Journal of Business & Economic Statistics

ISSN: 0735-0015 (Print) 1537-2707 (Online) Journal homepage: https://www.tandfonline.com/loi/ubes20

Collective Labor Supply, Taxes, and Intrahousehold Allocation: An Empirical Approach

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Most empirical studies of the impact of labor income taxation on the labor supply behavior of households use a unitary modeling approach. In this article, we empirically analyze income taxation and the choice of working hours by combining the collective approach for household behavior and the discrete hours choice framework with fixed costs of work. We identify the sharing rule parameters with data on working hours of both the husband and the wife within a couple. Parameter estimates are used to evaluate various model outcomes, like the wage elasticities of labor supply and the impacts of wage changes on the intrahousehold allocation of income. We also simulate the consequences of a policy change in the tax system. We find that the collective model has different empirical outcomes of income sharing than a restricted model that imposes income pooling. In particular, a specification with income pooling fails to capture asymmetries in the income sharing across spouses. These differences in outcomes have consequences for the evaluation of policy changes in the tax system and shed light on the effectiveness of certain policies.

KEY WORDS: Household behavior and family economics; Intrahousehold allocation; Labor supply; Model construction and estimation; Taxation.

1. INTRODUCTION

The empirical literature on labor supply has devoted much attention to the evaluation of the impact of the income tax system on the choice of working hours and participation. The focus of the analysis has been increasingly directed toward the joint labor supply decision of couples.[1] Studies known in the literature almost invariably use the unitary model of household labor supply for this analysis. The unitary approach assumes the existence of a household utility function, and does not specify the preferences of the individual household members. The intrahousehold allocation process is ignored as income pooling is imposed. Labor supply studies that test for the restrictions of the unitary model on the labor supply of household members almost invariably reject the unitary restrictions.[2] Moreover, policy makers often target policy instruments to specific individuals within a household. Within a unitary framework, the intrahousehold implications of such instruments cannot be revealed.[3]

McElroy and Horney (1981) formulated a household decision model that allows for individual preferences of household members, and specifies a Nash bargaining process between husband and wife. The approach by Apps and Rees (1988) only needs the assumption of efficiency, whereas the specification of an explicit bargaining rule is not required. Chiappori (1988, 1992) formulated a collective model of household labor supply. The collective model explicitly specifies the preferences of the individual household members, and assumes Pareto efficient bargaining between household members. Chiappori (1988, 1992) showed that under certain conditions both the preference parameters and a sharing rule, specifying the allocation of income between household members, can be identified up to an additive constant.

The empirical implementation of the collective model involves some complications, which explains why studies on household labor supply and taxes mostly employ the unitary model, as discussed by Beninger and Laisney (2002). In the collective model, it is less straightforward to incorporate the participation decision and taxation. Recently, Blundell et al. (2007) and Donni (2003) extended the identification result of the sharing rule to include the case of nonparticipation by one of the partners. Bloemen (2010) specified an empirical model of collective household labor supply which allows for nonparticipation.

Donni (2003) derived conditions for the implementation of a nonlinear but convex budget constraint in a collective labor

[1] See, for example, Hausman and Ruud (1984), Van Soest (1995), Hoynes (1996), Keane and Moffit (1998), Blundell and MaCurdy (1999), and Blundell et al. (2000).

[2] In these studies, the tax system is not incorporated explicitly. See, for example, Fortin and Lacroix (1997) for an extensive test of the unitary model, and Thomas (1990) for a test of income pooling.

[3] See Vermeulen (2002) for a discussion of the unitary framework versus the collective model.

Journal of Business & Economic Statistics
July 2019, Vol. 37, No. 3
DOI: 10.1080/07350015.2017.1379407

supply model. Bargain and Moreau (2007) simulated a collective model with taxes and showed the implications of using the collective approach for various model outcomes. Beninger and Laisney (2002) simulated data from a specification of the collective model with taxes to estimate a misspecified unitary discrete hours labor supply model and showed that the unitary model generates substantially different results than the underlying collective model. Vermeulen (2006) used the discrete hours choice model to empirically implement taxes in a collective type of model. His focus is on couples with husbands in full-time employment. Vermeulen et al. (2006) suggested a calibration approach for modeling collective labor supply with income taxes. Their identification strategy, though, is based on comparing married and single women.[4]

In this study, we specify an implementable empirical model of household labor supply with taxes that can be estimated with labor supply data for both husband and wife, is based on individual preferences, and does not a priori impose income pooling, such that conclusions can be drawn about the intrahousehold allocation mechanism. The sharing rule parameters and preferences are identified using data of husband and wife within couples, rather than by relying on equality of preference parameters for single and married females.[5]

Donni (2003) proved the unique identification of the sharing rule from male and female working hours under the condition of a convex budget set and regular preferences. However, most tax systems contain nonconvexities, often generated by tax credits, and generally the most interesting policy issues are concentrated around these nonconvexities. Convexication to impose regularity of the budget set does not allow these policy instruments to be incorporated in the analysis. The most well-known functional forms for utility functions that satisfy regularity conditions and are still reasonably well to manage in a setting with taxation are quite restrictive.[6]

Van Soest (1995) used the discrete model in the context of a unitary household labor supply model. The discrete hours choice model allows for dealing with flexible functional forms for preferences and nonconvexities in the budget constraint. We adapt this approach to the collective model.[7]

Applying this approach to the collective model has implications for the uniqueness of the model's solution. For a given set of random preference variables, at given explanatory variables for husband and wife and at given parameter values, there can be more than one combination of male–female working hours that satisfies the equilibrium conditions with positive probability.

The implication for full information maximum likelihood estimation is that the probabilities over all choice alternatives (which are combinations of male–female working hours) need not add up to one. Estimation based on the full information maximum likelihood function will therefore lead to inconsistent estimates, since maximizing the likelihood value will push parameters in the direction of the regime with more than one solution. We propose an estimation strategy based on partial likelihood functions to consistently estimate the model parameters.

We specify two restricted sharing rules, one of which imposes income pooling, and a variant with a "flexible" sharing rule. We evaluate the model on the basis of elasticities of labor supply, the implications for intrahousehold allocation, and the simulation of a policy change in the tax system. We use a dataset on childless couples from the Dutch Socio Economic Panel (SEP) for the years 1990–2001.

The results show that the model variant with a "flexible" sharing rule has quite different outcomes for the allocation of income between household members, even if differences in wage elasticities of labor supply are not that outspoken. Income pooling fails because it is not able to capture asymmetries in the allocation of income between household members. Men, often the primary earner, transfer more of their earnings to their spouse than women, and the allocation of nonlabor income goes in the same direction. This has implications for the effectiveness of tax policies, as for instance changes in tax allowances act as changes in households' nonlabor incomes which affect the intrahousehold allocation of resources asymmetrically, while the same holds true for changes in marginal tax rates.

In Section 2, we formulate the collective version of the discrete hours choice model. In Section 3, we present the econometric specification of our model. In Section 4, we briefly describe the Dutch income tax system. Section 5 provides descriptive statistics of the data. Section 6 contains the results. Section 7 concludes.

2. THE MODEL

2.1 Individual Preferences and the Household Budget Constraint

Throughout we consider a two-member household consisting of husband and wife. The consumption level and the working hours are denoted by (C_m, h_m) for the husband and (C_f, h_f) for the wife. Utility of each household member is defined over consumption and working hours, and is denoted by $U_j(C_j, h_j)$, $j = m, f$. We assume that preferences are egoistic, and that there are no public goods in the household.[8] Individuals allocate their total time to leisure and paid work.[9] The gross hourly wage rates of husband and wife, and the household's nonlabor income are denoted by w_m, w_f, and y, respectively.

The tax system is assumed to be known and the after tax income is a function of the working hours and the gross hourly wage rates of both spouses and of the household's nonlabor income. A general formulation of the after tax income of the household is $g(h_m, h_f, w_m, w_f, y)$, and the household budget

[4]The study by Vermeulen et al. (2006) is included in an issue of Review of Economics of the Household (2006, Volume 4, Number 2) that is completely devoted to the collective model. However, since this promising initiative most studies on labor supply and taxation still employ the unitary framework, ignoring the implications of tax instruments for the intrahousehold allocation.

[5]The fact that some persons are single and others part of a couple may be related to differences in preferences for the formation of couples (see Manser and Brown 1980).

[6]See, for instance, Bloemen and Kapteyn (2008), for a discussion.

[7]The need for the specification of flexible preferences in the context of collective labor supply model was recognized by Fortin and Lacroix (1997).

[8]Chiappori, Blundell, and Meghir (2005) relaxed the assumption of the absence of public goods. However, identification of the model parameters requires information of the households' expenditures on the public good.

[9]Thus, we do not consider time that is spent on household production. Chiappori (1997) incorporated household production in the collective labor supply model. Unfortunately, time spent on household production by separate household members is not observed in our data.

constraint reads

$$C_m + C_f = g(h_m, h_f, w_m, w_f, y). \tag{1}$$

Most tax systems consist of several tax brackets, each with their own marginal tax rate, leading to a piecewise linear budget constraint. To keep notation as general as possible, we assume that the prevailing tax bracket is the result of the combination of gross hourly wage rates (w_m and w_f), working hours (h_m and h_f) of both partners,[10] and the household's nonlabor income y,[11] and as such we denote the slopes ω_m and ω_f for husband and wife, and the intercepts μ of the household budget constraint, as

$$\begin{aligned} \omega_j &= \omega_j(w_m, w_f, h_m, h_f, y), \\ \mu &= \mu(w_m, w_f, h_m, h_f, y),\ j = m, f. \end{aligned} \tag{2}$$

The slopes and intercept in (2) are defined by the parameters of the tax system.[12] The budget constraint can be written as

$$C_m + C_f = \omega_m h_m + \omega_f h_f + \mu \text{ given (2)}. \tag{3}$$

2.2 The Collective Framework

Under these assumptions, a general representation of the choice problem of the household members according to the collective model is:[13]

$$\begin{aligned} &\max_{h_m \in S_m, h_f \in S_f, C_m, C_f} U_f(C_f, h_f) \\ &\text{s.t. } U_m(C_m, h_m) \geq \bar{u}_m(w_m, w_f, y) \text{ and (3)} \end{aligned} \tag{4}$$

with S_j the choice set of working hours of spouse j, $j = m, f$, and $\bar{u}_m(w_m, w_f, y)$ denotes the utility level that is at least available to the husband, the outcome of some bargaining process that leads to Pareto efficient allocations. This bargaining process is left unspecified in the collective approach. In general, the bargaining outcome is assumed to be a function of the individual wage rates and nonlabor income, but further generalization need not be ruled out.

If the choice set is discrete, it can be represented by

$$S_j \equiv \{h_j^0, h_j^1, \ldots, h_j^{H_j}\},\ j = m, f. \tag{5}$$

Throughout, we assume that the discrete choice set can be interpreted as an approximation of underlying continuous choices. We do not consider the case in which discrete choices come from demand side restrictions.

A particular assumption that we make here is that household members are able to exercise their bargaining power via the shape of the total household budget constraint. Since (w_m, w_f, y) completely characterizes this budget constraint together with the parameters of the tax system,[14] $\bar{u}$ implicitly depends on the tax parameters by assumption.[15]

In the empirical literature of collective household labor supply models, the sharing rule representation of the collective model (4) is specified, since the sharing rule representation sheds light on the intrahousehold allocation process of household members. Before commenting on its existence and properties, we formulate the sharing rule representation as

$$\begin{aligned} &\max_{h_j \in S_j} U_j(C_j, h_j) \\ &\text{subject to } C_j = \omega_j h_j + \rho_j(\omega_m, \omega_f, \mu) \\ &\rho_m = \rho,\ \rho_f = \mu - \rho \\ &j = m, f, \end{aligned} \tag{6}$$

where $\rho(\omega_m, \omega_f, \mu)$ represents the sharing rule, expressed as a function of the virtual wage rates and nonlabor income, as in Donni (2013). The system (6) imposes that individual net incomes add-up to the household's net income (3).

The original results for the sharing rule representation by Chiappori (1988) were presented in a context without the nonparticipation decision. Both Donni (2003) and Blundell et al. (2007) addressed the inclusion of nonparticipation in the collective model, where the first study includes the participation decision and hours choices of both partners, and the second models the case where the husband can participate or not and work full time only, while the wife can choose any amount of hours.

Both approaches show that Pareto efficiency requires certain continuity conditions on the participation frontier of a spouse, the space where one spouse is indifferent between working or not. Blundell et al. (2007) formulated this in terms of the "double indifference" condition.

Double indifference. At the participation frontier of spouse m (f), where m (f) is indifferent between working or not, spouse f (m) is indifferent as well.

Now the literature tends to emphasize the link between double indifference and Pareto efficiency, but it is important to realize that the double indifference condition is essential for obtaining decentralization. In other words, double indifference is important for the existence of sharing rule representation (6).

To address the double indifference condition in more detail, consider a change in male working hours dh_m. It will affect the utility of the wife as

$$MU_C^f \times \frac{dC_f}{dh_m}. \tag{7}$$

If dh_m represents the a shift along the participation frontier of the husband, indifference of the wife implies that (7) equals zero. To gain insight in the implications of working with the discretized choice set (5) and nonconvex tax systems, we give three examples.

[10] By this notation we do not mean that the marginal tax rates themselves depend on working hours, but that the segment of the budget set where a household ends depends on the choice of hours.

[11] In practice, tax systems can be of simpler nature. For instance, the prevailing tax bracket may depend on either joint or individual earnings of household members, but these specific cases fit in the general notation that we employ.

[12] For instance, the slopes are obtained after applying the corresponding marginal tax rates to the gross hourly wage rates.

[13] Note that we could have written the decision problem (4) in an alternative way, by changing the roles of husband and wife, since a priori we do not assume any asymmetry in the choice set faced by husband and wife. This is one of the aspects in which our model differs from Blundell et al. (2007), who asumed that women can choose any hours level, while the choice of men is restricted to participation.

[14] This is because tax brackets are defined by earnings levels, not by specific hours levels. Therefore (w_m, w_f, y) together with the parameters of the tax system determine the slopes and intercepts of the budget constraint.

[15] We will use this assumption to express the sharing rule in terms of shadow wages, rather than gross wages. Donni (2003) explicitly formulated the required assumption R2, stating that the Jacobian matrix of the mapping from (w_m, w_f, y) to $(\omega_m, \omega_f, \mu)$ is nonsingular, which is in general fulfilled.

Example 2.1. Participation. For males, the discretized choice set is $S_m = \{0, 40\}$.

Thus, for males only the choice between working full-time or not working at all is modeled. In this example, we abstract from taxation. For a nonparticipating husband ($h_m = 0$), we have $C_m = \rho_m$, $C_f = \rho_f$. For the working husband ($h_m = 40$), $C_m = \omega_m 40 + \rho_m$, $C_f = \rho_f$. The husband's consumption depends on the decision to participate while the wife's share does not, as long as the sharing rule does not depend on male participation. See online Appendix A for a more detailed presentation of the case of nonparticipation.

A more general implication is that working hours should not be included explicitly in the sharing rule, and for nonworking individuals the wage rate needs to be included in the sharing rule as a determinant of bargaining power, even though actual earnings are zero.

Example 2.2. Discretized choice sets as in (5), a piecewise linear and convex budget constraint.

For the continuous case, Donni (2003) showed that the sharing rule is well-defined if the budget set is piecewise linear and convex and preferences satisfy regularity conditions, since a unique solution to the household's optimization problem exists. In applications of discrete choice labor supply models with taxation, the discrete choice set is usually a refined approximation of the original continuous budget set. With a sufficiently refined discretization, it is likely to still have one unique value of the choice set for which utility is highest. If spouse j were indifferent between choosing hours h_j^k and h_j^{k+1}, the difference in the labor income of spouse j due to choosing either hours level ends up in the consumption of spouse j and does not affect the other spouse, as required by double indifference.

Therefore, the most interesting cases are those caused by specific nonconvexities of the budget set, with the property that discontinuities in the budget set are persistent, even if the choice set were refined. An example is a labor market state specific tax credit.

Example 2.3. A nonconvex budget constraint due to an individual tax credit.

Consider a stylized example of a tax credit, which includes an amount of income tc for the husband, with $tc \neq 0$ if $h_m > 0$, and $tc = 0$ if $h_m = 0$. Double indifference requires that this tax credit is to be assigned to the husband and should not affect the choice of the wife. Redefining $\mu^* = \mu - tc$ (nonlabor income net of the amount tc), and $C_m = \omega_m h_m + tc + \rho_m$, with $\rho_m = \rho(\omega_m, \omega_f, \mu^*)$ and $C_f = \omega_f h_f + \rho_f$ with $\rho_f = \mu^* - \rho(\omega_m, \omega_f, \mu^*)$. Thus, the sharing rule ρ is formulated in terms of nonlabor income net of the income advantage for workers, such that double indifference is not violated, and it is assigned to the participating partner. The resulting consumptions still add-up to total household income, as in (3). An advantage of this approach is that we still incorporate the tax credit in modeling household labor supply (as opposed to convexication).

Example 2.3 shows a case for which it is relatively easy to incorporate double indifference. The example is a case of individual taxation, rather than joint taxation, and it is clear that for an individual tax system it is easier to find compensation rules such that double indifference can be imposed. But even for the example above, use is made of the specific properties of the tax system, revealing that there is no general rule to deal with nonconvexities due to taxation.

3. ECONOMETRIC SPECIFICATION

3.1 The Error Structure

We add extreme value distributed error terms to the utility levels of each working hours level from the choice set (see, e.g., Van Soest 2005). Suppose that the observed numbers of working hours of husband and wife are h_m^k and h_f^l, respectively, with $k \in \{0, \dots, H_m\}$, $l \in \{0, \dots, H_f\}$. We denote the utility of husband and wife by

$$\begin{aligned} u_m\left(C_m^{kl} - F_m^k, h_m^k\right) &= u_m^{kl}(\nu_m) + \epsilon_m^k \\ u_f\left(C_f^{lk} - F_f^l, h_f^l\right) &= u_f^{lk}(\nu_f) + \epsilon_f^l \\ k \in \{0, \dots, H_m\}, l &\in \{0, \dots, H_f\}. \end{aligned} \tag{8}$$

The superscripts kl and lk indicate the dependence of the utility levels on h_m^k and h_f^l. F_m^k and F_f^l denote fixed cost of work, with $F_j^s = F_j$, $j = m, f$, $s = k, l$ if $s > 0$ and zero for $s = 0$. F_m and F_f are defined as parameters of the utility function.[16] Wages and the sharing rule enter utility via the consumption level, as in (6).

Unobserved heterogeneity is denoted by ν_m and ν_f. They affect preferences but are not specific to the hours category chosen. For the additive error terms ϵ_m^k and ϵ_f^l, we make the following assumptions: (i) ϵ_j^r, $j = m, f$, $r = 0, \dots, H$, are independently and identically distributed according to the extreme value distribution; (ii) $E(\epsilon_j^r | h_m, h_f, w_m, w_f, y, \nu_j) = 0$, $j = m, f$, $r = 0, \dots, H_j$.

The combination of working hours h_m^k and h_f^l is observed if two conditions are met simultaneously. For the wife, we have

$$u_f^{lk}(\nu_f) + \epsilon_f^l > u_f^{sk}(\nu_f) + \epsilon_f^s, s \neq l, s = 0, \dots, H_f \tag{9}$$

whereas for the husband

$$u_m^{kl}(\nu_m) + \epsilon_m^k > u_m^{rl}(\nu_m) + \epsilon_m^r, r \neq k, r = 0, \dots, H_m. \tag{10}$$

The probability that (9) occurs is denoted by $p_f^{lk}(\nu_f)$:

$$p_f^{lk}(\nu_f) = \frac{\exp\left(u_f^{lk}(\nu_f)\right)}{\sum_{s=0}^{H_f} \exp\left(u_f^{sk}(\nu_f)\right)}, l = 0, \dots, H_f. \tag{11}$$

The probabilities add up to 1 over hours levels $l = 0, \dots, H_f$. Similarly, we denote the probability that (10) occurs by

$$p_m^{kl}(\nu_m) = \frac{\exp\left(u_m^{kl}(\nu_m)\right)}{\sum_{r=0}^{H_m} \exp(u_m^{rl}(\nu_m))}, k = 0, \dots, H_m. \tag{12}$$

[16]Previous studies that use the discrete hours framework reveal that the discrete choice model, once the parameters have been estimated, typically fails to predict the sample fraction of nonworking individuals (see Van Soest 1995, and the remarks in Beninger and Laisney 2002). This led to the practice of introducing fixed costs of work (see, for instance, Van Soest and Das 2001).

The joint probability $p_{mf}^{kl}(\nu_m, \nu_f)$ that (9) and (10) are satisfied simultaneously is

$$p_{mf}^{kl}(\nu_m, \nu_f) = p_m^{kl}(\nu_m)p_f^{lk}(\nu_f), k = 0, \dots, H_m, l = 0, \dots, H_f. \quad (13)$$

Finally, the joint distribution $g(\nu_m, \nu_f)$ of (ν_m, ν_f) is used to integrate over ν_m and ν_f:

$$p_{mf}^{kl} = \int\int p_{mf}^{kl}(\nu_m, \nu_f)g(\nu_m, \nu_f)d\nu_m d\nu_f, k = 0, \dots, H_m, l = 0, \dots, H_f. \quad (14)$$

3.2 Coherency Problem and Estimation Strategy

To perform maximum likelihood estimation based on the joint probability (14), the outcome of (9) and (10) needs to be unique. By uniqueness we mean that for the set of values of $\epsilon_f^s, s = 0, \dots, H_f$ and $\epsilon_m^r, r = 0, \dots, H_m$ (and given the observed and unobserved heterogeneity affecting the utility level) for which the observed hours combination (h_m^k, h_f^l) satisfies (9) and (10), this combination is the unique combination of male and female working hours that satisfies the conditions. In other words, the intersection with the set of errors for which the pair of working hours (h_m^r, h_f^s), $r \neq k, s \neq l$ satisfies (9) and (10) simultaneously is empty (except for the boundary with measure zero). If there is an overlap between these sets, the probability of a multiple outcome is positive, and probabilities over all choice options add up to an amount larger than one.

The most simple case of generating a unique solution occurs if husband and wife act as two unrelated persons, and we have $u_m^{kl} = u_m^k$ (and $u_f^{lk} = u_f^l$). To understand the more general case where utility levels of both household members depend on working hours of their spouse, we need to be aware how working hours of the spouse enter preferences. (7) implies that spousal outcomes are affected by whether preferences satisfy the regularity condition of positive marginal utility of consumption, and the shape of the budget constraint and sharing rule. The outcome depends on whether double indifference can be imposed. Example 2.2 showed the specific case of a convex budget constraint, while Example 2.3 showed that a specific nonconvexity of budget set, a labor market state dependent tax credit, can be dealt with by an appropriate specification of the sharing rule.

More general, not imposing regularity conditions on preferences and nonconvexities of the budget set potentially generates multiple outcomes for (9) and (10). Suppose there are two pairs of working hours (h_m^k, h_f^l) and (h_m^j, h_f^s), $j \neq k, s \neq l$ satisfying (9) and (10). According to (9) this means that for certain values of $\epsilon_f^s, s = 0, \dots, H_f$, the outcome of female working hours h_f^l is unique if male working hours are h_m^k, but for the same values of $\epsilon_f^s, s = 0, \dots, H_f$, the alternative h_f^s is preferred if male working hours are h_m^j. Since male working hours enter female preferences via the consumption level, regularity conditions play a role in causing this switch in preferred hours.

Female preferred working hours depending on the level of male working hours by itself is not enough to create a multiple outcome. In addition, we need that at given values $\epsilon_m^r, r = 0, \dots, H$ for which (10) is satisfied, (i.e., h_m^k is optimal at h_f^l) h_m^j, $j \neq k$ is optimal at h_f^s, $s \neq l$, for the same j and s as above. Again, uniqueness of the outcome h_m^k for arbitrary values of the wife's hours depends on how the wife's hours influence the husband's decision problem.

Thus, in the general case flexible functional forms for utility functions are chosen, tax systems can be nonconvex, and multiple solutions may occur. This does not mean that in an empirical application, multiple outcomes will happen at a large scale. In fact, the analysis above shows that for a multiple outcome two conditions in (9) and (10) have to be met simultaneously. But for the estimation of the model, the consequence of possibly having multiple solutions is that the joint probabilities in (13) and (14) may add up to an amount larger than 1 (added up over male hours, $k = 0, \dots, H_m$, and female hours $l = 0, \dots, H_f$). As a result, we cannot use the joint probability in the estimation of the model: applying maximum likelihood will bias outcomes in the direction of the regime where probabilities add up to values larger than one.

To overcome this problem, we use the probabilities (11) and (12) for the separate conditions (9) and (10). Both (11) and (12) satisfy regularity conditions: (11) and (12) add up to 1, aggregated over hours levels $l = 0, \dots, H_f$ and $k = 0, \dots, H_m$, respectively. This will come at the cost of losing efficiency in the estimation. For instance, using the separate conditions (11) and (12) precludes the estimation of a correlation between the unobserved heterogeneity ν_m and ν_f of men and women (as in (14)). To explicitly write the likelihood contribution of a household with observed working hours (h_m^k, h_f^l), we first average the probabilities in (11) and (12):

$$p_f^{lk} = \int p_f^{lk}(\nu_f)g_f(\nu_f)d\nu_f \text{ and } p_m^{kl} = \int p_m^{kl}(\nu_m)g_m(\nu_m)d\nu_m, \quad (15)$$

where $g_j(.)$ refers to the marginal density of ν_j for spouse j, $j = m, f$. Then the log-likelihood contribution L^{kl} is

$$L^{kl} = \ln(p_m^{kl}) + \ln(p_f^{lk}). \quad (16)$$

The likelihood contribution consists of separate terms for each spouse, both of which depend on the parameters of the sharing rule.

3.3 The Utility Function

We represent preferences by the following quadratic direct utility function:[17]

$$\begin{aligned} u_m^{kl} &= (\beta_{0,hh}^m + \beta_{hh}^j{}' z_m)(\ln(T - h_m^k))^2 \\ &\quad + \beta_{ch}^m \ln(T - h_m^k)(C_m^{kl} - F_m^k) + \beta_c^m(C_m^{kl} - F_m^k) \\ &\quad + \beta_{cc}^m(C_m^{kl} - F_m^k)^2 + (\beta_{0h}^m + \beta_h^m{}' z_m + \nu_m)\ln(T - h_m^k) \\ u_f^{lk} &= (\beta_{0,hh}^f + \beta_{hh}^f{}' z_f)(\ln(T - h_f^l))^2 + \beta_{ch}^f \ln(T - h_f^l)(C_j^{lk} - F_f^l) \\ &\quad + \beta_c^f(C_f^{lk} - F_f^l) \end{aligned}$$

[17]Van Soest (1995) specified a discrete utility function that is log-quadratic in its arguments. However, in our model, based on the collective approach, the consumption level of a household member is equal to his or her earnings plus the share of nonlabor income, determined by the sharing rule. The intercept of the sharing rule is (nonparametrically) not identified, since the only restriction imposed is adding-up across household members. Consequently, the sharing rule need not be positive. Therefore, we include consumption in levels.

$$+\beta_{cc}^f(C_f^{lk}-F_f^l)^2+(\beta_{0h}^f+\beta_h^{f\prime}z_f+\nu_f)\ln(T-h_f^l). \quad (17)$$

In (17), z_j represents a vector of observable taste shifters that may influence the preferences for leisure,[18] whereas $\beta_{0,hh}^j$, β_{hh}^j, β_ν^j, β_{ch}^j, β_c^j, β_{cc}^j, $\beta_{0,h}^j$, β_h^j, F_m, and F_f are the parameters of the utility function. T is the total time endowment. It is set to 168 hr a week in the empirical application.

Flexibility is often heard as an argument in favor of the quadratic utility function. In the application of the collective model, there is an additional advantage. A well-known result (Chiappori 1988) is that the intercept of the sharing rule, or any additive heterogeneity, is not identified separately from preferences. Having a quadratic utility function, the intercept merges with other sources of heterogeneity in preferences. This is different for other often used functional forms in this field, like for instance the specification that imposes regularity conditions with a Box–Cox transformed consumption level, which in the case of the collective model includes the sharing rule.

The utility function of spouse j contains an unobserved taste shifter ν_j, and we assume that it is normally distributed:

$$\begin{pmatrix}\nu_m\\ \nu_f\end{pmatrix}\sim N\left(\begin{pmatrix}0\\0\end{pmatrix},\begin{pmatrix}\sigma_{\nu,m}^2 & ---\\ --- & \sigma_{\nu,f}^2\end{pmatrix}\right). \quad (18)$$

A consequence of the estimation strategy in (15) and (16) is that the covariance between the unobserved heterogeneity of the two spouses cannot be estimated, and for this reason is indicated by—in the covariance matrix.

3.4 Specification of the Sharing Rule

We specify the following sharing rule:[19]

$$\rho(\omega_m,\omega_f,\mu)=\alpha_0+\alpha_1\omega_m+\alpha_2\omega_f+\alpha_3\mu+\alpha_4 D+\alpha_5\mu^2. \quad (19)$$

In (19), D is a factor that represents the relative bargaining power of husband and wife. Economic theory does not provide strong guidelines for parameterizing a bargaining measure. We choose D as the husband's virtual wage rate expressed as the share of the sum of husband's and wife's virtual wage rates:

$$D=\frac{\omega_m}{\omega_m+\omega_f}. \quad (20)$$

We estimate two alternative specifications with a restrictive sharing rule. In the first we assume that half of the household's virtual nonlabor income is assigned to each partner:

$$\rho_{\text{half}}=\frac{1}{2}\mu. \quad (21)$$

This rule is almost equivalent to assuming that each household member consumes his or her own earnings and only the virtual nonlabor income is split. The next variant is equivalent to income pooling: household members base their decision on total household income. The corresponding sharing rule is

$$\rho_{\text{pool}}=-\frac{1}{2}\omega_m h_m+\frac{1}{2}\omega_f h_f-\frac{1}{2}\mu. \quad (22)$$

Formally, the sharing mechanism (22) implies that the husband transfers half of his net earnings to the wife, while the wife transfers half of her net earnings to the husband, and virtual nonlabor income is split equally. This leads to consumption levels $C_m=C_f=(\omega_m h_m+\omega_f h_f+\mu)/2$. When implemented in a model with utility specification (17), this is equivalent to basing individual labor supply choices on pooled household income. This also shows that income pooling in the presence of a labor market specific tax credit can never satisfy double indifference (see Example 2.3).

In the estimation of the model, data for several years are used. Throughout we assume that the parameters of the sharing rule α_j remain constant across time. Thus, we implicitly assume that there is no renegotiation on the shape of the sharing rule if the value of any of the variables entering the sharing rule changes over time.

In the online Appendix C, it is shown that the parameters of the utility functions and the sharing rule, the structural parameters, can be recovered from reduced form parameters and cross equation restrictions between spouses.

4. THE INCOME TAX SYSTEM IN THE NETHERLANDS

Our data provide information for the years 1990–2001. Throughout the years 1990–2000 there are year to year differences in marginal tax rates and general tax credits, but no major changes in the Dutch income tax system occurred. In the Dutch tax system *individual* incomes are taxed. Every individual has a general (applicable, irrespective of the individual characteristics) tax credit:[20]the marginal tax rate for any income below this amount is zero. There is some relationship between the income taxation of two partners in a household. Only if a household member earns an income that is below the general tax credit, s/he can transfer the tax credit to her/his partner. This raises household income if the partner earns more than the tax credit. Transferring the tax credit to the higher income partner, if the household is eligible for it, is the standard practice among households in the Netherlands. In the years 1998 through 2000, the tax credit was split up into a small nontransferable amount[21]and the transferable amount. In 1990 through 1998, there were three tax brackets for the income net of the general tax credit.[22] In 1999, a fourth income tax bracket was introduced. The marginal tax rate for the first bracket varies from year to year, because it partly consists of premiums for social welfare. The marginal tax rate for the two higher brackets remained at 50% and 60% throughout the years, except for 2001, for which the values are 42% and 52%. Table 1 shows the tax credits throughout the years 1990–2001.[23]

[18]We could have made the utility specification even more flexible, by making the parameters of consumption, β_c^j and β_{cc}^j a function of the taste shifters z_j. But in the present specification, the marginal rate of substitution between consumption and leisure already is a function of the taste shifters z_j and also making β_c^j and β_{cc}^j a function of the taste shifters z_j a function of taste shifters would make both the numerator and the denominator of the marginal rate of substitution a function of the taste shifters, which looks like over-parameterizing the model.

[19]In the empirical application, we will allow the parameters of the sharing rule to be different by marital status.

[20]The Dutch terminology in the law is the "basisaftrek."

[21]The so-called "bovenbasisaftrek."

[22]The "belastbare som."

[23]As an example, consider the year 1997 and suppose that the wife earns less than 7102 guilders a year. (The actual tax credit can never exceed the value of

Table 1. Properties of the Dutch tax system

Year	Transferable amount tax credit	Nontransferable amount tax credit	Marginal tax rate 1st bracket	Upper bound 1st bracket = lwb. 2nd br.	Upper bound 2nd bracket = lwb. 3rd br.
1990	4568	0	31.5%	42,123	84,245
1991	4660	0	35.75%	42,966	85,930
1992	5225	0	38.55%	42,966	85,930
1993	5769	0	38.4%	43,267	86,532
1994	5925	0	38.125%	43,267	86,532
1995	6074	0	37.65%	44,349	88,696
1996	7003	0	37.5%	45,325	92,773
1997	7102	0	37.3%	45,960	97,422
1998	8207	410	36.35%	47,184	103,774
1999	8380	419	35.75%/ /37.05%	15,000/48,175	105,954
2000	8523	427	33.9%/ /37.95%	15,255/48,994	107,756
	General tax credit	Labor tax credit			
2001	3473	2027	32.35%/ 37.60%/	32,769/59,520	102,052

Note: Amounts in Dutch Guilders. Marginal tax rates of the 2nd and 3rd bracket: 50% and 60% (1990–2000), 42% and 52% (2001), from 1999 on: first bracket split in two bracket bounds.

5. THE DATA

The Socio-Economic Panel (SEP) is a household survey collected by Statistics Netherlands. We use data from the SEP for the years 1990 to 2002. During this period, Statistics Netherlands interviewed households on a yearly basis, every May. The income in a given survey wave refers to the previous calendar year. For this reason, we link data from two subsequent waves to get the complete information for 1 year. Consequently, for each individual we have information for the years 1990 through 2001.

For each year, we selected couples living together (either married or unmarried) without children, in which the male is in the age range of 22 to 60 and the female is no older than 60.[24] We excluded households in which either husband or wife reports to be self-employed. Furthermore, we require the availability of information on the labor market state of both household members, the nonlabor income, and information on the level of schooling and the sector of education. We use information on hourly wage rates and employment status for the estimation of the wage equation. The pooled dataset contains 8049 observations (in which the observation unit is the two-member household).

Table 2 contains descriptive statistics for the pooled data. Note that 86.3% of the male respondents is employed and 72.5% of their female partners. In interpreting these numbers, we should recall that we selected couples without children. Therefore, the percentage of working females is relatively high in our sample. At the household level we see that in 66.9% of the households both spouses are working and in 19.5% of the households the husband works, while the wife does not. For 8.1% of the households none of the members is working, whereas in only 5.6% of the households only the wife works.

The males in the sample are on average higher educated than the females. We have also information about the direction, or sector, of education and here we see some typical differences between males and females. There are few women with a technical type of education whereas the majority of the men was trained for technical professions. The majority of women is educated for the service sector. There are more women than men without specialization in education. The mean age for males is about 2 years higher than for females.

Mean weekly working hours for males are about 40, whereas females work 31 hr a week on average. The male hourly wage rate is more than 2 guilders higher than the wage rate of females. The nonlabor income includes interest income, income out of real estate, rent subsidy, income out of life insurance,[25] gifts by family, dividend income and income out of profits and scholarships. In the survey, it is measured on a yearly basis and in Table 2 it is converted to guilders per week, showing an average of 37 guilders a week.

her income). Then she may transfer the full tax credit of 7102 to her husband. She will then have a tax credit of zero, whereas the tax credit for her husband will be 14,204 guilders. The advantage for the household income as a whole is (i) that the complete tax credit of 7102 is exploited. (For instance, if the wife's income is 6000 guilders, her tax credit is only 6000) and (ii) if the husband is in the second or third tax bracket, there is an additional gain since at the margin the husband's income is taxed at a higher rate than the wife's income as the tax system is progressive. Van Soest and Das (2001) plotted the impact of transferring the deductible to the other partner on the budget constraint for the year 1998. The shape of the budget constraint shows a nonconvex kink at low numbers of working hours, but the nonconvexity is rather small.

[24]The age of 60 was the most common age for eligibility to early retirement benefits in the Netherlands.

[25]"Lijfrente."

Table 2. Descriptive statistics of the pooled data with 8049 observations

Variable	Husband	Wife
Employment status		
Employed	84.5%	70.3%
Not employed	15.5%	29.7%
Education level		
Primary	7.3%	11.2%
Lower vocational	16.0%	23.4%
Intermediate	49.3%	42.5%
Higher Vocational	20.0%	18.2%
University degree	7.0%	4.4%
Education sector		
Technical	34.4%	5.3%
Economic/administrative	25.9%	24.5%
General (not specialized)	18.1%	30.2%
Services	21.5%	40.0%
Weekly working hours		
# Observations	$n = 6618$	$n = 5408$
Mean	39.4	30.9
(Standard deviation)	(7.9)	(10.8)
Hourly gross wage rates		
# Observations	$n = 6100$	$n = 5029$
Mean (Guilders)	30.2	24.7
(Standard deviation)	(10.0)	(8.4)
Age		
Mean	40.8	38.7
(Standard deviation)	(12.4)	(12.5)
Household level variables		
Nonlabor income		
Household level, weekly		
Mean (guilders)	37.7	
Standard deviation	(94.8)	
Employment status		
Both partners working	64.3%	
Husband working, wife not	20.2%	
Wife working, husband not	6.0%	
Both not working	9.5%	
Marital status		
Married	69.1%	

Our point of departure was to classify working hours into intervals of 6 hr, and such that the most prevailing working hours levels have a separate category.[26] However, we imposed restrictions because sample frequencies of men working less than 2 days a week were quite low.[27] In addition, there are hardly any women working more than 40 hr a week. We therefore have a somewhat different classification for men and women. Zero working hours is treated as a separate class. If h_m^k denotes the classified hours value for men and h is the observed value, then we classify h (for men) as follows:

$$h_m^0 = 0 \text{ if } h = 0$$

$$h_m^1 = 9 \text{ if } 0 < h <= 18$$
$$h_m^k = 6(k+2) - 3 \text{ if } 6(k+1) < h \leq 6(k+2),\ k = 2, \ldots, 7$$
$$h_m^8 = 57 \text{ if } h > 54. \tag{23}$$

For women, we have

$$h_f^0 = 0 \text{ if } h = 0$$
$$h_f^k = 6k - 3 \text{ if } 6(k-1) < h \leq 6k,\ k = 1, \ldots, 8$$
$$h_f^9 = 51 \text{ if } h > 48. \tag{24}$$

6. ESTIMATION RESULTS

As a first step, we estimated parameters of selectivity corrected wage equations (see online Appendix B, the estimates in the Tables B.1 and B.2). Next, to estimate the parameters of the labor supply model by (simulated) maximum likelihood, we use 25 Halton draws to simulate gross wage rates[28]and unobserved heterogeneity and average the hours choice probabilities in (11) and (12), as shown in (15), leading to likelihood contributions (16). The resulting likelihood function is maximized with respect to the preference parameters for both household members and the sharing rule parameters.

We present the estimation results of three model variants. We have the simplified sharing mechanisms (21) and (22), the latter of which represents income pooling, and the flexible sharing rule (19).

Table 3 contains the base parameters of the utility function for each specification, and Table 4 shows the parameters of the sharing rule (for the model variant with the flexible sharing rule). The parameter estimates of all the taste shifters and fixed costs are presented in online Appendix D, Tables D1 through D3.

Most of the parameters are not directly interpretable in isolation, so we use different ways to evaluate the estimation results obtained with the different model variants. In the evaluation, we place the emphasis on the behavioral outcomes of the model variants. Presenting the wage elasticities of working hours and participation is an obvious way to see whether different model variants imply different outcomes. The collective model allows for the analysis of the intrahousehold allocation of income. We will evaluate how this allocation changes as a response to changes in husband's and wife's (gross) wage rates. We simulate a change in the tax system that is similar to the actual policy change that took place in the Netherlands in the year 2001. We will evaluate how this affects the income sharing between husband and wife.

6.1 Parameter Estimates: Preferences and the Sharing Rule

The preference parameters in Table 3 determine whether positive marginal utility of consumption is satisfied. We verified

[26]For instance, part-time jobs of 20 hr a week and 24 hr a week (3 days) are included in a separate category $k = 4$, so are jobs of 4 working days a week are included and full-time jobs of 38–40 hr a week.

[27]There is a positive frequency in each 6 hr category, but in combination with the female hours classes we ended up with some empty combinations of male and female working hours.

[28]Halton draws are generally known to perform well, even with a low number of replications. We use simulated wages for both the nonemployed and the employed in the sample. By using simulated wage rates, rather than expected wage rates, we aim to incorporate the impact of wage dispersion in this nonlinear model. In a previous version of this study, we only used predicted wages, thereby ignoring the dispersion of wages.

Table 3. Estimates of the utility parameters

	Model variant:		
	Restricted sharing rule		Unrestricted sharing rule
Parameter, variable	share ρ_{half} Equation (21)	share ρ_{pool} Equation (22)	share ρ Equation (19)
Parameters husband			
$\beta^m_{0,hh}$, $\ln(1-h_m)^2$	−121.6**	−118.3**	−222.7**
	(13.4)	(13.1)	(18.6)
β^m_{ch}, $\ln(T-h_m)C_m$	−6.7**	−5.2**	−123.2**
	(1.8)	(1.4)	(7.8)
β^m_c, C_m	34.8**	27.1**	631.4**
	(8.7)	(6.7)	(40.1)
β^m_{cc}, C^2_m	−0.0003	−0.0003	−0.091
	(0.002)	(0.003)	(0.14)
β^m_{0h}, $\ln(T-h_m)$	1055.4 **	1020.4	1984.4**
	(346.1)	(682.0)	(221.6)
% with $MU_C > 0$	100	100	100
Parameters wife			
$\beta^f_{0,hh}$, $\ln(T-h_f)^2$	−103.5**	−106.2**	−103.8**
	(13.8)	(13.9)	(13.9)
β^f_{ch}, $\ln(T-h_f)C_f$	−7.6**	−8.2**	−1.9**
	(2.0)	(1.3)	(0.7)
β^f_c, C_f	42.2**	43.0**	10.9**
	(9.8)	(7.0)	(3.4)
β^f_{cc}, C^2_f	0.47**	0.07	0.11**
	(0.21)	(0.06)	(0.03)
β^f_{0h}, $\ln(T-h_f)$	981.7**	947.8**	1001.0**
	(138.8)	(147.1)	(139.5)
% with $MU_C > 0$	98.5	99.7	97.1

Note: ** significant at 5% level, * significant at 10% level.
Consumption divided by 1000, so parameter measures the impact of $C_j/1000$, $j = m, f$.

Table 4. Estimates of the sharing rule

Parameter, variable	Unmarried	Married
α_1, ω_m	−30.6**	−37.1**
	(3.2)	(2.3)
α_2, ω_f	−17.1**	−6.1**
	(3.1)	(1.9)
α_3, μ	−0.63**	−0.18**
	(0.06)	(0.04)
α_4, D	−11.4**	−4.0**
	(2.0)	(1.5)
α_5, $\mu^2/1000$	0.61**	0.09**
	(0.07)	(0.04)

Note: **: significant at 5% level, *: 10% level.

this condition globally, that is, for all hours combinations k and l, and for each of the 25 simulated wage rates of both partners used in the estimation. Table 3 shows that positive marginal utility of consumption is satisfied for all men in the sample for all the model specifications, and for around 98% of the women. Given the global nature of our check and the small percentage that does not satisfy positive marginal utility for all variants, we do not undertake additional action to impose positive marginal utility of consumption in one way or another.

Table 4 shows the parameter estimates of the sharing rule. Since the parameters represent marginal effects of virtual wage rates, the relative income measure, and virtual nonlabor income, the parameters are not interpretable in isolation, and in Section 6.3 we will therefore discuss results of changes in gross wage rates on the share and consumption of each spouse.

A first observation that we can make from Table 4 is that the wage effect of men on their share is negative (the estimates of both α_1 and α_4 are negative), indicating that husbands transfer funds to their wives upon an increase in their wages.

6.2 Elasticities

To compute wage elasticities of working hours, a simulation was run that increased the gross wage rates of, subsequently, men and women, by 1%. Working hours of men and women were simulated before and after the simulated wage increase. A similar simulation was run for nonlabor income. To simulate the impact on working hours, for each scenario errors are drawn from the extreme value distribution to evaluate the equilibrium conditions (9) and (10) to check which hours combination is preferred, and whether there is more than one combination satisfying the conditions.[29] If there are two (or, in general, more) equilibria we add both to the set of outcomes.

The simulation also provides the opportunity to check the incidence of multiple equilibria. For sharing rule (21) there were two equilibria for 0.0099% of the cases, which is a very low percentage. For sharing rules (22) and (19), the percentages are 0.27% and 0.15%, which is still very low.[30] These numbers show that in this particular application multiple equilibria are empirically not a major issue, but since they occur, they cannot be ignored in the estimation procedure.

Table 5 displays the elasticities of both working hours (including zeros) and participation. Standard errors of the elasticities were computed by drawing 100 parameter vectors from its distribution, repeating the simulation for the different parameter values, and computing the mean and variance of the different elasticities.

For all variants the largest elasticities are the female own wage elasticities for participation and working hours, which are significantly positive in all cases. The wife's own wage effects are bigger for the restricted sharing rule (21). This sharing mechanism allocates own wage incomes largely to the own consumption, while nonlabor income is shared equally. This may explain why the wife's own elasticity is bigger in this case. It is interesting to see that the elasticity under sharing rule (22), which exhibits income pooling, is virtually equal to the

[29]For each variant, we use the parameter estimates shown in the tables. Since we cannot identify correlation in unobserved heterogeneity between husband and wife, this is set to zero in the simulations.

[30]Note that income pooling (22) does not satisfy double indifference since labor market state specific tax credits are pooled, which may explain the slightly higher number for this variant.

Table 5. Elasticities of working hours and participation

	Model variant:		
	Restricted sharing rule		Unrestricted sharing rule
	share ρ_{half} Equation (21)	share ρ_{pool} Equation (22)	share ρ Equation (19)
Working hours husband:			
Wage rate husband	0.094	0.030	– 0.041
	(0.119)	(0.058)	(0.601)
Wage rate wife	0.004	0.012	– 0.023
	(0.008)	(0.025)	(0.076)
Nonlabor income	0.002	0.002	– 0.004
	(0.003)	(0.004)	(0.089)
Participation husband:			
Wage rate husband	0.045	0.014	– 0.293
	(0.101)	(0.048)	(0.590)
Wage rate wife	0.002	0.006	– 0.019
	(0.007)	(0.022)	(0.066)
Nonlabor income	0.001	0.001	– 0.008
	(0.002)	(0.004)	(0.024)
Working hours wife:			
Wage rate husband	0.019	0.083	– 0.040
	(0.027)	(0.054)	(0.059)
Wage rate wife	0.370**	0.168**	0.136**
	(0.088)	(0.050)	(0.025)
Nonlabor income	0.005	0.007	– 0.003
	(0.004)	(0.004)	(0.003)
Participation wife:			
Wage rate husband	0.012	0.051	– 0.079
	(0.021)	(0.037)	(0.065)
Wage rate wife	0.250**	0.100**	0.089**
	(0.064)	(0.036)	(0.015)
Nonlabor income	0.001	0.004	– 0.005**
	(0.004)	(0.003)	(0.002)

Note: **: significant at 5% level, *: 10% level.

flexible sharing mechanism (19). So for the estimation of the wife's own wage elasticities, income pooling does not seem to impose heavy restrictions. However, we should note that all the cross wage elasticities are small in magnitude, so this outcome cannot be generalized. For the flexible sharing rule, we see some evidence of a negative effect of nonlabor income on female participation.[31]

6.3 Intrahousehold Allocation

To make visible the models' implications for income allocation, Table 6 records who gains by an increase of, subsequently, the gross wage rate of the husband, the gross wage rate of the wife, and the household's nonlabor income. Table 6 shows the percentage of husbands and wives with increases in consumption and in the share (set by the sharing rule) as a result of these increases in income components. To obtain the results of a 1% increase in the gross wage of, say, the husband, wages were drawn and increased by 1%. We simulated the joint

[31] In a model with continuous hours, no fixed costs, a linear budget set, and net wage rates, Bloemen (2010) found elasticities that are somewhat bigger in magnitude, as may be expected for the given differences in wage measures and model specification.

Table 6. Effects of changes in wage rates and nonlabor income on intrahousehold allocation

Percentage with increase in:	1% increase gross wage rate husband	1% increase gross wage rate wife	1 guilder increase nonlabor income
Variant: Restricted sharing rule ρ_{half}, Equation (21)			
Unmarried subsample			
Consumption husband	91.9	1.0	99.9
Consumption wife	1.4	87.9	99.9
Share husband (ρ_m)	1.4	1.0	100
Share wife (ρ_f)	1.4	1.0	100
Married subsample			
Consumption husband	79.0	0.7	99.9
Consumption wife	1.4	60.4	100
Share husband (ρ_m)	1.4	0.8	100
Share wife (ρ_f)	1.4	0.8	100
Variant: Restricted sharing rule ρ_{pool} Equation (22) (pooling)			
Unmarried subsample			
Consumption husband	93.2	89.0	99.9
Consumption wife	93.0	89.0	99.9
Share husband (ρ_m)	1.4	89.0	99.9
Share wife (ρ_f)	93.2	0.9	99.9
Married subsample			
Consumption husband	80.1	61.1	99.9
Consumption wife	80.1	61.1	99.9
Share husband (ρ_m)	1.3	61.1	99.9
Share wife (ρ_f)	80.1	0.6	99.9
Variant: Flexible sharing rule Equation (19)			
Unmarried subsample			
Consumption husband	13.6	70.9	3.0
Consumption wife	99.4	92.9	99.2
Share husband (ρ_m)	1.8	70.9	3.0
Share wife (ρ_f)	99.4	29.2	99.2
Married subsample			
Consumption husband	27.3	53.7	0.3
Consumption wife	99.1	84.2	100.0
Share husband (ρ_m)	1.9	53.7	0.3
Share wife (ρ_f)	99.1	46.3	100.0

labor supply of husband and wife before and after this wage increases.

Table 6 (upper pane) shows that the allocation mechanism for sharing rule (21) is very much set by the restrictive nature of the specific sharing rule. According to this rule, individual consumption levels are set to individual earnings plus half of the household's nonlabor income. Accordingly, Table 6 shows that the increase in the wage rate is largely allocated to the individual that experiences the wage increase and is participating (for nonparticipating individuals with zero working hours a wage increase does have no impact on earnings), or is changing labor force status. A change in nonlabor income, which is shared across household members, increases both partners' shares and consumption levels. Differences between married and unmarried women mainly come from their difference in labor market participation.

The results with sharing rule (22), which imposes income pooling, show that both partners benefit from the increase in the wage rate of one partner (Table 6, middle pane), since the person with the increase in earnings transfers half of it to his or her spouse. Behavioral changes in labor supply and participation do not change this pattern much. Both partners benefit from an increase in the nonlabor income.

Table 6 (lower pane) shows the results for the flexible sharing rule (19). An increase in the husband's wage rate mostly increases the share of the wife and her consumption, while a much smaller part of the husbands benefit from their own wage increase. This suggests that the husband transfers income to his wife.

An increase in the wife's wage rate increases the consumption of both husband and wife. For husbands this increase comes from their increased share. The interpretation could be that the husband, who is usually the primary earner in the household, reduces income transfers to the wife once her own individual wage rate rises.

Participating women gain from the increase in income, and for this reason unmarried women gain more. But the percentage of women with an increase is bigger than the percentage of participating women, so there are also nonparticipating women who gain. In addition, we see an increase in the share for a large part of the men. The results therefore show heterogeneity, depending on the size of the wage of the husband relative to the wage of the wife. Parameter α_2 is negative, implying a decrease in the share of the husband upon an increase in the wage rate of the wife, while parameter α_4 (negative) implies an increase in the share of the husband upon an increase of the wife's wage rate, and this increase is bigger the larger is the husband's wage rate relative to the wife's wage rate.

An increase in nonlabor income is mainly attributed to the wife. Results like this have implications for policy since something like a general tax credit operates like a shift in nonlabor income.

The results show very well why the restricted variants fail. First, we see that each partner shares at least part of his or her wage increase with the other partner, which contradicts the restricted specification ρ_{half} in (21). The clear rejection of income pooling is shown by the asymmetry of an increase in the household's nonlabor income, from which largely the wife benefits in terms of income sharing, and also the asymmetry of an increase in the husband's wage rate, who apparently transfers a large part of his wage increase to his wife.

Table 7. Tax policy simulation implications for intrahousehold allocation

	Model variant:		
	Restricted sharing rule:		Unrestricted sharing rule
Percentage with increase in:	ρ_{half} Equation (21)	ρ_{pool} Equation (22)	ρ Equation (19)
	Unmarried subsample		
Consumption husband	48.8	39.3	56.8
Consumption wife	44.5	39.0	58.1
Share husband	13.1	7.0	41.4
Share wife	13.1	14.6	33.9
	Married subsample		
Consumption husband	44.6	30.4	46.9
Consumption wife	29.5	29.7	58.9
Share husband	11.8	6.4	33.3
Share wife	11.8	14.7	43.0

6.4 Simulating the Tax Reform

The following counter-factual policy change in the tax system was simulated. First, the tax system of the year 2000 was applied to every observation in the sample and the working hours of husband and wife were generated from its joint distribution. Next, the simulation was repeated, but now with the tax rules of the year 2001. The policy change in 2001 was described in Section 4. According to this policy change, marginal tax rates stayed the same for the lower brackets but decreased for the higher, tax allowances partly became labor market state specific to stimulate participation, in total tax allowances became smaller, opportunities to transfer deductibles to the higher income partner were abolished, and the bounds of tax brackets changed. Without change in behavior, some families with at least one nonworking spouse are faced by decreased net incomes, while some workers may benefit from a lower marginal tax rate, either by an actual decrease in it, or by an extension of the tax bracket. A priori it is expected that this policy change stimulates participation, notably for women.

Table 7 shows the outcomes of the simulation for consumption and the share. It shows the percentage[32] with increases in the consumption of husband and the wife, and the share of the husband and the wife due to changing the properties of the tax system. It should be noted that household members that do not experience an increase in consumption do not necessarily experience a decrease.

[32]Per household 12,500 replications were done.

Table 8. Tax policy simulation implications for female labor supply

	Model variant:		
	Restricted sharing rule:		Unrestricted sharing rule
Change in:	ρ_{half} Equation (21)	ρ_{pool} Equation (22)	ρ Equation (19)
	Unmarried subsample		
Working hours	0.7	0.2	0.6
Participation	1.3	0.3	1.5
	Married subsample		
Working hours	0.7	0.2	0.4
Participation	1.5	0.5	1.1

Note: Working hours: change in average number per week.
Participation: change in percentage points.

For the restricted sharing rules married women do worse than unmarried women, mainly because of the differences in participation rates between the groups. Comparing the restricted sharing rules with the unrestricted rule, we notably see that husbands do better according to the flexible rule. The main reason is that the decrease in the general tax allowance makes the husband withdraw funds from his wife. On the other hand, the decrease in marginal tax rates of husbands increases the share of the wife. As a consequence, we see relatively more women with an increase in their consumption for the flexible sharing rule. The fact that husbands decrease transfers to their wives need not necessarily be seen as an adverse effect of the reform, since it merely implies that women are induced to rely more on their own income sources.

Table 8 shows the labor supply responses for women. Depending on the specification, participation increases with 0.3 to 1.5 percentage points. Hours per week increase with 0.2 to 0.7.[33] These effects are not very big, and therefore looking at differences across specifications is not very meaningful. It is interesting, though, that the flexible sharing rule shows bigger increases in female participation, notably for unmarried women. This may be related to the withdrawal of funds by husbands from their wives.

7. CONCLUSIONS

We specified a discrete hours choice model that incorporates income taxation, individual preferences, and income sharing between partners. The identification of the sharing rule parameters was achieved by using data on both men and women within couples. Our estimation strategy deals with the coherency problem. This allows us to estimate the model without a priori imposing assumptions like monotonicity of preferences and a convex budget set. We estimated model specifications with restricted sharing mechanisms, one of which implies income pooling, and a more flexible specification.

Different specifications do not always lead to different conclusions for female own wage elasticities of working hours and participation: a restricted variant with income pooling shows similar values for elasticities as the flexible specifications.

The most notable differences are found for the income allocation between partners. The flexible specification shows a tendency of husbands to assign an increase in their wage rate or in the household's nonlabor income to their wives. This asymmetry in intrahousehold income allocation cannot be explained by a restricted variant with income pooling.

We simulated the effects of a tax reform, introduced in the year 2001. The reform is meant to create additional incentives for participation by decreasing tax allowances, especially for the nonemployed, and decreasing marginal tax rates. One of the consequences of lower tax allowances is that men withdraw funds from their partner. Variants with a restricted sharing rule are not flexible enough to capture this implication for intrahousehold allocation. Nevertheless more women gain according to the flexible sharing rules, compared to the restricted variants, since the decrease in marginal tax rates for some women affects both their own wages (direct effect) and the wages of their husbands, which in turn positively effects income transfers from husband to wife.

The results show how various tax policies influence intrahousehold allocation. A policy that increases the taxation of the income of the primary earner, usually the husband, leads to a reduction of intrahousehold transfers from the husband to the wife, which creates additional incentives for the wife to work. A combination of this policy with a decrease in marginal tax rates for the secondary earner could be more effective than a simple decrease in overall marginal tax rates. Similarly, a decrease in tax allowances reduces transfers from husband to wife, creating more incentives for the wife, that may be further increased by a decrease in marginal tax rates of secondary earners.[34]

ACKNOWLEDGMENTS

The author is greatly indebted to Statistics Netherlands for providing the data. The author thanks three anonymous reviewers and the associate editor for their helpful comments. Other affiliations: IZA, Bonn; Netspar. An early version of this article circulated under the title "Income taxation in an empirical collective household labor supply model with discrete hours."

[Received October 2015. Revised September 2017.]

[33]The lowest effects are found for the restricted variant with income pooling, possibly because the labor market-specific tax credit is pooled across household members which reduced individual labor supply incentives.

[34]Note that the effectiveness of taxing secondary earners not just comes from the higher own wage elasticity of labor supply of women, but the intrahousehold allocation mechanism provides an additional incentive for different tax rates for primary and secondary earners. In a different and theoretical model context that also includes family bargaining, Alesina, Ichino, and Karabarbounis (2011) showed that incorporating family bargaining adds to the explanation of the potential effectiveness of gender-based taxation.

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