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IZA DP No. 5113

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August 2010

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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ABSTRACT

Efficient Intra-Household Allocation of Parental Leave*

We propose a model of how parents resolve conflicts about sharing the negative short and long-term consequences from parenthood-related career interruptions on earnings. We introduce childcare sharing in a collective model of household behavior with public consumption as in Blundell, Chiappori, and Meghier (2005). Conceptually, the solution to the household problem can be thought of as a two-stage process: Parents first agree on public expenditures on professional childcare; then, conditional on the level of public consumption and the budget constraint stemming from stage one, parents determine their individual job absence durations and private consumption shares. Using relative income measures from German parental benefit data as distribution factors, we find evidence for Pareto efficiency in childcare sharing. More precisely, households with higher total incomes purchase more professional childcare, and changes in distribution factors shift the conditional parental leave allocation in favor of the partner whose relative income increased.

JEL Classification: D13, J12, J13

Keywords: childcare, collective model, conditional sharing rule, intra-household allocation

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* The authors wish to thank David Card, Pierre-André Chiappori, David Jaeger, Patrick Kline, Fabian Lange, Monika Merz, Nora Reich, seminar participants at UC Berkeley, UPF Barcelona, SOLE-EALE Conference 2010, and IZA Bonn for very helpful discussions and comments. This paper was written while Juliane Parys was a visiting scholar at UC Berkeley. Its hospitality as well as financial support from the Ministry of Innovation, Science, Research, and Technology of NRW in Germany and the German Academic Exchange Service are gratefully acknowledged. Gregor Schwerhoff is grateful for financial support from the German Research Foundation. All remaining errors are our own.

1 Introduction

Long labor market absence after the birth of a child causes substantial and durable income and career drawbacks due to, e.g., forgone growth of human capital and a negative work commitment signal to the employer.[1] Traditionally, this has mainly been borne by mothers.[2] However, the intra-household allocation of childcare time, that conflicts with market work, is increasingly subject to discussion between parents. This applies especially to countries with generous parental leave legislations. We propose a model of how parents resolve conflicts about the sharing of income, career, and consumption penalties involved with parenthood.

Treating many-person households as a rational entity with a single set of goals has been rejected by many economists.[3] This is especially important for the present study as it aims to gain insight into the intra-household decision about parents' time allocation between childcare and labor market participation. As an alternative to unitary household models, Chiappori (1988, 1992) and Apps and Rees (1988) are the first who propose the most general form of a collective model of household behavior. It assumes that, however household decisions are made, the outcome is Pareto efficient. Browning and Chiappori (1998), Chiappori, Fortin, and Lacroix (2002), and Chiappori and Ekeland (2006) extend this model by including distribution factors that affect household decisions even though they do not have an impact on preferences nor on budgets directly. The existence of distribution factors is crucial for the testability of collective rationality. Blundell, Chiappori, and Meghir (2005) interpret the solution to the household problem as a two-stage process, where household members share what is left for private consumption after purchasing a public good.

The collective framework nests any axiomatic bargaining approach that takes efficiency as an axiom. For instance, the Nash bargaining solution can be expressed as a maximization of the product of individual surpluses. Each agent's surplus involves the agent's status quo value which varies with personal characteristics and distribution factors. As pointed out in Bourguignon, Browning, and Chiappori (2009), any efficient intra-household allocation can

[1] Some of the early references are Mincer and Polachek (1974) as well as Corcoran and Duncan (1979) among others. The importance of work experience for each spouse's acquisition of human capital is formalized in chapter 6 of Ott (1992).

[2] Ruhm (1998) reveals that brief parental leave periods (3months) have little effect on women's earnings, but lengthier leave (9 months or more) is associated with substantial and durable reductions in relative wages within Western European countries. Erosa, Fuster, and Restuccia (2002) find that fertility decisions generate important long-lasting gender differences in employment and wages that account for almost all the U.S. gender wage gap that is attributed to labor market experience.

[3] A convincing empirical example is Lundberg, Pollak, and Wales (1997).

be constructed as a bargaining solution for well-chosen status quo points.

Applications of the collective setting to parental leave sharing are still few in the literature. One example is Amilon (2007). She analyzes temporary leave sharing in Sweden in a non-cooperative bargaining model and finds a first-mover advantage for men due to an unexplained "cultural factor". In the empirical literature the effect of different parental benefit schemes across countries on parents' childcare time contributions has been analyzed. Ekberg, Eriksson, and Friebel (2005), e.g., evaluate the introduction of a "daddy month" in Sweden and find an increase of fathers' childcare time contribution, but no learning-by-doing effect for childcare.

In this study, we introduce childcare sharing into a collective model of household behavior with public consumption as in Blundell, Chiappori, and Meghir (2005). Our model intends to explain the intra-household allocation of childcare time and consumption while assuming Pareto-optimality of the outcome. Couples maximize a weighted household utility function. The Pareto weights have a clear interpretation as "distribution of power" parameters that depend on distribution factors. Bourguignon, Browning, and Chiappori (2009) provide testable restrictions based on the presence of such factors which we exploit to empirically distinguish between unitary and collective rationality in childcare allocation decisions.

The public good in our model is professional childcare, which parents can purchase in order to reduce the total parental leave duration of the household. The household decision process can be imagined to happen in two stages, where parents first agree on how much professional childcare to purchase, and then, conditional on the level of public good consumption and the budget constraint stemming from the first stage, determine their individual levels of private consumption and labor market participation at the second stage. The more a partner contributes to household income, the larger is his or her share of private consumption. Although income during leave is mainly replaced through parental benefit, both parents value labor market participation as an input to human capital that positively impacts their individual earnings and therefore their private consumption shares later in life.[4]

The model predicts that households with higher incomes purchase more professional childcare. Conditional on the level of public consumption, the parent with less power then takes relatively more leave time than the other. If we consider, e.g., a strengthening of one partner's Pareto weight in the household maximization problem through an increase in his or her

[4] We abstract from modeling different childcare qualities. Instead, we assume the child's well-being to give constant utility to both parents as long as appropriate childcare provision is continuously assured.

income, this allows him or her to shift some of the own leave duration to the other partner. The net effect on the other partner's leave time, however, is not straightforward. On the one hand, there is a wealth effect stemming from the household income increase, which allows the couple to purchase more professional childcare. On the other hand, the change in Pareto weights leads to a redistribution of leave time between parents.

Our model's empirical restrictions are then tested on German parental benefit data from 2007. The German legislation allows both parents to receive generous benefits that replace 67-100% of the average monthly net income from before the child's birth. Leave time allocation between parents is relatively flexible. The data reject unitary rationality in parental leave sharing. They cannot reject Pareto-efficiency of intra-household leave allocations. The data also confirm income effects on professional childcare use and leave durations.

The paper is organized as follows. Section 2 introduces a collective model of intra-household childcare and consumption sharing. An overview of the legal parental benefit situation in Germany in 2007 and a data description are provided in section 3. In Section 4 we empirically test our collective model and its predictions. The last section concludes.

2 A Collective Model of Parental Leave Sharing

2.1 Unitary versus Collective Household Models

For decades, most theoretical and applied microeconomic work involving household decision-making behavior has assumed that a household behaves as if it had a single set of goals. Following Browning and Chiappori (1998) we refer to them as "unitary" models. In the unitary household model the partners' utility functions represent the same preferences such that their joint utility is maximized under a budget constraint. More precisely, a weighted sum of utilities is maximized, but the weights are fixed. This does not take into consideration that spouses might have conflicting interests and that the degree to which they can influence household decisions might depend on individual characteristics.

Note that a model with individual utility functions and a weighted sum of these as the household utility function is formally a unitary model as long as the weights do not depend on factors that do not enter individual preferences nor the overall household budget constraint but do influence the decision process. Such variables are known as distribution factors.

In order to study the intra-household decision process on parental leave allocation we apply a "collective" setting as in Blundell, Chiappori, and Meghir (2005) to explicitly model the conflict of interests between partners. The key insight of such models is not that the household does not maximize some weighted household utility function, but rather that the weights do in general depend directly on distribution factors. The following description points out some basic differences between unitary and collective household models.

Figure 1 plots an attainable utility allocation between partners in a given situation. $\mu(\cdot)$ and $1-\mu(\cdot)$ denote the intra-household power of the man and the woman, respectively. Examples of distribution factors determining $\mu(\cdot)$ are relative income and alimony transfers that would be enforced in case of a separation or divorce. The maximum possible utility for each spouse is denoted $U_{\max}$. The curved line represents the Pareto frontier, the tangent line the indifference curve of a household planner who puts weight $\mu(\cdot)$ on the man's utility and weight $1-\mu(\cdot)$ on the woman's utility. If one partner's weight is strengthened, that spouse's utility is increased at the expense of the other partner.

Let us assume an increase in the woman's *relative* income leaving the level of total household income unchanged. In the unitary model a change in the source of income does not affect the intra-household allocation. Collective rationality, however, predicts a utility reallocation from the man to the woman through an increase in the woman's power $1-\mu(\cdot)$. Figure 2 demonstrates this effect.

We now consider an enlargement of the feasible set following, say, an increase in the woman's income. Figure 3 demonstrates the predictions of a unitary household model. There is a "wealth effect" (WE henceforth) reflected by an outward movement of the Pareto frontier. The unitary model predicts that point (U_{1m}, U_{1w}) is realized with higher individual utility levels for both partners. The new tangent's slope at (U_{1m}, U_{1w}) is the same as before at point (U_{0m}, U_{0w}), and both spouses get a constant share of the profit from the income increase.

In contrast to a unitary setting, the effects of an increase in the woman's income in a collective model are twofold. First, the Pareto frontier moves out, and second, the tangent slope changes in favor of the woman as her relative income increases. We refer to the latter as the "bargaining effect" (BE henceforth) which causes the woman's utility to increase more than the WE would predict. The man's utility increases because of the WE, but decreases due to the BE. Figure 4 is based on a collective setting where the BE dominates the WE.

2.2 Model Setup

Time allocation in our model concerns working time in a given period 1 right after the birth of a child. During working hours there are only two possible activities for parents: market work and childcare. A parent not going on leave is free for market work. Therefore, shortening leave time is equivalent to extending working time. Our model does not include any explicit measure of leisure, because we focus on the extensive margin of labor supply. Work experience is valued by both partners as an input to human capital accumulation. It increases own income and consequently the individual consumption share in the second period. In addition, a long leave period might imply career drawbacks as it signals weak work commitment to the employer.

Our model focusses on two main trade-offs involved with the intra-household allocation of parental leave. One major trade-off parents face concerns the consumption allocation between partners. Childcare provided by a parent him- or herself reduces that parent's market working time. Although income is replaced to a large extend through parental benefit during the leave period itself, parenthood-related job absence still involves an income penalty in the second period compared to a situation without any career interruption.

The second trade-off is between consumption during the period right after birth, when the child is very young and needs intensive care, and later. Parents can hire professional childcare such as nannies, daycare facilities, etc, in order to reduce the total household parental leave time. The more professional childcare parents purchase, the more it reduces the household's level of private consumption in period 1, but the more it also allows partners to reduce parenthood-related income and consumption drawbacks for the second period. The amount of public expenditures therefore determines the total amount of leave time the household needs to take. Given the central role of time use we begin by defining its allocation:

Time Constraints

In period 1, which are the T_1 months immediately after the birth of a child, each parent i has to allocate his or her time between market work h_i and leave time with income replacement through parental benefit b_i in order to provide childcare:

$$T_1 \quad = \quad h_i + b_i, \quad i \in \{m, w\} \ , \tag{1}$$

where $i = m$ indexes men and $i = w$ women. Permanent childcare needs to be guaranteed either by parents providing childcare themselves, denoted b_m and b_w, or by hiring professional childcare, denoted b_p, such that

$$T_1 = b_m + b_w + b_p \ . \tag{2}$$

Market work and childcare time are restricted by zero below and by T_1 above. For future reference, note that a woman can work on the labor market whenever she is not on leave, i.e. $h_w = T_1 - b_w$, and that a man's work time can be expressed as the time when either the woman is at home or professional childcare is hired, i.e. $h_m = b_w + b_p$.

Income and Budget Constraint

Monthly income is denoted w_{it}, where $i \in \{m, w\}$ denotes the spouse concerned and $t \in \{1, 2\}$ is the time period. Income of partner i in period t is consequently given by $w_{it}\ T_t$. In the first period, parents have two ways of using income. They can either consume private goods or purchase professional childcare at a monthly rate w_p. The latter is considered a public good which shortens the household's total leave duration. The level of public good consumption is denoted b_p. The couple's budget constraint is thus

$$c_{m1} + c_{w1} + b_p w_p = (w_{m1} + w_{w1})\ T_1 \ . \tag{3}$$

The right-hand side of the equation above implies that parental benefit is assumed to compensate for the most part of the immediate income loss parents encounter from going on leave. Our model therefore focusses on the long-term drawbacks from parenthood-related job absence and applies especially to countries with generous income replacement during leave through parental benefit. However, direct income reductions during parental leave could be easily reflected in the model through multiplying the monthly income of the parent on leave by an income-reduction factor λ with $0 \leq \lambda < 1$. $\lambda = 0$ reflects the situation of countries with unpaid parental leave, whereas our model assumes full income replacement, i.e. $\lambda = 1$.

Utility and Human Capital

Parents derive utility from consumption and from the well-being of their child. The utility derived from having a kid and its well-being explains a couples' demand for children. However, once the decision for a child has been made, the derived utility is constant[5] given that at least one appropriate person takes care of it. Thus, we model consumption in each

[5] See Chiappori and Weiss (2007) for an example of this assumption in the literature.

of the two periods as the variable to be maximized. The utility function is given as

$$U_i = U(c_{i1}, c_{i2}). \tag{4}$$

Our model of household behavior contains public and private consumption. Partners share what is left for private consumption after purchasing a public good. We argue that partners' individual contributions to household income strongly influence the intra-household distribution of power and therefore determine the individual private consumption shares. The higher a partner's contribution is, the more private goods he or she can consume.

The level of public consumption implicitly determines the amount of time parents can work on the market in order to accumulate human capital and raise future earnings. For the decision about both partners' individual consumptions shares, we focus on private consumption for two reasons: First, private consumption is especially important to both partners as it remains to a large extend even after a potential marital dissolution; second, we want to investigate the impact of the intra-household power distribution on consumption shares and public consumption is not affected by changes in the power allocation.

First-period monthly incomes w_{m1} and w_{w1} reflect the level of human capital from schooling and work experience acquired up to the child's birth. The income level in period 2 depends on the initial human capital reflected in first-period incomes, and on the amount of work experience acquired during period 1, or alternatively, on the work commitment signal to the employer by choosing the leave duration. We thus model consumption in the period 2 as a function of first-period experience and first-period income:

$$c_{i2} = c_2(h_i, w_{i1}). \tag{5}$$

Pareto Weights

Partners maximize a weighted sum of utilities. The resulting allocation of household resources is assumed to be Pareto optimal. The man's Pareto weight is denoted by $\mu(\mathbf{z}) \in [0, 1]$, that of the woman by $1 - \mu(\mathbf{z})$.[6] The weights reflect the power of each partner and depend on a Q-dimensional vector of distribution factors $\mathbf{z}$. Following Bourguignon, Browning, and Chiappori (2009) distribution factors are defined as variables that affect household decisions even though they do neither enter individual preferences nor the overall budget constraint.

[6] If $\mu(\mathbf{z}) = 1$ the household behaves as though the man always gets his way, whereas if $\mu(\mathbf{z}) = 0$ it is as though the woman were the effective dictator. For intermediate values, the household behaves as though each person has some decision power.

Examples from the literature for observable and unobservable distribution factors include relative incomes, relative physical attractiveness, and the local sex ratio. In the context of childcare, custody allocation and alimony transfers from the custody to the non-custody parent after divorce are further examples.

After an hypothetical divorce the custody parent would be exclusively responsible for childcare during the entire working time of period 1. The custody parent needs to go on leave whenever no professional childcare is purchased, i.e. $b_{\text{custody}} = T_1 - b_p$. The noncustody parent does not take any leave, i.e. $b_{\text{noncustody}} = 0$, but needs to make alimony transfers to the custody parent. However, alimony transfers do usually not fully compensate the custody parent for expenses on professional childcare and for negative impacts on future incomes due to long leave periods.[7] The custody parent's outside option is c.p. therefore economically worse than the non-custody parent's. Since it is usually the mother who obtains custody,[8] the amount of alimony transfers enters the man's power function negatively.

Assuming that $\mu(\mathbf{z})$ is known to be increasing in z_1, which could be, e.g., the man's relative income or relative physical attractiveness, and decreasing in z_2, e.g. the amount of alimony payments from non-custodial fathers to custodial mothers, we can write $\partial\mu(\mathbf{z})/\partial z_1 > 0$ and $\partial\mu(\mathbf{z})/\partial z_2 < 0$.

The man's relative income w_{m1}/w_{w1} as a distribution factor implies the Pareto weight $\mu(\mathbf{z})$ to be increasing in the man's monthly contribution to total household income w_{m1} and to be decreasing in the woman's contribution w_{w1}, i.e. $\partial\mu(\mathbf{z})/\partial w_{m1} > 0$ and $\partial\mu(\mathbf{z})/\partial w_{w1} < 0$.

2.3 Simple General Model

Function Specifications

In this section we impose only minimal assumptions on the utility functions. We focus on the consumption allocation between partners and consider the decision about professional childcare use as given, i.e. $b_p = \bar{b}_p$. For simplicity and without loss of generality we set $\bar{b}_p = 0$. Partial derivatives are denoted in parentheses in the upper index. The first derivative of utility function U with respect to its second argument, e.g., is denoted $U^{(0,1)}(\cdot,\cdot)$.

[7] Alimony transfers by the father help to reduce the inequality after divorce, but Bartfeld (2000), DiPrete and McManus (2000), Jarvis and Jenkins (1999), and Bianchi, Subaiya, and Kahn (1999) among others find that the economic situation of custodial-mother families is still dramatically worse than the economic situation of fathers after separation.

[8] In Germany in 2004, e.g., in 85% of cases it is the mother, where children live and who provides almost all childcare after marital dissolution (cf. Federal Statistical Office of Germany (2006, p. 39)).

Utility is increasing in consumption within each period, i.e. $U^{(1,0)}(c_1, c_2) > 0$ and $U^{(0,1)}(c_1, c_2) > 0$, with diminishing returns, i.e. $U^{(2,0)}(c_1, c_2) < 0$ and $U^{(0,2)}(c_1, c_2) < 0$. Cross partial derivatives are assumed to be zero, i.e. $U^{(1,1)}(c_1, c_2) = 0$. In practice, it suffices to assume cross period partial effects to be small in absolute terms.

Second-period consumption is increasing in first-period market work, i.e. $c_2^{(1,0)}(b, w_1) > 0$ as work experience positively impacts future earnings. Following standard modeling of human capital we assume market work experience during period 1 to enter human capital formation linearly or with diminishing returns, i.e. $c_2^{(2,0)}(b, w_1) \leq 0$. For simplicity we assume the functional forms of utility U and second-period consumption c_2 to be identical for both partners.

Maximization

Partners maximize a weighted sum of utilities such that the household problem reads

$$\begin{aligned} \max_{b_w,\, c_{w1}} \mathbb{L} \;:=\; \max_{b_w,\, c_{w1}} \;& [\mu(\mathbf{z})\, U[T_1(w_{w1} + w_{m1}) - c_{w1}, c_2(b_w, w_{m1})] \\ & +\; (1 - \mu(\mathbf{z}))\, U[c_{w1}, c_2(T_1 - b_w, w_{w1})]] \end{aligned} \tag{6}$$

s.t.

$$b_w \geq 0 \quad \text{and} \quad b_m = T_1 - b_w \geq 0\,.$$

See Appendix Appendix B: for the first- and second-order conditions.

Comparative Statics

The following two propositions focus on childcare sharing between parents after they have agreed on the level of public expenditures on professional childcare. Therefore, no WE appears. We start our analysis with the effect of distribution factors. Asterisks indicate solutions to the household maximization problem. Appendix Appendix B: provides the proofs.

Proposition 1

A distribution factor z_1 that increases a partner's Pareto weight decreases this partner's optimal leave duration and increases the leave duration of the spouse. The inverse holds for a distribution factor z_2 that decreases a partner's Pareto weight:

$$\text{(i)}\ \frac{\partial \mu(\mathbf{z})}{\partial z_1} > 0 \qquad \Rightarrow \qquad \frac{\partial b_w^*}{\partial z_1} > 0 \ \text{ and } \ \frac{\partial b_m^*}{\partial z_1} < 0$$

$$\text{(ii)}\ \frac{\partial \mu(\mathbf{z})}{\partial z_2} < 0 \qquad \Rightarrow \qquad \frac{\partial b_w^*}{\partial z_2} < 0 \ \text{ and } \ \frac{\partial b_m^*}{\partial z_2} > 0$$

This proposition shows that the intra-household parental leave allocation depends on the distribution of power between partners and therefore on distribution factors. Quite intuitively, the leave allocation changes in favor of the spouse who gains power.

For the second proposition we need to assume second-order effects on utilities to be such that

$$
\begin{array}{lcccc}
\text{(I)} & \dfrac{\partial^2 U_w}{\partial b_w\, \partial w_{w1}} & = & \dfrac{\partial^2\, U[c_{w1}, c_2(T_1 - b_w, w_{w1})]}{\partial b_w\, \partial w_{w1}} & \leq\ 0 \\
\text{(II)} & \dfrac{\partial^2 U_m}{\partial b_w\, \partial w_{1m}} & = & \dfrac{\partial^2\, U[T(w_{w1} + w_{m1}) - c_{w1}, c_2(b_w, w_{m1})]}{\partial b_w\, \partial w_{1m}} & \geq\ 0\,.
\end{array}
$$

Assumptions (I) and (II) might even be weakened as we only need $\partial\ \mathbb{L}^{(1,0)}/\partial\ w_{w1} < 0$ and $\partial\ \mathbb{L}^{(1,0)}/\partial\ w_{m1} > 0$ to hold.[9] However, the economic interpretation is clearer from the way the two assumptions are formulated. Assumption (I) basically states that the female's utility loss from another unit of labor market absence is (weakly) stronger, if her first-period income was higher. This implies that human capital depreciation is assumed to be (weakly) more severe for well-earning women. Assumption (II) means that the male's utility increase from one unit less of paternity leave is (weakly) stronger for well-earning men. Taken together, Assumptions (I) and (II) imply longer labor market absences to be more harmful for the professional career of people who are in a job with a higher initial income.

The two assumptions are necessary to exclude the following, unconvincing reaction to an income increase of one partner: Due to the BE the partner, who experienced the income increase, gets a stronger Pareto weight implying a higher utility level due to intra-household redistribution of resources; however, the utility increase from a shorter parenthood-related job absence becomes weaker (!) as income increases, and it becomes so much weaker that this effect overcompensates the utility increase from the BE.

Proposition 2

Under Assumptions (I) and (II) the optimal leave duration of each parent decreases when his or her own income increases. It increases when the partner's income increases. This means

$$
\begin{array}{llll}
\text{(i)} & \dfrac{\partial b_w^*}{\partial w_{w1}} < 0 & \text{(ii)} & \dfrac{\partial b_w^*}{\partial w_{1m}} > 0 \\
\text{(iii)} & \dfrac{\partial b_m^*}{\partial w_{m1}} < 0 & \text{(iv)} & \dfrac{\partial b_m^*}{\partial w_{w1}} > 0
\end{array}
$$

[9] See Appendix Appendix B: for the exact expressions.

Proposition 2 states that an income increase of one partner is accompanied by a stronger Pareto weight of this partner, and consequently leads to a shift of the intra-household leave allocation towards the other partner.

2.4 Extended Model

Maximization

Based on the setup from Section 2.2 we now want to allow parents to hire professional childcare during working hours in period 1 in order to shorten the total household parental leave duration. Daycare facilities etc. are considered a public good which parents can purchase in exchange for a lower level of first-period private consumption. Less labor market absence in period 1 reduces drawbacks for second-period earnings and therefore increases the level of private consumption in period 2. The level of expenditures on professional childcare in period 1 is equivalent with an intertemporal consumption allocation within the household.

The additional dimension in the household problem requires us to impose more structure on the functional forms. The utility functions of the partners are assumed to be given through

$$\begin{aligned} U_m &:= \log[(w_{m1}+w_{w1})T_1 - w_p b_p - c_{w1}] + \log[(b_w + b_p + h_{m0}) w_{m1} T_2] \\ U_w &:= \log[c_{w1}] + \log[(T_1 - b_w + h_{w0}) w_{w1} T_2] \ . \end{aligned}$$

where h_{i0} is work experience of spouse i from before period 1.

The couple's maximization problem reads

$$\max_{b_w, c_{w1}, b_p} \mathbb{L}' = \max_{b_w, c_{w1}, b_p} \ [\mu(\mathbf{z})\, U_m + (1-\mu(\mathbf{z}))\, U_w] \tag{7}$$

s.t.

$$b_w \geq 0, \quad b_p \geq 0, \quad \text{and} \quad b_m = T_1 - b_w - b_p \geq 0 \ .$$

Assuming for the moment that the non-negativity constraints are nonbinding, the first-order conditions can be solved:[10]

$$b_w^* = (1+\mu(\mathbf{z}))\, \frac{T_1 + h_{w0}}{2} - (1-\mu(\mathbf{z}))\, \frac{(w_{m1}+w_{w1})T_1 + w_p h_{m0}}{2 w_p} \tag{8}$$

$$c_{w1}^* = (1-\mu(\mathbf{z}))\, \frac{(w_{m1}+w_{w1})T_1 + w_p(T_1 + h_{m0} + h_{w0})}{2} \tag{9}$$

[10] See Appendix Appendix C: for the explicit expressions and details on the non-negativity constraints.

$$
\begin{aligned}
b_p^* &= -\frac{T_1 + h_{m0} + h_{w0}}{2} + \frac{(w_{m1} + w_{w1})T_1}{2w_p} && (10) \\
b_m^* &= T_1 - b_w^* - b_p^* \\
&= (2 - \mu(\mathbf{z}))\,\frac{T_1 + h_{m0}}{2} - \mu(\mathbf{z})\,\frac{(w_{m1} + w_{w1})T_1 + w_p h_{w0}}{2w_p}\;. && (11)
\end{aligned}
$$

Comparative Statics

The qualitative results from Propositions 1 and 2 remain valid such that we denote the first two results of this model as a variant of those from the previous section. Proofs for this section can be found in Appendix Appendix C:.

Proposition 1′

A distribution factor z_1 that increases a partner's Pareto weight decreases this partner's optimal leave duration and increases the leave duration of the spouse. The inverse holds for a distribution factor z_2 that decreases a partner's Pareto weight:

$$
\begin{aligned}
&\text{(i)}\ \frac{\partial \mu(\mathbf{z})}{\partial z_1} > 0 \quad \Rightarrow \quad \frac{\partial b_w^*}{\partial z_1} > 0 \text{ and } \frac{\partial b_m^*}{\partial z_1} < 0 \\
&\text{(ii)}\ \frac{\partial \mu(\mathbf{z})}{\partial z_2} < 0 \quad \Rightarrow \quad \frac{\partial b_w^*}{\partial z_2} < 0 \text{ and } \frac{\partial b_m^*}{\partial z_2} > 0
\end{aligned}
$$

Proposition 2′

The optimal leave duration of each parent decreases when his or her own income increases.

$$
\text{(i)}\ \frac{\partial b_w^*}{\partial w_{w1}} < 0 \qquad \text{(ii)}\ \frac{\partial b_m^*}{\partial w_{1m}} < 0
$$

The optimal leave duration of each parent increases when the partner's income increases iff the change in the "distribution of power" parameter is stronger than the effect on the household's budget, i.e.

$$
\begin{aligned}
&\text{(iii)}\ \frac{\partial b_w^*}{\partial w_{m1}} > 0 \quad \Leftrightarrow \quad \frac{\partial \mu(\mathbf{z})}{\partial w_{m1}} > \frac{1 - \mu(\mathbf{z})}{w_{m1} + w_{w1} + w_p(1 + \frac{h_{m0} + h_{w0}}{T_1})} \\
&\text{(iv)}\ \frac{\partial b_m^*}{\partial w_{w1}} > 0 \quad \Leftrightarrow \quad -\frac{\partial \mu(\mathbf{z})}{\partial w_{w1}} > \frac{\mu(\mathbf{z})}{w_{m1} + w_{w1} + w_p(1 + \frac{h_{m0} + h_{w0}}{T_1})}
\end{aligned}
$$

An increase in one partner's income has the following two effects. On the one hand, the level of public expenditures increases due the increase in household income, which reduces the total parental leave duration of the household. Spouses agree on the amount of professional childcare they want to hire based on their symmetric preferences with respect to the intertemporal private consumption allocation. This effect is reflected in Proposition 3. On the other hand, the power allocation inside the household, and therefore the parental childcare allocation, shifts in favor of the partner whose contribution to household income has increased. The cut-off parameter constellation for a longer leave duration of one partner as a net response to an increase in the other partner's income is provided in Proposition 2 $'$.

Proposition 3

The amount of professional childcare hired increases with total household income and is independent of distribution factors $\mathbf{z}$, *i.e. for all* $q = 1, \dots, Q$ *we have*

$$\text{(i)} \quad \frac{\partial b_p^*}{\partial(w_{m1} + w_{w1})} > 0 \qquad \textit{and} \qquad \text{(ii)} \quad \frac{\partial b_p^*}{\partial z_q} = 0 \ .$$

The previous propositions focus on changes in the composition of childcare sources. Proposition 4 states, in theoretical terms, how relative parental childcare shares compare depending on the intra-household distribution of power. When initial work experience from before period 1 and Pareto weights are equal, symmetric preferences imply an equal sharing of childcare responsibilities. If, however, one partner has more power inside the household, this partner turns out to bear the smaller share of parenthood-related income and career penalties.

Proposition 4

Consider a situation in which both partners have the same initial market work experience from before period 1, i.e. $h_{m0} = h_{w0}$. *In this case the mother takes a longer leave period than the father whenever* $\mu(\mathbf{z}) > \frac{1}{2}$.

Conditional on the level of household expenditures on professional childcare parents agreed on, the Pareto weight $\mu(\mathbf{z})$ determines the sharing rule of parental childcare between partners. If we assume $\mu(\mathbf{z})$ to be increasing in relative income, that is $z_1 = w_{m1}/w_{w1}$, and decreasing in the amount of alimony transfers after separation, then women are likely to take longer leave periods than men, i.e. $b_w^* > b_m^*$, (i) if women contribute relatively less than men to total household income, and (ii) if the alimony legislation does not enforce fully compensation of custody mothers for expenses on professional childcare and for negative impacts on their future incomes from long leave periods.

3 Legal Background and Data

3.1 The German Parental Benefit Legislation

In 2007 a modified parental benefit legislation has been introduced in Germany. The new law is known as "Elterngeld". The benefit is now directed to the parent going on leave in order to take care of the child and not, as it has been the case until 2006, to the household. In addition, both parents have become eligible for the benefit independent of the individual and household income. No parent is excluded for passing an income threshold. The main eligibility conditions are residence in Germany, less than 30 hours of weekly working time, and legal guardian status for the child concerned.

Under the new law, 67%-100% of the average monthly net income over the previous 12 months before applying for parental benefit is paid as a tax-free benefit to a parent on leave. A minimum monthly benefit amount of 300 EUR is paid even on top of unemployment benefits. An upper bound of 1,800 EUR per month corresponds to a monthly net income of 2,700 EUR. The amount of parental benefit is calculated from the individual income, so that two parents with different incomes receive different amounts. If a parent chooses to go on leave only part time, the monthly benefit is calculated based on the amount of net-income reduction. When a parent's net income is less than 1,000 EUR, the percentage paid as benefit exceeds 67%, and reaches 100% for low incomes. The maximum total benefit duration per family is 14 months, but each parent can at most go on paid leave for 12 months. Unpaid leave with job protection is possible thereafter for another 24 months. In order to exploit the full 14 months of paid leave, each parent has to stay at home for at least two months.[11]

Before 2007, the amount of parental benefit was not relative to net income. It also provided only one parent per birth with a fixed amount of 300 EUR per month, and only if the household's income was below a certain threshold. We do not observe whether only one or both parents went on leave. As a consequence, pre-2007 parental benefit data do not contain individual income information. In addition, there is no information available on the parent who did not apply for benefit.

[11] Single parents with exclusive custody of the child can go on paid leave for up to 14 months.

3.2 Data

In Germany in 2007, 675,886 women gave birth to 684,862 children, including multiple births. Since it is the country of domicile of the legal parents that determines entitlement to parental benefit, this figure gives a close estimate of the number of households who could go on paid leave. For 658,389 births and 669,139 children a parental benefit application has been approved, meaning that at least one month of benefit has been paid. Therefore, about 97.5% of all births in 2007 appear in the administrative parental benefit statistic. One reason why parents might not go on paid leave is that they continue working with more than 30 hours per week or that the family moved abroad after having given birth in Germany.

For our analysis, we use two different datasets. The first is a survey on young families, conducted by the Rhine-Westphalia Institute for Economic Research Essen (2008). Between May and June 2008 and 2009 the survey was conducted on parents whose youngest child has been born between January and April 2007. Mothers were interviewed and provided information on themselves and on their partners if applicable. The survey contains direct information on individual net income, employment sector, educational attainment, and on the use of daycare facilities as components of a rich set of personal characteristics. Summary statistics of all variables used in our analysis are provided in Table 1. The RWI survey provides information also on parents who did not receive any benefit. It covers 4,177 randomly selected married and cohabiting hetero- and homosexual couples.

Our second data source is a random 65% subsample of the complete parental benefit statistic 2007 provided by the Federal Statistical Office of Germany (2008). This administrative dataset contains information about parents who received benefit for at least one month. This, however, also means that complete information about both parents of a child is only available if both received parental benefit. For 35,938 out of 417,832 households in the full sample both parents are observed.[12]

One drawback of the official parental benefit statistic is that the both-parents sample is likely to be highly self-selected. In addition, it contains only indirect income information. A censored net income variable can be calculated unambiguously from the benefit amount. Income information is not informative for those parents having used the option to reduce income, which allows parents to reduce working hours to less than 30 hours per week. The

[12] See also Table 2.

benefit is then calculated from the amount by which income has been reduced, and accurate income information cannot be obtained. However, 28,481 couples remain, for whom income information is available. The second drawback of the parental benefit statistic is that it does not contain data on parents' employment sector, educational background, or the use of daycare facilities. This is in contrast to the RWI survey.

The two datasets used for our empirical analysis are complementary, and both have advantages that are important for the questions analyzed. The RWI survey contains rich information on parents' personal characteristics. It allows to specify the regression models used to explain parental leave durations and professional childcare use substantially better than the administrative data. The parental benefit statistic, on the other hand, provides information for a large number of parents without the potential problems of self-reported data, i.e. wrong information due to misunderstandings and non-random missing information. The large number of observations allows a representative description of the parental benefit use for children born in 2007 in Germany. We combine the advantages of both datasets by giving descriptive figures based on the parental benefit statistic, and by focussing on the RWI survey for all regressions in section 4.[13]

Tables 2 to 6 provide an overview of the parental benefit use for children having been born in Germany in 2007. Table 2 reveals that only 8.6% of parents both make use of the benefit. In 86.7% of the families only the mother goes on paid leave. Not only do few fathers take paternity leave at all, fathers on leave also take shorter periods off than mothers. Only 5.3% of total parental benefit time is taken by fathers. The corresponding distribution of parental leave time is provided in Table 3. Corner solutions (2 or 12 months) are a favorite for both genders. However, it also becomes clear that a considerable number of parents do not opt for a corner solution.

Table 4 illustrates the average monthly net income of parents in the year before their child has been born by the number of children in the household, including the newborn child. With every additional child the average income of mothers is significantly lower. The reason is mainly an increasing propensity to stay out of the labor market with every additional child. Mischke (2009, p. 48) provides evidence that the employment rate of women decreases from 75.6% for mothers with one child to 49.9% for mothers with three or more children in Germany in 2007. Men's employment rate is not much influenced by the number of children

[13] Regression results based on the parental benefit statistic are available from the authors upon request.

and drops just slightly from 90.7% to 88.3%. Income effects go in the same direction. For fathers, the relative decrease in income means is not as severe.

Net income in the parental benefit statistic is left-censored at 300 EUR and right-censored at 2,700 EUR. Tables 5 and 6 compare the parental benefit duration of parents earning at most 300 EUR to parents with an income of 2,700 EUR or more. Relatively well-earning parents tend to shorten their leave period compared to parents with lower income.

4 Empirical Results

4.1 Econometric Method

In order to investigate the intra-household allocation of parental leave we regress maternity and paternity leave durations on a number of individual and household characteristics. Importantly, we assume the underlying variables to be continuous while we do only observe a discrete number of full parental benefit months. These numbers are non-negative integers with an upper bound at 12 in the considered cohort of cohabiting or married couples.

We follow an approach by Papke and Wooldridge (1996), who introduce a quasi-maximum likelihood estimator (QMLE henceforth) based on the logistic function in order to estimate fractional response models. This estimator is consistent and $\sqrt{N}$-asymptotically normal regardless of the distribution of the dependent variable conditional on the regressors. The explained variable can be continuous or discrete, but is restricted to the unit interval $[0, 1]$. According to Wooldridge (2002) rescaling a variable that is restricted to the interval $[a, b]$, where $a < b$, using the transformation $(b_{in} - a)/(b - a) =: \widetilde{h}_{in}$ does not affect the properties of their QMLE approach. Hereby, $i \in \{w, m\}$ and $n = 1, 2, \ldots, N$ is a household index. For the subsequent fractional logit regressions we rescale the parental benefit durations setting $b = 12$ and $a = 0$. For comparability, also in the benchmark OLS estimations leave durations are rescaled.

$\mathbf{x}_{in}$ is the $1 \times K$ vector of explanatory variables from observation i with one column being equal to unity. Although $\mathbf{x}_{wn}$ might be different from $\mathbf{x}_{mn}$ in reality, we assume equality of the two for simplicity. Papke and Wooldridge (1996) assume that, for all n,

$$\mathbb{E}[\widetilde{h}_{in}|\mathbf{x}_n] = G(\mathbf{x}_n\delta) \ . \tag{12}$$

The linear specification assumes $G(\mathbf{x}_n\delta) = \mathbf{x}_n\delta$ whereas in the non-linear fractional response model $G(\cdot)$ is chosen to be the logistic function $G(\mathbf{x}_n\delta) = \exp\{\mathbf{x}_n\delta\}/(1 + \exp\{\mathbf{x}_n\delta\})$ that satisfies $0 < G(\cdot) < 1$. QMLE is shown to be consistent as long as the conditional mean function (12) is correctly specified. For the non-linear fractional response model Papke and Wooldridge (1996) suggest to maximize the Bernoulli log-likelihood function

$$l_{in}(\delta) \equiv \widetilde{h}_{in} \log[G(\mathbf{x}_n\delta)] + (1 - \widetilde{h}_{in}) \log[1 - G(\mathbf{x}_n\delta)]$$

following McCullagh and Nelder (1989).

We begin our empirical analysis with the linear model as a benchmark, which we estimate by OLS with White (1980) heteroskedasticity-robust standard errors. We then estimate non-linear fractional response models based on the logistic function.

4.2 Tests of Unitary versus Collective Rationality in Childcare Sharing

Bourguignon, Browning, and Chiappori (2009) provide a characterization of testability in the collective framework when only cross-sectional data without price variation is available. They develop a necessary and sufficient test of the Pareto-efficiency hypothesis. The collective setting encompasses all cooperative bargaining models that take Pareto optimality of allocations as an axiom. The presence of distribution factors is crucial as their influence on behavior provides the only testable restrictions of the collective model.

This paper considers a version of the collective model where professional childcare use is considered a collective good that reduces total household leave time. Both parents try to minimize the time they stay absent of the labor market in order to minimize career drawbacks. Since there is no price variation in professional childcare in our data, we can normalize w_p to unity in the budget constraint (3). Each partner has preferences represented by (4). The arguments of the utility function affect preferences directly and are referred to as “preference factors” following Bourguignon, Browning, and Chiappori (2009).

Observable preference factors in the following estimations include parents’ employment sector and educational attainment, their age, regional location, citizenship, and the number and age of children. As empirically established in, e.g., Schultz (1990) or Thomas (1990), we consider relative income and partner-specific contributions to total household income as observable distribution factors. Unobservable preference and distribution factors go into the statistical error term ε_{in} and are assumed to be orthogonal to all observable characteristics.

The solution to maximization problem (6) implies that both partners have a demand for the good "working time in period 1" as an input to future consumption. As a consequence, partners want to minimize the "bad" leave time in period 1, denoted b_{mn} and b_{wn}. Parents' leave duration and professional childcare use are estimated as functions of the observable distribution factor relative income while controlling for monthly total household income y_n,[14] of total parental leave duration $b_{\text{tot}} = b_{mn} + b_{wn}$, and of further individual and household characteristics, denoted by vector $\mathbf{a}_n$:

$$\mathbb{E}[\widetilde{h}_{in}|\mathbf{x}_n] = G\left(\alpha_{i0} + \alpha_{i1}\frac{w_{m1n}}{w_{w1n}} + \alpha_{i2}y_n + \alpha_{i3}b_{\text{tot}} + f_i(\mathbf{a}_n)\right) \qquad \forall\, i \in \{m, w, p\} \, .$$

Testing for Unitary Rationality

The first testable implication comes from Proposition 1 in Bourguignon, Browning, and Chiappori (2009). Accordingly, the demands for leave time are compatible with unitary rationality if and only if

$$\alpha_{i1} = 0 \qquad \forall\, i \in \{m, w, p\} \, .$$

This means that in the unitary framework, the impact of distribution factors on parental leave durations and professional childcare use should be zero once we control for total household income and preference factors.

Table 7 reveals that the impact of the distribution factor relative income on the maternity and paternity leave duration is significantly different from zero in each of the two estimations, and also jointly across the two models. If leave time was split between parents based on unitary rationality, the source of income should not affect the sharing rule once we control for the level of household income. Table 7 therefore provides evidence against unitary rationality in parental leave sharing.

The decision to hire professional childcare, however, does not depend on relative income, but only on total household income as can be seen in Table 9. This finding confirms the expression we obtained for b_p^* in equation (10), where only joint household income but no distribution factors enter. Although all decisions happen simultaneously, one can think about the decision mechanism as the following. Somebody needs to take care of the child at all times. We consider maternal, paternal, and professional childcare as possible sources. Parents

[14] As we only observe two sources of income, we have $y_n = w_{m1n} + w_{w1n}$.

first decide, based on total household income, on whether to use professional childcare in order to reduce the amount of total parental leave $b_m + b_w$. By choosing the amount of professional childcare hired, the amount of the public good "total labor market working time" is determined at the same time. Once the optimal total leave duration has been chosen, the between-parents leave sharing then depends on the intra-household distribution of power.

It might still be claimed that relative income provides a measure for potential drawbacks from job absence of both partners and therefore enters preferences directly. So far we are not able to completely rule this argument out. However, in the following we provide further pieces of evidence for the plausibility of collective rationality in parental leave sharing.

Testing for Pareto Optimality

The central assumption for the allocation of private goods in collective models is that the intra-household decision process leads to a Pareto-efficient outcome. This is what Bourguignon, Browning, and Chiappori (2009) refer to as "collective rationality". We consider a second specification with partner-specific contributions to household income as distribution factors in order to test for Pareto-efficiency in the allocation of parental leave:

$$\mathbb{E}[\widetilde{h}_{in}|\mathbf{x}_n] = G\left(\beta_{i0} + \beta_{i1} w_{m1n} + \beta_{i2} w_{w1n} + \beta_{i3} b_{\text{tot}} + f_i(\mathbf{a}_n)\right) \qquad \forall\, i \in \{m, w\}\ . \tag{13}$$

In the collective framework changes in partner-specific incomes affect household demands and therefore allocation decisions. The main testable prediction of collective rationality based on variation in distribution factors follows from Proposition 2 of Bourguignon, Browning, and Chiappori (2009), which has become know as the proportionality condition. Intuitively, the proportionality condition implies that the effect of distribution factors on the optimal leave duration is proportional to the influence of the distribution factors on the intra-household "distribution of power" function, i.e.

$$\frac{\partial\, \mu(\mathbf{z})/\partial\, w_{m1}}{\partial\, \mu(\mathbf{z})/\partial\, w_{w1}} = \frac{\beta_{i1}}{\beta_{i2}} \qquad \forall i \in \{m, w\}\ .$$

Since the proportionality condition holds for both, maternity and paternity leave durations, the ratio of partial derivatives needs to be equal for both.

The proportionality condition implies that the ratio of partial derivatives of each good with respect to each distribution factor conditional on aggregate household resources is equal across all goods. If we additionally assume the man's weight $\mu(\mathbf{z})$ to be increasing in his own income w_{m1}, and to be decreasing in his partner's income w_{w1}, then the demand functions consistent with any bargaining model are such that

$$\frac{\beta_{m1}}{\beta_{m2}} = \frac{\beta_{w1}}{\beta_{w2}} \leq 0 \ . \tag{14}$$

Bourguignon, Browning, and Chiappori (2009) have recently shown that the proportionality condition is necessary and sufficient for Pareto efficiency. Table 8 shows that the ratio equality above cannot be rejected. In addition, the ratios are jointly significantly different from zero and negative in both models. These results provide further evidence for collective rationality in parental leave sharing. The parent who contributes more to household income does c.p. have more intra-household power which puts him or her in the position to shift a bigger leave time share to the partner.

Testing the impact of distribution factors on parental leave durations and the proportionality condition requires the joint estimation of the system of parental leave equations which allows for disturbance term correlations across equations. We then need to test linear and nonlinear cross-equation restrictions over the parameter estimates of the distribution factors. Unfortunately, Wald tests tend to overreject the null hypothesis in system OLS and seemingly unrelated regression models. In addition, nonlinear Wald test statistics are invariant to reformulations of the null. We follow Bobonis (2009) for both issues. First, we present p-values from the bootstrap percentile interval of the test statistic, which has been shown to significantly reduce the overrejection bias in this setting. Second, we assess the robustness of our inferences by constructing linear Wald tests as described below in Robustness Checks Part 1 and 2.

Robustness Checks Part 1: Assuming that Only Relative Income Matters

As a robustness check for the proportionality condition we might further assume that only relative income w_{m1}/w_{w1} matters. We can then estimate

$$\mathbb{E}[\widetilde{h}_{in}|\mathbf{x}_n] = G\left(\gamma_{i0} + \gamma_{i1}\log(w_{m1n}) + \gamma_{i2}\log(w_{w1n}) + \gamma_{i3}y_n + \gamma_{i4}b_{\text{tot}} + f_i(\mathbf{a}_n)\right) \qquad \forall\ i \in \{m, w\}$$

and test whether

$$\gamma_{i1} + \gamma_{i2} = 0 \qquad \forall\ i \in \{m, w\}\ .$$

Table 10 provides further pieces of evidence for Pareto optimality in parental leave sharing as the proportionality tests can again not reject the proportionality hypothesis.

Robustness Checks Part 2: Testing based on z-Conditional Demands

Further testable implications come from an alternative demand system that is consistent with collective rationality. It follows from the effect of distribution factors on the intra-household allocation being one-dimensional which is implied by the proportionality condition. Independent of the number of distribution factors they can influence the parental leave allocation among parents only through a single, real-valued function $\mu(\mathbf{z})$. The demand for one good can therefore be expressed as a function containing the demand for another good as an argument.

Bourguignon, Browning, and Chiappori (2009) introduce z-conditional demands which are useful to resolve, e.g., the empirical difficulty of non-linear Wald test statistics being noninvariant to reformulations of the null hypothesis. We follow Bobonis (2009) and construct linear Wald tests based on parametric versions of the z-conditional demand functions in order to assess the robustness of our previous results to reformulations of the null hypotheses.

The idea of z-conditional demands is demonstrated in the following for $G(\cdot)$ being the logistic function. Under the assumption that the man's first-period contribution to household income w_{m1n} has a strictly monotone influence on his and her optimal leave duration, we can invert (13):

$$\begin{aligned} w_{m1n} &= \frac{1}{\beta_{i1}} \log\left(\frac{\widetilde{h}_{in}}{1-\widetilde{h}_{in}}\right) - \frac{\beta_{i0}}{\beta_{i1}} - \frac{\beta_{i2}}{\beta_{i1}}\, w_{w1n} - \frac{\beta_{i3}}{\beta_{i1}}\, b_{\text{tot}} \\ &\quad - \frac{1}{\beta_{i1}}\, f_i(\mathbf{a}_n) - \frac{1}{\beta_{i1}}\, \varepsilon_{in} \qquad \forall\, i \in \{m, w\}\ . \end{aligned}$$

As total household leave duration is simply the sum of maternity and paternity leave time, we can replace b_{tot} by $b_{in} + 12\widetilde{h}_{jn}$. For parent j with $j \in \{m, w\}$ and $j \neq i$, we can substitute the above equation into (13) to obtain

$$\begin{aligned} \mathbb{E}[\widetilde{h}_{jn}|\mathbf{x}_n] &= G\ \Bigg(\frac{1}{\beta_{i1}(1-12\beta_{j3}) + 12\beta_{i3}\beta_{j1}}\, [\ (\beta_{i1}\beta_{j0} - \beta_{i0}\beta_{j1}) + (\beta_{i1}\beta_{j2} - \beta_{i2}\beta_{j1})\ w_{w1n} \\ &\quad + (\beta_{i1}\beta_{j3} - \beta_{i3}\beta_{j1})\ b_{in} + \beta_{j1}\ \log\left(\frac{\widetilde{h}_{in}}{1-\widetilde{h}_{in}}\right) + (\beta_{i1}\ f_j(\mathbf{a}_n) - \beta_{j1}\ f_i(\mathbf{a}_n))\ ]\Bigg)\ . \end{aligned}$$

An important remark is that if $G(\cdot)$ is linear total household leave duration becomes redundant once we control for the partner's leave duration and

$$\mathbb{E}[\widetilde{h}_{jn}|\mathbf{x}_n] \;=\; \frac{1}{\beta_{i1}(1-12\beta_{j3})+12\beta_{i3}\beta_{j1}} \,[\,(\beta_{i1}\beta_{j0}-\beta_{i0}\beta_{j1})+(\beta_{i1}\beta_{j2}-\beta_{i2}\beta_{j1})\;w_{w1n}$$
$$+(\beta_{i1}\beta_{j3}-\beta_{i3}\beta_{j1})\;b_{in}+(\beta_{i1}\;f_j(\mathbf{a}_n)-\beta_{j1}\;f_i(\mathbf{a}_n))+(\beta_{i1}\;\varepsilon_{jn}-\beta_{j1}\;\varepsilon_{in})\,]\,.$$

Benchmark OLS and fractional logit regression results are provided in Table 11. As expected we find that the mother's contribution to total household income has no significant impact on either maternity or paternity leave duration anymore once we control for the partner's leave duration. This must be true if the collective model is correct as the father's contribution to household income as one distribution factor already absorbs the one-dimensional effect of all distribution factors together on parental leave sharing.

Robustness Checks Part 3: Restricted Sample and Tobit Estimations

A concern might be that in those families who already had children before the most recent child, parents might have specialized in different activities. Mothers might have provided the larger share of childcare already for the older children and is therefore relatively more productive in childcare provision than the man. In that sense the lower market wage of women reflects their specialization in household production and not their lower intra-household power.

In order to address this concern we restrict our sample to families without any older children, which reduces the sample to roughly one half of the full sample. We redo the fractional logit estimations of Tables 7 and 8 and can confirm our findings from before. Unitary rationality in parental leave sharing can be rejected for families without older children, whereas Pareto optimality cannot be rejected.

These findings can also be confirmed when we estimate Tobit models with a lower censoring at 0 and an upper censoring at 12 parental benefit months. In addition, the magnitudes of the coefficients are larger in absolute terms than in the fractional logit regressions as we focus on interior solutions.[15] Families that do not opt for a corner solution, i.e. where each partner takes some positive leave time, are likely to react stronger to a change in relative incomes compared to partners opting for a corner solution as the decision to temporarily drop out of the labor market has been done by both parents before anyways.

[15] Note that the dependent variables in columns 3 and 4 of Table 12 are not rescaled. Therefore, coefficients do not need to be multiplied by 12 as in the other tables.

Concerns and Limitations

The variation in relative contributions to total income between households could be correlated with unobservable characteristics of couples with varying separation probabilities, and couples with a lower risk of divorce may have different preferences for childcare sharing than partners with a high risk of separation. The considered distribution factors would then have an indirect effect on the sharing rule through the effect on divorce probabilities. However, Bobonis (2009) points out that tests of the proportionality condition are not invalidated by this possibility since the ratio of the direct and indirect effects of changes in income contributions on Pareto weights does not involve anything specific to either maternity or paternity leave durations. Effects of changes in relative contributions to household income on leave durations are again equally proportional to the distribution factors' influence on the intra-household power distribution.

Another concern addresses unobserved heterogeneity in distribution factor effects on individual leave durations, which involves the possibility of differences in estimated coefficients stemming from heterogeneity in individuals' preferences rather than from differences in individuals' intra-household power. Changes in women's contributions to household income might, e.g., affect total household leave durations in the lower range of the distribution between 0 and 12 months as well-earning women are more likely to go on leave for less than the maximum duration of one year. Men's contributions to household income, on the other hand, might affect more the upper range of the leave distribution between 12 and 14 months because men mainly decide to participate in leave at all and are unlikely to take more than the minimum requirement of two months. The main consequence would be that Pareto optimality tests, which rely on testing condition (14), may consider significant differences between the ratios of distribution factor coefficients in the demand for different goods as evidence against the predictions of the collective model. In reality, however, rejections of the proportionality condition could be caused by heterogeneity in household demand functions. As we cannot reject Pareto efficiency in parental leave sharing in any of the tests, this concern does not seem to be harmful in our application.

Finally, if individuals' preferences for leisure are not separable from those for leave time or childcare, respectively, then the estimated income effects may suffer from an omitted variable bias. We therefore assume that conditioning on the employment status before birth, the employment sector, and the additional socioeconomic and demographic variables, preferences for leisure are separable from those for childcare. A related limitation is that labor incomes may be endogenous to households' childcare allocation decisions. Due to a lack of observed non-labor income or exogenous variation in incomes, we need to focus on distribution factors' correlations with household demands.

4.3 Empirical Intra-Household Allocation of Parental Leave

Concerning Propositions 1 and 1 $'$

Propositions 1 and 1 $'$ address the importance of distribution factors, that do not enter individual preferences but do influence the decision process. The presence of such variables is inconsistent with the unitary framework. Examples of distribution factors in the absence of price variation, that have been suggested in the literature, include relative incomes, relative physical attractiveness, and local sex ratio. In our particular framework, also custody allocation after divorce and alimony transfers from the custody to the non-custody parent are examples of distribution factors. Due to a lack of substantial variation in the other potential distribution factors between the 16 German states,[16] for the empirical analysis we need to focus on relative income changes while controlling for the level of household income. The unitary model predicts that only the level and not the sources of household income matter.

Table 7 provides evidence against unitary rationality in parental leave sharing by confirming the impact of relative income changes on individual leave durations. A higher relative income of the father is correlated with a shorter own leave duration and with a longer leave duration of the mother. Once we include relative income the level of household income does not have a significant impact on parental leave durations anymore. This provides a piece of evidence for the WE on maternity and paternity leave duration being weaker than the BE.

Concerning Propositions 2 and 2 $'$

Propositions 2 and 2 $'$ predict that each spouse's leave share is decreasing in own income. Empirical support for this prediction is presented in Tables 8, 10, and 12. The magnitudes of the Tobit parameter estimates from Table 12 tell us that a 1,000 EUR increase in the mother's income leads to a 1.17 months decrease of her own parental benefit duration. For fathers the corresponding coefficient from the last column of Table 12 is a little bit larger in

[16] Unfortunately, we do not observe smaller geographical regions than states.

absolute terms, namely it corresponds to a 1.35 months decrease.

Additionally, a 1,000 EUR increase in the mother's earnings involves an increase in the father's leave time of about two thirds of a month. If the father's income rises by 1,000 EUR, the coefficient is more than twice as big, i.e. mothers go on leave for 1.37 months longer. The magnitude of the coefficients might even be expected to become larger in absolute terms in the future if we consider that the most recent data available are from the first third of 2007 - the four months after the new parental benefit legislation has been introduced in Germany.

Tables 2 to 3 demonstrate a strong asymmetry between maternity and paternity leave durations on an aggregate level. Table 2 tells us that, based on the parental benefit statistic, for 95.3% of the children born in 2007 the mother went on leave for at least one month. This number needs to be compared to only 13.3% of fathers who took some time off. Table 3 then shows that fathers take only 5.3% of the total leave duration.

However, if we look at the development of fathers' participation rate in Scandinavian countries, who introduced generous parental leave legislations much earlier, paternity leave durations in Germany will probably increase in the future.

Concerning Proposition 3

The third proposition predicates that the amount of professional childcare hired increases with total household income, but is independent of distribution factors. The consumption of the public good determines the amount of total parental leave time that is then to share between parents.

Some descriptive facts from RWI survey data are that 30.7% of parents with a monthly household net income below 2,000 EUR plan to hire professional childcare. This percentage rises with income until it reaches 55.4% for parents with a household income of more than 5,000 EUR. Marginal effects from logit QMLE in Table 9 suggest that only household income and not relative income matters for the decision to hire professional childcare. In particular, a family is roughly 2.4% more likely to hire professional childcare if monthly household net income exceeds the average income of households by 1,000 EUR.[17]

[17] As the dependent variable is a dummy, logit QMLE simplifies to a usual logit estimation. We calculate marginal effects with all variables at means. Qualitative results for different covariate values are similar and available from the authors upon request.

Concerning Proposition 4

Proposition 4 states that the mother's leave share is relatively larger if the father's Pareto weight is relatively stronger. This theoretical result is difficult to bring to the data, as the exact functional form of the power function is unknown. A multiplicity of factors are likely to determine the exact intra-household "distribution of power" out of which we observe substantial variation only in one distribution factor (relative income).

We still provide suggestive empirical evidence for women to be represented in childcare relatively stronger than their partner in couples where the woman's Pareto weight is relatively weaker, i.e. when $1 - \mu(\mathbf{z}) < \mu(\mathbf{z})$. We construct a dummy variable which equals one if the woman takes more leave time than the man. A second dummy equals one if the man's contribution to household income is bigger than the woman's. Then, families in which the latter dummy variable equals one are 5.1% more likely that the woman takes relatively more leave time than families where the man's relative income is less than 1.[18]

However, while in 75% of the observed households from the RWI survey the man's relative income is larger than 1, in more than 89% of households the woman's relative leave time is larger than 1. This means that, as the effect of all distribution factors on the intra-household allocation of leave time is one-dimensional, we are able to infer the effect of changes in the observed distribution factor on relative leave times to happen through changes relative Pareto weights. Still, we cannot credibly predict the exact magnitude of the man's and the woman's Pareto weight in a given household without knowing the exact functional form and without observing all arguments of the power function.

5 Conclusion

This paper aims to gain insight into the intra-household allocation of career and income drawbacks involved with parenthood-related labor market absence under a generous parental leave legislation. Both parents value labor market work as an input to their human capital that positively impacts their individual earnings and private consumption later in life.

We introduce parental leave sharing in a collective model of household behavior with public consumption. The model's restrictions are then tested on German data on parental benefit use. In contrast to unitary models, the collective setting explicitly addresses the

[18] The t statistic of the marginal effect is 4.22 when regressing the leave-time dummy on the relative-income dummy in a logit regression while using the same remaining controls as in Table 7.

existence of distribution factors that affect household decisions even though they do not have an impact on preferences nor on budgets.

Although all decisions happen simultaneously, the allocation decision can be thought of as a two-stage process. Parents first agree on public expenditures, which in our model is professional childcare use. At the second stage, household members choose their individual levels of private consumption and labor market participation conditional on the amount of public good consumption. Each partner's private consumption is increasing in the own contribution to household income.

To summarize, households face trade-offs concerning an intertemporal private consumption allocation between the nearer and the farther future by choosing the amount of professional childcare they hire on the one hand, and a decision on parental leave sharing between partners on the other hand. The intra-household distribution of power seems to be such that parenthood-related income and career penalties are allocated strongly towards women. Possibly, this might be due to an economically weaker outside option of women in case of a separation or martial dissolution. Still, as we observe in the data, the childcare allocation is sensitive to relative incomes and is more equal in households where the woman contributes relatively more to household income.

Appendix A: Figures

Figure 1

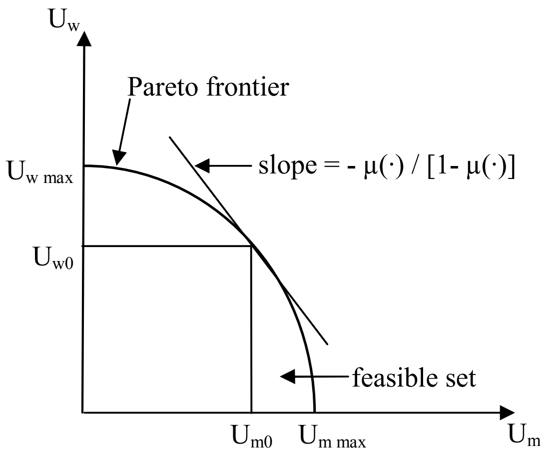


Figure 2:
Increase in the Woman's Relative Income
with Constant Level of Household Income

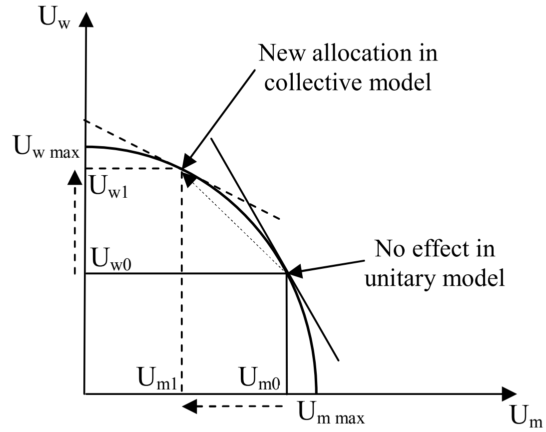


Figure 3

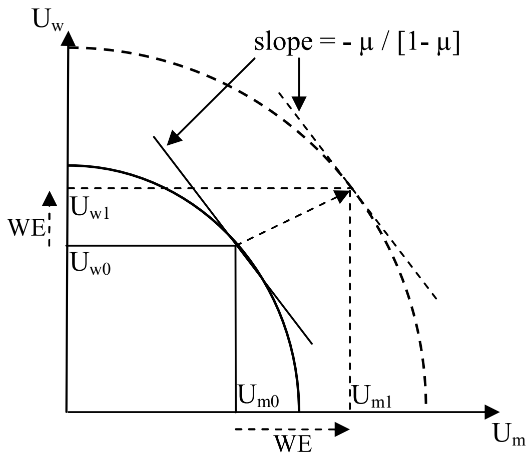
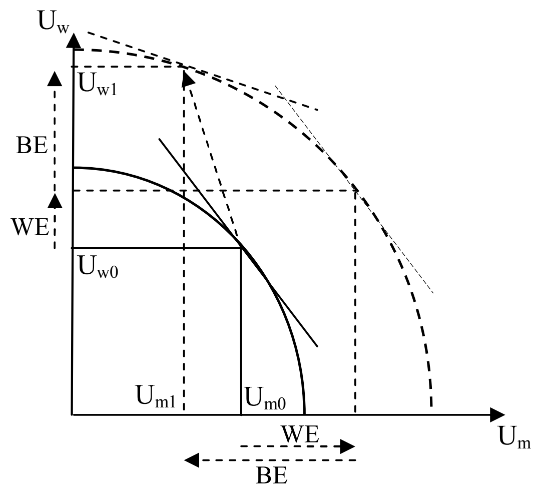


Figure 4



Appendix B: Proofs for Section 2.3 - Simple General Model

The Hessian Matrix

We can write the FOCs as:

$$\begin{aligned}
\mathbb{L}^{(1,0)} &= \mu(\cdot)\, U_m^{(0,1)} c_{m2}^{(1,0)} - (1-\mu(\cdot))\, U_w^{(0,1)} c_{w2}^{(1,0)} &\equiv 0 \\
\mathbb{L}^{(0,1)} &= -\mu(\cdot)\, U_m^{(1,0)} + (1-\mu(\cdot))\, U_w^{(1,0)} &\equiv 0
\end{aligned}$$

The Hessian of $\mathbb{L}$ is given by

$$\mathbb{H} = \begin{bmatrix} \mathbb{L}^{(2,0)} & \mathbb{L}^{(1,1)} \\ \mathbb{L}^{(1,1)} & \mathbb{L}^{(0,2)} \end{bmatrix}$$

with

$$\begin{aligned}
\mathbb{L}^{(2,0)} = & \quad \mu(\cdot)\left[U_m^{(0,2)}\left(c_{m2}^{(1,0)}\right)^2 + U_m^{(0,1)}c_{m2}^{(2,0)}\right] + (1-\mu)\left[U_w^{(0,2)}\left(c_{w2}^{(1,0)}\right)^2 + U_w^{(0,1)}c_{w2}^{(2,0)}\right] & < 0 \\
\mathbb{L}^{(0,2)} = & \quad \mu(\cdot)U_m^{(2,0)} + (1-\mu(\cdot))U_w^{(2,0)} & < 0 \\
\mathbb{L}^{(1,1)} = & \quad -\left[\mu(\cdot)U_m^{(1,1)}c_{m2}^{1,0} + (1-\mu(\cdot))U_w^{(1,1)}c_{w2}^{(1,0}\right] & = 0
\end{aligned}$$

The determinant of the Hessian is given by

$$|\mathbb{H}| = \mathbb{L}^{(2,0)}\mathbb{L}^{(0,2)} > 0 \ ,$$

as it is required for $\mathbb{L}(b_w^*, c_{w1}^*)$ to be a (global) maximum. Solutions to the FOC are indicated through asterisks. If $\mu(\cdot)$ is such that $b_w^* < 0$ ($b_w^* > T_1$) a corner solution $b_w^{\text{corner}} = 0$ ($b_w^{\text{corner}} = T_1$) is reached.

Exact expressions for $\partial\, \mathbb{L}^{(1,0)}/\partial\, w_{w1} < 0$ and $\partial\, \mathbb{L}^{(1,0)}/\partial\, w_{m1} > 0$ are

$$\frac{\partial\, \mathbb{L}^{(1,0)}}{\partial\, w_{w1}} = \frac{\partial\, \mu(\cdot)}{\partial\, w_{w1}}\left[U_m^{(0,1)}c_{m2}^{(1,0)} + U_w^{(0,1)}c_{w2}^{(1,0)}\right] - (1-\mu(\cdot))\left[U_w^{(0,2)}c_{w2}^{(1,0)}c_{w2}^{(0,1)} + U_w^{(0,1)}c_{w2}^{(1,1)}\right]$$

and

$$\frac{\partial\, \mathbb{L}^{(1,0)}}{\partial\, w_{m1}} = \frac{\partial\, \mu(\cdot)}{\partial\, w_{m1}}\left[U_m^{(0,1)}c_{m2}^{(1,0)} + U_w^{(0,1)}c_{w2}^{(1,0)}\right] + \mu(\cdot)\left[U_m^{(0,2)}c_{m2}^{(1,0)}c_{m2}^{(0,1)} + U_m^{(0,1)}c_{m2}^{(1,1)}\right] \ .$$

Proof of Proposition 1

(i) The implicit function theorem is applied in order to obtain the effect of a parameter change on the couple's optimal leave time and consumption choice. Define as

$$\mathbb{J}(z_1, c_{w1}) = \begin{bmatrix} \frac{\partial \mathbb{L}^{(1,0)}}{\partial z_1} & \mathbb{L}^{(1,1)} \\ \frac{\partial \mathbb{L}^{(0,1)}}{\partial z_1} & \mathbb{L}^{(0,2)} \end{bmatrix}$$

the matrix which replaces the derivatives with respect to b_w in the Jacobi matrix with the derivatives with respect to distribution factor z_1. Then, the proposition statement can be obtained by applying the implicit function theorem:

$$\text{sign}\left(\frac{\partial h_w^*}{\partial z_1}\right) = \text{sign}\left(-\frac{|\mathbb{J}(z_1, c_{w1})|}{|\mathbb{J}|}\right) ,$$

where the Jacobian $\mathbb{J}$ of the first order conditions from (6) equals the Hessian $\mathbb{H}$ of $\mathbb{L}$. As we have seen above, the determinant of the Hessian is positive, i.e. $|\mathbb{H}| > 0$. It remains to determine the sign of the numerator. We have $\mathbb{L}^{(0,2)} < 0$, $\mathbb{L}^{(1,1)} = 0$ and

$$\frac{\partial\, \mathbb{L}^{(1,0)}}{\partial\, z_1} = \frac{\partial\, \mu(\mathbf{z})}{\partial\, z_1}\left[U_m^{(0,1)} c_{m2}^{(1,0)} + U_w^{(0,1)} c_{w2}^{(1,0)}\right] > 0 \, .$$

so that $\partial h_w^*/\partial z_1 > 0$. The result concerning b_m^* follows from the time constraint.

(ii) analogous to (i). □

Proof of Proposition 2

(i) Under assumption (I) we assure

$$\frac{\partial\, \mathbb{L}^{(1,0)}}{\partial\, w_{w1}} = \frac{\partial\, \mu(\mathbf{z})}{\partial\, w_{w1}}\left[U_m^{(0,1)} c_{m2}^{(1,0)} + U_w^{(0,1)} c_{w2}^{(1,0)}\right] + (1-\mu(\mathbf{z}))\left[\frac{\partial^2 U_w}{\partial b_w\, \partial w_{w1}}\right] < 0 \, .$$

Using the implicit function theorem as above, the result follows directly.

(ii) We use the same method as above. Under assumption (II) the first entry of $\mathbb{J}(b_w, c_{w1})$ is given by

$$\frac{\partial\, \mathbb{L}^{(1,0)}}{\partial\, w_{m1}} = \frac{\partial\, \mu(\mathbf{z})}{\partial\, w_{m1}}\left[U_m^{(0,1)} c_{m2}^{(1,0)} + U_w^{(0,1)} c_{w2}^{(1,0)}\right] + \mu(\mathbf{z})\left[\frac{\partial^2 U_m}{\partial b_w\, \partial w_{m1}}\right] > 0 \, .$$

(iii) and (iv) follow directly from (i), (ii), and from the time constraint $T_1 = b_w + b_m$. □

Appendix C: Proofs for Section 2.4 - Extended Model

First- and Second-Order Conditions

Assuming for the moment that the non-negativity constraints are nonbinding,[19] the FOCs are

[19] See next section for details on the non-negativity constraints.

$$
\begin{aligned}
\mathbb{L}^{(1,0,0)} &= & \frac{\mu(\cdot)}{b_w+b_p+h_{m0}} - \frac{1-\mu(\cdot)}{T_1-b_w+h_{w0}} && \equiv 0 \\
\mathbb{L}^{(0,1,0)} &= & -\frac{\mu(\cdot)}{(w_{m1}+w_{m1})T_1-w_pb_p-c_{w1}} + \frac{1-\mu(\cdot)}{c_{w1}} && \equiv 0 \\
\mathbb{L}^{(0,0,1)} &= & \mu(\cdot)\left(\frac{1}{b_w+b_p+h_{m0}} - \frac{w_p}{(w_{m1}+w_{m1})T_1-w_pb_p-c_{w1}}\right) && \equiv 0
\end{aligned}
$$

This is a linear equation system in three variables. Results are given in Section 2.4.

The Hessian of $\mathbb{L}$ is given by

$$
H = \begin{bmatrix} L^{(2,0,0)} & L^{(1,1,0)} & L^{(1,0,1)} \\ L^{(1,1,0)} & L^{(0,2,0)} & L^{(0,1,1)} \\ L^{(1,0,1)} & L^{(0,1,1)} & L^{(0,0,2)} \end{bmatrix}
$$

with

$$
\begin{aligned}
\mathbb{L}^{(2,0,0)}(b_w^*, c_{w1}^*, b_p^*) &= -\frac{\mu}{(b_w^*+b_p^*+h_{m0})^2} - \frac{1-\mu}{(T_1-b_w^*+h_{w0})^2} < 0 \\
\mathbb{L}^{(0,2,0)}(b_w^*, c_{w1}^*, b_p^*) &= -\frac{\mu}{((w_{m1}+w_{w1})T_1-w_pb_p^*-c_{w1}^*)^2} - \frac{1-\mu}{(c_{w1}^*)^2} < 0 \\
\mathbb{L}^{(0,0,2)}(b_w^*, c_{w1}^*, b_p^*) &= -\mu\left(\frac{1}{(+b_w^*+b_p^*+h_{m0})^2} + \frac{w_p^2}{((w_{m1}+w_{w1})T_1-w_pb_p^*-c_{w1}^*)^2}\right) < 0 \\
\mathbb{L}^{(1,1,0)}(b_w^*, c_{w1}^*, b_p^*) &= 0 \\
\mathbb{L}^{(1,0,1)}(b_w^*, c_{w1}^*, b_p^*) &= -\frac{\mu}{(b_w^*+b_p^*+h_{m0})^2} < 0 \\
\mathbb{L}^{(0,1,1)}(b_w^*, c_{w1}^*, b_p^*) &= -\frac{\mu\, w_p}{((w_{m1}+w_{w1})T_1-w_pb_p^*-c_{w1}^*)^2} < 0
\end{aligned}
$$

The first minor is negative, the second is $|\mathbb{H}_2| = \mathbb{L}^{(2,0,0)}\mathbb{L}^{(0,2,0)} > 0$. The determinant of the Hessian at the maximum is

$$
\begin{aligned}
|\mathbb{H}_3(b_w^*, c_{w1}^*, b_p^*)| &= \mathbb{L}^{(2,0,0)}(b_w^*, c_{w1}^*, b_p^*)\,\mathbb{L}^{(0,2,0)}(b_w^*, c_{w1}^*, b_p^*)\,\mathbb{L}^{(0,0,2)}(b_w^*, c_{w1}^*, b_p^*) \\
&\quad -\mathbb{L}^{(2,0,0)}\left(\mathbb{L}^{(0,1,1)}(b_w^*, c_{w1}^*, b_p^*)\right)^2 - \mathbb{L}^{(0,0,2)}(b_w^*, c_{w1}^*, b_p^*)\left(\mathbb{L}^{(1,0,1)}(b_w^*, c_{w1}^*, b_p^*)\right)^2 < 0\,.
\end{aligned}
$$

Therefore, the Hessian is negative definite at (b_w^*, c_{w1}^*, b_p^*) and $\mathbb{L}(b_w^*, c_{w1}^*, b_p^*)$ is a maximum.

The Non-negativity Constraints

When solving the maximization problem (7), we consider only the case where the non-negativity constraints are nonbinding. We then use the resulting solutions to derive our propositions. In order for this to be meaningful, we have to show that there exists a range of parameters, for which the non-negativity constraints are indeed nonbinding.

From equation (8) and (11) it can be seen that if the Pareto weight of one spouse equals zero, this leads to an excessive leave duration for the other spouse, i.e. $\mu(\cdot) = 0 \Rightarrow b_m^* \geq T_1$ and $\mu(\cdot) = 1 \Rightarrow b_w^* \geq T_1$. The interpretation is that if the utility of one spouse has no importance, then this partner would be overly exploited in favor of the other. The non-negativity constraints therefore only hold for an intermediate range of weights $\mu_{\min}(\cdot)$ to $\mu_{\max}(\cdot)$ with $0 < \mu_{\min}(\cdot) < \mu_{\max}(\cdot) < 1$. Outside of this range, a corner solution with $b_m = 0$ or $b_w = 0$ maximizes the household's utility. In the following, we show that all constraints can hold at the same time, so that we are not in a degenerate case.

The non-negativity constraints for the duration of maternity and paternity leave can be written:

$$
\begin{aligned}
& & b_w^* & \geq 0 \\
\Leftrightarrow & & (1+\mu(\cdot))\,\frac{T_1 + h_{w0}}{2} - (1-\mu(\cdot))\,\frac{(w_{m1}+w_{w1})T_1 + w_p h_{m0}}{2w_p} & \geq 0 \\
\Leftrightarrow & & \frac{(w_{m1}+w_{w1})T_1 - w_p T_1 + w_p(h_{m0}-h_{w0})}{(w_{m1}+w_{w1})T_1 + w_p T_1 + w_p(h_{m0}+h_{w0})} & \leq \mu(\cdot) \qquad \text{and}
\end{aligned}
$$

$$
\begin{aligned}
& & b_m^* & \geq 0 \\
\Leftrightarrow & & (2-\mu(\cdot))\frac{T_1 + h_{m0}}{2} - \mu(\cdot)\,\frac{(w_{m1}+w_{w1})T_1 + w_p h_{w0}}{2w_p} & \geq 0 \\
\Leftrightarrow & & \frac{2w_p(T_1 + h_{m0})}{(w_{m1}+w_{w1})T_1 + w_p T_1 + w_p(h_{m0}+h_{w0})} & \geq \mu(\cdot)
\end{aligned}
$$

The non-negativity constraints for b_m^* and b_m^* can be simultaneously fulfilled only if

$$
\begin{aligned}
& \frac{2w_p(T_1 + h_{m0})}{(w_{m1}+w_{w1})T_1 + w_p T_1 + w_p(h_{m0}+h_{w0})} & \geq & \ \frac{(w_{m1}+w_{w1})T_1 - w_p T_1 + w_p(h_{m0}-h_{w0})}{(w_{m1}+w_{w1})T_1 + w_p T_1 + w_p(h_{m0}+h_{w0})} \\
\Leftrightarrow \quad & w_{m1} + w_{w1} & \leq & \ 2w_p + \left(1 + \frac{h_{m0}+h_{w0}}{T_1}\right) w_p \,.
\end{aligned}
$$

In addition, the duration of professional childcare use needs to be nonnegative, i.e.

$$
\begin{aligned}
& b_p^* && \geq \ 0 \\
\Leftrightarrow \quad & \frac{(w_{m1}+w_{w1})T_1 - w_p T_1 - w_p(h_{m0}+h_{w0})}{2w_p} && \geq \ 0 \\
\Leftrightarrow \quad & w_{m1}+w_{w1} && \geq \ \left(1+\frac{h_{m0}+h_{w0}}{T_1}\right) \ w_p \ .
\end{aligned}
$$

Let us consider, e.g., parameter values such that $w_{m1} = w_{w1} = w_p$ and $h_{m0} = h_{w0} = 0$. In this case, all non-negativity constraints hold simultaneously if $1/3 \leq \mu(\cdot) \leq 2/3$. An interior solution is reached as long as one partner does not have more than twice the power of the other.

Proof of Proposition 1′

We have

$$\frac{\partial b_w^*}{\partial z_1} = \frac{\partial\, \mu(\mathbf{z})}{\partial\, z_1} \frac{(w_{m1}+w_{w1}+w_p)T_1 + w_p(h_{m0}+h_{w0})}{2w_p}$$

and

$$\frac{\partial b_w^*}{\partial z_2} = -\frac{\partial\, \mu(\mathbf{z})}{\partial\, z_2} \frac{(w_{m1}+w_{w1}+w_p)T_1 + w_p(h_{m0}+h_{w0})}{2w_p}$$

The signs of these expressions depend in an obvious way on sign$(\partial\, \mu(\mathbf{z})/\partial\, z_q)$ for $q = 1, 2$. □

Proof of Proposition 2′

(i) $$\frac{\partial b_w^*}{\partial w_{w1}} = \frac{\partial\, \mu(\mathbf{z})}{\partial\, w_{w1}} \frac{(w_{m1}+w_{w1}+w_p)T_1 + w_p(h_{m0}+h_{w0})}{2w_p} - \frac{(1-\mu(\mathbf{z}))T_1}{2w_p}$$

(ii) analogous

(iii) $$\frac{\partial b_w^*}{\partial w_{m1}} = \frac{\partial\, \mu(\mathbf{z})}{\partial\, w_{m1}} \frac{(w_{m1}+w_{w1}+w_p)T_1 + w_p(h_{m0}+h_{w0})}{2w_p} - \frac{(1-\mu(\mathbf{z}))T_1}{2w_p}$$

(iv) analogous

□

Proof of Proposition 3

$$\frac{\partial b_p^*}{\partial(w_{m1}+w_{w1})} = \frac{T_1}{2w_p} \qquad \text{and} \qquad \text{(ii)} \quad \frac{\partial b_p^*}{\partial z_q} = \frac{\partial b_p^*}{\partial \mu(\mathbf{z})} \frac{\partial \mu(\mathbf{z})}{\partial z_q} \quad \forall\, q = 1, \ldots, Q \ .$$

□

Proof of Proposition 4

$$b_w^* > b_m^* \qquad \text{iff} \qquad \mu(\mathbf{z}) > \tfrac{1}{2} \ .$$

□

Appendix D: Tables

Table 1

Summary Statistics for the RWI Survey of Children Born in January till April 2007

Variable	Description	Mean	Std. dev.	N
Mother's months	number of parental benefit	10.15	3.45	4,177
Father's months	months (range: 0-12)	1.03	2.63	4,177
Total leave duration	(range: 0-14)	11.18	2.98	4,177
Professional childcare	d = 1 if used	0.36	0.48	4,151
Mother's income	(range: 0.08-6.0)	0.98	0.81	3,536
Father's income	(range: 0-6.0)	1.72	1.11	3,228
Household income	(range: 0.3-12)	2.78	1.44	3,130
net monthly income in tEUR, means from categories;				
(Father's) Relative income	(range: 0-59)	3.10	3.85	3,130
Mother in public sector	d = 1 if working in public	0.06	0.25	4,017
Father in public sector	sector	0.07	0.24	3,523
Mother in private sector	d = 1 if working in private	0.53	0.50	4,017
Father in private sector	sector	0.71	0.45	3,523
Mother is self-employed	d = 1 if self-employed	0.04	0.20	4,017
Father is self-employed		0.11	0.31	3,523
Mother secondary school	d = 1 if highest education	0.46	0.50	4,177
Father secondary school	level is secondary school	0.47	0.50	4,177
Mother highschool	d = 1 if highest education	0.24	0.43	4,177
Father highschool	level is highschool	0.18	0.39	4,177
Mother college/university	d = 1 if highest education	0.26	0.44	4,177
Father college/university	level is college/university	0.28	0.45	4,177
Mother's age	age at birth in years	30.64	5.28	4,158
Father's age	(range: 13-51 / 14-66)	33.65	6.08	4,132
Age of the oldest child	(range: 0-24)	2.44	3.83	4,149
Children	no.of children (range: 1-11)	1.75	0.95	4,177
Twins	d = 1 if multiple births	0.02	0.14	4,177
Mother is foreign	d = 1 if not German	0.11	0.31	4,142
East	d = 1 if living in East FRG	0.09	0.28	4,078
Big city	d = 1 if ≥100T inhabitants	0.27	0.45	3,868
Summary Statistics for the Parental Benefit Statistic 2007 (Couples)				
Mother's months	number of parental benefit	11.15	3.09	35,938
Father's months	months (range: 1-12)	2.69	2.05	35,938
Cumulative months	(range: 2-14)	13.83	0.72	35,938
Mother's income	(range: 0.3-2.7)	1.18	0.75	34,936
Father's income	(range: 0.3-2.7)	1.43	0.82	28,481
in tEUR, calculated from parental benefit amount, left-censored at 0.3, right-censored at 2.7				
Mother's income = 300	dummies (d) = 1 if	0.23	0.43	34,936
Father's income = 300	income = 0.3	0.22	0.41	29,168
Mother's income = 2,700	d = 1 if income = 2.7	0.05	0.22	34,936
Father's income = 2,700		0.12	0.32	29,168
Mother employed	d = 1 if employed	0.79	0.41	35,938
Father employed		0.84	0.37	35,938

Note: Unweighted data. Remaining parental benefit statistic 2007 variables similar to RWI data.

Table 2

Frequencies of Parental Benefit Users by Gender

Case	Frequency	Percent
Only the mother made use of the parental benefit	362,368	86.7%
Only the father made use of the parental benefit	19,526	4.7%
Both mother and father made use of the parental benefit	35,938	8.6%
Total	417,832	100.0%

Source: Author's calculations from the parental benefit statistic 2007.

Table 3

Frequencies of Parental Benefit Users by Gender and Duration of Benefit Use

No. of benefit months	Women		Men	
1	133	0.03%	886	1.6%
2	1,337	0.34%	34,323	61.9%
3	506	0.13%	1,578	2.8%
4	655	0.16%	1,250	2.3%
5	774	0.19%	944	1.7%
6	1,419	0.36%	1,513	2.7%
7	1,659	0.42%	1,348	2.4%
8	1,904	0.48%	949	1.7%
9	2,341	0.59%	833	1.5%
10	5,426	1.36%	1,284	2.3%
11	5,473	1.37%	1,751	3.2%
12	357,335	89.71%	8,501	15.3%
13	7,051	1.77%	205	0.4%
14	12,293	3.09%	99	0.2%
Total	398,306	100.00%	55,464	100.0%

Source: Author's calculations from the parental benefit statistic 2007.

Table 4

Mean Monthly Net Income of Parental Benefit Users by Number of Children

	Mean Income in EUR [a)]		Observations	
No. of children	**Women**	**Men**	**Women**	**Men**
1	903.23 (1.40)	1,317.09 (4.89)	219,737	28,064
2	559.10 (1.47)	1,349.96 (8.76)	117,920	10,469
3	467.47 (2.10)	1,251.32 (17.12)	38,424	2,933
≥ 4	392.92 (26.23)	1,034.55 (29.07)	13,687	926

Source: Author's calculations from the parental benefit statistic 2007.

a: Standard errors of means in parentheses.

Table 5

Difference in Women's Benefit Use by Monthly Net Income

No. of parental benefit months	**Income <= 300EUR** Frequency	Percentage	**Income >= 2,700EUR** Frequency	Percentage
1	97	0,0%	5	0,1%
2	963	0,5%	34	0,5%
3	327	0,2%	19	0,3%
4	398	0,2%	33	0,5%
5	489	0,2%	36	0,6%
6	837	0,4%	89	1,4%
7	827	0,4%	107	1,6%
8	908	0,5%	120	1,8%
9	1.075	0,5%	105	1,6%
10	1.853	0,9%	219	3,4%
11	2.488	1,2%	189	2,9%
12	183.438	91,5%	5.133	79,1%
13	3.608	1,8%	123	1,9%
14	3.090	1,5%	278	4,3%
Total	200.398	100,0%	6.490	100,0%

Source: Author's calculations from the parental benefit statistic 2007.

Table 6

Difference in Men's Benefit Use by Monthly Net Income

No. of parental benefit months	**Income <= 300EUR** Frequency	Percentage	**Income >= 2,700EUR** Frequency	Percentage
1	55	0,4%	174	3,7%
2	6.416	49,8%	3.051	64,6%
3	211	1,6%	197	4,2%
4	169	1,3%	133	2,8%
5	174	1,4%	84	1,8%
6	415	3,2%	127	2,7%
7	280	2,2%	126	2,7%
8	225	1,7%	82	1,7%
9	208	1,6%	57	1,2%
10	332	2,6%	98	2,1%
11	396	3,1%	142	3,0%
12	3.924	30,5%	429	9,1%
13	64	0,5%	14	0,3%
14	14	0,1%	10	0,2%
Total	12.883	100,0%	4.724	100,0%

Source: Author's calculations from the parental benefit statistic 2007.

Table 7

Tests of Unitary Rationality in Parental Leave Sharing

Leave duration of the	**Mother**		**Father**	
Estimation Method	OLS	Logit QMLE	OLS	Logit QMLE
Relative income	0.0047*	0.0062*	-0.0047*	-0.0044*
Robust std. err.	(0.0010)	(0.0015)	(0.0010)	(0.0011)
Household income (in tEUR)	-0.0019	-0.0010	-0.0019	0.0012
Robust std. err.	(0.0041)	(0.0036)	(0.0041)	(0.0022)
Total household leave duration	0.0600*	0.0374*	0.0233*	0.0297*
Robust std. err.	(0.0019)	(0.0011)	(0.0019)	(0.0016)
SER [a)]	0.19	0.73	0.19	1.38
R squared	0.39	0.45	0.13	0.24
Testing joint significance				
of relative income [b)]		χ^2 (2) = 18.97 [p-value = 0.00]		
of sector dummies [c)]	5.19 [0.00]	29.98 [0.00]	5.19 [0.00]	27.36 [0.00]
of education dummies [c)]	1.55 [0.16]	5.66 [0.46]	1.55 [0.16]	7.00 [0.32]

Note: Regression results from RWI survey 2007. Sample size is 2,489. The dependent variables are the number of parental benefit months divided by 12. For logit QMLE marginal effects with all variables at means are shown. Controls for parents' in public sector, self-employed, not working (reference group is private sector), parents' education and age at birth, number of children in household, twins, foreign mother, parents living in East Germany, and living in a big city are included.

a: Standard error of the regression; for QMLE the SER is defined in terms of weighted residuals.

b: Test across models based on logit QMLE with p-value from the bootstrap percentile interval of the test statistic.

c: Wald statistic and p-values from F distribution (OLS) and chi-square distribution (QMLE).

*: Significantly different from zero on the 5% level (two-sided test).

Table 8

Tests of Collective Rationality in Parental Leave Sharing

Leave duration of the	**Mother**		**Father**	
Estimation Method	OLS	Logit QMLE	OLS	Logit QMLE
Mother's income (in tEUR)	-0.0394*	-0.0313*	0.0394*	0.0162*
Robust std. err.	(0.0082)	(0.0064)	(0.0082)	(0.0039)
Father's income (in tEUR)	0.0244*	0.0197*	-0.0244*	-0.0114*
Robust std. err.	(0.0037)	(0.0037)	(0.0037)	(0.0029)
Total household leave duration	0.0604*	0.0373*	0.0229*	0.0288*
Robust std. err.	(0.0019)	(0.0010)	(0.0019)	(0.0016)
SER [a)]	0.19	0.72	0.19	1.17
R squared	0.40	0.46	0.15	0.24
Testing joint significance				
of sector dummies [b)]	3.71 [0.00]	26.28 [0.00]	3.71 [0.00]	24.13 [0.00]
of education dummies [b)]	1.07 [0.38]	3.49 [0.75]	1.07 [0.38]	15.21 [0.52]
Proportionality tests (based on logit QMLE estimations)				
joint significance of ratios test [c)]		χ^2 (2) = 12.64 [p-value = 0.02]		
ratio equality test [d)]		χ^2 (1) = 0.87 [p-value = 0.86]		

Note: Regression results from RWI survey 2007. Sample size is 2,489. The dependent variables are the number of parental benefit months divided by 12. For logit QMLE marginal effects with all variables at means are shown. Controls for parents' in public sector, self-employed, not working (reference group is private sector), parents' education and age at birth, number of children in household, twins, foreign mother, parents living in East Germany, and living in a big city are included.

a: Standard error of the regression; for QMLE the SER is defined in terms of weighted residuals.

b: Wald statistic and p-values from F distribution (OLS) and chi-square distribution (QMLE).

c: Non-linear Wald test of joint significance of the ratio of distribution factors' correlations with bootstrapped p-values.

d: Non-linear Wald test of equality of the ratio of distribution factors' correlations with bootstrapped p-values.

*: Significantly different from zero on the 5% level (two-sided test).

Table 9

Professional Childcare Use Estimations

	Professional childcare use			
Estimation Method	OLS	Logit QMLE	OLS	Logit QMLE
Relative income	-0.0029	-0.0024		
Robust std. err.	(0.0028)	(0.0031)		
Household income (in tEUR)	0.0248*	0.0244*		
Robust std. err.	(0.0091)	(0.0093)		
Mother's income (in tEUR)			0.0304	0.0276
Robust std. err.			(0.0157)	(0.0163)
Father's income (in tEUR)			0.0192	0.0207
Robust std. err.			(0.0100)	(0.0106)
Total household leave duration	-0.0095*	-0.0103*	-0.0095*	-0.0103*
Robust std. err.	(0.0039)	(0.0041)	(0.0039)	(0.0041)
SER [a)]	0.46	1.00	0.46	1.00
R squared	0.10	0.10	0.10	0.10
Testing joint significance				
of sector dummies [b)]	6.94 [0.00]	40.65 [0.00]	7.36 [0.00]	42.39 [0.00]
of education dummies [b)]	7.58 [0.00]	44.85 [0.00]	7.54 [0.00]	44.74 [0.00]

Note: Regression results from RWI survey 2007. Sample size is 2,489. The dependent variable is a dummy equal to one if professional childcare is used. For logit QMLE marginal effects with all variables at means are shown. Controls for parents' in public sector, self-employed, not working (reference group is private sector), parents' education and age at birth, number of children in household, twins, foreign mother, parents living in East Germany, and living in a big city are included.
a: Standard error of the regression; for QMLE the SER is defined in terms of weighted residuals.
b: Wald statistic and p-values from F distribution (OLS) and chi-square distribution (QMLE).
*: Significantly different from zero on the 5% level (two-sided test).

Table 10

Robustness Checks Part 1: Assuming that Only Relative Income Matters

Leave duration of the	**Mother**		**Father**	
Estimation Method	OLS	Logit QMLE	OLS	Logit QMLE
Log(mother's income)	-0.0385*	-0.0406*	0.0385*	0.0206*
Robust std. err.	(0.0096)	(0.0096)	(0.0096)	(0.0070)
Log(father's income)	0.0301*	0.0206*	-0.0301*	-0.0115*
Robust std. err.	(0.0109)	(0.0079)	(0.0109)	(0.0058)
Household income (in tEUR)	0.0028	0.0034	-0.0028	-0.0018
Robust std. err.	(0.0067)	(0.0055)	(0.0067)	(0.0043)
Total household leave duration	0.0599*	0.0373*	0.0234*	0.0296*
Robust std. err.	(0.0019)	(0.0011)	(0.0019)	(0.0016)
SER [a)]	0.19	0.73	0.19	1.19
R squared	0.39	0.45	0.15	0.24
Proportionality test [b)]	0.23 [0.63]	0.61 [0.44]	0.23 [0.63]	0.30 [0.58]

Note: Regression results from RWI survey 2007. Sample size is 2,489. The dependent variables are the number of parental benefit months divided by 12. For logit QMLE marginal effects with all variables at means are shown. Controls for parents' in public sector, self-employed, not working (reference group is private sector), parents' education and age at birth, number of children in household, twins, foreign mother, parents living in East Germany, and living in a big city are included.
a: Standard error of the regression; for QMLE the SER is defined in terms of weighted residuals.
b: Testing the hypothesis: Log(mother's income) + Log(father's income) = 0 while assuming that μ is increasing in father's income and decreasing in mother's income and that only relative income matters. Wald statistic and p-values from F distribution (OLS) and chi-square distribution (QMLE).
*: Significantly different from zero on the 5% level (two-sided test).

Table 11

Robustness Checks Part 2: z-Conditional Demands

Leave duration of the	**Mother**		**Father**	
Estimation Method	OLS	Logit QMLE	OLS	Logit QMLE
Sample	N = 2,489	N = 659	N = 2,489	N = 908
Mother's income (in tEUR)	-0.0095	-0.0046	0.0217*	0.0081
Robust std. err.	(0.0076)	(0.0096)	(0.0065)	(0.0097)
Partner's leave duration	-0.0592*	-0.1549*	-0.0402*	-0.1162*
Robust std. err.	(0.0017)	(0.0348)	(0.0027)	(0.0198)
Partner's leave duration measure [a)]		0.2734*		0.1872*
Robust std. err.		(0.0853)		(0.0453)
SER [b)]	0.19	0.51	0.16	0.53
R squared	0.37	0.52	0.38	0.54
Testing joint significance of mother's income				
across logit QMLE models		χ^2 (2) = 2.49 [p-value = 0.79]		

Note: Regression results from RWI survey 2007. The dependent variables are the number of parental benefit months divided by 12. For logit QMLE marginal effects with all variables at means are shown. Controls for parents' in public sector, self-employed, not working (reference group is private sector), parents' education and age at birth, number of children in household, twins, foreign mother, parents living in East Germany, and living in a big city are included.

a: log[partner's leave duration divided by 12 / (1 - partner's leave duration divided by 12)], defined for leave durations > 0 and < 12.

b: Standard error of the regression; for QMLE the SER is defined in terms of weighted residuals.

*: Significantly different from zero on the 5% level (two-sided test).

Table 12

Robustness Checks Part 3: Restricted Sample and Tobit Estimation

Leave duration of the	**Mother**	**Father**	**Mother**	**Father**
Estimation Method	logit QMLE		Tobit estimations [c)]	
Sample	Only first births (N = 1,266)		Full sample (N = 2,489)	
Relative income	0.0077*	-0.0055*	0.1973*	-0.3805*
Robust std. err.	(0.0037)	(0.0024)	(0.0498)	(0.0765)
Household income (in tEUR)	-0.0034	0.0027	-0.0667	-0.2158
Robust std. err.	(0.0049)	(0.0038)	(0.1190)	(0.1595)
Total household leave duration	0.0384*	0.0311*	1.5689*	1.7886*
Robust std. err.	(0.0015)	(0.0021)	(0.0675)	(0.2056)
R squared / Pseudo R squared	0.42	0.26	0.14	0.11
Mother's income (in tEUR)	-0.0355*	0.0204*	-1.1721*	1.3711*
Robust std. err.	(0.0092)	(0.0064)	(0.2226)	(0.2624)
Father's income (in tEUR)	0.0178*	-0.0114*	0.6438*	-1.3488*
Robust std. err.	(0.0061)	(0.0052)	(0.1231)	(0.1903)
Total household leave duration	0.0389*	0.0299*	1.5671*	1.7235*
Robust std. err.	(0.0015)	(0.0021)	(0.0669)	(0.1979)
R squared / Pseudo R squared	0.43	0.27	0.14	0.12
Proportionality tests				
joint significance of ratios test [a)]	χ^2 (2) = 8.13 [p-value = 0.27]		χ^2 (2) = 17.94 [p-value = 0.00]	
ratio equality test [b)]	χ^2 (1) = 0.37 [p-value = 0.91]		χ^2 (1) = 5.48 [p-value = 0.27]	

Note: Regression results from RWI survey 2007. The dependent variables are the number of parental benefit months. For logit QMLE leave durations are divided by 12 (not for Tobit estimations!) and marginal effects with all variables at means are presented Controls for parents' in public sector, self-employed, not working (reference group is private sector), parents' education and age at birth, number of children in household, twins, foreign mother, parents living in East Germany, and living in a big city are included.

a: Non-linear Wald test of joint significance of the ratio of distribution factors' correlations with bootstrapped p-values.

b: Non-linear Wald test of equality of the ratio of distribution factors' correlations with bootstrapped p-values.

c: Tobit estiamtions with a lower limit at 0 and an upper limit at 12 parental benefit months.

*: Significantly different from zero on the 5% level (two-sided test).

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