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Care for Elderly Parents, Siblings' Interactions and Gender

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Abstract

We analyze how siblings interact when deciding informal care provision to their elderly parent. We consider a non-cooperative model of the children's care decisions, allowing productivity of care provision to vary with the child's gender. We show that this implies that the strategic interaction effects depend on the siblings' gender composition. The theory leads to a simultaneous bivariate tobit model. Estimation results suggest that sons' and daughters' free-riding behavior is significantly larger when the sibling is a sister. This is in line with a higher care provision productivity for women and can explain why women more often provide informal care than men do.

JEL codes: J14; J16; D13; D64.

Keywords: Informal care, Long-term care, Strategic interactions, Simultaneous tobit.

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1 Introduction

Family members play a key role in the production of long term care (LTC) to elderly people. Indeed, in France, Brunel et al. (2019) estimated that in 2015, 3.9 million people regularly provided assistance to an elderly person with LTC needs and most informal care givers were family members: Among seniors receiving care, 38% declared that care was provided by a spouse, 55% that it was provided by one or more children and 6% that both a spouse and at least one child provided care.

Due to population aging, the demand for informal care is increasing and expected to increase further (European Commission, 2018). In addition, policies in many countries aim at enabling the elderly to grow old in their own home in order to limit the rise of public spending for LTC. Such policies particularly rely on family support (Zigante, 2018). The way in which the relatives of older people interact in their informal care decisions is a central issue in how much informal care is provided and how this is organized. Insight in the interactions among different potential care providers and family members in particular, should lead to a better understanding of the allocation of informal care provision among family members, and should help to design effective public policies concerning formal and informal long term care.

It is well known that women are more likely to be care givers and provide more intensive care than men do (Bauer and Sousa-Poza, 2015). These gender differences partly arise from an unequal distribution of care giving responsibilities between siblings. To our knowledge, there is no study that specifically focuses simultaneously on strategic interactions and gender. In the current paper, we first develop a stylized theoretical model of a non-cooperative game in which two siblings choose the time they spend on care provision to an elderly parent, and the two siblings can have different productivity. To introduce gender considerations we allow the productivity to systematically differ between male and female care givers. The model implies that the effect of one child's time of care provision on the optimal time of care provision by the sibling – the sibling effect – depends on the gender of both children. The sibling effects are different for daughters and sons, and also depend on whether the daughter or son's sibling is a brother or a sister. From the theoretical model, we derive an empirical model that is a system

of two simultaneous tobit equations.

As enlightened by Manski's reflection problem (Manski, 1993), the main challenge in this type of analysis is to empirically disentangle the effect of the sibling's care giving behavior (strategic or endogenous interactions) from the effect of the sibling's characteristics (contextual interactions). Moreover, Manski's framework suggests that the siblings' care giving decisions can be correlated through their common unobserved characteristics (family values, for example) or their shared environment (correlated effects). The literature proposes different methods to overcome this difficulty, including the use of instrumental variables or relying on non-linearities that help identification.[1] Our non-cooperative framework implies that one child's optimal time devoted to care provision is not directly affected by the sibling's observable characteristics unless these affect the sibling's productivity in care giving. In our empirical model, productivity varies by gender only and we use the other characteristics of the sibling as instruments (or exclusion restrictions). Finally, we also use the non-linearity of the bivariate tobit model. The model allows us to take account of the correlation between the unobservable characteristics (the unobserved preference heterogeneity) of both siblings. We are thus able to estimate the best response functions of each child and to explore the strategic interactions as well as correlated effects in the care giving decisions of both children.

Our paper is closely related to the literature on siblings' strategic interactions on informal care provision to an elderly parent, and also to gender differences in providing informal care. Most papers in this literature estimate children's best response functions derived from a symmetric noncooperative game, taking living arrangements as given. They estimate models in which the intensity of care provision directly depends on the care giving behavior of all the siblings. These studies suggest that siblings are strategic substitutes (Checkovich and Stern, 2002; Antman, 2012; Callegaro and Pasini, 2008; Wolf et al., 1997); that is, children reduce the time of informal care they devote to their parent in response to an increase in the time of care provided by their sibling(s). One notable exception is Byrne et al. (2009) who estimate a structural noncooperative model. In their study, the children strategically interact on the time

[1]For other methods or more details, see Manski (2000, 1993); Brock and Durlauf; Moffitt (2001).

they devote to care through a health production function. As their model does not allow to directly estimate one child's response to the other children's care giving behavior, they use a simulation procedure to explore possible free-riding between siblings. They find that children's decisions are nearly independent. Byrne et al. (2009) also find that the gender differences in care provision can be explained by differences in effectiveness, the burden of care giving, and opportunity costs.

Our contributions can be summarized as follows. First, we put more emphasis on the gender differences in the allocation of care giving. Most papers include gender as a control variable so that gender shifts the propensity to provide informal care, but they do not account for the fact that the gender of the sibling might impact the strategic behavior. We argue that gender differences in productivity (or effectiveness) may generate incentives to free-ride that depend on the gender of the sibling. We develop a simple model to rationalize such complex interactions that cannot be captured by the models used in the literature (Byrne et al., 2009; Antman, 2012; Checkovich and Stern, 2002; Wolf et al., 1997; Callegaro and Pasini, 2008). Our empirical results suggest that sons' as well as daughters' free-riding behavior is significantly larger when the sibling is a sister. This can be theoretically explained by a higher productivity for women than men in care provision, and it can explain the stylized fact that women are generally more involved in providing care to elderly parents than men are. Our findings therefore reconcile results from the literature that provide evidence of strategic interactions (Antman, 2012; Wolf et al., 1997; Callegaro and Pasini, 2008) and studies that find differences in effectiveness (Byrne et al., 2009). It also provides explanations of the gender differences in care giving involvement. The magnitudes of the estimated sibling effects are substantial but far from implying one-to-one substitution. A ten hours increase of the sister's (brother's) monthly hours spent on care giving reduces care giving by about 48 (27) minutes for men and 1.15 hours (39 minutes) for women. On average, it would reduce the probability to participate in care giving by 1.3 (0.9) percentage points for men and by 1.6 (0.7) percentage points for women.

The remainder of the paper is organized as follows: Section 2 presents a review of the literature. Section 3 introduces the theoretical framework. Section 4 presents the empirical model. Section 5 describes the data. Section 6 shows our main results. Section 7 concludes.

2 Literature review

The organization of LTC in the family is usually studied within a game-theoretic framework. Some studies have focused on the issue of long term care arrangements and the seniors' choice of residence (Engers and Stern, 2002; Hiedemann and Stern, 1999; Hiedemann et al., 2017).[2] More specifically, these studies develop a family decision-making process to determine the parent's primary care giver with as main alternatives living in an institution, or receiving informal care from a child and living independently in the community.[3] Even though all the children are considered as potential care givers, the paper focuses on the one child that plays the role of the main care giver. Considering only one care giver when the parent lives in the community has its limitations, since informal care can be a shared responsibility. Indeed, about 36% of the French seniors living in the community and receiving informal care have multiple informal care givers (Brunel et al., 2019). Checkovich and Stern (2002) and Fontaine et al. (2009) also noticed that shared care giving is not uncommon.

Some papers that study the strategic interactions on informal care provision among siblings do allow for multiple care givers, taking living arrangements as given. Byrne et al. (2009) estimate a structural noncooperative model. In their paper, the children strategically interact on the time they devote to care through a health production function. As their model does not allow to directly estimate one child's response to the other children's care giving behavior, they use a simulation procedure to explore possible free-riding between siblings. They find that children's decisions are nearly independent. Checkovich and Stern (2002), Antman (2012), Callegaro and Pasini (2008) and Wolf et al. (1997) estimate models in which the intensity of care provision

[2]Pezzin and Schone (1999) also use a game theoretic model to study the cohabitation of a parent and their daughter, but do not allow the other siblings to participate in the decision process.

[3]Note that Hiedemann et al. (2017) abstract from the family decisions process, but study the dynamics of LTC arrangements.

directly depends on the care giving behavior of all the siblings.[4] These studies suggest that siblings are strategic substitutes. Checkovich and Stern (2002) go further to explore the heterogeneity of this result and find that the population can be divided in two groups: (i) those who consider their siblings' care as a perfect substitute for their own care and (ii) those who do not consider their siblings behavior at all when making care giving decisions.

Fontaine et al. (2009) and Roquebert et al. (2018) assume a pure Nash noncooperative decision process where each child decides to participate (or not) in helping an elderly parent, taking the participation decision of the sibling as given.[5] To have a flexible model that allows the effect of the sibling's care giving behavior to be asymmetric, they focus on families with two children. Their results suggest the existence of asymmetric interactions in informal care participation. For example, Fontaine et al. (2009) find that the oldest child's participation in informal care provision increases with the youngest child's participation, while the youngest child's participation falls if the older child's participates.

Finally, some papers assume strategic behavior on children's location choices. They assume that both children want the parent to receive informal care, but would rather not provide it themselves. They use the framework of a sequential game in which the oldest child, who is usually the first to leave the house of the parent(s), chooses to locate far from the parents such that the younger child has to stay closer in order to provide care (Konrad et al., 2002). Maruyama and Johar (2017) and Stern (2014) find that this model does not provide a good fit to data for the United States. The latter two papers also find that children's location choices are complementary: children prefer to live closes to their parent(s) when another sibling is also living close. This can be explained by the fact 'younger siblings may enjoy living close to each other' (Maruyama and Johar, 2017). One should bear in mind that these results do not necessar-

[4]The framework developed in Antman (2012) aims to study care giving decisions in relation to children's migration in Mexico and the possibility to make financial transfers to the parent. The financial transfers are particularly relevant in this context as the migrant children cannot provide time transfers. Checkovich and Stern (2002) do not consider hours devoted to care, but the number of days of care provided per week.

[5]We use the term "helping" rather than "caring" as the outcome in Fontaine et al. (2009) is a dummy equal to one when the child provides informal care or financial assistance or lives with the parent.

ily imply that informal care decisions are strategic complements since the focus these studies is on location choices, which are determinants of but not the same as care giving choices. Finally, they do not find much strategic behavior in location choices.

These existing papers do not really allow to understand the gender differences in the distribution of care giving responsibilities. The current paper, as most papers in the literature, considers location choices and living arrangements as given, and focuses on families with a non-institutionalized parent. To introduce gender considerations we allow the productivity to systematically differ by gender in a model of noncooperative public good provision. This extension allows us to study strategic interactions according to the gender composition of the siblings.

3 Theoretical framework

Theoretical models of bargaining are well developed, especially in the context of household decisions. The way in which these models can be adapted to long term care arrangements is summarized in Antman (2012). She argues that the noncooperative decision process appears to be the most suited to the context of siblings' interactions on care provision for a parent, as children may have their own family and interests which may conflict with those of their siblings. This assumption is empirically supported by Knoef and Kooreman (2011) who study the cooperativeness of siblings' interactions in European families with two children and find that the noncooperative model fits the data better than a cooperative model for the majority (71%) of all families. Checkovich and Stern (2002) also support this assumption: they empirically reject the collective model and find evidence supporting the noncooperative model.

We therefore consider a simple framework of noncooperative interactions on the time devoted to care between children with complete information in families with a single parent and two children: each child decides how much time to spend on care provision while observing the sibling's time devoted to care. We focus on families with a single parent as this parent is more likely to need care from the children, avoiding issues related to interaction between the two partners in elderly couples. While other models study interactions on living arrangements

(Hiedemann and Stern, 1999; Engers and Stern, 2002; Hiedemann et al., 2017) and location choices (Konrad et al., 2002; Maruyama and Johar, 2017; Stern, 2014), our model takes living arrangements and location choices of children and parents as given. This assumption is made in most studies that are based upon observations drawn from the population of elderly living in the community (Antman, 2012; Fontaine et al., 2009; Roquebert et al., 2018; Byrne et al., 2009; Callegaro and Pasini, 2008; Checkovich and Stern, 2002).

Let us assume each child i maximizes a utility function U_i with arguments l_i and $c = \pi_i c_i + \pi_j c_j$, where l_i is the child's own leisure, c_i is time that i spends on caring for the parent, c_j is the time that i-s sibling (j) spends on caring for the parent, and π_i, π_j are the productivity of child i and sibling j, respectively. In other words, one hour spent by i on care giving generates π_i units of the "public good" c, and similarly for c_j. This specification implies that c_i and c_j are perfect substitutes, and that the strategic interactions in the model are operating through the total amount of care provided to the parent by the two children (c). The assumption of perfect substitutes is also used in the literature because it captures the essence of the problem faced by the siblings and is mathematically and econometrically easier to handle than imperfect substitution (Checkovich and Stern, 2002). We assume that i-s labor supply h_i is exogenously given. Although this assumption might seem unrealistic in theory, it appears to be empirically supported: in the large majority of existing studies, the time devoted to informal care has no causal effect on the labor market participation (see Lilly et al. (2007) and Bauer and Sousa-Poza (2015) for a reviews). In addition, Crespo and Mira (2014) who estimate the causal effect of daily (intensive) care giving on labor market participation, find a significant effect only for Southern European countries but not for Western European countries such as France. The time constraint for sibling i is given by $h_i + c_i + l_i = T$, where T is the time endowment (e.g., 168 hours per week). We consider a non-cooperative Nash-equilibrium, so i maximizes utility under the time constraint taking c_j as given. We use the additive quadratic utility function given by

$$U(l_i, c) = \alpha_1 l_i^2 + \beta_1 l_i + \alpha_2 c^2 + \beta_2 c. \tag{1}$$

This quadratic utility function with "private good" l_i and "public good" c is close to the

example proposed by Checkovich and Stern (2002).[6] The parameters $\alpha_1, \alpha_2, \beta_1, \beta_2$ reflect preferences of child i. In the empirical model, we will allow for heterogeneity in some of them to account for heterogeneity of preferences, but for now we do not make this explicit in the notation. If the utility function is increasing and concave in its arguments, we have: $\alpha_1 < 0, \alpha_2 < 0, \beta_1 > 0, \beta_2 > 0$. Taking the sibling's hours of care provision c_j as given, we can solve the utility maximization problem for child i using substitution, writing everything in terms of c_i: $l_i = T - h_i - c_i$ and $c = \pi_i c_i + \pi_j c_j$. The first order condition for the optimum c_i^* ignoring nonnegativity constraints becomes:

$$c_i^*[2\alpha_1 + 2\alpha_2\pi_i^2] - 2\alpha_1(T - h_i) - \beta_1 + 2\alpha_2\pi_i\pi_j c_j + \beta_2\pi_i = 0 \tag{2}$$

The second order condition implies $2\alpha_1 + 2\alpha_2\pi_i^2 < 0$, which is automatically satisfied for $\alpha_1 < 0, \alpha_2 < 0$. This gives

$$c_i^* = -[2\alpha_1 + 2\alpha_2\pi_i^2]^{-1}[-2\alpha_1(T - h_i) - \beta_1 + 2\alpha_2\pi_i\pi_j c_j + \beta_2\pi_i]. \tag{3}$$

This can also be written as:

$$c_i^* = \gamma_0(\pi_i) + \gamma_1(\pi_i)h_i + \gamma_2(\pi_i)\pi_j c_j \tag{4}$$

where

$$\gamma_0(\pi_i) = -[2\alpha_1 + 2\alpha_2\pi_i^2]^{-1}[-2\alpha_1 T - \beta_1 + \beta_2\pi_i] \tag{5}$$

$$\gamma_1(\pi_i) = -[\alpha_1 + \alpha_2\pi_i^2]^{-1}\alpha_1 \tag{6}$$

[6]Note that there is no strategic bequest motive in the sense that children would provide care in order to compete for the bequest of the parent. A strategic bequest motive does not seem to be empirically supported in the US (Stern, 2014). Nor does is seem to be relevant in the French context, since according to inheritance rights, a very large proportion of the bequest must be equally distributed among the children. In addition, inter-vivos transfers do not help since they are taken into account when the bequest is distributed evenly. Finally, it is not possible to disinherit a child except in very exceptional circumstances (e.g. the child mistreated the parent or killed him/her).

$$\gamma_2(\pi_i) = -[\alpha_1 + \alpha_2 \pi_i^2]^{-1} \alpha_2 \pi_i \tag{7}$$

The restricted optimum satisfying nonnegativity is given by $c_i = max(0, c_i^*)$.

The theory and the signs of α_1 and α_2 imply, as expected: $\gamma_1(\pi_i) < 0, \gamma_2(\pi_i) < 0$ (and $\gamma_0(\pi_i) > 0$). In other words, keeping other variables constant, optimal hours of care c_i^* fall with own hours of paid work h_i (due to the time constraint); they also fall with effective care produced by the sibling ($\pi_j c_j$), since both types of care are (perfect) substitutes. Moreover, the negative effect of c_j on c_i^* increases (in absolute value) with the productivity π_j of sibling j. How c_i^* depends on π_i is not so easy to determine: the partial derivative cannot be signed. This is because an increase in π_i has a "price effect" (spending time on care becomes more effective) as well as an "income effect" (since it raises the level of effective care, it reduces the marginal utility of additional care).

4 Empirical Model

In order to obtain a parsimonious empirical model, we allow for preference heterogeneity through β_2 only. This seems a natural choice, since a change in β_2 immediately translates into a shift in the marginal utility of (total) care c. Moreover, we allow π_i and π_j to be gender specific, so π_i depends on the gender of the child i and π_j on the gender of the sibling j. Indeed, productivity can differ between male and female care givers. A difference in the productivity of informal care provision between sons and daughters is supported by Byrne et al. (2009) who find that care provided by daughters is more effective than care given by sons. Van Houtven et al. (2008) also argue that a difference in effectiveness between men and women may exist. Note that we do not impose that sons are less or more productive than daughters; both are possible, in the theoretical as well as in the empirical model. We assume that π_i and π_j do not depend on other characteristics on i and j; this would be a straightforward extension in principle but would lead to a nonlinear model for c_i^*.

These assumptions imply that γ_0 becomes a gender of the child specific function of ob-

served characteristics and unobserved characteristics of child i:

$$\gamma_0(\pi_i) = X(i)\delta(g(i)) + \sigma(g(i))\epsilon_i.$$

Here $g(i)$ denotes the gender of child i, $X(i)$ is a vector of child i's individual characteristics, ϵ_i is assumed to be drawn from a standard normal distribution, and $\delta(g(i))$ and $\sigma(g(i)), g(i) = m, f$ are (gender specific) parameters to be estimated. Note that ϵ_i is a taste shifter affecting β_2 that is unobserved by the econometrician, but known by the siblings – the game is a game with complete information. Since we do not observe the child's hours of paid work, we replace h_i by a dummy for paid work of child i. $\gamma_1(\pi_i)$ then becomes a gender of child i specific coefficient on this dummy. To simplify notation, we can add the dummy to $X(i)$ and include $\gamma_1(\pi_i)$ as one of the parameters in $\delta(g(i))$. Finally, the term $\gamma_2(\pi_i)\pi_j c_j$ can be written as $\theta(g(i), g(j))c_j$, where $g(j)$ is the gender of the sibling (j). In other words, we get four different parameters on c_j, depending on both the gender of the child $g(i)$ whose care provision we are explaining and the gender of this child's sibling $(g(j))$.

Combining these assumptions gives the following equation for hours of care provided by child i:

$$c_i^* = X(i)\delta(g(i)) + \theta(g(i), g(j))c_j + \sigma(g(i))\epsilon_i; c_i = max(0, c_i^*) \tag{8}$$

Reversing the roles of the two children, we obtain a similar equation for care provided by sibling j:

$$c_j^* = X(j)\delta(g(j)) + \theta(g(j), g(i))c_i + \sigma(g(j))\epsilon_j; c_j = max(0, c_j^*) \tag{9}$$

We assume that (ϵ_i, ϵ_j) is drawn from a bivariate normal distribution with means zero, variances 1, and correlation coefficient ρ, independent of $X(i)$ and $X(j)$. This makes equations 8 and 9 a generalized simultaneous bivariate tobit model (with gender specific coefficients on the other dependent variable and heteroskedasticity due to the gender specific parameters $\sigma(g(i))$ and $\sigma((g)j))$.

Without imposing restrictions on the parameters, this bivariate nonlinear model might suffer from incoherency in the sense that, for a given vector of exogenous variables (both observed

and unobserved), it does not always predict a unique solution (Amemiya, 1974). This incoherency would be due to the fact that the equilibrium of the game is defined as the intersection of two non-linear functions giving the optimal time devoted to care of one child as a function of the optimal care giving of the other child. To ensure the uniqueness of the equilibrium, a coherency condition must be satisfied (Gourieroux et al., 1980). Amemiya (1974) derived this condition for standard multivariate simultaneous tobit models. Adapting his result to our econometric model with gender specific parameters on the dependent variable, three conditions need to be verified: $1 - \theta_{ww}^2 > 0$, $1 - \theta_{mm}^2 > 0$ and $1 - \theta_{wm}\theta_{mw} > 0$. We do not impose these conditions in the empirical analysis but check *ex post* whether they are satisfied or not. We will find they are all satisfied, so that model incoherency is not a concern.

As discussed above, the parameters $\theta_{mm}, \theta_{mw}, \theta_{wm}$ and θ_{ww} measure the strategic interactions of siblings – the effect of the time spent on care giving of the sibling on the child's own time of care provision. The econometric model also allows to explore the correlated effect: This is the common part of the effects of the unobserved (and observed) characteristics of both siblings (e.g., family values) on their care giving behavior, captured by the ρ-s (and by the correlation between $X(i)\delta(g(i))$ and $X(j)\delta(g(j))$). In contrast, the contextual interactions as presented by Manski (2000) cannot be captured in the model. This is due to the assumption of a noncooperative decision process which implies that child i only responds to sibling j-s preferences through c_j; Keeping c_j constant, preferences of sibling j do not affect c_i, so the observed characteristics $X(j)$ of the sibling do not influence child i-s optimal time of care in any other way than through c_j. The advantage of this assumption is that it leads to a natural exclusion restriction that non-parametrically identifies the two equations: Sibling j's characteristics other than gender do not enter the equation for c_i^* (and vice versa).

Finally, the static and non-cooperative nature of the model implies that there is no essential difference between the roles of the older and younger sibling. Unlike in the models of, for example, Fontaine et al. (2009) and Roquebert et al. (2018), the order in which decisions are made plays no role. We include age in $X(i)$ and $X(j)$, but other than that, we do not distinguish between the older and younger sibling.

5 Data

We use data from the French CARE (Capacités, Aide et REssources des séniors) survey, a nationally representative survey of individuals aged 60 or more living in the community, conducted in 2015.[7] This survey gathers information on health and limitations of the senior respondents, the formal care and informal care they receive, and also on their children. Using the information reported by the senior, referred to as the parent in the rest of the paper, we are able to construct a data set with the children as the individuals of interest. We focus on two-child families with a single parent (that is divorced, widow or never married); this is in line with the theoretical model; an extension to more than two children would be straightforward in principle but computationally burdensome.

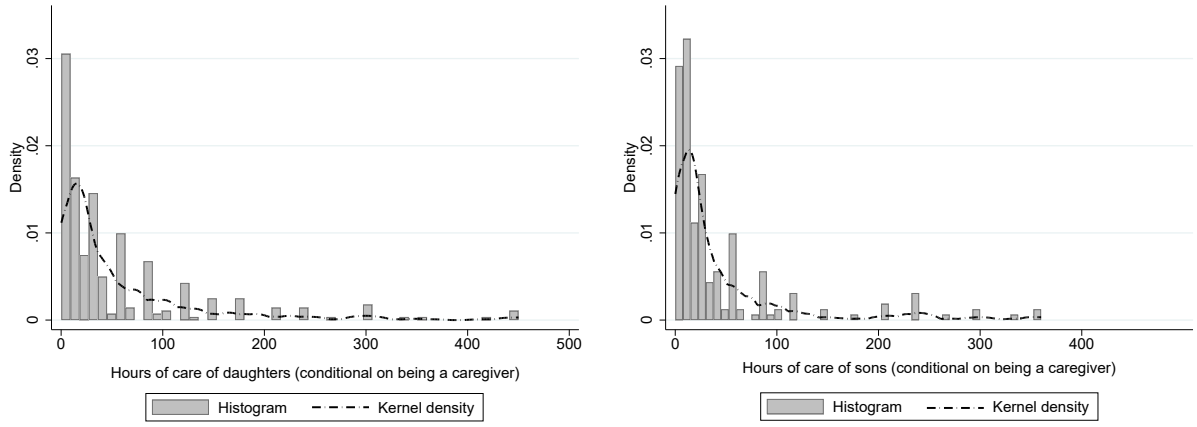
The time devoted to care by a given child is reported by the parent. The parents are first asked whether or not they have some difficulties with a variety of different activities of daily living, and, if so, whether they receive informal care for each type of difficulties or not.[8] If informal care is received, the respondents can report up to ten informal care givers (mostly children or a spouse). The following question was then asked for each informal care giver: *"On average, how many hours does [Caregiver's Name] help you with activities of daily living in a day / week / month?"*. We use this question to construct the amount of care provided by the two children on a monthly basis, the endogenous variables in our analysis. We should bear in mind that the questions are asked in order to identify if care is received because of the age or the health of the respondent.[9] Finally, as this variable also captures several types of care that can be provided to parents without physical limitations, we do not restrict the sample to parents with such limitations. The top 1% of the distribution of the time devoted to care has been dropped to remove outliers. The results are qualitatively similar when we include these observations in the sample but the magnitude of the effect is much larger, suggesting that this small group of observations is driving the results when we include them. We plot the time devoted to care by

[7] More information on this data source can be found on the website of the Directorate of Research, Studies, Evaluation and Statistics (DREES): https://drees.solidarites-sante.gouv.fr

[8] The list of activities is given in the appendix.

[9] This was done in order to be able to identify informal care for household members as good as possible.

Figure 1: Distribution of hours of caregiving



(a) Daughters (b) Sons

Note: This graphs represent the distribution of the time devoted to care of each child, conditional on being a caregiver.
Source: CARE survey (authors' calculation)

care giving sons and daughters in Figure 1. Even though outliers are omitted, the distributions are strongly skewed to the right: The large majority provides less than 50 hours of care per month, but there are some children who, according to their parent, provide more than 300 hours of care per month.

We control for the child's gender, age, the number of children, and a dummy indicating whether the child is single (that is divorced, widow or never married) or not. We do not have information on hours of paid work for the children, and can therefore only use a dummy variable for participation in paid work (equal to one when the child is working for pay and zero otherwise). We also control for the distance between the parent and the child, captured by a categorical variable with values "same neighborhood", "same city", "same region", or "further away".[10] The distance might be thought of as possibly endogenous, as some children may relocate in order to care for their parents. Still, we follow most of the literature and assume that the distance is exogenous (see Section 2). As a robustness check, we have also estimated models without the distance; this does not affect our main findings.

We also control for several parental characteristics that may influence the child's prefer-

[10]Note that the survey information on distance is self-assessed, not referring to any administrative region.

ences for informal care giving: the yearly income of the parent (derived from administrative records), the number of activities of daily living for which the parent has some limitations, a dummy indicating if the parent has Alzheimer or a similar disease, and the parent's gender, age, and highest educational degree.

Descriptive statistics of the variables used in the analysis are displayed in Table 1. In Panel A, we observe that daughters are more likely to be care givers than sons and that they also provide more intensive care. In Panel B, we describe care provision at the family level. Many parents receive no care from either child, suggesting that many children are at a corner solution with a binding nonnegativity constraint. Among parents receiving care, the caring responsibility is shared by both children in 29% of all cases. This number highlights the importance of shared care giving and is line with studies using other French surveys (Fontaine et al., 2009; Roquebert et al., 2018). The percentage of families with shared care giving in our sample (29%) is a little smaller than in the general population (36%). This difference might be explained by the fact that shared care giving increases with the number of siblings (Checkovich and Stern, 2002) and we only consider parents with two children.

The characteristics of sons and daughters are described in Panel C. We do not observe major differences between sons and daughters except for labor market participation, as sons are more frequently working for pay than daughters are. From panels C and D, we can also deduce that the sample is composed of 252 families with two men, 249 families with two women and 568 gender-mixed families. Concerning the characteristics of the parent, we observe that the average age of the parent is 79, which seems high if we consider that the original sample is representative of seniors aged 60 or more. This can be explained by the sample selection on singles, as widowhood occurs in late life. This selection may also explain why the sample is mostly composed of mothers rather than fathers, in light of the differential in life expectancy between men and women and the fact that on average, husbands are older than their wives. This may also explain the relatively low income as women from this generation, who have shorter careers, and thus tend to have lower pensions.

We provide further descriptive statistics on care provision by family composition in Table

Table 1: Descriptive statistics

	Daughter (1)	Son (2)
Panel A: *Outcome*		
Caregivers (%)	29.36	20.06
Informal care time (among caregivers)	56.38	44.79
	(79.05)	(68.35)
Panel B: *Care at the family level*		
No care provided (%)	61.65	
One caregiver (%)	27.32	
Two caregivers (%)	11.04	
Panel C: *Child's characteristics*		
Single (%)	31.52	28.17
Nb children	1.66	1.56
	(1.08)	(1.13)
Age	52.13	51.16
	(11.04)	(11.14)
Working (%)	63.88	68.94
Same neighborhood (%)	14.26	14.93
Same city (%)	14.26	12.41
Same region (%)	41.93	41.88
Further away (%)	29.55	30.78
N	1066	1072
Panel D: *Sibling's characteristics*		
Sister	46.72	52.99
Panel E: *Parent's characteristics*		
No ADL	51.64	
1 ADL	13.28	
2 ADL	10.20	
3 ADL	10.48	
$\geq$ 4 ADL	14.41	
Alzheimer or alike (%)	5.15	
Mother (%)	81.57	
Yearly income	18,900	
	(11,001)	
Age	78.88	
	(9.99)	
No diploma (%)	24.32	
Primary (%)	34.42	
Lower secondary (%)	22.64	
Higher secondary or higher (%)	18.62	
N (parents)	1,069	

Notes: The time devoted to care is on a monthly basis.
Source: CARE Survey. Means and, in parentheses, standard deviations (except for dummy variables).

Table 2: Distribution of care by family composition

	Two sons (1)	Two daughters (2)	Mixed (3)
No care provided	64.68	55.82	62.85
One caregiver	23.81	29.32	27.99
Two caregivers	11.51	14.86	9.15
Main caregiver is the daugther	-	-	70.44
% of time provided by main caregiver[a]	65.76 (15.77)	64.15 (15.23)	70.66 (15.62)
Total hours of care provided[b]	52.72	76.78	67.00
N	252	249	568

[a]Among families with shared care giving, that means with both children providing care.

[b]Among families with care provided to the parent by at least one child. The other child is allowed to provide any care.

Note: The time devoted to care is on a monthly basis.

Source: CARE Survey. Means and, in parentheses, standard deviations (except for dummy variables)

2. Parents with two daughters more often receive informal care from their children than other parents: The percentage of parents who do not receive any care is higher in families with two sons (64.68%) and families one son and on daughter (62.85%). Shared care giving is less prevalent in families with children of different gender (24.63%) than in families with children of the same gender (33.63% with two daughters and 32.58% with two sons). In the families with one son and one daughter, the main care giver is more often the daughter (70.44% of all cases). In case of shared care giving, the two shares are typically rather unequal - on average 67% of the total care provided to the parent is provided by the main care giver. The total amount of care received by the parent increases with the number of daughters in the family – the parents who receive most intensive care have two daughters, followed by those with one daughter and one son, and finally those with sons only.

6 Results

We have estimated several versions of the model, starting with a model that does not impose any restrictions on the effects of taste shifters across both genders. The results for this model are presented in the appendix (Table B.1). To obtain more precise results, we have tested whether taste shifters (X_i) should really enter with different coefficients for men and women. Since, using a likelihood ratio test, we could not reject the null hypothesis that the coefficients on all components of X_i (including the paid work dummy) except the intercept are the same for men and women, we present the model that imposes equality of these slope coefficients for men and women. Moreover, since the estimates for $\sigma(m)$ and $\sigma(w)$ in this unconstrained model were virtually identical, we also impose $\sigma(m) = \sigma(w)$. Tables 3 presents the results for this more parsimonious model.

First, the results in Panel C of Table 3 show that the coherency conditions are satisfied such that the estimated model gives a unique Nash equilibrium for each gender composition of the two siblings. Second, the estimated interaction coefficients are negative. The negative signs are in line with the predictions of the theoretical model and suggest that care provided by different children are substitutes, which is also in line with the literature (Wolf et al., 1997; Antman, 2012; Callegaro and Pasini, 2008; Checkovich and Stern, 2002). However, as we said before, none of these earlier studies analyzed the strategic behavior of siblings accounting for the gender composition of the family. The coefficients θ_{ww} and θ_{mw}, but also θ_{wm} and θ_{wm} appear to be virtually the same. We have tested that $\theta_{ww} = \theta_{mw}$ and $\theta_{wm} = \theta_{wm}$, that is the sibling effect is the same irrespective the child's gender, using a likelihood ratio test. The results, presented in the appendix (Table B.2), do not reject this assumption but also suggest that θ_{ww} and θ_{mw} are also larger in absolute value than θ_{wm} and θ_{wm} (Table B.6), implying that both male and female children are more responsive to the care giving behavior of their sibling when their sibling is a sister than when their sibling is a brother. Since $\theta(g(i), g(j)) = \gamma_2(\pi_i)\pi_j$, these results can be rationalized from the theory in Section 3 if $\pi_w > \pi_m$, that is, if women's productivity in providing care is substantially larger than that of men.

We find a positive correlated effect: the estimate of ρ is 0.579 and it is significantly posi-

Table 3: Main specification

Panel A: Interaction coefficients			
	θ_{ww}	θ_{mm}	θ_{wm}
	-0.381***	-0.222**	-0.255**
	(0.084)	(0.110)	(0.129)
	θ_{mw}	ρ	
	-0.435***	0.579***	
	(0.090)	(0.090)	
Panel B: Coefficients for observed characteristics			
Child's characteristics		*Parent's characteristics*	
Age	-0.095	1 ADL	35.315***
	(0.531)		(9.900)
Single	18.532***	2 ADL	49.693***
	(5.776)		(10.601)
Nb children	-4.817*	3 ADL	54.745***
	(2.624)		(10.180)
Working	-12.821**	$\geq$ 4 ADL	93.346***
	(5.999)		(9.782)
Same neigborhood	60.319***	Alzheimer or alike	41.187***
	(6.921)		(12.157)
Same city	21.198***	No diploma	ref
	(7.172)	Primary	-15.998**
Same region	ref		(7.615)
Further away	-57.073***	Lower secondary	-34.787***
	(8.024)		(10.005)
		At least higher secondary	-36.408***
Constant			(11.390)
Men	-121.721***	Mother	-4.557
	(25.067)		(8.977)
Women	-101.982***	Annual income/12,000	-8.886**
	(24.984)		(4.059)
σ	85.217***	Age	2.990***
	(2.973)		(0.628)
Panel C: Coherency conditions			
	$1-\theta_{ww}^2$	$1-\theta_{mm}^2$	$1-\theta_{wm}\theta_{mw}$
	0.855***	0.810***	0.942***
	(0.064)	(0.080)	(0.049)
Likelihood	-3487.4047		

Source: CARE Survey. N = 1,069. Standard errors in parentheses. In this model, the coefficients associated to the taste shifters are assumed to be the same for men and women. θ_{ww} (θ_{mw}) is the effect of a the time devoted to care of a sister for a woman (man). θ_{wm} (θ_{mm}) is the effect of a the time devoted to care of a brother for a woman (man). * p<0.1, ** p<0.05, *** p<0.01.

tive, implying that some unobserved shared characteristics like unobserved needs of the parent or family values affect informal care time of both siblings in the same direction. Most papers

in the literature do not allow exploring this correlated effect. Exceptions are Fontaine et al. (2009) and Roquebert et al. (2018), who find no evidence of a correlated effect in the decisions to participate in informal care or not.[11] There are two possible explanations for this difference. First, it is possible that the correlated effect operates at the intensive margin of care provision only. Second, the estimated correlation of the unobserved random terms might be imprecise in these other papers, as the data are less precise (participation decisions only), the sample size is relatively small, and no exclusion restrictions are used.[12]

The estimated coefficients on the child's observed characteristics (Table 3) have the expected sign and we observe that the main determinants of the time devoted to care is the distance from the parent. As expected, age and the physical and cognitive limitations of the parent (number of limitations in activities of daily living and symptoms of Alzheimer disease) increase the time the children devote to informal care for their parent. On the other hand, income of the parent reduces care provision, possibly because richer parents can pay for certain types of help, instead of having to rely on their children.[13] The parent's education also has a large negative effect (keeping income and other variables constant). This negative effect may reflect the fact that the more educated elderly are better able to cope with their health limitations or better understand the long term care system, so that they can more easily mobilize other kinds of support.

Finally, the gender specific constant terms capture gender differences in the baseline propensity to provide informal care. This gender difference can be explained by differences in preferences or productivity – see the equation for $\gamma_0(\pi_1)$ in Section 3. We cannot determine which of the two drives this result. The propensity to provide informal care is lower for men than for women, implying that, keeping other variables as well as sibling's hours of care constant, women tend to involve more in care giving than men.

[11] It could also be acknowledged that Maruyama and Johar (2017) and Stern (2014) also find a positive correlated effect in the context of location choices.

[12] The estimation results for the θ-s and ρ are very similar to the corresponding results in the unconstrained model, see Table B.1 in the appendix.

[13] We have tested different nonlinear specification of the parent's income and the results always suggested a linear relationship.

Turning to the magnitude of the estimated sibling effects, we computed some marginal effects of an increase of the time devoted to care for the elderly parent by a sister for women.[14] On average, a one hour increase per month in care provided by the sister induces a decrease of 6.9 (4.8) minutes in the expected time spent on care by a women (man). For a women (man) whose brother increases his hours of care, the effect would be somewhat smaller, about 4 (2.7) minutes. The average marginal effect of a one hour change in care provided by the sister on the probability of providing care for a woman is a fall of about 0.16 percentage points; for men, it is about 0.13 percentage points. An increase of the sister's hours by 79 hours (the standard deviation of hours of care among care givers) would induce a reduction of about 12 percentage points for women and 10 percentage points for men. Given that participation rates in informal care are about 20% for men and 30% for women, these effects are substantial.

We may wonder why some effects appear to be rather small in magnitude. One possible explanation is the low effectiveness in care provision by the children. In the model, the effect of the sister's hours of care is amplified by her productivity: the higher the productivity of the sister, the larger is the strategic response. If the sister has low productivity, the strategic response will be small. It is quite intuitive that an increase in ineffective care only leads to a small substitution effect on the other source of care (i.e. the sibling). This channel highlights the fact that even though women are more productive in providing care than men, their productivity can still be rather small. Another potential explanation relates to the curvature of the utility function with respect to the public good and leisure. Everything being equal, smaller (larger) is the absolute value of α_2 (α_1), lower (higher) is $\gamma_2(\pi_i)$. These two parameters capture the shape of utility according to the public good and leisure respectively. More child i values the public good, higher the optimal level of care received of care by the parent is. This means that, when children have a high value of the total time of care their parent received, they are less sensitive to the time of care provided by their sibling because they want to maintain the total level of care received by their parent as high as possible. On the other hand, lower is value of leisure, lower the optimal level of leisure is. Therefore children do not substitute the time they devote

[14] The formulas for the marginal effects are $\frac{\partial E(c_i|X_i)}{\partial c_j} = \theta(i,j)\Phi(\frac{X\delta+\theta(i,j)c_j}{\sigma})$; $\frac{\partial P(c_i>0|X_i)}{\partial c_j} = \phi(\frac{X\delta+\theta(i,j)c_j}{\sigma})\frac{\theta(i,j)}{\sigma}$.

on care provision to leisure activities.

To test the robustness of our results, we have conducted several sensitivity checks. We do not address the questions related to formal care received by the parent. This might be a particular threat to our results if there exist a substitution between formal and informal care. The literature on the possible substitution between these two sources of care does not provide a very clear response. Balia and Brau (2013) find evidence of 'negligible' substitution: one additional hour of informal care use per month reduces the expected use of formal care by less than 2 minutes, while one additional hour of formal care reduces informal care by less than 5 min. These results suggest that not considering formal care should therefore not invalidate our results. In our sensitivity check, we estimated our model with the time of formal care received by the parent as an additional control variable. The main results remain unchanged; see Table B.5.

We use the distance of the children from the parent as a control variable while it can be thought as endogenous. In Table B.3, we present the main results obtained without the distance as a control variable. The results are very similar from the main analysis as we observe that children mostly free-ride on sisters, suggesting again that daughters are more productive than sons.

Finally, the model predicts that the rank in the family should have not effect on the children's propensity to provide informal care. To test for this assumption, we have included a dummy indicating whether the older child or not as a control variable. The results, displayed in Table B.4, provide empirical support for this assumption since the estimate of the θs are very similar and the older child dummy is not significantly different from zero.

7 Conclusion

Because of aging in place policies and the growing share of elderly in the population, more and more individuals living at home will need care. Family members, and children in particular, are the main provider of care for the elderly living at home. Understanding the decisions on

how much care these potential informal care givers provide is therefore of particular interest. We have considered a noncooperative model of children's informal care decisions in two-child families with a single elderly parent. To explain how gender plays a role in the strategic interactions between siblings, we allow the children to have different productivity in care provision according to their gender. The estimates of the best response functions suggest that hours of parental care provided by the two siblings are strategic substitutes, and sons' as well as daughters' free-riding behavior is significantly larger when the sibling is a sister. This new result can be theoretically explained by a higher productivity for women than men in care provision, and may explain why women are generally more involved in care for an elderly parent. We also find evidence of a substantial positive correlated effect, in the sense that unobserved factors such as family values or unobserved needs of the parent lead to a positive correlation between the tendencies to give care of the two siblings, given how much care is provided by their sibling.

The magnitudes of the estimating sibling effects are substantial but far from one-to-one substitution. A ten hours increase of the sister's (brother's) monthly hours spent on care giving reduces care giving by about 48 (27) minutes for men and 1.15 hours (39 minutes) for women. On average, it would reduce the probability to participate in care giving by 1.3 (0.9) percentage points for men and by 1.6 (0.7) percentage points for women.

In terms of policy implications, free-riding behavior implies that the level of public provision (i.e. the total level of informal care) is less than optimal. A subsidy for providing informal care (a care giving allowance) would be a way would to compensate care givers for the time cost of informal care and might undo the inefficiency. Our results imply that this would particularly increase care giving by women, since they are the most productive and often the only care giving child in mixed families. Intensifying their care giving task might even have potential negative mental health effects (Bom et al., 2018). Such a public policy would not redistribute informal care provision among children by reducing the share of care provided by daughters.

Finally, some limitations need to be discussed. The first is the focus on families with

exactly two children only, which reduces the sample size but also makes the generalization of the results difficult for larger families. The other limitation is related to the fact that the strategic interaction effect could be different at the extensive and intensive margin. This cannot be captured in our model as changes at the extensive and intensive margin are driven by the same coefficients. Finally, we do not account for care provided by daughters and sons in law. Even though, Brunel et al. (2019) estimated that, in France, among the elderly who receive informal care, only 7% of them report a daughter or a son in law among their care givers. Suggesting that it is not an major source of care.

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Appendices

Appendix A List of activities

The daily living activities are:

- Washing or dressing
- Eating or drinking
- Cleaning, washing dishes or laundry
- Preparing meals (cooking)
- Manage your budget, paperwork and administrative procedures
- Shopping
- Book an appointment with the doctor, take you to the doctor, buy your medicines or help you take them
- Moving in your dwelling, getting up, or going to the toilet
- Getting out of your dwelling

Appendix B Additional tables

Table B.1: Unconstrained model

	Women	Men
	(1)	(2)
Panel A: Interaction coefficients		
	θ_{ww}	θ_{mw}
	-0.407***	-0.462***
	(0.083)	(0.104)
	θ_{wm}	θ_{mm}
	-0.275**	-0.267**
	(0.129)	(0.109)
Panel B: Coefficients for observed characteristics		
	Child's characteristics	
Age	-0.554	0.638
	(0.630)	(0.774)
Single	14.401**	24.842***
	(7.220)	(9.059)
Nb children	-3.459	-6.630
	(3.295)	(4.055)
Working	-14.958*	-8.630
	(7.729)	(8.655)
Same neigborhood	73.210***	42.079***
	(9.123)	(9.959)
Same city	28.195***	13.699
	(8.879)	(10.897)
Same region	ref	ref
Further away	-50.540***	-65.808***
	(9.730)	(12.177)
	Parent's characteristics	
1 ADL	31.385**	40.996***
	(12.204)	(13.297)
2 ADL	58.326***	38.065***
	(12.539)	(14.359)
3 ADL	63.795***	42.262***
	(12.342)	(13.685)
$\geq$ 4 ADL	102.272***	85.497***
	(11.810)	(13.380)
Alzheimer or alike	29.400**	60.455***
	(14.134)	(16.100)
No diploma	ref	ref
Primary education	-18.178**	-11.886
	(8.985)	(10.156)
Lower secondary education	-40.676***	-28.942**

To be continued

Source: CARE Survey. N = 1,069. Standard errors in parentheses. This Table present the results from the unconstrained model. θ_{ww} (θ_{mw}) is the effect of a the time devoted to care of a sister for a woman (man). θ_{wm} (θ_{mm}) is the effect of a the time devoted to care of a brother for a woman (man). * p<0.1, ** p<0.05, *** p<0.01.

Table B.1: Unconstrained model

	Women	Men
	(1)	(2)
	(12.328)	(13.775)
At least higher secondary education	-33.878**	-37.732**
	(13.801)	(15.823)
Mother	-2.441	-8.325
	(10.649)	(12.165)
Annual income/12,000	-11.135**	-6.553
	(5.580)	(5.165)
Age	3.000***	2.885***
	(0.754)	(0.873)
Constant	-79.152***	-153.589***
	(29.652)	(36.902)
σ	83.712***	86.507***
	(3.694)	(4.846)
ρ	0.629***	
	(0.084)	
Likelihood: -3477.1233		

Source: CARE Survey. N = 1,069. Standard errors in parentheses. This Table present the results from the unconstrained model. θ_{ww} (θ_{mw}) is the effect of a the time devoted to care of a sister for a woman (man). θ_{wm} (θ_{mm}) is the effect of a the time devoted to care of a brother for a woman (man). * p<0.1, ** p<0.05, *** p<0.01.

Table B.2: Constrained models

Panel A: Coefficients assumed to be equal by pair		
$\theta_{ww} = \theta_{wm}$	$\theta_{mm} = \theta_{mw}$	ρ
-0.399***	-0.229**	0.566***
(0.075)	(0.102)	(0.088)
Likelihood-3487.6454		
Panel B: All coefficients are assumed to be equal		
$\theta_{ww} = \theta_{mw} = \theta_{mm} = \theta_{wm}$		ρ
-0.358***		0.595***
(0.076)		(0.085)
Likelihood: -3490.0673		

Source: CARE Survey. N = 1,069. θ_{ww} (θ_{mw}) is the effect of a the time devoted to care of a sister for a woman (man). θ_{wm} (θ_{mm}) is the effect of a the time devoted to care of a brother for a woman (man). The controls are the parent's age, gender, income, number of ADL limitations, Alzheimer disease or similar, and the higher educational degree. We also control for the child's age, distance from the parent, marital status, gender and number of children. Standard errors in parentheses. In this model, the coefficients associated to the taste shifters are assumed to be the same for men and women. * p<0.1, ** p<0.05, *** p<0.01.

Table B.3: Midel without the distance as control variable

Panel A: Interaction coefficients			
θ_{ww}	θ_{mm}	θ_{wm}	θ_{mw}
-0.324***	-0.167	-0.163	-0.336**
(0.106)	(0.125)	(0.160)	(0.117)
ρ			
0.410***			
(0.122)			

Panel B: Coefficients for observed characteristics			
Child's characteristics		*Parent's characteristics*	
Age	0.475	1 ADL	39.947***
	(0.545)		(9.899)
Single	34.401***	2 ADL	51.713***
	(6.050)		(10.621)
Nb children	-8.912***	3 ADL	64.753****
	(2.663)		(10.227)
Working	-13.231**	$\geq$ 4 ADL	102.861***
	(6.499)		(10.020)
		Alzheimer or alike	42.722***
			(12.275)
		Primary	-21.899***
			(7.635)
		No diploma	ref
		Lower secondary	-43.792***
			(10.042)
		At least higher secondary	-51.488***
Constants			(11.328)
Men	-128.053***	Mother	-3.193
	(26.733)		(8.955)
Women	-104.445***	Annual income/12,000	-10.897***
	(25.475)		(4.111)
σ	90.654***	Age	2.877***
	(3.084)		(0.627)
Likelihood	-3597.9871		

Source: CARE Survey. N = 1,069. θ_{ww} (θ_{mw}) is the effect of a the time devoted to care of a sister for a woman (man). θ_{wm} (θ_{mm}) is the effect of a the time devoted to care of a brother for a woman (man). The controls are the parent's age, gender, income, number of ADL limitations, Alzheimer disease or similar, and the higher educational degree. We also control for the child's age, marital status, gender and number of children. Standard errors in parentheses. In this model, the coefficients associated to the taste shifters are assumed to be the same for men and women. * p<0.1, ** p<0.05, *** p<0.01.

Table B.4: Robustness check: control for older child dummy

Panel A: Interaction coefficients			
θ_{ww}	θ_{mm}	θ_{wm}	θ_{wm}
-0.376***	-0.217**	-0.248*	-0.434**
(0.085)	(0.110)	(0.130)	(0.092)
ρ			
0.574***			
(0.090)			
Panel B: Coefficient older child			
Older child			
5.392			
(5.705)			
Likelihood -3486.9537			

Source: CARE Survey. N = 1,069. θ_{ww} (θ_{mw}) is the effect of a the time devoted to care of a sister for a woman (man). θ_{wm} (θ_{mm}) is the effect of a the time devoted to care of a brother for a woman (man). The controls are the parent's age, gender, income, number of ADL limitations, Alzheimer disease or similar, and the higher educational degree. We also control for the child's age, distance from the parent, marital status, gender and number of children. Standard errors in parentheses. In this model, we add a dummy equal to one if the child is the older in the family, and zero otherwise. Its effect is assumed to be the same for men and women. The constant term is allowed to be vary according to gender. * p<0.1, ** p<0.05, *** p<0.01.

Table B.5: Model including the time of formal care received as a control variable

Panel A: Interaction coefficients				
θ_{ww}	θ_{mm}	θ_{wm}	θ_{wm}	ρ
-0.381***	-0.221**	-0.255**	-0.431***	0.577***
(0.084)	(0.110)	(0.129)	(0.093)	(0.090)
Panel B: Coefficient of the formal care variable				
0.085				
(0.058)				
Likelihood: -3486.3422				

Source: CARE Survey. N = 1,069. θ_{ww} (θ_{mw}) is the effect of a the time devoted to care of a sister for a woman (man). θ_{wm} (θ_{mm}) is the effect of a the time devoted to care of a brother for a woman (man). The controls are the parent's age, gender, income, number of ADL limitations, Alzheimer disease or similar, and the higher educational degree. We also control for the child's age, distance from the parent, marital status, gender and number of children. Standard errors in parentheses. In this model, we add a dummy equal to one if the child is the older in the family, and zero otherwise. Its effect is assumed to be the same for men and women. The constant term is allowed to be vary according to gender. * p<0.1, ** p<0.05, *** p<0.01.

Table B.6: Likelihood ratio test for the different models

Models tested	LR	DF	p-value
Main specification vs Unrestricted model	20.56	19	0.362
Main specification vs Restricted model by pair	0.48	2	0.786
Main specification vs All interaction coefficients equal	5.33	3	0.149
Restricted model by pair vs All interaction coefficients equal	4.84	1	0.023

Main specification: assume that the tastes shifters (X) have the same coefficient for men and women. The constant terms and interaction coefficients are not constrained.
Restricted model by pair: assume that the tastes shifters (X) have the same coefficient for men and women. We also assume that $\theta_{ww} = \theta_{mw}$ and $\theta_{mm} = \theta_{wm}$. The constants terms are not constrained.
All interaction coefficients equal: assume that the tastes shifters (X) have the same coefficient for men and women. We also assume that $\theta_{ww} = \theta_{mw} = \theta_{mm} = \theta_{wm}$. The constants terms are not constrained.