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ABSTRACT

Geography of the Family

by Kai A. Konrad, Harald Künemund, Kjell Erik Lommerud and Julio R. Robledo*

We study the residential choice of siblings who are altruistic towards their parents. The first-born child's location choice influences the behavior of the second-born child and can shift some of the burden of providing care for the parents from one child to the other. These strategic considerations lead to an equilibrium location pattern with first-born children locating further away from their parents than second-born children. We also analyze the location choices empirically using German data. These data confirm our theoretical predictions.

Keywords: Family public goods, voluntary intergenerational transfers
JEL classification: H41, J10

ZUSAMMENFASSUNG

Die Geographie der Familie

Wir untersuchen die Wohnortwahl von Geschwisterkindern, die altruistisch gegenüber ihren Eltern sind. Ältere Geschwister können durch ihre Wohnortwahl die Wohnortwahl ihrer jüngeren Geschwister beeinflussen und damit die mögliche Last der Pflege der alternden Eltern auf die jüngeren Geschwister verlagern. Diese strategischen Überlegungen führen im Gleichgewicht zu einem bestimmten Verhaltensmuster, was die Wohnortentscheidungen von Kindern im Verhältnis zu ihren Eltern angeht, einer „Geographie der Familie". Wir zeigen ferner, dass sich dieses Verhaltensmuster in den Wohnortentscheidungen einer repräsentativen Stichprobe deutscher Haushalte widerspiegelt.

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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 children's visits typically exceeds the children's desire to visit them. Vern L. Bengtson and Joseph A. Kuypers (1971), for instance, report 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. However, 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.

The costs of providing attention and care for the parents are important determinants for the amount of care which each child chooses to contribute. A child, say B, is likely to provide little if its cost is high. Moreover, if the other child B knows that child A provides little, in the equilibrium this will induce B to provide more. Accordingly, prior to the actual voluntary contributions, children have an incentive to change their own cost of making contributions.[2] Distance between a sibling's residence and the location where

[1] B. Douglas Bernheim, Andrei Shleifer and Lawrence H. Summers (1985) consider family visits or 'contact' with parents as burdensome, at least at the margin. Donald Cox and Mark R. Rank (1992) treat intergenerational transfers as an exchange between parents and their children, and hence make a similar assumption. Laurence J. Kotlikoff and John N. Morris (1989: 168) assume that parents bribe their children to elicit more attention.

[2] The implications of relative contribution cost in games of voluntary contributions to a public good has been highlighted, e.g., in Theodore C. Bergstrom (1989).

his or her parents live is crucial for the actual cost of providing care for the parents or for visiting them.

Children make the choice of residence many years before the problem of care giving becomes relevant. They could consider moving to their parents when these are old and need care. However, we expect that most often the cost of such a move is prohibitive. Children build up a social network of friends in their local area, depending on their type of work, they establish local business links that tie them to the area, and they may have children themselves who have their own friends and ties, for instance, at school.[3] Job seniority has a positive and significant income effect, e. g. due to job-specific human capital accumulation. This is well documented, for instance, for the U.S. by Robert E. Topel (1991). The income loss associated with a job change reduces job mobility and thus the workers' geographical mobility. Wim Groot and Maartje Verberne (1997) report that job mobility decreases with age up to the age of 55, with most of the lifetime mobility occuring early during working life (p. 380).[4] Hence, the children's choice of residence at the time when they enter their professional life determines their future cost of contributions in the care-giving game that is played many years later. This makes the choice of residence a strategic variable.[5]

In this paper we study the strategic incentives of siblings for choosing residence (sections 2 to 4). Reasonable restrictions on preferences yield a

[3]This may be even more true for European societies, compared to 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 for those who actually move.

[4]For a survey on migration patterns and the determinants of migration see Michael J. Greenwood (1997).

[5]For justification of non-cooperative behavior in families, particularly for strategic choices that yield commitment, see Shelly Lundberg and Robert Pollak (1993) and Kai A. Konrad and Kjell Erik Lommerud (1995). For a survey on family economics see Theodore C. Bergstrom (1993).

full characterization of all subgame perfect equilibria in pure strategies. In one set of equilibria, the older child moves sufficiently far away to induce the younger child to locate next to the parents, even though this implies that the younger child will provide all care in the later contribution game. We allow for parents deciding whether they move closer to their children when they are old and need care. Such a move has considerable cost, and the equilibrium outcome will depend on the size of this cost. We confront the theoretical results with empirical evidence in section 5. The theoretical analysis predicts that, on average, a child with a younger sibling locates further away from its parents than an only child or a child without a younger sibling.

A large literature exists on intra-family resource allocation, and much is known by now about the factors determining actual intra-family transfers of money and services.[6] This paper is related to this literature but is not a contribution to it. We are interested in the determinants of family members' choice of residence with respect to each other, not in their transfers.[7] Children know that location with respect to their parents will be an important determinant of their as well as their siblings' actual transfers in the future, and they could try to make a strategic location choice, anticipating and influencing what these transfers will be in the future. Whether children make such far sighted strategic decisions to try and affect the outcome of games that are played between them and their siblings decades later is the central question of this paper. We concentrate on one strategic action that is made by all children: their choice of residence. This yields a 'geography

[6] For a survey see Beth J. Soldo and Martha S. Hill (1993), and for key survey references see Joseph G. Altonji, Fumio Hayashi and Kotlikoff (1995, 1996), Kenneth A. Couch, Mary C. Daly and Douglas A. Wolf (1999), Kotlikoff (1992), Kotlikoff and Morris (1989), and, for Germany, Martin Kohli, Harald Künemund, Andreas Motel and Marc Szydlik (2000).

[7] We will concentrate on transfers of services. However, we will discuss why taking money transfers into account would not change our results qualitatively.

of the family': theoretical evidence that explains location choice, and empirical evidence that shows that location choice is in line with the theoretical predictions, and may be guided by far sighted strategic behavior.

2 The model family

Consider the following family that consists of parents P, and two children, A(dam) who is born first, and B(enjamin), who is born later. Parents P live and raise their children at some place, that is normalized to 0. When A and B are about eighteen to thirty years old, they make a location choice. The choices are points a and b. These locations can be interpreted as points in the two-dimensional plane or on the real line, as only distance matters here. We assume that Adam chooses his location a first. Empirically, this should be true in the majority of cases, because Adam is older. His choice constitutes STAGE 1 of a game with four stages. At STAGE 2 Benjamin chooses his location b. The children stay in these places. For professional or social reasons discussed in the introduction, we assume that moving becomes prohibitively costly for them.

Years after the children have made their choices of residence, their parents retire and may need attention. Parents may consider moving closer to their children. In many cases these costs are also prohibitive for parents. However, at the time when parents enter retirement age, their cost of moving may be much lower for them than for children who are in the midst of their professional life and may have dependent children.[8] Also the amount of care parents receive is a more important factor in parents' utility than it is for the children. This makes it reasonable to disregard the possibility of children moving at this stage, but to consider the possibility of a move by parents

[8] Greenwood (1997, 705n) surveys evidence according to which migration occurs frequently in connection with a change in life-cycle circumstances.

more explicitly. Parents choose whether to move at STAGE 3. They have a cost (e.g., loss of social contacts) equal to K only if they move, and we assume that this cost is independent of the distance by which they move.[9] The parents' place of residence at the end of STAGE 3 is p, with $p = 0$ (and no cost) if parents do not move. Denote the distance between two points x and y by $\delta(x, y)$. The distances between P and A and P and B are finally determined at the end of STAGE 3 as functions of a, b, and of the parents' final location p, and denoted by $\delta_A = \delta(a, p)$ and $\delta_B = \delta(b, p)$.

Parents care about their cost of moving, and about the number of visits ('care units') they receive from their children. The number of visits will depend on the locations of parents and children. Let G be the total number of visits that parents receive. Their objective function is assumed to be

$$U^P = w(G) - \kappa(p). \tag{1}$$

Here $w(G)$ is a twice differentiable, monotonically increasing and strictly concave function, and $\kappa(p) = K$ if $p \neq 0$ (i.e., if parents move), and $\kappa(p) = 0$ if $p = 0$ (i.e., if parents do not move).

Finally, at STAGE 4, A and B decide simultaneously about the number of visits, g_A and g_B.[10] Each visit involves a cost. The time cost per visit consists of one unit of time actually spent with the parents, plus travel time that, by appropriate normalization, is equal to the actual distance δ_i between child i's place of residence and the parents' place. Accordingly, child i's time budget m is allocated between activities x_i that yield private consumption,

[9] A permanent change of location involves several costs. A major share of these costs is independent of the distance between the past and the future locations, making the binary cost assumption here a good approximation that simplifies the exposition. In the end of section 4 we discuss why our results generalize to a location dependent cost function.

[10] STAGE 4 has many periods in reality, allowing perhaps for some cooperation between siblings. We focus on the non-cooperative outcome at STAGE 4, and discuss possible cooperation at STAGE 4 at the end of section 4.

and family visits:

$$m = x_i + (1 + \delta_i)g_i \qquad \text{for} \quad i \in \{A, B\}. \tag{2}$$

When making their simultaneous choices about the number of visits at STAGE 4, i cares about his private consumption x_i, and about the total number

$$G = g_A + g_B \tag{3}$$

of family visits that his parents get:

$$U^i(x_i, G) = x_i + u(G), \text{ for } i = A, B. \tag{4}$$

Utility (4) parallels the standard preferences with one private and one public good, where the public good is the total sum of the visits. To concentrate on interior solutions, we assume throughout the paper that $u' > 0$, $u'' < 0$, $u'(m) < 1$ and $\lim_{G \to 0} u'(G) = \infty$.

We disregard the possibility that children may derive additional private utility from their own contributions as in impure altruism models like those in James Andreoni (1989, 1990). Utility (4) is quasi-linear, increasing in both arguments, and strictly concave in aggregate contributions. By these simplifications we avoid letting cross effects or income effects cloud the strategic incentive on which we focus. Our qualitative results generalize to a broader class of preferences. We will discuss this further in section 4. Before we solve this game we consider the situation with an only child.

3 An only child

An only child S(arah) has no brother or sister who could contribute to parents' visits. Suppose S is located in s and parents are located in p. Sarah maximizes utility for given distance $\delta_S = \delta(s, p)$ by a choice of $g_S = G$ that maximizes (4) subject to (2). We call this amount *stand-alone contribution.*

By our assumptions about u, an interior equilibrium exists and is determined by $1 + \delta_S = u'(G)$ and $g_S = G$.

At STAGE 1 S chooses a location s. The parents stay at 0 or, if they move, they move to s. In any case, a choice $s = 0$, which induces $p = 0$, maximizes her payoff. 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.

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 or emotional attachment to a particular region. 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 else will compensate for the lack of own attention to his or her parents. This will be different if parents have more than one child.

4 Siblings

Consider now the game with two children, A and B. To characterize the equilibrium we define

$$\hat{\delta} \equiv \min\{\delta_A, \delta_B\} \tag{5}$$

the shorter of the distances between parents and their children. Further, we define $\gamma(\delta)$ the amount G of contributions that solves

$$u'(G) = 1 + \delta. \tag{6}$$

Note that $\gamma(\delta)$ is strictly decreasing in δ.

Lemma 1 *The contribution equilibrium of* STAGE 4 *is characterized by aggregate contributions* $g_A + g_B = \gamma(\hat{\delta})$. *If* $\hat{\delta} = \delta_i < \delta_j$, *then* $g_i = \gamma(\hat{\delta})$ *and* $g_j = 0$, *for* $i, j \in \{A, B\}$. *If* $\hat{\delta} = \delta_A = \delta_B$, *any* $g_A = \alpha\gamma(\hat{\delta})$ *and* $g_B = (1 - \alpha)\gamma(\hat{\delta})$ *with* $0 \leq \alpha \leq 1$ *is a contribution equilibrium.*

The proof is in the appendix. Due to the absence of income effects for (4), the aggregate contributions G in the equilibrium for given location choices a, b and p are characterized by (6). The contribution equals the stand-alone contribution of the child who lives closest to the parents. Hence, it is a function $\gamma(\hat{\delta})$ of this minimum distance $\hat{\delta}$. The full amount $\gamma(\hat{\delta})$ is contributed by the one child who lives closer to the parents. The other child contributes zero. If both children live at the same distance from their parents, the aggregate contributions $\gamma(\hat{\delta})$ are also uniquely determined, but any pair of contributions that sums up to this amount is an equilibrium. The non-negative shares contributed by A and B in the equilibrium if both children locate at the same distance from their parents are denoted α and $(1 - \alpha)$.

Next we define a critical distance for parents' choice to move. Parents anticipate that the care they receive is $G = \gamma(\hat{\delta})$. They can influence this distance for given location choices a and b by their choice of whether to move. If parents move they can locate anywhere. But from Lemma 1 they choose $p \in \{a, b\}$ because only these locations yield $\hat{\delta} = 0$ and maximize the care they receive. Let $\delta(K)$ be the distance for which

$$w(\gamma(0)) - w(\gamma(\delta(K))) = K. \tag{7}$$

This distance can be used to characterize the parents' decision at STAGE 3. Parents are indifferent between $p = 0$ and $p \in \{a, b\}$ if $\min\{\delta(a, 0), \delta(b, 0)\} = \delta(K)$. They do not move (i.e., choose $p = 0$) if $\min\{\delta(a, 0), \delta(b, 0)\} < \delta(K)$, because the cost K of moving would exceed the parents' benefit from increased care. They move to $p \in \{a, b\}$ if $\min\{\delta(a, 0), \delta(b, 0)\} > \delta(K)$. We denote π_A and π_B the conditional probabilities for moving to a or b respectively. In general, these probabilities can be functions $\pi_A(a, b)$ and $\pi_B(a, b)$ of a and b. The conditional probability π_B will be important for characterizing the set of subgame perfect equilibria.

Turning to STAGE 2, we define a distance that is critical for B's location choice. Let δ_{crit} be the distance for which

$$u(\gamma(0)) + m - \gamma(0) = u(\gamma(\delta_{crit})) + m. \tag{8}$$

Consider the situation when $\delta_{crit} < \delta(K)$. B anticipates that his parents will not move at STAGE 3. Thus, B has two relevant alternatives. First, B can choose some b with $\delta(b, 0) > \delta(a, 0)$. A will be the only contributor to the public good and B earns utility equal to $u(\gamma(\delta(a, 0))) + m$. Second, B can decide to locate closer to their parents than $\delta(a, 0)$, thus becoming the only contributor. In this second alternative, B would prefer to locate as close as possible to his parents and earn the utility on the left-hand side of (8).

B's choice of distance depends on A's location choice. Therefore, we need to distinguish between three cases, namely whether $\delta(a, 0)$ is equal to, smaller or greater than δ_{crit}. If $\delta(a, 0) = \delta_{crit}$, B is indifferent between these alternatives. If $\delta(a, 0) < \delta_{crit}$, B prefers to choose some b with $\delta(b, 0) > \delta(a, 0)$ such that only A makes contributions to G. Finally, if $\delta(a, 0) > \delta_{crit}$, then child B strictly prefers to stay next to their parents. Note that for these considerations $\delta_{crit} < \delta(K)$ was crucial.

The discussion about the critical distance δ_{crit} shows that A's choice of location is strategic. By his choice of distance, A can induce B to stay close to their parents and to assume the whole burden of making contributions.

Proposition 1 *Let $\delta_{crit} < \delta(K)$. (i) If $\alpha \in [0, 1]$ and $\pi \in [0, 1]$, the set of subgame perfect equilibrium location choices of A is $\{a \,|\delta(a, 0) \geq \delta_{crit}\}$.*
(ii) If $\alpha \in (0, 1)$ and $\pi \in (0, 1)$, then the set of subgame perfect equilibria is described by (a, b, p) with $\delta(a, 0) \in [\delta_{crit}, \delta(K)]$, $b = 0$ and $p = 0$.

A formal proof is in the appendix. The equilibria described in part *(ii)* of Proposition 1 have a simple intuition. Suppose, e.g., $K = \infty$; that is, regardless of children's location choices, parents never relocate. Consider A's choice of location. A knows that B's choice will depend on A's choice as described by the critical distance in (8). B can always induce A to become the only contributor by locating further away than A. But if A locates far away from their parents and B locates even further away, B will not contribute, but A will contribute very little. If A locates sufficiently far away from their parents, as the sole contributor he would contribute so little that B is better off by locating close to the parents even though this implies that B becomes the sole contributor. A will always generate this outcome, because he gets the maximum contribution level $G = \gamma(0)$ without having to contribute himself.

Part *(i)* of Proposition 1 reveals that the set of equilibrium locations is larger than the set described in (ii) if we allow for all tie-breaking rules, that is, even some tie-breaking rules that are extreme in some sense. For instance, suppose parents always move to B if they move, and B is the sole contributor if $\delta_A = \delta_B$. Formally, this is described by tie-breaking rules $\pi_B = 1$ and $\alpha = 0$. In this case A has a few other location choices that generate maximum utility to him. For instance, $a = b = p$ with $\delta(a, 0) > \delta(K)$, and (a, b, p) with $\delta(a, 0) > \delta(K)$ and $b = p = 0$ become subgame perfect equilibria.

Let us now consider the situation when $\delta_{crit} > \delta(K)$. Here, the strategic effect of distance by which A can induce B to move to $b = 0$ does not work. If A moves sufficiently far away in trying to induce B to become the only contributor, B now has a different option: B also moves far away and waits for the parents' decision to move next to one of them, which also leads to total care equal to $\gamma(0)$, but reduces the probability that B has to contribute this amount. In the equilibrium both children locate far away. Parents then, by their move to one of them, decide who is going to contribute $\gamma(0)$. More specifically:

Proposition 2 *Let $\delta_{crit} > \delta(K)$. If $0 < \alpha < 1$ and $0 < \pi_B < 1$ then the set of subgame perfect location equilibria is described by (a, b, p) with $\delta(a, 0) \geq \delta(K)$, $\delta(b, 0) \geq \delta(K)$, and $p \in \{a, b\}$.*

The equilibrium results are qualitatively robust with respect to several directions of generalization. First, the result about the structure of equilibrium location choices of children generalizes to a larger subset of utility functions $U(x_i, G)$ for which the income effect is not too strong. (The precise characterization of this subset is not straightforward and space consuming).

Second, the result generalizes to some contribution technologies other than the one in equation (3). For instance, indivisibilities or increasing returns may make it desirable for all care to be provided by one of the siblings. In the theoretical analysis we assumed that total care is the sum of children's contributions, but we ended up with a corner solution in which one child contributes the full amount. Including indivisibilities in the theoretical analysis increases the strategic incentives to move away. Indivisibilities can even extend the corner solution outcome to a broader class of children's utility functions.

Third, children may make their location choices simultaneously instead of sequentially. This may be the case if commitment does not result from the choice of residence itself, but from living in some place for many years. Therefore the strategic situation at stages 1 and 2 may collapse into one single stage and may be appropriately described by a simultaneous choice of locations. As is shown in the appendix:

Proposition 3 *The sequential location choices (a, b, p) described in Proposition 1 are also equilibrium location choices if children choose their locations simultaneously.*

Fourth, the children may differ in their preferences. Only if A's marginal utility of contributions considerably exceeds that of B, may this force A

into an equilibrium choice $a = 0$, with A becoming the only contributor in this case, with b arbitrary. If A's and B's preferences differ only slightly, or if B's marginal utility of contributions exceeds that of A, Proposition 1 generalizes in a straightforward way. Note that in this case δ_{crit} is smaller the higher B's valuation of contributions. For instance, if male and female children value contributions differently, we should expect children's sex and the combination of sexes to be important. We will discuss this more closely when presenting the empirical results.

Fifth, while preemption by location choice may be described well by non-cooperative behavior, the children may play cooperatively in the care-giving stage. The efficient number of visits is denoted $\Gamma(\hat{\delta})$ and is determined by the condition

$$2u'(\Gamma(\hat{\delta})) = 1 + \hat{\delta}. \tag{9}$$

If A and B Nash bargain and have transferable utility, this amount Γ is provided by the child who is located closer to the parents. If they have equal bargaining power, this child receives a side payment from the other child that is equivalent to $\frac{1}{2}(\Gamma(\hat{\delta}) - \gamma(\hat{\delta}))(1 + \hat{\delta})$ and enjoys utility $U^c(\hat{\delta})$ with

$$U^c(\delta) = u(\Gamma(\delta)) + m - \gamma(\delta)(1 + \delta) - \frac{1}{2}[\Gamma(\delta) - \gamma(\delta)](1 + \delta), \tag{10}$$

where the superscript c denotes the cooperation in the care-giving stage. This utility depends on δ. A decrease in δ reduces provision cost, which, for a given transfer, increases U^c. However, a decrease in δ also changes the transfer. Depending on δ and $(\Gamma'(\delta) - \gamma'(\delta))$, the transfer may increase or decrease in δ. Analogously to (8), let Δ_{crit} be defined by as the solution to

$$U^c(0) = u(\Gamma(\Delta_{crit})) + m - \frac{1}{2}(1 + \Delta_{crit})[\Gamma(\Delta_{crit}) - \gamma(\Delta_{crit})]. \tag{11}$$

Further, let $\Delta(K)$ be the critical distance that makes parents indifferent between staying at 0 or moving to A or to B. This distance is determined analogously to (7) by the solution to

$$w(\Gamma(0)) - w(\Gamma(\Delta(K))) = K. \tag{12}$$

Consideration is straightforward if $\max\{U^c(\delta)\} = U^c(0)$, and we concentrate on this case here.

Proposition 4 *Suppose the outcome in stage 4 is characterized by symmetric Nash bargaining with side payments. Let* $\Delta_{crit} < \Delta(K)$*, and let* $U^c(\delta)$ *in (10) take its maximum at* $\delta = 0$ *for all* δ*. If* $0 < \alpha < 1$ *and* $0 < \pi_B < 1$*, then the set of subgame perfect equilibria is described by* (a, b, p) *with* $\delta(a, 0) \in [\Delta_{crit}, \Delta(K)]$*,* $b = 0$ *and* $p = 0$*.*

Proposition 4 generalizes the main Proposition 1 for the case with a co-operative care-giving stage. The relevant distances δ_{crit} and $\delta(K)$ change to Δ_{crit} and $\Delta(K)$, but the nature of the equilibrium does not change.

Sixth, we assumed that the cost to parents if they relocate is independent of the distance between their old and their new location. These costs differ in nature from children's cost of visits. Unlike with children's unit cost of visits, for relocation actual travel time to the new place of residence is unimportant. The cost could nevertheless be an increasing function $\kappa(\delta(0, p))$ of the distance, consisting of some fixed cost K plus some cost that depends on $\delta(0, p)$ with $\kappa'(\delta) > 0$, for instance because parents may be able to sustain a larger share of their social network after a move if the distance $\delta(0, p)$ is smaller. It is then not clear whether parents who move move right next to one of their children. This changes the utility levels for children in subgames in which parents move. Also $\delta(K)$ is determined by variations of the conditions (7) and (8). However, the incentives for preemptive behavior by A and the resulting structure of equilibria remain qualitatively the same.

Seventh, we did not consider monetary gifts from children to parents. For Germany, Kohli et al. (2000) show that there are very few monetary transfers from children to parents.[11] Parents are financially independent due to generous old-age social security programs, making sickness care perhaps less important than the emotional benefits from children's visits, and for this type of care, monetary transfers are not a substitute. From a theory point of view, monetary altruistic transfers do not alter any of the results if they enter additively separably.[12] The strategic incentives are even stronger if giving of money and time are complements, but weaken if they are very strong substitutes. Couch et al. (1999) provide empirical evidence that time, gifts and money may even be complements.

The following conjecture summarizes some hypotheses regarding the empirical results:

Conjecture 1 *Adams differ significantly from Benjamins (and from only children) in their location pattern. Adams locate further away from their parents than Benjamins, particularly in families in which parents have not moved after the children have left home.*

5 Empirical evidence

We test our theory using the data set from the *German Aging Survey.* This is 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 by age groups, sex, and location in East and West Germany. The survey is designed as a first wave of a panel study and comprises economic and sociological criteria of the various dimensions of life situations and welfare as

[11]Similar results are reported for the US by Soldo and Hill (1993). Time transfers from children to elderly parents are much more likely than financial transfers.

[12]Quasi-linearity of utility is important for this result. For more general preferences, monetary transfers can have income effects that may weaken or strengthen the incentives for visits, even if monetary transfers enter utility additively separably.

well as psychological measures of self and life concepts.[13]

We restrict our attention to parents with one and two biological children who are still alive. The reason for this restriction is that we have developed a theory about the location choice of families with exactly two children. Also, this restriction avoids a possible endogeneity problem caused by possible parental preferences for children. We further require that all children are 30 years of age or older. The rationale for this requirement is the assumption that children of this age have had the chance to leave their parents' household, e.g. that existing coresidence is a result of a decision as discussed above. Finally, we disregard families where the parents have moved after both children have moved out. Thus, we focus on families where the strategic equilibrium is characterized by Proposition 1 and/or Proposition 4. If parents move (e.g. when $\delta(K) > \delta_{crit}$), the strategic effect for first-born children vanishes. Using this subgroup, we have 1993 observations, 625 families with an only child and 684 families with two children.

The key variable of our analysis is the distance D_i between the parents' and child i's place of residence. Our data set provides information 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 ($D_i \equiv 4$).

[13] 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. For the questionnaire and additional information see the website of the Research Group on Aging and the Life Course at `http://www.fall-berlin.de/`. The dataset is available to researchers at the *Central Archive for Empirical Social Research* at the University of Cologne (Study No. 3264). A comprehensive report of the sociological results is given by Kohli and Künemund (2000).

Our aim is to analyze whether the existence of a younger brother or sister affects children's choice of proximity to the parents. Our main hypothesis is that Adams have a higher probability of being in a higher distance category. Note that our theory rests on the assumption that location choice predetermines care decisions at a later stage when care is actually needed. We do not consider whether Adams provide more or less care. However, our theoretical argument is that Adams move away in order to reduce their *expected* contributions to care. This is true if Adam can expect to spend less care if he moves further away than his brother. We cannot measure a child's expectations directly, but rely on the extremely close empirical correlation between distance and care (for instance, Cox and Rank (1992) proxy actual care with distance).

Simple descriptive statistics suggest a systematic difference in behavior between only children and children with a younger sibling regarding their residence choice. Figure 5 shows graphically how Adams locate less often near the parents and more often further away. The black, left column denotes the proportion of Adams locating at that distance. The middle, grey column stands for the Benjamin and the right, white column represents the only children. Consider the first distance category "same house or household". Only 11% of all Adams live in the same house or household as their parents, while 17% of all Benjamins and 19% of all only children do. In the higher distance categories, the proportion of Adams living further away increases compared both to Benjamins and only children. In the furthest distance category, more than two hours travel time away from the parents, we find 19% of all Adams, 16% of all Benjamins and 15% of all only children.

We carried out independence tests between the child type and the distance category. The Pearson statistic $\chi^2 = 23.45$ and the likelihood-ratio statistic $LR = 24.16$ lead to a clear rejection of the null hypothesis that the child type and the distance category are statistically independent (both with 8 degrees

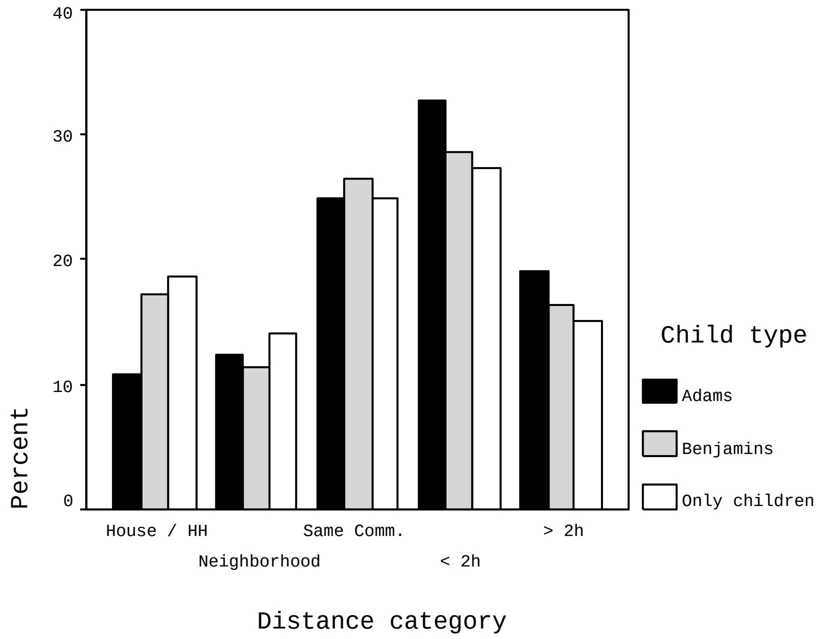

Figure 1: Distance choices by child type

of freedom, the p-value is 0.003 and 0.002, respectively).

But this different location behavior may be shaped by other factors concerning both children and their parents, e.g. the first-born child may obtain a better education, which is usually associated with a higher geographic mobility. Thus, we include several characteristics of children and parents in a multivariate model. We estimate an ordered logistic model to verify that Adams locate further away from the parents than Benjamins and only children after controlling for the effects of other variables.

On the children's side, we include sex, marital status, and socio-economic status in our analysis. Marital status is a dummy variable (1 for married children, and 0 in all other cases). We expect married children to live further away from their parents than non-married children because of their respective spouses' choice of residence. The expected sign of sex is ambiguous because there are several relevant effects. We consider this more closely below.

The data does not provide explicit information about the children's education or their income, but it does provide detailed information about their occupation. We therefore use the international socio-economic index of occupational status which was designed to attain maximal correlation between occupation and both income and education (see Harry B. Ganzeboom, Paul M. De Graaf and Donald J. Treiman (1992)). This index of socio-economic status (SES) was 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 for socio-economic status.

As for the parents, we consider age, health status (three categories: healthy, small and large disabilities), a dummy measuring the parents' marital status, and a dummy for the existence of grandchildren. Older parents and parents with health disabilities require more care, and a single or widowed parent may also need more attention than couple parents. If grandparents look after the grandchildren, this could be an incentive for their children to locate near the grandparents. These four characteristics are known to be very important for explaining actual care and intergenerational transfers in goods and services. However, we would not expect them to contribute much to explaining the children's strategic location decision, which usually takes place years before care is needed. We also include a wealth dummy for the parents which is 1 if the parents are wealthy and/or homeowners. Parents' wealth is different from the other parental variables: when children make their location choice, in many cases it is not difficult for them to anticipate whether their parents will be wealthy a decade or two later. We will take this up in Section 6.

The ordered logistic regression estimates the following equations for a dependent variable with 5 distance categories:

$$\ln\left(\frac{P(D_i > j)}{P(D_i \leq j)}\right) = \alpha_j + \beta_k' X_k, \quad \text{for } j = 0, 1, 2, 3. \tag{13}$$

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 than or equal to 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 1.

The central result confirms that first-born Adams are 45% more likely to locate in a higher distance category than only children. This result is highly significant, controlling for all the variables mentioned above, and is therefore very strong evidence in line with our theoretical predictions. Benjamins' location choices do not significantly differ from that of only children, and this is also in line with our theoretical results.

Our control variables are mostly not significant, except for marital status

Table 1: Ordinal logistic regression for 3 child types,
$n = 1709$ valid observations

Variables	β_k	Std.Err.	p-value	$\exp(\beta_k)$
Sex	0.057	0.093	0.539	1.059
Marital Status	0.326	0.114	0.004	1.386**
SES data missing	0.085	0.186	0.646	1.089
SES index below average	-0.471	0.114	0.000	0.625**
SES index above average	0.603	0.117	0.000	1.828**
Age Parents	-0.003	0.006	0.585	0.997
Marital Status Parents	0.061	0.106	0.562	1.063
Wealth Parents	-0.086	0.104	0.406	0.917
Grandchildren	-0.054	0.113	0.634	0.947
Health Parents Small Disab.	-0.081	0.098	0.409	0.922
Health Parents Large Disab.	0.099	0.129	0.445	1.104
Adams	0.372	0.109	0.001	1.451**
Benjamins	0.094	0.109	0.385	1.099
α_j	Coeff.	Std.Err.	p-value	
α_0	1.635	0.423	0.000	
α_1	0.831	0.421	0.048	
α_2	-0.289	0.420	0.491	
α_3	-1.795	0.423	0.000	
LR-test all slope coefficients = 0: $\chi^2 = 96.483$ (13 d.f.), p < 0.001				

The reference categories for non scaled variables are male, non-married, average SES, only child, married parents, poor parents, no grandchildren, no health problems. We denote significance at the 5% and 10% level with ** and *, respectively.

and socio-economic status. Married children locate further away compared to unmarried children. Moreover, it is more likely that a child locates further away if the socio-economic status is above average. Conversely, a socio-economic status below average is associated with lower geographical mobility.

Children's sex is known to be an important and highly significant explanatory variable for actual care giving. It is well-established that daughters give more help than sons (e.g., Jeffrey W. Dwyer and Raymond T. Coward (1991), and Nadine F. Marks (1996)). For the children's location decision, sex on its own seems not be a determinant. These two facts are not contradictory. Suppose daughters are more willing to provide care or have a comparative productivity advantage in providing care. As discussed in Section 4, when they make a strategic location choice, they may have an incentive to move even further away than sons to commit credibly to not being the provider of care, or they may be unable to use location choice to shift the burden of provision of care to their younger brother or sister, because they had to move away too far [i.e., $\delta_{crit} > \delta(K)$], or because their younger brother would provide too little care. Also, women participate less often in the labor force. Accordingly, their costs of moving are often smaller. When new families are founded, wives may move to their husbands more often than husbands to their wives, which increases the distance of female children.

To examine this possibly differential behavior of the various sex combinations of siblings, we estimate an ordinal logistic regression in which, instead of considering 3 types of children, we consider 9 types: only children (we do not differentiate with respect to their sex and use them as reference group), Adams who have a younger brother (Benjamin), Adams who have a younger sister (Betty), Alices with a younger brother (Benjamin), Alices who have a younger sister (Betty), and the complementary combinations for the younger siblings, Benjamin and Betty.

In Table 2 we report the results for this estimation: all A-siblings are

Table 2: Ordinal logistic regression for 9 child types,
$n = 1709$ valid observations

Variables	β_k	Std.Err.	p-value	$\exp(\beta_k)$
Marital Status	0.329	0.114	0.004	1.390**
SES data missing	0.093	0.186	0.618	1.097
SES index below average	-0.449	0.112	0.000	0.638**
SES index above average	0.630	0.118	0.000	1.877**
Age Parents	-0.003	0.006	0.627	0.997
Marital Status Parents	0.055	0.106	0.604	1.057
Wealth Parents	-0.092	0.104	0.379	0.913
Grandchildren	-0.066	0.113	0.560	0.936
Health Parents Small Disab.	-0.076	0.098	0.440	0.927
Health Parents Large Disab.	0.091	0.129	0.483	1.095
Adam of Adam-Benjamin	0.334	0.174	0.055	1.397*
Adam of Adam-Betty	0.322	0.164	0.049	1.380**
Alice of Alice-Betty	0.391	0.175	0.026	1.478**
Alice of Alice-Benjamin	0.446	0.159	0.005	1.562**
Benjamin of Adam-Benjamin	-0.190	0.177	0.282	0.827
Betty of Adam-Betty	0.196	0.164	0.231	1.217
Betty of Alice-Betty	0.239	0.175	0.173	1.270
Benjamin of Alice-Benjamin	0.112	0.162	0.490	1.119
α_j	Coeff.	Std.Err.	p-value	
α_0	1.641	0.421	0.000	
α_1	0.835	0.418	0.046	
α_2	-0.288	0.417	0.491	
α_3	-1.795	0.421	0.000	
LR-test all slope coefficients = 0: $\chi^2 = 101.026$ (18 d.f.), $p < 0.001$				

The reference categories for non scaled variables are male, non-married, average SES, only child, married parents, poor parents, no grandchildren, no health problems. We denote significance at the 5% and 10% level with ** and *, respectively.

more likely to locate further away than B-siblings or only children. Adam and Alice are both more likely to locate in a higher distance category than only children and the results are significant at the 5% level. Doing pairwise comparisons, daughthers move further away than sons. Consider Adam and Alice with a younger Benjamin: while Adam's probability of locating in a further distance category is 40% higher, for Alice it is 56%. For Adam and Alice with a female sibling, the values are 38% and 48%, respectively. However, these effects are small. Our main result regarding the older siblings' locating further away is confirmed when we analyze the effect of different sex combinations in more detail. We carried out several robustness tests that all confirmed the asymmetry in siblings' behavior as predicted by Proposition 1, according to which the child with the opportunity to commit first moves further away.[14]

6 Discussion

The results are in line with the predictions of the theoretical model. However, we would like to discuss a few possible complications and alternative explanations for the observed location pattern.

Reciprocity. We assume that care giving is a gift, motivated by altruism.

[14]First, we replaced the variable "Adam" by the variable "child who moved out first". The two variables are highly correlated. First movers were Adams in 79% of the cases and they move significantly further away than the child leaving the parents after his sibling. Second, we compared the behavior of Adams and Benjamins without including only children. Adams are more likely to move further away than Benjamins, and the effect is highly significant. Third, we considered possible interactions of the child type with the age difference of the siblings and with parental age. A large age difference between the siblings increases the asymmetry between Adams and Benjamins. Regarding parental age, Adams are again significantly more likely to move further away than Benjamins, and Adams of older parents move slightly further away than Adams of younger parents.

However, in some families, care giving may instead be the outcome of reciprocity.[15] In case of reciprocity, anticipated money transfers and mutually beneficial exchange between parents and their children could induce children to locate closer to the parents. But reciprocity does not explain why the first-born child behaves systematically differently from his or her sibling.

Efficient negotiations. Suppose that Adams and Benjamins negotiate efficiently before they make their location choices and write a complete contract about care giving and side payments in the far future that takes into account all contingencies. This is a theoretical possibility, and may also explain asymmetric location choices of siblings. However, this cannot explain why there is a significant bias for Adams being more likely to locate far away more frequently than Benjamins. Also, this bias cannot be attributed to different family roles of Adams and Benjamins, with Adams receiving a better education than Benjamins, because our estimation controls for factors like education and income with the SES-variable.

Parents-in-law. Our theoretical model and the estimations do not take into account the fact that the actual strategic situation of children is sometimes more complex, because a child's possible marriage generates additional care problems with respect to the child's parents-in-law and strategic interaction between them and their brothers or sisters-in-law has to be considered. On theoretical grounds, a large variety of somewhat similar complex strategic situations had to be considered. We expect, however, that the basic qualitative result, according to which Adams typically have a strategic incentive to move away, survives. The future in-law family ties are typically undetermined at the stage when children make their location choice. Hence, they

[15] This idea has a long tradition in sociology. See, e.g., Alvin W. Gouldner (1960). For a detailed account on reciprocity see Künemund and Rein (1999). Soldo and Hill (1993) report in their survey that there is little evidence for reciprocity as the motivating force in the transfers between parents and children.

would not affect the location choices in a systematic way.[16]

Instilled preferences. The number of children and parents' investment behavior in terms of monetary transfers or instilling altruistic preferences may be co-determined by parents' preferences for children. In order to control for this, our empirical analysis concentrates on the differences between siblings in families with two children, not the differences between only children and children in families with more than one child. Of course, one cannot rule out that Adams simply are instilled with preferences to move further away than their younger brother. Note, however, that the differential location pattern of Adams and Benjamins cannot be attributed to observable differences in, e.g., education received, as we control for such effects.

Social norms. The empirical result according to which the first- born child has a higher probability of moving further away could also be explained as a result of compliance with social norms. In former times, some societies had developed strong norms about the roles of children in taking care of the elderly parents. For instance, in Japan, it was customary for the parents to live with the oldest son (see, e.g., Wataru Koyano et al. 1994). Such norms may have been important to overcoming inefficiencies that are generated by the strategic considerations of location choice. To our knowledge, no such general social norm exists in present Germany.

Strategic bequests. Finally we contrast our model and empirical results with the model of strategic bequests. In the strategic bequests model of Bernheim et al. (1985), parents design a contest for their children. They make the bequest dependent on children's relative attention. The children's 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

[16]Of course, it would be nice to confirm this hypothesis, but, as discussed by Wolf (1994, p. 155), there are almost no data available about family networks including the effects of marriage and resulting parents, brothers, and sisters-in-law.

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 (see, e.g., Shmuel Nitzan 1994). Accordingly, in the strategic bequest model each child has a strategic incentive to locate as close as possible to the parents. Therefore, consideration of the residence choice in the strategic bequest model would not explain the asymmetric behavior of siblings. Also, we expect that the strategic bequest motive is stronger if parents are rich. This would explain if children locate closer to their parents if their parents are rich. For Germany there is no such effect.

However, we cannot discriminate against the strategic bequests model. First, only a subgroup of families may engage in a strategic bequests game, whereas another group may play the strategic location game considered here. Second, the strategic bequests story becomes more complex if the set of parents' strategies is more sophisticated. For instance, parents could correct the contest between their children and handicap the child that has a location advantage. Also, the issue of collusion between siblings and the role of distance choice for the possibility of collusion makes considerations more involved. Third, higher income and social status is usually associated with higher mobility. The resulting increase in distance might - on an aggregate level - outweigh a possible proximity effect resulting from strategic bequests. But none of these cases could explain the asymmetry between Adams and Benjamins which we found in our data.

7 Conclusions

Much work has been done on the determinants of intergenerational transfers. Our analysis does not contribute to this literature by identifying new or different determinants, but we build on the work that has shown that there is a close relationship between in-kind transfers from children to parents and the distance between them. We focus on the role of location decisions as a strategic commitment instrument.

In a theoretical analysis we showed that location choice has a strategic commitment value if it is made before actual care giving occurs. The analysis predicts some structural properties of the equilibrium location choices by the children and their parents that yields a 'geography of the family'. Several location patterns are possible, but one main pattern in families with two children emerges. For this pattern, the older child Adam locates in some distance from his or her parents, essentially forcing the younger child Benjamin into staying with the parents and providing the major share of care giving.

We then turned to the question whether individuals are sufficiently far sighted and rational to make such strategic location choices. We test our theoretical predictions with a set of data on elderly households. Our major finding shows that, controlling for all socio-economic variables available, Adams are more likely to locate further away from parents than Benjamins. This finding proves to be very robust. We consider this asymmetric behavior of siblings as evidence that is in line with the theoretical results, suggesting that a significant share of siblings indeed acts far-sightedly and strategically when making location choices.

8 Appendix

Proof of Lemma 1. At STAGE 4, a, b and p, and the implied distances $\delta_A = \delta(a, p)$ and $\delta_B = \delta(b, p)$ and $\hat{\delta} \equiv \min\{\delta_A, \delta_B\}$ are given. For a given contribution g_j of $j \neq i$, child i's optimization problem is to maximize (4) subject to (2), (3) and to $g_i \geq 0$. Solving this problem yields the reaction function of child i as

$$g_i = \max\{0, \gamma(\delta_i) - g_j\} \tag{A1}$$

for $g_j \geq 0$, for $i, j \in \{A, B\}$ and $i \neq j$, with $\gamma(\delta_i)$ determined by the first order condition (6). This proves Lemma 1 and characterizes the STAGE-4 contribution equilibrium. $\hat{\delta}$ and condition (6) uniquely determine aggregate contributions G. By (A1) the child which is located closer to the parents contributes this full amount G and if both children locate at the same distance, any (g_A, g_B) with $g_A + g_B = \gamma(\hat{\delta})$ and $g_A = \alpha\gamma(\hat{\delta})$ and $g_B = (1-\alpha)\gamma(\hat{\delta})$ with $0 \leq \alpha \leq 1$ is an equilibrium. Note that, in this case of indifference, the share $\alpha \in [0, 1]$ which is contributed by A may be a function $\alpha(a, b, p)$ of a, b, and p. □

Proof of Proposition 1. Before we proceed with the proof, we discuss and denote three tie-breaking rules. First, A's share $\alpha(a, b, p)$ of aggregate contributions if $\delta_A = \delta_B$ at STAGE 4 has already been discussed in Lemma 1. Two further tie-breaking rules are important at STAGE 3. Parents have to choose whether they move (to one of their children) if they are indifferent between moving or not, that is, if $\min\{\delta(a, 0), \delta(b, 0)\} = \delta(K)$. The probability of moving in case of indifference is denoted π_m and can generally be a function $\pi_m(a, b)$ of children's locations. If parents move, they move to $p = a$ or to $p = b$, because this maximizes the amount of care received. Finally, also at STAGE 3, if parents move and if $a \neq b$ they have to choose between a and b. We denote π_A and π_B the conditional probabilities for moving to a or b, respectively. In general, these probabilities can be functions $\pi_A(a, b)$ and

$\pi_B(a,b)$ of a and b.

We note the following properties:

Property 1: The payoff for a child in the equilibrium cannot exceed $U_{\max} \equiv u(\gamma(0)) + m$.

To confirm property 1, note that $U_{\max}$ is obtained by a child if it contributes nothing, and if the other child is located next to the parents and contributes the whole equilibrium amount $\gamma(0)$ that is associated with this distance. Property 1 implies

Property 2: Any choice a that yields A a payoff equal to $U_{\max}$ in the subgame equilibrium of STAGES 2-4 *is an equilibrium choice for A.*

Property 3: If A chooses some a with $\delta(a,0) \in (\delta_{crit}, \delta(K))$, the subgame perfect equilibrium of STAGES 2-4 *has $b = 0$, $p = 0$ and $g_B = \gamma(0) = G$.*

To confirm Property 3, note that $p = 0$, regardless of b, because $\delta(a,0) < \delta(K)$. B's payoff is

$$\Theta_B = \begin{cases} u(\gamma(\delta(b,0))) + m - \gamma(\delta(b,0))(1+\delta(b,0)) & \text{if } \delta(b,0) < \delta(a,0) \\ u(\gamma(\delta(b,0))) + m - (1-\alpha)\gamma(\delta(b,0))(1+\delta(b,0)) & \text{if } \delta(b,0) = \delta(a,0) \\ u(\gamma(\delta(a,0))) + m & \text{if } \delta(b,0) > \delta(a,0) \end{cases} \tag{A2}$$

By $\delta(a,0) > \delta_{crit}$ and the definition of δ_{crit} in (8), this payoff has a unique maximum at $b = 0$. Hence, A's payoff is $u(\gamma(0)) + m = U_{\max}$.

The proof of part (i) proceeds now in steps (I)-(V).

(I) Any a with $0 < \delta(a,0) < \delta_{crit}$ is not an equilibrium choice. By properties 2 and 3, a can be an equilibrium location only if it yields payoff $U_{\max}$ to A, because A can obtain $U_{\max}$ by locating at some a with $\delta(a,0) \in (\delta_{crit}, \delta(K))$. Let $\delta(a,0) < \delta_{crit}$ instead. Parents do not move, given $\delta(a,0) < \delta(K)$. Hence, the only location for B that yields $U_{\max}$ to A is $b = 0$ if $\delta(a,0) \in (0, \delta_{crit})$, or $b = 0$ if $a = 0$ and $\alpha(0,0,0) = 1$. However, $b = 0$ is suboptimal for B if $\delta(a,0) \in (0, \delta_{crit})$, and also if $a = 0$ and $\alpha(0,0,0) = 1$, as B's payoff at $b = 0$ is equal to $u(\gamma(0)) + m - \gamma(0)$ in these cases, and, by

$\delta(a,0) < \delta_{crit}$, this payoff is smaller than the payoff which B can achieve by, for instance, a choice of b with $\delta(b,0) > \delta(a,0)$.

(II) Properties 2 and 3 imply that all a with $\delta(a,0) \in (\delta_{crit}, \delta(K))$ are equilibrium location choices for A.

(III) A location a with $\delta(a,0) = \delta_{crit}$ is an equilibrium choice for A, for instance if $\alpha = 0$. Parents do not move if $\delta(a,0) = \delta_{crit} < \delta(K)$, regardless of B's choice of b. By the definition of δ_{crit}, B is indifferent between $b = 0$ [implying a payoff to B equal to $u(\gamma(0)) + m - \gamma(0)$] and any b with $\delta(b,0) > \delta(a,0)$ [implying a payoff to B equal to $u(\gamma(\delta_{crit})) + m$], and B prefers these choices to all other location choices. If B chooses $b = 0$ given this indifference, then A receives $U_{\max}$, and hence, a with $\delta(a,0) = \delta_{crit}$ is an equilibrium location.

(IV) A location a with $\delta(a,0) = \delta(K)$ is an equilibrium choice for A, for instance if $\pi_m = 0$, because for this tie-breaking rule the proof of property 3 above extends to $\delta(a,0) = \delta(K)$.

(V) Finally, (a,b,p) with $\delta(a,0) > \delta(K), b = 0$ and $p = 0$ is an equilibrium location choice if, for instance, $\alpha = 0$ and $\pi_B = 1$. To see this, note that B can choose $b = 0$. Parents do not move in this case, A obtains a payoff equal to $U_{\max}$, and B obtains a payoff equal to $u(\gamma(0)) + m - \gamma(0)$. Any other choice b for which parents do not move has a lower payoff equal to $u(\gamma(\delta(b,0))) + m - \gamma(\delta(b,0))(1 + \delta(b,0))$ for B. A choice b for which parents move makes them move to b, by $\pi_B = 1$. B will make contributions $g_B = \gamma(0)$ also in this case and end up with the same payoff as for $b = 0$. Note that $\alpha = 0$ is needed to make this (a,b,p) an equilibrium here, because B could choose $b = a$, and for a to be optimal for A it is necessary that B then still bears the full contribution cost. This completes the proof of part *(i)* in Proposition 1.

Consider now part (ii) of Proposition 1.

Let $0 < \alpha < 1$ and $0 < \pi_B < 1$. Properties 2 and 3 imply that all (a,b,p)

with $\delta(a,0) \in (\delta_{crit}, \delta(K))$, $b = 0$ and $p = 0$ are equilibrium location choices, as this property was independent of any tie-breaking rule, and that $\delta(a,0) \in (\delta_{crit}, \delta(K))$ implies $b = 0$ and $p = 0$ in the subgame perfect equilibrium.

We already showed that any a with $\delta(a,0) < \delta_{crit}$ is not an equilibrium choice even if there is no restriction as regards tie-breaking rules. It remains to show (I) that a with $\delta(a,0) = \delta_{crit}$ is an equilibrium location choice and has $b = 0$ and $p = 0$ as unique subgame perfect location choices, (II) that a with $\delta(a,0) = \delta(K)$ is an equilibrium location and has $b = 0$ and $p = 0$ as unique subgame perfect location choices, and (III) that all a with $\delta(a,0) > \delta(K)$ are no longer equilibrium location choices if $0 < \alpha < 1$ and $0 < \pi_B < 1$.

(I) Let $\delta(a,0) = \delta_{crit} < \delta(K)$. Given such an a and regardless of b, parents do not move. Hence, A achieves $U_{\max}$ if and only if $b = 0$. B's payoff as a function of b is given by (A2). Hence, $b = 0$ is the unique location choice that maximizes B's payoff for $\delta(a,0) = \delta_{crit}$ if $\alpha < 1$.

(II) Let $\delta(a,0) = \delta(K)$. The triples of locations (a,b,p) with $\delta(a,0) = \delta(K)$, $b = 0$ and $p = 0$ describes an equilibrium of location choices. To see this we first note that these locations yield maximum utility $U_{\max}$ for A (hence, is optimal for A) and that this choice of a is compatible with $p = 0$ regardless of B's location choice. Further, given that parents do not move, B's payoff is again described by (A2) and $b = 0$ maximizes B's payoff (A2) given this a and anticipated $p = 0$. Note also that (a,b,p) with $\delta(a,0) = \delta(K)$ and $b \neq 0$ is not an equilibrium if $0 < \alpha < 1$ and $\pi_B < 1$. For this combination of locations to be an equilibrium, it must yield $U_{\max}$ to A. This requires that parents must move to B (i.e., $p = b$) with probability 1 and that B contributes $G = g_B = \gamma(0)$. However, by $\pi_B < 1$, if parents move, the probability that they move to b is less than 1 if $b \neq a$. If $b = a$, and if parents move to this location, $0 < \alpha < 1$ rules out that B is the sole contributor in this case. Hence, A's payoff would be smaller than $U_{\max}$.

(III) We have to show that the restrictions on the tie-breaking rules eliminate a with $\delta(a,0) > \delta(K)$ as equilibrium locations. Suppose such a location is an equilibrium location for A. Then the equilibrium must yield $U_{\max}$ to A, by property 2. This is the case only if $b = 0$, or if parents move to B (i.e., $p = b$) with probability 1 and B contributes $G = g_B = \gamma(0)$ with probability 1. However, $b = 0$ is not an equilibrium choice for B given $\delta(a,0) > \delta(K)$ and $0 < \alpha < 1$, because, for instance, $b = a$ yields higher payoff to B. $\square$

Proof of Proposition 2. We show: (I) Any a with $\delta(a,0) < \delta(K)$ cannot be an equilibrium location choice for A in a subgame perfect equilibrium. (II) Any a with $\delta(a,0) \geq \delta(K)$ can be an equilibrium location choice, and this equilibrium choice implies b with $\delta(b,0) \geq \delta(K)$.

(I) A choice a with $\delta(a,0) < \delta(K)$ yields payoff equal to $u(\gamma(\delta(a,0)))+m-\gamma(\delta(a,0))(1+\delta(a,0))$ in the resulting subgame perfect equilibrium, because B will maximize its payoff for such a's by some b with $\delta(b,0) > \delta(a,0)$, anticipating that parents will choose $p = 0$ for such a's and A becomes the sole contributor. For $0 < \alpha < 1$ and $0 < \pi_B < 1$, this payoff is lower than A's payoff from any choice a with $\delta(a,0) > \delta(K)$, which yields at least payoff $u(\gamma(0)) + m - \eta\gamma(0)$ to A, for some η with $\eta < 1$.

(II) Consider now choices a with $\delta(a,0) > \delta(K)$. B would not choose some b with $\delta(b,0) < \delta(K)$. This can be seen as follows. Suppose B chooses some b with $\delta(b,0) < \delta(K)$. Parents do not move given b, and B's payoff in this location would be $u(\gamma(\delta(b,0))) + m - \gamma(\delta(b,0))(1+\delta(b,0)) \leq u(\gamma(0)) + m - \gamma(0)$. B could achieve at most the right-hand side utility, by choosing $b = 0$. However, $b = 0$ is also suboptimal for B, because any choice with $\delta(b,0) > \delta(K)$ yields even higher utility $u(\gamma(0)) + m - \beta\gamma(0)$, with some $\beta(a,b,p)$ for which $\beta < 1$ by $0 < \alpha < 1$ and $0 < \pi_B < 1$.

Finally, any pair (a,b) with $\delta(a,0) > \delta(K)$ and $\delta(b,0) > \delta(K)$ can be a pair of equilibrium location choices for appropriate tie-breaking rules. For instance, if $\pi_B = \pi_A = 1/2$ for all such (a,b) with $a \neq b$, and with $\alpha \equiv 1/2$, B is indifferent as to where to locate for all b with $\delta(b,0) > \delta(K)$ for any given choice of a with $\delta(a,0) > \delta(K)$. Also A's payoff is the same for all choices a with $\delta(b,0) > \delta(K)$ and does not depend on b's location choice. Both children have expected equilibrium payoff equal to $u(\gamma(0)) + m - \frac{1}{2}\gamma(0)$.

The proof extends to location choices with $\delta(a,0) = \delta(K)$ and $\delta(b,0) = \delta(K)$, for instance, for $\pi_m = 1$. (Note that $\pi_m = 1$ is compatible with $0 < \pi_B < 1$, because π_B is the probability that parents move to b, *if* they move.) $\square$

Proof of Proposition 3. Consider an equilibrium location choice (a, b) from Proposition 1. For any of these equilibrium choices by a, the optimal reaction of B and of the parents can establish a subgame perfect equilibrium in which A receives the maximum possible payoff $U_{\max}$. This implies that any of these choices a made by A are also optimal for A if made simultaneously with B's choice of b. This completes the proof. $\square$

Proof of Proposition 4. The outcome in the contribution game in stage 4 is already characterized in the main text. As Γ is a decreasing function of $\hat{\delta}$, the location decision of parents in stage 3 depends on the minimum distance $\min\{\delta_A, \delta_B\}$ and on the critical distance $\Delta(K)$ as defined by (12).

Consider now stage 3. For a given choice $\delta_A < \Delta(K)$ by A, B's payoff as a function of A's and B's location choices and the resulting location choice $p = 0$ by parents is

$$U_B = \begin{cases} u(\Gamma(\delta_B)) + m - \frac{1}{2}(1+\delta_B)(\Gamma(\delta_B) + \gamma(\delta_B)), & \text{if } \delta_B > \delta_A \\ u(\Gamma(\delta_B)) + m - (1-\alpha)\gamma(\delta_B) - \frac{1}{2}(1+\delta_B)(\Gamma(\delta_B) - \gamma(\delta_B)), & \\ & \text{if } \delta_B = \delta_A \\ u(\Gamma(\delta_A)) + m - \frac{1}{2}(1+\delta_A)(\Gamma(\delta_A) - \gamma(\delta_A)), & \text{if } \delta_B < \delta_A \end{cases} \tag{A3}$$

The choice $\delta_A = \delta_B$ for B is dominated by a slightly larger distance $\delta_B > \delta_A$. Among all choices $\delta_B < \delta_A$, B prefers $\delta_B = 0$ by $U^c(0) = \max\{U^c(\delta)\}$. All choices $\delta_B > \delta_A$ yield the identical payoff $u(\Gamma(\delta_A)) + m - \frac{1}{2}(1+\delta_A)(\Gamma(\delta_A) - \gamma(\delta_A))$. Accordingly, B chooses $\delta_B = 0$ if $\delta_A > \Delta_{crit}$, B chooses some $\delta_B > \delta_A$

if $\delta_A < \Delta_{crit}$, and, given the tie-breaking rules, B chooses $\delta_B = 0$ or some $\delta_B > \delta_A$ if $\delta_A = \Delta_{crit}$.

For $\delta_A > \Delta(K)$, and the assumed tie-breaking rules on π_B and α, B's payoff is maximal for some choice $\delta_B > \Delta(K)$, and this yields a positive probability that the parents move to them, for each of the children. For $\delta_A = \Delta(K)$, and the tie-breaking rules on π_B and α, the payoff-maximizing choice of B depends on the parents' choice given that they are indifferent between moving or not moving. If we assume that parents do not move in this case, then B prefers $\delta_B = 0$. This will be important for including $\delta_A = \Delta(K)$ in the set of equilibrium choices.

We turn to stage 1. A's maximum payoff among all choices for (a, b, p) is $u(\Gamma(0)) + m - \frac{1}{2}(\Gamma(0) - \gamma(0))$. This maximum payoff is reached if A can induce B to choose $\delta_B = 0$ and let B make all contributions. Also, for the tie-breaking rules on π_B and α, this maximum payoff is obtained only if B chooses $\delta_B = 0$ and B makes all contributions. To confirm this we note that $u(\Gamma(\delta_B)) + m - \frac{1}{2}(\Gamma(\delta_B) - \gamma(\delta_B))(1 + \delta_B)$ is the utility that A obtains if $\delta_A > \delta_B$, that this utility is strictly decreasing in δ (which can be shown by using $u''(G) < 0$, $2u'(\Gamma) = 1 + \delta$, $u'(\gamma) = 1 + \delta$, and the total differentials of these conditions). Further, A's utility is strictly lower if $\delta_A \leq \delta_B$. Note that the corners of the interval $[\Delta_{crit}, \Delta(K)]$ are also possible equilibrium choices for A, because $(\delta(a, 0), \delta(b, 0), p) = (\Delta_{crit}, 0, 0)$ and $(\delta(a, 0), \delta(b, 0), p) = (\Delta(K), 0, 0)$ are also equilibria. To support the left corner of the interval as an equilibrium, we need to assume that B chooses 0 with certainty if B is indifferent between staying or moving, and to support the right corner of the interval, we need to assume that parents do not move if they are indifferent between moving or not moving. Finally, we note that any other choice a does not (or not with probability 1) lead to $\delta_B = 0$ and $p = 0$. Hence, A would not achieve the maximum payoff. $\square$

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