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**Collective Labor Supply and  
Child Care Expenditures:  
Theory and Application**

*Chris Van Klaveren and Joris Ghysel*

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# Collective Labor Supply and Child Care Expenditures: Theory and Application

Chris van Klaveren\*

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## Abstract

In this study we examine the collective labor supply choices of dual-earner parents and take into account child care expenditures.

We find that the individual labor supplies are hardly affected by changes in the prices of child care services. In addition, the child care price effects on the individual labor supplies are much smaller than the wage effects.

Furthermore, we find that the additional earnings due to an increase in household non-labor income minus the child care expenditures are mainly transferred to the female partner.

JEL Codes: D12, D13, J22

Keywords: Collective Model; Labor Supply; Child Care

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# 1 Introduction

The traditional unitary model that is often used to describe household behavior assumes that a household, even if it consists of different individuals, acts as a single decision-making unit (Vermeulen, 2002). The model predicts that comparative wage advantages within the family lead to gender specialization in economic activities (Becker, 1991). Because the hourly wage rate of the male partner is on average higher, he specializes in paid labor, while she specializes in housework activities and child care. Insofar as child care services play a role, it is only mentioned to point out that women are unlikely to participate in paid labor if the prices of child care services are higher than her hourly wage rate. As long as the male breadwinner arrangements were dominant in Western societies, the predictions of the unitary model were consistent with the time allocations observed.

The unitary model became increasingly under fire. First of all, the growing employment rates of women, since the 1970s, resulted in more two-earner households and less male breadwinner arrangements in Western societies, and the unitary predictions were often not consistent with the observed time allocations of two-earner households. Second, the unitary model is criticized because of its theoretical deficiencies. It imposes that household members pool their income, and that compensated wage changes of spouses have the same effect on each other's labor supply and these restrictions are regularly rejected when tested on household data (see among others Thomas, 1990; Browning et al., 1994; Lundberg et al., 1997; Chiappori et al., 2002; Browning and Chiappori, 1998; Blundell et al., 2005). Furthermore, individual preferences are not considered in the unitary approach and so nothing can be said on the intra-household allocation of welfare, which is clearly a disadvantage from a welfare economic perspective.

Around the 1990s, the collective model was developed, and this model gradually found acceptance in the family economics literature as an alternative model for the unitary model (see Chiappori, 1988a, 1992, 1997). The collective approach starts from the minimal assumption that intra-household decisions are Pareto efficient. Even this weak restriction makes it possible to derive some testable implications of the model and to identify an important part of the intra-household decision-making process and individual preferences (Vermeulen, 2002). Moreover, because individual preferences and the bargaining process between the household members are considered it is possible to examine the intra-household allocation of welfare.

The growing employment rates of women stimulated the development of child care services. The latter were increasingly seen as necessary conditions for the reduction of the gender gap in employment and, consequently, for the realization of equal opportunities for women as compared to men. So it is not surprising that the introduction of collective household models, were soon followed by extensions regarding public goods

(Chiappori, 1997) and applications of this general public goods framework towards child care time (Chiuri, 1999) or the consumption of child related items (Bourguignon, 1999). In the past ten years, more child related extensions of the collective household model have followed (See for example Browning, Bourguignon, Chiappori, and Lechene, 1994; Blundell, Chiappori, and Meghir, 2005 and Couprie, 2007).

In this study we add to the growing literature on collective models that incorporate children. We examine the labor supply choices of parents who are living in Flanders, the Dutch speaking region of Belgium, and take into account the expenditures on child care services. Inspired by Chiappori, Fortin, and Lacroix (2002) and Blundell, Chiappori, and Meghir (2005), our first contribution is that we extend theory by allowing for a public child care good that incorporates the child care bought on the market. Hence, we assume that parents allocate time to market activities, child care and leisure, which produces a more credible view on time allocation than in the usual approach that equates leisure to non-market time (see also Couprie, 2007).

To be more precise, we describe the household decision process as a two-staged budgeting game. At the first stage parents decide how they share the non-labor income minus the total expenditures on child care services. At the second stage they separately choose the optimal amount of labor supply and their individual contribution to child care. We thereby assume that preferences over private consumption, and leisure are separable from child care expenditures. Assuming separability is restrictive, because the level of child care expenditures may be expected to affect the trade-off between consumption and labor supply at the individual level. We emphasize, however, that within this setting individual preferences can depend on the parents choice to make use of paid child care, but these preferences are not affected by the amount that parents spend on it.

We argue that the separability assumption may be credible for the Belgian case because the net price of child care services (after tax allowance) is considerably lower than the hourly wages of both parents (over the whole wage range). Therefore, it is not likely that child care expenditures will affect the trade-off between labor and leisure. Although child care expenditures do affect the trade-off between labor and the individual contribution to child care, it is not clear which partner would take care of the children if the demand for child care was lower. Therefore, we model child care expenditures as a potential public ‘bargaining’ good.

The second contribution of this study is that the use of a collective model allows us to examine how parents share the non-labor income minus the expenditures on child care services. The third contribution is that we examine how the individual labor supplies are affected by the expenditures of child care services. The fourth contribution is that we derive the wage and child care price elasticities from the estimation results, so that we obtain information on how the individual labor supplies react on wage changes and changes in

the prices of child care services. The latter is particularly interesting from a policy perspective as it reflects how subsidies (or taxes) targeted on different individuals within the household will affect labor supply.

In this study, we make use of the Flemish Families and Care Survey (FFCS) that was conducted between November 2004 and May 2005 and held among households with children who were living in the Dutch speaking part of Belgium. For the purpose of this study, we focus on dual-earner families and exploit the information on parental time use, the use of child care services and individual characteristics of both parents and children. The complete survey has information on almost 2000 Flemish households with children, but because of the specific data requirements needed for this study we are left with a sample that contains 382 household observations with full information.

We proceed as follows. In Section 2 we discuss the theory. In Section 3 we choose the parametric specification and discuss the estimation method. In chapter 4 we discuss the data that we use in more detail and in 5 we present the empirical results. Finally, in Chapter 6 we conclude.

## 2 Theory

In this section we develop a collective labor supply model where the expenditures on paid child care and the production of child care by the parents themselves is taken into account. As is usual in a collective setting, we assume that parents (potentially) have distinct preferences and that there may be an unequal division of bargaining power between the two parents. The core assumption underlying the collective model is that the household decision process, whatever its true nature is, will yield Pareto efficient outcomes.

We consider a two parent ( $s = m, f$ ) household where parent  $s$ 's preferences are represented by the utility function

$$U^s(X^s, l^s, Q, H), \tag{1}$$

where  $l$  represents leisure and private consumption is denoted by  $X$ . Since there is usually no information in data sets on the individual expenditures of a family, we represent the consumption of these private goods as one Hicksian composite good, whose price is set to unity. In other words, each parent consumes a bundle of private commodities and  $X^s$  represents the money value of this bundle for parent  $s$ .

Additionally, the utility function contains two public goods  $Q$  and  $H$ .  $Q$  represents the household expenditures on child care services, while  $H$  refers to the (monetary equivalent of) child care provided by the parents themselves. Note, regarding  $Q$ , that not only the amount of child care services varies considerably between households, but also the unit price, because some parents pay for this child care, while for others it

is virtually free when, for example, the grandparents are the care providers.

Regarding  $H$ , we should stress that we incorporate the care time parents spend on their children as a public rather than a private good. In this we differ from the earlier literature on collective labor supply with home production where these non market activities were viewed as private and assignable goods (see Chiappori (1997), Apps and Rees (1997) and Rapoport et al., 2005). We concur with Couprie (2007) when she mentions that family life involves a high degree of sharing and therefore it would be more appropriate to view the production of goods within the household as public goods. The latter argument especially holds for the home production of child care, since the consumption by one parent, in principle, never excludes the consumption of the same good by the other parent. We furthermore assume the household production function to have standard properties of positive and decreasing marginal returns and, for simplicity, assume neither complementarity nor substitution between the time inputs of the parents:<sup>1</sup>

$$H = H(c^m, c^f) \text{ with } \frac{\partial H}{\partial c^s} > 0, \frac{\partial^2 H}{\partial c^s c^s} < 0 \text{ and } \frac{\partial^2 H}{\partial c^m c^f} = 0, \quad (2)$$

where child care hours are denoted by  $c$ .

With the separate inclusion of  $Q$  and  $H$  in the utility function we do not make specific assumptions about the relationship between the two inputs in one household production function of ‘child welfare’ (e.g. Blundell et al., 2005). As such, we allow every parent to have a specific preference for the combination of these two household public goods. Obviously, a main source of difference between both is that one (service use) comes at a direct monetary cost, while the other (parental care time) translates in a reduction of available leisure and/or time for paid work (opportunity cost). Below, we will return to this issue.

For expositional purposes, we assume in this section that both household members have ‘egoistic’ preferences, since preferences only depend on own consumption and own leisure. However, the results that we derive in this section also hold when we would assume that parents have ‘caring’ preferences, i.e. preferences that depend on the leisure and the consumption of both partners (see Chiappori, Fortin, and Lacroix, p.12, 2002).<sup>2</sup> In fact the solution set under ‘caring’ behavior of the parents is a subset of the solution set under egoistic behavior of the parents (Chiappori, 1992).

For identification purposes, we assume that preferences over private consumption, and leisure are sepa-

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<sup>1</sup>The latter may seem a restrictive assumption, but holds a middle position between the various results found in the empirical literature, compare for example Ghysels, 2005 and Beblo, 1999.

<sup>2</sup>The utility function of parent  $s$  under caring preferences can be represented as:  $U^s = f^s(u^m(X^m, Q, l^m), u^f(X^f, Q, l^f))$ ,  $s = m, f$  (see Becker, 1991).

rable from the public goods (see Blundell et al., 2005), i.e

$$U^s(X^s, Q, l^s) = U^s(u^s(X^s, l^s), Q, H). \quad (3)$$

Intuitively, separability means that individual preferences over child care do not affect the individual trade-off between private consumption and leisure (represented by  $u^s$ ). More precisely, Blundell et al. (2005) clarify that under the separability assumption of (3) individual preferences can depend on the parents choice to make use of paid child care, but these preferences are not affected by the amount that parents spend on it.

Using the elements specified above and following the basic assumption of Pareto-efficiency of the collective model, we can now proceed to the formulation of the collective maximization program.<sup>3</sup> This is equivalent to a situation where the parents behave as if they maximize the following household utility function:

$$\begin{aligned} \max_{l^m, l^f, c^m, c^f} & \mu(w_m, w_f, y, d) \cdot U^m(u^m(X^m, l^m), Q, H) \\ & + (1 - \mu(w_m, w_f, y, d)) \cdot U^f(u^f(X^f, l^f), Q, H), \end{aligned} \quad (4)$$

subject to

$$\begin{aligned} (1) \quad & X^m + X^f + Q = w_m \cdot h^m + w_f \cdot h^f + y \\ (2) \quad & h^s + c^s + l^s = 1, \forall s \in \{m, f\} \end{aligned}$$

where the time endowment is normalized to one,  $h^s$  represent the labor that is supplied by parent  $s$ ,  $c^s$  the child care time provided by parent  $s$ , leisure is  $l^s$  and  $y$  represents the non-labor household income. The first constraint represents the budget constraint and imposes that, in the optimum, the household consumption equals the household budget. The second constraint represent the typical time constraint. It implies the obvious consequence that all time categories are bound between zero and one, but also that the amount spent on one category can be deduced from the knowledge of the two others, with for example  $l^s = 1 - c^s - h^s$ .

The individual utility functions are weighted by the utility weight function  $\mu(\cdot)$  and this function usually depends on wages, non-labor income *and* on variables that do not enter the individual preferences directly but influence the utility weight distribution. Hereafter, we refer to the latter as distribution factors,  $d$ , and we assume for expositional purposes that there is only one distribution factor (see Browning, Bourguignon, Chiappori, and Lechene, 1994). An intuitive interpretation of the utility weight is that it represents the

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<sup>3</sup>For detailed discussions on collective household models, we refer to excellent recent surveys by Vermeulen, 2002, Browning, Chiappori, and Lechene, 2006, and Donni, 2008.

division of bargaining power between the parents. The utility function of household member  $m$  is weighted more heavily in the household utility function as the value of  $\mu(\cdot)$  is higher. Hence, an increase in  $\mu(\cdot)$  can be interpreted as an improvement of the bargaining position of parent  $m$  and this can be caused by a change in wage rates, the non-labor income or other factors that affect the distribution of power between the parents.

We emphasize that  $\mu(\cdot)$  should depend on wages. If not, the marginal compensated wage changes of the spouses have the same effect on each other's labor supply by definition (usually referred to as the Slutsky symmetry condition). The model would then collapse into a neo-classical unitary model where individual preferences are not considered and where the intra-household allocation of welfare cannot be studied. For an elaborate discussion on the consequences when  $\mu$  is misspecified we refer to Browning et al. (2006).

According to the second fundamental welfare theorem any Pareto efficient outcome can be achieved by a lump-sum wealth redistribution. As a consequence, the household decision process in (4), can be decentralized into a two-stage decision process and the individual preferences and the intra-household sharing rule can be recovered from the observations of labor supply. Based on the assumption that private consumption and leisure are separable from the expenditures on child care, the following holds. At the first stage parents decide how they share the non-labor income minus the total expenditures on child care services  $Q$ . At the second stage the parents *separately* choose the optimal amount of labor supply  $h^s$  and their individual contribution to child care  $c^s$ . As a consequence, there exists some sharing rule such that each parent solves the following program:<sup>4</sup>

$$\max_{h^s, c^s} U^s(u^s(X^s, 1 - c^s - h^s), H, Q), \quad (5)$$

subject to

$$\begin{aligned} (1) \quad & X^s = w_s \cdot h^s + \rho^s \\ (2) \quad & 0 < h^s \leq 1 - c^s \\ (3) \quad & 0 \leq c^s < 1, \end{aligned} \quad (6)$$

where  $\rho^m = \rho$  and  $\rho^f = y - Q - \rho$ .  $\rho$  represents how parents divide the non-labor income conditional on child care expenditures (services) and therefore it is a conditional sharing rule. Blundell et al. (2005) have shown that this conditional sharing rule can be recovered up to a constant under the separability assumption. As is mentioned by the latter and by Couprie (2007), the existence of the conditional sharing rule does not guarantee the efficiency of public expenditures. In empirical applications this efficiency has to be assumed.

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<sup>4</sup>The proof is given in Chiappori (1992).

Assuming interior solutions in (5) we obtain the following Marshallian labor supply demand functions:

$$\begin{aligned} h^m &= \Lambda^m(w_m, \rho(w_m, w_f, \tilde{y}, d, z), z) \\ h^f &= \Lambda^f(w_f, \tilde{y} - \rho(w_m, w_f, \tilde{y}, d, z), z), \end{aligned} \tag{7}$$

where,  $\tilde{y}$  represents  $y - Q$ , the residual non-labor income, and  $z$  is a preference vector that we introduce to allow for individual and household level heterogeneity in the sharing rule and the labor supply functions.

The left hand side of the equations in (7) represent the unrestricted labor supply functions, while the right hand side represent the restricted labor supply functions. The particular structure of the latter imposes testable restrictions on the demand functions and allows to recover the sharing rule. To be more precise, the partial derivatives of the sharing rule can be exactly recovered when there is at least one distribution factor present (See Chiappori et al. (2002) and Appendix B). However, it is not the case that this distribution factor is needed for identifiability of the model. Without a distribution factor, the sharing rule can be recovered up to an additive constant, but this constant is welfare irrelevant. As Browning et al. (2008) mention: changing this constant affects neither the comparative statics nor the welfare analysis derived from the model.<sup>5</sup>

Based on the labor supply functions in (7) we can derive the income and wage effects. The income effects are measured through the sharing rule and in (8) we show these income effects for parent  $m$ :

$$\begin{aligned} \frac{\partial h^m}{\partial w_f} &= \frac{\partial \Lambda^m}{\partial \rho} \frac{\partial \rho}{\partial w_f} \\ \frac{\partial h^m}{\partial \tilde{y}} &= \frac{\partial \Lambda^m}{\partial \rho} \frac{\partial \rho}{\partial \tilde{y}} \\ \frac{\partial h^m}{\partial d} &= \frac{\partial \Lambda^m}{\partial \rho} \frac{\partial \rho}{\partial d}, \end{aligned} \tag{8}$$

where the partial  $\partial \Lambda^m / \partial \rho$  denotes the partial of  $\Lambda^m$  with respect to  $m$ 's allocated income. It follows that

$$\frac{\partial h^m / \partial \tilde{y}}{\partial h^m / \partial d} = \frac{\partial \rho / \partial \tilde{y}}{\partial \rho / \partial d}$$

and

$$\frac{\partial h^m / \partial \tilde{y}}{\partial h^m / \partial w_f} = \frac{\partial \rho / \partial \tilde{y}}{\partial \rho / \partial w_f}$$

A change in the non-labor income, after deducting the expenditures on child care, influences labor supply

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<sup>5</sup>In addition it holds that the sharing rule is identifiable up to an additive constant  $\kappa(z)$  when we would assume that preferences and the sharing rule are simultaneously influenced by certain preference factors ( $z$ ).

only through the sharing rule. Since the expenditures on child care are captured by  $\tilde{y}$ , it is possible to examine the effects of a change in child care expenditures on labor supply. Interestingly, we can examine these effects relatively to, for example, the labor supply effect of a wage change of the partner. The income effects for parent  $f$  can be derived in a similar manner.

Given that child care expenditures are captured by  $\tilde{y}$ , we rewrite the second equation of (8) as an elasticity:

$$\frac{\tilde{y}}{h^m} \frac{\partial h^m}{\partial \tilde{y}} = \left( \frac{\rho}{\Lambda^m} \frac{\partial \Lambda^m}{\partial \rho} \right) \left( \frac{\tilde{y}}{\rho} \frac{\partial \rho}{\partial \tilde{y}} \right) \quad (9)$$

The right hand side of the elasticity consist of two terms. The first term represents the total income effect on the labor supply of parent  $m$ . The second term represents the change of labor supply in percentage of parent  $m$  resulting from a percentage change in the non labor income. An increase in child care costs diminishes the amount of non labor income that is left to divide between the partners and this can affect the labor supply of the parents. For example, an increase in the hourly price of child care can improve the bargaining position of parent  $m$  and this may induce parent  $m$  to supply more labor. At the same time, parent  $f$  may supply less labor hours due to this change in the division of bargaining power. Since we observe  $\tilde{y} = y - Q$  and because the child care expenditures are the product of child care demand and child care prices, it is possible to simulate how a change in the price of child care would affect labor supply, under the assumption that child care demand is optimally chosen.

It is obvious from the demand functions in (7) that the labor supply of parent  $m$  is not directly influenced by the spouse's wage.<sup>6</sup> The wage elasticity of parent  $m$  is shown in equation (10).

$$\frac{w_m}{h^m} \frac{\partial h^m}{\partial w_m} = \frac{w_m}{\Lambda^m} \frac{\partial \Lambda^m}{\partial w_m} + \left( \frac{\rho}{\Lambda^m} \frac{\partial \Lambda^m}{\partial \rho} \right) \left( \frac{w_m}{\rho} \frac{\partial \rho}{\partial w_m} \right) \quad (10)$$

The labor supply of parent  $m$  is influenced directly through his or her own wage (*preferences*), but is also affected through the sharing rule (*income effect*), as it depends on wages as well. It can be that  $\frac{\partial \rho}{\partial w_m} < 0$ , because the additional wealth that is resulting from a wage increase will be partially transferred to the partner. On the other hand, it may be that  $\frac{\partial \rho}{\partial w_m} > 0$ , since an increase in wage improves the bargaining position of the household member resulting in a larger income share. Furthermore, it is likely that  $\frac{\partial \Lambda}{\partial \rho} \leq 0$ , because leisure is a normal good and individuals will replace labor hours by leisure hours when the income increases (see Browning et al., 2008).

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<sup>6</sup>Labor supply would depend on the spouse's wage when we would assume caring preferences and the demand function of parent  $A$  would then write:  $h^m = \Lambda^m(w_m, w_f, \rho(w_m, w_f, \tilde{y}, d, z), z)$ .

Finally note that, in this analysis, we focus on the derivation of the labor supply functions and on the effects of wage and income on labor supply. Therefore, we do not explicitly derive the individual care supply functions. We show in Appendix A, however, for interior solutions (dual earners) and under the assumption that child care expenditures and individual time allocation decisions are separable, that the familiar assumption of individual private productive efficiency guarantees that for all types of activities, the amount of time spent on it depends on the market wage of the individual (see also Blundell et al., 2005). Consequently, it is not required to disentangle the distribution of time between leisure and parental care to be able to study the individual labor supply. For our further analysis, it suffices to know that both categories jointly function as the (daily) time complement to paid employment and that both produce positive utility (in a further non-specified, but individually different way). We leave the analysis of the time allocation between pure leisure and individual child care time for future work.

### 3 Parametric specification

When we specify the functional form of the system of labor supply functions it is, first of all, important that the restrictions of the collective labor supply model can be empirically tested and, therefore, it should not be the case that these collective restrictions are already imposed by the parametric specification itself. Second, it must be the case that the theoretical model and in particular the sharing rule can be recovered up to a constant, from the specified system of demand functions. This is important because there may other, functionally different structural models that may lead to the same reduced form. The parametric specification of the system of labor supply demand functions is assumed to be the following:

$$\begin{aligned}
 h^m = & \alpha_0 + \alpha_1 \log w_m + \alpha_2 \log w_m^2 + \alpha_3 \log w_f \\
 & + \alpha_4 \tilde{y} + \alpha_5 \log w_m \log w_f + \alpha_6 d + \alpha_7 z;
 \end{aligned}
 \tag{11}$$

$$\begin{aligned}
 h^f = & \beta_0 + \beta_1 \log w_m + \beta_2 \log w_f^2 + \beta_3 \log w_f \\
 & + \beta_4 \tilde{y} + \beta_5 \log w_m \log w_f + \beta_6 d + \beta_7 z,
 \end{aligned}
 \tag{12}$$

For this exposition, we assume that there is one distribution factor,  $d$ , and that heterogenous preferences are caused by one preference factor  $z$ . The wage rates enter the labor supply system in a log form to allow for the fact that the additional labor that is supplied by a wage increase will diminish as the wage rate increases. By including the square of the individual logarithmic wage rates we can test whether labor supply increases

monotonically in ones own wage rate, i.e. we can test for parent  $s$  whether  $\partial h^s / \partial w_s > 0$  for the entire range of  $w_s$  (see Chiappori et al., 2002). In addition, an interaction effect is added between the own wage rate and the wage rate of the partner such that the sign of  $\partial h^s / \partial w_s$  is dependent on the level of  $w_{-s}$ . It follows that the marginal effect of wages on labor supply can be affected by the wage rate of the partner.

In Chiappori et al. (2002) the conditions are shown that are imposed by the collective labor supply model and these conditions are presented in Appendix B. The collective model restrictions with respect to our model are derived using proposition 1 in Appendix B. We define  $A = h_{w_f}^m / h_y^m$ ,  $B = h_{w_m}^f / h_y^f$ ,  $C = h_d^m / h_y^m$ ,  $D = h_d^f / h_y^f$  and obtain the following fractions:

$$\begin{aligned}
 A &= \frac{h_{w_f}^m}{h_y^m} = \frac{\alpha_3 + \alpha_5 \log w_m}{\alpha_4 w_f} \\
 B &= \frac{h_{w_m}^f}{h_y^f} = \frac{\beta_1 + \beta_5 \log w_f}{\beta_4 w_m} \\
 C &= \frac{h_d^m}{h_y^m} = \frac{\alpha_6}{\alpha_4} \\
 D &= \frac{h_d^f}{h_y^f} = \frac{\beta_6}{\beta_4}
 \end{aligned} \tag{13}$$

The first restriction of the collective model is that  $C \neq D$  and this restriction is satisfied unless:<sup>7</sup>

$$\frac{\alpha_4}{\beta_4} = \frac{\alpha_6}{\beta_6}. \tag{14}$$

The fraction  $\frac{\alpha_6}{\beta_6}$  represents the ratio of income effects on labor supplies through the distribution factor. The sign of this fraction should be negative because it represents how the residual non-labor income is distributed between the parents. Therefore, an increase in the woman's share of non-labor income automatically implies a decrease in the man's share of non-labor income. The fraction  $\frac{\alpha_4}{\beta_4}$  represents how the ratio of labor supplies is affected by the income effects. It is generally assumed that leisure is a normal good and therefore an increase in the residual non-labor income will result in more leisure and less labor supply. It follows that the fraction  $\frac{\alpha_4}{\beta_4}$  is positive whenever the increase in the residual non-labor income is (minimally) shared between the parents. It is therefore unlikely that (14) holds.

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<sup>7</sup>Theoretically, this restrictions means that it cannot be the case that  $\frac{\partial h^m / \partial \bar{y}}{\partial h^f / \partial \bar{y}}$  equals  $\frac{\partial h^m / \partial d}{\partial h^f / \partial d}$ .

Assuming that  $C \neq D$ , it follows from condition (B.7) that the necessary and sufficient conditions are:<sup>8</sup>

$$\frac{\alpha_5}{\beta_5} = \frac{\alpha_6}{\beta_6}. \quad (15)$$

The ratio of marginal effects of  $\log w_m \cdot \log w_f$  must, therefore, be equal to the corresponding ratio of the marginal effects of the distribution factors on labor supplies (see also Chiappori et al., 2002). Intuitively, the cross wage and distribution effects do not affect the position of the Pareto frontier, but only affect the labor supplies by affecting the position on the Pareto frontier. As a consequence, there must be a trade-off between the ratio of marginal effects of  $\log w_m \cdot \log w_f$  and the ratio of the marginal effects of the distribution factors that hold in the optimum.

Using proposition 1 in Appendix B and the restriction in (19), we derive the partial derivatives of the sharing rule with respect to wages, non-labor income and the distribution factor:

$$\begin{aligned} \rho_{\tilde{y}} &= \frac{\alpha_4 \beta_5}{\Delta} \\ \rho_d &= \frac{\alpha_6 \beta_5}{\Delta} \\ \rho_{w_m} &= \frac{\alpha_5}{\Delta} \cdot \frac{\beta_1 + \beta_5 \log w_f}{w_m} \\ \rho_{w_f} &= \frac{\beta_5}{\Delta} \cdot \frac{\alpha_3 + \alpha_5 \log w_m}{w_f}, \end{aligned} \quad (16)$$

where  $\Delta = \alpha_4 \beta_5 - \beta_4 \alpha_5$ . Solving the system in (16), we obtain the following sharing rule equation:

$$\begin{aligned} \rho &= \frac{1}{\Delta} \cdot [\alpha_4 \beta_5 \tilde{y} + \alpha_6 \beta_5 d + \alpha_5 \beta_1 \log w_m + \alpha_5 \beta_5 \log w_f \log w_m \\ &\quad + \beta_5 \alpha_3 \log w_f] + \kappa(z) \end{aligned} \quad (17)$$

This means that the sharing rule is identified by the equation (17) up to an additive constant  $z$  for each household member. The variable  $z$  represents the preference factor and may also affect the individual bargaining position.

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<sup>8</sup>We have that  $\frac{\partial}{\partial w_f} \left( \frac{BC}{D-C} \right) = \frac{\partial}{\partial w_m} \left( \frac{AD}{D-C} \right)$  which is similar to  $\frac{\partial}{\partial w_f} (BC) = \frac{\partial}{\partial w_m} (AD)$ . When we substitute  $A, B, C, D$  and determine these derivatives we have that  $\frac{\alpha_6 \beta_5}{\alpha_4 \beta_4 w_m w_f} = \frac{\beta_6 \alpha_5}{\alpha_4 \beta_4 w_m w_f}$  which simplifies to  $\alpha_6 \beta_5 = \beta_6 \alpha_5$ .

## 4 Data

### 4.1 Data

The data for our analysis stem from the Flemish Families and Care Survey (FFCS), a survey among almost 2000 Flemish households with children that was conducted between November 2004 and May 2005. The main purpose of the survey was to investigate how Flemish parents organize care for their children. As part of the study, parents were asked to fill out time-use sheets for their children. Additionally, every parent in the household was asked to produce a weekly work schedule. Taken together, we can therefore rely on data regarding the time allocation of parents to employment and to child care over a period of one week. Moreover, we know from the time sheets of the children how many hours they spent in non-parental child care. Consequently, we observe how parents effectively distributed care over parental and non-parental care in one specific week.

For the purpose of the present article, we focus on families with two employed parents, of which the aforementioned sample contains 382 household observations with full information. This means that 382 of the 2000 households are used in the analysis. There are two main reasons for this drop in the number of observations. First of all, we use two-earner households only, which causes a drop in the number of observations from 2000 to 1608. Second, we only use information for parents who produced a weekly work schedule so that we know the distribution of hours over parental and non-parental care and this results in a drop of observations from 1608 to 551 households.

In Table 1 we show the individual specific summary statistics of the spouses. Ultimately, we are left with a sample of 382 households and this is because there are missing observations on variables that we need in the analysis, such as child care costs, wage rates, etc.

The descriptive statistics between males and females confirm what is regularly found in empirical studies. On average men are older, work more paid labor hours and have a higher hourly net wage. We note that the paid labor hours represent the paid labor hours that a person actually works. The education variable represents the highest education level that is attained and it is measured on a 4 point scale, where 1 stands for lower educated and 4 stands for having a university degree. The women in our sample are, on average, higher educated than their partners and although this is usually not the case for other Western European countries, it is common for Belgium. A rather large proportion of the men and women are entrepreneur and we should therefore control for this entrepreneurial effect in the empirical analysis.

Table 1: **Individual Summary Statistics**

	Male		Female	
	Mean	St.Dev.	Mean	St.Dev.
Age	39.09	5.84	35.71	5.82
Education	2.57	0.90	2.73	0.84
Paid labor hours	43.73	10.72	32.85	10.59
Net hourly wage	11.83	6.68	10.80	7.48
Hours of child care	27.17	21.45	48.28	26.42
Entrepreneur	0.16	0.37	0.12	0.32
Observations	382		382	

In Table 2 we show the household specific summary statistics. The average family size is about 4 and this means that each household has, on average, 2 children. On average, 0.79 of these 2 children are children who are too young to go to school and we refer to these children as preschool children. The net weekly household income is about 843 euros and 59.92 percent of this income is earned by the male. The average amount of non-labor income is substantial with 6.6 percent of the household income. Note that in most cases non-labor income derives exclusively from child benefits, which are monthly flat rate amounts (untaxed, depending on the number and age of the children only).

Table 2: **Household Summary Statistics**

	Mean	St.Dev.
Family size	4.09	0.93
Number of pre-school children	0.79	0.60
Net household income	843.87	436.39
Net income male	505.65	320.01
Net income female	338.22	246.39
Net non-labor income	56.40	44.10
Observations	382	

As we have discussed in Sections 3 and 4, we use a distribution factor that gives information on the individual bargaining positions of the parents. To each parent the following question was asked: “*Who do you prefer to be the main income provider?*”, and they could choose between three answer categories: (1) I prefer the male; (2) I prefer the female; (3) I prefer both parents to be the main income providers. When

both parents give the same answer they apparently have similar preferences on who should be the main income provider in the household. However, when parents give different answers, it reflects that the man and the woman have a different opinion about the roles that each parent should have within the household. In Table 3 we show the answers of the parents on this question. Four outcomes are clearly dominant and we will discuss these four outcomes. In 139 cases the man and the woman answer that they both should be the main income provider, and in these cases the opinions of both parents are aligned. However, in, respectively, 63 and 56 cases, one parent answers that both parents should be the main income providers, while the other parent finds that only he or she should be the main income provider. These answers indicate a conflict that may have its effect on the individual bargaining positions of the parents. The same holds for the situation where each parent answers that they themselves should be the main income provider. It is, furthermore, interesting to see that men and women almost never state that the partner should be the main income provider.

Table 3: **Who in the household should be the main income provider?**

<b>Male Answer:</b>	<b>Female Answer:</b>			<b>Total</b>
	<i>Male</i>	<i>Female</i>	<i>Both</i>	
<i>Male</i>	6	108	63	<b>177</b>
<i>Female</i>	5	0	3	<b>8</b>
<i>Both</i>	2	56	139	<b>197</b>
<b>Total</b>	<b>13</b>	<b>164</b>	<b>205</b>	<b>382</b>

In accordance with the idea of Lundberg and Pollak (1993), we also constructed a distribution factor representing the position on the marriage market of men and women. More specifically, we constructed the singles/non-singles ratio for each man and woman, conditioned on their age, living region and education level. The intuition is that the outside option of a person improves as the non-single/single ratio of the partner is lower. By dividing the single/non-single ratio of men by the single/non-single ratio of women, we then measure how the outside option of men relates to that of his partner and can identify which partner in the household presumably has the better outside option. However, in the empirical analysis this measure was consistently insignificant and therefore we do not use it as distribution factor. We mention this result, because we thereby rejected the hypothesis that the bargaining position of household members is affected by their relative outside option.

## 4.2 Child care in Belgium

For this study it is important to have an idea of how child care is arranged in Belgium. Actually, we refer to the Dutch speaking part of Belgium, Flanders, because there are large regional disparities within Belgium regarding child care services and because our data set is confined to Flemish households only. Within Flanders, the child care picture is rather diverse. First a distinction is to be made between preschool children and those attending school. The schooling system starts, to international standards, early.<sup>9</sup> By the age of 3, almost all Flemish children attend pre-primary school (Unicef, 2008), with typical school hours starting at 8:30 a.m. and ending at 3:30 p.m. Accordingly, the demand for child care services is completely different before and after the age of 3.

Furthermore, parental leave can be taken by both the father and the mother for three months in a full-time arrangement and proportionally longer in part-time arrangements. Moreover, there exists a career break scheme that allows for a leave of up to one year.<sup>10</sup> Both systems are increasingly popular and are mostly used in part-time arrangements and by mothers. Historically, grandparents were important providers of child care and they continue to play a role, despite the increase in employment rates among generations that are now reaching the grandparent stage. However, grandparents are now increasingly focusing on part-time care, both for preschool children (e.g. one day a week) and for grandchildren attending school (e.g. before and after school, during holiday periods). Consequently, the demand for formal child care services is much larger among parents with children below 3 and is predominantly directed at part-time care.

Within the sector of formal child care both center-based care (e.g. crèche) and family-based care (typically childminder) are important. Figure 1 differentiates the use of child care services according to the age of the youngest child in the household. The figures in the graph refer to the dominant type of child care service used in a normal week for parents in the region of Flanders.<sup>11</sup>

As described before, a combination of formal care with supplementary grandparent care is common, but this combination does not show in the figure. The figure illustrates how the use of formal child care is declining with the rising age of the children to the advantage of informal care, mostly grandparent care. Not shown is the decline in overall use of child care services that is associated with age. Almost 70% of the families with a young child use child care in a normal week, while this figure is only 65% for families with

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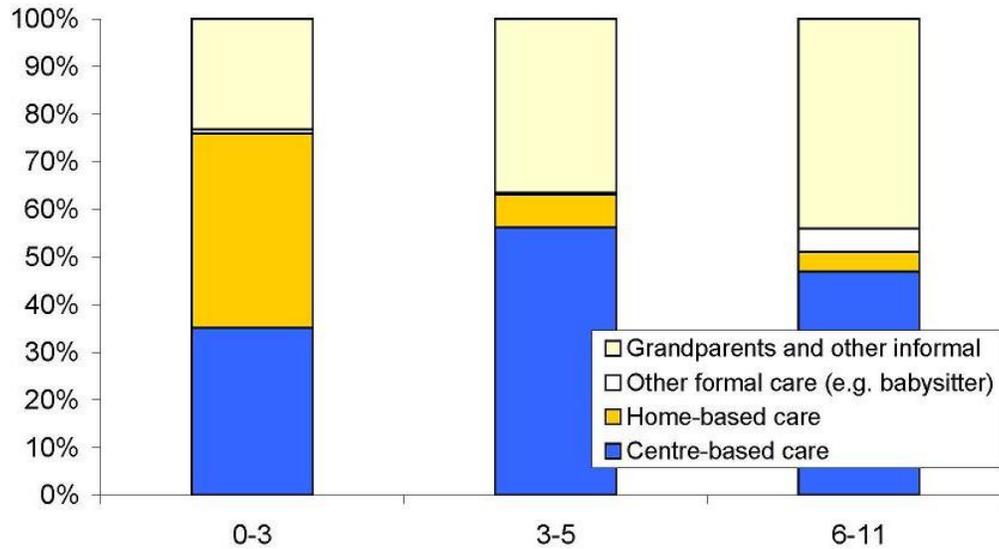
<sup>9</sup>Children are allowed to start pre-primary school on the first of five entry moments (after holiday periods) after they have reached the age of 30 months. Hence, many children enter pre-primary school slightly before their third birthday.

<sup>10</sup>In some economic sector, collective agreements allow for longer career breaks (up to five years). Furthermore, it is interesting to know that the flat fee for career breaks is considerably lower than the benefit for parental leave.

<sup>11</sup>Population wise the Flemish community represents slightly more than 60% of the inhabitants of Belgium. The public provision of and control over child care is a community matter in Belgium, which accounts for policy differences between the communities. Our text reflects the situation in Flanders.

a child between 3 and 5 and decreases to only 41% for families with a child in primary school (Ghysels and Debacker, 2007).

Figure 1: Most frequently used type of care services



In Table 4, we show how the parents of the dual earner couples in our sample distribute the total hours of child care in a normal week over the grandparents, formal child care institutions and themselves. The child care that is supplied by the grandparents and by formal child care institutions is 25 hours per week, which is roughly 3 days per week. The amount supplied by the formal child care institutions is about equal to the amount supplied by the grandparents. The bulk of child care is provided by the parents themselves (75 percent). However, it is difficult to relate the parent outcomes to the other outcomes, as the parent outcomes relate to the child care given during a complete week, while the other outcomes more likely relate to child care given on times when parents are working. Nevertheless, the percentage of care supplied by the grandparents and formal child care institutions is substantial.

To have an idea of the child care costs that parents face, we show in Table 5 the child care costs per week. These costs reflect the out-of-pocket costs of parents and are not truly net amounts, because parents can obtain a tax allowance for child care through their personal income tax. Because the tax allowance takes two years to materialize and, moreover, it is a complex function of the personal income of the head of the household, we assume for simplicity that the parental reaction on price changes in child care is driven by the monthly invoices, rather than by the true net costs of child care.

Table 4: **Distribution of Child Care hours**

	<b>Hours</b>	<b>%</b>	<b>Cum. %</b>
Grandparents	11.87	11.81	11.81
Formal child care	13.17	13.10	24.92
Care by mother	48.28	48.04	72.96
Care by Father	27.17	27.04	100.00
Total	100.49	100.00	100.00
Observations	382		

In the table we distinguish between households where child care is provided only by the grandparents, only by formal child care institutions and households where child care is provided by both. The total costs and hourly price are relatively low when only the grandparents provide child care, and the hourly price is relatively high when parents make use of only formal child care. The low hourly price when grandparents are the only child care providers is not so surprising: usually grandparents provide child care for free or for a minimum amount of money. When child care is provided by the grandparents and formal child care institutions, we see that the price lies between the other two prices in the table, as is expected.

Table 5: **Child care costs (weekly averages)**

<b>Costs when parents use</b>	<b>Hours</b>	<b>Total Costs</b>	<b>Hourly Price</b>
		(in euro's)	(in euro's)
Only Grandparents	20.94	9.93	0.55
Formal child care & grandparents	37.90	53.01	1.70
Only Formal child care	29.71	57.70	2.77
Total average	25.04	32.56	1.56
Observations	382		

## 5 Estimation Method and Empirical Findings

### 5.1 Estimation Method

The system of labor supply equations that we plan to estimate is the following:

$$h_n^m = \alpha_0 + \alpha_1 \log w_{m,n} + \alpha_2 \log w_{m,n}^2 + \alpha_3 \log w_{f,n} + \alpha_4 \tilde{y}_n + \alpha_5 \log w_{m,n} \log w_{f,n} + \alpha_6 d_n + \sum_{j=7}^J \alpha_j \cdot z_{j,n} + \varepsilon_{m,n}$$

$$h_n^f = \beta_0 + \beta_1 \log w_{m,n} + \beta_2 \log w_{f,n}^2 + \beta_3 \log w_{f,n} + \beta_4 \tilde{y}_n + \beta_5 \log w_{m,n} \log w_{f,n} + \beta_6 d_n + \sum_{j=7}^J \beta_j \cdot z_{j,n} + \varepsilon_{f,n}$$

where  $n$  represent household  $n$  of the  $N$  observations of households. We introduce the error vector  $\varepsilon \sim N(0, \Sigma_\varepsilon)$  and assume that the behavior of distinct households is not correlated, that is,  $E(\varepsilon_n, \varepsilon_{n'}) = 0$  if  $n \neq n'$ . The  $(2 \times 2)$ -error-covariance-matrix  $\Sigma_\varepsilon$  may be non-diagonal in order to include the possibility that errors in time-spending decisions are correlated. Such a correlation is probable given the overall time budget constraints and the correlation between the partners' decisions. We note that  $z_{j,n}$  represent the heterogenous preferences factors.

When the system of labor supply functions is estimated, we should take into account that the error terms may be heteroscedastic (Chiappori et al., 2002). We therefore estimated the system using a full information GMM method and performed the Pagan and Hall's (1983) test of heteroscedasticity. The hypothesis that the error terms are heteroscedastic is rejected on the basis of this test, with a Pagan-Hall general test statistic of  $\chi^2(1) = 2.49$ . Because the error terms are homoscedastic and the labor supply functions are linear in the estimation parameters, a Seemingly Unrelated Regression (SUR) model provides estimates that are as efficient as those obtained by using a full information GMM (see Cameron and Trivedi, 2005). We, therefore, estimate the system of labor supply functions by using the more simpler method of SUR.

A second issue is that we do not take into account the decision to participation in paid labor which is endogenous with the number of paid labor hours. The exclusion of households, where household members do not participate in paid labor, could potentially result in a selectivity bias. To control for this selection effect we estimated a probit model and predicted whether a person will be working based on several background characteristics, such as gender, age, education level and living region. Based on the probit estimates we constructed the inverse Mills' ratio and included it as a regressor in the appropriate labor supply equation.

Intuitively, the inclusion of the inverse Mills' ratio then corrects for the fact that persons with more favorable characteristics are more likely to participate in paid labor (see Tobin, 1958). However, as in our empirical estimates we found that the inverse Mills' ratio was statistically insignificant, we excluded it from the model, because otherwise it would make the other parameter estimates less efficient.<sup>12</sup>

By estimating the labor supply function equations, we explain the variation in  $h^s$ , but also the variation in  $T - c_s - l_s$ , because we have that  $h^s = T - c_s - l_s$  for  $s = m, f$ . We note that the aggregate amount of leisure and child care is optimally chosen when both parents choose their labor supply optimally. However, this does not imply that child care and leisure are optimally chosen. More formally, we have that  $h^{s*} = T - \mu_s^*$ , where  $h^{s*}$  stands for optimal labor supply of parent  $s$ , and where  $\mu_s^*$  stands for the optimal amount of  $c_s + l_s$ . Even though  $\mu_s^*$  is optimally chosen, this does not guarantee an optimal amount of  $c_s$  and  $l_s$ , and this optimally is therefore assumed in the empirical analysis.

## 5.2 Empirical Findings

The preference factors that are used in the estimation model are living region, age, age squared, education level, a dummy that indicates whether the person is an entrepreneur and a dummy that indicates if a person works irregular working hours, in the weekends or in shifts.<sup>13</sup> In Table 6, we show the estimated labor supply equations.

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<sup>12</sup>Another issue is the endogeneity of wages. We have instrumented the individual (log) wages using third order polynomials for age, a set of education dummies, a set of living region dummies, a dummy variable that indicates whether a person is an entrepreneur and family size. Because the data did not provide us with a good instrument, the exogenous wage variation that is predicted is entirely driven by the functional form that is chosen. Moreover, the SUR estimation results yielded rather similar results and, therefore, we use the observed wage rates instead of the instrumented wage rates in this paper.

<sup>13</sup>We do not include child variables as preference factors, such as the number of pre-school children and family size, as they are correlated with the child care benefits and the child care demand included in  $\tilde{y}_n$ . We note that these child variables are insignificant when we include them in the labor supply functions, and this is likely caused by the  $\tilde{y}$  variable that captures this effect.

Table 6: Estimated Labor Supply Functions

	Men		Women	
	Estimate	Std. Err.	Estimate	Std. Err.
$\log w_m$	-17.19***	5.42	-10.91***	4.21
$(\log w_m)^2$	-1.14*	0.69	.	.
$\log w_f$	-15.44***	3.53	-7.90***	3.49
$(\log w_f)^2$	.	.	-1.57***	0.43
$\tilde{y}$	-0.02***	0.01	-0.02***	0.01
$\log w_m \cdot \log w_f$	6.99***	1.57	3.55**	1.67
$d$	-1.58*	0.96	4.49***	0.98
<b>Control Variables:</b>				
Living region Limburg	-2.93**	1.45	-0.37	1.45
Living region East Flanders	-1.13	1.26	-0.18	1.27
Living region Flemisch Brabant	0.40	1.69	3.47**	1.69
Living region West Flanders	-0.12	1.25	-1.13	1.25
Age	1.06	0.85	-1.02	0.74
Age squared	-0.01	0.01	0.01	0.01
Education level	2.31***	0.54	1.32**	0.60
Entrepreneur dummy	10.38***	1.40	-2.06***	1.54
Irregular working hours	1.45	1.01	-1.97*	1.09
Constant	59.20***	18.47	78.37***	15.95
R-squared	0.35		0.32	
Observations	382		382	

Note: the reference region is Antwerpen. \*/\*\*/\*\* statistically significant at the 10/5/1 percent level.

In order to test whether the collective framework is supported by the data, we test if the two collective model restrictions, discussed in Chapter 3, are satisfied. These collective model restrictions are satisfied if:

$$\frac{\alpha_4}{\beta_4} \neq \frac{\alpha_6}{\beta_6} \quad (18)$$

and

$$\frac{\alpha_5}{\beta_5} = \frac{\alpha_6}{\beta_6}. \quad (19)$$

The restriction in (18) states that the ratio of income effects on labor supplies through the distribution factor should not be equal to the ratio of income effects on labor supplies, i.e.  $\frac{h_d^m}{h_y^m} = \frac{h_d^f}{h_y^f}$ . By performing a Wald test, we reject the hypothesis that  $\frac{\alpha_4}{\beta_4} = \frac{\alpha_6}{\beta_6}$  ( $\chi_{0.01}^2 = 7.85$ ). The restriction in equation (19) states that the effect of the ratio of marginal effects of  $\log w_m \cdot \log w_f$  on the labor supplies should be equal to the effect of the ratio of marginal effects of the distribution factors on the labor supplies. When we perform a Wald test, we do not reject the hypothesis that  $\frac{\alpha_5}{\beta_5} = \frac{\alpha_6}{\beta_6}$  ( $\chi_{0.01}^2 = 3.22$ ). We conclude that both collective model restrictions are satisfied and so the collective framework is supported by the data.

Even though our primary focus is not on the control, we shortly discuss the estimation results related to these variables. Persons who are entrepreneur or who are higher educated tend to work more labor hours, and this is usually found in the empirical labor supply literature. We also find that women work less labor hours if they work irregular working times, in shifts or in the weekends. Men who live in Limburg tend to work less labor hours than men who live in Antwerp and women who live in Flemish Brabant tend to work more hours than women who live in Antwerp.

In Section 2 we showed that the labor supply demand functions are functions of the individual wages, non-labor income and the distribution factor and it is therefore not surprising that these factors influence the amount of labor supply significantly. When we focus on the distribution factor, we find that it is positive and significant in the women's equation and that it is negative and significant in the men's equation. It implies that women work less labor hours and men work more labor hours if the parents opinions on who should be the main income provider are aligned.

The amount of non-labor income that is left after deducting the costs of child care services influences labor supply negatively. This result corresponds with the idea that leisure is a normal good: the man and the woman replace labor hours by leisure hours when the residual non-labor income increases.

The labor supplied by the man and the woman is influenced by the wages of both partners. To have a better idea of how wage changes influence the individual labor supplies we determine the (cross-)wage elasticities and these wage elasticities are reported in Table 7. On the basis of a t-test we conclude that all elasticities are statistically different from zero.

Table 7: **Wage elasticities**

	<b>Men</b>		<b>Women</b>		
	<b>Estimate</b>	<b>Std.Dev.</b>	<b>Estimate</b>	<b>Std.Dev.</b>	
$\frac{\partial h^m}{\partial w_m} \frac{w_m}{h^m}$	-0.17***	0.12	$\frac{\partial h^f}{\partial w_m} \frac{w_m}{h^f}$	-0.11***	0.10
$\frac{\partial h^m}{\partial w_f} \frac{w_f}{h^m}$	0.024***	0.11	$\frac{\partial h^f}{\partial w_f} \frac{w_f}{h^f}$	-0.22***	0.17

Note: \*/\*\*/\*\* statistically significant at the 10/5/1 percent level.

For both men and women, we find small negative wage elasticities meaning that they tend to supply less paid labor when their wage rate increases. Using the average wages and labor hours from Table 1 we find that the labor supply of men drops with 0.6 hour as a result of a 1 euro wage increase, which is equivalent to a wage increase of 8.5 percent. For women we find that her labor supply drops with 0.7 hours as a result of a 1 euro wage increase, which is equivalent to a wage increase of 9.3 percent.

While negative wage elasticities are often found for men, they are usually not found for women in Western European countries (see Evers, de Mooij, and van Vuuren, 2005). Blundell and MaCurdy (1998), Borjas (2002) and Cahuc and Zylberberger (2005) emphasize that the positive wage elasticities found for women are related to the participation decision of these women. They mention that it is not so clear what the wage elasticity is for women who are already participating in paid labor and for these women, they argue, the wage elasticity is likely to be close to zero. Studies performed for Belgium report negative wage elasticities (see, for example, Kesenne, 1983 and Vermeulen, 2005) and when we compare our findings to the wage elasticities found for Belgium, we find elasticities that are closer to zero but still negative.

We find a cross-wage elasticity that is positive for men and negative for women. This means that the man supplies more labor hours when the wage rate of his wife increases and that the woman supplies less labor hours if the wage rate of her husband increases. An explanation for men may be that their income share decreases when the wage rate of his wife increases and that this results in more labor supply to compensate for this relative loss of non-labor income. An explanation for women may be that the increase in her husband wage rate does not decrease the amount of non-labor income she receives after sharing. Furthermore, we find that labor supply is more influenced by a change in the persons own wage rate than by the partners wage rate, and this holds especially for men.

Table 8: **Estimated Sharing Rule**

	Estimates		Partial Derivatives
$\log w_m$	-76.26	(32.73)	-24.91 <sup>†</sup>
$\log w_f$	-54.74	(27.25)	5.91 <sup>†</sup>
$\log w_m \cdot \log w_f$	24.78	(12.12)	.
$\tilde{y}$	-0.07	(0.04)	-0.93
$d$	-5.61	(3.84)	-79.83

Note: The partial derivatives are taken with respect to the wages, instead of the log-wages.

<sup>†</sup>The partial derivatives with respect to wages are evaluated at the median wage levels.

At this point, it is interesting to present the sharing rule estimates, because it gives information on how the sharing rule variables influence the division of non-labor income between the man and the woman. In Section 3, we explained how the sharing rule estimates, presented in Table 8, can be calculated from the estimated labor supply functions presented in Table 6. The second column of Table 8 presents the sharing rule estimates, with the standard errors in parenthesis, while the third column presents the partial derivatives of the sharing rule variables. These partial derivatives represent the impact of a variable on the residual non-labor income given to the man after sharing. We will focus mainly on these partial derivatives, as they can be interpreted more intuitively. Considering the large standard errors, we note that the partial effects are not very precisely estimated. However, this does not affect the calculated wage and price elasticities presented in this section.

The partial derivative associated with the wage rate of men indicates that if the man earns one euro more he transfers 24.91 euro of his additional earnings to his wife. Given that men work, on average, 43.73 hours per week (see Table 1), this means that men transfer 59 percent of their additional earnings to their wives. When women earn one euro more, they transfer 5.91 euro of their additional earnings to the partner. Given that women work, on average, 32.85 hours per week, this means that 18 percent of their additional income is transferred to the partner. These results support the idea that women supply less labor hours when the wage of the partner increases because they are the ones who benefit the most from this wage increase (i.e. they receive 59 percent of the additional earnings).

The residual non-labor income,  $\tilde{y}$ , is a function of the household non-labor income and the expenditures on child care services, i.e.  $\tilde{y} = y - Q$ . Therefore, the partial derivative associated with the residual non-labor shows the impact of an increase in household non-labor income, after deducting child care expenditures, on the division of the residual non-labor income given to the man after sharing. The partial derivative indicates

that a one euro increase in the household residual non-labor income will increase the woman's income with 0.93 euro. This means that almost the entire amount is transferred to the woman. We emphasize, again, that the large standard errors indicate that the sharing rule parameters are not very precisely estimated, but nevertheless the estimates show that an increase in household non-labor income implies a money transfer that is more favorable for the woman. An explanation may be that women, on average, earn less income than their partners and that money transfers are made to realize an equal division of income. Another explanation is that the income transfers within the household are the result of women being the household manager. If women decide what commodities are bought for the household (such as food and clothing for the child) then she is the one who will effectively spend the income.

The partial derivative associated with the distribution factor shows that 30 euro is transferred to the woman if the man and the woman agree on who the income provider should be within the family.

**Child care price elasticities** The sharing rule in our model is a conditional sharing rule that represents how parents divide the non-labor income conditional on the expenditures on child care services. Therefore, child care expenditures influence the individual labor supplies only through the residual non-labor income. This residual non-labor income is defined as  $\tilde{y} = y - Q$  and because we observe the hourly prices of child care services we can also write it as  $\tilde{y} = y - p_c \cdot c$ , where  $c$  represents the hours of child care services. In Section 2, we mentioned that the existence of the conditional sharing rule does not guarantee the efficiency of public expenditures. In the empirical analysis we therefore assume that parents choose the hours of child care services efficiently, i.e.  $\tilde{y} = y - p_c \cdot c^*$ , where  $c^*$  stands for the efficient hours of child care services. We have that  $\frac{\partial \tilde{y}}{\partial p_c} = -c^*$  with  $c^* > 0$  and this means that a price increase of child care services lowers the residual non-labor income. The estimation results in Table 6 show that the estimation parameter belonging to  $\tilde{y}$  is negative and this corresponds with the idea that leisure is a normal good: the man and the woman replace labor hours by leisure hours when household non-labor income increases. It follows that an increase in the price of child care services has a positive effect on the individual labor supplies, because it lowers the residual income.

In Table 9 we show how the individual labor supplies react to price changes of child care services and assume that the efficient hours of child care services are not affected by this price change. The table shows the average child care price elasticities, but the results are comparable if we would show the median child care price elasticities.

Table 9: **Child Care Price Elasticities**

	Men		Women	
	Estimate	Std.Dev.	Estimate	Std.Dev.
$\frac{\partial h^m}{\partial \bar{y}} \frac{\partial \bar{y}}{\partial p_{care}} \frac{p_{care}}{h^m}$	0.013***	0.020	$\frac{\partial h^f}{\partial \bar{y}} \frac{\partial \bar{y}}{\partial p_{care}} \frac{p_{care}}{h^f}$	0.017*** 0.028

Note: \*/\*\*/\*\*\* statistically significant at the 10/5/1 percent level.

We find positive child care price elasticities for both the man and the women and we pointed out above why this is the case. The effect of a price increase of child care services on the individual labor supplies is minor. A lower household residual non-labor income as a result of a one euro price increase of child care services, which is equivalent to a price increase of 36 percent, implies that men and women supply 0.2 hours more paid labor.<sup>14</sup>

This is an interesting result from a policy perspective. It means that changing the price of child care services is a rather ineffective instrument to increase the labor supply of men and women. This is even more so because wage changes have more impact on the individual labor supplies than price changes in child care services. Also, the reported price elasticities of child care services in Table 9 are likely to be smaller because households receive tax allowance for child care services. On the other hand, we may find small price elasticities for child care services because we only consider two-earner households. The argument is similar to that of Blundell and MaCurdy (1998), Borjas (2002) and Cahuc and Zylberberger (2005) with respect to the wage elasticities, namely that the child care price elasticities are related to the choice of making use of child care services. For one-earner households, where the non-working partners have, on average, lower market wages, these price effects may therefore be larger.

## 6 Conclusion

In this study we contribute to the growing literature on collective models that incorporate children in four ways. First of all, we extend theory by allowing for a public child care good that incorporates the child care bought on the market. In this way we assume that parents allocate time to market activities, child care and leisure, which produces a more credible view on time allocation than in the usual approach that equates leisure to non-market time. The second contribution is that the use of a collective model allows us to examine how parents share the non-labor income minus the expenditures on child care services. The third contribution is that we examine how the individual labor supplies are affected by the expenditures of child

<sup>14</sup>For these predictions we used the price of formal child care which is on average 2.77 euro for the households in our sample.

care services. The fourth contribution is that we derive the wage and child care price elasticities from the estimation results, so that we obtain information on how the individual labor supplies react on wage changes and changes in the prices of child care. The latter is particularly interesting from a policy perspective as it reflects how subsidies (or taxes) targeted on different individuals within the household will affect labor supply.

The collective model that we estimate is identified by a distribution factor that gives information on the individual bargaining positions of the parents. Each parent is asked the following question: “*Who do you prefer to be the main income provider?*” and could choose between three answer categories: (1) I prefer the male; (2) I prefer the female; (3) I prefer that both parents are the main income providers. When both parents give the same answer, they are assumed to have similar preferences on who should be the main income provider in the household. However, when parents give different answers, we assume that it reflects a difference in preference on the roles that each parent should have within the household.

We find that the individual wages, the non-labor income and the distribution factor enter the labor supply demand functions significantly. The distribution factor influences the labor supply of women positively and influences the labor supply of men negatively. It implies that women work less labor hours and men work more labor hours if the parents opinions on who should be the main income provider are aligned. The amount of non-labor income that is left after deducting the costs of child care services influences labor supply negatively. This result corresponds with the idea that leisure is a normal good: the man and the woman replace labor hours by leisure hours when the residual non-labor income increases.

To evaluate the wage effects on the individual labor supplies we determine the wage elasticities. For both men and women, we find small negative wage elasticities meaning that men and women tend to supply less paid labor when their wage rate increases. Compared to other empirical labor supply studies for Belgium, we conclude that we find less negative wage elasticities (see, for example, Kesenne, 1983 and Vermeulen, 2005). For western countries in general, usually positive wage elasticities are found for women, but Blundell and MaCurdy (1998), Borjas (2002) and Cahuc and Zylberberger (2005) argue this is related to the participation decision of these women and that it is not so clear what the wage elasticity is for women who are already participating in paid labor.

The cross-wage elasticity is positive for men and negative for women. This means that men supply more labor hours if the hourly wage of his partner increases, while women supply less labor hours if the hourly wage of her partner increases. Moreover, we find the individual labor supplies react more to a change in the persons own wage rate than to a change in the partners wage rate, and this holds especially for men.

With respect to how parents share the residual non-labor income, i.e. the non-labor income minus the expenditures on child care services, we find the following results. In general our results show that an increase in the residual non-labor income is transferred mainly to the female partner. If the man would earn one euro more per hour, he transfers 59 percent of his additional earnings to the partner. For woman we find that if she would earn one euro more per hour, she transfers 18 percent of her additional earnings to her partner. If the residual non-labor income increases with one euro, then this amount is almost entirely being transferred to the female partner. An explanation for why an increase in the household non-labor income implies a money transfer that is more favorable to the female partner may be that women, on average, earn less income than their partners and that a more equal division of income is realized through the money transfer. Another explanation is that the income transfers within the household are the result of women being the household manager. If women decide what commodities are bought for the household (such as food and clothing for the child) then she is the one who will effectively spend the income.

The price effects of child care services on the individual labor supplies are measured through the residual non-labor income. Because leisure is a normal good, parents replace labor hours by leisure hours when the residual non-labor income increases. An increase in child care expenditures reduces the residual non-labor income and therefore we would expect positive price effects of child care services. We find positive, but very small child care price elasticities for both the man and the women. A lower household residual non-labor income as a result of a one euro price increase of child care services, which is equivalent to a price increase of 36 percent, implies that men and women supply 0.2 hours more paid labor.

This is an interesting result from a policy perspective. It means that changing the price of child care services is a rather ineffective instrument to increase the labor supply of men and women. This is even more so because wage changes have more impact on the individual labor supplies than price changes in child care services. Also, the calculated price elasticities of child care services are likely to be smaller because we did not consider the fact that households receive tax allowance for child care services.

## Appendix A

In this appendix, we show that productive efficiency requires the individual child care supply functions to depend on wages, just like labor supply. Let us consider the Lagrangian maximand  $\mathcal{L}$  using the maximization program in 5, i.e.  $\max_{h^s, c^s} U^s(u^s(X^s, 1 - c^s - h^s), H, Q)$ . By assuming interior solutions, we can disregard the time constraints so that the Lagrange multiplier is attributed to the budget constraint  $X^s = w_s \cdot h^s + \rho^s$ .

The first order conditions then write:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial h^s} &\equiv -\frac{\partial U^s}{\partial u^s} \frac{\partial u^s}{\partial h^s} - \lambda w_s = 0 \\
\frac{\partial \mathcal{L}}{\partial c^s} &\equiv -\frac{\partial U^s}{\partial u^s} \frac{\partial u^s}{\partial c^s} + \frac{\partial U^s}{\partial H} \frac{\partial H}{\partial c^s} = 0 \\
\frac{\partial \mathcal{L}}{\partial \lambda} &\equiv X^s - w_s h^s - \rho^s = 0
\end{aligned} \tag{A.1}$$

From  $\frac{\partial \mathcal{L}}{\partial h^s}$  and  $\frac{\partial \mathcal{L}}{\partial c^s}$  it follows that the disutility of one time-unit of paid labor is equal to that of one time-unit of child care, in the sense that both have an equal and negative impact on the remaining leisure time. Consequently, we have that  $-\lambda w_s = \frac{\partial U^s}{\partial H} \frac{\partial H}{\partial c^s}$  and so the marginal utility contribution of individual child care time equals the marginal utility contribution of labor time in the optimum. As such (and in our specific case of an interior solution) the exogenous individual wage rate determines both the optimal amount of working time and care time.

## Appendix B

Based on Chiappori et al. (2002), we show in this appendix the conditions that are imposed by the collective labor supply model. For this exposition we assume that there is only one distribution factor,  $d$ . Consider again the restricted labor supply functions of both parents:

$$\begin{aligned}
h^m &= \Lambda^m(w_m, \rho(w_m, w_f, \tilde{y}, d)) \\
h^f &= \Lambda^f(w_f, \tilde{y} - \rho(w_m, w_f, \tilde{y}, d)),
\end{aligned} \tag{B.1}$$

and define  $A = h_{w_f}^m / h_{\tilde{y}}^m$ ,  $B = h_{w_m}^f / h_{\tilde{y}}^f$ ,  $C = h_d^m / h_{\tilde{y}}^m$ ,  $D = h_d^f / h_{\tilde{y}}^f$ , whenever  $h_{\tilde{y}}^m \cdot h_{\tilde{y}}^f \neq 0$ . We now follow the proposition from Chiappori et al. (2002):

**Proposition 1** *Take any point such that  $h_{\tilde{y}}^m \cdot h_{\tilde{y}}^f \neq 0$ . Then*

(i) *If there exists exactly one distribution factor, and it is such that  $C \neq D$ , the following conditions are necessary and sufficient for any pair  $(h^m, h^f)$  to be solutions of the program in (4) for some sharing rule  $\rho$ :*

$$\frac{\partial}{\partial d} \left( \frac{D}{D-C} \right) = \frac{\partial}{\partial \tilde{y}} \left( \frac{CD}{D-C} \right) \tag{B.2}$$

$$\frac{\partial}{\partial w_m} \left( \frac{D}{D-C} \right) = \frac{\partial}{\partial \tilde{y}} \left( \frac{BC}{D-C} \right) \tag{B.3}$$

$$\frac{\partial}{\partial w_f} \left( \frac{D}{D-C} \right) = \frac{\partial}{\partial \tilde{y}} \left( \frac{AD}{D-C} \right) \tag{B.4}$$

$$\frac{\partial}{\partial w_m} \left( \frac{CD}{D-C} \right) = \frac{\partial}{\partial d} \left( \frac{BC}{D-C} \right) \quad (\text{B.5})$$

$$\frac{\partial}{\partial w_f} \left( \frac{CD}{D-C} \right) = \frac{\partial}{\partial d} \left( \frac{AD}{D-C} \right) \quad (\text{B.6})$$

$$\frac{\partial}{\partial w_f} \left( \frac{BC}{D-C} \right) = \frac{\partial}{\partial w_m} \left( \frac{AD}{D-C} \right) \quad (\text{B.7})$$

$$h_{w_m}^m - h_{\bar{y}}^m \left( h^m + \frac{BC}{D-C} \right) \left( -\frac{D-C}{C} \right) \geq 0 \quad (\text{B.8})$$

and

$$h_{w_f}^f - h_{\bar{y}}^f \left( h^f - \frac{AD}{D-C} \right) \left( -\frac{D-C}{C} \right) \geq 0. \quad (\text{B.9})$$

(ii) Assuming that conditions (B.2)-(B.9) hold and for a given  $d$ , the sharing rule is defined up to an additive function  $\kappa(z)$  depending only on the preference factor  $z$ . The partial derivatives of the sharing rule with respect to wages, non-labor income and the distribution factor are given by:

$$\rho_{\bar{y}} = \frac{D}{D-C} \quad (\text{B.10})$$

$$\rho_d = \frac{CD}{D-C} \quad (\text{B.11})$$

$$\rho_{w_m} = \frac{BC}{D-C} \quad (\text{B.12})$$

$$\rho_{w_f} = \frac{AD}{D-C}. \quad (\text{B.13})$$

if there are several distribution factors ( $k = 1, \dots, K$ ), an additional set of necessary and sufficient conditions are:

$$\frac{C_k}{D_k} = \frac{C_1}{D_1}, \quad k = 2, \dots, K. \quad (\text{B.14})$$

Moreover, the partial derivative of the sharing rule with respect to the additional distribution factors are given by:

$$\rho_{d_k} = \frac{C_k D_k}{D_k - C_k}, \quad k = 2, \dots, K. \quad (\text{B.15})$$

For the proof we refer to Appendix A and B in Chiappori et al. (2002).

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