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ABSTRACT

Geography of the Family*

In this paper we study the residential choice of siblings who are altruistic towards their parents. If some sibling moves further away, he or she can shift some of the burden of taking care of the parents to his or her siblings. Thus, siblings have a strategic incentive to move away that only children do not have. Siblings locate further away from parents than only children do and, for some preferences, asymmetric location patterns emerge. These theoretical predictions are also confirmed by empirical data.

JEL Classification: H41, J10
Keywords: family public goods, voluntary intergenerational transfers

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NON-TECHNICAL SUMMARY

Children often like their parents. They care for them and like to visit and socialize with them. However, parents' desire for children's attention typically exceeds the children's desire for such activities. This altruism generates a serious strategic problem if parents have more than one child. If several children can visit their parents, each child may like it if their parents get much attention. However, the child prefers a greater share of this attention to be paid by its brothers and sisters.

So how can a child shift the 'burden' of visiting the parents to its siblings? This paper suggests that location choice of siblings vis-à-vis their parents plays a strategic role. If parents have several children that locate in places that are different distances from them, it seems likely that the children living closest to their parents visit them more frequently than others and pay more attention to their parents, mostly because the cost of time and travel for each single visit is higher the greater the distance is between the parents' and the child's place of residence. If location plays a major role as regards the question of who visits his or her parents and how frequently, then children can influence their own future visiting behaviour by making a location choice. Even more importantly, because siblings can observe each other's location choices, they can make inferences on each other's visiting. They adjust and increase their own attention to compensate for the lack of attention their siblings give to their parents. Hence, children can even affect their siblings' visiting behaviour by their own location choice.

Of course, the choice of location is endogenous not only for one child, but typically for all children. Hence, the strategic situation is more complicated. We characterize the various equilibrium location choices that are likely to emerge. All these choices have one thing in common. When making their location choice, children with siblings have a strategic incentive to move further away from their parents which an only child does not have: a child with siblings can hope that, by moving further away, he or she may be able to shift some of the burden of taking care of their parents to their brothers or sisters. An only child cannot have such hopes. Hence, we derive a testable hypothesis from the theoretical analysis: children with siblings should – on average – locate further away from their parents than only children.

We derive a second hypothesis about equilibrium outcomes in families with exactly two children. In such families, our model predicts a very particular location pattern: one should frequently observe that one child stays with the parents whereas the other child moves far away from the parents, 'sufficiently' far to shift the burden of providing care for the parents to the other child.

In this paper we also test the hypotheses that are derived from the theoretical model. It turns out that children with siblings indeed locate further away from their parents than only children do. The difference is significant and, of course, we control for various socio-demographic variables when testing the hypothesis. Also we find that there is indeed a major group of siblings who behave according to the second hypothesis: one child staying with the parents, the other child moving sufficiently far away.

From a normative perspective, the strategic incentive to move further away generates a prisoner's dilemma situation in which siblings move ‘too far’ away from their parents. Their choice of a greater distance is made because this shifts some burden to their brothers and sisters – that is, their choice of a large distance imposes a negative externality on their brothers and sisters. Accordingly, if they could cooperatively decide on location, they would typically make a different choice and, on average, would locate closer to their parents. These results highlight the important role of social norms in overcoming such strategic problems: such norms exist in some countries, e.g. Japan, but are on the retreat.

1 Introduction

In many families, when parents grow old, the problem of taking care of the elderly emerges. Children often like their parents and they like to visit them. However, parents' desire for childrens' visits typically exceeds the children's desire to visit them. Bengtson and Kuypers (1971) argue that children loosen the ties with their parents when they grow older, while the latter try to hang on to their children as long as possible.[1] Suppose children are altruistic with respect to their parents. They feel good if they know their parents are well treated and well taken care of.[2] However, despite –or rather because of– this altruism, a serious public good problem emerges if parents have more than one child. If two children, A and B, pay attention to their parents and visit them, each is happy if the parents get a lot of attention and a large number of visits. However, the increase in child A's utility from a marginal additional unit of attention is larger if child B rather than child A pays this attention.

Small numbers of individuals are tied together in families in long-term relationships. It is often argued (sometimes with reference to the folk-theorem) that the long-term relationship in family life leads to cooperative outcomes (see, for instance, Bergstrom (1993) for an overview). While this does not obviously imply harmony or the lack of conflict of interests within families, it does suggest efficient outcomes. An objection to this view is that some decisions within families are irreversible and have commitment value. An important example of such behavior with respect to the problem of taking

[1] Bernheim et al. (1985) take it as self-evident that family visits or 'contact' with parents is burdensome. They base their discussion of strategic bequests on precisely this phenomenon. In their model, the parents set up a contest between their children: the child that pays more attention will inherit everything. Cox and Rank (1992) also treat intergenerational transfers as an exchange between parents and their children. In Kotlikoff and Morris (1989: 168) parents bribe their children to elicit more attention.

[2] The role of childrens' age, health, sex, wage rate, income levels and distance, and parents' age, reported health, institutionalization status, as empirical determinants for children's attention and care are well researched. See, e.g., Altonji et al. (1995, 1996), Kotlikoff (1992), and Kotlikoff and Morris (1989).

care of the elderly is the siblings' choice of residence. People build up a social network of friends in their local area, and, depending on their type of work, they establish local business links that tie them to the area.[3] For these reasons it may be very costly for individuals to move when they have lived and worked for 20 years in one place. This may be even more true for European societies, compared to, e.g., the more mobile American society: in low-mobility societies few people migrate, and hence, few people have an interest in making new acquaintances and this further raises the cost to those who actually move.

The choice of residence, and the implied distance between a sibling's residence and the location where his or her parents live is crucial for the actual cost of paying attention to or visiting the parents. These costs matter in the conflict of interests between siblings about who is to visit the parents. It has been shown that absolute contribution cost and relative cost of contributing to a public good are essential for the outcome of a game of private provision of public goods. Consequently, individual contributors have incentives to change their relative contribution cost.[4]

In this paper we first study the strategic incentives of siblings for choosing residence in a fully non-cooperative model in sections 2 to 4. Reasonable restrictions on preferences yield unique types of coordination equilibria in pure strategies in which one sibling lives close to the parents and essentially provides all care and the other fully free rides, simply by having moved sufficiently far away. We then describe our data set and confront the theoretical results with empirical evidence in section 5. The theoretical analysis predicts firstly that, on average, siblings locate further away from their parents than an only child. Empirical evidence shows that this is indeed the case. Second,

[3]Job tenure, for instance, has a positive and significant income effect. This is well documented (for the U.S. see, e.g., Topel 1991).

[4]For instance, in the family context, individuals who will end up as a married couple have an incentive to increase their productivities of generating income for private good consumption, e.g., by human capital investment in the labor market, and to decrease their skills in contributing to the family public good (Konrad and Lommerud 1995, 1996).

the theoretical analysis suggests that some siblings should find themselves in highly asymmetric locations: one sibling staying near to the parents, the other sibling moving far away. The data are consistent with this finding.

2 The model family

Consider the following family. Parents live at some place 0 and raise their children, A(dam), and B(enjamin). When A and B are about eighteen to twenty-five years old, they make a location choice. The choices are D_A and D_B from the interval $[0, \infty)$ measuring the distance from their parents' place of residence. These choices constitute stage 1 of a two-stage game. They stay in this place for a considerable time. They build up a local social network of friends in the area where they live, and establish local business links that tie them to the area. Moving becomes so costly that the choice of residence becomes practically irreversible after some time.

One child may get an opportunity to make a choice of residence before the other child. This suggests that the strategic situation in stage 1 is a Stackelberg game in which children choose their residence sequentially. On the other hand, the commitment with respect to contributions to the public good does not necessarily result from the choice of residence itself, but from living in some place for many years. This process of building up commitment happens simultaneously, and this suggests that the strategic situation in stage 1 may be appropriately described by a Nash game. In what follows, we consider both cases, but concentrate more on the Nash game. As will turn out, the empirical predictions obtained from the Nash game are broader and encompass the Stackelberg outcome.

Years after the children have made their choices of residence, their parents need attention. At this stage A and B decide about the number of visits, g_A and g_B. Each visit involves costs. The time cost $1 + D_i$ per visit consists of one unit of time actually spent with the parents, plus travel time that, by appropriate normalization, is equal to the distance D_i between i's place of residence and i's parents' place. Accordingly, i's time budget m is allocated between activities x_i that yield private consumption, and family visits:

$$m = x_i + (1 + D_i)g_i. \tag{1}$$

Son i cares about his private consumption x_i, about the total number

$$G = g_A + g_B \tag{2}$$

of family visits that his parents get, and possibly about his own visits to the parents, g_i:

$$U^i = U^i(x_i, G, g_i). \tag{3}$$

Utility (3) parallels the "warm glow model" used by Andreoni (1989, 1990) to describe preferences about charitable giving, where the public good is the sum of contributions, but each contributor attributes some extra utility to his own contribution, for instance because the donor has some private benefits from his own giving (e.g., a "warm glow" feeling). Utility should be increasing in the first two arguments, and quasi-concave. A child i may derive some (private) pleasure from visiting his parents, where the first visits are more enjoyable than further visits, and the marginal utility of additional visits may become negative long before the whole time budget is used up for visiting parents. We do not rule out that even the first visit causes negative private utility.

We summarize the time structure of decisions. We consider a two-stage game. In stage 1 children make their choice of residence. Over the years this choice becomes irreversible and determines childrens' time cost of visiting parents. Then, in stage 2, children decide how often they visit their parents.[5]

[5]Stage 2 has many periods in reality, allowing perhaps for some cooperation between siblings. We focus on the non-cooperative outcome in stage 2 for two reasons. First, efficient cooperation is only one possible outcome, and a sequence of fully non-cooperative contribution games in stage 2 is an equilibrium as well. Second, as is well-known from related games, the non-cooperative outcome is the threat-point of any cooperative outcome

3 An only child

An only child S(arah) has no brother or sister who could contribute to parents' visits. She maximizes utility in stage 2 for given residential choice D_S by a choice of $g_S = G$ that maximizes (3) subject to (1). If the solution has positive private good consumption and a positive number of visits, the optimum has

$$(1 + D_S)\frac{\partial U^S}{\partial x_S} = \frac{\partial U^S}{\partial G} + \frac{\partial U^S}{\partial g_S}. \tag{4}$$

In stage 1 she chooses D_S. A choice of $D_S = 0$ maximizes her possibility set in stage 2 and is therefore optimal. Hence, our model predicts that –in the absence of further motives– an only child has an incentive to live as close as possible to his or her parents in order to minimize the time cost.

There are many other reasons affecting children's choice of residence that are exogenous to the analysis here, and may induce the child to choose a residence at some distance. For instance, particular job opportunities, emotional attachment to a particular region, or the location of the spouse or the family of the spouse may be such reasons. Hence, we would not expect that all only children live with their parents in the same household or house. However, the analysis will show that siblings have a strategic reason to move away from their parents which an only child does not have. An only child cannot expect that anyone will compensate for the lack of own attention to his or her parents. This will be different if parents have more than one child.

(outside option principle). Therefore, the strategic incentives for choice of residence that are analysed here would also emerge with a cooperative stage 2, as children would use their choice of residence in order to shift their threat point in a way that increases their individual payoff in the cooperative outcome. As has been shown in a different context (Konrad and Lommerud 1996), the strategic incentives in such a framework can be even stronger than in a purely non-cooperative framework.

4 Siblings

Consider next the game between two children, A and B. In stage 2 they play a non-cooperative game of private provision of an impure public good. They maximize their own payoffs by their choice of the number of visits given the number of visits chosen by their sibling. Depending on the parameters in the utility functions, the stage-2 Nash equilibrium can be an interior equilibrium which is characterized by first-order conditions

$$(1+D_i)\frac{\partial U^i}{\partial x_i} = \frac{\partial U^i}{\partial G} + \frac{\partial U^i}{\partial g_i} \text{ for } i = A, B. \tag{5}$$

Alternatively, if the cost of making contributions g_i is particularly high for one (say, A) and low for the other (say, B), the stage-2 equilibrium can be extremely asymmetric with only B making strictly positive contributions. In this case an equilibrium is described by the first-order conditions

$$(1+D_A)\frac{\partial U^A}{\partial x_A} \geq \frac{\partial U^A}{\partial G} + \frac{\partial U^A}{\partial g_A} \tag{6}$$

at $x_A = m$, $G = g_B$ and $g_A = 0$, and

$$(1+D_B)\frac{\partial U^B}{\partial x_B} = \frac{\partial U^B}{\partial G} + \frac{\partial U^B}{\partial g_B} \tag{7}$$

at $x_B = m - (1+D_B)g_B$ and $G = g_B$.

We denote pairs of equilibrium choices of contributions as functions of location choices, $g_A^*(D_A, D_B)$ and $g_B^*(D_A, D_B)$. It is known from Andreoni (1989, 1990) that utility as in (3) provides too little structure to obtain unique equilibria or qualitatively determined comparative statics. This is not needed, however, to compare the outcome of the family with two children with the only child family. As has been shown, an only child has an incentive to locate next to his or her parents, that is, to choose zero distance. To show that, on average, siblings locate further away from their parents than only children do, it is sufficient to show that for some siblings the choice of zero distance is not a subgame perfect equilibrium. We establish this result by showing that $(D_A, D_B) = (0, 0)$ is not an equilibrium for a large subset of possible preferences for the case where siblings choose locations simultaneously (Nash). A similar result rules out $(0,0)$ as a Stackelberg equilibrium. For brevity we provide a detailed exposition only of the Nash case. First we observe:

Lemma 1 *Let $U^i = u(x_i) + v(G) + w(g_i)$. If u and v are strictly concave and w concave, the contribution game has a unique equilibrium.*

Proof. From the first-order conditions we calculate the reaction curves $\gamma_A(g_B; D_A, D_B) \geq 0$ and $\gamma_B(g_A; D_A, D_B) \geq 0$. The slope of these curves is $\frac{d\gamma_i}{dg_j} = \frac{-v''}{(1+D_i)^2u''+v''+w''} \in (-1, 0)$ for $i, j \in \{A, B\}$. $\square$

Given the uniqueness of the stage-2 equilibrium, we address the location choice in stage 1.

Proposition 1 *Let u and v be strictly concave and w concave. $D_A = D_B = 0$ is not a pair of subgame perfect Nash equilibrium location choices if, at $g_A^*(0,0) = g_B^*(0,0) \equiv g^* > 0$,*

$$(\frac{\partial \gamma_B}{\partial g_A^*}\frac{\partial g_A^*(0,0)}{\partial D_A} - g^*)v'(2g^*) > g^*w'(g^*), \tag{8}$$

where $\frac{\partial \gamma_B}{\partial g_A^*}$ describes the optimal reaction of B to an anticipated change in A's contribution.

Proof. By (3), A's equilibrium utility increases in D_A at $D_A = D_B = 0$, if

$$-u'(m - g^*)(g^* + \frac{\partial g_A^*}{\partial D_A}) + v'(2g^*)(1 + \frac{\partial \gamma_B}{\partial g_A^*})\frac{\partial g_A^*}{\partial D_A} + w'(g^*)\frac{\partial g_A^*}{\partial D_A} > 0. \tag{9}$$

The first-order condition for the contribution game in stage 2 that determines g^* at $D_A = D_B = 0$ is $u'(x) = v'(G) + w'(g)$. Using this condition shows that (9) is equivalent to (8). $\square$

Proposition 1 states that zero distance that minimizes the contribution cost is not a subgame perfect Nash equilibrium choice for a large set of preferences. Note that $\frac{\partial \gamma_B}{\partial g_A^*} < 0$, that is, each child knows that his or her sibling will partially offset a reduction in his or her own contribution, if this reduction is anticipated (e.g., caused by increased contribution cost). Condition (8) is more likely to hold if the amount of contributions $g^*(0,0)$ is small, if there is strongly offsetting behavior $\frac{\partial \gamma_B}{\partial g_A^*}$, and if the private benefit of making contributions is small or even negative for the first units of contributions.

Proposition 1 makes a prediction about a systematic difference between siblings and only children. Some siblings may choose the smallest possible distance (zero), just as only children do. But some siblings choose $D_A > 0$. On average, therefore, children in families with two children should locate further away from their parents than only children. This leads to an empirically testable implication which we state as

Conjecture 1 *The average distance of siblings from their parents should be larger for families with more than one child.*

It would be interesting to characterize the subgame perfect equilibrium. However, even for additively separable utility, the two-stage game between siblings may have multiple equilibria as regards location choices. The possibility of multiple equilibria and the fact that different preferences allow for different types of equilibrium outcomes precludes precise predictions about the distribution of the location choice, other than the one just outlined. The equilibrium can be characterized if further restrictions on the siblings' preferences are imposed. We consider quasi-linear preferences

$$U^i = x_i + v(G) \tag{10}$$

with $v'(G) > 0$ and $v''(G) < 0$ in what follows. Quasi-linearity is stronger than what is needed for the results to follow, but it simplifies the analysis considerably. The relevant aspect regarding preferences needed is that utility is considerably less concave in private goods consumption than in the public good. This is likely to be the case if the public good is only a small share in the individual's overall time budget. We should expect that this condition holds for a considerable share of siblings. For these preferences we find

Proposition 2 *Let the utility of children be quasi-linear as in (10) with* $v'(0) > 1$ *and* $v'(m) < 1$. *Then the equilibrium is characterized as follows.*
(i) The equilibrium amount $G^*(\Delta)$ *of aggregate contributions that results in the unique stage-2 contribution equilibrium for given distances* D_A *and* D_B *depends only on* $\Delta \equiv \min\{D_A, D_B\}$ *and is implicitly determined by*

$$v'(G^*(\Delta)) = (1 + \Delta).$$

(ii) The only subgame perfect equilibria in pure strategies are corner equilibria with one sibling choosing $D_i = 0$ *and the other sibling choosing* $D_j \geq D_{crit} > 0$ *with* D_{crit} *determined by*

$$m + v(G^*(D_{crit})) = [m - G^*(0)] + v(G^*(0)). \tag{11}$$

For a proof consider first stage 2. Let $G(D_A)$ and $G(D_B)$ be the solutions of $v'(G) = (1 + D_i)$ for $i = A, B$, respectively. A's optimal response to any $g_B \geq 0$ is $\gamma_A = \min\{0, G(D_A) - g_B\}$ and similarly, B's optimal response to any g_A is $\gamma_B = \min\{0, G(D_B) - g_A\}$. Then $G^*(\Delta) = \max\{G(D_A), G(D_B)\}$ is the unique equilibrium sum of visits and determined by $v'(G^*) = (1 + \Delta)$. Individual contributions are $g_B = G^*$ and $g_A = 0$ if $D_A > D_B$ and $g_A = G^*$ and $g_B = 0$ if $D_A < D_B$. If $D_A = D_B$, a continuum of equilibrium shares $g_A = \alpha G^*$ and $g_B = (1 - \alpha)G^*$ exists. All shares $\alpha \in [0, 1]$ constitute an equilibrium in stage 2. This confirms (i) and also describes the equilibrium numbers of visits by each child.

Consider next (ii). The meaning of the critical distance, D_{crit} defined by (11) is as follows. Consider A's payoff for a given location choice of B with $D_B > 0$. A can locate closer to the parents. In this case he will be the only contributor. Among all location choices $D_A < D_B$, therefore, $D_A = 0$ maximizes A's payoff and yields utility as on the right-hand side of (11). Alternatively, A may choose $D_A > D_B$, in which case only B contributes and A obtains utility $m + v(G^*(D_B))$. If $D_B = D_{crit}$, A is just indifferent whether to choose $D_A = 0$, or some $D_A > D_B$.

We could now verify that any pair from the set

$$\{(0, D_B)\,|D_B \geq D_{crit}\} \cup \{(D_A, 0)\,|\ \ D_A\ \geq D_{crit}\}$$

constitutes subgame perfect equilibrium location choices, and show for all remaining cases that any other pair (D_A, D_B) opens up the possibility for A or B to deviate from his or her choice and increase his or her payoff. Because this latter part requires distinguishing between many cases, we choose a constructive proof instead.

Assume first that, if siblings choose precisely the same distance from their parents, they both have strictly positive shares in contributions, that is, $\alpha \in (0, 1)$. Consider stage 1. i's reaction correspondence is

$$D_i = \zeta(D_j) = \begin{cases} \{0\} \text{ if } D_j > D_{crit} \\ \{0\} \cup \{D \,|D > D_{crit}\} \text{ if } D_j = D_{crit} \\ \{D \,|D > D_j\} \text{ if } D_j < D_{crit} \,. \end{cases} \tag{12}$$

Any pair of equilibrium choices must be an element of $\{(\zeta(D_B), D_B)|D_B \in [0, \infty)\} \cap \{(D_A, \zeta(D_A))|D_A \in [0, \infty)\} = \{(0, D)|D \geq D_{crit}\} \cup \{(D, 0)|D \geq D_{crit}\}$. These are the asymmetric pairs of distances characterized in Proposition 2.

Consider now $\alpha = 0$ (the case $\alpha = 1$ is analogous with A and B changing roles). In this case the reaction correspondence of B is the same as in (12), and the reaction correspondence of A becomes

$$D_A = \zeta(D_B) = \begin{cases} \{0\} \text{ if } D_B > D_{crit} \\ \{0\} \cup \{D \,|D \geq D_{crit}\} \text{ if } D_B = D_{crit} \\ \{D \,|D \geq D_B\} \text{ if } D_B < D_{crit} \,. \end{cases} \tag{13}$$

The pair of equilibrium choices must be a choice of $\{(\zeta(D_B), D_B)|D_B \in [0, \infty)\} \cap \{(D_A, \zeta(D_A))|D_A \in [0, \infty)\} = \{(0, D_B)|D_B \geq D_{crit}\} \cup \{(D_A, 0)|D_A \geq D_{crit}\}$.$\square$

Proposition 2 describes a set of equilibria, all characterized by considerable asymmetry. With a slight increase in notational effort, the qualitative results can be generalized for siblings with asymmetric quasi-linear preferences. This leads to a conjecture which can be used to test the model.

Conjecture 2 *A significant share of siblings makes asymmetric location choices* $(0, D)$ *and* $(D, 0)$ *for some* $D \gg 0$.

The assumptions about preferences that lead to Proposition 2 can be justified, but these assumptions are certainly not innocent. In a more general setting other equilibria may exist, some of which may even be symmetric. For instance, if the utility function is additively separable as in Lemma 1, and $v'(G) \equiv 0$, there is no strategic interaction between siblings at all, and both siblings locate next to their parents, just as in the only child case. Our results therefore must be interpreted in the sense that for some types of children there is strategic interaction between siblings that leads to behavior as described in Conjectures 1 and 2.

An equilibrium selection among the equilibria outlined in Proposition 2 can be made if one assumes that individuals have a weak preference in the sense of lexicographic preference for staying close to the area of their origin. The equilibria $(0, D_{crit})$ and $(D_{crit}, 0)$ emerge as the only equilibria in pure strategies if, in the case of two choices of distance $D_i < \hat{D}_i$ leading to the same equilibrium utility level U^i, child i prefers D_i to $\hat{D}_i$ weakly.

Note that the equilibrium is strictly non-cooperative, but requires coordination between the siblings. Since each sibling prefers to be the one who locates away from his or her parents and would like to leave it to the brother or sister to take care of the parents, coordination is not a trivial problem. When coordination fails, they may play a mixed strategy equilibrium for which also symmetric choices should be observed. Coordination may be facilitated if siblings differ in some important aspects. For instance, it may be understood that the younger child stays with the parents.

So far we have assumed that siblings choose their residence simultaneously. In many families it may be true that one of them gets a chance to move first, and we would expect that the older child gets this chance more frequently than the younger child. The resulting Stackelberg equilibrium is characterized as follows.

Proposition 3 *Let the utility of children be quasi-linear as in (10) with $v'(0) > 1$ and $v'(m) < 1$. Suppose A can choose D_A first and B must make his or her choice of D_B on the basis of given and observed D_A, whereas* *stage 2 (simultaneous choices of the number of visits) is unchanged. The only subgame perfect equilibria in pure strategies are corner equilibria with A choosing $D_A \geq D_{crit} > 0$ with D_{crit} determined by (11) and B choosing $D_B = 0$.*

A proof straightforwardly follows along the lines of the proof of Proposition 2, taking into account that the Stackelberg leader can choose the coordination equilibrium and prefers the one in which the follower stays with the parents and provides the whole public good. To achieve this outcome, the Stackelberg leader must choose a distance of at least D_{crit}.

If we take for granted that the older sibling has the opportunity to move first, the empirical implication of Proposition 3 is that we should observe situations in which the younger sibling stays close to their parents and the older sibling has moved far away more frequently. But, of course, we would not expect this to hold strictly and for all cases. For instance, there may be reasons why the younger sibling can move first. Also, asymmetric preferences may alter the equilibrium outcome. For instance, if the older sibling attributes much higher utility to visits to parents, he may be better off by staying with his parents and letting the younger sibling move away.

In any case, the theoretical considerations suggest that there is a frequent occurrence of observations with asymmetric choices, and that older siblings more frequently take the role of the sibling who moves sufficiently far away. In what follows we confront these hypotheses with empirical results drawing on a large data set that provides detailed information on Germans born betweeen 1911 and 1956 collected by Dittmann-Kohli et al. (1995,1997). But first we briefly describe this data set.

5 Empirical evidence

Our empirical basis is the German Aging Survey, a large representative survey of 40-85 year old German nationals living in private households, collected in the first half of 1996. The sample ($n = 4838$) is stratified according to age groups, sex, and East and West Germany. The survey program is designed as a first wave of a panel study and comprises sociological criteria of the various dimensions of life situations and welfare as well as psychological measures of self and life concepts (Dittmann-Kohli et al. (1995)).[6] The respondants were asked detailed questions about their children: their number and the individual characteristics of children, e.g., year of birth, sex, whether the child is their own child or an adopted child, whether the child is still alive or not, the child's employment situation, the child's marital status and, in particular, the distance between the parents' and the child's place of residence.

We use some of the variables to eliminate some less useful observations. In particular, we concentrate on parents with one and two own children who are still alive. Sex, marital status and professional status of children will be used as control variables. The key variable of our analysis, however, is the distance D_i between the parents' and the child i's place of residence. The information provided for each child is whether a particular child lives in the same house or household as the parents ($D_i \equiv 0$), in the neighborhood ($D_i \equiv 1$), in the same urban community ($D_i \equiv 2$), in a different community, but less than 2 hours travel time away ($D_i \equiv 3$), or further away ($D_i \equiv 4$).

In a first step we analyze whether the existence of a younger brother or sister has an impact on the choice of proximity to the parents (Conjecture 1). In a second step we determine how the specific choice of the older child has an impact on the choice of the younger child.

Our theory suggests that children with a sibling are more likely to move further away from their parents than only children. As a reference group we choose only children. The sample used in our statistical analysis is therefore

[6]The German Aging Survey has been designed and analyzed jointly by the *Research Group on Aging and the Life Course* at the Free University of Berlin (Germany) and the *Research Group on Psychogerontology* at the University of Nijmegen (Netherlands) in collaboration with *infas Sozialforschung* (Bonn, Germany) and financed by the German Federal Ministry for Families, the Elderly, Women and Youth. Any opinions expressed in this paper are those of the authors. The instruments are published in Dittmann-Kohli et al. (1997); a full report of the sociological results is given by Kohli and Künemund (1998).

based on dyads of parent-child relationships of children without siblings or with exactly one brother or sister. All of these children are 30 years of age or older (born 1966 or earlier). The rationale for this is the assumption that children of this age have had the chance to leave the parental household, e.g. that existing coresidence is a result of a decision as discussed above. Using this subsample, we have 2047 valid observations: 611 parents with an only child and 1436 children of parents with two children. Table 1 gives the distribution of children's location choice.

Table 1: Observed residential choice of sole children and siblings

	$D_i = 0$	$D_i = 1$	$D_i = 2$	$D_i = 3$	$D_i = 4$	Total
Only Children	18.7% 3.2	14.1% 1.4	24.9% -0.1	27.3% -1.7	15.1% -2.0	100.0%
First of 2 children	10.2% -4.3	12.1% -.4	24.3% -0.5	33.5% 2.5	19.9% 2.0	100.0%
Second of 2 children	16.1% 1.2	11.5% -1.0	25.7% 0.6	28.9% -0.8	17.7% 0.0	100.0%
Total	14.8%	12.5%	25.0%	30.0%	17.7%	100.0%

$\chi^2 = 28.519$ (8 d.f.), Prob < 0.001.

The rows give the distribution of only children, of the "Adams" (born first) and of the "Benjamins" (born second) in 2-children families. The last row gives the total distribution of children. The first value in a cell is the proportion of only children, Adams and Benjamins choosing distance D_i (e.g., every row sums up to 100%). The second value in a cell is the standardized residual.

Consider the first column in Table 1. 18.7% of only children stay with their parents in the same house or household, while only 10.2% of Adams and 16.1% of the Benjamins do so. Thus, only children are much more likely to stay close to their parents than children with siblings. The second column is similar, though the difference is not as big as in the first column. While the middle column is quite similar for all children, the last two columns again show a difference in behavior between only children and children with siblings. The proportion of children with siblings moving further away is higher than the proportion of only children doing so, and children born first tend to move furthest away. The hypothesis that the location choice is independent of the child type is rejected clearly by the χ^2 independence test.

Table 1 suggests that there is a systematic difference in behavior between only children and children with siblings regarding their residence choice. This latter choice may also be shaped by other factors such as marital status, sex and socio-economic status. For example, higher education is typically associated with higher geographic mobility. To control for these variables and to analyze whether the differences shown in Table 1 are significant, we estimate an ordered logistic regression model to quantify whether children with siblings have significantly higher odds of moving further away from their parents than only children. The aim of this regression model is *not* to explain the choice of a specific distance in detail but to show that the existence of a brother or sister has a significant impact on the decision controlling for other relevant variables. Our model assumes that the distance choice depends on the child being an only child or having a sibling, his sex, marital status and socio-economic status[7]. The ordered logistic regression estimates the following equations for a dependent variable with 5 categories:

$$\ln\left(\frac{P(D_i > j)}{P(D_i \leq j)}\right) = \alpha_j + \beta_k' X_k, \quad \text{for } j = 0, 1, 2, 3. \tag{14}$$

The model estimates 4 "cut-off" points for D_i and a single effect parameter β_k for each independent variable X_k. This effect of the independent variables X_k on the log odds is therefore the same for all distance categories. The fraction on the left hand side is the *logit*, that is, the probability that D_i is greater than j versus smaller or equal j. When X_k changes, the change in the probablity that D_i is in a higher category is the same for all categories. The results are given in Table 2.

[7]We here use the ISEI-index of socio-economic status according to Ganzeboom et al. (1992) recoded into a set of four dummy variables: No information on occupation (and therefore no information on socio-economic status), both the bottom and top 40 percent of the scale values and finally the middle group which serves as the reference group.

Table 2: Ordinal logistic regression, $n = 2027$

Variables	β_k	Std.Err.	Prob.	$\exp(\beta_k)$
Sex	0.038	0.084	0.651	1.039
Marital Status	0.288	0.092	0.002	1.334
SES n.a.	-0.001	0.167	0.996	0.999
SES below average	-0.444	0.104	0.000	0.642
SES above average	0.630	0.107	0.000	1.877
First of 2 children	0.427	0.099	0.000	1.533
Second of 2 children	0.170	0.100	0.088	1.185
α_j	Coeff.	Std.Err.	Prob.	
α_0	1.332	0.128	0.000	
α_1	0.544	0.124	0.000	
α_2	-0.572	0.123	0.000	
α_3	-2.076	0.132	0.000	
LR test all slope coefficients = 0: $\chi^2 = 116.870$ (7 d.f.), Prob.<0.001				

The variables are: Child type (0=only child, 1=Adam, 2=Benjamin), child's sex (0=male, 1=female), marital status (0=married, 1=non married) and SES (0=below average, 1=average, 2=above average, 3=data n.a.). The reference categories are, respectively, only child, female, non married and average SES.

Consider the last column in Table 2. Sex has no significant effect. Even if the effect were significant, the magnitude of the effect is almost zero, since the value in the last column is 1.039. The other two control variables behave as expected. Married children have a higher probability of moving further away and the difference is significant. While children with an above average socio-economic status are 87.7% more likely to move further away, children with a below average socio-economic status tend to stay close to their parents (odds ratio = 0.642). After controlling for those variables, we find that the Adams have (for all distances) a highly significant 53.3% higher probability of being in a higher category (e.g. of moving further away) than only children. Benjamins also tend to move further away when compared to only children, but this effect is only significant at a 10% level.

This result is very much in line with Conjecture 1. There is a systematic difference between only children and children with siblings as regards their choices of residence, in line with the predictions of our model of strategic choice of residence.

Let us now consider which particular type of equilibrium may emerge for parents with two children (Conjecture 2). Table 2 is a cross-tabulation that presents the relative frequencies of pairs (D_A, D_B) with A=Adam the older and B=Benjamin the younger child in families with exactly two children. In each of the 25 cells, the first value denotes the observed relative frequency of pairs (D_i, D_j). The second value in a cell is the standardized residual, that is, the standardized difference between the actual value and the value that should be expected under the null hypothesis that the children's residence choices are independent. The residuals show whether a cell is over/underrepresented (positive/negative residual). Overrepresented cells are in bold type.

Table 3: Cross tabulation of the residential choice of children with siblings

		Distance Benjamin					
		House or HH	NB	Same Comm.	Less than 2h	More than 2h	Total
Dist. Adam	House or HH	**2.3%** **1.4**	0.8% -0.8	1.5% -1.7	**4.5%** **2.5**	0.8% -1.9	10.0%
	NB	1.8% -0.2	**4.2%** **6.2**	2.3% -1.4	2.1% -2.0	1.8% -0.6	12.3%
	Same Comm.	2.8% -1.4	1.5% -2.0	**12.1%** **6.3**	4.9% -2.1	2.8% -1.9	24.2%
	Less than 2h	**6.3%** **1.2**	2.1% -2.4	5.5% -2.9	**13.7%** **3.4**	6.1% 0.0	33.7%
	More than 2h	2.5% -0.9	**3.0%** **1.1**	4.4% -0.9	3.7% -2.3	**6.3%** **3.9**	19.9%
	Total	15.8%	11.7%	25.8%	28.9%	17.9%	100.0%

χ^2 = 164.605 (16 d.f.), Prob $<$ 0.001. Overrepresented cells are in bold type. n = 710. Missing answers were excluded from the table. Therefore, there are a few cases less than in Table 1.

Again, the hypothesis that both location choices are independent from each other is rejected clearly. Asymmetric coordination equilibria should lead to overrepresentation in cells such as $(0, D)$ and $(D, 0)$ for sufficiently large $D \geq D_{crit}$. Of course, the D_{crit} cannot be determined from the theoretical model without specifying preferences and contribution cost. But the hypothesis still singles out a number of cells in the cross tabulation that should be overrepresented. The cells along the diagonal in Table 3 are all overrepresented. In addition, cells $(0,3)$, $(3,0)$ and $(4,1)$ are overrepresented. We interpret the overrepresentation in the asymmetric cells $(3,0)$ and $(0,3)$ as evidence supporting Conjecture 2: a considerable number of siblings play the asymmetric coordination equilibrium. To explore whether this pattern shows up while controlling for sex, socio-economic status, etc., we estimate a logistic regression model.

Table 3 suggests that there is no monotonic relationship between the siblings' location choices. An ordered model like the one presented above assumes that an increase in some dependent variable shifts the distribution of the dependent variable in a monotonic way and would lead to invalid results (see Bender and Grouven (1998)). Because of this nonlinearity we discard the ordered approach and choose an unordered multinomial logistic regression, which allows us to estimate the effects of each specific distance of the first child on the probability of any choice of the second child. We use the same set of variables as before. Our set of 2-children-families contains 701 observations.

The multinomial logistic regression estimates the following equations for a dependent variable with 5 categories and k explanatory variables:

$$\ln\left(\frac{P(D_i = j)}{P(D_i = 4)}\right) = \alpha_j + \beta'_{jk} X_k, \quad \text{for } j = 0, 1, 2, 3, \tag{15}$$

where we have chosen $D_i = 4$ as our reference category, i.e. children living more than 2 hours away from his parents. The results are given in Table 4 and consist of values for each distance category with respect to the reference category $D_i = 4$.

The first block analyzes how the odds of choosing $D_B = 0$ vs. $D_B = 4$ depend on the explanatory variables. Among the control variables, we find that the marital status and an above average socio-economic status have a

Table 4: Multinomial logistic regression. reference category $D_i = 4$. $n = 701$

Variable	β_{jk}	Std. Error	Prob.	$\exp(\beta_{jk})$
Results for $D_2 = 0$				
Sex	-0.511	0.294	0.082	0.600
Marital Status	-0.954	0.290	0.001	0.385
SES below average	-0.637	0.495	0.198	0.529
SES above average	-1.324	0.393	0.001	0.266
SES Data n.a.	0.347	0.365	0.342	1.415
Distance A = 0	1.680	0.569	0.003	5.366
Distance A = 1	0.971	0.498	0.051	2.639
Distance A = 2	0.861	0.436	0.048	2.365
Distance A = 3	0.998	0.367	0.007	2.713
Intercept	0.221	0.423	0.601	
Results for $D_2 = 1$				
Sex	0.008	0.321	0.794	1.088
Marital Status	-0.195	0.335	0.560	0.822
SES below average	-0.928	0.545	0.089	0.395
SES above average	-1.151	0.403	0.004	0.316
SES Data n.a.	-0.434	0.429	0.311	0.648
Distance A = 0	0.591	0.643	0.357	1.807
Distance A = 1	1.542	0.435	0.000	4.674
Distance A = 2	-0.001	0.475	0.977	0.986
Distance A = 3	-0.223	0.406	0.583	0.800
Intercept	-0.194	0.452	0.668	
Results for $D_2 = 2$				
Sex	-0.318	0.264	0.228	0.728
Marital Status	0.001	0.281	0.997	1.001
SES below average	-1.487	0.514	0.004	0.226
SES above average	-1.028	0.320	0.001	0.358
SES Data n.a.	-0.002	0.344	0.952	0.979
Distance A = 0	0.803	0.567	0.157	2.233
Distance A = 1	0.513	0.449	0.253	1.670
Distance A = 2	1.731	0.349	0.000	5.647
Distance A = 3	0.282	0.330	0.394	1.326
Intercept	0.203	0.388	0.600	
Results for $D_2 = 3$				
Sex	0.130	0.254	0.608	1.139
Marital Status	0.443	0.281	0.115	1.557
SES below average	-0.662	0.426	0.120	0.516
SES above average	-0.576	0.297	0.052	0.562
SES Data n.a.	-0.124	0.348	0.721	0.883
Distance A = 0	2.152	0.516	0.000	8.606
Distance A = 1	0.671	0.458	0.143	1.956
Distance A = 2	1.088	0.379	0.004	2.968
Distance A = 3	1.445	0.315	0.000	4.242
Intercept	-0.731	0.407	0.073	
LR test all slope coefficients = 0: $\chi^2 = 219.087$ (36 d.f.), Prob.<0.001				

significant impact on the odds of Benjamin choosing $D_0 = 0$: married and educated Benjamins have much smaller odds of staying with their parents in the same house or household vs. moving further away than unmarried children do (only .385 and .266 times more likely). Two distance choices by the older sibling Adam have a significant influence on the odds of Benjamin staying with his parents rather than moving furthest away: if Adam chooses $D_A = 0$ and $D_A = 3$. In these two cases, Benjamin is more than 5 times more likely to choose $D_B = 0$ and almost 3 times more likely to choose $D_B = 3$. The first fact corresponds to the situation where Benjamin matches the distance chosen by Adam and is not explained by our theory. It could be explained by a number of unobserved explanatory variables. The second fact reflects the asymmetric equilibrium where Benjamin moves further away whenever Adam stays close to his parents.

The other blocks show a similar pattern. The odds of Benjamin choosing $D_B = 1$ and $D_B = 2$ vs. $D_B = 4$ are much higher when his brother chooses the distance categories 1 and 2, respectively. Again, an above average socio-economic status makes it less likely that Benjamin stays closer to his parents. The last block describing the odds of Benjamin choosing $D_B = 3$ vs. $D_B = 4$ show again how Adam's choice influences Benjamin's choice: the odds are the highest when Adam chooses $D_A = 0$ (asymmetric equilibrium) and $D_A = 3$ (symmetric outcome). In all cases, as in our previous ordinal model, sex has no significant effect.

The Stackelberg outcome described in Proposition 3 suggests we should more frequently observe situations in which Adam moves sufficiently far away leaving the younger Benjamin close to their parents. But we also find in our data the opposite asymmetric equilibrium where Adam stays close to the parents and Benjamin locates further away. The overrepresented cell (0,3) and the significant coefficient 2.713 in the first block of Table 4 (which means that the odds of Benjamin choosing $D_B = 3$ increase when Adam chooses $D_A = 3$) suggest that *both* asymmetric equilibria are present in the data. This is consistent with siblings playing the Nash game and the differences among the siblings (preferences, but mainly age) help them to coordinate, and determines why the asymmetric equilibrium (3,0) occurs more often than the asymmetric equilibrium (0,3). It is usually Adam who (because of his age) is the first to move out.

However, we observe that both children often choose the same distance from their parents. This overrepresentation in the cells along the diagonal may have many reasons. If the choice of distance is strongly affected, for example, by education, the fact that both children have chosen the same distance may be simply a result of similar socialization and education. Some siblings may match the distance chosen by his/her sibling and move away up to a distance in which it is advantageous for neither of them to increase the own distance. Such equilibria are compatible with some specifications of the general “warm glow” utility function. There are also many plausible ad hoc explanations for overrepresentation along the diagonal and we discuss this in the concluding section. Since there are many other factors determining individual residential choices, we could not expect that the strategic incentives discussed in the formal model in section 2 are strong enough to be decisive for the residential choice of all siblings. Therefore, we conclude that Adam’s distance choice has an important influence on Benjamin’s behavior regardless of similarities in socio-economic status, sex or marital status. Our model is consistent with the data but cannot explain every data aspect.

6 Discussion

In former times, many societies had developed strong norms about the roles of children in taking care of the elderly parents (Künemund and Rein 1999). Although there has been rapid change, in Japan, for instance, it was customary that the parents live with the oldest son (see, e.g., Koyano et al. 1994). Such norms make considerable sense in a non-cooperative family world. As we have seen, the residential choice equilibrium in the family is distorted due to the strategic incentives of siblings to induce higher contributions by their brothers and sisters. A norm that exogenously assigns the duties of taking care of the elderly parents to one of the children makes these choices independent of their residential choice and makes the strategic incentives disappear. This can be efficiency enhancing.

We should note that there may be many other reasons not considered in the model for the choice of residence. In particular, the strong overrepresentation along the diagonal displayed in Table 2 may have many reasons. For instance, if siblings had a preference for living closely to one another to socialize a lot, this would also yield a distribution in which the diagonal elements in Table 2 are overrepresented. Alternatively, there may be exactly one optimal migration pattern for both siblings and both simply follow this pattern. For instance, the choice of university may be strongly influenced by distance from "home". In many cases there may be one university (in a larger city near the parents' place) that is the natural choice for both children. Both may study at the same university and then take up a job in this university city. However, these explanations cannot explain the significant increase in siblings' average distance from parents when moving from only child families to families with two children.

Finally we contrast our model and empirical results with the model of strategic bequests. In the strategic bequests model by Bernheim et al. (1985), parents design a contest for their children. They make the bequest dependent on childrens' relative attention. The childrens' choice of residence in such a model is also a strategic variable, but compared to our model, the strategic incentives work in the opposite direction. Both children make contributions in the contest. The bequest is the prize and is allocated according to a contest success function. The child who has the lower cost of making contributions (that is, who lives closer to the parents) has an advantage. As is well-known from contest theory, the contestant with lower contribution cost earns a higher expected rent in the contest equilibrium. Accordingly, in the strategic bequest model children have a strategic incentive to locate as close as possible to the parents. In comparison, this incentive is again absent for an only child. Therefore, consideration of the strategic residence choice in the "strategic bequest" model would predict that siblings locate closer to the parents than an only child does. This prediction would be rejected by the data. The opposite seems to be true instead.

However, this evidence cannot be the final verdict regarding the strategic bequests model. First, only a subgroup of families may engage in a strategic bequests game, whereas another -supposedly larger- group may play the strategic location game considered here. Second, the strategic bequests motive may be less strongly reflected in German data. The German laws regulating bequests limit the degree of freedom to allocate one's wealth among heirs. The strategic bequests motive is ruled out to some extent by institutional constraints. Third, the strategic bequests story becomes more complicated if the set of parents' strategies is more sophisticated.

Summarizing, a voluntary contributions model of childrens' attention for their parents suggests that siblings and only children make different location choices. Siblings have a strategic incentive to move away from their parents. This incentive is absent for only children. Theory therefore suggests that, on average, siblings locate further away from their parents than only children do, and the empirical evidence confirms this. Theory cannot make sharp predictions about the type of location choice equilibrium for siblings. However, there is reason to believe that some siblings will end up in a very asymmetric equilibrium in which one of the children moves far away and leaves the burden of care to his brother or sister who stays close to their parents. Empirical data also confirm this second result: such location choices are overrepresented in the sample. However, the data also show that many other aspects must be important for siblings' location choice.

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