And the winner is... An empirical evaluation of unitary and collective labour supply models

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Abstract

An empirical evaluation is presented of two competing flexible labour supply models. The first is a standard unitary model, while the second is based on the collective approach to household behaviour. The evaluation focuses on the testing of the models' theoretical implications and on their ability to identify structural information, like preferences and the intrahousehold allocation process. Models are applied to Dutch microdata from the DNB Household Survey. The unitary model cannot be rejected for male and female singles, while it is rejected for a sample of couples. The alternative collective model cannot be rejected for the same sample, allowing identification of individual preferences and an intrahousehold sharing rule that can be used as a basis for welfare economic policy evaluations.

Key words: collective household models, household bargaining, intrahousehold allocation, labour supply.
JEL classification: D12, J22.

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1 Introduction

The traditional approach to household behaviour assumes that households behave as if they were single decision makers. Consequently, household consumption and labour supply are considered to be the observable result of the maximization of unique rational preferences, constrained by a household budget restriction.

This unitary approach, however, seems to act as an empirical straitjacket for household behaviour; its theoretical implications of homogeneity, symmetry and negative semidefiniteness of the Slutsky matrix were repeatedly rejected when confronted with the data (see Blundell and Meghir, 1986, and Blundell and Walker, 1986, for some evidence in labour supply models, and Blundell, 1988, for evidence in consumption allocation models). Apart from these theoretical restrictions, the unitary model implies the so-called 'income pooling hypothesis'. This asserts that the source of a household's nonlabour income does not affect observed allocations. This restriction too has been repeatedly rejected by the data (see, e.g., Lundberg, 1988, Thomas, 1990, and Fortin and Lacroix, 1997).

But the unitary model also suffers from welfare economic deficiencies. For example, it cannot shed any light on the intrahousehold distribution of consumption or welfare. Apps and Rees (1988) and Brett (1998) have shown, however, that when evaluating the welfare effects of tax changes, intrahousehold distributional effects can in general not be ignored. Moreover, Alderman et alii (1995) argue that accepting the unitary model, when it is inappropriate, has more serious consequences for policy prescriptions than rejecting the unitary model when it is appropriate. In programs that target individuals in certain groups (e.g. women or children), knowledge of the intrahousehold decision process may be especially important.

A valuable alternative to the unitary model is the collective approach to household behaviour. In the collective household model, as initially defined by Chiappori (1988, 1992), it is explicitly recognized that many person households consist of several individuals who may have different preferences. Among these individuals, a household bargaining process takes place that is assumed to be Pareto efficient. Chiappori (1988, 1992) showed that even this rather weak assumption is able to generate testable implications on labour supply that differ from those of the unitary model. Moreover, the repeated rejections of symmetry and negativity can be interpreted somewhat, since the latter are not to be satisfied in the collective model (see Browning and Chiappori, 1998). Given its particular set-up, the collective model incorporates a natural answer to the empirical and welfare economic disadvantages of the unitary model. (See Vermeulen, 2002, for a more elaborate survey of the collective approach.)

This paper has the objective of balancing the above two competing theories in a household labour supply context. The question can be asked, however, when is a theory of household behaviour a good theory? Two rather neutral basic requirements are the following (see Bourguignon and Chiappori, 1994). First, one should expect a theory of household behaviour to generate testable implications that are potentially rejectable. Apart from the ability to save on degrees of freedom, these restrictions can be used to test the adequacy of the theory. A second requirement is that a theory of household behaviour should be able to recover some structural information, like preferences or the intrahousehold allocation process. Knowledge of preferences or the intrahousehold allocation process may be important, since these can be used as a basis for normative welfare analyses.

As to the above requirements, the unitary model passes with flying colours. Firstly, it generates its well-known testable restrictions on demand. Secondly, demand that satisfies these restrictions can be shown to be integrable to a rational preference ordering. Also the collective household model meets the above requirements to some extent. In Chiappori (1988), Browning et alii (1994) and Browning and Chiappori (1998), to give only a few examples, testable and rejectable implications of the model are derived. As to the second requirement, integrability results are less strong than in the unitary model. Extra assumptions, apart from Pareto efficiency of household decisions, are needed to recover a great deal of the intrahousehold allocation process and individual preferences. More specifically, a necessary condition for such an identification result is that individual preferences of the household members are of the 'egoistic' or the Beckerian 'caring' type (see, for example, Chiappori, 1992).

We will evaluate the unitary and collective approaches by means of the above requirements of good theories. Firstly, attention will be focused on the estimation and testing of both a unitary and a collective labour supply model. This will be done on three samples of households from the 1995-2003 waves of the Dutch DNB Household Survey, which was formerly known as the CentER Savings Survey. The first two samples consist of male and female singles with a positive labour supply, since for these groups of households, the unitary approach should be entirely applicable. The second sample consists of couples where both individuals have a positive labour supply. In general, the unitary and collective approaches should have different implications on observable behaviour for this sample. In order not to reject the theoretical implications of the models because of a too restrictive specification of labour supply, flexible labour supply models that are generalizations of the linear expenditure system are opted for. Estimation and testing of the unitary model does not pose too many problems in the given set-up. As for its competitor, in the first instance account will be taken of general individual preferences, allowing public consumption, and externalities within a household. This is a different approach than Fortin and Lacroix (1997), who start from a collective labour supply model where egoistic and caring preferences are assumed from the outset. On the other hand, our approach is on a par with Chiappori, Fortin and Lacroix (2002). To test the collective model, we will make use of the robust distribution factor proportionality test of Bourguignon et alii (1993). This test makes use of so-called 'distribution factors', which are defined as variables that influence the intrahousehold distribution process, but that do not directly affect individual preferences or the household budget constraint. Examples of such distribution factors are laws on alimony, child benefits, tax laws that differ according to marital status and individual nonlabour incomes (that affect the household budget constraint only indirectly through a change in total household nonlabour income).

Secondly, as already mentioned, the identification of individual preferences and the intrahousehold allocation process requires egoistic or caring preferences in the collective approach. Therefore, the general collective labour supply model will be reformulated in terms of these types of preferences. Again useful testable restrictions can be derived. Note however, that a rejection of these restrictions does not necessarily imply that the collective model is rejected. If the above distribution factor proportionality test is not rejected, a rejection of the additional restrictions may be considered as a rejection of the particular egoistic or caring preferences, rather than a rejection of the collective approach.

The rest of the paper is structured as follows. Section 2 deals with the functional specifications for unitary and collective labour supply models, which are chosen for the empirical evaluation. Data and econometric issues are discussed in Section 3. Section 4 gives empirical results, while Section 5 concludes.

2 Household labour supply: two competing empirical approaches

In what follows, we focus on households consisting of two working-age individuals who both participate in the labour market. The unitary and collective labour supply approaches that will be dealt with are static within-period models in a cross-sectional context. Consequently, the only price variation that is assumed to be observable are the wages of both individuals. Moreover, we assume that these hourly wage rates do not depend on hours worked, which gives rise to simple linear budget constraints. Note also that the models focused on are not embedded in the household production theory, where individuals derive utility from, among others, domestic goods that are produced within the household by means of domestic labour and market goods (see Apps and Rees, 1997 and Chiappori, 1997, for examples of such models in a collective context).

Apart from the choice of an appropriate theory to model household labour supply, a functional form for the models has to be chosen. Given this paper's objective, the functional specifications should satisfy at least three criteria. Firstly, labour supply should be consistent with utility maximization (both in the unitary model and in the collective approach for singles) or with the collective setting (for couples). Secondly, there should be some flexibility in the functional form, even if (most of) the unitary or collective restrictions are imposed upon it. With regard to changes in the wage rates, a variety of responses should be allowed. Finally, a normative welfare analysis requires judgements on the effect of policy reforms on the household's or the individual's welfare. Therefore, structural information like utility functions should be recoverable by means of the specification. In what follows, we opt for functional forms for the unitary and collective model that only coincide for single individual households. The approach followed here is different from that of Fortin and Lacroix (1997), who derived a labour supply model that nests a unitary and a collective model. This approach has the advantage that both models are easily tested against each other. On the other hand, their model does not allow much flexibility in behavioural responses. Our approach does not encompass a unitary and collective model in the same functional specification for many person households. The gain in flexibility comes at the cost of both models being less easily tested against each other.

2.1 A unitary labour supply model

Traditionally, a household's preferences are assumed to be representable by a well-behaved utility function that is unique up to a monotone increasing transformation. The functional specification that is opted for here, is based on Blundell and Meghir's (1986) generalization of Stone-Geary preferences. It allows a wide variety of wage responses, and demographic variables are easily incorporated. The indirect utility function for two income earners A and B, underlying the chosen specification, is of the Gorman polar form:

$$u = \frac{y + a\left(w^A, w^B, p, \mathbf{d}\right)}{b\left(w^A, w^B, p, \mathbf{d}\right)}, \tag{1}$$

where y is the household's nonlabour income, w^I is the hourly wage rate of individual I $(I = A, B)$, p is the price of a Hicksian aggregate commodity and $\mathbf{d}$ is a vector of demographic and taste shifter variables (e.g. age and education level of the household members). The functions a and b are linearly homogeneous and concave functions in w^A, w^B and p. The following forms are chosen for these functions:

$$\begin{aligned} a\left(w^A, w^B, p, \mathbf{d}\right) &= \alpha_1(\mathbf{d})\, w^A + \alpha_2(\mathbf{d})\, w^B - \alpha_3(\mathbf{d})\, p - \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3}\gamma_{ij}^{*} \ln v_i \ln v_j \\ b\left(w^A, w^B, p, \mathbf{d}\right) &= \left(w^A\right)^{\beta_1}\left(w^B\right)^{\beta_2} p^{\beta_3}, \end{aligned} \tag{2}$$

where v_i is the ith element of the vector $\mathbf{v} = \left(w^A, w^B, p\right)'$. These functions are linearly homogeneous if $\sum_i \gamma_{ij}^{*} = \sum_j \gamma_{ij}^{*} = 0$ and $\sum_i \beta_i = 1$. Demographic variables are only taken up in a in order not to complicate matters too much. We obtain the following labour supply functions (where the price of consumption is normalized to one) via Roy's identity:

$$\ell^A = \alpha_1(\mathbf{d}) - \frac{1}{w^A}\left(\gamma_{11}\ln w^A + \gamma_{12}\ln w^B\right) - \frac{\beta_1}{w^A}\left(y + a^{*}\left(w^A, w^B, \mathbf{d}\right)\right) \tag{3}$$

$$\ell^B = \alpha_2(\mathbf{d}) - \frac{1}{w^B}\left(\gamma_{21}\ln w^A + \gamma_{22}\ln w^B\right) - \frac{\beta_2}{w^B}\left(y + a^{*}\left(w^A, w^B, \mathbf{d}\right)\right), \tag{4}$$

where $\gamma_{ij} = \frac{\gamma_{ij}^{*} + \gamma_{ji}^{*}}{2}$ and $a^{*}\left(w^A, w^B, \mathbf{d}\right) = a(w^A, w^B, 1, \mathbf{d})$. Symmetry of the Slutsky matrix is satisfied if $\gamma_{12} = \gamma_{21}$. As is well-known for flexible functional forms, concavity cannot be imposed globally without losing flexibility. Therefore, we opt to estimate the above labour supplies without imposing concavity restrictions and then check whether these are satisfied for the given data. Note that if γ_{ij} $(i, j = 1, 2)$ are equal to zero, then the above labour supply system reduces to the linear expenditure system. Note finally that the above specification does not include distribution factors, since these cannot play any role in the unitary approach by definition.

Specifications for the indirect utility function and labour supply function for singles are obtained by setting the parameters associated with, say, w^B equal to zero in equations (1), (2) and (3).[1]

[1] As usual in applied demand analysis, additive error terms are tagged to the labour supply equations in the empirical exercise. See Lewbel (2001) for (relatively loose) necessary and sufficient conditions for rationality of econometrically estimated demand, given that consumers are rational with preferences that may differ arbitrarily across agents. However, since a test of these conditions requires long panel data on household purchases, we cannot test these conditions by means of our data.

2.2 Collective labour supply models

2.2.1 A short theoretical digression

The general approach In the collective approach to household behaviour, both household members A and B have their own rational preferences over consumption and leisure bundles. These preferences can be very general in that they may be defined over both one's own consumption and leisure and the consumption and leisure bundle of the other household member. Individual preferences are assumed to be representable by the following utility functions ($I = A, B$):

$$u^I = v^I \left(c^A, c^B, l^A, l^B, \mathbf{d}\right), \tag{5}$$

where v^I is a twice continuously differentiable, strongly concave utility function with individual consumptions of the Hicksian aggregate commodity c^A and c^B and the leisure amounts l^A and l^B as arguments (where $l^I = T - \ell^I$ ($I = A, B$); T being the individuals' time endowment and ℓ^I hours worked). The utility function v^I is assumed to be strictly increasing in c^I and l^I, $I = A, B$. Externalities in consumption and leisure can be both positive and negative. Therefore, v^I is not necessarily increasing in c^J and l^J, for $J \neq I$. The (full) household budget constraint equals:

$$c^A + c^B + w^A l^A + w^B l^B \leq y + w^A T + w^B T. \tag{6}$$

Since individual preferences are assumed to be represented by strongly concave utility functions and the household budget constraint defines a convex set, the utility possibility set is strictly convex. Therefore, each Pareto efficient household allocation, as a core assumption of the collective approach, can be represented as the unique solution to the maximization of a linear 'social welfare function':

$$\begin{aligned} \max_{c^A, c^B, l^A, l^B} \; & \mu\left(y, \mathbf{w}, \mathbf{z}, \mathbf{d}\right) v^A \left(c^A, c^B, l^A, l^B, \mathbf{d}\right) \\ & + \left(1 - \mu\left(y, \mathbf{w}, \mathbf{z}, \mathbf{d}\right)\right) v^B \left(c^A, c^B, l^A, l^B, \mathbf{d}\right) \end{aligned} \tag{7}$$

subject to

$$c^A + c^B + w^A l^A + w^B l^B \leq y + w^A T + w^B T,$$

where the welfare or bargaining weights μ and $(1 - \mu)$ are assumed to be continuously differentiable and homogeneous of degree zero in y and $\mathbf{w} = \left(w^A, w^B\right)'$. Other arguments of these weights are the vectors $\mathbf{d}$ and $\mathbf{z} = (z_1, ..., z_m)'$. The latter is a vector of distribution factors, different from demographic variables $\mathbf{d}$. Distribution factors are defined as variables that affect the welfare weight attached to household members, but that do not have any *direct* influence on the household members' preferences or the household budget constraint.

In Browning and Chiappori (1998), a test of the collective model is derived, which is based on the so-called pseudo-Slutsky matrix. However, since this test requires at least five different commodities, we cannot make use of it in the current setting.

An alternative test for the collective labour supply model can be derived, though. The test makes use of the properties of the variables $\mathbf{z}$. As is clear from equation (7), this vector only occurs in the bargaining weights μ and $(1 - \mu)$ and does not enter individual preferences or the household budget constraint. This implies the following test for the collective labour supply model:

Proposition 1 Distribution factor proportionality. *If observed labour supply functions* $\mathbf{h} = \left(h^A, h^B\right)'$ *fit into the collective household approach and distribution factors have a nonzero effect on* μ, *then* $\frac{\partial \mathbf{h}}{\partial \mathbf{r}'} = \frac{\partial \mathbf{h}}{\partial z_1}\boldsymbol{\theta}'$ *for* $\mathbf{r} = (z_2, ..., z_m)'$ *and* $\boldsymbol{\theta}$ *a vector of dimension* $(m-1)$. *The latter vector captures the marginal substitution effects between* z_1 *and every element of* $\mathbf{r}$ *in the function* μ.

Proof: See Bourguignon et alii (1993) and Chiappori, Fortin and Lacroix (2002).

The result thus says that the ratios of marginal effects of the distribution factors on both individual labour supplies are equal. This general restriction on the given collective model is easily tested. Note, however, that the result is fundamentally driven by the fact that at least two separate distribution factors $\mathbf{z}$ can be observed.

Identification results: the sharing rule interpretation It is a well-known result of the unitary model that if demand functions add up, are homogeneous of degree zero and have a symmetric and negative semidefinite Slutsky matrix, then these are integrable to a rational preference ordering. In the collective approach, more assumptions are needed to obtain a similar result. More specifically, individual preferences have to be of the egoistic or caring type.

Household members have *egoistic* preferences if their preferences only depend on their own consumption and leisure:

$$u^I = v^I\left(c^I, l^I, \mathbf{d}\right),\ I = A, B. \tag{8}$$

Preferences are of the *caring* type if they can be represented as (see Becker, 1974a, 1974b):

$$u^I = f^I\left(v^A\left(c^A, l^A, \mathbf{d}\right), v^B\left(c^B, l^B, \mathbf{d}\right)\right),\ I = A, B, \tag{9}$$

where f^I is an increasing function in its arguments. These preferences allow a favourable re-interpretation of the collective labour supply model:

Proposition 2 Sharing rule result. *If individual preferences are of the egoistic or caring type, then the household allocation problem (7) is equivalent to the maximization problems* $(I = A, B)$:

$$\max_{c^I, l^I} v^I\left(c^I, l^I, \mathbf{d}\right), \tag{10}$$

subject to

$$c^I + w^I l^I \leq \phi^I\left(y, \mathbf{w}, \mathbf{z}, \mathbf{d}\right) + w^I T,$$

for some function ϕ *such that* $\phi^A = \phi$ *and* $\phi^B = y - \phi^A$.

Proof: See Chiappori (1992).

The result can be interpreted as a two-stage budgeting process. Firstly, household members allocate the total nonlabour income y among each other according to the *sharing rule* ϕ. Following the above results on the bargaining power of the individuals, ϕ will in general depend on total nonlabour income, wages, distribution factors $\mathbf{z}$ and demographic variables $\mathbf{d}$. In a second stage, both individuals allocate their share in the household's means to their own consumption and leisure in a way that maximizes their individual welfare.

Since individual preferences are assumed to be weakly separable in $\left(c^A, l^A\right)$ and $\left(c^B, l^B\right)$, individual labour supplies can be written as:

$$\begin{aligned} \ell^A &= m^A\left(\phi\left(y, \mathbf{w}, \mathbf{z}, \mathbf{d}\right), w^A, \mathbf{d}\right) \\ \ell^B &= m^B\left(y - \phi\left(y, \mathbf{w}, \mathbf{z}, \mathbf{d}\right), w^B, \mathbf{d}\right). \end{aligned} \tag{11}$$

Let $\boldsymbol{\psi}$ denote a vector of dimension $(m+3)$, with typical element $\frac{\partial \phi}{\partial f_i}$; f_i being an element of the vector $\mathbf{f} = \left(y, \mathbf{w}', \mathbf{z}'\right)'$. The above representation of labour supply produces the following result:

Proposition 3 Testability and identification results. *Assume that the partial derivatives of the labour supply functions are not equal to zero. Then the following conditions are necessary for ℓ^A and ℓ^B to be compatible with the individual maximization problems (10) for some sharing rule ϕ. A first condition equals:*

$$\frac{\partial \boldsymbol{\psi}}{\partial \mathbf{f}'} = \left(\frac{\partial \boldsymbol{\psi}}{\partial \mathbf{f}'}\right)'. \tag{12}$$

Secondly, we have:

$$\begin{aligned} \frac{\partial m^A}{\partial w^A} &\mid_{\overline{\phi}} - \frac{\partial m^A}{\partial \phi}\ell^A \geq 0 \\ \frac{\partial m^B}{\partial w^B} &\mid_{\overline{y-\phi}} - \frac{\partial m^B}{\partial \left(y - \phi\right)}\ell^B \geq 0. \end{aligned} \tag{13}$$

Moreover, if the conditions (12) and (13) are satisfied, then the sharing rule is identified up to an additive constant $k\left(\mathbf{d}\right)$. For a given constant $k\left(\mathbf{d}\right)$, individual preferences are uniquely defined.

Proof: See Chiappori, Fortin and Lacroix (2002).

The intuition, behind which these conditions are derived is the following. The obtained results are entirely driven through the applicability of the sharing rule result when preferences are egoistic or of the caring type. Firstly, as is clear from (11) marginal changes in nonlabour income y and distribution factors $\mathbf{z}$ only affect individual labour supplies ℓ^A and ℓ^B via the individuals' shares in total nonlabour income. Secondly, a marginal change of a household member's wage has only an income effect on the other one's labour supply. This effect runs again through the individuals' shares of total nonlabour income. Taken together, these results allow one to derive the marginal rates of substitution, between each couple of variables in $\mathbf{f}$, of the sharing rule ϕ in terms of observable labour supplies ℓ^A and ℓ^B. By means of this set of marginal substitution rates, the partial derivatives of the sharing rule ϕ (i.e., the elements in $\boldsymbol{\psi}$) can be derived. In order to make this set of partial differential equations integrable to ϕ, a set of cross-equation restrictions has to be satisfied. This is captured by (12). Since labour supplies ℓ^A and ℓ^B can also be considered as resulting from utility maximization problems (10), standard integrability conditions on the associated Slutsky matrices have to be satisfied. This is given by (13).

Thus, if the above conditions are satisfied, then the sharing rule ϕ is identified up to an additive constant. Consequently, the individual consumptions of the Hicksian aggregate commodity c^A and c^B are also identified up to the same additive constant. Moreover, keeping in mind the sharing rule result, individual indirect utility functions can also be defined for the given additive constant, via observable labour supply behaviour.[2]

2.2.2 Functional specification

We choose a specification for the collective model that implies that if the above collective restrictions are satisfied, then the individuals in couples have the same specification for the indirect utility function as singles (cf. singles' version of equations (1), (2) and (3)). This requirement is satisfied for the following flexible functional specification for individual labour supplies (where the price of consumption has been normalized to one):

$$\begin{aligned}\ell^A &= \gamma_1(\mathbf{d}) - \frac{\gamma_2}{w^A}\ln w^A - \frac{\gamma_3}{w^A}[\frac{1}{2}y + \gamma_1(\mathbf{d})\,w^A - \frac{1}{2}\gamma_2 \ln^2 w^A \\ &\quad + \boldsymbol{\gamma}_4'\mathbf{z} + \gamma_5\left(\ln w^A - \ln w^B\right) + \gamma_6]\end{aligned} \tag{14}$$

$$\begin{aligned}\ell^B &= \delta_1(\mathbf{d}) - \frac{\delta_2}{w^B}\ln w^B - \frac{\delta_3}{w^B}[\frac{1}{2}y + \delta_1(\mathbf{d})\,w^B - \frac{1}{2}\delta_2 \ln^2 w^B \\ &\quad + \boldsymbol{\delta}_4'\mathbf{z} + \delta_5\left(\ln w^A - \ln w^B\right) + \delta_6],\end{aligned} \tag{15}$$

where $\boldsymbol{\gamma}_4$ and $\boldsymbol{\delta}_4$ are two vectors of dimension m.

In the empirical section, three distribution factors will be used (i.e., $m = 3$). It is easily checked that *distribution factor proportionality* (see Proposition 1) is satisfied if:

$$\frac{\gamma_{4;2}}{\gamma_{4;1}} = \frac{\delta_{4;2}}{\delta_{4;1}}; \frac{\gamma_{4;3}}{\gamma_{4;1}} = \frac{\delta_{4;3}}{\delta_{4;1}} \tag{16}$$

where $\gamma_{4;i}$ and $\delta_{4;i}$ are the ith elements of respectively $\boldsymbol{\gamma}_4$ and $\boldsymbol{\delta}_4$.

Let us now consider the more specific setting of the sharing rule interpretation, where individual labour supplies can be considered as the observable result of a two-stage budgeting process (see Proposition 3). Via the partial derivatives of the individual labour supply functions, the following set of partial derivatives of the sharing rule ϕ can be derived:

$$\begin{aligned}\frac{\partial \phi}{\partial y} &= \frac{\delta_{4;1}}{\delta_{4;1} - \gamma_{4;1}} \\ \frac{\partial \phi}{\partial w^A} &= \frac{2\gamma_{4;1}\delta_5}{w^A\left(\delta_{4;1} - \gamma_{4;1}\right)} \\ \frac{\partial \phi}{\partial w^B} &= \frac{-2\delta_{4;1}\gamma_5}{w^B\left(\delta_{4;1} - \gamma_{4;1}\right)} \\ \frac{\partial \phi}{\partial z_i} &= \frac{2\gamma_{4;i}\delta_{4;1}}{\delta_{4;1} - \gamma_{4;1}} \text{ for } i = 1, 2, 3.\end{aligned} \tag{17}$$

[2] These results imply enough information to determine the qualitative effects of tax reforms on individual utilities (see, e.g., Chiappori, 1992). However, tax reform analyses by means of inequality indices or social welfare functions at the individual level will in general depend on the unknown constant. One possible way out is to conduct a sensitivity analysis, where inequality indices are calculated for some (plausible) values of this constant.

The denominator of the above equations has to be different from zero in the collective setting. This can be easily tested.

Let us denote the vector $\left(y, w^A, w^B, \mathbf{z}'\right)'$ by $\mathbf{f}$ and capture the right-hand sides of equation (17) by the vector $\boldsymbol{\psi}$:

$$\begin{aligned}\boldsymbol{\psi} &= (\frac{\delta_{4;1}}{\delta_{4;1}-\gamma_{4;1}}, \frac{2\gamma_{4;1}\delta_5}{w^A\left(\delta_{4;1}-\gamma_{4;1}\right)}, \frac{-2\delta_{4;1}\gamma_5}{w^B\left(\delta_{4;1}-\gamma_{4;1}\right)}, \\ & \frac{2\gamma_{4;1}\delta_{4;1}}{\delta_{4;1}-\gamma_{4;1}}, \frac{2\gamma_{4;2}\delta_{4;1}}{\delta_{4;1}-\gamma_{4;1}}, \frac{2\gamma_{4;3}\delta_{4;1}}{\delta_{4;1}-\gamma_{4;1}})'. \qquad (18)\end{aligned}$$

A necessary and sufficient condition to integrate the above set of partial differential equations back to the sharing rule, is that the matrix $\frac{\partial \psi}{\partial \mathbf{f}'}$ is symmetric. This is always satisfied for the chosen specification. The *sharing rule* ϕ is identified, up to an additive constant $k(\mathbf{d})$, by the solution of the set of partial differential equations in (17):

$$\begin{aligned}\phi &= \frac{1}{\delta_{4;1}-\gamma_{4;1}}(\delta_{4;1}y + 2\gamma_{4;1}\delta_5 \ln w^A - 2\gamma_5\delta_{4;1}\ln w^B \qquad (19) \\ & +2\gamma_{4;1}\delta_{4;1}z_1 + 2\gamma_{4;2}\delta_{4;1}z_2 + 2\gamma_{4;3}\delta_{4;1}z_3) + k(\mathbf{d}).\end{aligned}$$

Second stage individual labour supply functions and individual indirect utility functions for the chosen specification can now be derived by means of the next proposition:

Proposition 4 Second stage individual labour supply functions. *If the restrictions $\gamma_{4;1} = -\delta_{4;1}, \gamma_{4;2} = -\delta_{4;2}, \gamma_{4;3} = -\delta_{4;3}$ and $\gamma_5 = -\delta_5$ are satisfied, then second stage individual labour supplies, corresponding to (11), are derived from the indirect utility functions (with normalized price of the Hicksian aggregate commodity)*

$$u^A = \frac{\phi + a^A\left(w^A, \mathbf{d}\right)}{b^A\left(w^A\right)} \qquad (20)$$

and

$$u^B = \frac{y - \phi + a^B\left(w^B, \mathbf{d}\right)}{b^B\left(w^B\right)} \qquad (21)$$

where the price index functions a^I and b^I $(I = A, B)$ are of the form:

$$\begin{aligned}a^A\left(w^A, \mathbf{d}\right) &= \alpha_1^A(\mathbf{d})\, w^A - \alpha_2^A - \frac{1}{2}\gamma_{11}^A \ln^2 w^A \qquad (22) \\ b^A\left(w^A\right) &= \left(w^A\right)^{\beta_1^A} \\ a^B\left(w^B, \mathbf{d}\right) &= \alpha_1^B(\mathbf{d})\, w^B - \alpha_2^B - \frac{1}{2}\gamma_{11}^B \ln^2 w^B \\ b^B\left(w^B\right) &= \left(w^B\right)^{\beta_1^B}.\end{aligned}$$

Coefficients of these indirect utility functions are identified as follows: $\alpha_1^A(\mathbf{d}) = \gamma_1(\mathbf{d})$, $\gamma_{11}^A = \gamma_2$, $\beta_1^A = \gamma_3$, $\alpha_1^B(\mathbf{d}) = \delta_1(\mathbf{d})$, $\gamma_{11}^B = \delta_2$ and $\beta_1^B = \delta_3$. The coefficients α_2^A and α_2^B cannot be identified by means of observable labour supply, since they depend on the additive constant $k(\mathbf{d})$.

Proof: See Appendix A.

Second stage labour supply functions are thus of the same form as the unitary labour supply functions for singles (see (3) or (4)). Consequently, welfare evaluations at the intrahousehold level of changes in wages or other exogenous variables can be done by means of the Gorman polar form individual utility functions (20) and (21) which are identified for any given $k(\mathbf{d})$. Note that the functional specification does not directly allow to test for negativity since the Slutsky effects are a function of ϕ, which is unobservable. However, such a test is possible for given values of the constant $k(\mathbf{d})$.

3 Data and econometric issues

The above unitary and collective labour supply models are estimated and tested on the 1995-2003 waves of the Dutch DNB Household Survey. This yearly survey, which was formerly known as the CentER Savings Survey, is representative for the Dutch population and contains a very rich amount of economic, socio-demographic and psychological variables.[3] From this dataset, three samples of households are kept back. Both labour supply approaches are applied to a sample of childless two person households of which both individuals have a positive labour supply.[4] The sample is further restricted to households of which both members are between 18 and 65 years old. Also the self-employed are excluded. After deleting observations with important missing information, this results in a sample size of 680 couples. Since the unitary model should be applicable to single person households in both approaches, two samples of participating male and female singles, without children, between 18 and 65 years old and who are not self-employed act as a type of benchmark. Sample sizes are respectively equal to 894 and 536 for male and female singles. Summary statistics of the three different subsamples are given in Tables 8 and 9 of Appendix B.

Wage rates are obtained by dividing the individual labour incomes by the number of hours worked. In order to avoid a division bias, wages are treated as endogenous variables and are instrumented by work experience (years employed and the square of years employed), the square of age and dummies capturing the individuals' education level.

Three distribution factors were taken up in the collective labour supply model. These are the age difference between both household members, a dummy variable indicating whether the individuals are married or cohabiting, and the share of the male's individually assignable nonlabour income in the household's

[3] We did not make use of the panel structure of the data during the estimations. The reason for this choice is that there are relatively too few households that were observed in a fairly large number of waves of the DNB Household Survey. E.g., more than 40% of the households in the selected sample appear in only one wave.

[4] The approach of focusing on households with working individuals may be subject to sample selection bias. Following Chiappori, Fortin and Lacroix (2002), we ignore this potential bias; mainly because of the fact that the nontrivial extension of the collective model to non-participation is beyond the scope of this empirical exercise. See Blundell et alii (2001), Donni (2003), Vermeulen (2003) and Vermeulen et alii (2003) for alternative collective labour supply models that explicitly take account of corner solutions. We further do not concentrate on households with children. Tests on consumption data for collective rationality of households with more than two persons can be found in Dauphin and Fortin (2001) and Browning and Chiappori (1998). Testability and identification results with respect to public goods (or more specifically expenditures on children) are discussed in Chiappori, Blundell and Meghir (2002).

total nonlabour income.[5] Remark that the latter variable allows for a deviation from the income pooling hypothesis of the unitary model, which implies that the source of the nonlabour income does not have any influence on observed household choices. The three distribution factors are used to test the collective restrictions of equation (16) and of Proposition 4. Note that it may be problematic to find convincing distribution factors. Contrary to the exercise in Chiappori, Fortin and Lacroix (2002), an index capturing divorce laws (or laws on alimony) cannot be used for the Netherlands, since the whole country has the same legislation on divorce and alimony. A possible critique on the marriage dummy in the current exercise may be that it captures preference differences between individuals who are married and individuals who are cohabiting.

Age and dummies for geographical regions are taken up as demographic and taste shifter variables in the labour supply equations (3), (4), (14) and (15). Linear specifications for the functions $\alpha_1(\mathbf{d})$, $\alpha_2(\mathbf{d})$, $\gamma_1(\mathbf{d})$ and $\delta_1(\mathbf{d})$ were chosen. Estimations are done with the generalized method of moments (GMM).

4 Empirical results

4.1 The unitary model

4.1.1 Single person households

Table 1 gives parameter estimates and standard errors of the estimation of the unitary model for single males and females (cf. singles' version of (3)).[6] Let us start with a discussion of the males' estimates. As is clear from the table, about half of the parameters are significantly estimated. A 100 euro increase in the weekly nonlabour income of a single man, with an average wage, significantly, although far from substantially, decreases his labour supply by a fraction of an hour. Living in the southern region increases average labour supply by about one hour, when compared to living in one of the three largest cities (Amsterdam, Rotterdam or The Hague). Also the parameter associated with the own wage is significantly estimated. It is, however, less easily interpreted. Therefore, we will focus on elasticities further in the paper. Since the γ_{11}-parameter is significantly estimated, the LES labour supply specification is rejected at any conventional significance level. The sign of the compensated wage effects was checked for each male in the subsample. These wage effects have the right positive sign for all 894 observations, so that Slutsky conditions are at least locally satisfied for this sample.

[5] This variable of course captures observable information and should not be confused with the implicit share in the household's nonlabour income resulting from the intrahousehold allocation process.

[6] In principle, the model is completely identified. For the given sample, however, there was a problem to estimate the parameter associated with the Hicksian aggregate commodity (because of too little variation in some (combinations of) explanatory variables). Therefore, this parameter has been assigned a value of -50. Filled into the labour supply equation, this can be interpreted as committed (subsistence) expenditure on household consumption of 50 euro per week. Some sensitivity tests with respect to this parameter were conducted; values were set at different levels between 0 and 100. Neither of the alternatives resulted in substantial changes of the obtained estimates; this both with respect to parameter values and significance levels.

For single women, it turns out that age has a significantly estimated, but not very important, negative impact on labour supply. Living in Amsterdam, Rotterdam or The Hague, on the other hand, increases average weekly labour supply by respectively 2 and 3 hours, when compared to living in the western and northern regions outside one of these cities. Note that the parameter associated with the own wage is not significantly estimated; implying that the LES labour supply specification cannot be rejected for single women. Finally, only 23 of the 536 observations do not have the expected positive compensated wage effect.

Summarizing, it is clear that the unitary model performs rather well for both male and female singles. In what follows, we turn attention to couples.

Table 1: Estimates singles

	Males (894 obs.)	Females (536 obs.)
Constant	38.48 (1.00)**	39.65 (1.73)**
Wage effect γ_{11}	0.05 (0.02)**	0.81 (6.73)
Nonlabour income effect β_1	0.01 (0.00)**	0.00 (0.01)
Age	-0.02 (0.02)	-0.08 (0.03)**
Dummy western region	0.11 (0.53)	-1.93 (0.83)**
Dummy northern region	0.55 (0.77)	-2.86 (1.29)**
Dummy eastern region	1.47 (0.98)	0.36 (0.81)
Dummy southern region	1.15 (0.53)**	-0.44 (0.94)

Note: Asymptotic standard errors are beween brackets. Living in one of the three largest cities (Amsterdam, Rotterdam and The Hague) serves as reference category for the geographical dummies. A(n) (double) asterisk denotes significance at the ten (five) percent significance level.

4.1.2 Two person households

GMM estimation results for the unitary model applied to the sample of two person households are given in Tables 2 and 3 (see equations (3) and (4)).[7] About half of the parameters are significantly estimated at conventional significance levels. The own wage has a significantly estimated impact for men in both sets of estimates. Again, this variable will be interpreted further in the paper by means of elasticities. For women, age has a significantly estimated negative effect on female labour supply. Further, living in one of the three largest cities implies a higher labour supply than living in one of the other regions. This effect ranges from a higher labour supply of about two to four hours.

It is important for the theoretical consistency of the model that a Wald test cannot reject symmetry (test statistic of 0.16 < $\chi^2_{0.05}(1)$ =3.84). The LES labour supply specification (γ_{11}=γ_{12}=γ_{21}=γ_{22}=0) is strongly rejected by means of a Wald test in both unrestricted and restricted versions (test statistics of respectively 13.62 and 13.90 > $\chi^2_{0.05}$ (4)=9.49). Finally, concavity conditions are not satisfied for 420 of the 680 households in the sample for the unrestricted labour supply version. In the symmetry restricted version, Slutsky conditions

[7] Note that the parameter associated with the Hicksian aggregate commodity has been set equal to -100 to make the committed expenditure comparable to that of single person households. Here also, a sensitivity analysis did not show substantial changes in magnitude and significance of parameter estimates.

are not satisfied for 514 households. Note the important difference between these results and the estimation results for singles, with a similar functional specification, where Slutsky conditions are not satisfied for only a marginal fraction of the singles.

To summarize, it is clear that the unitary model seems to perform better when applied to singles than when applied to couples. This indicates that there is indeed something wrong with the aggregation assumptions that underly this model for multiperson households. In the following subsection, we will check whether the collective model is a valuable alternative to the unitary model.

Table 2: Unrestricted estimates unitary model couples (680 obs.)

	Males	Females
Constant	34.47 (4.20)**	52.62 (7.06)**
Own wage effect γ_{ii} $(i = 1, 2)$	-51.22 (15.58)**	6.75 (36.06)
Partner's wage effect γ_{ij} $(i, j = 1, 2;\ i \neq j)$	18.83 (12.73)	9.72 (20.56)
Nonlabour income effect β_i $(i = 1, 2)$	0.03 (0.02)	0.03 (0.02)
Age men	-0.04 (0.07)	-0.06 (0.12)
Age women	-0.01 (0.05)	-0.22 (0.10)**
Dummy western region	0.74 (0.58)	-2.32 (1.03)*
Dummy northern region	-0.03 (0.86)	-4.24 (2.01)**
Dummy eastern region	0.95 (0.69)	-1.89 (1.15)*
Dummy southern region	0.29 (0.64)	-2.04 (1.18)*

Note: Asymptotic standard errors are beween brackets. Living in one of the three largest cities (Amsterdam, Rotterdam and The Hague) serves as reference category for the geographical dummies. A(n) (double) asterisk denotes significance at the ten (five) percent significance level.

Table 3: Symmetry restricted estimates unitary model couples (680 obs.)

	Males	Females
Constant	34.49 (4.15)**	50.96 (5.50)**
Own wage effect γ_{ii} $(i = 1, 2)$	-49.11 (14.12)**	-3.86 (23.97)
Partner's wage effect γ_{ij} $(i, j = 1, 2;\ i \neq j)$	16.77 (11.27)	16.77 (11.27)
Nonlabour income effect β_i $(i = 1, 2)$	0.03 (0.02)*	0.03 (0.02)
Age men	-0.03 (0.07)	-0.04 (0.10)
Age women	-0.01 (0.05)	-0.23 (0.10)**
Dummy western region	0.74 (0.58)	-2.36 (1.02)**
Dummy northern region	-0.03 (0.84)	-4.34 (1.99)**
Dummy eastern region	0.96 (0.69)	-1.89 (1.15)*
Dummy southern region	0.29 (0.63)	-2.04 (1.18)*

Note: Asymptotic standard errors are beween brackets. Living in one of the three largest cities (Amsterdam, Rotterdam and The Hague) serves as reference category for the geographical dummies. A(n) (double) asterisk denotes significance at the ten (five) percent significance level.

4.2 The collective model

In Tables 4 to 6 GMM estimation results are shown for three versions of the collective labour supply model: an unrestricted version of the model (see (14) and (15)), the collective labour supply model with distribution factor proportionality restrictions (16) imposed and the collective model with the restrictions of Proposition 4 imposed. Quite some parameters are significantly estimated; especially in the restricted estimates as could be expected. Consistent with the unitary model's estimates, an increase in a household's nonlabour income, decreases labour supply of both individuals. If a household's nonlabour income increases by 100 euro per week, then men, with average wages, reduce their labour supply by about one hour per week, according to the unrestricted estimates. The same conclusion can be drawn for women in the restricted estimates. Also age has a strong negative impact on labour supply for both sexes.

Let us now turn attention to the testing of the collective restrictions. By means of the Wald test, distribution factor proportionality (see equation (16)) cannot be rejected in the unrestricted version of the collective labour supply model at the 5% significance level (test statistic of $0.35 < \chi^2_{0.05}(2) = 5.99$). Consequently, the theoretical implications of the general collective household model cannot be rejected for the given sample. Moreover, in both the unrestricted version and the collective model with distribution factor proportionality imposed, the hypothesis of second stage individual labour supplies derived from Gorman polar form preferences (see Proposition 4) cannot be rejected. Test statistics are respectively 0.47 and 0.16 and are to be compared to $\chi^2_{0.05}(4)$=9.49 and $\chi^2_{0.05}(2)$=5.99). As already discussed, concavity conditions on second stage individual labour supplies cannot be directly checked since these depend on the integration constant $k(\mathbf{d})$. Some indication of the validity of these restrictions might be obtained by testing the sign of compensated wage responses for $k(\mathbf{d})$ fixed to some number. If this unknown constant is fixed at 300 euro for every household, for example, then concavity is not satisfied for only 7 men and 9 women in the sample; for a fixation at 200, we obtain a rejection for 34 men and 4 women.[8] Finally, a test for the denominator of the sharing rule (17) being different from zero, strongly rejected equality of the parameters associated with the male's share in nonlabour income in both labour supply equations. The test statistic equals 4.09 and is to be compared with $\chi^2_{0.05}(1)$=3.84. Consequently, it seems that the assumption of egoistic or caring preferences of individuals in couples is not too strong. This is an important result from a welfare economic point of view, since intrahousehold welfare evaluations of changes in the explanatory variables can be done by means of the individual indirect utility functions (20) and (21). Summarizing these testing results, one can conclude that the collective model at hand seems to be a valuable alternative to the unitary model for couples which was rejected for the same data.

As has been shown earlier, if individual preferences are of the egoistic or caring type, then the observed household allocation can be seen as the implicit result of a two-stage budgeting process. First, household members allocate total

[8] Note that this constant $k(\mathbf{d})$ may differ over different houshold types, implying the possibility that every individual's behaviour may be consistent with rationality for well-chosen values of this constant. Some distributional characteristics of the sharing rule and its implications on individual consumption levels for different values of this constant are given in Appendix C.

household nonlabour income among each other according to some sharing rule, while in a second stage, each individual maximizes her utility subject to her share in total nonlabour income. Partial derivatives of the sharing rule (19), associated with the chosen parameterization, can be found in the estimation results of the third version of the collective model in Table 6. These partials can be interpreted as follows. First of all, being married implies a significant increase of 167 euro per week in the implicit share going to women in comparison with cohabitation. In terms of household bargaining, one might argue that marriage improves the bargaining position of women in comparison with cohabitation. Also the age difference has a positive impact on the share in nonlabour income going to women. There is a (not significantly estimated) positive effect on the weekly transfer to women of about 4.6 euro per year difference. Somewhat counterintuitive is that also the male's share in nonlabour income has a significantly estimated favorable impact on the share accruing to women. An increase of the male's share by 10% implies an increase of the women's share of about one euro. Finally, at mean wage rates, an increase of the hourly wage rate of men by 1 euro, implies a (not significantly estimated) increase of the share going to women of about 90 euro per week.

Table 4: Unrestricted estimates collective model (680 obs.)

	Males	Females
Constant	39.83 (5.20)**	47.24 (8.60)**
Own wage (γ_2 and δ_2)	-21.42 (13.43)	-3.50 (26.72)
Nonlabour income (γ_3 and δ_3)	0.09 (0.05)*	0.06 (0.04)
Dummy married	-115.57 (186.40)	338.70 (446.0)
Age difference	-5.51 (7.23)	-2.41 (14.81)
Male's share in nonlabour income	-9.50 (6.29)	11.09 (7.35)
Difference in log wages	-275.91 (238.6)	369.75 (415.7)
Age	-0.09 (0.05)*	-0.23 (0.08)**
Dummy western region	0.89 (0.64)	-2.12 (1.11)*
Dummy northern region	0.05 (1.07)	-3.58 (2.20)
Dummy eastern region	1.16 (0.81)	-1.70 (1.35)
Dummy southern region	0.35 (0.76)	-1.83 (1.31)*

Note: Asymptotic standard errors are beween brackets. Living in one of the three largest cities (Amsterdam, Rotterdam and The Hague) serves as reference category for the geographical dummies. A(n) (double) asterisk denotes significance at the ten (five) percent significance level.

4.3 Elasticities

Table 7 provides elasticities for the different labour supply models with the above theoretical restrictions imposed. Let us start with a discussion of the elasticities of singles. Mean own wage elasticities are positive, although rather small, for both single men and women. As could be expected, leisure turns out to be a normal commodity, since the income elasticities derived from the labour supply equations are negative.

As is clear from the table, couples' elasticities obtained by means of the unitary and collective models are qualitatively very similar. According to both

Table 5: Distribution factor proportionality estimates collective model (680 obs.)

	Males	Females
Constant	41.06 (4.95)**	50.87 (7.04)**
Own wage (γ_2 and δ_2)	-20.22 (12.67)	6.29 (22.16)
Nonlabour income (γ_3 and δ_3)	0.10 (0.05)**	0.07 (0.04)*
Dummy married	-116.24 (160.10)	152.12 (216.6)
Age difference	-3.16 (5.78)	4.13 (7.62)
Male's share in nonlabour income	-7.93 (7.10)	10.38 (6.17)*
Difference in log wages	-254.73 (202.7)	307.18 (322.5)
Age	-0.10 (0.05)**	-0.27 (0.06)**
Dummy western region	0.91 (0.66)	-2.22 (1.09)**
Dummy northern region	0.12 (1.14)	-3.67 (2.15)*
Dummy eastern region	1.22 (0.85)	-2.12 (1.26)*
Dummy southern region	0.44 (0.80)	-2.03 (1.28)

Note: Asymptotic standard errors are beween brackets. Living in one of the three largest cities (Amsterdam, Rotterdam and The Hague) serves as reference category for the geographical dummies. A(n) (double) asterisk denotes significance at the ten (five) percent significance level.

Table 6: Gorman polar form estimates collective model (680 obs.)

	Males	Females
Constant	40.23 (4.38)**	50.99 (6.02)**
Own wage (γ_2 and δ_2)	-19.38 (12.00)	5.94 (20.73)
Nonlabour income (γ_3 and δ_3)	0.09 (0.04)**	0.07 (0.03)**
Dummy married	-166.88 (176.1)	166.88 (176.1)
Age difference	-4.61 (6.42)	4.61 (6.42)
Male's share in nonlabour income	-9.91 (4.50)**	9.91 (4.50)**
Difference in log wages	-262.23 (201.8)	262.23 (201.8)
Age	-0.10 (0.04)**	-0.27 (0.05)**
Dummy western region	0.85 (0.63)	-2.21 (1.09)**
Dummy northern region	-0.13 (1.07)	-3.55 (2.12)*
Dummy eastern region	1.08 (0.79)	-2.07 (1.24)*
Dummy southern region	0.31 (0.76)	-1.98 (1.27)

Note: Asymptotic standard errors are beween brackets. Living in one of the three largest cities (Amsterdam, Rotterdam and The Hague) serves as reference category for the geographical dummies. A(n) (double) asterisk denotes significance at the ten (five) percent significance level.

models, men seem to be on the backward bending part of the labour supply curve. Women, on the other hand, have a fairly large positive mean wage elasticity. Mean cross-wage elasticities are negative for both sexes in both models. Finally, the models agree on the income elasticities, which are negative for men and women; implying that leisure is a normal commodity for couples or individuals in couples.

Table 7 also shows elasticities that are calculated by means of the second stage labour supply functions (see Proposition 4). They can be interpreted as elasticities with the sharing rule ϕ kept constant. Of course, this sharing rule is only observed up to an additive constant $k(\mathbf{d})$. Therefore, the elasticities are calculated with this constant equal to 300, the value earlier used to test concavity of the individual utility functions. Total elasticities can in this way be disentangled in a part stemming from a marginal change in wages or nonlabour income with the sharing rule held constant, and a part originating from a shift in nonlabour income from one individual to the other (i.e., due to a change in bargaining power). As is clear from the table, the bargaining power does not entail sign reversals between both sets of elasticities, but has some quantitave effect on the different elasticities.

Table 7: Elasticities

	Mean	1st quart.	Median	3rd quart.
UNITARY MODEL MALE SINGLES				
Own wage	0.007 (0.045)	0.002	0.003	0.004
Nonlabour income	-0.004 (0.038)	-0.002	-0.002	-0.001
UNITARY MODEL FEMALE SINGLES				
Own wage	0.003 (0.017)	0.003	0.004	0.004
Nonlabour income	-0.002 (0.01)	-0.001	-0.001	-0.000
UNITARY MODEL COUPLES				
Males				
Own wage	-0.03 (0.06)	-0.06	-0.03	-0.01
Partner's wage	-0.07 (0.03)	-0.08	-0.06	-0.05
Nonlabour income	-0.01 (0.01)	-0.01	-0.01	-0.01
Females				
Own wage	0.27 (0.24)	0.16	0.20	0.30
Partner's wage	-0.14 (0.12)	-0.16	-0.11	-0.09
Nonlabour income	-0.02 (0.02)	-0.02	-0.01	-0.01
COLLECTIVE MODEL COUPLES				
Males				
Own wage	-0.01 (0.07)	-0.05	-0.02	0.00
Own wage with sharing rule constant	-0.07 (0.05)	-0.10	-0.08	-0.06
Partner's wage	-0.06 (0.03)	-0.07	-0.06	-0.05
Nonlabour income	-0.02 (0.02)	-0.02	-0.01	-0.01
Nonlabour income with sharing rule constant	-0.03 (0.03)	-0.04	-0.03	-0.02
Females				
Own wage	0.26 (0.24)	0.14	0.19	0.28
Own wage with sharing rule constant	0.35 (0.31)	0.20	0.27	0.38
Partner's wage	-0.09 (0.07)	-0.10	-0.08	-0.06
Nonlabour income	-0.03 (0.03)	-0.03	-0.02	-0.01
Nonlabour income with sharing rule constant	-0.05 (0.06)	-0.06	-0.04	-0.02

Note: Standard errors beween brackets.

5 Conclusion

The objective of this paper was to empirically evaluate two competing approaches to household labour supply. The first approach is the standard unitary model where households are assumed to behave as single rational decision making units. An alternative to this traditional model is the collective approach. In this approach, as initially defined by Chiappori (1988, 1992), it is explicitly taken into account that many person households consist of several individuals with own rational preferences. Among these individuals, a Pareto efficient intrahousehold bargaining process is assumed to take place.

The empirical evaluation focused on the testing of implied theoretical restrictions of both models and on the ability to identify structural information, like preferences and the intrahousehold allocation process. Flexible functional specifications were derived for both approaches. For the unitary model, labour supply functions come from preferences that can be represented by an indirect utility function of the Gorman polar form. Testable implications of this unitary labour supply model are standard restrictions on the Slutsky matrix. As to the collective model, we followed the approach of Chiappori, Fortin and Lacroix (2002), who derived a collective labour supply model with distribution factors. The latter are defined as variables that affect the intrahousehold distribution process, but that do not have any direct effect on individual preferences or the joint household budget constraint. By means of these distribution factors, testable implications of the collective approach can be derived. If some additional restrictions on the chosen parameterization of the collective model are satisfied, then utility function specifications for individuals in couples and singles in the unitary model coincide.

Both models were applied to a sample of couples where both members have a positive labour supply, coming from the 1995-2003 waves of the DNB Household Survey, which was formerly known as the CentER Savings Survey. Since the unitary model should be entirely applicable to singles, the former was also tested on samples of male and female singles. In the collective labour supply model, a variable capturing whether the household members are married or cohabiting, the age difference between individuals and the share of the male's individual nonlabour income in the couple's total nonlabour income were taken up as distribution factors. Estimations were done by means of the generalized method of moments.

Since symmetry is not a theoretical restriction for singles, the only restriction incorporated by the unitary model is the requirement of positive compensated wage effects. These were of the correct sign for all male singles in the sample. Only for a small fraction of the women's sample, compensated wage effects were of the wrong sign. Consequently, it can be argued that, at least locally, the unitary model could not be rejected for single person households. As to the theoretical implications of the unitary model for two person households, symmetry could not be rejected at conventional significance levels. However, Slutsky sign restrictions were not satisfied for about two thirds of the sample. The fact that the unitary model is not rejected for singles, but rejected when applied to couples data, is really important since it may indicate that there is indeed something wrong with the usual aggregation assumptions in the unitary model. Note that the same conclusion was obtained by Browning and Chiappori (1998) in a consumption context.

As for the collective model, the general collective restriction of distribution factor proportionality could not be rejected for the given sample. Moreover, the restrictions associated with the important assumption of egoistic or caring preferences of the individual household members could not be rejected. These results imply the collective approach being a valuable alternative to the rejected unitary model for couples; a conclusion on a par with Browning and Chiappori (1998).

A second criterion that was focused on to evaluate the unitary and the collective models is the ability to identify structural information. If observed labour supply satisfies the usual unitary restrictions, then it can be integrated back to rational household preferences. This is important for welfare economic evaluations of policy reforms at the household level. A similar integration result applies to the collective model if individual preferences are of the egoistic or caring type. In this case, household labour supply behaviour can be modelled as a two stage budgeting process. Firstly, household members allocate total household nonlabour income among each other according to some sharing rule. In a second stage, both individuals maximize individual preferences subject to the implied individual budget constraints. If preferences are egoistic or caring, then this sharing rule is identified up to an additive constant, while individual preferences are uniquely identified for a given constant. Some main results connected with this sharing rule interpretation of the collective model are the following. Being married in comparison to cohabiting implies a substantial increase of the implicit share going to women. Also the age difference between men and women, the share of the male's individual nonlabour income in the total nonlabour income, and the wage difference between men and women have a favourable effect on the share of total nonlabour income going to women. Not all these effects are significantly different from zero, though. Note that the ability to gain information on the intrahousehold allocation and the implications of it on individual welfare, is an important comparative advantage of the collective approach. Since the crucial assumption of egoistic or caring preferences could not be rejected, welfare analyses cannot only be done at the household level, but also in terms of individual welfare levels.

Future research may test whether the above results are robust with respect to other functional forms that can describe the same variety in observed labour supply behaviour. Another research avenue is the incorporation of nonparticipation into the collective model (see, e.g., Blundell et alii, 2001 and Donni, 2003). Note that this option has the positive by-product of generating extra observations for the sample, which might benefit the precision of estimated parameters. Another path for future research is the modelling of expenditures on children and other public goods within a household (see Chiappori, Blundell and Meghir, 2002). Finally, the collective model in the current study does not take into account household production (see Apps and Rees, 1997, and Chiappori, 1997). The simple dichotomy between market time and leisure may be an inadequate assumption in modelling household labour supply. The increasing availability of time budget studies may enhance the empirical modelling of household labour supply incorporating household production.

Appendix A: Proof of Proposition 4.

Firstly, taking account of the restrictions $\gamma_{4;1} = -\delta_{4;1}$ and $\gamma_5 = -\delta_5$ and rewriting the sharing rule (19) results in:

$$\frac{1}{2}y = \phi - \gamma_{4;1}z_1 - \gamma_{4;2}z_2 - \gamma_{4;3}z_3 - \gamma_5\left(\ln w^A - \ln w^B\right) - k\left(\mathbf{d}\right). \qquad (23)$$

Substituting the right-hand side of equation (23) for $\frac{1}{2}y$ in individual A's collective labour supply function (14) results in

$$\ell^A = \gamma_1\left(\mathbf{d}\right) - \frac{\gamma_2}{w^A}\ln w^A - \frac{\gamma_3}{w^A}(\phi + \gamma_1\left(\mathbf{d}\right)w^A - \frac{1}{2}\gamma_2\ln^2 w^A + \gamma_6 - k\left(\mathbf{d}\right)), \quad (24)$$

which is easily seen to be derived from A's indirect utility function (20) with parameters $\alpha_1^A\left(\mathbf{d}\right) = \gamma_1\left(\mathbf{d}\right)$, $\gamma_{11}^A = \gamma_2$, $\beta_1^A = \gamma_3$ and $\alpha_2^A = \gamma_6 - k\left(\mathbf{d}\right)$.

Second, taking into account $\gamma_{4;1} = -\delta_{4;1}, \gamma_{4;2} = -\delta_{4;2}$, $\gamma_{4;3} = -\delta_{4;3}$ and $\gamma_5 = -\delta_5$ and manipulating the sharing rule (19) somewhat, results in the implicit equation:

$$\frac{1}{2}y = y - \phi - \delta_{4;1}z_1 - \delta_{4;2}z_2 - \delta_{4;3}z_3 - \delta_5\left(\ln w^A - \ln w^B\right) + k\left(\mathbf{d}\right). \qquad (25)$$

Substitution of the right-hand side of (25) for $\frac{1}{2}y$ in the collective labour supply function of individual B (15) gives

$$\ell^B = \delta_1\left(\mathbf{d}\right) - \frac{\delta_2}{w^B}\ln w^B - \frac{\delta_3}{w^B}(y - \phi + \delta_1\left(\mathbf{d}\right)w^B - \frac{1}{2}\delta_2\ln^2 w^B + \delta_6 + k(\mathbf{d})), \quad (26)$$

which corresponds to individual B's labour supply derived from the indirect utility function (21) with parameters $\alpha_1^B\left(\mathbf{d}\right) = \delta_1\left(\mathbf{d}\right)$, $\gamma_{11}^B = \delta_2, \beta_1^B = \delta_3$ and $\alpha_2^B = \delta_6 + k\left(\mathbf{d}\right)$.

□

Appendix B: Data

Table 8: Sample statistics male and female singles

	Males (894 obs.)		Females (536 obs.)	
Variable	Mean	St. dev.	Mean	St. dev.
Weekly working hours	37.29	5.03	34.67	6.44
Net hourly wage rate	10.64	8.06	9.42	5.04
Age	40.80	9.01	41.32	10.64
Years employed	18.59	12.36	18.14	12.46
Dummy primary education	0.11		0.11	
Dummy secondary education	0.39		0.27	
Dummy non-academic higher education	0.29		0.43	
Dummy academic higher education	0.21		0.19	
Dummy three largest cities	0.32		0.28	
Dummy western region	0.27		0.29	
Dummy northern region	0.07		0.09	
Dummy eastern region	0.18		0.15	
Dummy southern region	0.16		0.18	
Weekly nonlabour income	103.96	783.70	111.97	174.53

Note: Monetary variables are in 2003 euro. Three largest cities are Amsterdam, Rotterdam and The Hague.

Table 9: Sample statistics two person households (680 obs.)

	Males		Females	
Variable	Mean	St. dev.	Mean	St. dev.
Weekly working hours	37.73	4.50	30.68	8.56
Net hourly wage rate	11.32	4.87	8.67	3.45
Age	42.77	10.50	40.47	10.32
Years employed	22.26	12.89	17.05	10.53
Dummy primary education	0.15		0.13	
Dummy secondary education	0.38		0.44	
Dummy non-academic higher education	0.30		0.32	
Dummy academic higher education	0.17		0.11	
Dummy three largest cities	0.17		0.17	
Dummy western region	0.34		0.34	
Dummy northern region	0.07		0.07	
Dummy eastern region	0.20		0.20	
Dummy southern region	0.21		0.21	
Dummy married	0.74		0.74	
Weekly nonlabour income	89.24	117.98	57.12	64.96

Note: Monetary variables are in 2003 euro. Three largest cities are Amsterdam, Rotterdam and The Hague.

Appendix C: Distributional characteristics sharing rule and individual consumption

Table 10: Distributional characteristics of sharing rule

Variable	ϕ	
	$k(\mathbf{d}) = 300$	$k(\mathbf{d}) = 200$
Mean	162.63	62.63
Standard deviation	184.59	184.59
First quartile	58.19	-41.81
Median	155.50	55.50
Third quartile	272.82	172.82

Note: Values in cells are in 2003 euro per week.

Table 11: Distributional characteristics of male consumption

Variable	c^A	
	$k(\mathbf{d}) = 300$	$k(\mathbf{d}) = 200$
Mean	585.56	485.56
Standard deviation	176.61	176.61
First quartile	466.61	366.61
Median	571.81	471.81
Third quartile	676.87	576.87

Note: Values in cells are in 2003 euro per week.

Table 12: Distributional characteristics female consumption

Variable	c^B	
	$k(\mathbf{d}) = 300$	$k(\mathbf{d}) = 200$
Mean	245.24	345.24
Standard deviation	169.49	169.49
First quartile	146.51	246.51
Median	250.69	350.69
Third quartile	341.14	441.14

Note: Values in cells are in 2003 euro per week.

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