or the erroneous match, or overrepresentation of matched units may arise and relevant information may be lost (Chesher and Nesheim 2006). Both the SHIW and the TBS contain information on socio-demographic characteristics of the households—such as household composition, age and level of education of each household member—which are relevant in explaining time use choices. Addabbo and Caiumi (2003) check whether the records drawn from the different data sources with reference to the selected household types, that is, couples with and without children, belong to the same population by testing the distance between different data sources.

week, for couples with and without children conditional on a set of socio-demographic characteristics of the household.[13] The variables used for the imputation are individual characteristics such as age, years of education, employment condition, type of job (industry, position, part-time job), partner's socio-demographic characteristics, area where the family lives, number and presence of children in different age groups. This allows the computation in our matched sample of domestic production costs that vary by couple members and across households of different composition.

The sample is restricted to married couples with both parents with age from 19 to 64 and children <18 years old. The selected sample consists of 2,521 records. Following Apps and Rees (1996, 2002), the sample is split into two subsamples: the subsample of "traditional single-earner" families, where the female partner is a housewife, and the subsample of "non-traditional double-earner" families, where both members are employed at least 30 h a week. This selection criterion, that excludes married couples where the woman works part time, gives a sample of 660 observations representing the traditional households and 558 observations for non-traditional ones.[14]

The descriptive statistics of the variables used in the econometric analysis are reported in Table 1. The upper part of the Table 1(a) describes the time allocation in market, home and pure leisure activities. Both in traditional and non-traditional households, the husband works about 43 h per week at a wage that does not differ significantly between the two type of households. Traditional households have about 1.3 times the number of children that non-traditional families have. In non-traditional families, working time and earnings are not evenly distributed between husband and wife. Women work outside the home almost as many hours as men do. However, the domestic working time is ten times higher. On the other hand, both female wage and non-labor income are much lower than male ones. Inspection of Table 1(b) also reveals that for single-earner households, the housewife unpaid working time is about 30 % higher than the husband total working time.

Unearned incomes do not include returns from capital accumulation in order to avoid possible endogeneity problems with past and current labor supply (Lundberg et al. 1997). Individual full incomes are individual expenditures constructed by assigning an equal share of non-assignable household consumption of market and domestic goods among the members plus the value of leisure consumed by each

[13] In particular, the matching procedure adopted in Addabbo and Caiumi (2003) can be illustrated as follows: To impute the variable of interest, y', into the survey where it is unobserved, the authors take the conditional mean of the regression obtained from the survey where the y is observed, $E(y|X_1) = \beta X_1$, and substitute the exogenous variables drawn from the survey where it is missing, X_0. The standard error of the regression is added, in order to reproduce as best as possible the unobserved heterogeneity not captured by the conditional mean of the regression. The variable of interest is then computed as $y' = \beta X_0 + \sigma_\varepsilon$. To test the matching procedure, the authors compare the estimated hours of work—devoted to child care, domestic activities and constrained time—and the observed data for the selected TBS subsample. They show that the simulated distribution is statistically close to the observed one on the basis of the first and second moments.

[14] It is worth noticing that this selection rule may generate a selection bias. However, our major concern was to maintain the comparability of our results with the original work by Apps and Rees. Non-participation, full or part time, is an extension of the collective model that has been treated in contexts without household production (Donni 2003; Blundell et al. 2007) only from a theoretical point of view. To the best of our knowledge, this important aspect has not been empirically implemented yet.

Table 1 Descriptive statistics

	All families		Families w/o children		Families with children < 6		Families w/o children < 6 and husband > 40	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
(a) Non-traditional (double-earner) families								
Husband								
H.rs of market work/week	42.93	7.17	42.98	7.11	42.87	7.25	42.47	6.80
H.rs of domestic work/week	3.40	1.69	3.21	1.49	4.91	2.04	3.12	1.43
H.rs of leisure	65.67	7.09	65.81	6.87	64.22	7.24	66.41	6.68
Hourly wage/1,000	14.10	10.85	13.15	8.52	14.24	12.38	14.97	12.94
Non-labor income/year	590.7	4,872.1	854.1	4,997.5	178.0	926.2	1,033.9	6,810.0
Age	41.80	8.39	43.48	10.55	34.68	5.05	48.53	4.92
Education (years)	10.60	3.88	9.98	3.86	11.51	3.39	9.83	4.18
Share—leisure	0.62	0.10	0.62	0.11	0.62	0.11	0.62	0.10
Share—domestic product	0.15	0.07	0.14	0.07	0.16	0.05	0.14	0.06
Share—market goods	0.23	0.08	0.24	0.09	0.22	0.08	0.24	0.09
Full income/month (000Lira)	5,773.0	3,282.7	5,536.5	3,049.4	5,666.9	3,147.9	6,094.7	3,788.9
Wife								
H.rs of market work/week	40.23	5.72	40.98	6.09	40.65	6.19	40.12	5.72
H.rs of domestic work/week	31.20	6.22	29.50	6.19	33.21	5.65	31.31	6.22
H.rs of leisure	40.57	7.82	41.52	8.10	38.14	7.44	40.57	8.09
Hourly wage/1,000	11.73	17.95	12.66	28.16	11.15	4.27	10.95	6.24
Non-labor income/year	76.47	676.99	132.18	930.77	71.08	724.96	56.08	532.47
Age	38.64	8.02	40.66	10.23	31.64	4.05	44.79	5.46
Education (years)	10.73	3.77	10.07	3.93	12.11	3.19	9.75	4.06
Share—leisure	0.46	0.11	0.46	0.12	0.45	0.10	0.44	0.11
Share—domestic product	0.20	0.06	0.19	0.05	0.24	0.06	0.20	0.06
Share—market goods	0.34	0.12	0.35	0.13	0.32	0.10	0.36	0.12
Full income/month (000Lira)	3986.70	3,869.74	4,177.70	5,959.09	3,745.89	1,223.09	3,921.81	1,743.28
Estimated price—domestic good (000Lira)	12.30	23.63	13.50	37.43	11.52	4.16	11.42	6.53
No. children	1.38	0.88	0.00	0.00	1.15	0.38	1.52	0.79
No. children <6	0.26	0.49	0.00	0.00	1.15	0.38	0.00	0.00
Northwest (%)	0.29	0.45	0.33	0.47	0.26	0.44	0.28	0.45
Northeast (%)	0.26	0.44	0.31	0.46	0.28	0.45	0.25	0.44
Center (%)	0.22	0.41	0.22	0.41	0.15	0.36	0.24	0.43
South (%)	0.23	0.42	0.14	0.35	0.31	0.46	0.22	0.00

Table 1 continued

	All families		Families w/o children		Families with children < 6		Families w/o children < 6 and husband > 40	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Number of records	558		203		103		169	
(b) Traditional families (single-earner)								
Husband								
H.rs of market work/week	43.57	7.84	43.44	7.80	44.14	7.60	43.33	7.63
H.rs of domestic work/week	2.11	1.18	2.04	0.91	3.52	1.84	1.71	0.74
H.rs of leisure	66.32	7.75	66.52	7.67	64.34	7.47	66.96	7.53
Hourly wage/1,000	13.59	13.68	14.40	17.23	12.55	11.48	13.36	6.83
Non-labor income/year	794.4	4186.2	1,335.6	5,995.2	407.9	1,437.2	560.3	3098.2
Age	45.05	9.24	50.68	9.36	33.54	4.63	47.22	4.70
Education (years)	8.84	3.68	8.73	4.01	9.93	3.54	8.54	3.65
Share—leisure	0.64	0.10	0.64	0.11	0.63	0.11	0.64	0.10
Share—domestic product	0.18	0.07	0.17	0.06	0.20	0.07	0.17	0.06
Share—market goods	0.19	0.06	0.19	0.07	0.17	0.06	0.19	0.07
Full income/month (000Lira)	5,441.2	3,896.5	5,715.5	4,825.5	4,911.4	3,282.5	5,452.5	2,224.6
Wife								
H.rs of market work/week	0.23	2.71	0.38	3.64	0.27	3.12	0.12	1.62
H.rs of domestic work/week	55.51	7.12	52.23	6.00	57.12	7.15	56.77	6.24
H.rs of leisure	56.26	7.59	59.39	6.93	54.61	7.78	55.11	6.78
Hourly potential wage/1,000	7.34	3.94	7.71	5.41	7.14	2.26	7.25	2.33
Non-labor income/year	67.28	904.3	68.50	673.27	46.10	410.26	65.30	1040.8
Age	41.34	9.44	47.29	9.62	29.37	4.85	43.09	5.14
Education (years)	7.79	3.47	7.17	3.55	9.83	3.13	7.41	3.28
Share—leisure	0.47	0.08	0.49	0.07	0.48	0.07	0.46	0.07
Share—domestic product	0.25	0.05	0.23	0.04	0.28	0.05	0.25	0.04
Share—market goods	0.27	0.08	0.28	0.08	0.24	0.07	0.29	0.08
Full income/month (000Lira)	3,474.94	1,406.0	3,695.21	1,797.46	3,253.59	1,072.05	3,468.59	1,092.27
Estimated price—domestic good (000Lira)	7.59	4.05	7.98	5.51	7.49	2.49	7.46	2.42
No. children	1.84	0.92	0.00	0.00	1.46	0.60	2.31	0.86
No. children <6	0.25	0.51	0.00	0.00	1.46	0.60	0.00	0.00
Northwest (%)	0.17	0.37	0.19	0.39	0.20	0.40	0.16	0.36
Northeast (%)	0.14	0.35	0.16	0.37	0.14	0.35	0.14	0.35
Center (%)	0.20	0.40	0.23	0.42	0.17	0.38	0.19	0.39
South (%)	0.49	0.50	0.42	0.49	0.49	0.50	0.51	0.50
Number of records	660		161		117		175	

'Non-traditional families' are selected as those in which both members work more than 30 h a week. 'Traditional families' denote families where the female partner is a housewife

individual, which we assume to be assignable because enjoyed mainly privately.[15] We assume that non-assignable goods are divided equally in half in the household. Menon and Perali (2012) show that this assumption is innocent because it does not alter the information associated with assignable goods on which identification of the sharing rule relies upon in line with Chiappori's (1988; 1992) original identification strategy. The more information on assignable goods is available in the data, the better we can learn something about the rule governing the allocation of family material and time resources within the household and the higher the estimation accuracy of individual preferences. For example, we could have also exploited the information about gender-specific clothing expenditure if it were available in our main data source, the Italian Income Household Survey, which is not a consumption survey.

We assume that the bargaining process over the share of income is influenced by market wages even if an individual is not employed in the market. This assumption implies that the threat point depends on the wage that the individual would receive if he or she chose to work. Potential wages are predicted from a wage equation estimated by applying the Heckman procedure to account for self-selection bias.[16] The results are reported in the "Appendix" only for women in the traditional household because in our sample men are employed for at least 30 h a week. The estimation is based on the 1995 Bank of Italy sample of married couples. Inspection of Table 8 reveals that the presence of children, as it is plausible to expect in Italy, significantly affects the participation decision of women. The likelihood of a woman being employed is positively affected by the age and level of education and negatively affected by the regional unemployment rate. The working conditions of the partner do not affect the participation decision of the woman to a decreasing extent as the child grows old. The level of household income does not significantly affect the probability of a woman being employed. The specification of the wage equation includes variables describing the household members' endowment of human capital and regional dummies to account for wage discrimination. The estimated rate of return to schooling, expressed in years of education, is 8 %. Age does not have a statistically significant effect on women's wage. Work experience increases women's wage by 6 %. Wages are significantly lower for women living in the southwest (16 % less than those living in the North), in the southeast (10 % less) and in the center of Italy (−11 %).

6 Results

The household production technology has been estimated as in Eq. (8). The estimates, both for traditional and non-traditional households, are reported in Table 2.

[15] Browning and Bonke (2009) distinguish three items categories: (a) assignable items because bought exclusively for one member, (b) assignable items because bought exclusively for the other member and (c) non-assignable items bought for the household such as food.

[16] We recognize that market wages for women fully employed in household production at best provide a lower bound to the real opportunity cost of their time. We thank a referee for this comment.

Table 2 Estimates of the household technology of non-traditional and traditional families (instrumental variable estimation for traditional families)

Parameter	Variable name and definition	Non-traditional households	Traditional households
a_{00}	Constant of the share	0.0032	0.0035
		0.0195	*0.0095*
a_1	nf02—no. of children 0–2	0.0743*	0.0469*
		0.0086	*0.0031*
a_2	nf35—no. of children 3-5	0.0251*	0.0195*
		0.0052	*0.0026*
a_3	nf617—no. of children 6-17	−0.0061*	−0.0036*
		0.0026	*0.0012*
a_4	eta1—age, husband	0.0019*	0.0011*
		0.0007	*0.0003*
a_5	eta2—age, wife	0.0000	−0.0007
		0.0006	*0.0003*
a_6	anst1—years of education, husband	0.0035*	0.0000
		0.0008	*0.0004*
a_7	anst2—years of education, wife	0.0006	0.0003
		0.0007	*0.0005*
a_8	l_dip1—f dependent worker, husband	0.0357*	0.0042
		0.0101	*0.0026*
a_9	l_dip2—if dependent worker, wife	−0.0563	
		0.0109	
a_{10}	r1—Northwest	0.0272*	0.0195*
		0.0069	*0.0038*
a_{11}	r2—Northeast	0.0248*	0.0195*
		0.0091	*0.0038*
a_{12}	r4—South	−0.0455*	−0.0171*
		0.0062	*0.0031*
a_{11}	wage_h—wage, husband	0.0552*	0.0616*
		0.0099	*0.0027*
a_0	constant of the cost function	5.2299*	5.2753*
		0.0539	*0.0086*
	Allen partial elasticities of substitution (computed at the sample mean)		
σ_{11}	Husband hours unpaid work/own wage	−3.4166*	−0.5419
		0.5782	*0.5668*
σ_{22}	Wife hours unpaid work/own wage	−0.2237*	−0.1452*
		0.0131	*0.0031*
σ_{12}	Husband hours unpaid work/wife wage	0.5145*	0.0402
		0.0871	*0.0420*

Cost function R^2: (*a*) single-earner: 0.74, double-earner: 0.84; (b) * denotes statistically significant coefficients at the 5 % significance level and heteroskedsticity-consistent standard errors in italics; (*c*) instruments used are: dwelling size (in square-meters), number of bathrooms, location (urban, rural, suburbs), location's evaluation, husband's age-cubed and wife's age-cubed

For traditional households, the estimation technique is IV, because of the endogeneity of female wages as confirmed by the Durbin–Wu–Hausman's test.[17] We correct for this source of endogeneity selecting a set of exogenous regressors after testing for their weakness with an F test and for the presence of over-identifying restrictions using Sargan–Hansen's test. The set of instruments used include dwelling size (in square-meters), number of bathrooms, location (urban, rural, suburbs), location's evaluation, husband's age-cubed and wife's age-cubed. The signs are consistent with expectations. The number of children with less than three or six years of age positively and significantly affect, at least at the five percent significance level, household costs in both traditional and non-traditional households. The presence of older children between 6 and 17 years old has a negative and statistically significant impact on the household technology probably because of the lower demand for care. Interestingly, the personal characteristics such as age, education and the condition of dependent worker are significantly different from zero and positive only for the husband in non-traditional households likely because at a later life stage, better-educated husbands with a sure job and with a working wife own larger houses. The household technology is significantly more expensive in the north of Italy. In the south, wages are significantly lower for both genders (Prasard and Utili 1998). The impact is larger in households with double-earners because of relatively higher costs.

Both technologies satisfy the curvature conditions, as shown in the bottom portion of the table reporting the Allen elasticities of substitution for wages. The own elasticity of substitution associated with the wage of the husband (σ_{11}) is ten times larger in double-earner families.

The collective model of consumption–leisure choice (Eq. 6) has been estimated for a sample of double- and single-earner households and for other subsamples referring to household types at different stages of the life cycle in order to capture differences in behavior associated with cohort effects and the presence of children. We have selected families without children, families with children under six and families without children under six and husbands older than 40. The estimation has been carried out with homogeneity and symmetry restrictions imposed (Tables 9 and 10).

Tables 3 and 4 present the compensated price elasticities describing the curvature properties of the individual expenditure functions at the data means. In general, the signs of the diagonal elements of the gender-specific compensated price elasticities are negative and very significant for double-earner families both in the aggregate and within groups (Table 3). The Slutsky requirements (Apps and Rees 1997) are respected for the single-earner households at the aggregate level, but the compliance is lower for the selected groups (Table 4) for both couple members. This is probably due to the differential involvement in non-market activities of the female component or to other aspects related to unobserved heterogeneity. For double-earner households, it is interesting to note that husbands' behavior is not affected by the presence of children, while wives react by becoming less sensitive to wage changes. In fact, the female

[17] As expected, we find that wages for females employed in the labor market, according to the same test, are exogenous.

Table 3 Compensated price (e_k) and income elasticities (e_y) by gender and family type. Non-traditional (double-earner) households

	Husband				*Wife*				*Shares*	
	e_l	e_z	e_x	e_y	e_l	e_z	e_x	e_y	*H*	*W*
l. Leisure	−0.15**	0.06**	−0.39**	1.26**	−0.05**	0.80**	0.18	1.61**	0.63	0.48
z. Domestic good	0.09**	−0.28**	−0.20**	−0.52**	−0.51**	−0.51**	−0.17**	−0.54**	0.15	0.20
x. Market good	0.66**	0.17**	−0.10**	1.35**	−0.01**	0.68**	−0.17**	1.04**	0.22	0.32
Without children										
l. Leisure	−0.01**	−0.51	−0.22**	1.12**	−0.72**	1.17**	−0.03**	1.01**	0.62	0.46
z. Domestic good	0.26**	−0.08	0.24	0.71	0.88**	−1.70**	0.30**	1.00**	0.14	0.19
x. Market good	0.29**	0.25	−0.23**	0.81*	0.22**	0.13**	−0.28**	0.98**	0.24	0.35
With children < 5 years old										
l. Leisure	−0.01**	0.36	0.38**	1.65**	−0.18	0.47	0.75**	1.90**	0.62	0.45
z. Domestic good	−0.38**	−0.05*	0.08**	−0.15	−0.45	−0.05	−0.10	−0.04	0.16	0.24
x. Market good	−0.31**	0.10**	−0.17**	0.02	−0.32**	0.00	−0.13**	0.14**	0.22	0.32
With children > 5 years old and husband > 40 years old										
l. Leisure	−0.04**	0.12**	−0.38**	1.14**	−0.22**	0.89**	0.21*	1.55**	0.62	0.44
z. Domestic good	−0.23**	0.00**	−0.18	−0.08**	−0.33**	−0.64**	−0.22**	−0.43**	0.14	0.20
x. Market good	0.70	0.28**	−0.27**	1.35**	0.01**	0.58**	−0.20**	1.04**	0.24	0.36

l. Leisure, *z*. domestic good, *x*. market good

** Denotes statistical significance at the 5% level; * at the 10% level

Table 4 Compensated price (e_k) and income elasticities (e_y) by gender and family type. Traditional (single-earner) households

	Husband				Wife				Shares	
	e_l	e_z	e_x	e_y	e_l	e_z	e_x	e_y	H	W
l. Leisure	−0.02**	−0.02**	0.04**	1.58**	−0.11	0.13*	−0.02*	1.58**	0.64	0.47
z. Domestic good	−0.11**	0.08	0.03	−0.11**	0.25	−0.56**	0.31**	−0.44**	0.17	0.25
x. Market good	0.15**	0.03	−0.18**	−.08	−0.04**	0.31**	−0.27**	1.31**	0.19	0.27
Without children										
l. Leisure	0.00	0.00	−0.01	1.37**	0.37**	−0.35**	−0.03	1.52**	0.64	0.49
z. Domestic good	−0.03	0.02	0.01	−0.08	−1.15**	0.67**	0.48**	−0.51**	0.17	0.23
x. Market good	−0.51**	0.02	0.18**	0.14	−0.17**	0.50**	−0.27**	0.87**	0.19	0.28
With children <5 years old										
l. Leisure	−0.00	−0.02*	0.02	1.53**	0.25	−0.19	−0.07**	1.86**	0.63	0.48
z. Domestic good	−0.07**	−0.02	0.06	−0.04	−0.31	−0.13	0.44**	−0.25**	0.20	0.28
x. Market good	0.06	0.07	−0.13**	0.17	0.08	0.54**	−0.39**	0.74**	0.17	0.24
With children >5 years old and husband > 40 years old										
l. Leisure	0.03**	−0.02**	−0.02	1.53**	0.52**	−0.46**	−0.05**	1.55**	0.64	0.46
z. Domestic good	−0.11**	−0.01	0.12**	−0.10*	−0.99**	0.51**	0.48**	−0.77**	0.17	0.25
x. Market good	−0.09**	0.12**	−0.02	−0.03	−0.25**	0.46**	−0.33**	1.58**	0.19	0.29

l. Leisure, z. domestic good, x. market good

** Denotes statistical significance at the 5 % level; * at the 10 % level

demand for leisure is significantly more inelastic with respect to the own opportunity cost. Also, the magnitude of the impact of the value of household production is significantly smaller for the mother, decreasing from −1.70 without a child to −0.05 with a young child. The increase in the price of household production observed in the presence of children less than six years old is also associated with a decrease in the price elasticity of the demand for the domestic product of the mother (Table 3 non-traditional panel) that becomes inelastic. These results may indicate that, when a child arrives, women in non-traditional households employ more time to home activities regardless of its opportunity cost and income level, while husbands' allocation remains almost unchanged. In general, leisure is a luxury good. The demand elasticity of leisure with respect to income is greater than one for both couple members in all-family types. It is interesting to note that it is higher for households with small children. On the other hand, the income elasticity of the domestic good is significantly different from zero and negative for wives belonging to older non-traditional families, while in traditional families the elasticities are all negative. This means that the demand for the domestic product decreases as the amount of available resources increases.

The impact of a change in wage of agent i on j's consumption of market, domestic goods and leisure acts as an income effect through the sharing function. Table 5 reports the estimated parameters of the sharing rule for each household type and the comparison between the estimated $\phi_1/Y = Y_1 m(.)/Y$ and the actual Y_1/Y full-income share of the husband. The reported parameters correspond to the exponents in Eq. (7) with the exception of the parameter associated with the demographic variable that has been dropped from the final specification of the double logarithmic sharing function because demographic factors do not add useful information for the identification of the sharing rule. The interpretation of the effects may be illustrated with an example. Consider a change in w_2 for all traditional families included in the sample. A 10 % increase in the potential wage of the non working women increases by 7 % the value of the scaling function $m(.)$. If we suppose that $m(.)$=1 before the salary increase, then the 7 % increase of $m(.)$ corresponds to a positive transfer from the wife to the husband of $Y_1 m(.)$. At the mean full-income level of 3.475.000 £ (Liras) [see Table 1(b)] corresponding to about 1795 Euros, the transfer amounts to about 243.250 £ (Liras) or about 122 Euros.

Most parameter estimates are statistically significant at conventional levels for all distribution factors, except for the male non-labor income variable. The effect of this variable is weak for both members, with the exception of non-traditional families without children, due to the fact that non-labor income records a high percentage of zero values. Keeping in mind the specification of the sharing rule described in Eq. (7), the positive sign of the coefficients for the whole sample of non-traditional households indicates that an increase in labor and non-labor income of both members gives raise to an increase of the husband's own share, because the wife transfers resources to the husband, while the husband keeps the resources for himself. This is not the case for childless non-traditional households. As is suggested by the negative sign associated with both the wage and non-labor income variables, the wife's behavior can be interpreted as egoistic both for childless couples and for households with young children. On the other hand, for the older cohort, where the

Table 5 Intra-household allocation of resources by gender and family type

Parameters	Non-traditional (double-earner) families				Traditional (single-earner) families			
	All	Without children	With children < 5 years old	With children >5 years old and husband > 40 years old	All	Without children	With children < 5 years old	With children >5 years old and husband >40 years old
	Estimates of the sharing rule Eq. (7)							
$\theta_1(w1)$	0.010**	−0.006**	0.014**	0.005	0.008**	−0.068**	−0.036**	−0.052**
	0.005	*0.001*	*0.005*	*0.003*	*0.002*	*0.015*	*0.011*	*0.009*
$\theta_2(w2)$	0.102**	−0.438**	−0.049**	0.066**	0.068**	0.109**	0.102**	0.093**
	0.017	*0.046*	*0.024*	*0.019*	*0.017*	*0.026*	*0.024*	*0.013*
$\eta_1(y1)$	0.001	0.013**	0.000	0.000	0.000	−0.000	−0.000	0.000
	0.001	*0.001*	*0.001*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
$\eta_2(y2)$	0.003**	−0.013**	0.000	0.002**	0.001**	0.000	0.001*	0.000
	0.001	*0.001*	*0.001*	*0.001*	*0.000*	*0.000*	*0.000*	*0.001*
Y_1/Y	58.8	59.3	58.9	60.6	59.2	55.9	58.9	59.6
ϕ_1/Y	56.6	57.3	59.3	59.6	58.6	55.8	58.6	59.8

Heteroscedasticity-consistent standard errors in italics

** Denotes statistically significant coefficients at the 5% significance level, * 10% level

female wage variable is associated with a positive sign, the female transfers part of her resources to the husband. The husband does not reciprocate this altruistic behavior. The altruistic behavior of the female prevails also at the level of the aggregate sample.

The estimated sharing rule for traditional households reveals that in single-earner households the wife behaves altruistically in all cases. In fact, an increase in the wife's potential wage implies an increase in the husband's share. On the other hand, an increase in the husband's wage raises his transfers to the wife through the link $Y_2 = Y - \phi_1$. A negative sign for the male wage can therefore be associated with altruistic behavior from the husband. This pattern suggests that the subgroups of traditional households of our sample behave as "mutual exchange" economies. The behavior of the couple is altruistic in the sense that both members are willing to share resources. In the case referring to all traditional households, the impact of the male wage on the share ϕ_1 is positive and statistically significantly different from zero. This sign change stems from the fact that the aggregate sample includes other households not included in the selected subsamples and is therefore not in contrast to the evidence shown for the other selected traditional household types.

Inspection of the bottom of Table 5 reveals that the actual and predicted share of the household full income pertaining to the husband does not differ significantly at the means. As shown in Fig. 1, the actual and estimated shares have a similar pattern contained within the expected 0–1 bounds. Figure 1 compares the splines of the actual and estimated male share of household full income across income quintiles for both non-traditional and traditional households. At low-income levels, both predicted and actual values for both household types show a more egalitarian distribution of resources as a result of a more equal distribution of power.

Table 6 shows the cost of a child by age profile (Eq. 14) and the relative contribution of each parent to the "full" cost (Eq. 15). The equivalence scale for a child less than three years old is 23 % of the cost of living of a childless couple corresponding to 47 % of the cost of an adult equivalent. The full cost of a child decreases as the child grows old. The cost of a child is comparable across household types. The pattern of the relative contributions to the "full" cost reflects the different organization of traditional and non-traditional households. In households where both members work and the child is less than three years old, the father's contribution corresponds to 46 % of the total increase in full costs due to the presence of a child. When the child is less than three years old, the relative contribution is in the same proportion for both traditional and non-traditional households. When both parents work, the mother bears most of the costs. In traditional households, the relative contribution of the father is larger than the contribution of the mother when the children are more than five years old. It is worthwhile to stress that the equivalence scales presented here, which are independent of income by construction as explained in Sect. 4, are not directly comparable with the full consumption equivalence scales presented in Apps and Rees (2002), Bradbury (2008) and Koulovatianos et al. (2009) that are clearly dependent on income and, in general, higher.

In order to isolate the single components of the full cost of a child, we compute the cost of living index associated with market goods, household production and leisure for both members of traditional and non-traditional households following the formal-

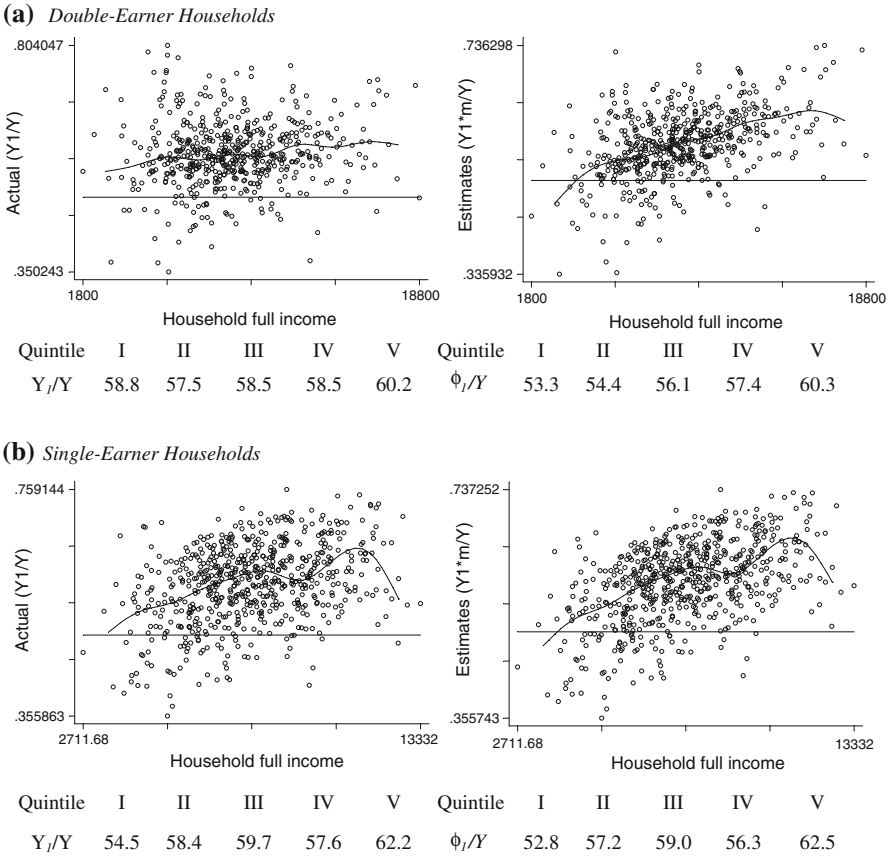

Fig. 1 Intra-household allocation of resources: male share of household full income—actual (*left column*) and estimated (*right column*)

ization described in Eq. (16). The decomposition is presented in Table 7. The cost of a child older than three decreases because both the market and product component decrease. In general, the pattern for traditional and non-traditional households is similar. The market goods component of the full cost of a child is smallest when compared to the size of the household product and leisure component. This pattern is due to the fact that the Bank of Italy income survey underestimates expenditure information. In fact, the descriptive statistics in Table 1 show that the share of market goods is small in comparison with the share of household production and leisure. The household production component of the full cost of a child decreases as the child grows. With respect to childless couples, both parents of both household types increase their involvement in household production. For both members of non-traditional households, the index is relatively higher. This evidence does not imply that the members of households where both work are also more involved in domestic activities. The index for traditional households, which compares the situation of a couple with a child and a childless couple, is relatively lower because the members of traditional households

Table 6 Contribution of each parent to the cost of a child

	Household equivalence scale (Eq. 14)	Contribution by parents (%) (Eq. 15)	
		Father	Mother
(a) Non-traditional (double-earner) families			
Child 0–2	1.23**	0.47	0.53
Child 3–5	1.1**	0.4	0.6
Child 6–17	1.07**	0.4	0.6
(b) Traditional (single-earner) families			
Child 0–2	1.21**	0.44	0.56
Child 3–5	1.06**	0.44	0.56
Child 6–17	1.09**	0.61	0.39

The equivalence scale is based on the consumption of the market good x_m and the domestic product x_z according to Eq. (14). The figures are obtained multiplying the cost components reported in Table 5 for x_m and x_z weighted by the full income share reported at the bottom of Tables 3 and 4 for the households without children

** Denotes statistically significant equivalence scales at the 5 % significance level

Table 7 Decomposition of the full cost of a child by full-income component, gender and family type

	Father			Mother		
	M_m^1	M_z^1	M_l^1	M_m^2	M_z^2	M_l^2
(a) Non-traditional (double-earner) families						
Child 0–2	1.06	1.13	0.84	1.08	1.2	0.79
Child 3–5	1.01	1.06	0.93	1.06	1.08	0.88
Child 6–17	1.01	1.04	0.95	1.05	1.05	0.92
(b) Traditional (single-earner) families						
Child 0–2	1.07	1.09	0.84	1.11	1.14	0.82
Child 3–5	1.02	1.03	0.94	1.03	1.05	0.94
Child 6–17	1.06	1.04	0.92	1.05	1.03	0.92

m Denotes market goods, z domestic product, and l is leisure

are, as a matter of fact, relatively more engaged in domestic activities. This commitment decreases as the child gets older. A higher investment in household production comes at the expense of the enjoyment of leisure, especially for mothers. Fathers do the same to a lesser extent.

7 Conclusions

This study represents an effort to reconcile the literature on decision making within families and the literature on the estimation of equivalence scales. Within the context of a collective model, we estimate a gender-specific demand system incorpo-

rating the rule adopted by traditional and non-traditional Italian households to share resources within the household and compute the cost of a child accounting for market, household products and time costs. Both aspects are innovative contributions to both the literature of collective household models and traditional household equivalence scales.

The main results can be highlighted as follows. Gender-specific demand systems are coherent with theory for non-traditional families and for traditional families at the aggregate. The estimates of the sharing rule show that in non-traditional families both without and with children, women maintain control over their resources. On the other hand, altruistic behavior in which both members are willing to share resources prevails in traditional families. In the presence of a child, the parental investment in household production increases, especially for mothers, at the expenses of the consumption of leisure. When the child is very young, this effect is relatively higher. In general, mothers bear more than half of the cost of the child with the exception of traditional households with older children where the contribution of the father becomes preponderant.

This study provides some comforting indications. Gender-specific collective demand systems can be robustly estimated. The structural estimation of the sharing rule within a complete demand system expressed in terms of full income is feasible. The cost of a child can be effectively decomposed in terms of the wives and husbands' relative contribution of market goods, household products and leisure. Provided that sufficient information on assignable consumption is available, the easy implementation of the proposed collective demand system opens up the possibility to design effective tax benefit analysis also at the individual level.

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Appendix 1: Estimation results

See Tables 8, 9 and 10

Table 8 Estimation of the potential wage equation for women

Employment probability (Obs. 1290)			Wage equation for women (Obs. 1290)		
Variables	Coeff.	Sig.	Variables	Coeff.	Sig.
Constant	−5.177	*	Constant	0.504	
	0.538			*0.47*	
Household income	−0.001		Years of education	0.084	*
	0.002			*0.009*	
Age	0.238	*	Age	0.03	
	0.028			*0.019*	
Age squared	−0.003	*	Age squared	−0.0001	
	0.001			*0.00011*	
Years of education	0.134	*	Work experience	0.064	*
	0.007			*0.019*	
Number of children aged <3	−0.343	*	Southeast	−0.103	
	0.088			*0.057*	
Number of children aged 3–5	−0.231	*	Southwest	−0.164	*
	0.064			*0.057*	
Number of children aged 6–17	−0.183	*	Centre	−0.109	*
	0.036			*0.038*	
Number of children aged 18–24	−0.157	*	Heckman's lambda	0.175	
	0.044			*0.106*	
Regional unemployment rate	−0.049	*			
	0.006		R^2	0.27	
Chronic disease	−0.27	*			
	0.087				
Partner not employed	0.156				
	0.106				

Standard errors in italic are heteroscedasticity-robust
* Denotes statistically significant coefficients at the 5 % significance level

Table 9 Estimation of gender-specific demand equations for non-traditional (double-earner) households

	$\hat{\alpha}_k$	$\hat{t}_{k\_nf02}$	$\hat{t}_{k\_nf35}$	$\hat{t}_{k\_nf614}$	$\hat{t}_{k\_nf\hat{}2}$	$\hat{v}_{k1}$	$\hat{v}_{k2}$	$\hat{v}_{k3}$	$\hat{\beta}_k$	$\hat{\theta}_1$	$\hat{\theta}_2$	$\hat{\eta}_1$	$\hat{\eta}_2$
Husband										*Sharing rule*			
1. Leisure	0.732**	−0.067**	−0.027**	−0.020**	0.000	0.218**	−0.135**	−0.082**	0.157**	0.010**	0.102**	0.001	0.003**
	0.009	*0.010*	*0.009*	*0.008*	*0.002*	*0.005*	*0.003*	*0.005*	*0.018*	*0.005*	*0.017*	*0.001*	*0.001*
2. Domestic product	0.057**	0.050**	0.024**	0.015**	0.000		0.191**	−0.056**	−0.229**				
	0.004	*0.005*	*0.004*	*0.004*	*0.001*		*0.005*	*0.005*	*0.008*				
3. Market good	0.210**	0.016*	0.003	0.005	0.000			0.138**	0.072**				
	0.010	*0.009*	*0.009*	*0.008*	*0.003*			*0.007*	*0.022*				
Wife													
1. Leisure	0.744**	−0.098**	−0.052**	−0.036**	0.002	0.260**	−0.106**	−0.155**	0.293**				
	0.016	*0.013*	*0.012*	*0.011*	*0.003*	*0.020*	*0.017*	*0.013*	*0.019*				
2. Domestic product	−0.013*	0.073**	0.033**	0.019**	0.001*		0.106**	−0.000	−0.303**				
	0.008	*0.006*	*0.006*	*0.005*	*0.002*		*0.025*	*0.015*	*0.013*				
3. Market good	0.198**	0.048**	0.027	0.022**	−0.001			0.155**	0.009**				
	0.015	*0.011*	*0.010*	*0.008*	*0.002*			*0.013*	*0.023*				

Heteroscedasticity-consistent standard errors in italics

** Denotes statistically significant coefficients at the 5 % significance level, *10 % level

Table 10 Estimation of gender-specific demand equations for traditional (single-earner) households

	$\hat{\alpha}_k$	$\hat{t}_{k\_nf02}$	$\hat{t}_{k\_nf35}$	$\hat{t}_{k\_nf614}$	$\hat{t}_{k\_nf\wedge 2}$	$\hat{v}_{k1}$	$\hat{v}_{k2}$	$\hat{v}_{k3}$	$\hat{\beta}_k$	$\hat{\theta}_1$	$\hat{\theta}_2$	$\hat{\eta}_1$	$\hat{\eta}_2$
Husband										*Sharing rule*			
1. Leisure	0.904**	−0.079**	−0.030**	−0.034**	0.003	0.284**	−0.169**	−0.116**	0.378**	0.008**	0.068**	0.000	0.001**
	0.010	*0.010*	*0.009*	*0.007*	*0.002*	*0.004*	*0.004*	*0.005*	*0.020*	*0.002*	*0.017*	*0.000*	*0.000*
2. Domestic product	0.046**	0.048**	0.018**	0.015**	0.000		0.177**	−0.008	−0.195**				
	0.004	*0.003*	*0.002*	*0.002*	*0.000*		*0.011*	*0.008*	*0.007*				
3. Market good	0.050**	0.031**	0.012	0.019**	−0.003*			0.123**	−0.182**				
	0.011	*0.009*	*0.009*	*0.006*	*0.001*			*0.007*	*0.020*				
Wife													
1. Leisure	0.824**	−0.111**	−0.035**	−0.039**	0.001	0.270**	−0.154**	−0.116**	0.286**				
	0.017	*0.012*	*0.011*	*0.008*	*0.002*	*0.042*	*0.042*	*0.007*	*0.020*				
2. Domestic product	−0.107**	0.069**	0.023**	0.017**	0.001*		0.163**	−0.009	−0.363**				
	0.008	*0.004*	*0.003*	*0.002*	*0.001*		*0.050*	*0.017*	*0.009*				
3. Market good	0.130**	0.063**	0.017	0.024**	−0.001			0.125**	0.077**				
	0.018	*0.010*	*0.011*	*0.008*	*0.002*			*0.011*	*0.021*				

Heteroscedasticity-consistent standard errors in italics

** Denotes statistically significant coefficients at the 5% significance level, * 10% level

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