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Estimating intrahousehold allocation in a collective model with household production

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Abstract. The purpose of this paper is to estimate the intra-family distribution of income and the individual demand for leisure and household production from Swedish cross-sectional household data. As a basis for the analysis, we use a collective model where each individual is characterized by his or her own utility function and divides total time between leisure, household production and market work. For the purpose of comparison, we also estimate a version that is consistent with a more traditional model of labor supply, the unitary model.

JEL classification: D13, J22

Key words: Time-use, household production, collective model

1. Introduction

Traditionally, the household has been considered as a single utility maximizing agent. This so called unitary model has lately been criticized both from a theoretical and an empirical viewpoint. It has been argued that a multiperson household cannot be modeled as a single individual because it contradicts the neoclassical starting point that every individual should be characterized by his/her own preferences. Moreover, the unitary model only considers allocations between households and disregards questions concerning intra-household inequalities, which may lead to wrong welfare implications (see Haddad and

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Kanbur 1990, 1992). One testable restriction imposed by the unitary model is that the distribution of nonlabor income across spouses is not important for behavior: only the sum of the spouses' nonlabor income matters. This so called pooling restriction has also been rejected in several empirical studies, e.g., in Schultz (1990); Thomas (1990) and Kawaguchi (1994).

The theoretical and empirical criticism against the unitary model has lead to other models of household behavior, where individual preferences are recognized. One model that has received widespread attention is the collective model, developed by Chiappori (1988, 1992). In the collective model, the household is assumed to reach a Pareto-efficient outcome. Within this framework, testable restrictions can be derived and the intra-household distribution of income can be estimated. As pointed out by Becker (1965) a significant amount of time not used for market work is used for household production. Apps and Rees (1997) extend Chiappori's model by introducing a good produced by the households. They show that the sharing arrangement underlying the collective model cannot be retrieved unless specific assumptions are made. Chiappori (1997) shows that when the household good is tradable at a given price, the sharing arrangement may still be retrieved up to an additive constant.

There have been few empirical studies based on the collective model. Among the exceptions are Browning et al. (1994); Fortin and Lacroix (1997) and Chiappori et al. (1998). The results from their studies are generally supportive of the collective model. However, none of these studies have considered household production. The purpose of our study is to use the extended collective model to estimate simultaneously the intra-family distribution of income, individual leisure demands and the household production function from Swedish cross-sectional household data. Two versions of the model are estimated, one that is consistent with the household good being tradable on the market, and the other where households cannot buy or sell the household good. For purposes of comparison, we also estimate a version that is consistent with the unitary model.

The paper is organized as follows. In the next section, we present the theoretical background of our study based on Chiappori's (1997) work. Section 3 consists of a description of the data used in the empirical study. In Sect. 4, we present the empirical model and the estimation results. Section 5 concludes the paper.

2. Theory

We consider a two-member household where m denotes the male and f denotes the female. Assume that individual i's direct utility function can be written

$$u^i = u^i(l_i, c_i, x_i; \mathbf{z}_i), \quad i = m, f.$$

Utility is defined over three different goods: leisure, l_i, a market consumption good, c_i, and a consumption good, x_i, that is produced within the household. The vector of demographic characteristics of the individual is denoted as $\mathbf{z}_i$. Let us for the time being assume that x_i is marketable, i.e., it can be sold and bought on the market. The household production function, $h(t_m, t_f; \mathbf{a})$, is assumed to be characterized by constant returns to scale[1], where t_m and t_f are hours of household work for the male and the female respectively, and

$\mathbf{a} = (\mathbf{a}_m, \mathbf{a}_f)$ denote characteristics of the household members that are of importance for household production.

Suppose that the household decision process can be interpreted as a two-stage procedure where the household members first determine a production plan and how the resources are going to be shared within the household. Following the collective approach, we assume that the household decision process leads to a (within household) Pareto-efficient outcome. The domestic production plan can formally be written as a profit maximization problem

$$\max_{t_m, t_f} \pi = ph(t_m, t_f; \mathbf{a}) - w_m t_m - w_f t_f, \tag{1}$$

where w_m and w_f denote marginal (after tax) wage rates, and p is the price of the domestically produced good. The first order conditions for t_m and t_f can be combined to read

$$\frac{\partial h(\cdot)/\partial t_m}{\partial h(\cdot)/\partial t_f} = \frac{w_m}{w_f}.$$

Given the production plan and the sharing arrangement, the second stage of the decision problem will be

$$\max_{l_i, c_i, x_i} u^i(l_i, c_i, x_i; \mathbf{z}_i), \quad i = m, f, \tag{2}$$

$$\text{s t} \quad c_i + px_i + w_i l_i = s_i,$$

where s_i denotes member i's part of the household's full income.

We assume that the tax system is piecewise linear, so the marginal wages are defined conditional on the segment of the tax schedule where individual's labor supply is observed. In this case, the full income of the household can formally be written

$$s_F = s_m + s_f = (w_m + w_f)H + \tilde{y}_m + \tilde{y}_f,$$

where H are the maximum hours available, $\tilde{y}_m$ and $\tilde{y}_f$ are, respectively, the male's and the female's virtual income components. The virtual income is defined as the intercept income resulting from linearizing the individual's budget constraint around the tax segment where the observed hours of work are located.[2] Each member's share of the household's full income, s_i, can in general be seen as a reduced form function describing the determinants of the sharing arrangement made in the first stage of the decision process. We choose to write family member i:s part of the full income as $s_i = s_i(w_m, w_f, y_m, y_f, \mathbf{z}, \mathbf{EEP})$, where y_m and y_f denote nonlabor incomes, $\mathbf{z} = (\mathbf{z}_m, \mathbf{z}_f)$ the personal characteristics and **EEP** is a vector of so called extra-environmental parameters (EEP's) describing the opportunity cost of household membership.[3] The consumption of leisure determined by (2) can be written

$$l_i = l_i[w_i, p, s_i(w_m, w_f, y_m, y_f, \mathbf{z}, \mathbf{EEP}); \mathbf{z}_i], \quad i = m, f. \tag{3}$$

Within this framework it is possible to identify the intra-family distribution of income up to an additive constant (see Chiappori 1997).

If we assume that the household good, x_i, cannot be sold or bought on the market, the analysis becomes more complicated from the point of view of identification. In the maximization problem (2), p now depends on the marginal wages of the household members as well as household production characteristics, $\mathbf{a}$, and can be interpreted as the shadow price of the market consumption good (see Apps and Rees 1997). The budget constraints now read $c_i + p(w_m, w_f, \mathbf{a})x_i + w_i l_i = s_i$, $i = m, f$. The demand for leisure can be written

$$l_i = l_i[w_i, p(w_m, w_f, \mathbf{a}), s_i(w_m, w_f, y_m, y_f, \mathbf{z}, \mathbf{a}, \mathbf{EEP}); \mathbf{z}_i], \quad i = m, f. \tag{4}$$

where we have indicated that the sharing rule depends on all characteristics of the household. This implies that it is not possible to retrieve all the partial derivatives of the sharing rule. However, nonlabor incomes and the EEP's affect leisure demands only through their effect on the sharing rule. This means that we can at least obtain partial information of the sharing rule by estimating male and female leisure demands on the form of (4).[4]

3. Data

The data used in this study are based on the 1984 and 1993 Swedish Survey of Household Market and Nonmarket Activities (HUS)[5]. The 1984 (1993) HUS-Survey consists of 2619 (4137) randomly selected individuals aged 18 to 74. Besides the conventional survey, a selection of the respondents were subject to a time-use study. The interviews were performed using the yesterday 24 hour recall diary technique (see Juster and Stafford 1991), and each respondent was interviewed on at most two occasions. The sample size for the first and second time-use interview in 1984 (1993) was 2552 (3249) and 2468 (3218) individuals respectively.

One important characteristic of HUS is that both partners have been interviewed. This is a necessary condition for our empirical study, as we want to estimate the distribution of resources among the household members. Our main sample refers to two-adult households with and without children where both spouses are between 20 and 60 years of age. Including families with children may not be entirely unproblematic, however. Children may be seen as public goods within households. If these goods are nonseparable in the utility functions of their parents, the collective model portrayed above may not be valid. We will, therefore, compare the estimates based on our main sample with those obtained from restricting the sample by excluding families with children.

In the empirical analysis we include households where both adult members have participated in the main survey and at least in one time-use interview.[6] The number of hours used for household production is calculated from the time use data, and the sample is restricted to households were both members have stated a positive amount of household work. Only information on primary activities are used and household work is defined as the sum of: (i) traditional housework, i.e., food and drink preparation, dishwashing, cleaning-up, washing, ironing, clothes care and household management; (ii) active child care; (iii) purchase of everyday goods and clothing together with associated travel; and (iv) maintenance, repairs and improvement on one's home including yard work.

Information on hours worked on the market is collected from the conventional survey data and we only consider households where both partners have chosen to participate in the labor market. Households were at least one of the members has been on sick leave for more than three weeks during the year, or has provided inconsistent tax-return values are excluded. We also exclude households were individual wages are reported missing. Non-labor income is defined as the sum of interest incomes, interest subsidies, dividends and capital gains less capital losses, interest on debts and administrative expenses. To obtain a measure of non-labor income that is consistent with this definition, farmers and owners of more than one property (aside from vacation home) are excluded from the 1984 data.

Following Chiappori et al. (1998) we use measures of the sex ratio, i.e., the relative supplies of males and females in the marriage market, as EEP's describing the state of the marriage market. Using data from Statistics Sweden, we calculate sex ratios on the basis of age group, county (län) of residence, and sex. We have experimented with several different measures of the sex ratio. The final measure that is used in the empirical analysis is the female sex ratio defined as the number of females in an age group over the 'efficient' number of males supplied to that age group. We assume that females match with men that are 0–3 years older than themselves. The efficient number of males, however, is reduced by the fact that they can match with women other than those from the relevant age group.[7] In addition, a number of individual and household characteristics are used in the empirical study. These are described in the empirical section below. In total, the 1984 and 1993 main sample contains 326 and 338 households, respectively. Descriptive statistics are presented in Table 1.

4. Empirical model and estimation results

4.1. Empirical model

In this section we will estimate a collective model including household production. From the discussion in Sect. 2, it is clear that the assumption of constant returns to scale in home production is convenient from the viewpoint of identification, and this is also how we proceed. Household production is assumed to be of the constant elasticity variety. Specifically, we assume that the household production function take the CES-form;

$$f(t_m, t_f; a_m, a_f) = (a_m t_m^{-\rho} + a_f t_f^{-\rho})^{-1/\rho}$$

where a_m and a_f are productivity parameters that may be made dependent upon personal characteristics of each spouse. We will describe their content below. The first order conditions for t_m and t_f can be combined to read

$$\ln(t_m/t_f) = \lambda[\ln(w_m/w_f) - \ln a_m + \ln a_f] \quad (5)$$

where $\lambda = -\dfrac{1}{1+\rho}$.

Leisure demand functions emanate from Eqs. (3) and (4). In the latter case, the demand functions depend on the endogenously determined price of the household good. Since our main interest is to estimate the intrahousehold distribution of resources, and since there is no identification to be gained by

Table 1. Sample statistics

Variables	1984				1993			
	Men		Women		Men		Women	
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Age	40.84	(8.90)	38.30	(8.80)	43.77	(9.12)	41.55	(9.21)
Years of education	11.74	(3.63)	11.28	(3.11)	12.61	(3.60)	12.55	(3.32)
Gross wage rate	53.06	(18.74)	41.30	(10.96)	106.49	(78.20)	86.55	(52.99)
Marginal wage rate	21.85	(6.53)	22.89	(6.35)	57.79	(40.14)	57.78	(48.21)
Marginal tax rate	56.20	(13.24)	43.34	(12.27)	43.99	(11.02)	32.53	(36.83)
Nonlabor income	−817.47	(5572.8)	509.11	(3490.68)	−14756	(31017)	−3407.03	(17866)
Market work	2193.18	(320.46)	1651.83	(543.24)	2207.29	(329.76)	1787.63	(460.34)
Household work	811.31	(600.20)	1456.26	(800.43)	851.49	(612.24)	1336.55	(756.37)
Leisure	5731.51	(664.43)	5627.92	(830.08)	5677.22	(700.14)	5611.22	(810.10)
Sexratio	1.02	(0.05)	0.98	(0.05)	1.02	(0.06)	0.98	(0.06)
H-hold full income	433077	(80232)			1055946	(531660)		
Children/household	1.32	(1.00)			1.04	(1.08)		

explicitly modelling the price of the household good, we choose not to model the price function explicitly. Instead, we specify leisure demand functions on 'semi-reduced' forms, i.e. they depend on cross wages as well as spouse characteristics. We shall also assume that the leisure demand functions are linear;

$$l_m = \beta_m w_m + \delta_m w_f + \gamma_m s_m + \tilde{z}_m + \tilde{z}_f \tag{6}$$

$$l_f = \beta_f w_f + \delta_f w_m + \gamma_f s_f + \hat{z}_m + \hat{z}_f \tag{7}$$

where s_m and s_f denote, as before, the male and female share of the households full income. The scalars $\tilde{z}_m$, $\tilde{z}_f$, $\hat{z}_m$, and $\hat{z}_f$, should now be interpreted to contain characteristics originating from the utility function as well as from the production function, and β_i, δ_i, γ_i, $i = m, f$, are parameters to be estimated. Characteristics are assumed to include age, a dummy variable indicating the presence of children in a specific age bracket (0–6, 7–12 and 13–17 years of age) and a dummy variable reflecting the educational attainment of the individual. The educational dummy variable takes the value one if the respondent has a university or a university college degree. Equations (5), (6), and (7) correspond to our most general model specification, which is the case where the household good cannot be traded. We will below discuss how to impose restrictions in order to make the empirical model compatible with alternative theoretical interpretations.

Denote by θ_m the male's relative share of full income such that $s_m = \theta_m s_F$. Consequently, $\theta_f = 1 - \theta_m$ is the female's relative share. We assume that these relative shares are determined by marginal wages and nonlabor incomes, and, in addition, a number of other exogenous variables (to be described below) reflecting the income sharing arrangement. Following Browning et al. (1994) we assume that the relative shares can be modelled by a logistic function, i.e., $\theta_m = 1/(1 + \exp(d))$, and $\theta_f = 1 - 1/(1 + \exp(d))$, where d contains the variables affecting the income sharing arrangement.

In specifying the determinants of the sharing rule, the reader should first observe that when the household good is tradable, it can be seen from Eq. (3) that $\partial l_i/\partial \mathbf{z}_j = \partial l_i/\partial s_i \cdot \partial s_i/\partial \mathbf{z}_j$, meaning that the characteristics of the partner only affect the leisure demand via the sharing rule. Therefore, spouse characteristics can be used to obtain identification of the parameters of the sharing rule in this case. This could be done for instance by including differences in wage rates and other characteristics between the household members (see also Browning et al. 1994, for a similar argument). If, on the other hand, the household good cannot be traded, identification of the sharing rule originates from the nonlabor income of the spouses and the EEP's, since spouse characteristics will in this case affect l_i both via the sharing arrangement and via the price of the household good. We assume that the sharing rule is determined by the female sex ratio and by the differences in age, the number of years of schooling, marginal wages, and nonlabor incomes between the household members. Finally, since the sharing rule cannot be fully recovered in either of the two models set out in Sect. 2, the mean of the sharing rule is centered around one half.

In an economy without nonlinear taxation the wage rate is exogenous to hours of work. However, under progressive income taxation the marginal wage rate is endogenous. To address this problem, estimation is accomplished using an instrumental variables method. The instruments chosen for the marginal wage rate are the gross wage rate, the square of the gross wage rate, capital income and capital income squared. Similarly, full income of the household is also endogenous under nonlinear taxation and is instrumented as well. In this case, capital income, the gross wage rate for both spouses and nontaxable benefits are used as instruments. The final Eqs. (5), (6), and (7) are then estimated jointly using the nonlinear least-squares estimator, where cross equation restrictions pertaining to the sharing rule parameters are invoked and the stochastic specification allows for contemporaneous correlations of the error terms.

4.2. Estimation results

The estimation results are presented in Tables 2 and 3. The tables contain three different versions of the empirical model. Model I refers to the full model given by Eqs. (5), (6), and (7). Model II is a restricted version of model I, where cross-wage effects are set to zero in the leisure demand equations, and the spouse's characteristics affect leisure demands solely via the sharing rule. Model III, finally, is based on the assumption that the sharing rule is constant by imposing the restrictions that $\theta_f = \theta_m = 1/2$. With reference to the theoretical section, we can interpret these models as consistent with the non-marketable household good case (model I), the marketable household good case (model II), and the unitary model (model III). The restrictions imposed by models II and III can easily be tested against the more general alternative (model I).

We start by comparing the estimates of model I with those of models II and III by performing Wald tests. Comparing model I and model III, the latter is obtained as a special case of the former by setting the five parameters in the sharing rule to zero. The critical value for rejecting the null at the conventional 95% level of significance is $\chi^2(5) = 11.07$. The Wald-test statistic is 3.96 and 46.7 for the 1984 and 1993 data respectively. A similar test of model II yields the Wald-test statistics 6.59 and 17.59 (the critical value is in this case given by 12.59). Hence, we are not able to reject model II and model III using the 1984 data, while using the 1993 data both models II and III can be rejected. We have also tested the null hypothesis of constant parameters over time. This hypothesis was clearly rejected.

The reader should note that, since identification of the sharing rule in model I is obtained by assumptions regarding functional form, the test discussed above can also be interpreted as tests of functional form. It is, therefore, important to impose as few restrictions as possible during estimation. In addition to the estimates presented in Tables 2 and 3, we have tried other more complex functional forms of the leisure demand equations, for instance by allowing for quadratic wage effects. However, the additional parameters introduced did not contribute significantly to the value of the likelihood function. Therefore, our conclusions regarding model selection may not depend much on the choice of the functional form for the leisure demand functions.

Turning to the individual parameter estimates, note first that the (relative) amount of time spent working in the household is insensitive to the relative wage. Similarly, the wage and income effects are generally not significantly determined in the leisure demand equations, and the point estimates differ between the different versions of the collective model.

As can be seen from Tables 2 and 3, the estimates suggest that the presence of pre-school children (0–6 years of age) reduces leisure time for both spouses. In addition, younger school children (7–12 years of age) significantly reduces

Table 2. Estimation results 1984 sample

Equation/parameter	Model I		Model II		Model III	
	Estimate	t-value	Estimate	t-value	Estimate	t-value
Household work eq.						
Constant	−1.13	−3.28	−1.08	−3.15	−1.15	−3.33
Relative wage	−0.173	−0.70	−0.147	−0.61	−0.173	−0.70
Male age	0.008	0.47	0.010	0.59	0.007	0.41
Female age	−0.001	−0.07	−0.004	−0.26	$0.14 \cdot 10^{-3}$	−0.46
Male education	−0.072	−0.39	0.017	0.10	−0.071	−0.39
Female education	0.459	2.36	0.324	1.92	0.463	2.38
Child dummy (0–6)	0.247	1.66	0.233	1.56	0.238	1.60
Child dummy (7–12)	0.006	0.05	0.005	0.04	0.013	0.10
Child dummy (13–17)	0.003	0.02	$-0.61 \cdot 10^{-5}$	−0.18	0.003	0.02
Female demand eq.						
Constant	5073.4	10.70	5358.87	13.47	4965.15	10.83
Own marginal wage	8.93	0.55	7.90	0.42	15.53	0.86
Cross marginal wage	18.71	0.91	0^a		26.71	0.87
Full income	0.001	0.85	0.002	1.08	$0.2 \cdot 10^{-4}$	0.005
Female age	8.01	0.32	−6.58	−0.99	−9.21	−0.67
Male age	−14.40	−0.55	0^a		4.42	0.33
Female education	102.95	0.63	116.17	0.80	103.56	0.63
Male education	−105.74	−0.70	0^a		−87.21	−0.60
Child dummy (0–6)	−236.99	−1.93	−241.24	−1.97	−236.00	−1.89
Child dummy (7–12)	−105.11	−1.02	−121.37	−1.18	−94.67	−0.91
Child dummy (13–17)	−22.17	−0.20	−0.025	−18.56	−7.90	−0.07
Male demand eq.						
Constant	5840.8	16.93	5999.70	17.69	6047.03	18.71
Own marginal wage	−8.30	−0.31	−18.59	−0.83	−11.80	−0.57
Cross marginal wage	−3.89	−0.21	0^a		−11.42	−0.90
Full income	0.003	1.61	0.003	1.31	0.003	1.08
Male age	37.55	1.48	−4.73	−0.95	−1.62	−0.16
Female age	−42.73	−1.67	0^a		−5.97	−0.58
Male education	−173.01	−1.48	−216.06	−2.10	−203.87	−1.82
Female education	−140.22	−1.13	0^a		−124.93	−1.03
Child dummy (0–6)	−261.11	−2.80	−248.76	−2.67	−256.37	−2.76
Child dummy (7–12)	−156.37	−2.01	−163.63	−2.10	−163.58	−2.11
Child dummy (13–17)	22.56	0.28	29.81	0.37	5.22	0.06
Sharing rule param.						
Age difference	0.171	1.94	0.006	0.22	0^a	
Years of educ. diff.	0.057	1.18	0.041	1.03	0^a	
Marginal wage diff.	−0.030	−0.50	−0.028	−0.97	0^a	
Nonlabour income diff.	$-0.57 \cdot 10^{-4}$	−1.13	$-0.46 \cdot 10^{-4}$	−1.46	0^a	
Sexratio	1.89	0.77	1.34	0.63	0^a	
Log L	−5342.22		−5345.10		−5364.04	

Note: Standard errors are heteroscedastic consistent. a: parameter restricted.

leisure time for the male in the 1984 data. This effect is not present in the 1993 data, where the presence of older school children (13–17 years of age) instead significantly reduces leisure time for the female. The results also suggest that the individual education level is important for the allocation of time within the household. In the 1984 data, female education appears to be an important determinant of the relative amount of time spent in household work, while male education is not. In households where the woman is highly educated, she spends

Table 3. Estimation results 1993 sample

Equation/parameter	Model I		Model II		Model III	
	Estimate	*t*-value	Estimate	*t*-value	Estimate	*t*-value
Household work eq.						
Constant	−0.431	−1.20	−0.405	−1.14	−0.422	−1.18
Relative wage	0.085	0.72	0.113	1.13	0.180	1.69
Male age	−0.001	−0.08	−0.006	−0.42	−0.001	−0.08
Female age	−0.002	−0.13	0.002	0.14	−0.002	−0.15
Male education	−0.098	−0.62	0.065	0.45	−0.127	−0.81
Female education	0.171	1.16	0.028	0.24	0.194	1.31
Child dummy (0–6)	−0.057	−0.35	−0.045	−0.28	−0.058	−0.35
Child dummy (7–12)	−0.080	−0.55	−0.080	−0.55	−0.074	−0.51
Child dummy (13–17)	−0.057	−0.41	−0.057	−0.41	−0.060	−0.43
Female demand eq.						
Constant	5725.84	21.71	5718.85	22.74	5695.30	21.94
Own marginal wage	10.45	1.65	1.65	1.06	−2.47	−0.31
Cross marginal wage	−1.67	−1.46	0[a]		−5.27	−0.53
Full income	−0.001	−1.50	$-0.27 \cdot 10^{-3}$	−1.87	$0.89 \cdot 10^{-3}$	0.44
Female age	−32.44	−2.11	1.23	0.22	−20.70	−1.81
Male age	33.94	2.21	0[a]		22.09	1.94
Female education	−135.51	−1.29	−170.29	−1.76	−151.81	−1.46
Male education	−185.58	−1.65	0[a]		−194.07	−1.71
Child dummy (0–6)	−265.42	−2.29	−240.36	−2.08	−255.01	−2.16
Child dummy (7–12)	97.96	0.96	76.47	0.74	87.22	0.86
Child dummy (13–17)	−195.08	−2.00	−190.61	−1.93	−205.27	−2.11
Male demand eq.						
Constant	5985.74	25.08	6114.27	27.21	6068.08	27.14
Own marginal wage	19.79	2.72	−2.24	−1.66	8.26	1.10
Cross marginal wage	−1.01	−0.74	0[a]		9.40	1.57
Full income	−0.002	−2.86	$0.21 \cdot 10^{-3}$	1.88	−0.002	−1.25
Male age	−17.80	−0.95	−7.31	−1.54	5.60	0.57
Female age	12.88	0.69	0[a]		−12.03	−1.22
Male education	58.79	0.59	−70.43	−0.80	29.28	0.30
Female education	−218.37	−2.34	0[a]		−171.85	−1.92
Child dummy (0–6)	−285.46	−2.83	−334.46	−3.37	−320.89	−3.21
Child dummy (7–12)	−31.64	−0.36	−29.74	−0.34	−20.01	−0.23
Child dummy (13–17)	−93.44	−1.09	−67.59	−0.80	−74.03	−0.88
Sharing rule param.						
Age difference	0.056	1.46	−0.67	−0.83	0[a]	
Years of educ. diff.	−0.046	−2.18	−0.75	−0.82	0[a]	
Marginal wage diff.	−0.016	−6.46	0.004	0.61	0[a]	
Nonlabour income diff.	$0.44 \cdot 10^{-7}$	0.03	$0.14 \cdot 10^{-4}$	0.43	0[a]	
Sexratio	−1.37	−1.19	−5.63	−0.32	0[a]	
Log *L*	−5777.73		−5792.62		−5788.73	

Note: Standard errors are heteroscedastic consistent. *a*: parameter restricted.

relatively less time in household work in comparison with households where the female has less education. The important insights with respect to the consequences of education appear to be that educated females work more in the market and enjoy about the same leisure as do uneducated females. For men, on the other hand, the results using the 1984 data provide a weak indication that educated men enjoy less leisure but work more in the labor market and/or in the household depending on the characteristics of the spouse. In the 1993

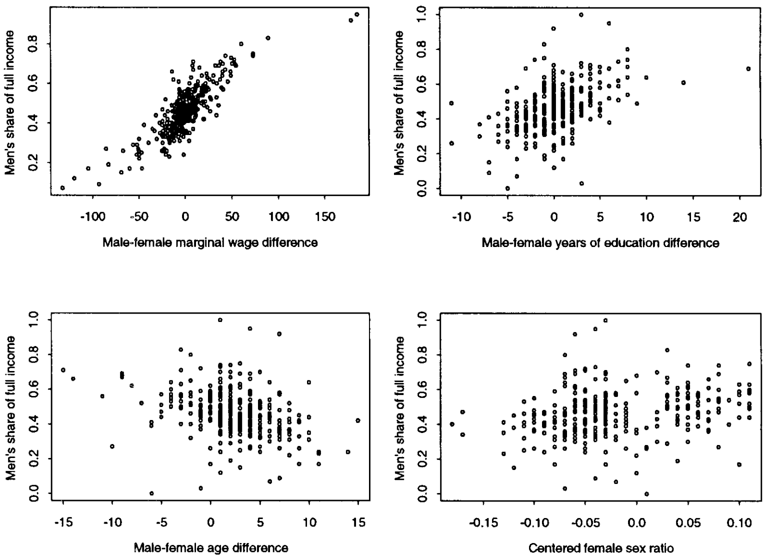

Fig. 1. Estimated sharing rule 1993

data, highly educated females seem to have a negative effect on the leisure consumed by the male, but there is no evidence that these men spend more time in household production.

Turning to the determinants of the sharing rule, in the 1984 data none of the determinants are statistically significant at the 5% level. By using the 1993 data, model I suggests that years of education differences appear to matter as well as wage differences, and to some extent age differences. In contrast to Chiappori et al. (1998), the sex ratio does not significantly influence the sharing rule and leisure consumption. Figure 1 plots the men's estimated share of full income for the year 1993 against four of the variables entering the sharing rule. As can be seen from the figure, male-female wage differences and years of education differences are positively related to the men's share of full income.

One important implication of the unitary model of labor supply is that the distribution of income within the household does not matter for the allocation of leisure in the household, i.e. only aggregate income matters. This so called pooling hypothesis has been tested in several earlier studies, and most studies find that the pooling hypothesis can be rejected. In the present framework we can test the hypothesis simply by checking the t-value for the parameter of nonlabor income differences. As can be seen from the tables, we are not able to reject the pooling hypothesis at the conventional 5% level. We would, nevertheless, like to exercise caution when interpreting this result. Personalized nonlabor incomes may be difficult to measure and there may be an element of choice involved when distributing nonlabor incomes between the spouses. Hence, although we cannot reject the hypothesis, this may be due to poor measurement and/or endogeneity problems.

The estimates based on our main sample is compared to the estimates from a restricted sample containing families without children. The results are presented in Tables A1 and A2 in the Appendix. The number of observations of this restricted sample is 81 in 1984 and 144 in 1993, and it may therefore be difficult to draw any strong conclusions based on such a small number of observations. Nevertheless, the results are similar to those obtained for the main sample. In the 1984 data, we are not able to reject models II and III, while both these models can be rejected using the 1993 data.

5. Conclusions

This paper analyzes leisure consumption and household production within the framework of a collective model. The paper should be viewed as a first attempt to empirically include household production in the collective framework. Three different models are estimated on Swedish data from 1984 and 1993. By comparing the results of the different models, we are able to reject the unitary model against a (statistically) more general alternative using the 1993 data. In the 1993 data, we are also able to reject the version of the collective model where the household good can be traded against the model where the household good is non-tradable. On the other hand, by using the 1984 data, we cannot distinguish between the three models. A formal test of the income pooling hypothesis indicates that pooling cannot be rejected. This result contradicts many earlier studies. The major determinants of leisure demands and household production appear to be household characteristics such as the presence of children and the education of the household members.

Note finally that the paper is based on a set of very restrictive assumptions regarding the technology and measurement of household production. First, the estimation rests on the assumption that household production can be characterized by constant returns to scale. One advantage of this assumption is that the system of equations to be estimated becomes recursive so that household work does not directly affect leisure demands. Future work should consider relaxing this assumption. Second, it may be fruitful to distinguish more carefully among different activities of home production in order to characterize the household technology more properly.

Appendix

Table A1. Estimation results 1984 sample (no children)

Equation/parameter	Model I		Model II		Model III	
	Estimate	*t*-value	Estimate	*t*-value	Estimate	*t*-value
Household work eq.						
Constant	−1.01	−2.26	−1.06	−2.43	−1.00	−2.26
Relative wage	−0.931	−1.61	−0.91	−1.78	−0.886	−1.55
Male age	−0.064	−1.73	−0.039	−1.15	−0.064	−1.72
Female age	0.072	2.00	0.046	1.41	0.072	1.99
Male education	−0.504	−1.16	−0.303	−0.74	−0.505	−1.16
Female education	0.782	1.82	0.674	1.79	0.789	1.84
Female demand eq.						
Constant	5643.87	9.33	5581.21	11.10	5631.57	9.51
Own marginal wage	95.57	1.30	10.88	0.51	26.37	0.91
Cross marginal wage	−39.47	−0.67	0[a]		31.43	0.74
Full income	−0.005	−1.05	−0.0003	−0.54	−0.005	−0.97
Female age	93.91	1.33	−1.46	1.48	26.21	1.04
Male age	−93.06	−1.33	0[a]		−26.76	−1.03
Female education	481.88	1.56	431.70	1.48	468.62	1.51
Male education	−359.85	−1.15	0[a]		−359.54	−1.16
Male demand eq.						
Constant	5679.84	12.39	5833.53	13.59	5687.19	12.59
Own marginal wage	102.01	1.37	26.30	1.32	48.25	1.49
Cross marginal wage	−43.75	−0.82	0[a]		7.99	0.35
Full income	−0.004	−1.10	−0.001	−2.57	−0.004	−1.02
Male age	102.21	2.23	−5.79	−1.04	52.62	2.53
Female age	−109.34	−2.43	0[a]		−58.74	−2.90
Male education	−61.26	−0.24	32.91	0.14	−60.88	−0.25
Female education	28.24	0.11	0[a]		36.55	0.14
Sharing rule param.						
Age difference	−0.14	−1.20	0.65	1.21	0[a]	
Years of educ. diff.	0.007	0.23	−0.12	−0.59	0[a]	
Marginal wage diff.	−0.15	−0.99	0.13	0.61	0[a]	
Nonlabour income diff.	$0.15 \cdot 10^{-4}$	0.67	0.0005	1.11	0[a]	
Sexratio	1.61	0.58	8.12	0.48	0[a]	
Log *L*	−1359.35		−1360.41		−1360.63	

Note: Standard errors are heteroscedastic consistent. [a] parameter restricted.

Table A2. Estimation results 1993 sample (no children)

Equation/parameter	Model I		Model II		Model III	
	Estimate	t-value	Estimate	t-value	Estimate	t-value
Household work eq.						
Constant	−0.308	−0.61	−0.169	−0.34	−0.310	−0.62
Relative wage	0.344	1.65	0.350	1.77	0.469	2.35
Male age	−0.031	−1.02	−0.378	−1.35	−0.033	−1.08
Female age	0.022	0.77	0.028	1.02	0.024	0.83
Male education	−0.015	−0.06	0.283	1.22	−0.051	−0.19
Female education	0.450	1.69	0.032	0.15	0.485	1.81
Female demand eq.						
Constant	5865.94	17.67	5679.80	21.01	5676.35	14.20
Own marginal wage	10.40	2.16	9.25	1.18	1.07	0.09
Cross marginal wage	0.71	0.16	0[a]		1.04	0.052
Full income	−0.001	−2.03	−0.0009	−1.04	$-0.85 \cdot 10^{-4}$	−0.03
Female age	63.55	1.90	0.82	0.14	2.83	0.17
Male age	−65.78	−1.87	0[a]		−1.44	−0.08
Female education	19.09	0.12	−123.39	−0.92	−63.86	−0.42
Male education	−260.45	−1.58	0[a]		−204.40	−1.26
Male demand eq.						
Constant	5790.45	16.68	5634.40	16.51	6463.56	17.66
Own marginal wage	8.91	1.10	21.40	2.28	−30.33	−1.71
Cross marginal wage	2.21	1.69	0[a]		−11.86	−1.14
Full income	−0.001	−2.10	−0.002	−2.67	0.004	1.43
Male age	79.99	2.48	1.15	0.18	19.48	1.18
Female age	−78.75	−2.58	0[a]		−23.01	−1.44
Male education	46.10	0.30	−123.80	−0.88	−7.50	−0.05
Female education	−374.25	−2.57	0[a]		−353.43	−2.43
Sharing rule param.						
Age difference	−0.358	−2.95	0.038	1.27	0[a]	
Years of educ. diff.	−0.127	−1.82	−0.031	−1.34	0[a]	
Marginal wage diff.	−0.018	−3.88	−0.019	−3.90	0[a]	
Nonlabour income diff.	$-0.43 \cdot 10^{-5}$	−0.74	$0.15 \cdot 10^{-6}$	0.05	0[a]	
Sexratio	−4.12	−1.36	−1.94	−1.10	0[a]	
Log L	−2470.25		−2478.28		−2479.14	

Note: Standard errors are heteroscedastic consistent. [a] parameter restricted.

Endnotes

[1] As noted by Pollak and Wachter (1975), characteristics influencing preferences and household productivity cannot be distinguish from each other if the household production process is not characterized by constant returns to scale.

[2] Formally, let the tax system be described by J linear segments and denote by $\tau^k,\ k = 1 \dots J$, the marginal tax rate corresponding to each segment. Further, let $H^k,\ k = 1, \dots, J-1$, be kink-points in the tax schedule in terms of hours of work, where the labor supply interval (H^{k-1}, H^k) corresponds to the marginal tax rate τ^k. Then, the virtual income of the individual observed on segment k can be calculated as $\tilde{y}^k = w^g(\tau^k H^{k-1} - \sum_{j=2}^{k-1} \tau^j (H^j - H^{j-1})) + y$, where w^g is the gross wage rate and y the nonlabor income.

[3] Extra-environmental parameters was first definied by McElroy (1990) as factors affecting the intra-household bargaining power, although they do not affect individual prices and nonlabor incomes. Examples of *EEPs* are the competitiveness in the marriage market, additional non-labor income if the household is dissolved, the elimination of the marriage tax and the legal structure within which household formation and seperation occur.

[4] To see this, note that the derivates with respect to nonlabor income are given by $\frac{\partial l_i}{\partial y_j} = \frac{\partial l_i}{\partial s_i}\frac{\partial s_i}{\partial y_j}$, $i, j = m, f$. Since $s_i = s_F - s_j$, where s_F is known, it holds that $\frac{\partial s_i}{\partial y_j} = \frac{-\partial s_j}{\partial y_j}$. This means that we have four unknown partial derivates on the right hand side of the above equation, $\frac{\partial l_m}{\partial s_m}, \frac{\partial l_f}{\partial s_f}, \frac{\partial s_m}{\partial y_m} = \frac{-\partial s_f}{\partial y_m}$, and $\frac{\partial s_f}{\partial y_f} = \frac{-\partial s_m}{\partial y_f}$. This is equal to the number of income effects that can be identified, i.e., the partials on the right hand side of the above equation are exactly identified. For discussions about identification in the extended collective model, see Apps and Ress (1997) and Chiappori (1997).

[5] For further details about HUS, see Klevmarken and Olovsson (1993) and Flood et al. (1997).

[6] For individuals that have been interviewed about their time allocation once on a weekend and once during the working week, time used for each household activity is computed as a weighted average with the weights 5/7 for week days and 2/7 for weekend days.

[7] The sex ratio for the female is computed as:

$$\frac{F_t}{M_t \cdot \left(\frac{F_t}{F_t + F_{t-1} + F_{t-2} + F_{t-3}}\right) + \cdots + M_{t+3} \cdot \left(\frac{F_t}{F_{t+3} + F_{t+2} + F_{t+1} + F_t}\right)}$$

where M_t and F_t are the number of males and females of age t in a specific region (county). In a similar vein, we have constructed a male sex ratio. The two measures, however, are highly correlated (the correlation coefficient is -0.73 in 1984 and -0.71 in 1993). Therefore we have chosen to include only the female sex ratio in the empirical analysis.

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