ONLINE APPENDIX

Togetherness in the Household

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A Data appendix

A.1 Construction of baseline sample and variables

The main data we use come from the Longitudinal Internet Studies for the Social sciences in the Netherlands (CentERdata, 2012). The LISS consists of different questionnaires, each with its own data covering a given topic. We combine data from the (1.) *Household Box* for baseline demographics and income, (2.) *Core Study 5 Family and Household* for household composition, the presence and age of children etc., (3.) *Core Study 6 Work and Schooling* for working hours and timing of work, and (4.) *Assembled Study 34 Time Use and Consumption* for consumption and time use. The latter module, which provides the bulk of our data, is described in detail in Cherchye, De Rock and Vermeulen (2012). All modules above are administered to the same subjects.

We draw data from three waves, covering calendar years 2009, 2010, and 2012. Although the LISS is running continuously since late 2007, it is only in those three years that we can obtain consistent consumption and time use data. Our sample consists of 398 household×year observations on households with children up to 12 years old and in which both spouses participate in the labor market. We construct this sample as follows:

1. Within our time frame, we select households where two spouses are present.

2. We drop households who experience marital status changes within a given year as their behavior may be constrained by such changes. We also drop those with inconsistent information on gender and year of birth, homosexual couples, as well as couples where both spouses declare themselves as household heads (this makes hard to assign information subsequently).

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3. We require that a household has completed the *Household Box*, *Core Study 5*, *Core Study 6*, and *Assembled Study 34*; then we merge data per household across studies. Up to this point, our simple selection criteria result in approximately 3,130 household×year observations, already a fraction of the approximately 10,200 household×year observations present prior to any selection (the last number counts unique households in *Core Study 5* in years 2009, 2010, and 2012).

4. Both spouses must be between 25-60 years old (we do not want time use to be restricted by statutory retirement or schooling) and participate in the labor market. The latter restricts our sample to 1,410 household×year observations.

5. Households must have at least one child up to 12 years old. This leaves us with 477 observations representing another large, but inevitable given our focus, sample cut.

6. Finally, we require that the age and gender of children is reported consistently, that parents have non-missing childcare, and that consumption is not missing, unusable, or zero. Our final sample has 398 household×year observations.

Further we define the variables we use in the paper. The respondents submit answers via online questionnaires that refer to a typical week or a typical month in the past.

Joint leisure is the leisure time that spouses spend together with one another. Both spouses report this (variables `bf09a064-65` in wave 2009). Differences in spouses' response are in most cases negligible; there are some households, however, where the difference is large but seemingly unrelated to household characteristics or other time use variables. We opted for using the minimum of the spouses' respective responses as this is the only choice that guarantees non-negative private leisure. *Private leisure* is the difference between individual total leisure and joint leisure. *Individual total leisure* is the time that each spouse spends on leisure activities (variables `bf09a021-22` in 2009).

Individual total childcare is the time each spouse spends on activities with children (variables `bf09a013-14` in wave 2009). The LISS contains a large array of separate questions on various time uses (e.g. chores, personal care, commuting, and more), so we are confident that the childcare measure indeed reflects time devoted to children.

Market work is the time each spouse spends working for pay on the market, including time on a second job (if any). These are variables `cw09b127` for the main job and `cw09b144` for a second job from Core Study 6. For commuting (robustness check 1 in section IV.D) we use `bf09a007/bf09a008`. We impose a theoretical maximum of 84 weekly market hours (12 hours per day × 7 days per week). We split market work into regular and irregular hours according to the rule described in section IV.A; to implement this, we use indicator variables for how often one works irregular hours (variable `cw09b425` in wave 2009). To check the sectors where irregular hours are concentrated (sections I and II.A), we use information on the employment sector of individuals (variable `cw09b402`).

Table A.1 – Linear regressions: joint variation between leisure and childcare

	(1) leisure male	(2) leisure female	(3) joint leisure	(4) childcare male	(5) childcare female
leisure male		-0.103	0.467	-0.161	-0.070
		(0.056)	(0.051)	(0.083)	(0.066)
leisure female	-0.135		0.609	-0.037	-0.427
	(0.075)		(0.054)	(0.094)	(0.110)
joint leisure	0.455	0.451		0.023	0.167
	(0.072)	(0.049)		(0.077)	(0.080)
childcare male	-0.092	-0.016	0.013		0.352
	(0.046)	(0.042)	(0.046)		(0.045)
childcare female	-0.044	-0.202	0.107	0.382	
	(0.042)	(0.050)	(0.050)	(0.058)	

Notes: The table reports coefficients and st.errors from linear regressions of log leisure and childcare on themselves and a constant. St.errors are clustered at the household level. In column 4 we report a coefficient on female childcare at 0.382. This differs from $\widehat{\beta} = 0.28$ in main text figure 2 because the time use variables here are in log. Results in levels are qualitatively similar.

We require that the weekly time budget of each spouse adds up to 168 hours. To confirm this we use information on several time uses recorded in Assembled Study 34. Interestingly, the vast majority of households have their time uses add up to exactly (or very close to) 168 hours; for the rest we make a normalization ourselves.

Hourly wages are calculated as monthly earnings over monthly hours of work. *Monthly earnings* is the personal monthly income net of taxes (variable `nettoink_f`), which, unless directly reported by the individual, is imputed by the LISS based on gross income.

Parental consumption is the raw sum of expenditure on various goods, net of goods for children. These include food (at home or away), excluding food of children, tobacco products, clothing, personal care products and services, medical costs, leisure activities costs, costs of further schooling, donations and gifts, rent, household utilities, transport costs, insurance costs, alimony and financial support for children not living at home, costs of debts and loans, and home maintenance costs (variables `bf09a066-70`, `bf09a072-77`, `bf09a095-103` in wave 2009). Several of those items (those considered public expenditure) are reported by both spouses. The responses match surprisingly well. We opt for using the female responses as they include slightly fewer zeros. We have dropped one household where husband-wife responses differ by orders of magnitude.

Child consumption is the raw sum of expenditure on goods for children. These include food (at home or away), clothing, personal care products and services, medical costs, leisure activities costs, costs of schooling, and gifts and presents (variables `bf09a093`, `bf09a105-113` in wave 2009). We impute child consumption for four households for which it is missing. The imputation is statistical: we regress C_K (non-missing in the majority of households) on a large array of demographics, work hours, and parents' consumption, and we predict it for the households for which it is missing.

Table A.1 presents the joint variation between uses of time (each time use is regressed on all other uses and a constant). The linear regression coefficients are similar to correlations because the various time uses have similar cross-sectional variances. Table A.2 presents linear regressions of leisure and childcare on the gender wage gap, the incidence of irregular work, select demographics, and education and occupation dummies.

A.2 Non-participation, time diary, and childless couples

Our estimation method requires wages for both spouses, thus we select households in which both spouses participate in the labor market. Here we first explore how leisure and childcare in our sample compare to leisure and childcare among couples in which spouses do not necessarily participate in the market, but for whom all other selection criteria (e.g. age, presence of young children) still apply. This larger sample has 530 household/year observations. Among them, 98% of men and 76% of women work.

Table A.3 mimics table 1 in the main text, and table A.4 mimics table A.1. The distributions of leisure and childcare in the larger sample look remarkably similar to our baseline sample. The only noticeable difference is that women spend on average a bit more time on childcare than before (23.4 vs. 21.7 weekly hours). The correlations between the time use variables look similar to the baseline. Again, childcare correlates negatively to overall leisure but positively to joint leisure.

The LISS also includes a small time diary conducted in year 2013. The diary, officially *Assembled Study 122 Time Use*, contains detailed time use for 224 individuals. Using a mobile application, eligible subjects record their activities in 10-minute intervals in a typical weekday and weekend. They also record with whom, if any, they carry out a given activity, which is what allows us to categorize time as private or joint.

There are three reasons why we cannot use the time diary in our empirical exercise. First, consumption and time use data are available in years 2009, 2010, 2012, but *not* in 2013. Second, our model is for married couples with young children. Once we apply this selection in the time diary and remove non-respondents, we are left with only 12 observations without even conditioning on labor market participation. Third, no more than one person per household participates in the diary so one cannot use it to check what *both* spouses do at a time. Nevertheless, we observe among the 12 individuals that: 1.) weekly overall and joint leisure is effectively similar to the first three lines of table 1 in the main text and A.3; 2.) joint childcare exists, it is prevalent, and it accounts on average for about 40% of a parent's overall childcare, consistent with our results in appendix table C.1.

In section V.B we repeat our empirical exercise over a sample of childless couples. This includes couples who do not (yet) have children but for whom all other selection criteria (e.g. age, participation) still apply. This sample has 346 household/year observations.

Table A.2 – Linear regressions: leisure and childcare with controls for education and occupation

	(1) leisure male	(2) leisure female	(3) joint leisure	(4) childcare male	(5) childcare female
gender wage gap	0.012 (0.005)	-0.004 (0.006)	-0.001 (0.006)	0.007 (0.008)	-0.013 (0.008)
1[irregular work male]	0.042 (0.076)	-0.018 (0.065)	-0.059 (0.087)	0.111 (0.103)	0.021 (0.073)
1[irregular work female]	-0.146 (0.078)	-0.075 (0.075)	-0.126 (0.092)	0.156 (0.096)	0.075 (0.079)
gender age gap	-0.009 (0.011)	-0.004 (0.011)	-0.005 (0.013)	0.005 (0.014)	0.008 (0.014)
1[child 4-6 yrs]	-0.045 (0.096)	0.067 (0.086)	-0.006 (0.104)	-0.229 (0.112)	-0.156 (0.094)
1[child 7-12 yrs]	0.061 (0.083)	0.112 (0.081)	-0.031 (0.096)	-0.592 (0.102)	-0.734 (0.101)
Male education:					
secondary	-0.036 (0.195)		0.583 (0.265)	-0.093 (0.277)	
vocational	0.020 (0.190)		0.495 (0.268)	0.083 (0.268)	
university	-0.004 (0.203)		0.331 (0.270)	-0.067 (0.285)	
post graduate	0.107 (0.219)		0.821 (0.296)	0.291 (0.309)	
Male occupation:					
higher professional	0.002 (0.154)		0.048 (0.182)	-0.354 (0.191)	
middle professional	0.045 (0.166)		-0.062 (0.183)	-0.282 (0.169)	
commercial	-0.041 (0.162)		0.015 (0.172)	-0.297 (0.164)	
other office work	-0.084 (0.174)		0.003 (0.179)	-0.382 (0.172)	
skilled work	0.077 (0.183)		0.064 (0.212)	-0.158 (0.199)	
semi-skilled	0.156 (0.185)		-0.038 (0.207)	-0.100 (0.222)	
manual work	-0.269 (0.279)		-0.470 (0.353)	-0.269 (0.407)	
Female education:					
secondary		0.182 (0.176)	0.236 (0.394)		-0.081 (0.278)
vocational		0.106 (0.173)	0.261 (0.385)		-0.105 (0.279)
university		0.099 (0.187)	0.110 (0.389)		-0.045 (0.282)
post graduate		0.289 (0.208)	0.355 (0.412)		-0.112 (0.335)
Female occupation:					
higher professional		-0.269 (0.187)	0.082 (0.235)		0.214 (0.253)
middle professional		-0.129 (0.165)	0.174 (0.226)		-0.078 (0.238)
commercial		-0.119 (0.212)	0.034 (0.245)		0.083 (0.246)
other office work		0.051 (0.176)	0.313 (0.228)		-0.054 (0.246)
skilled work		0.120 (0.180)	0.157 (0.469)		-0.094 (0.269)
semi-skilled		0.283 (0.213)	0.619 (0.271)		-0.158 (0.306)
manual work		0.099 (0.231)	0.235 (0.322)		0.040 (0.294)
constant	3.118 (0.253)	2.876 (0.242)	1.275 (0.506)	2.734 (0.334)	3.227 (0.357)
R^2	0.05	0.06	0.12	0.14	0.22
# of observations	391	394	361	387	395

Notes: The table reports coefficients and standard errors from linear regressions of log leisure and childcare on the gender wage gap (male−female wage), the gender age gap (male−female age), indicator variables for whether a spouse works irregular hours *at least sometimes*, for children's age (excluding children less than 4 years old), for education (excluding primary education), for profession, and a constant. Profession takes discrete values for academic or independent occupation (architect, physician, scholar, engineer; excluded category), higher professional (manager, director, supervisory civil servant), middle professional (teacher, artist, nurse, social worker), commercial (department manager, shopkeeper), other office work (administrative assistant, accountant, sales assistant), skilled work (car mechanic, foreman, electrician), semi-skilled (driver, factory worker), and manual work (cleaner, packer). Standard errors are clustered at the household level. The number of observations varies because not everyone has positive amounts of leisure and childcare (see e.g. main text figure 1 for joint leisure) or because occupation is missing. Results in levels are qualitatively similar.

Table A.3 – Descriptive statistics, sample unconditional on market participation: weekly leisure and childcare

	mean	median	10^{th} pct.	90^{th} pct.
leisure male	26.4	25.0	10.0	44.5
leisure female	23.9	21.0	8.0	41.0
joint leisure	9.5	8.0	1.0	20.0
childcare male	12.9	10.0	3.0	24.8
childcare female	23.4	20.0	5.7	45.0

Notes: The table reports the average, median, 10^{th} and 90^{th} percentiles of leisure and childcare. All statistics are calculated over 530 household/year observations that satisfy all our baseline sample criteria except labor market participation.

Table A.4 – Linear regressions, sample unconditional on market participation: joint variation between leisure and childcare

	(1) leisure male	(2) leisure female	(3) joint leisure	(4) childcare male	(5) childcare female
leisure male		-0.116	0.499	-0.189	-0.055
		(0.050)	(0.042)	(0.068)	(0.058)
leisure female	-0.133		0.585	-0.027	-0.349
	(0.059)		(0.044)	(0.074)	(0.092)
joint leisure	0.449	0.457		0.091	0.105
	(0.058)	(0.043)		(0.064)	(0.069)
childcare male	-0.106	-0.013	0.057		0.316
	(0.037)	(0.036)	(0.041)		(0.041)
childcare female	-0.030	-0.167	0.064	0.308	
	(0.033)	(0.042)	(0.041)	(0.046)	

Notes: The table reports coefficients and standard errors from linear regressions of log leisure and childcare on themselves and a constant. Standard errors are clustered at the household level. The regressions run over the larger sample that satisfies all our baseline sample criteria except labor market participation. Results in levels are qualitatively similar.

B Model appendix

B.1 Upper limit on joint time

Here we show how we obtain condition (5) in the main text. Let $\mathcal{T}_m$ be the total amount of time after sleep, personal care, chores etc. If this is different between spouses, the applicable $\mathcal{T}_m$ is the lowest between the two. Togetherness cannot be larger than this, therefore $l_J + t_J \leq \mathcal{T}_m$. The spouses, however, work privately on the market, so their available right hand side time is actually even lower. So we need to subtract the amount of time they are at work. If there is no irregular work, we subtract the *maximum* of the spouse's regular hours as we have assumed these hours always overlap. The spouse who works for longer limits maximum togetherness, therefore $l_J + t_J \leq \mathcal{T}_m - \max\left\{h_1^R, h_2^R\right\}$. If there is irregular work, we further subtract the total amount of such work by *either* spouse as we have assumed irregular hours never overlap. This gives us

$$l_J + t_J \leq \mathcal{T}_m - \max\left\{h_1^R, h_2^R\right\} - h_1^I - h_2^I$$

which is condition (5) in the main text. Note that we could, in principle, tighten this further by also introducing private leisure and private childcare. This would require assumptions on the joint timing of these activities, i.e. which of these private activities may overlap between spouses and to which extent. We refrain from making such assumptions as, unlike market work, there is little empirical guidance on this issue. Finally, this condition can be easily adapted if workers have some control over the schedule of irregular work (i.e. our robustness checks 2 and 3 in section IV.D).

B.2 Equivalent formulations of household problem

In this appendix we reformulate our baseline problem (P) in three alternative ways. We show that a formulation in which the couple cares about child utility insofar as it does not drop below a lower bound, one in which the parents obtain utility from the utility of their children through caring, and one in which child utility is in fact child quality produced by parental inputs are all *equivalent*. To simplify the illustration, we rewrite private leisure as $l_m = \mathcal{T}_m - l_J - t_m - t_J - h_m^R - h_m^I$. We plug this expression whenever l_m appears below, instead of treating the time budgets as separate constraints.

Let the objective function in our baseline problem (P) be $\mathcal{U}^0(\mathcal{C}) = \mu_1 U_1(l_1, l_J, C_P) + \mu_2 U_2(l_2, l_J, C_P) + \mu_K U_K(t_1, t_2, t_J, C_K)$. The Lagrangian function is then given by

$$\begin{aligned}\mathcal{L}^0(\mathcal{C}) = \mathcal{U}^0(\mathcal{C}) &+ \lambda\Big(Y + \textstyle\sum_{m=1}^2 w_m h_m^R + \sum_{m=1}^2 (w_m + p_m) h_m^I - C_P - C_K - w_K T_K\Big) \\ &+ \tau_J\Big(\mathcal{T}_m - \max\left\{h_1^R, h_2^R\right\} - h_1^I - h_2^I - l_J - t_J\Big) \\ &+ \tau_K\Big(\textstyle\sum_{m=1}^2 t_m + t_J + T_K - \mathcal{T}_K\Big).\end{aligned}$$

We use $\mathcal{L}^0(\mathcal{C})$ to obtain the problem's optimality conditions in section II.C.

Reformulation 1: lower bound to child utility. Suppose that instead of $\mathcal{U}^0(\mathcal{C})$, the household objective function is $\mathcal{U}^1(\mathcal{C}) = \mu_1 U_1(l_1, l_J, C_P) + \mu_2 U_2(l_2, l_J, C_P)$ as in the public goods collective model of Blundell, Chiappori and Meghir (2005). The problem is subject to the same constraints as in the baseline, and an additional constraint

$$\mu_K : \qquad U_K(t_1, t_2, t_J, C_K) \geq u_K$$

which ensures that parents care for children's welfare insofar as it does not drop below an exogenous threshold u_K. The Lagrangian function is then given by

$$\begin{aligned}\mathcal{L}^1(\mathcal{C}) = & \,\mathcal{U}^1(\mathcal{C}) + \mu_K\Big(U_K(t_1, t_2, t_J, C_K) - u_K\Big) \\ & + \lambda\Big(Y + \textstyle\sum_{m=1}^2 w_m h_m^R + \sum_{m=1}^2 (w_m + p_m) h_m^I - C_P - C_K - w_K T_K\Big) \\ & + \tau_J\Big(\mathcal{T}_m - \max\left\{h_1^R, h_2^R\right\} - h_1^I - h_2^I - l_J - t_J\Big) \\ & + \tau_K\Big(\textstyle\sum_{m=1}^2 t_m + t_J + T_K - \mathcal{T}_K\Big).\end{aligned}$$

The threshold u_K can be dropped from the first line because it does not depend on choice variables $\mathcal{C}$. Then $\mathcal{L}^1(\mathcal{C})$ becomes exactly the same as $\mathcal{L}^0(\mathcal{C})$.

Reformulation 2: caring. Suppose that the parents are not "egoistic" but they care for their children's welfare à la Becker. Let each spouse's preferences be given by an altruistic index $W_m = U_m(l_m, l_J, C_P) + \theta_m U_K(t_1, t_2, t_J, C_K)$. Here θ_m captures the degree to which parent m cares for his/her child's welfare. Suppose the household only maximizes the weighted sum of the parents' indexes. The household objective function can then be written as:

$$\begin{aligned}\mathcal{U}^2(\mathcal{C}) = \mu_1 W_1 + \mu_2 W_2 &= \mu_1\big(U_1 + \theta_1 U_K\big) + \mu_2\big(U_2 + \theta_2 U_K\big) \\ &= \mu_1 U_1 + \mu_2 U_2 + (\mu_1\theta_1 + \mu_2\theta_2) U_K \\ &= \mu_1 U_1 + \mu_2 U_2 + \widetilde{\mu}_K U_K.\end{aligned}$$

The last equality uses a simple redefinition of the utility weight, i.e. $\widetilde{\mu}_K = \mu_1\theta_1 + \mu_2\theta_2$. This is possible as we do not impose restrictions on μ_1, μ_2, $\widetilde{\mu}_K$. Replacing $\mathcal{U}^0(\mathcal{C})$ in the baseline with $\mathcal{U}^2(\mathcal{C})$, we obtain Lagrangian $\mathcal{L}^2(\mathcal{C})$ that is exactly the same as baseline $\mathcal{L}^0(\mathcal{C})$. This is in fact a well-known result (e.g. Chiappori, 1992). The crucial assumption is the separability between U_m and U_K in the caring functions. Chiappori (1992) shows extensions to weaker forms of separability than the strong version that we used above.

Reformulation 3: child quality. Let child quality Q_K be produced by a weakly increasing function of parental time inputs and child expenditure, $Q_K = F(t_1, t_2, t_J, C_K)$. F is a child development production function à la Del Boca, Flinn and Wiswall (2014). The parents enjoy utility from child quality and each spouse's preferences are an index $W_m = U_m(l_m, l_J, C_P) + \alpha_m U_K(Q_K)$. Here $\alpha_m > 0$ is the individual weight on child quality while U_K is the weakly increasing utility over it. Given the production function underlying Q_K, we rewrite the child quality utility term as $\widetilde{U}_K(t_1, t_2, t_J, C_K) = U_K F(t_1, t_2, t_J, C_K)$ where $\widetilde{U}_K$ is simply a composite function. The rest of the discussion is then similar to the previous formulation. The household objective function is:

$$\begin{aligned}\mathcal{U}^3(\mathcal{C}) = \mu_1 W_1 + \mu_2 W_2 &= \mu_1\big(U_1 + \alpha_1 \widetilde{U}_K\big) + \mu_2\big(U_2 + \alpha_2 \widetilde{U}_K\big)\\ &= \mu_1 U_1 + \mu_2 U_2 + (\mu_1 \alpha_1 \widetilde{U}_K + \mu_2 \alpha_2 \widetilde{U}_K)\\ &= \mu_1 U_1 + \mu_2 U_2 + \widetilde{\mu}_K \widetilde{U}_K.\end{aligned}$$

The last equality simply redefines the child quality term as $\widetilde{\mu}_K \widetilde{U}_K = \mu_1\alpha_1\widetilde{U}_K + \mu_2\alpha_2\widetilde{U}_K$. This is possible for the same reasons as in the case of caring. Replacing $\mathcal{U}^0(\mathcal{C})$ in the baseline with $\mathcal{U}^3(\mathcal{C})$, we get Lagrangian $\mathcal{L}^3(\mathcal{C})$ that is exactly the same as baseline $\mathcal{L}^0(\mathcal{C})$.

Our baseline formulation and the three alternative ones are all equivalent to each other. It is impossible to separate them (at least not without additional information) and the interpretation one chooses to put forward (e.g. caring, child development etc.) is down to taste. While we choose a baseline formulation in which childcare superficially appears to affect only children's but not parents' utility, alternative formulations 2 & 3 highlight that childcare may also enter parents' utility through caring or child quality. So, regardless of the specific interpretation one puts forward, our formulation is consistent with parents enjoying time with their children because such time improves children's welfare.

C Revealed preferences appendix

C.1 Proof of Proposition 1

Since Proposition 1 is a special case of Proposition 2, we do not repeat the full proof here but we refer the reader to appendix C.2 for the full proof. Here we prove that if $\tilde{S}_K$ satisfies GARP, then S_K also satisfies GARP.

Let $\widetilde{S}_K = \{\delta^{(v)}_{K,t_1}, \delta^{(v)}_{K,t_2}, \delta^{(v)}_{K,t_J}, \delta^{(v)}_{K,C_K};\ t^{(v)}_1, t^{(v)}_2, t^{(v)}_J, C^{(v)}_K\}_{v\in V}$ and $S_K = \{\delta^{(v)}_{K,t_1}, \delta^{(v)}_{K,t_2}, \delta^{(v)}_{K,C_K};$ $T^{(v)}_1, T^{(v)}_2, C^{(v)}_K\}_{v\in V}$. Note that $\delta^{(v)}_{K,C_K} = 1$ from the problem's first order conditions. It follows that

$$\begin{aligned}\delta^{(v)}_{K,t_1}(t^{(s)}_1 - t^{(v)}_1) + \delta^{(v)}_{K,t_2}(t^{(s)}_2 - t^{(v)}_2) + \delta^{(v)}_{K,t_J}(t^{(s)}_J - t^{(v)}_J) + (C^{(s)}_K - C^{(v)}_K) \le 0\\ \Leftrightarrow w^{(v)}_1(t^{(s)}_1 - t^{(v)}_1) + w^{(v)}_2(t^{(s)}_2 - t^{(v)}_2) + (w^{(v)}_1 + w^{(v)}_2)(t^{(s)}_J - t^{(v)}_J) + (C^{(s)}_K - C^{(v)}_K) \le 0\\ \Leftrightarrow w^{(v)}_1(T^{(s)}_1 - T^{(v)}_1) + w^{(v)}_2(T^{(s)}_2 - T^{(v)}_2) + (C^{(s)}_K - C^{(v)}_K) \le 0.\end{aligned}$$

To obtain the second line, we use that $\delta^{(v)}_{K,t_m} = w^{(v)}_m$ and $\delta^{(v)}_{K,t_J} = w^{(v)}_1 + w^{(v)}_2$ consistent with the first order conditions associated with Proposition 1. To obtain the third line, we use that $t^{(v)}_1 + t^{(v)}_J = T^{(v)}_1$ and $t^{(v)}_2 + t^{(v)}_J = T^{(v)}_2$. Summarizing, any revealed preference relation that exists for $\tilde{S}_K$ exists also for S_K, and vice versa. We may therefore conclude that S_K satisfies GARP if and only if $\tilde{S}_K$ satisfies GARP. The equivalence holds also with corners

$t_J^{(v)} = 0$. Rationality implies $\delta_{K,t_J}^{(v)} \leq w_1^{(v)} + w_2^{(v)}$ because it also implies $\delta_{K,t_J}^{(v)} = w_1^{(v)} + w_2^{(v)}$. Next, $\delta_{K,t_J}^{(v)} \leq w_1^{(v)} + w_2^{(v)}$ implies rationality because $\delta_{K,t_J}^{(v)}(t_J^{(s)} - 0) \leq (w_1^{(v)} + w_2^{(v)})(t_J^{(s)} - 0)$, thus constructing the same preference relations as before.

C.2 Proof of Proposition 2

In the first part of the proof ((1) $\Rightarrow$ (2)), we use that a necessary condition for consistency with a convex problem is that the Karush-Kuhn-Tucker conditions hold. Assuming continuity and concavity of U_m and U_K we replace the partial derivatives of the utility functions with suitable super-gradients to obtain

$$\begin{aligned}
u_m^{(s)} - u_m^{(v)} &\leq \eta_m^{(v)} \left[\delta_{m,l_m}^{(v)}(l_m^{(s)} - l_m^{(v)}) + \delta_{m,l_J}^{(v)}(l_J^{(s)} - l_J^{(v)}) + \delta_{m,C_P}^{(v)}(C_P^{(s)} - C_P^{(v)}) \right] \\
u_K^{(s)} - u_K^{(v)} &\leq \eta_K^{(v)} \left[\delta_{K,t_1}^{(v)}(t_1^{(s)} - t_1^{(v)}) + \delta_{K,t_2}^{(v)}(t_2^{(s)} - t_2^{(v)}) + \delta_{K,t_J}^{(v)}(t_J^{(s)} - t_J^{(v)}) + (C_K^{(s)} - C_K^{(v)}) \right],
\end{aligned}$$

with $\eta_m^{(v)} = \lambda^{(v)}/\mu_m^{(v)}$ and $\eta_K^{(v)} = \lambda^{(v)}/\mu_K^{(v)}$. Finally, given that $\{\delta_{m,l_m}^{(v)}, \delta_{m,l_J}^{(v)}, \delta_{m,C_P}^{(v)}\}$ and $\{\delta_{K,t_1}^{(v)}, \delta_{K,t_2}^{(v)}, \delta_{K,t_J}^{(v)}, 1\}$ act as prices in these Afriat-like inequalities (in the latter set, $\delta_{K,C_K}^{(v)} = 1$ is the price of child expenditure), and $\{l_m^{(v)}, l_J^{(v)}, C_P^{(v)}\}$ and $\{t_1^{(v)}, t_2^{(v)}, t_J^{(v)}, C_K^{(v)}\}$ as quantities, we can reformulate these conditions in terms of consistency of $\{\delta_{m,l_m}^{(v)}, \delta_{m,l_J}^{(v)}, \delta_{m,C_P}^{(v)}; l_m^{(v)}, l_J^{(v)}, C_P^{(v)}\}_{v \in V}$ and $\{\delta_{K,t_1}^{(v)}, \delta_{K,t_2}^{(v)}, \delta_{K,t_J}^{(v)}, 1; t_1^{(v)}, t_2^{(v)}, t_J^{(v)}, C_K^{(v)}\}_{v \in V}$ with GARP (Varian, 1982).

In the second part of the proof ((2) $\Rightarrow$ (1)), we have to show that there exist weights $\mu_m^{(v)}$ and $\mu_K^{(v)}$, and utility functions U_m and U_K that rationalize the data with togetherness, provided that the conditions in Proposition 2 hold. To this end, we first construct the utility functions. Let

$$\begin{aligned}
U_m(l_m, l_J, C_P) &= \min_{(s)} u_m^{(s)} + \eta_m^{(s)} \left(\delta_{m,l_m}^{(s)}(l_m - l_m^{(s)}) + \delta_{m,l_J}^{(s)}(l_J - l_J^{(s)}) + \delta_{m,C_P}^{(s)}(C_P - C_P^{(s)}) \right) \\
U_K(t_1, t_2, t_J, C_K) &= \min_{(s)} u_K^{(s)} + \eta_K^{(s)} \left(\delta_{K,t_1}^{(s)}(t_1 - t_1^{(s)}) + \delta_{K,t_2}^{(s)}(t_2 - t_2^{(s)}) + \delta_{K,t_J}^{(s)}(t_J - t_J^{(s)}) + (C_K - C_K^{(s)}) \right).
\end{aligned}$$

One can verify that these piecewise linear functions are nonsatiated, continuous and concave. After all, the minimum of concave functions is concave. One can also show that $U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)}) = u_1^{(v)}$. By definition of U_1:

$$U_1(l_1, l_J, C_P) = \min_{(s)} u_1^{(s)} + \eta_1^{(s)} \left(\delta_{1,l_1}^{(s)}(l_1 - l_1^{(s)}) + \delta_{1,l_J}^{(s)}(l_J - l_J^{(s)}) + \delta_{1,C_P}^{(s)}(C_P - C_P^{(s)}) \right).$$

This implies $U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)}) \leq u_1^{(v)}$. We cannot have that $U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)}) < u_1^{(v)}$ because this violates the Afriat inequalities. Suppose that $U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)})$ is at its minimum in situation r, i.e.

$$U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)}) = u_1^{(r)} + \eta_1^{(r)} \left(\delta_{1,l_1}^{(r)}(l_1^{(v)} - l_1^{(r)}) + \delta_{1,l_J}^{(r)}(l_J^{(v)} - l_J^{(r)}) + \delta_{1,C_P}^{(r)}(C_P^{(v)} - C_P^{(r)}) \right).$$

Then $u_1^{(v)} > U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)})$ implies

$$u_1^{(v)} > u_1^{(r)} + \eta_1^{(r)} \left(\delta_{1,l_1}^{(r)}(l_1^{(v)} - l_1^{(r)}) + \delta_{1,l_J}^{(r)}(l_J^{(v)} - l_J^{(r)}) + \delta_{1,C_P}^{(r)}(C_P^{(v)} - C_P^{(r)}) \right),$$

a contradiction of the Afriat inequalities implied by Proposition 2. This shows that $U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)}) = u_1^{(v)}$. A similar reasoning gives that $U_2(l_2^{(v)}, l_J^{(v)}, C_P^{(v)}) = u_2^{(v)}$ and $U_K(t_1^{(v)}, t_2^{(v)}, t_J^{(v)}, C_K^{(v)}) = u_K^{(v)}$.

Second, we need to show that the data under consideration maximize the constructed utility functions. In other words, for any l_m, l_J, h_m^R, h_m^I, t_m, t_J, T_K, C_P, C_K that satisfy

- $C_P + C_K + w_K^{(v)} T_K - \sum_{m=1}^2 (w_m^{(v)} h_m^R + (w_m^{(v)} + p_m^{(v)}) h_m^I)$
  $\leq C_P^{(v)} + C_K^{(v)} + w_K^{(v)} T_K^{(v)} - \sum_{m=1}^2 (w_m^{(v)} h_m^{R\,(v)} + (w_m^{(v)} + p_m^{(v)}) h_m^{I\,(v)})$;
- $l_m + l_J + t_m + t_J + h_m^R + h_m^I = l_m^{(v)} + l_J^{(v)} + t_m^{(v)} + t_J^{(v)} + h_m^{R\,(v)} + h_m^{I\,(v)}$;
- $\sum_{m=1}^2 t_m + t_J + T_K \geq \sum_{m=1}^2 t_m^{(v)} + t_J^{(v)} + T_K^{(v)}$; and
- $l_J + t_J + \max\{h_1^R, h_2^R\} + h_1^I + h_2^I \leq l_J^{(v)} + t_J^{(v)} + \max\{h_1^{R(v)}, h_2^{R(v)}\} + h_1^{I(v)} + h_2^{I(v)}$,

it must be that $\sum_m \mu_m^{(v)} U_m(l_m, l_J, C_P) + \mu_K^{(v)} U_K(t_1, t_2, t_J, C_K) \leq \sum_m \mu_m^{(v)} U_m(l_m^{(v)}, l_J^{(v)}, C_P^{(v)}) + \mu_K^{(v)} U_K(t_1^{(v)}, t_2^{(v)}, t_J^{(v)}, C_K^{(v)})$. Supplementary to our construction of utility functions, we also choose $\mu_m^{(v)} = 1/\eta_m^{(v)}$ and $\mu_K^{(v)} = 1/\eta_K^{(v)}$. Thus

$$\begin{aligned}
& \mu_1^{(v)} U_1(l_1, l_J, C_P) + \mu_2^{(v)} U_2(l_2, l_J, C_P) + \mu_K^{(v)} U_K(t_1, t_2, t_J, C_K) \\
\leq\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& + \textstyle\sum_m \left(\delta_{m,l_m}^{(v)}(l_m - l_m^{(v)}) + \delta_{m,l_J}^{(v)}(l_J - l_J^{(v)}) + \delta_{m,C_P}^{(v)}(C_P - C_P^{(v)}) \right) \\
& + \delta_{K,t_1}^{(v)}(t_1 - t_1^{(v)}) + \delta_{K,t_2}^{(v)}(t_2 - t_2^{(v)}) + \delta_{K,t_J}^{(v)}(t_J - t_J^{(v)}) + (C_K - C_K^{(v)}) \\
=\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& + \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)})(l_m - l_m^{(v)}) + (w_1^{(v)} + w_2^{(v)})(l_J - l_J^{(v)}) + (C_P - C_P^{(v)}) \\
& + \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)} - w_K^{(v)})(t_m - t_m^{(v)}) + (w_1^{(v)} + w_2^{(v)} - w_K^{(v)})(t_J - t_J^{(v)}) + (C_K - C_K^{(v)}) \\
=\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& + \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)})(l_m - l_m^{(v)}) + (w_1^{(v)} + w_2^{(v)})(l_J - l_J^{(v)}) + (C_P - C_P^{(v)}) \\
& + \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)})(t_m - t_m^{(v)}) + (w_1^{(v)} + w_2^{(v)})(t_J - t_J^{(v)}) \\
& - w_K^{(v)}(t_1 + t_2 + t_J - t_1^{(v)} - t_2^{(v)} - t_J^{(v)}) + (C_K - C_K^{(v)}) \\
\leq\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& + \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)})(l_m - l_m^{(v)}) + (w_1^{(v)} + w_2^{(v)})(l_J - l_J^{(v)}) + (C_P - C_P^{(v)}) \\
& + \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)})(t_m - t_m^{(v)}) + (w_1^{(v)} + w_2^{(v)})(t_J - t_J^{(v)}) + w_K^{(v)}(T_K - T_K^{(v)}) + (C_K - C_K^{(v)}) \\
=\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& + \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)})(L_m + T_m - L_m^{(v)} - T_m^{(v)}) + \sum_m p_{-m}^{(v)}(l_J + t_J - l_J^{(v)} - t_J^{(v)})
\end{aligned}$$

$$
\begin{aligned}
& +w_K^{(v)}(T_K - T_K^{(v)}) + (C_P - C_P^{(v)}) + (C_K - C_K^{(v)}) \\
\leq\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& - \textstyle\sum_m (w_m^{(v)} - p_{-m}^{(v)})(h_m^R + h_m^I - h_m^{R\,(v)} - h_m^{I\,(v)}) \\
& - \textstyle\sum_m p_{-m}^{(v)} \left(\max\{h_1^R, h_2^R\} + h_1^I + h_2^I - \max\{h_1^{R(v)}, h_2^{R(v)}\} - h_1^{I(v)} - h_2^{I(v)} \right) \\
& +w_K^{(v)}(T_K - T_K^{(v)}) + (C_P - C_P^{(v)}) + (C_K - C_K^{(v)}) \\
\leq\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& - \textstyle\sum_m \left(w_m^{(v)}(h_m^R - h_m^{R(v)}) + w_m^{(v)}(h_m^I - h_m^{I\,(v)}) \right) + p_o^{(v)}((h_n^R - h_n^{R(v)}) + (h_n^I - h_n^{I\,(v)})) \\
& -p_o^{(v)} \left((h_n^R - h_n^{R(v)}) + (h_1^I - h_1^{I(v)}) + (h_2^I - h_2^{I(v)}) \right) \\
& +w_K^{(v)}(T_K - T_K^{(v)}) + (C_P - C_P^{(v)}) + (C_K - C_K^{(v)}) \\
=\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
& -w_n^{(v)} H_n - w_o^{(v)} h_o^R - (w_o^{(v)} + p_o^{(v)}) h_o^I + w_n^{(v)} H_n{}^{(v)} + w_o^{(v)} h_o^{R(v)} + (w_o^{(v)} + p_o^{(v)}) h_o^{I(v)} \\
& +C_P + C_K + w_K^{(v)} T_K - C_P^{(v)} - C_K^{(v)} - w_K^{(v)} T_K^{(v)} \\
\leq\ & \textstyle\sum_m \mu_m^{(v)} u_m^{(v)} + \mu_K^{(v)} u_K^{(v)} \\
=\ & \mu_1^{(v)} U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)}) + \mu_2^{(v)} U_2(l_2^{(v)}, l_J^{(v)}, C_P^{(v)}) + \mu_K^{(v)} U_K(t_1^{(v)}, t_2^{(v)}, t_J^{(v)}, C_K^{(v)}).
\end{aligned}
$$

The first relation in the sequence (inequality) follows by construction of U_m and U_K. The second (equality) uses the conditions of Proposition 2 to replace shadow prices with wages and premiums. The third (equality) simply rearranges the terms. The fourth relation (inequality) follows from the childcare constraint. The fifth (equality) rearranges terms and uses the leisure and childcare identities (2). The sixth (inequality) stems from the time budgets and the upper bound on togetherness. The seventh relation (inequality) is due to concavity of function $-\max\{h_1^R, h_2^R\}$. Let index $o \in \{1, 2\}$ denote the spouse who works the least regular hours and let $n \in \{1, 2\}$ denote the spouse who works the most: $h_n^{R(v)} \geq h_o^{R(v)}$. Then $\max\{h_1^R, h_2^R\} - \max\{h_1^{R(v)}, h_2^{R(v)}\} \geq h_n^R - h_n^{R(v)}$. Notice that $p_n^{(v)} = 0$ follows from Proposition 2. The eighth relation (equality) rearranges terms and uses the hours identity (3). The ninth relation (inequality) is due to the budget constraint.

For each bundle l_m, l_J, h_m^R, h_m^I, t_m, t_J, T_K, C_P, C_K that respects the budget constraint, the parental time constraints, the childcare constraint and the upper bound on joint time use, we have thus shown that

$$
\begin{aligned}
& \mu_1^{(v)} U_1(l_1, l_J, C_P) + \mu_2^{(v)} U_2(l_2, l_J, C_P) + \mu_K^{(v)} U_K(t_1, t_2, t_J, C_K) \\
\leq\ & \mu_1^{(v)} U_1(l_1^{(v)}, l_J^{(v)}, C_P^{(v)}) + \mu_2^{(v)} U_2(l_2^{(v)}, l_J^{(v)}, C_P^{(v)}) + \mu_K^{(v)} U_K(t_1^{(v)}, t_2^{(v)}, t_J^{(v)}, C_K^{(v)}).
\end{aligned}
$$

We conclude that the constructed weights $\mu_m^{(v)}$, $\mu_K^{(v)}$ and utility functions U_m, U_K effectively provide a collective rationalization with togetherness.

C.3 Set identification of joint childcare

C.3.1 Illustration

The second example of section III.C shows that the hypothetical data of table 4 are not consistent with *collective rationality*, as described in Proposition 1. Let us now show that the data *are* consistent with *collective rationality with togetherness*, as per Proposition 2. Invoking the opening condition in Definition 1, bundle A is revealed preferred over bundle B if

$$\delta_{K,t_1}^{(A)} \times (t_1^{(A)} - t_1^{(B)}) + \delta_{K,t_2}^{(A)} \times (t_2^{(A)} - t_2^{(B)}) + \delta_{K,t_J}^{(A)} \times (t_J^{(A)} - t_J^{(B)}) + (C_K^{(A)} - C_K^{(B)}) > 0.$$

This should then imply (invoking the closing condition of Definition 1) that

$$\delta_{K,t_1}^{(B)} \times (t_1^{(B)} - t_1^{(A)}) + \delta_{K,t_2}^{(B)} \times (t_2^{(B)} - t_2^{(A)}) + \delta_{K,t_J}^{(B)} \times (t_J^{(B)} - t_J^{(A)}) + (C_K^{(B)} - C_K^{(A)}) \leq 0.$$

One can use the childcare identity (2) to express private childcare as a function of total childcare and joint childcare. Given that the shadow prices are all disciplined by Proposition 2, it is easy to show that the inequalities are both satisfied if $t_J^{(A)} - t_J^{(B)} \geq \frac{55}{3}$. This offers us some information about unobserved joint childcare in our data: joint childcare is higher at prices A than prices B by at least $\frac{55}{3}$ because joint childcare at A is relatively cheaper ($\delta_{K,t_J}^{(A)}/\delta_{K,t_m}^{(A)} = 37/17$) than joint childcare at prices B ($\delta_{K,t_J}^{(B)}/\delta_{K,t_m}^{(B)} = 17/7$).

While the above application of GARP (Definition 1) illustrates the workings of set identification of childcare in our setting, the result $t_J^{(A)} - t_J^{(B)} \geq \frac{55}{3}$ does not say much about the number of hours joint childcare really takes up in a typical week. Perhaps joint childcare at prices A takes up 100 hours and joint childcare at B takes up zero hours, or perhaps joint childcare at A is about 20 hours while joint childcare at B only one hour. Fortunately there is more information in our design that helps further discipline joint childcare. By construction, joint childcare is always between 0 and the minimum individual total childcare, $t_J \in [0, \min\{T_1, T_2\}]$. This upper bound is because joint childcare cannot be larger than *either* parent's own childcare, so a value of 100 is not a possibility here. This suggests that we should bring in these naive *theoretical* bounds into the problem, namely $0 \leq t_J^{(A)} \leq 20$ and $0 \leq t_J^{(B)} \leq 10$.

Suppose $t_J^{(B)}$ is at its lowest theoretical value (0); then $t_J^{(A)} - t_J^{(B)} \geq \frac{55}{3}$ implies that $t_J^{(A)} \geq \frac{55}{3}$. Suppose, alternatively, that $t_J^{(B)}$ is at its maximum theoretical value (10); $t_J^{(A)} - t_J^{(B)} \geq \frac{55}{3}$ implies that $t_J^{(A)} \geq \frac{85}{3}$ which is higher than the maximum theoretical value for $t_J^{(A)}$ (20). So $t_J^{(B)}$ cannot be at its maximum theoretical value and the sole new information out of this line of argument is that $t_J^{(A)} \geq \frac{55}{3}$. Similarly, suppose $t_J^{(A)}$ is at its updated lowest value ($\frac{55}{3}$); then $t_J^{(A)} - t_J^{(B)} \geq \frac{55}{3}$ implies that $t_J^{(B)} = 0$. Suppose, alternatively, that $t_J^{(A)}$ is at its maximum theoretical value (20); $t_J^{(A)} - t_J^{(B)} \geq \frac{55}{3}$ implies that $t_J^{(B)} \leq \frac{5}{3}$. Combining all this, we conclude that $\frac{55}{3} \leq t_J^{(A)} \leq 20$ and $0 \leq t_J^{(B)} \leq \frac{5}{3}$ are

Table C.1 – Distribution of bounds on weekly t_J, after additional restrictions

t_J	estimated lower bound	estimated upper bound	naive upper bound
Distribution across households:			
min	0	0	0
first quartile	0	5.12	5.37
median	0	10.00	10.53
mean	3.75	11.92	12.90
third quartile	5.54	16.65	17.78
max	34.75	51.49	51.49

Notes: The table reports the distribution *across households* of the bounds on joint childcare t_J (weekly hours). The results are over 250 households consistent with collective rationality with togetherness (T–CR).

the applicable bounds of joint childcare in the hypothetical data of table 4.

When there are more than two price regimes, as there usually are in practice, the calculations above may become tedious. A somewhat related but slightly more structured way to do the same thing is to work with $\alpha^{(v)} = t_J^{(v)} / \min\{T_1^{(v)}, T_2^{(v)}\}$, namely the fraction that joint childcare at prices v is of its naive theoretical maximum. We can then choose $t_J^{(v)}$'s in order to minimize and maximize $\alpha = (\sum_v 1)^{-1} \sum_v \alpha^{(v)}$ subject to $t_J^{(A)} - t_J^{(B)} \geq \frac{55}{3}$, thus obtain the lowest and highest fractions of joint childcare (out of its naive theoretical maximum) that rationalize the data. This is precisely what we do with our actual data in section IV.B. In our hypothetical data of table 4, the minimization yields $t_J^{(A)} = 18.33$ and $t_J^{(B)} = 0$, corresponding to a lower bound on α of 0.458, while the maximization yields $t_J^{(A)} = 20$ and $t_J^{(B)} = 1.67$, corresponding to an upper bound on α of 0.583.

C.3.2 Optional additional restrictions for empirical implementation

Following the above illustration, table 8 in the main text reports bounds on the average $t_J / \min\{T_1, T_2\}$ within household groups consistent with collective rationality with togetherness (Proposition 2). These bounds can be tightened further by imposing additional structure on the problem. One appealing restriction is $\alpha - \Delta \leq t_J^{(v)} / \min\{T_1^{(v)}, T_2^{(v)}\} \leq \alpha + \Delta$ for a choice of Δ. This guarantees that the proportion of joint childcare for a given household v within a group does not deviate too much from the mean proportion in the group. For example, $\Delta = 0.1$ implies that the proportion of joint childcare of any given household does not deviate by more than 10 percentage points from the group average.

The choice of Δ will matter for the results and an unrealistic value may mean households violate the conditions of Proposition 2. So an interesting choice for Δ is to fix it at the lowest possible level per group that still allows to collectively rationalize the households with togetherness. This effectively minimizes heterogeneity in $t_J^{(v)} / \min\{T_1^{(v)}, T_2^{(v)}\}$ across households in the same group, though it may well increase heterogeneity across

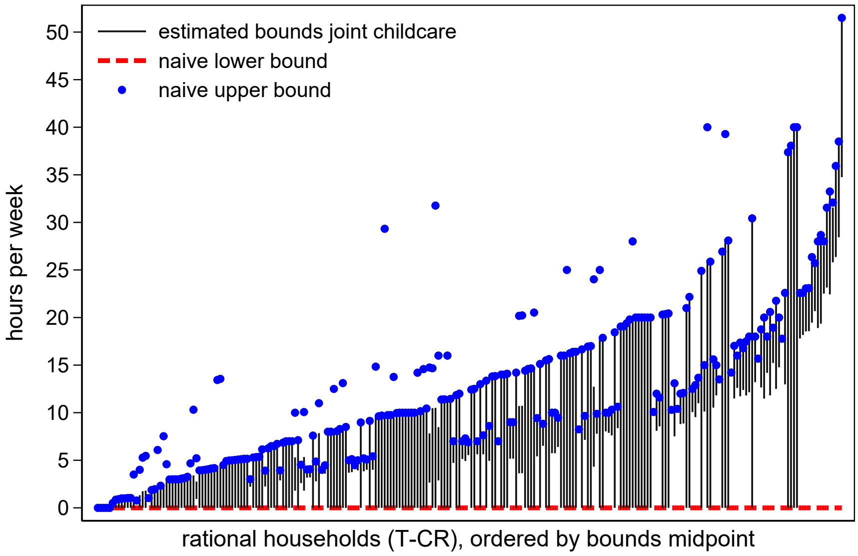


Figure C.1 – Bounds on weekly t_J, after additional restrictions

Notes: The figure plots the estimated bounds on joint childcare t_J (weekly hours) among 250 households consistent with collective rationality with togetherness (T–CR). The naive lower bound is zero; the naive upper bound is $\min\{T_1, T_2\}$.

different groups. We apply this restriction and we observe that our bounds are sharpened substantially. Table C.1 presents the distribution of bounds (switching from bounds on proportions to bounds on t_J) for all 250 households consistent with T–CR; figure C.1 plots the bounds along with the naive minimum and maximum per household. Each household has a different naive maximum so the bounds on t_J are mechanically household-specific. Figure C.1 reveals that our approach produces informative and often sharp bounds for a large fraction of admissible households. Joint childcare takes up a substantial amount of the overall supply of childcare in the family: while on average men spend 13.3 and women 21.7 hours with their children per week (raw data table 1 in main text), our average lower bound is 3.8 hours and our average upper bound is 11.9 hours. These results suggest that joint childcare -like joint leisure- is an important component of household time use.

C.4 Mixed integer linear programming problem

In this appendix we show how we formulate our revealed preference conditions as a mixed integer linear programming problem. We define binary variables $x_m^{(s),(v)}$ and $x_K^{(s),(v)}$, with $x_m^{(s),(v)}$ equal to 1 if spouse m 'revealed prefers' bundle s over v and 0 otherwise, and $x_K^{(s),(v)}$ equal to 1 if child bundle s is 'revealed preferred' over v and 0 otherwise.

A set of observations V in D_{LISS} is consistent with collective rationality with togetherness (Proposition 2) if and only if the following problem is feasible (i.e. it has a solution). For all observations $s, s1, v \in V$ in which $h_1^R > h_2^R$ (without loss of generality), there exist

- binary variables $x_1^{(s),(v)}$, $x_2^{(s),(v)}$, $x_K^{(s),(v)}$, all $\in \{0, 1\}$,
- shadow prices associated with joint leisure $\delta_{1,l_J}^{(v)}$, $\delta_{2,l_J}^{(v)} \in R_+$,

- shadow prices associated with parental consumption $\delta_{1,C_P}^{(v)}$, $\delta_{2,C_P}^{(v)} \in R_+$,
- wage premium and price of market childcare $p_m^{(v)}$, $w_K^{(v)}$ within their respective grids,
- levels of private and joint childcare $t_1^{(v)}$, $t_2^{(v)}$, $t_J^{(v)} \in R_+$,

such that

$$\begin{aligned}
\delta_{1,l_J}^{(v)} + \delta_{2,l_J}^{(v)} &= w_1^{(v)} + w_2^{(v)} \\
\delta_{1,C_P}^{(v)} + \delta_{2,C_P}^{(v)} &= 1 \\
t_m^{(v)} + t_J^{(v)} &= T_m^{(v)} \\
\\
x_1^{(s),(v)} M &> (w_1^{(s)} - p_2^{(s)})(l_1^{(s)} - l_1^{(v)}) + \delta_{1,l_J}^{(s)}(l_J^{(s)} - l_J^{(v)}) + \delta_{1,C_P}^{(s)}(C_P^{(s)} - C_P^{(v)}) \\
x_1^{(s),(s1)} + x_1^{(s1),(v)} &\leq 1 + x_1^{(s),(v)} \\
(1 - x_1^{(s),(v)})M &\geq (w_1^{(v)} - p_2^{(v)})(l_1^{(v)} - l_1^{(s)}) + \delta_{1,l_J}^{(v)}(l_J^{(v)} - l_J^{(s)}) + \delta_{1,C_P}^{(v)}(C_P^{(v)} - C_P^{(s)}) \\
\\
x_2^{(s),(v)} M &> w_2^{(s)}(l_2^{(s)} - l_2^{(v)}) + \delta_{2,l_J}^{(s)}(l_J^{(s)} - l_J^{(v)}) + \delta_{2,C_P}^{(s)}(C_P^{(s)} - C_P^{(v)}) \\
x_2^{(s),(s1)} + x_2^{(s1),(v)} &\leq 1 + x_2^{(s),(v)} \\
(1 - x_2^{(s),(v)})M &\geq w_2^{(v)}(l_2^{(v)} - l_2^{(s)}) + \delta_{2,l_J}^{(v)}(l_J^{(v)} - l_J^{(s)}) + \delta_{2,C_P}^{(v)}(C_P^{(v)} - C_P^{(s)}) \\
\\
x_K^{(s),(v)} M &> (w_1^{(s)} - p_2^{(s)} - w_K^{(s)})(t_1^{(s)} - t_1^{(v)}) + (w_2^{(s)} - w_K^{(s)})(t_2^{(s)} - t_2^{(v)}) \\
&\quad + (w_1^{(s)} + w_2^{(s)} - w_K^{(s)})(t_J^{(s)} - t_J^{(v)}) + (C_K^{(s)} - C_K^{(v)}) \\
x_K^{(s),(s1)} + x_K^{(s1),(v)} &\leq 1 + x_K^{(s),(v)} \\
(1 - x_K^{(s),(v)})M &\geq (w_1^{(v)} - p_2^{(v)} - w_K^{(v)})(t_1^{(v)} - t_1^{(s)}) + (w_2^{(v)} - w_K^{(v)})(t_2^{(v)} - t_2^{(s)}) \\
&\quad + (w_1^{(v)} + w_2^{(v)} - w_K^{(v)})(t_J^{(v)} - t_J^{(s)}) + (C_K^{(v)} - C_K^{(s)})
\end{aligned}$$

with M arbitrarily large. We have substituted the shadow prices of private leisure and childcare with their equivalent expressions from Proposition 2.

The first two conditions implement the Lindahl-Bowen-Samuelson condition for the optimal provision of public goods (joint leisure and consumption, respectively). The third condition is the childcare identity (2). Conditions 4 through 6 impose GARP on commodities (l_1, l_J, C_P) of spouse 1 in bundles s and v. The opening condition states that spouse 1 'revealed prefers' s over v ($x_1^{(s),(v)} = 1$) if $(w_1^{(s)} - p_2^{(s)})(l_1^{(s)} - l_1^{(v)}) + \delta_{1,l_J}^{(s)}(l_J^{(s)} - l_J^{(v)}) + \delta_{1,C_P}^{(s)}(C_P^{(s)} - C_P^{(v)}) \geq 0$. Bundle v was affordable given the prices and personalized budget at observation s, but spouse 1 chose s. The middle condition imposes transitivity on revealed preferences. The closing condition requires that if spouse 1 'revealed prefers' s over v ($x_1^{(s),(v)} = 1$) then bundle v must be less expensive than s at prices v. Otherwise, it was not rational to choose v. The other conditions are analogous; they impose GARP on spouse 2's commodities (l_2, l_J, C_P) and child inputs (t_1, t_2, t_J, C_K) respectively.

Linearity. Binary variables $x^{(s),(v)}$ transform the `if/then` GARP condition of Definition 1 into inequalities that are linear in $x^{(s),(v)}$, the δ's, and the t's. Of course, linearity in childcare times t is only possible because we have not kept wage premium p_m and childcare price w_K as unknowns. As we explain in section III.D, we try values for p_m and w_K over a grid such that $p_m = \{0;\ 0.25;\ 0.5\} \times m$'s regular wage and $w_K = \{0;\ 0.33\} \times$ household's lowest wage. If, for a given p_m and w_K, the program has a solution, then the data are consistent with collective rationality with togetherness. We can search for a solution using standard software, such as `intlinprog` on Matlab. If there are multiple (p_m, w_K) tuples for which the program has a solution, we select the lowest possible prices.

Recovery of joint childcare. To recover bounds on t_J, we minimize and maximize (lower and upper bounds respectively) an appropriate function of t_J subject to all aforementioned conditions. Technically, this is the same mixed integer linear programming problem wrapped around an optimization routine. The appropriate function of t_J is $\alpha = (\sum_v 1)^{-1} \sum_v \alpha^{(v)}$, where $\alpha^{(v)} = t_J^{(v)} / \min\{T_1^{(v)}, T_2^{(v)}\}$ is the fraction that t_J at prices v is of its theoretical maximum value. This has the advantage of incorporating information on the theoretical maximum value of joint childcare (see appendix C.3.1).

Recovery of sharing rule. To recover bounds on the sharing rule, we minimize and maximize $\eta_m / \sum_m \eta_m$ subject to all aforementioned conditions. This is the same mixed integer linear programming problem, again wrapped around an optimization routine.

Measurement error. To address measurement error in individual total childcare without losing linearity, we rewrite the childcare identity (2) as $t_m^{(v)} + t_J^{(v)} = (1 + \varepsilon_m^{(v)}) \times T_m^{(v)}$. Measurement error $\varepsilon_m^{(v)}$ captures the relative deviation of observed individual total childcare $T_m^{(v)}$ from its true level $\widetilde{T}_m^{(v)} = (1 + \varepsilon_m^{(v)}) \times T_m^{(v)}$.

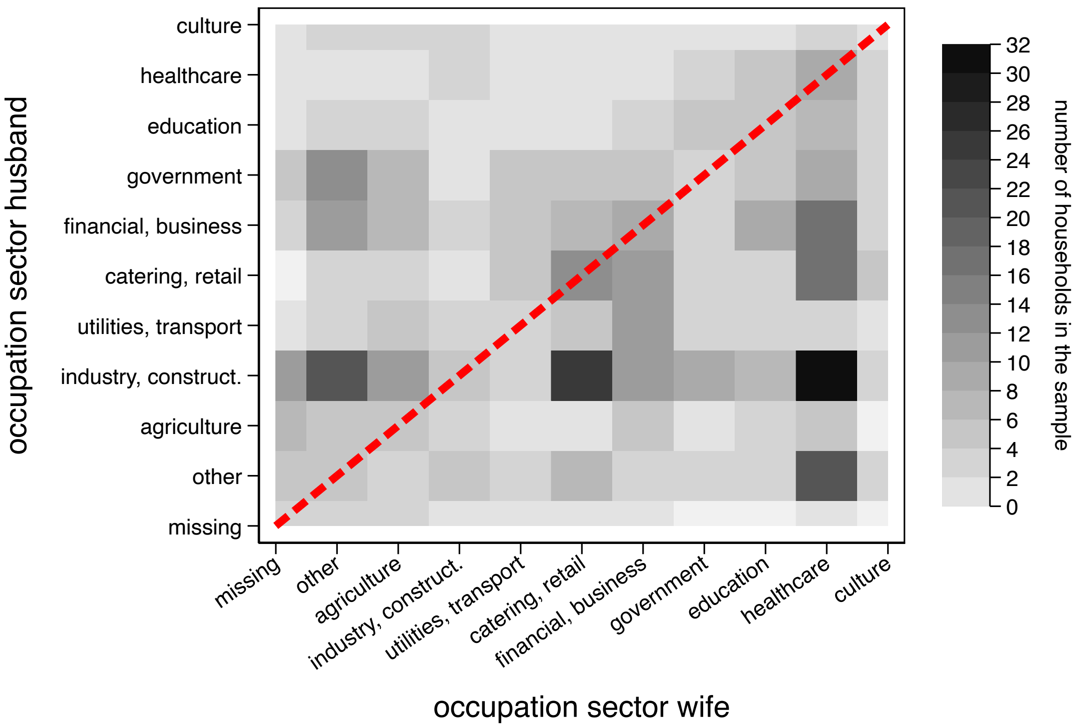
D Extensions

Table D.1 – Extensions: fit and value of togetherness

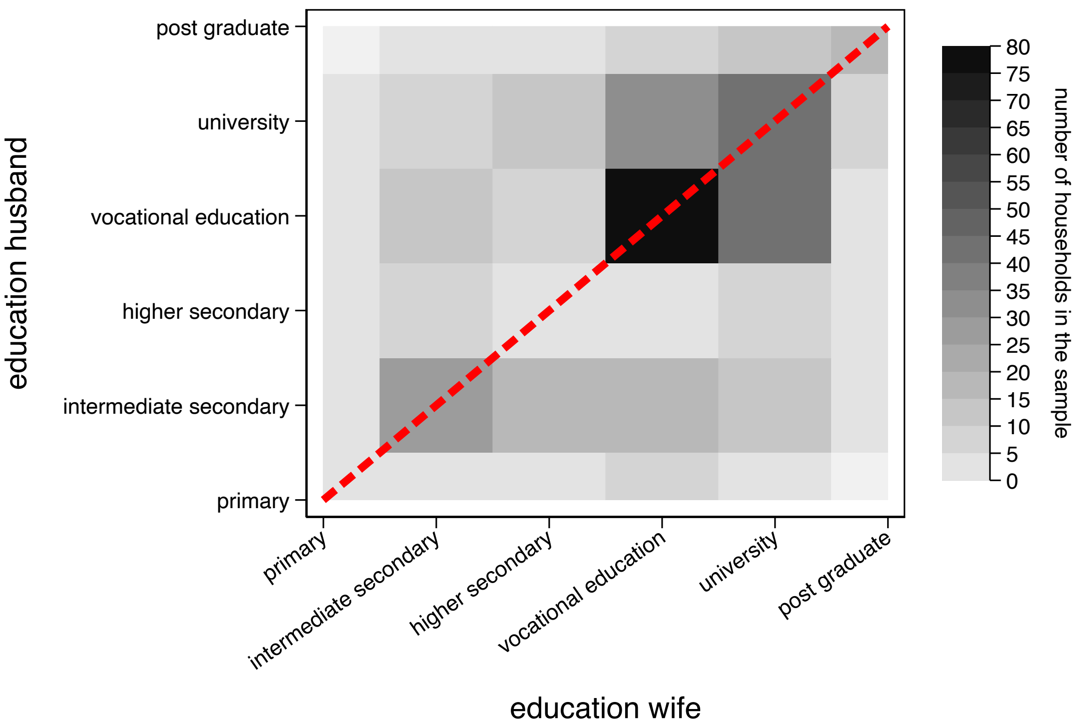
		Children and assortative matching scenarios				
	Baseline	(1) 1-2 children	(2) 3+ children	(3) Child-less	(4) Positive matching	(5) Negative matching
Testing (pass rates, power, predictive success)						
pass CR	0.25	0.06	0.61	0.67	0.39	0.22
pass T–CR	0.67	0.5	0.89	0.71	0.83	0.44
pass # groups	24	9	16	17	15	8
pass # HHs	250	137	94	233	133	99
power CR	0.82	0.97	0.49	0.62	0.71	0.91
power T–CR	0.62	0.87	0.26	0.59	0.44	0.73
pred. succ. CR	0.07	0.02	0.10	0.29	0.10	0.13
pred. succ. T–CR	0.29	0.37	0.15	0.30	0.27	0.18
Value of joint leisure $\sum_m \delta_{m,l_J} - \sum_m \delta_{m,l_m}$						
first quartile	0	0	0	0	0	0
median	0	0	0	0	0	0
mean	1.22	0.90	0.75	0.14	0.37	0.90
third quartile	2.60	2.18	1.52	0	0	2.17
max	9.46	6.34	8.45	6.25	6.34	5.90
Value of joint childcare $\delta_{K,t_J} - \sum_m \delta_{K,t_m}$						
first quartile	0	2.78	0	0	0	0
median	2.44	3.30	0	0	2.22	0
mean	2.08	3.59	0.97	0.14	1.88	1.83
third quartile	3.30	4.09	1.94	0	3.43	3.23
max	9.46	10.37	8.45	6.25	6.34	9.57

Notes: The table reports pass rates, power, and predictive success of collective rationality (CR) and collective rationality with togetherness (T–CR), and the distribution of the value of joint leisure and joint childcare among households consistent with T–CR. We introduce the following scenarios: (1) sample families with 1-2 children (288 households; 18 groups); (2) sample families with 3+ children (110; 18); (3) a sample of childless families (346; 24) briefly presented in appendix A.2; (4) sample families in which the partners have the same education (166; 18); (5) sample families in which the partners differ in the level of schooling (232; 18). These samples have fewer observations than the baseline so we introduce a smaller number of household groups. Households in scenarios (1)-(2) and (4)-(5) are assigned to 18 homogeneous groups, with the assignment determined by calendar year (for 2009, 2010, 2012), age of youngest child (for 0-5, 6-12), average age of parents (for 25-34, 35-44, 45-60), but not parental education. Households in scenario (3) are assigned to 24 homogeneous groups according to calendar year (for 2009, 2010, 2012), average age of the partners (for 25-35, 36-51, 52-55, 56-60), and education (2 values, cutoff at intermediate vocational education). Unlike the baseline assignment, we have introduced here a fourth bracket for the age of parents given that our sample size in this case (346 households) justifies a finer split. In all cases our assignment to groups is such that the resulting groups have as equal size between them as possible.

Figure D.1 – Assortative matching: occupational sector and education



(a) Occupational sector heatmap



(b) Education heatmap

Notes: The figure plots occupational sector and education husband-wife heatmaps. The heatmaps show the number of sample households in each cell. The red dotted diagonal indicates the cells in which positive matching occurs.

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