HEDG

HEALTH, ECONOMETRICS AND DATA GROUP

THE UNIVERSITY of York

WP 22/13

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July 2022

http://www.york.ac.uk/economics/postgrad/herc/hedg/wps/

Care for Elderly Parents: Do Children Cooperate?*

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Abstract

Do children cooperate when they decide to provide informal care to their elderly parent? This paper assesses which model drives the caregiving decisions of children. I compare the predictive power of two models: a (joint-utility) cooperative and a Nash noncooperative model. I focus on families with two children and one single parent. The model allows caregiving by one child to have a direct externality on the well-being of the sibling. The results suggest that the cooperative model overestimates the level of care received by the parents observed in the data and its predictive power is outperformed by the noncooperative model. This suggests that children are more likely to behave according to a noncooperative model. I also find that children's participation in caregiving has a positive externality on the well-being of the sibling. I construct an indicator of the degree of noncooperativeness between children and show that it is positively correlated with the number of unmet needs the parent has. I conclude that, because children do not internalize the positive externality when they behave noncooperatively, the current level of informal care provided to parents appears to suffer from a public good problem.

*Correspondence: julien.bergeot@dauphine.psl.eu. I acknowledge financial support from the Fondation Médéric Alzheimer for this project. I thank Eric Bonsang, Olivier Donni, Roméo Fontaine, Marike Knoef, Hélène Le Forner, Dominique Meurs, Grégory Ponthière, Arthur van Soest, Marianne Tenand and Bram Wouterse for their thoughtful comments and suggestions. I also acknowledge participants of the Journées de Microéconomie Appliquée, LEGOS Seminar (Paris Dauphine), Society of the Economics of the Household Conference, EUHEA Early Career workshop and seminar at Ca'Foscari.

1 Introduction

The current wave of long-term care (LTC) reforms implemented in most countries try to foster aging in place (Zigante, 2018). In this setting, the main producer of care is the family (Colombo et al., 2011). For example, in France, among individuals who were receiving care in 2015, 82% of them were receiving informal care, and 53% were receiving formal care (Brunel et al., 2019). The assistance provided by relatives also covered a broader spectrum of activity (Brunel et al., 2019). Because of the current reforms, combined with population aging, the number of individuals living in the community with needs of LTC is expected to increase. Understanding the allocation of care provided by adult children to their elderly parents is therefore a major issue.

Little is known about the decision process of children: do siblings coordinate with each other when they decide whether to provide informal care to their parent(s)? Or does each child decide upon caregiving taking their siblings' involvment as given? However, it has important implications for the level of care received by the parents and the efficiency of the siblings' allocation of informal care, which have also implications for the well-being of the elderly. Having information on the decision process is therefore a major issue to determine the role of the public policies if the allocation is inefficient. Children's decisions to provide informal care to an elderly parent are always empirically studied under the assumption of a non-cooperative behavior: each child individually maximizes their own utility, taking the participation of the siblings as given (Antman, 2012; Byrne et al., 2009; Callegaro and Pasini, 2008; Checkovich and Stern, 2002; Fontaine et al., 2009; Roquebert et al., 2018).[1] Even if there are theoretical arguments for assuming a noncooperative behavior (Antman, 2012), the credibility of this assumption could be improved with an empirical support.

In this paper, I estimate a structural model of caregiving participation in families with two children under two different decision processes: cooperative and noncooperative. This model is inspired

[1]Note that these papers focus on the allocation of informal care provided by children to elderly parents living in the community. Note that there is also a literature using game-theoretic models to study long term care arrangements and the seniors' choice of residence (Engers and Stern, 2002; Hiedemann et al., 2017; Hiedemann and Stern, 1999). 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.

by Bresnahan and Reiss (1991). Each child's utility is composed of three additive components: i) the utility of providing care, ii) the utility of having a sibling providing care to the parent and iii) the utility of providing care when having a sibling who participates in care provision. The first component can be considered as the private utility of care provision that is not influenced by the caregiving behavior of the sibling. The second is the externality of one child's caregiving participation on the well-being of the sibling. This externality does not depend on whether the sibling provides informal care. The last component allows to account for siblings' preference for the joint provision of care and the complementarity or substitution of siblings' participation. In the cooperative model, I assume that children jointly maximize the sum of their utilities. Concerning the noncooperative model, the outcome of the game is assumed to be a pure Nash equilibrium.

I use the French CARE (Capacités, Aide et REssources des séniors, volet Ménages) survey, a general population survey representative of the non-institutionalized elderly aged 60 or more and conducted in 2015. The survey gathers information on health and limitations of the senior respondents, the informal care they receive, and also on their children (labor market status, marital status, number of children, distance, gender and age). When they receive informal care, the seniors report a list of the different informal caregivers (up to ten). We are therefore able to i) to construct a data set with the children as the individuals of interest and ii) know the caregiving participation of each child. This makes the survey well suited to analyze children's caregiving decisions.

I show that, under the assumption of cooperative equilibrium, one cannot empirically identify separately two different drivers of caregiving participation: i) child's own utility of care provision and ii) the externality the child has on the sibling's well-being when providing care. This is because siblings internalize the externality they have on their sibling in the cooperative model. To identify these parameters seperately I assume that the number of potential caregivers does not affect the utility of caregiving. This assumption makes possible the use of one-child families to identify the private utility of providing care of individuals in two-child families. Indeed, because they do not receive any externality from a sibling's caregiving participation, the only determinant of care provision for single children is the utility of caregiving and an unobserved random term. Concerning the noncooperative model, two different methods are used. First, I simulate the noncooperative allocation of informal care using the parameters estimated under the assumption of the cooperative model. This can be done because it is the same parameters that play a role in caregiving decisions in both decision processes. The only exception is the externality that children have on their sibling's well-being that children do not internalize when they behave noncooperatively. Second, using appropriate methods to account for the inherent incompletness of such model, the noncooperative model is structurally estimated. Using the estimated parameters for each decision process, I describe which model fits better the data and discuss the existence of externalities and the efficiency of the current allocation of children's informal care provision. I particularly construct an indicator of the degree of noncooperativeness in families, and explore how the lack of cooperation is associated to the unmet needs of the parent.

The most related paper is Knoef and Kooreman (2011). Using the SHARE survey, they estimate a discrete structural model in which children decide the time they devote to care, leisure and work on a sample of adult children without siblings. They asume that children's preferences are not affected by the number of siblings they have and use the estimated parameters to simulate the equilibrium of a noncooperative model and a cooperative model in families with two children. They find that the noncooperative model fits better the data for 70% of European families with two children. They also find that a cooperative model in which children jointly maximize the sum of their utilities leads to higher level of care provided to the parents. These two results suggest that the most common decision process of chidren is inefficient. The simulation procedure they implement has however one main limitation: they have to assume care provided by one child and care provided by their sibling are perfect subsitutes. This means that one hour increase in the time of care received by the parent has the same direct effect on a given child's utility whether it is provided by themself or their sibling. This might be a strong restriction on the externality that one child's participation has on the sibling's well-being and children preferences. Such assumption also imposes that children are necessarily strategic sibstitutes, i.e. one hour increase in the time devoted to care by one child decreases the time of care provided by the sibling.

The contributions of the current paper can be summarized as follows. We test whether siblings cooperate or not without assuming that children are perfect substitutes and we do not restrict chidlren's preferences for the joint provision of informal care (the utility of caregiving when having a sibling caregiving). The results show that the cooperative model overestimates the level of care received by the parents observed in the data and its predictive power is outperformed by the noncooperative model. This confirms the results from Knoef and Kooreman (2011) that the noncooperative model is more likely to drive siblings' informal care decisions. We also find that providing informal care is on average costly and children have a disutility of joint care provision. This result suggests that children are strategic substitutes, which is in line with the literature focusing on noncooperative strategic interactions between children (Antman, 2012; Byrne et al., 2009; Callegaro and Pasini, 2008; Checkovich and Stern, 2002; Fontaine et al., 2009; Roquebert et al., 2018). The estimation of a joint-utility cooperative model appears to underestimate this disutility of participating in informal care when having sibling providing care. I find evidence of a positive externality of children's participation in caregiving on the well-being of the sibling. This externality is higher when the parent has limitations in daily life activities and when the sibling who provides care is a sister. To our knowledge, this is a new result in this literature because such externality has not been explored yet.[2] Finally, the allocation of informal care suffers from a public good problem (or underprovision of care) since the lack of cooperation between children translates into a lower level of care, but also a higher level of unmet needs for the parent. This is because children have a positive externality on their sibling when they provide informal care, but they do not take it into account when they behave according to the noncooperative model. As a result of all the previous results, the current level of informal care provided to parents appears to be inefficient. Therefore, there should be a role for public policies to increase the level of care received by elderly people.

2 The model

2.1 Environment

I model siblings decisions of informal care provision to their elderly parent. While other models study interactions on the living arrangements (Engers and Stern, 2002; Hiedemann et al., 2017; Hiedemann and Stern, 1999) and location choices (Konrad et al., 2002; Maruyama and Johar, 2017; Stern, 2021), this model takes living arrangements and location choice 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; Byrne et al., 2009; Callegaro and Pasini, 2008; Checkovich and Stern, 2002; Fontaine et al., 2009; Roquebert et al., 2018). I focus on families with two children $i = 1, 2$. Let $a_{i,h} \in \{0, 1\}$ denote the action of child i in family $h = 1, ..., H$. If child i provides informal care to the elderly parent $a_{i,h} = 1$, and 0 otherwise.

[2]Two exceptions are Maruyama and Johar (2017) and Stern (2021), but these papers focus on the location of children (with a sequential game) and do not explore informal care decisions. Even if the distance from the parent is a determinant of informal care provision, one can argue that location choices are different from the decision to provide informal care.

Note that I only model informal care decisions of children, and the parent does not participate in informal care decisions. This simplification allows to focus on the interaction between siblings. The main drawback is that coefficients should be interpreted carefully and in a reduced-form way.

Also note that the game is static, simultaneous and does not account for the fact that siblings may renegociate later on. This is the standard approach in the literature and, to my knowledge, there is no dynamic structural model estimated yet. One notable exception, even though they do not make implicit assumptions on the decision process, is Hiedemann et al. (2017) who study the dynamics of LTC arrangements in the US.[3]

2.2 Preferences

Preferences are assumed to be symmetric and are modeled as in the more general cooperative version proposed by Bresnahan and Reiss (1991). Because our model can be closely related to the one proposed by Maruyama and Johar (2017), I use the same notations. Note that, even though the utility functions are similar, there are important differences. First, I study participation in care provision while they study location choices. Second, location choices are sequential by birth order in their model while the current model is simultaneous. The identification issues, estimation procedures and implications of the results are therefore different.

Denote the utility of child i for a given action of their sibling by $u_{ih}(a_{i,h}|a_{-i,h})$, where $a_{-i,h}$ denotes the action of i's sibling. Omitting the family subscript h, we assume an additive form of the utility functions such that for a given participation of the sibling, each child i obtains the utility level:

$$\begin{cases} u_i(a_i = 0|a_{-i}) = a_{-i}u_i^{\alpha} \\ u_i(a_i = 1|a_{-i}) = u_i^{\beta} + a_{-i}u_i^{\alpha} + a_{-i}u_i^{\gamma} \end{cases} \tag{1}$$

There are three different components: u_i^{α}, u_i^{β} and u_i^{γ}. The component u_i^{α} is the utility of having a sibling participating in caregiving. It is the externality of one child's caregiving participation on the well-being of the sibling. This externality does not depend on whether the individual provides informal care. This parameter captures the degree of the child's altruism as it is the utility gain

[3]They study LTC arrangements, and therefore whether the parents should live in a nursing home or in the community, and whether they should receive informal care from children if living in the community. The sample they use therefore does not include elderly living in the community only.

that arises from care received by the parent from the participation of the other child, which also increases the parent's well-being. Even though one could have a very general model, I assume that u_i^α is positive.[4] This assumption is based on the assumption that children are (potentially imperfectly) altruistic toward their parents and the parent's well-being is a public good.[5] One should note that this parameter may also capture the fact children's well-being is increased because their parent receives informal care from someone else.

The component u_i^β is the private utility of caregiving. It is private because it is the only component of the utility that is not influenced by the sibling's caregiving behavior. This component capture the individual utility of providing care (that can capture monetary costs associated to caregiving such as transportation costs), as well the increase in well-being due to the child own participation in caregiving.[6] Hence, I do not differenciate these two components that can determine the decision to provide care.

The component u_i^γ represents the additional individual utility (disutility) of caregiving when having a sibling participating in care provision. This is a second type of externality. Particularly, this externality may capture that providing informal care is less burdensome when the sibling is a caregiver. Later in the paper, I refer to this as the *preferences for joint participation*. When it is negative, this parameter might also capture the fact that children prefer to *not* provide care simultaneously with their siblings. This might lead to some free-riding behavior. On the other hand, when it is positive, it might capture that children prefer to be involved in caregiving when their sibling is also a caregiver. Finally, without loss of generality, the utility is normalized to zero when no child in the family provides informal care to the parent.

One should note that assuming symmetric preferences is a limitation because children could have different and asymmetric preferences. This assumption is however standard in the literature

[4]One should note that it is not assumed to be strictly positive.

[5]The assumption that children are (imperfectly) alstruistic appears realistic in European countries according to Klimaviciute et al. (2017). One should note that some papers argue that the exhange motive seem more appropriate to explain caregiving decisions (Alessie et al., 2014). Results differ with respect to sample used for the analyses as well as the theoretical model considered.

[6]Indeed, we can writte a more general utility fonction as follows: $a_i u^1 + \beta[u^{21} a_i + u^{22} a_{-i}] + u^3 = a_i(u^1 + \beta u^{21}) + u^{22} a_{-i} + u^3 a_{-i} a_i$. If we assume that $u_i^\beta = u^1 + \beta u^{21}$, $u_i^\alpha = u^{22}$ and $u_i^\gamma = u^3$, we have equation (1).

(Antman, 2012; Byrne et al., 2009; Callegaro and Pasini, 2008; Checkovich and Stern, 2002).[7] Notable exceptions are Fontaine et al. (2009) and Roquebert et al. (2018) who assume that children preferences are asymmetric according to the birth order in two-child families.[8] These two papers find evidence of asymmetric interactions (and therefore preferences): 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. However, I cannot renounce to this assumption because it makes possible the identification of some important parameters such as altruism.[9] One potential extension of the current model could be done by assuming that preferences vary according to gender.

2.3 Cooperative and noncooperative equilibria

It is assumed that children jointly maximize the sum of their utilities when they behave cooperatively. If each child action $a_i \in S_i$, this means that children choose together the best combination of each child caregiving participation (a_1, a_2) in the choice set $\mathcal{S} = S_1 \times S_2$ that maximizes the sum of their utilities. The maximization program of the siblings is therefore the following:

$$\max_{a_1 \in \{0,1\}, a_2 \in \{0,1\}} u_1(a_1|a_2) + u_2(a_2|a_1) \tag{2}$$

In the rest of the paper, this objective function is refered as the siblings welfare function (SWF) and I write it $W(a_1, a_2)$. I therefore assume one particular type of Pareto efficiency, that is joint-utility efficiency. One notable assumption that is made is that children have the same bargaining weights. This assumption is questionable since one child could have more weight than the other. We maintain this assumption for now and leave the issues related to the identification of Pareto-weights for futur research.

In the noncooperative model, I use pure Nash strategies as a solution concept: each child maximizes their own utility, taking the participation of the sibling as given. The maximization program

[7] This assumption is also made in game-theoretic paper focusing on LTC arrangements and the choice of the main caregiver (Engers and Stern, 2002; Hiedemann et al., 2017; Hiedemann and Stern, 1999).

[8] Note that these two papers estimate the same noncooperatice model with different datasets.

[9] Further explanations can be found in section 3.2.

for child i is the following:

$$\max_{a_i \in \{0,1\}} u_i(a_i|a_{-i}) \tag{3}$$

2.4 Theoretical predictions

2.4.1 Cooperative model

Theoretical predictions can be derived to study whether siblings' participation in caregiving is complementarity or substitute in this cooperative framework. As suggested by Topkis (1998), the complementarity is closely related to the notion of supermodularity (presented in Appendix A). If we adapt this general framework to this model, we find that siblings are complements if the SWF is supermodular[10], wich is the case if we observe the following decreasing differences:

$$\underbrace{W(1,1) - W(0,1)}_{\substack{\text{marginal gain in welfare induced by the partici-}\\ \text{pation of child 1 when child 2 is a caregiver}}} \quad > \quad \underbrace{W(1,0) - W(0,0)}_{\substack{\text{marginal gain in welfare induced by the partici-}\\ \text{pation of child 1 when child 2 is NOT a caregiver}}} \tag{4}$$

or

$$\underbrace{W(1,1) - W(1,0)}_{\substack{\text{marginal gain in welfare induced by the partici-}\\ \text{pation of child 2 when child 1 is a caregiver}}} \quad > \quad \underbrace{W(0,1) - W(0,0)}_{\substack{\text{marginal gain in welfare induced by the partici-}\\ \text{pation of child 2 when child 1 is NOT a caregiver}}} \tag{5}$$

This means that siblings' participations are complements when children are jointly better off when they both provide informal care than when only one does. These inequalities are verified when $u_1^\gamma + u_2^\gamma > 0$, thus testing the complementarity of the siblings' participation in informal care provision is equivalent to verify that $u_1^\gamma + u_2^\gamma > 0$ is positive. If on the contrary we find that $u_1^\gamma + u_2^\gamma < 0$, we should consider them as substitutes, i.e. children are jointly better off when only one of them is the caregiver. We should note that what matters is the sum of their externalities and it is because children internalize the externality they have on their sibling within the cooperative framework.

One should also note that when the utility of care provision (u^β) is positive, the parent always receive informal care because it is not costly. When it is negative, the relative sizes of u^β and u^α determine whether at least one child provides informal care. If $u^\alpha > |u^\beta|$, the parent will receive informal care by at least one child. Preferences for joint participation determines whether the par-

[10]On the contrary, they are substitutes if W is submodular.

ents receives care from both children or not. And simultaneous provision is less desirable when $u_1^\gamma + u_2^\gamma$ is negative. If $u^\alpha < |u^\beta|$, the parent can still receive informal care if the complementarity of children's partcipation is sufficiently large.

The outcome of the game therefore depends on the relative sizes of the different components. In the cooperative model, the number of caregiver is increasing with the externality that children's participation in caregiving have on their sibling's well-being (u^α).

2.4.2 Noncooperative model

Children are said to be srategic complements, or children's game is supermodular, when we observe the following increasing differences for one child i:

$$\underbrace{u_i(1,1) - u_i(0,1)}_{\substack{i\text{'s marginal utility of care provision} \\ \text{when the sibling is a caregiver}}} > \underbrace{u_i(1,0) - u_i(0,0)}_{\substack{i\text{'s marginal utility of care provision} \\ \text{when the sibling is NOT a caregiver}}} \tag{6}$$

This inequality is verified when $u_i^\gamma > 0$, with $i = 1, 2$. On the contrary, children are strategic substitutes (or the game is submodular) when $u_i^\gamma < 0$. When children play noncooperatively, they do not take into account the positive externality they have on their sibling's well-being. The two determinants of i's participation in care are thus u_i^β and u_i^γ. Child i provides informal care if $u_i^\beta + u_i^\gamma$ is positive, and does not if it is negative. One should note that when children behave noncooperatively, the parent can still have no caregiver even if the utility of being a caregiver is positive as long as the preferences for joint participation are negative and large enough (i.e such that $u_i^\beta + u_i^\gamma < 0$).

2.4.3 Inefficiency

The objective of the current paper is not only to determine the model driving children's allocation of care, but it is also to determine the inefficiency of informal care provision if children behave noncooperatively. The noncooperative model is said inefficient if the level of care received by the parent it generates is lower than the level of care under the cooperative joint-utility effiency. Because children do not internalize the externality they have on their sibling in the noncooperative framework, a larger u^α leads to a higher inefficiency - and therefore underprovision - of the allocation when they behave according to this model.[11]

2.4.4 Discussion

One could argue that the bequest motive, i.e children competing for a bequest, could play a role in the sign of the different parameters of the utility function (especially u^{γ}). However, such mechanism is unlikely in the French context since, according to inheritance rights, where a very large proportion of the bequest must be equally distributed among children. Hence, parents are very restricted and cannot really choose how to share their bequests between their children. In addition, inter-vivos transfers cannot be used to favor one child since they are taken into account when the bequest is distributed evenly. Finally, it is not possible to disinherit a child except under very exceptional circumstances (e.g. the child mistreated the parent or killed him/her).

The model does not incorporate the purchase of provision of formal care, either privately bought by the parent or publicly funded. This is a limitation given that it can be substitute or a complement to informal care (Bonsang, 2009; Carrino et al., 2018).

3 Estimation

3.1 Random terms

To estimate the model, I further add unobserved random terms. I particularly assume that each child has an unoberved random term that enters additively in their own (private) utility of informal care provision:

$$\begin{cases} u_i(a_i = 0|a_{-i}) = a_{-i}u_i^{\alpha} \\ u_i(a_i = 1|a_{-i}) = u_i^{\beta} + a_{-i}u_i^{\alpha} + a_{-i}u_i^{\gamma} + v_i \end{cases} \tag{7}$$

The unobserved random terms, v_1 and v_2, are assumed to be distributed a bivariate normal with mean 0 and correlation ρ. One should note that this unobserved random component is unobserved by the econometrician, but observed by the sibling who observes all the component of i's utility function. It can be interpreted as the correlation of the unobserved (for the econometrecian) shifters

[11] When we refer to inefficiency, we compare the noncooperative outcome with is the efficient outcome that maximizes the sum the utilities.

of the utility of providing informal care of the two siblings (family values for example).

3.2 Cooperative model

As noted by Bresnahan and Reiss (1991), some identification assumptions are needed. Firstly, because it is not possible to identify separately u_1^γ and u_2^γ, I let $s^\gamma = u_1^\gamma + u_2^\gamma$. This simplification does not affect the theoretical implications we can derive from the model because what matters on the complementarity or substitution of children's participation is the sum of the two different terms (see Section 2.4).

Secondly, we cannot distinguish u_i^β from u_{-i}^α. This means that we cannot distinguish the two different drivers of care provision: i) child's utility of care provision and ii) externality on the sibling's well-being. It can be easily understood because each time a child i provides informal care, the siblings welfare function necessarily includes their utility of caregiving (u_i^β) and the positive externality on their sibling's utility (u_{-i}^α). One identifying assumption is therefore needed: *the number of potential caregivers does not affect the utility of caregiving.*

This assumptions states that the number of potential caregiver can increase the level of care received by the parent, but it does not change each child's private utility of caregiving. Said differently, this assumption states that u^β is the same irrespective of the size of the family. This assumption allows me to use one-child families to identify the utility of care provision of individuals in two-child families.[12] Indeed, because they do not receive any externality from a sibling's caregiving participation, the only determinants of care provision for single children is their utility of caregiving and an unobserved random term. I use a two-step procedure in practice. Because the single child's utility is zero when they do not provide informal care and it is $u_i^\beta + v_i$ when they do provide care, we can simply estimate a probit model on the sample of single children to identify the parameters of u_i^β. Once these parameters are estimated, we can estimate the model for siblings in two-child families while constraining the parameters of u^β to be equal to those previously estimated. And we can therefore estimate the remaining parameters of the model.

We should emphasize that this assumption can be used because the preferences are assumed to be symmetric. This assumption is also made by Knoef and Kooreman (2011) who simulate the

[12]A similar assumption is often use to identify in household economics, where single individuals are often use to identify structural parameters for individuals in couple (Browning et al., 2013)

noncooperative and cooperative allocation of informal care provision in two-child families. The argument they use to justify this assumption is based on the results of Spitze and Logan (1991) who find that children's closeness to parents and attitudes towards filial responsibility are unrelated with being an only child or not. Another crucial assumption for this identification strategy is the separability of u^β and u^α.

In the econometrics of games, it is important for the model to be both coherent and complete (Tamer, 2003). Tamer (2003) defines an econometric model as incomplete as a model which may predict multiple equilibria. He also explains that a model is incoherent if it predicts no equilibria.[13] In Appendix B.1.1 I show that the cooperative model is indeed complete and coherent with a graphic representation of the game.

Finally, this model is estimated by maximum likelihood (see Appendix B.1.2).

3.3 Noncooperative model

In the noncooperative model, children make their caregiving decision taking the caregiving behavior of their sibling as given. A graphical representation of the game is displayed Appendix B.2.1. We can see that u^α does not appear in the conditions such that one allocation is being chosen, it is thus not identified. This is because children do not account for the externality they have on their sibling when they behave according to the noncooperative model.

The main econometric difficulty is that such model is generally incomplete (Tamer, 2003). As we can see, multiple equilibira may appear (at most two depending on the sign of u^γ) and the model is not point-identified. Note that the model is coherent because it does not predict an absence of equilibrium. This arises because preferences are assumed to be symmetric. To resolve this incompleteness, the model can be completed by modeling (or choosing) an equilibrium selection mechanism to determine wich equilibrium is being chosen (Bjorn and Vuong, 1984; Bresnahan and Reiss, 1991; Kooreman, 1994; Lewbel, 2019; Tamer, 2003). I use an iterative selection procedure proposed by Fontaine et al. (2009). It is first assumed that, when the econometric model predict multiple (or two)

[13]For an informal and intuitive definition of incoherence and incompleteness, but also to what extent these notions differ, see Lewbel (2019). Not that some authors, as Gourieroux et al. (1980), defines an incoherent model as a model that is, following Tamer's (2003) definitions, both incomplete and incoherent.

equilibria, they are chosen at random (i.e with probability one half) and estimate the model by maximum likelihood to estimate the parameters of the utility functions. I obtain an approximation of the selection rule by computing the selection that matches with the osbserved care arrangements for this given set of parameters. I reestimate the model using the updated selection and repeat this procedure iteratively until the probabilities of selecting each equilibria converge. All the parameters of the model are point-identified (except u^α that is never identified) with this equilibrium selection mechanism. The likelihood function is given in Appendix B.2.2.

3.4 Fonctional forms

I impose a fonctional form on the different components of the utility functions to estimate the model. Let X_i^β, X_i^α be a vector of observed characteristics, including a constant term.

$$u_i^\alpha = X_i^\alpha \alpha \tag{8}$$

$$u_i^\beta = X_i^\beta \beta \tag{9}$$

$$s^\gamma = \gamma^s \tag{10}$$

$$u^\gamma = \gamma^u \tag{11}$$

where α, β, γ^s and γ^u are parameters to be estimated. I therefore allow each components to be heterogeneous with respect to some observed characteristics. One exception is u^γ and s^γ that are assumed to be constant. As previously said, u^γ is estimated in the noncooperative model, while s^γ is estimated in the cooperative model. But since preferences are symmetric and $s^\gamma = u_1^\gamma + u_2^\gamma$, assuming that s^γ is a constant allows to recover the estimated u^γ in the cooperative model. This therefore makes the comparison of the estimated u^γ in the cooperative and noncooperative frameworks possible. Notice that, even though u_i^α is assumed to be positive, we do not use an exponential form because it is empirically positive whenever this restriction is imposed.

I estimate several specifications for the cooperative model. Specification 1 corresponds to a model where $s^\gamma = u_i^\alpha = 0$ and $\rho = 0$ is imposed. This specification is therefore a simple probit model for each child, in which there is no externality and no unobserved correlation of siblings' pareferences. In specification 2, ρ is allowed to be different from zero. This means that siblings' preferences for care provision are allowed to be correlated. In specification 3, I allow s^{γ} to be a constant, maintaining the assumption that $u_i^{\alpha} = 0$. In specification 4, I allow u_i^{α} to be different from zero. Finally, in specification 5, estimate the full model is estimated where u_i^{α} is allowed to be heterogenous.

4 Data

I use the French CARE (Capacités, Aide et REssources des séniors, volet Ménages) survey, a nationally representative survey of individuals aged 60 or more living in the community, conducted in 2015.[14] 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, it is possible to construct a data set with the children as the individuals of interest. I focus on seniors who are single and have two children.

The participation in 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.[15] If informal care is received, the respondents can report up to ten informal care givers. For each child, this information is used to construct a binary variable equal to one if the child provides informal care, and 0 otherwise. These are the outcome variables I use in this analysis.

With regard to the variables affecting the private utility of caregiving (X_i^{β}), I control for gender, age, the number of children and a dummy indicating wether the child is single (i.e. divorced, widow or never married) or not. I do not have information on hours of paid work for the children, and therefore only use a dummy variable equal to one when the child is working for pay and zero otherwise.[16] I also control for the distance between the parent and the child, captured by a cate-

[14] 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

[15] The list of activities is given in Appendix C.

[16] One might argue that participation in paid work is endogenous since children could have stopped working to provide informal care to the parent. Nonetheless, the literature have shown that, in general, providing informal care does not impact labor market participation (see Bauer and

gorical variable with values ”same neighborhood”, ”same city”, ”same region”, or ”further away”.[17] The distance might be thought of as possibly endogenous as some children may relocate in order to care for their parents. I still follow most of the literature and assume the distance to be exogenous. Previous studies suggest that even if distance were endogeneous the bias would be limited and the distance is still a strong predictor of informal care provision even after controlling for endogeneity (Hiedemann et al., 2017; Stern, 1995). I control for the yearly income of the parent (derived from administrative records), whether the parent has limitations in daily life activities[18], a dummy indicating if the parent has Alzheimer or a similar disease, and the parent's gender, age and highest educational degree.

Concerning the variables affecting the utility of having a sibling providing care (X_i^α), I allow it to vary with the existence of ADL limitations of the parent and the gender of the sibling.

Descriptive statistics of the variables used in the analysis are displayed in Table 1. Panel A describes care provision at the family level. Many parents receive no care from either child. 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). Even though, in most families, there is only one child who provides informal care to the parent.

The characteristics of children are described in Panel B. We can see that half of children are daughters, most of children are in a union and have a paid job. 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.

Sousa-Poza (2015); Lilly et al. (2007) for a review).

[17]Note that the survey doest not refer to administrative but subjective regions.

[18]I have also tried to introduce the number of limitations in daily life activities. The resuts suggest that the effect was not different between limitations in one ADL, two ADL, and three of more ADL. This indicates that the main driver is whether the parent has at least one limitation. I therefore chose to introduce only a dummy variable.

Table 1: Descriptive statistics

Panel A: *Care at the family level*	
No care provided (%)	61.65
One caregiver (%)	27.32
Two caregivers (%)	11.04
Panel B: *Children's characteristics*	
Woman (%)	49.86
Single (%)	29.84
Nb children	1.61
	(1.11)
Age	51.65
	(11.10)
Working (%)	66.42
Same neighborhood (%)	14.59
Same city (%)	13.33
Same region (%)	41.91
Further away (%)	30.17
Panel C: *Parent's characteristics*	
At least one adl (%)	22.36
Alzheimer or alike (%)	5.15
Mother (%)	81.57
Yearly income	18,900
	(11,001)
Age	78.88
	(9.99)
No diploma (%)	24.32
Primary education (%)	34.42
Lower secondary education (%)	22.64
Higher secondary or higher education (%)	18.62
Nb pair of siblings	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). Income in current euros.

5 Results

5.1 Utility of caregiving

The coefficients associated to the private utility of care provision - estimated on the sample of children without siblings - are provided in Table 2. In the sample of two-child families, the mean utility is -0.75, its range is [-3.30;1.88], and it is negative for 76% of children. I plot the distribution of the estimated utility in Appendix D. This suggests that caregiving is on average burdensome, but some individuals have a positive utility of caregiving. The estimated coefficients suggest that the disutility of caregiving is lower for women than men. This result is in line with Byrne et al. (2009) who estimate a structural model and find that daughters experience a lower caregiving burden. On the contrary, I find that the distance to the parent increases the burden of care provision. This can be explained by both the utility and monetary transportation costs. The other children's characteristics does not appear to shift the utility of caregiving.

Table 2: Coefficients for utility of caregiving - u^{β}

Children's characteristics		*Parent's characteristics*	
Age	-0.002	Mother	0.492***
	(0.006)		(0.086)
Single	0.093	At least one ADL	0.533***
	(0.082)		(0.084)
Nb children	-0.026	Alzheimer or alike	0.244*
	(0.035)		(0.134)
Woman	0.168**	No diploma	ref
	(0.168)	Primary	-0.052
Working	-0.120		(0.092)
	(0.082)	Lower secondary	-0.139
Same neigborhood	0.573***		(0.106)
	(0.094)	At least higher secondary	-0.166
Same city	0.321***		(0.131)
	(0.102)	Annual income/12,000	-0.100**
Same region	ref		(0.049)
Further away	-0.673***	Age	0.062***
	(0.104)		(0.007)
Constant	-2.002***		
	(0.284)		
Likelihood	-804.09		

Source: CARE Survey. The coefficients are estimated on the sample of children without siblings. N = 2,039. * p<0.1, ** p<0.05, *** p<0.01.

Concerning the characteristics of the parent, the caregiving burden is lower when care is provided to a mother rather than a father, but also when the parent is growing older, has at least one ADL restrictions or has a cognitive health issue. The results on the gender and age of the parent are in line with Byrne et al. (2009). On the contrary, Byrne et al. (2009) finds that the number of limitations the parents increase children's caregiving burden. This difference should arise from the fact we can only interpret the estimated coefficient in reduced form way.[19] Indeed, this result is in line with the literature that estimates reduced form models. Finally, the utility of providing care

[19]Byrne et al. (2009) finds that the number of ADL increases the probability that children provides

appears decreasing with the parent's income.

5.2 Cooperative model

The estimated coefficients for each specification can be found in Table 3. Results from specification 1 are not displayed because the only estimated coefficients are those from Table 2. I give the average predicted for each level of care provided to the parent in Table 4. Specification 1 overpredicts the level of care received by parents. It predicts that 46% of parents receive informal care while only 38% of them receive care in the sample. In specification 2, the probability that no child provides informal care is closer to what is observed in the sample. Nonetheless, we still over-predict by a lot the probability that both children are caregivers. The main change with respect to specification 1 is an increase in the probabilies of observing siblings with the same caregiving decision (i.e both caregivers or none of them is a caregiver). This change can be attributed to the large positive correlation of the unobserved preferences of children for caregiving (ρ), which make children more likely to behave similarly.

The result from specification 3 (Table 3) indicates a negative sum of the siblings preferences for joint participation (s^{γ}). This indicates that children prefers to not provide informal care when their sibling is also a caregiver. Children's caregiving participations are therefore substitutes and the siblings' welfare function is submodular. One should first note that this model predicts better the level of care received by the parents we observe in the data than the previous ones. Accounting for the fact that children do not like providing care simultaneously with their sibling counterbalance the positive correlation of the unobserved random terms.

In specification 4, the utility of having a sibling providing care (u^{α}) is positive. This is evidence of a positive externality of children's participation on their sibling's well-being. Results from specification 5 show that children's benefit from having a sibling providing care is the highest when the parent has limitations in daily life activities. The constant is positive but not significant. This results can be explained by the fact the parent's increase in well-being from the sibling's care should

informal care in a reduced form model. The authors explain that it is because informal care might be more effective when the parent has ADL problems, but also more burdensome. This conflicting effects make the effect of ADL problem on family members' incentive to provide informal care are complex.

Table 3: Estimated parameters - cooperative model

Specification 2: $u^{\alpha} = s^{\gamma} = 0$			
	ρ		
Constant	0.410***		
	(0.062)		
Likelihood: -885.73			
Specification 3: $u^{\alpha} = 0$, constant s^{γ}			
	ρ	s^{γ}	
Constant	0.830***	-0.644***	
	(0.034)	(0.063)	
Likelihood: -841.74			
Specification 4: constant u^{α} and s^{γ}			
	ρ	s^{γ}	u^{α}
Constant	0.894***	-0.691***	0.240***
	(0.021)	(0.064)	(0.042)
Likelihood: -826.99			
Specification 5: heterogeneity			
	ρ	s^{γ}	u^{α}
Constant	0.893***	-0.707***	0.040
	(0.021)	(0.065)	(0.073)
At least one ADL			0.233***
			(0.082)
Sibling is a sister			0.099**
			(0.049)
Likelihood: -820.62			

Source: CARE Survey. N = 1,069. s^{γ} is the sum of children utilities of providing informal care, when having a sibling participating in caregiving. u^{α} is the utility of having a sibling providing care to the parent.ρ is the correlation of the unobserved (for the econometrecian) shifters of the utility of providing informal care of the two siblings. The controls are the parent's age, gender, income, number of ADL limitations, Alzheimer disease or similar, and the highest educational degree. We also control for the child's age, marital status, gender and number of children.
Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

be small when the parent does not have limitations. In this case, the externality induced by the sibling's care provision should therefore be (or close to be) null. On the opposite, altruistic children are better off when their parent receives informal care from another person (the sibling in this case) and the parent cannot perform some activities anymore. Finally, u^{α} is also increased when the caregiver sibling is a sister. This might be explained by a result from Byrne et al. (2009) who find that informal care is more effective in increasing the parent's health quality when it is provided by a daughter rather than a son. Another potential explanation is gender norms, and that children prefer that their parent receives informal care by a woman.[20] To my knowledge, there is no paper providing empirical evidence on this positive externality in the context of informal caregiving and its heterogeneity.[21]

Table 4: Average predicted probabilities from the cooperative model

Restrictions	$u^{\alpha} = s^{\gamma} = 0$		constant s^{γ}		Full model	Observed
	$\rho = 0$	$\rho \neq 0$	$u^{\alpha} = 0$	$u^{\alpha} \neq 0$		
Specifications	(1)	(2)	(3)	(4)	(5)	
No caregiver	54.3	57.3	61.2	55.6	56.1	61.7
One caregiever	30.1	24.6	27.9	30.0	29.2	27.3
Two caregivers	15.1	18.2	10.9	14.4	14.6	11.0

Source: CARE Survey. The Table displays the average predicted probabilities obtained from the estimation of the cooperative model under different specifications of restrictions. s^{γ} is the sum of children utilities of providing informal care, when having a sibling participating in caregiving. u^{α} is the utility of having a sibling providing care to the parent. ρ is the correlation of the unobserved (for the econometrecian) shifters of the utility of providing informal care of the two siblings

Regarding the average predicted probalities, these two last specifications predict that about 44% of parents receive informal care and about 15% have two caregivers. This is 5 percentage points higher than what is observed in the data. Comparing with average predicted probabilities without altruism, the results suggest a public good problem because this latter provides a much better fit of the data. It also allows us to anticipate the results we should otbain with the noncooperative model. Because siblings ignore the externality they have on their siblings in the noncooperative model, this model should provide a better fit to the data. Finally, I can summarize the estimation results from the cooperative model by concluding that it over-predicts the probability that the parent receives informal care from at least one child.

5.3 Noncooperative model

I first use the parameters estimated in the cooperative model to simulate the allocation of caregiving in a noncooperative family. Then I discuss the results we obtain from the direct estimation of the

[20] Another explanation can be that the parents prefer to receive informal care by a daughters, and experience a higher well-being when receiving care by a daughter rather than a son.

[21] As I said in the introduction, Maruyama and Johar (2017) and Stern (2021), who study location choices, finds evidence of a positive externality of having a sibling who live near the parent.

noncooperative model.

The parameters included in the cooperative model also determine the equilibrium of the noncooperative model. Only u^α does not play any role because children do not internalize the externality they have on their sibling. The assumption of symmetric preferences can be used to recover u_i^γ when s^γ is a constant because it states that $u_1^\gamma = u_2^\gamma = s^\gamma/2$. I am therefore able to simulate the allocation of care provision in the family using the parameters from Table 3. Because unobserved heterogeneity plays a role in the children's choices and it is correlated among siblings, I draw 1,000 pair of random numbers distributed a bivariate normal with correlation $\rho = 0.893$.[22] Note that I directly simulate the allocation of care at the family level such that I do not have to deal with multiple equilibria.

In the column (2) of the Table 5 I display the simulated noncooperative allocation using the coefficients from the full cooperative model. This model predicts very well the probability that the parent receive informal care by at least one child. It nonetheless predict poorly the conditional number of caregivers since it over-predicts (under-predicts) the probability of having both children (one child) providing informal care.

Table 5: Predicted probabilities - noncooperative model

	Cooperative	Noncooperative		Observed
		Simulated	Estimated	
	(1)	(2)	(3)	(4)
No caregiver	56.1	61.9	61.9	61.7
One caregiever	29.2	22.1	27.0	27.5
Two caregivers	14.6	15.9	11.1	10.6

Source: CARE Survey. Notes: The simulated noncooperative probabilities in column (2) correspond to the caregiving allocation obtained with a simulated noncooperative model using the coefficient estimated with a cooperative model. The estimated noncooperative probabilities in column (3) corresponds to the allocation of caregiving computed under the assumption that the utility of caregiving is not affected by the number of potential caregivers.

The estimated coefficients from the estimation of the noncooperative model are presented in Panel A of Table 6. The results show that children are strategic substitutes and that children are playing a submodular game. We also find a positive correlation of the unobserved random term, as in the cooperative model, and the estimated coefficient is relatively similar. One should note that

[22]This means that I draw 2,000 unobserved random numbers in total. This ρ is taken from the estimation of the full cooperative model displayed in Table 3.

the strategic interaction coefficients or the preferences for joint provision (u^{γ}) is twice as large as it is estimated in the cooperative model. The average predictied probabilities of the level of care are displayed in column (3) of Table 5. This noncooperative model outperforms all other models in terms of prediction. The predicted probabilities are very close to what is empirically observed. Note that the only difference with the simulated model is the estimated preferences for the joint provision of informal care.

Table 6: Estimated parameters - noncooperative model

Panel A: endogenous selection mechanism		
	ρ	u^{γ}
Constant	0.888***	-0.663***
	(0.044)	(0.078)
Panel B: pooling of multiple equilibria		
	ρ	u^{γ}
Constant	0.925***	-0.689***
	(0.057)	(0.082)
Likelihood: -748.59		

Source: CARE Survey. N = 1,069. u^{γ} is the utility of providing care when having a sibling who prodives care. ρ is the correlation of the unobserved (for the econometrecian) shifters of the utility of providing informal care of the two siblings. The controls are the parent's age, gender, income, number of ADL limitations, Alzheimer disease or similar, and the highest educational degree. We also control for the child's age, marital status, gender and number of children. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

As a rosbustness check, I estimate the noncooperative model with an alternative identification strategy. The method consists in pooling the multiple equilibria and modeling the number of caregivers to avoid the use of a mechanism selection (Berry, 1992; Bresnahan and Reiss, 1990; de Paula, 2013).[23] The results are provided in Table 6 (Panel B) and the predicted allocations (not displayed) are very close to the previous noncooperative ones. The previous results are therefore supported by this robustness check.[24]

These results lead to some important conclusions. Firstly, the noncooperative model seems to

[23]See Appendix B.3 for a brief explanation of the method.

[24]I have also tried to estimate the selection rule using a parametric form as discussed by Bjorn and Vuong (1984). The parameters were poorly identified because, as noticed by Card and Giuliano (2013) who also tested this approach, the probability of multiple equilibra is low (about 4.5%).

better correspond to the decision process of children in France. Secondly, if we are willing to accept the first conclusion, the disutility of participating in informal care when having sibling providing care is underestimated in the cooperative model. Thirdly, children are strategic substitutes. Fourthly, the allocation of informal care generates a lower level of informal than if children would cooperate. This is because children have a positive externality on their sibling when they provide informal care, but they do not take it into account when they behave according to the noncooperative model.

6 Inefficiency and unmet needs

It is often argued that the noncooperative model suffers a public good problem because it generates a lower level of provision to the public good than the Pareto equilibrium (here the cooperative model). Said differently, there could be an underprovision of informal care to the elderly parent when children do not cooperate. But even if the level of care is lower that what it could be, this does not mean that the parent does not receive enough informal care. To assess whether the lack of cooperation is detrimental for the parent I construct an indicator of the degree of noncooperativeness in families, then I regress the number of unmet needs the parent has on this latter indicator.

I follow Knoef and Kooreman (2011) and construct an indicator of the a degree of noncooperativeness between siblings by the difference between the non-cooperative and the cooperative predicted probabilities for the realized outcome. The distribution of the degree of noncooperativeness is displayed in Appendix E. We can observe that families seem to behave according to a noncooperative model, but there are few families that seem to be cooperative. We also remark that the degree noncooperativeness of siblings appears smaller than in Knoef and Kooreman (2011). This can be related to the fact that noncooperation migth be more important if one considers the intensive margin of caregiving.

In order to understand how the lack of cooperation might lead to the underprovision of care to the parent, I regress the number of unmet needs the parent has on the degree of noncooperativeness.[25] This indicator is standardized between 0 and 1 such that its coefficient can be interpreted as

[25]In thurvey, for each ADL and IADL activities given in Appendix C, individuals report both if they have difficulties to do this specific activity and also whether they receive help for this activity (whether from a professional or informal caregiver). I can therefore construct the number of unmet needs as the number of activities for which an individual reports having difficulties but no help.

the effect of moving from the most cooperative families to the less cooperative ones (or the most noncooperative ones). Because most parents have no unmet needs and the distribution of the number of unmet needs is skewed we use a Quasi-Maximum Likelihood Poisson estimator.[26]

The results suggest that, on average, the difference in unmet needs between parents from the most cooperative and less cooperative families is a little above 1 (see Table 7). This shows that the lack of cooperation between siblings translastes into a higher underprovision if informal care. We can therefore ague that the current allocation of informal care is inefficient and suffers from a public good problem.

Table 7: Effect of the noncooperativeness on the parent's number of unmet needs

Panel A: witout covariates	
Degree of noncoopertivess	1.399***
	(0.163)
Panel B: with covariates	
Degree of noncoopertivess	1.427***
	(0.143)
Panel B: with covariates and controlling for formal care	
Degree of noncoopertivess	1.372***
	(0.141)
Hours of formal care receipt	-0.013***
	(0.001)

Source: CARE Survey. N = 1,069. The controls are the parent's age, gender, income, number of ADL limitations, number of IADL limitations, Alzheimer disease or similar, and the highest educational degree. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

7 Conclusion

The family is the main provider of long-term care for elderly people living in the community. But little is known about the decision process of children even though it has important implications for the level of care received by the parents and ultimately their well-being. This paper assesses which model drives the caregiving decisions of children by comparing the predictive power of two models: a (joint-utility) cooperative and a Nash noncooperative model.

[26] In our sample, 54% of parents have no unmet needs. The Quasi-Maximum Likelihood Poisson estimator is consistent and unbiased in such situation and is robust to overdispersion (Santos Silva and Tenreyro, 2011; Wooldridge, 2010).

The main result is that children are more likely to behave according to a noncooperative model. I also find that children's participation in caregiving has a positive externality on the well-being of the sibling, and that it is higher when the parent has ADL limitations or the sibling is a sister. Because children do not take it into account this externality when they behave according to the noncooperative model, the current level of informal care provided to parents appears to be inefficient and suffers from a public good problem. Therefore, pushing children into their cooperative equilibrium would increase informal care receipt for the elderly and reduce their number of unmet needs. But such policy might be difficult to find and implement. Another potential policy would be to increase the level of publicly financed formal care (Konrad and Lommerud, 1995). Indeed, formal care does not seem to have a large crowding-out effect on informal care receipt (Balia and Brau, 2013; Bonsang, 2009). In France, Fontaine (2012) shows that an increase in publicly funded formal care increases the total level of care received by the elderly inspite of a modest decrease in informal care receipt. He also shows that such policy can reduce the unmet needs of the beneficiaries.

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 second limitation is the focus on the extensive margin of caregiving, while the intensive margin is also important in determining the inefficiency of the total level of care received. The well-being of the parents is more likely to depend on the total care received than on whether they receive informal care or not. Finally, our empirical test relies on the comparison of the predictive power of both models. There is a need for a more general test based on the theory to discriminate the cooperative from the noncooperative model.

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Supplementary Material

Care for Elderly Parents: Do Children Cooperate?

A Supermodularity

First, it requires to define the decision variables over a lattice. Let $\mathcal{S}$ be a lattice if it is a partially oredered set which, $\forall\ a_1, a_2 \in \mathcal{S}$, have a unique supremum (also called a least upper bound or join) and a unique infimum (also called a greatest lower bound or meet). For $a_1, a_2 \in \mathrm{R}^n$, these latter are respectively defined as $a_1 \vee a_2 = (min\{a_{11}, a_{21}\}, ..., min\{a_{1n}, a_{2n}\})$ and $a_1 \wedge a_2 = (max\{a_{11}, IC_{21}\}, ..., max\{a_{1n}, a_{2n}\})$. We therefore assume that $\mathcal{S}$ is a lattice and $W(a_1, a_2)$ is supermodular if

$$W(a_1 \wedge a_2; \mathbb{X}) + W(a_1 \vee a_2; \mathbb{X}) \geq W(a_1; \mathbb{X}) + W(a_2; \mathbb{X}). \tag{A.1}$$

This definition also contains the notion of complementarity such that the maginitude of the utility gains from providing care both simultaneously are not the same as providing care separately. This is better proven with the property of increasing differences which is obtained rewritting the previous equation:

$$[W(a_1; \mathbb{X}) - W(a_1 \vee a_2; \mathbb{X})] + [W(a_2; \mathbb{X}) - W(a_1 \vee a_2; \mathbb{X})] \\ \leq W(a_1 \wedge a_2; \mathbb{X}) - W(a_1 \vee a_2; \mathbb{X}) \tag{A.2}$$

B List of activities given to seniors when asked about the help or care they receive

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
- Non of these activities

C Econometric issues

C.1 Cooperative model

C.1.1 Coherency and completness

To show that the model is complete and coherent, let us graphically represent the game in the space (v_1,v_2). This graphical representation can be found if we note that each of the four possible combinations provides the following different levels of siblings' welfare:

$$W(0,0) = 0 \tag{C.1.1}$$

$$W(1,0) = u_1^\beta + u_2^\alpha + v_1 \tag{C.1.2}$$

$$W(0,1) = u_2^\beta + u_1^\alpha + v_2 \tag{C.1.3}$$

$$W(1,1) = u_1^\beta + u_2^\alpha + u_2^\beta + u_1^\alpha + v_1 + v_2 + s^\gamma \tag{C.1.4}$$

Both siblings maximize the sum of their utilities, therefore they compare the welfare they obtain from each possible combination. The probability that a pair (a_1, a_2) is observed is given by three conditions. For example, no child provides informal care if:

$$W(0,0) > W(1,0) \Leftrightarrow v_1 > -u_1^\beta + u_2^\alpha \tag{C.1.5}$$

$$W(0,0) > W(0,1) \Leftrightarrow v_2 > -u_2^\beta - u_1^\alpha \tag{C.1.6}$$

$$W(0,0) > W(1,1) \Leftrightarrow v_2 + v_1 < -u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma \tag{C.1.7}$$

The conditions for the remaining combinations are displayed in Table C.1.1.

Table C.1.1: Conditions for observing each pair of choices

(1,1)	(1,0)
$v_1 > -u_1^\beta - u_2^\alpha - s^\gamma$	$v_1 > -u_1^\beta - u_2^\alpha$
$v_2 > -u_2^\beta - u_1^\alpha - s^\gamma$	$v_2 < -u_2^\beta - u_1^\alpha - s^\gamma$
$v_2 + v_1 > -u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma$[a]	$v_2 - v_1 < u_1^\beta + u_2^\alpha - u_2^\beta - u_1^\alpha$[b]
(0,1)	**(0,0)**
$v_1 < -u_1^\beta - u_2^\alpha - s^\gamma$	$v_1 < -u_1^\beta - u_2^\alpha$
$v_2 > -u_2^\beta - u_1^\alpha$	$v_2 < -u_2^\beta - u_1^\alpha$
$v_2 - v_1 > u_1^\beta + u_2^\alpha - u_2^\beta - u_1^\alpha$[b]	$v_2 + v_1 < -u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma$[a]

[a] This condition is not binding when $s^\gamma \leq 0$
[b] This condition is not binding when $s^\gamma \geq 0$

In figures C.1.1a and C.1.1b we display the graphical representation of these conditions in the space (v_1, v_2) which define the equilibrium of the game. The model appears to be complete and coherent in the sense of Tamer (2003): any given realization of the errors (v_1, v_2) is unambiguously associated with a siblings' joint strategy (a_1,a_2).[1] More rigorously, one could say that "the model has a harmless probability zero chance of incompleteness" (Lewbel, 2007), and this is because v_1 and v_2 are continuously distributed. The parameters of the model are therefore point identified.

One comment can be made on this econometric model: it takes into account the observed components of the co-movement of siblings' participation (through s^γ or u^γ) but also the unobserved ones through the correlation of the unobserved heterogeneity (ρ). This means that we also account for a possible positive (or negative) correlation that can be induced by unobserved components that shift the utilities of both siblings simultaneously.

C.1.2 Likelihood

The likelihood function is given by the different inequalities in Table C.1.1. In Figure C.1.1, if we look at the combination (1,1), i.e both siblings participate simulateneously in caregiving, it is defined by the region $R_{1,1} = [-u_1^\beta - u_2^\alpha - s^\gamma, \infty) \times [-u_2^\beta - u_1^\alpha - s^\gamma, \infty)$ in the space (v_1,v_2) when $s^\gamma \leq 0$ (Figure C.1.1), while the region is a subspace of $R_{1,1}$ when $s^\gamma > 0$ (Figure C.1.1b). This fact is accounted for with the condition $v_2 + v_1 > -u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma$.

To derive the likelihood function, we first need to derive the probability that each of the four possible arrangements (a_1,a_2) is observed are given by the different conditions in Table C.1.1. I first give the probability of observing that both children are caregivers as an example of how the formula is obtained. Then I give the formula for the other outcomes.

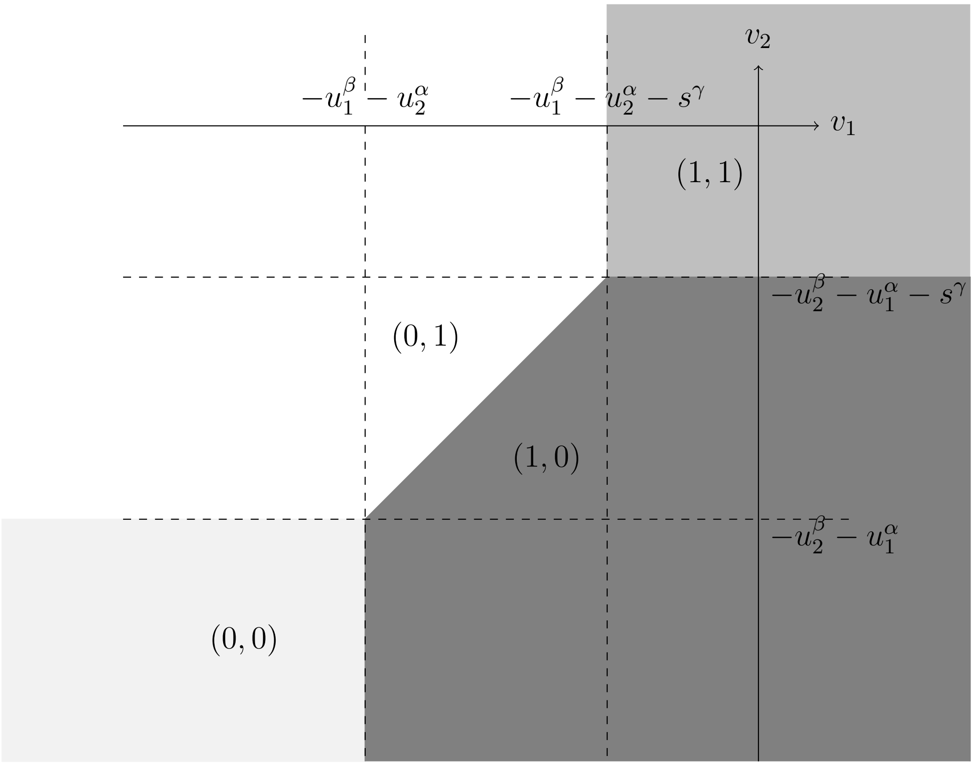
There are two different cases depending on the sign of s^γ.

1. $s^\gamma \leq 0$. In this case, the third constraint on $v_2 + v_1$ is not binding and we need only the two other constraints. This means that $(1, 1)$ is rectangular on the space (v_1, v_2), as in figure C.1.1a. The formula is

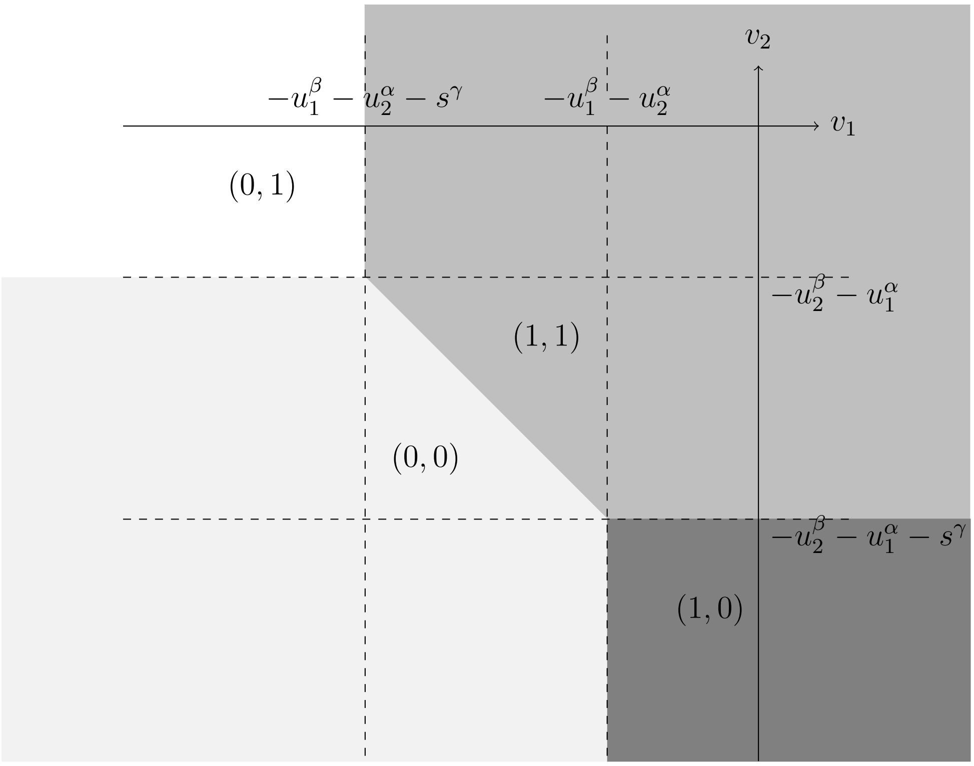
$$P(a_1 = 1, a_2 = 1) = \Phi_2\Big(u_1^\beta + u_2^\alpha + s^\gamma, u_2^\beta + u_1^\alpha + s^\gamma; \rho\Big) \tag{C.1.8}$$

[1] Tamer (2003) defines an econometric model as incomplete as a model which may predict multiple equalibria. He also explains that a model is incoherent if it is predicts no equilibria. For an informal and intuitive definition of incoherence and incompletness, but also to what extent these notions differ, see Lewbel (2019). Not that some authors, as Gourieroux et al. (1980), defines an incoherent model as a model that is, folowing Tamer's (2003) definitions, both incomplete and incoherent.

Figure C.1.1: Graphic representation - cooperative model



(a) $s^\gamma < 0$



(b) $s^\gamma > 0$

where $\Phi_2(,;\rho)$ is the cumulative density function of a standard bivariate normal distribution with correlation ρ.

2. $s^\gamma > 0$. The three inequalities are now binding and this corresponds to figure C.1.1b where $(1,1)$ is not rectangular. We split this region given by the three inequalities in two different regions that are given by the following pair of inequalities:

$$v_1 > -u_1^\beta - u_2^\alpha \tag{C.1.9}$$

$$v_2 > -u_2^\beta - u_1^\alpha - s^\gamma \tag{C.1.10}$$

and

$$-u_1^\beta - u_2^\alpha - s^\gamma < v_1 < -u_1^\beta - u_2^\alpha \tag{C.1.11}$$

$$v_2 + v_1 > -u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma. \tag{C.1.12}$$

The conditions from equations C.1.9 and C.1.10 gives:

$$P(v_1 > -u_1^\beta - u_2^\alpha, v_2 > -u_2^\beta - u_1^\alpha - s^\gamma) = \Phi_2\Big(u_1^\beta + u_2^\alpha, u_1^\beta + u_2^\alpha + s^\gamma; \rho\Big) \tag{C.1.13}$$

The conditions from equations C.1.11 and C.1.12 gives:

$$\begin{aligned} P(-u_1^\beta - u_2^\alpha - s^\gamma < v_1 < -u_1^\beta - u_2^\alpha, v_2 + v_1 > -u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma) = \\ \Phi_2\Big(u_1^\beta + u_2^\alpha + s^\gamma, \frac{u_1^\beta + u_2^\alpha + u_2^\beta + u_1^\alpha + s^\gamma}{\sqrt{2(1+\rho)}}; \frac{1+\rho}{\sqrt{2(1+\rho)}}\Big) \\ - \Phi_2\Big(u_1^\beta + u_2^\alpha, \frac{u_1^\beta + u_2^\alpha + u_2^\beta + u_1^\alpha + s^\gamma}{\sqrt{2(1+\rho)}}; \frac{1+\rho}{\sqrt{2(1+\rho)}}\Big). \end{aligned} \tag{C.1.14}$$

Combining equations C.1.13 and C.1.14, we obtain

$$\begin{aligned} P(a_1 = 1, a_2 = 1) = \Phi_2\Big(u_1^\beta + u_2^\alpha, u_2^\beta + u_1^\alpha + s^\gamma; \rho\Big) \\ + \Phi_2\Big(u_1^\beta + u_2^\alpha + s^\gamma, \frac{u_1^\beta + u_2^\alpha + u_2^\beta + u_1^\alpha + s^\gamma}{\sqrt{2(1+\rho)}}; \frac{1+\rho}{\sqrt{2(1+\rho)}}\Big) \\ - \Phi_2\Big(u_1^\beta + u_2^\alpha, \frac{u_1^\beta + u_2^\alpha + u_2^\beta + u_1^\alpha + s^\gamma}{\sqrt{2(1+\rho)}}; \frac{1+\rho}{\sqrt{2(1+\rho)}}\Big). \end{aligned} \tag{C.1.15}$$

Finally, from equations C.1.8 and C.1.15, the formula for probability to observe children being caregivers can therefore be written as following:

$$\begin{aligned} P(a_1=1,a_2=1) = \Phi_2\Big(& u_1^\beta + u_2^\alpha + 1[s^\gamma \le 0]s^\gamma, u_2^\beta + u_1^\alpha + s^\gamma; \rho\Big) \\ &+ 1[s^\gamma > 0]\Big[\Phi_2\Big(u_1^\beta + u_2^\alpha + s^\gamma, \frac{u_1^\beta + u_2^\alpha + u_2^\beta + u_1^\alpha + s^\gamma}{\sqrt{2(1+\rho)}}; \frac{1+\rho}{\sqrt{2(1+\rho)}}\Big) \\ &- \Phi_2\Big(u_1^\beta + u_2^\alpha, \frac{u_1^\beta + u_2^\alpha + u_2^\beta + u_1^\alpha + s^\gamma}{\sqrt{2(1+\rho)}}; \frac{1+\rho}{\sqrt{2(1+\rho)}}\Big)\Big] \end{aligned} \tag{C.1.16}$$

where $1[\,]$ is dummy equal to one the the condition in the bracket is true, and zero otherwise.

The probabilities of observing the other outcomes can be derived in a similar manner.

$$\begin{aligned} P(a_0=0,a_2=0) = \Phi_2\Big(& -u_1^\beta - u_2^\alpha - 1[s^\gamma \ge 0]s^\gamma, -u_2^\beta - u_1^\alpha; \rho\Big) \\ &+ 1[s^\gamma > 0]\Big[\Phi_2\Big(u_1^\beta + u_2^\alpha + s^\gamma, \frac{-u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma}{\sqrt{2(1+\rho)}}; -\frac{1+\rho}{\sqrt{2(1+\rho)}}\Big) \\ &- \Phi_2\Big(u_1^\beta + u_2^\alpha, \frac{-u_1^\beta - u_2^\alpha - u_2^\beta - u_1^\alpha - s^\gamma}{\sqrt{2(1+\rho)}}; -\frac{1+\rho}{\sqrt{2(1+\rho)}}\Big)\Big] \end{aligned} \tag{C.1.17}$$

$$\begin{aligned} P(a_1=1,a_2=0) = \Phi_2\Big(& u_1^\beta + u_2^\alpha + 1[s^\gamma \le 0]s^\gamma, -u_2^\beta - u_1^\alpha - s^\gamma; -\rho\Big) \\ &- 1[s^\gamma < 0]\Big[\Phi_2\Big(u_1^\beta + u_2^\alpha + s^\gamma, \frac{u_1^\beta + u_2^\alpha - u_2^\beta - u_1^\alpha}{-\sqrt{2(1-\rho)}}; -\frac{\rho-1}{\sqrt{2(1-\rho)}}\Big) \\ &- \Phi_2\Big(u_1^\beta + u_2^\alpha, \frac{u_1^\beta + u_2^\alpha - u_2^\beta - u_1^\alpha}{-\sqrt{2(1-\rho)}}; -\frac{\rho-1}{\sqrt{2(1-\rho)}}\Big)\Big] \end{aligned} \tag{C.1.18}$$

$$\begin{aligned} P(a_1=0,a_2=1) = \Phi_2\Big(& -u_1^\beta - u_2^\alpha - 1[s^\gamma \ge 0]s^\gamma, u_2^\beta + u_1^\alpha; -\rho\Big) \\ &- 1[s^\gamma < 0]\Big[\Phi_2\Big(u_1^\beta + u_2^\alpha + s^\gamma, \frac{-u_1^\beta - u_2^\alpha + u_2^\beta + u_1^\alpha}{\sqrt{2(1-\rho)}}; \frac{\rho-1}{\sqrt{2(1-\rho)}}\Big) \\ &- \Phi_2\Big(u_1^\beta + u_2^\alpha, \frac{-u_1^\beta - u_2^\alpha + u_2^\beta + u_1^\alpha}{\sqrt{2(1-\rho)}}; \frac{\rho-1}{\sqrt{2(1-\rho)}}\Big)\Big] \end{aligned} \tag{C.1.19}$$

From these probabilities, we can see that the model is a multinomial probit with three unobserved random term v_1, v_2 and $v_1 + v_2$. Note that it can correspond to a simple a bivariate probit according to the sign of s^γ.

Let $P_{hlm,c}$, with $l, m = 0, 1$, be $P(a_1 = l, a_2 = m)$ in the family h when they behave cooperatively, and $1[\ ]$ a dummy equal one if the statement in the bracket is verified and zero otherwise. The log-likelihood function is therefore:

$$\ln L = \sum_{h=1}^{H} \sum_{l} \sum_{m} 1[a_1 = l, a_2 = m] \ln P_{hlm,c} \tag{C.1.20}$$

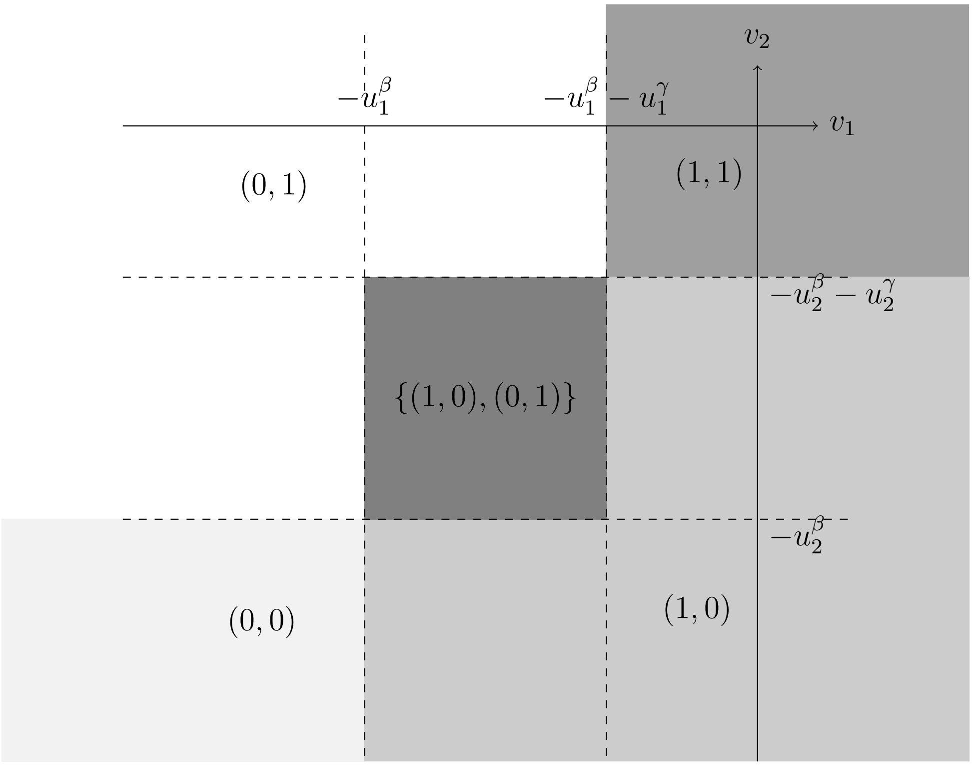
The likelihood function involves intregral of dimension two only and can be estimated by maximum likelihood.

C.2 Noncooperative model

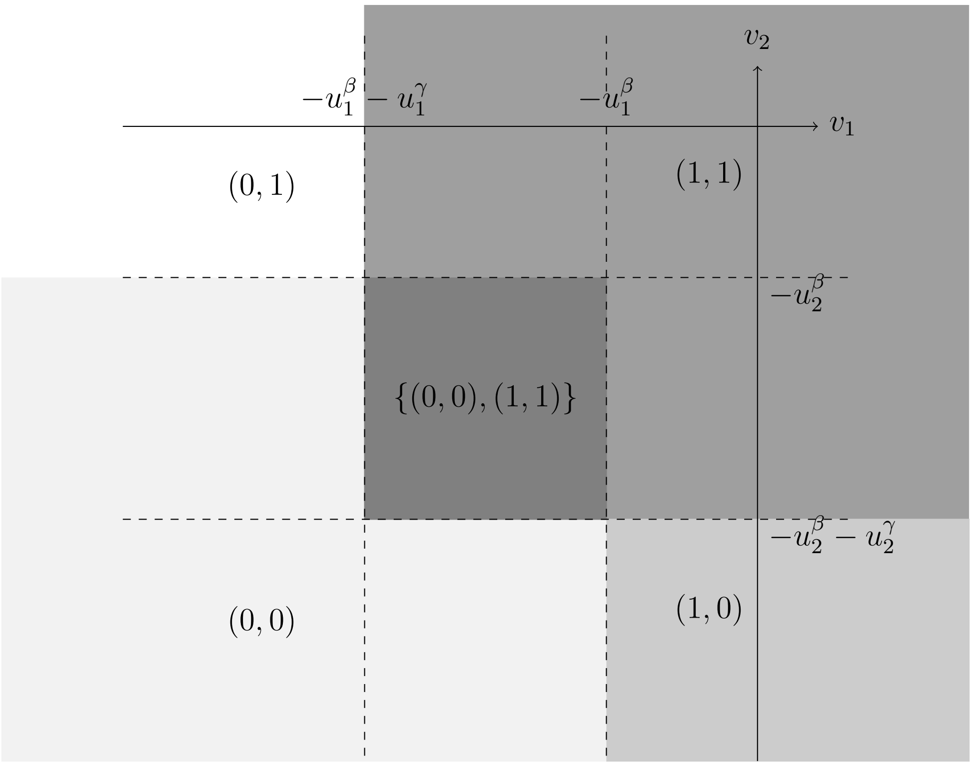
C.2.1 Coherency and completness

A graphical representation of the game is displayed in Figures C.2.1a and C.2.1b.

Figure C.2.1: Graphic representation - noncooperative



(a) $u_1^\gamma < 0$ *and* $u_2^\gamma < 0$



(b) $u_1^\gamma > 0$ *and* $u_2^\gamma > 0$

C.2.2 Likelihood

The probabilities of observing each potential outcome of the game are given by the following formula.

$$
\begin{aligned}
P(a_1 = 1, a_2 = 1) = & \int_{-u_1^\beta - u_1^\gamma}^{\infty} \int_{-u_2^\beta - u_2^\gamma}^{\infty} \phi_2(v_1, v_2) dv_2 dv_1 \\
& - 1_{(u_1^\gamma > 0, u_2^\gamma > 0)} \left\{ [1 - P(\text{sel}(1,1))] \Big(\int_{-u_1^\beta - u_1^\gamma}^{-u_1^\beta} \int_{-u_2^\beta - u_2^\gamma}^{-u_2^\beta} \phi_2(v_1, v_2) dv_2 dv_1 \Big) \right\}
\end{aligned} \tag{C.2.1}
$$

$$
\begin{aligned}
P(a_1 = 0, a_2 = 0) = & \int_{-\infty}^{-u_1^\beta} \int_{-\infty}^{-u_2^\beta} \phi_2(v_1, v_2) dv_2 dv_1 \\
& - 1_{(u_1^\gamma > 0, u_2^\gamma > 0)} \left\{ [1 - P(\text{sel}(0,0))] \Big(\int_{-u_1^\beta - u_1^\gamma}^{-u_1^\beta} \int_{-u_2^\beta - u_2^\gamma}^{-u_2^\beta} \phi_2(v_1, v_2) dv_2 dv_1 \Big) \right\}
\end{aligned} \tag{C.2.2}
$$

$$
\begin{aligned}
P(a_1 = 1, a_2 = 0) = & \int_{-u_1^\beta}^{\infty} \int_{-\infty}^{-u_2^\beta - u_2^\gamma} \phi_2(v_1, v_2) dv_2 dv_1 \\
& - 1_{(u_1^\gamma < 0, u_2^\gamma < 0)} \left\{ [1 - P(\text{sel}(1,0))] \Big(\int_{-u_1^\beta}^{-u_1^\beta - u_1^\gamma} \int_{-u_2^\beta}^{-u_2^\beta - u_2^\gamma} \phi_2(v_1, v_2) dv_2 dv_1 \Big) \right\}
\end{aligned} \tag{C.2.3}
$$

$$
\begin{aligned}
P(a_1 = 0, a_2 = 1) = & \int_{-\infty}^{-u_1^\beta - u_1^\gamma} \int_{-u_2^\beta}^{\infty} \phi_2(v_1, v_2) dv_2 dv_1 \\
& - 1_{(u_1^\gamma < 0, u_2^\gamma < 0)} \left\{ [1 - P(\text{sel}(0,1))] \Big(\int_{-u_1^\beta}^{-u_1^\beta - u_1^\gamma} \int_{-u_2^\beta}^{-u_2^\beta - u_2^\gamma} \phi_2(v_1, v_2) dv_2 dv_1 \Big) \right\}
\end{aligned} \tag{C.2.4}
$$

where $P(\text{sel}(1,1))$ and $P(\text{sel}(0,0))$ are the probabilities that both children and no children are caregivers respectively in case of multiple equilibria when $u_1^\gamma > 0$ and $u_2^\gamma > 0$. They are defined such that $P(\text{sel}(1,1)) + P(\text{sel}(0,0)) = 1$. $P(\text{sel}(0,1))$ and $P(\text{sel}(1,0))$ are the probabilities that each equilibrium is chosen in case of multiple equilibria when $u_1^\gamma < 0$ and $u_2^\gamma < 0$, and are also defined such that $P(\text{sel}(0,1)) + P(\text{sel}(1,0)) = 1$. These four probabilities therefore define the selection procedure in the presence of multiple equilibria.

Let $P_{hlm,n}$, with $l, m = 0, 1$, be $P(a_1 = l, a_2 = m)$ in the family h when they behave non-cooperatively, and $1[\ ]$ a dummy equal to one if the statement in the bracket is verified and zero otherwise. The log-likelihood function is therefore:

$$\ln L = \sum_{h=1}^{H} \sum_{l} \sum_{m} 1[a_1 = l, a_2 = m] \ln P_{hlm,n} \tag{C.2.5}$$

Because all the integrals can be simply evaluated, we use a standard maximum likelihood estimator.

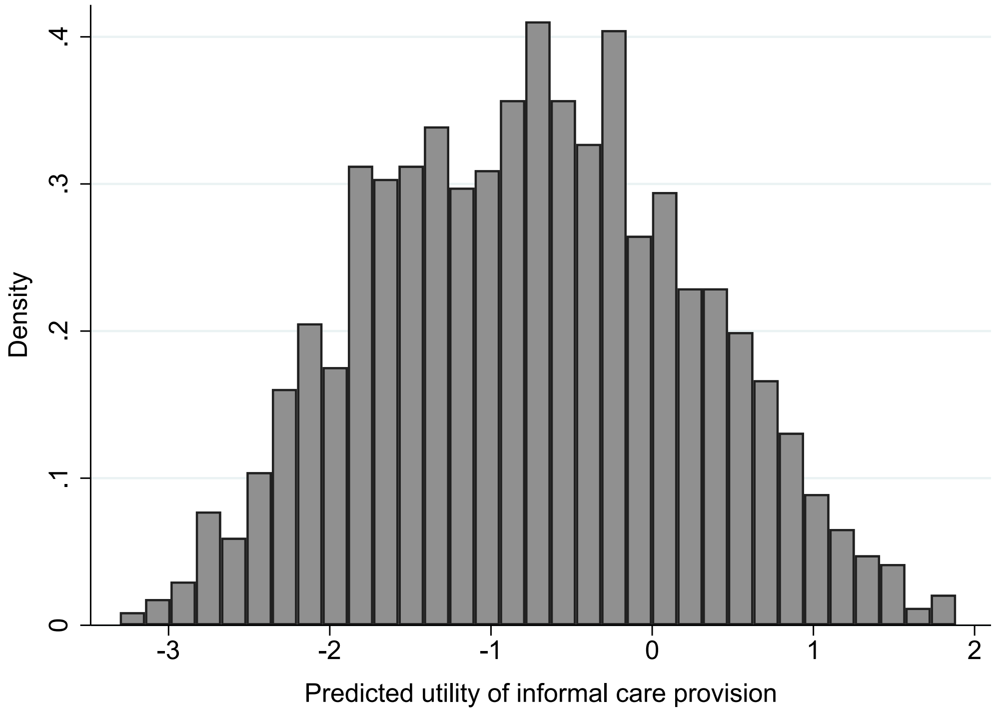
C.3 Pooling of multiple equilibria

This method requires to assume the sign of u^{γ} to be known. From the different previous results, it seems that one can assume it is negative with confidence. In this situation, (1,1) and (0,0) - which correspond to the total of two and no caregivers respectively - occur with a unique equilibria. Let N be the number of caregivers. The model can be easily estimated by maximum likelihood since $P(N = 2|X)$ and $P(N = 0|X)$ are uniquely determined and $P(N = 1|X) = 1 - P(N = 1|X) - P(N = 2|X)$.[2]

[2]For a discussion about this method, see Berry and Tamer (2006) and de Paula (2013).

D Utility of informal care provision

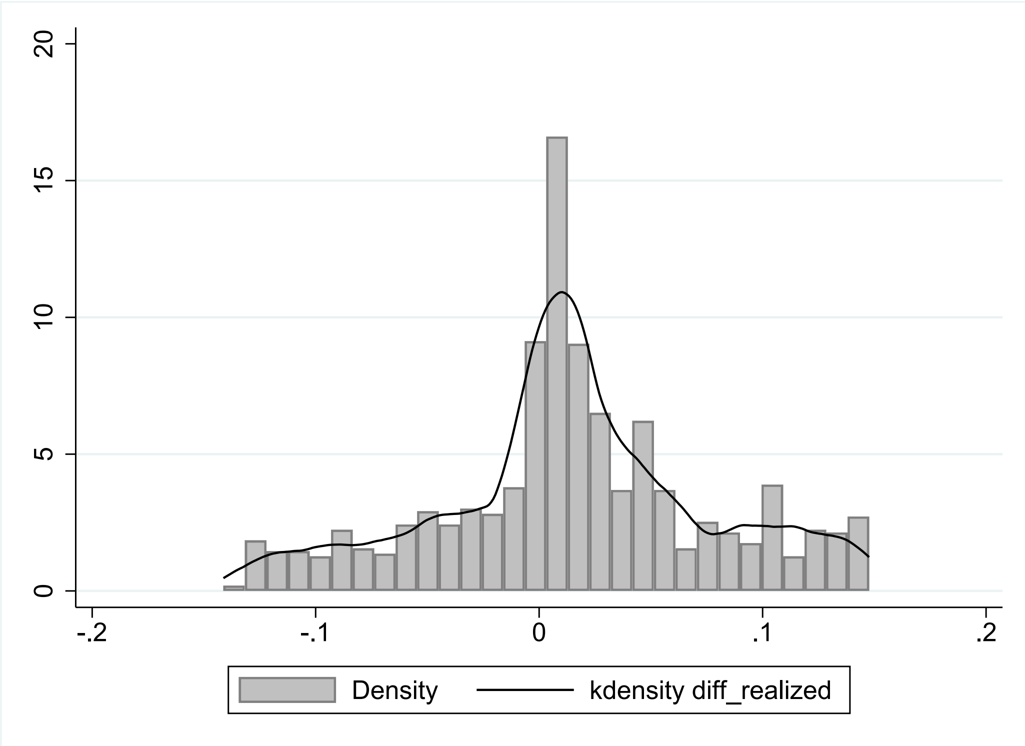
Figure D.1: Distribution of the utility of caregiving



Note: This graph represents the distribution of the predicted utility of informal care provision in two-child families. There are 2,138 children because the sample is composed of 1,069 two-child families.
Source: CARE survey (author's calculation)

E Distribution of degree of noncooperativeness

Figure E.1: Distribution of the utility of caregiving



Note: This graph represents the distribution of the predicted utility of informal care provision in two-child families. There are 2,138 children because the sample is composed of 1,069 two-child families.
Source: CARE survey (author's calculation)

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The present list mentions only the references quoted in the supplementary materials.