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ABSTRACT

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Studies have shown that the older sibling often chooses to live away from his elderly parents intending to free ride on the care provided by the younger child. In the presented model, we incorporate income effects and depict a different pattern frequently observed in Eastern countries; that is, the older sibling lives near his or her parents and takes care of them in old age. By generalizing the existing model, we show three cases of elderly parents being looked after by (1) the older sibling, (2) the younger sibling, and (3) both siblings, depending on the relative magnitude of the income effect and the strategic incentive for one sibling to free ride on the other. Our study also investigates the effect of changes in relative income on the level of total care received by parents.

JEL Classification: H41, J17

Keywords: location choice, income effect, sibling, elderly care arrangement

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1 Introduction

A certain man had two sons. The younger of them said to his father, "Father, give me my share of your property."[1] *He divided his livelihood between them. Not many days after, the younger son gathered all of this together and traveled into a far country (Luke, 15:11-13).*

Taking care of elderly parents has long been an important role in the family institution. Indeed, informal care by adult children is prevalent even in the developed world where social security and the residential care market are well established. According to the OECD (2005), 80% of informal care is provided by family and friends in the OECD countries, with the care provided by children differing by nation: 24% in Australia, 28% in Germany, 48% in Ireland, 60% in Japan, 55% in Korea, 38% in Spain, 46% in Sweden, 43% in the United Kingdom, and 41% in the United States. Deciding who cares for elderly parents is a major practical issue, especially in case of smaller number of siblings, because then each child has to share a larger part of the financial burden. For instance, according to Agingcare.com estimates, 34 million Americans personally provide care for their older family members, and of these, 34% spend $300 or more of their own money every month and 54% sacrifice spending money on themselves to take care of their parents. Moreover, the identity of the primary caregiver of elderly parents is of interest from an economic point of view, because caring for parents is a public good as long as the caregivers are altruistic toward their parents. Thus, voluntary caregiving by children will undersupply the care for parents who have a significant free-rider problem.

The primary caregiver of a family differs between Western and Eastern countries. While studies on Western countries show that it is typically the younger son (Konrad et al., 2002; Fontaine et al., 2009), the oldest son more frequently takes on this responsibility in Eastern countries (McLaughlin and Braun, 1998; Liu and Kendig, 2000). To examine this difference, the pioneering work of Konrad et al. (2002) considers the case of private provision of parents' care by two children in a game-theoretic model where the children's location affects the cost of visiting their parents. This study shows that the first-born child uses his first-mover advantage and chooses a location sufficiently far away from his parents and free rides on his altruistic younger brother.[2] However, they suggest that this finding can change depending on the parents' bequest decisions, as originally proposed by Bernheim et al. (1985).[3] In this vein, recent studies have theoretically shown that siblings compete for the bequest they expect to receive from parents (Chang and Weisman, 2005; Faith et al., 2008); however, the causality of the strategic bequest motive remains inconclusive (Sloan et al., 1997; Perozek, 1998; Pezzin and Schone, 1999; Sloan et al., 2002; Wakabayashi and Horioka, 2009; Johar et al., 2015).[4]

Unlike the strategic motive mentioned above, this study offers new insight into the caregiving behavior of siblings, focusing on the effect of income gap between two siblings on their location choice and caregiving decisions, which the quasi-linear utility function of Konrad et al. (2002) overlooked. Although location has been shown to affect decisions on caring for parents, the economic circumstances of siblings might also influence their location decisions and thereby their ability to care for their elderly parents. In Konrad

[1] At that time, he knew that he was supposed to receive only half of what the older sibling would do (Deuteronomy 21:17).

[2] In a recent article, Maruyama and Johar (2016) quantify Konrad et al.'s model, to find a moderate altruism and cooperation between siblings in the United States. Extending Konrad et al.'s model, Kureishi and Wakabayashi (2010) show that the first-born child tends to live with his parents in return for having received childcare assistance from his parents. Pezzin et al. (2015) also give an interesting example where the distance from parents affects the care arrangement. They present a model in which every child avoids to live with his or her parents since they know that once they decide to live with their parents, they would have to take the entire responsibility of caregiving.

[3] Other possible explanations for caregiving by first-born child include Cox's (1987) exchange model and Chu's (1991) dynasty model.

[4] For an excellent survey on intergenerational transfer from children to parents, see Maruyama and Nakamura (2012).

et al. (2002) model, the older son always uses his position to take up a first-mover advantage. However, the first-mover advantage depends on the income difference between the siblings because the older son cannot free ride on the younger son who has no income to spend on caring for parents. The income gap between siblings affects the first-mover advantage, and hence, the older son may have to serve as primary caregiver. We therefore extend and generalize Konrad et al.'s (2002) model by incorporating the role of income differential between two siblings. Specifically, we consider the income effect because the level of the public good of caregiving depends on not only the marginal cost of caregiving provision (i.e., distance from parents) but also the relative income of the siblings. In particular, income in our model is defined in a broad sense and includes fixed wealth such as land.[5] Until relatively recently, the eldest son took priority in inheriting the family estate even in developed countries. For instance, until 1947, the eldest son had the right to all family assets in Japan; furthermore, the eldest son was given a special status in Korea under the householder system until implementation of the legal reforms in 2005. Thus, if the siblings recognize a significant income gap between them, it could affect the equilibrium characteristics in their strategic interactions.

After incorporation of the income effect, our generalized model classifies three cases of caregiving: by (i) only the older brother, (ii) only the younger brother, and (iii) both siblings. In particular, we find that the older brother cares for his parents when his income is sufficiently larger than his younger brother's income, concurring with the existing evidence of positive relationship between the elder brother's caregiving and his expected bequest. Our model interprets this relationship as simply an income effect, because the bequest decision can influence the relative sibling income to a large degree.

The remainder of this paper is structured as follows. In section 2, we present the model used. Sections 3 and 4 discuss the results of siblings' location choice and provision of caregiving as a public good. Section 5 discusses the changes in overall care following a change in aggregate income of all siblings. The model is also extended to a cooperative provision of care for parents and fixed location of parents. Section 6 concludes the paper.

2 Basic Model

In line with Konrad et al. (2002), we consider the location choice and care provision of adult children who are altruistic toward their elderly parent(s). Our study excludes the gender issue to clarify our contribution and consider the problem of male siblings only.[6] Consider a family consisting of parents, a first-born child ($i = 1$), and a second-born child ($i = 2$). The utility function of child i is defined as

$$U_i = x_i^{\alpha} G^{1-\alpha}, \tag{1}$$

where x_i is the private consumption of child i and G is the total amount of care the parents receive from both children. Here, $1 - \alpha$ represents the magnitude of altruism: $\alpha = 1$ if the child displays no altruistic behavior, and $\alpha = 0$ if the child has extremely strong concern about his parents and no interest in private consumption. We thus assume that the care received by parents is the sum of the care provided by both children (overall care hereafter): $G = g_1 + g_2$, where g_i is the care provided by child i. Following Konrad et al. (2002), we assume that g_i denotes the number of visits by child i; thus, G is the total number of visits the parents receive.

[5] In studies such as Byrne et al. (2009) and Antman (2012), the monetary and opportunity costs of caring time are distinguished by considering formal and informal care.

[6] If we allow for both male and female siblings, our results could change by the additional effects of different productivity in domestic work, including caregiving, or different opportunity cost due to gender wage gap. Some empirical studies explore the children's gender difference effects on care arrangement.

Children and parents choose their place of residence. The location space of the economy is given by $\theta \in [0, 1]$. We denote t_i and p as the location point of child i and the parents, respectively. Figure 1 shows one of the location patterns for better understanding of the notation.

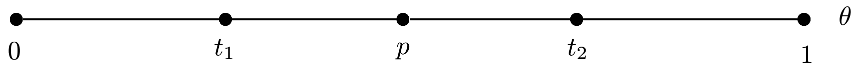

Figure 1. Location space

The budget constraint of child i is given by

$$y_i = x_i + (1 + T_i)g_i, \tag{2}$$

where y_i represents income and $T_i \equiv |t_i - p|$ denotes the spatial distance of child i's location from the parents. In (2), $1 + T_i$ denotes the marginal cost of visit by child i for caring the parents. Following Konrad et al. (2002), we here assume that it consists of two components; (i) a unit contribution of g_i eats up his endowment by one unit and (ii) the transportation cost is incurred in the contribution. The former is constant for all children regardless of their location, but the latter depends on the distance between child's and parents' location. Our model reduces to the standard model of privately provided public goods when $T_i = 0$ for all i, but it is not necessarily so since the parents and children choose their location strategically. While y_i is an exogenous variable, t_i is chosen by each child: $T_i = |t_i - p| = 0$ if he decides to live with his parents, and $T_i = |t_i - p| = 1$ when he chooses to live as far away from his parents as possible. Here, y_i does not depend on the location, which can be justified by assuming that the labor market is fully integrated and therefore wage income does not depend on the location. To focus on the outcome when the two children differ in timing of their decision as well as in their income, we rule out any gender-related differences between the children.

Following a standard sequential-move decision-making, the timings of the game are as follows:

1. Child 1 chooses location t_1,
2. Child 2 chooses location t_2,
3. The parents choose location p,
4. Both children decide on their level of care (g_1, g_2) simultaneously.

The outcome of this game can be obtained as a sub-game perfect Nash equilibrium. Thus, we apply backward induction and solve the problem from the final stage.

From (1) and (2) and the premise of interior solution, the reaction function in stage four of the game can be obtained as follows:

$$g_i = \frac{(1-\alpha)y_i}{1+T_i} - \alpha g_j, \quad i \neq j. \tag{3}$$

To clarify our main message, we simply assume that $\alpha = 1/2$ in the following analysis. We also assume that $y_1 = y$ and $y_2 = \beta y$ to capture the income gap between the siblings by parameter $\beta \geq 0$, meaning that child 1's income is higher than child 2's income if $\beta < 1$, and vice versa if $\beta > 1$.

3 Equilibrium

Since the model contains corner solutions, we derive the equilibrium by classifying the outcomes into three cases: (i) both children care for their parents, $g_1 > 0, g_2 > 0$; (ii) child 1 cares for his parents while child 2 free rides, $g_1 > 0, g_2 = 0$; and (iii) child 2 cares for his parents while child 1 free rides, $g_1 = 0, g_2 > 0$.

3.1 Both children care for their parents

We first analyze case (i). From (3) for $i = 1, 2$, the conditions leading to case (i)'s equilibrium are given as follows:

$$\frac{1+T_2}{2(1+T_1)} < \beta < \frac{2(1+T_2)}{1+T_1}. \tag{4}$$

Stage 4. If (4) holds, child i chooses the level of g_i as follows:

$$g_1 = \frac{2(1+T_2) - \beta(1+T_1)}{3(1+T_1)(1+T_2)} y \text{ and } g_2 = \frac{2\beta(1+T_1) - (1+T_2)}{3(1+T_1)(1+T_2)} y. \tag{5}$$

From (5), we have

$$g_1 \gtreqless g_2 \leftrightarrow \frac{1+T_2}{1+T_1} \gtreqless \beta,$$

implying that the smaller the distance from the parents and higher his income, the more likely it is for the child to provide a higher level of care. From (5), the total care provided by both children is

$$G = \frac{(1+T_1)\beta + (1+T_2)}{3\,(1+T_2)\,(1+T_1)} y. \tag{6}$$

Stage 3. Parents seek to maximize the total care they receive from their children. The maximization of (6) with respect to $p \in [t_1, t_2]$ gives[7]

$$\begin{aligned}
\frac{\partial G}{\partial p} &= -\frac{y_2\,(T_1+1)^2\,T_{2p} + y_1\,(T_2+1)^2\,T_{1p}}{3\,(T_1+1)^2\,(T_2+1)^2}, \\
\frac{\partial^2 G}{\partial p^2} &= \frac{2}{3}\frac{y_1\,(T_2+1)^3 + y_2\,(T_1+1)^3}{(T_1+1)^3\,(T_2+1)^3} > 0,
\end{aligned}$$

where $T_{ip} = \partial T_i / \partial p$. These equations suggest that parents choose either $p = t_1$ or $p = t_2$. To find the location of parents, we use (6) and compare the total care the parents receive from their children when $p = t_1$ and $p = t_2$:

$$G(p = t_1) - G_2(p = t_2) = \frac{y\,(1-\beta)\,|t_2 - t_1|}{3(1 + |t_2 - t_1|)},$$

suggesting that the parents live with the son having higher income:

[7] We exclude $p > t_i > t_k$ and $p < t_i < t_k$ $(i, k = 1, 2)$, which are inconsistent with the utility maximization by parents.

$$
\begin{aligned}
p &= t_1 && \text{if } \beta < 1 \\
p &= t_1 \text{ or } t_2 && \text{if } \beta = 1 \\
p &= t_2 && \text{if } \beta > 1
\end{aligned} \tag{7}
$$

The parents' choice of location is quite natural because they expect the son with higher income to provide better care.

Stage 2. The younger son (child 2) chooses his location to maximize his utility. Since the parents' location, given by (7), depends on the relative income of the siblings, we investigate the location choice of children as follows:

(a) *When child 1's income is higher than child 2's income ($\beta < 1$).*

From (7), $p = t_1$. Defining $\tau_2 \equiv |t_2 - t_1|$, the budget constraint of child 2 can be given by $y_2 = x_2 + (1+\tau_2)g_2$, where $g_2 = [2\beta - (1+\tau_2)]y/3(1+\tau_2)$. By substituting this equation into (1), we have the utility of child 2 in the second stage as follows:

$$
U_2 = \frac{(1+\beta+\tau_2\beta)^2}{9(1+\tau_2)}y^2.
$$

From the maximization of U_2, given t_1, we have

$$
\frac{\partial U_2}{\partial \tau_2} = \frac{\tau_2(\tau_2+2)(1+\beta)(1-\beta)}{9(\tau_2+1)^2}y^2 > 0, \tag{8}
$$

Since $\beta < 1$, (8) implies that child 2 lives as far away from his brother as possible. Depending on t_1, child 2 chooses either $t_2 = 0$ or $t_2 = 1$.

To find the location of child 2, we need to derive the utility of child 2 when he lives at the corner point:

$$
U_2(t_2 = 0) = \frac{(1+t_1+\beta)^2}{9(1+t_1)}y^2 \text{ and } U_2(t_2 = 1) = \frac{(2-t_1+\beta)^2}{9(1+(1-t_1))}y^2,
$$

giving

$$
U_2(t_2 = 0) - U_2(t_2 = 1) = \frac{(2t_1-1)}{9}\frac{(t_1+1)(2-t_1)-\beta^2}{(t_1+1)(2-t_1)}y^2. \tag{9}
$$

Since $\beta < 1$ and $t_1 \in [0,1]$, $(t_1+1)(2-t_1) - \beta^2 > 0$. Thus, from (9), the response function of child 2 is

$$
\begin{aligned}
t_2 &= 0 && \text{if } t_1 > 0.5, \\
t_2 &= 0 \text{ or } 1 && \text{if } t_1 = 0.5, \\
t_2 &= 1 && \text{if } t_1 < 0.5.
\end{aligned} \tag{10}
$$

(b) *When child 2's income is higher than child 1's income ($\beta > 1$).*

In this case, as shown in (7), $p = t_2$; thus, the budget constraint of child 2 is $y_2 = x_2 + g_2$, where $g_2 = [2\beta(1+\tau_2) - 1]y/3(1+\tau_2)$. As in case (a), the utility function of child 2 becomes

$$U_2 = \frac{(1 + (\tau_2 + 1)\beta)^2}{9(\tau_2 + 1)^2} y^2.$$

Again, from the maximization of U_2, given t_1, we have

$$\frac{\partial U_2}{\partial \tau_2} = -\frac{2y^2 (1 + (\tau_2 + 1)\beta)}{9(\tau_2 + 1)^3} < 0.$$

Thus, child 2 chooses t_2 to satisfy $\tau_2 = |t_2 - t_1| = 0$, implying that he lives as close to his brother as possible:

$$t_2 = t_1. \tag{11}$$

Stage 1. From (10) and (11), Child 1's location choice in the first stage affects child 2's location choice in the second stage. Child 1 knows that his location would influence child 2's location choice and thus strategically chooses his location before his younger brother makes his choice.

(a) *When child 1's income is higher than child 2's income ($\beta < 1$).*

By inserting (2), (5), and (7) into (1), we have the objective function of child 1 in the first stage as follows:

$$U_1 = \frac{(y_1 + y_2 + |t_2 - t_1| y_1)^2}{9(|t_2 - t_1| + 1)^2},$$

where t_2 in this equation is given by (10). The first-order conditions for the maximization problem are thus obtained from

$$\frac{\partial U_1(t_2 = 0)}{\partial t_1} = -\frac{2y_2 (y_1 + y_2 + t_1 y_1)}{9(t_1 + 1)^3} < 0 \ \text{ and } \ \frac{\partial U_1(t_2 = 1)}{\partial t_1} = \frac{2y_2 (y_2 + (2 - t_1) y_1)}{9(2 - t_1)^3} > 0.$$

Thus, in any case, child 1 minimizes $|t_2 - t_1|$. The reason why child 1 minimizes his distance from child 2 is simple. Child 1 expects his parents to live with him and wants to make child 2 participate in caregiving. To enable child 2 care for the parents, child 1 tries to live as near to him as possible. However, child 1 cannot reside with child 2 because child 2 would always move away from child 1 to avoid the burden of caring for their parents. Given the reaction of child 2, represented by (10), a possible equilibrium is child 1 choosing $t_1 = 0.5$, minimizing $|t_2 - t_1|$. That is, child 1 chooses to live at 0.5 to minimize the distance from child 2 and expects the second-born child to adjust by living away in the second stage. In this case, child 2 is indifferent between choosing $t_1 = 0$ and $t_1 = 1$, and, once he chooses either $t_1 = 0$ or $t_1 = 1$, he has no incentive to move.

Summarizing the results, we have the following proposition.

Proposition 1. *Suppose that child 1's income is higher than child 2's income ($\beta < 1$). Then, the parent lives with child 1 at $p = t_1 = 0.5$, while child 2 lives at either of the end points $t_2 = 0$ or $t_2 = 1$.*

From the information of equilibrium location pattern in (5) and (6), we have the following corollary:

Corollary 1. *Suppose that 1's income is higher than child 2's income ($\beta < 1$). Then, $g_1 = 2(3-\beta)y/9$, $g_2 = (4\beta - 3)y/9$, $g_1 - g_2 = (3 - 2\beta)y > 0$, and $G = (3 + 2\beta)y/9$.*

From (4), the equilibrium characterized by Proposition 1 and Corollary 1 holds if $0 < \beta < 3/4$, by which $g_1 > 0$ and $g_2 > 0$ hold.

(b) *When child 2's income is higher than child 1's income ($\beta > 1$).*

From (11), we obtain child 1's utility in the first stage as follows:

$$U_1 = \frac{1}{9}(y_1 + y_2)^2,$$

implying that child 1's location is not uniquely determined. With (7) and (11), this directly leads to the following proposition.

Proposition 2. *Suppose that child 2's income is higher than child 1's income ($\beta > 1$). Then, the parent and the two children live together somewhere (denoted by $\bar{t_1}$) in the unit space $p = t_2 = t_1 = \bar{t_1}$.*

From the information of equilibrium location in (5) and (6), we have the following corollary:

Corollary 2. *Suppose that child 1's income is higher than child 2's income ($\beta > 1$). Then, $g_1 = (2 - \beta)y/3$, $g_2 = (2\beta - 1)y/3$, $g_1 - g_2 = 1 - \beta < 0$, and $G = (1 + \beta)y/3$.*

From (4), the equilibrium characterized by Proposition 2 and Corollary 2 holds if $1 < \beta < 2$, by which $g_1 > 0$ and $g_2 > 0$ hold.

From Proposition 2, everyone chooses the same location and the second-born child becomes the primary caregiver. In the range ($1 < \beta < 2$), a small income gap leads to an interior solution such that both sons are involved in the care of their parents. Since the second-born child has higher income, he provides more care. The parents live at the same location of the second-born child to increase the care received from the primary caregiver. Since the second-born child knows this, he tries to live at the same location of the first-born child to make his brother participate more in caregiving. The first-born child is then indifferent to his location because he knows that his younger brother, the primary caregiver, would follow his choice.

3.2 Corner solutions

In the previous subsection, we restricted our analysis to the case of interior solution in which both children care for their parents. We now study the equilibrium pattern when $3/4 < \beta < 2$ does not hold. In this case, only one child cares for his parents and the other free rides on his brother.

(a) *When child 1's income is sufficiently higher than child 2's income ($\beta < 3/4$).*

We first consider the case of $\beta < 3/4$. Here, child 2 does not have sufficient income to care for his parents; thus, child 1 cares for his parents and child 2 free rides, $g_1 > 0$, and $g_2 = 0$. In the fourth stage, the care provided by each child is, respectively,

$$g_1 = G = \frac{y}{2(1 + |p - t_1|)} \quad \text{and} \quad g_2 = 0. \tag{12}$$

In the third stage, the parents maximize $G = 0.5y/(1 + |p - t_1|)$ with respect to p, with the result that they live with child 1, $p = t_1$. In the second stage, child 2 accounts for $p = t_1$. From this equation, the utility of child 2 is $U_2 = \beta y^2/2$, which does not depend on t_2, suggesting that the location of child 2 is indeterminate. We here denote $\bar{t_2}$ as child 2's location. Finally, in the first stage, child 1 chooses his location to maximize his utility, $U_1 = y^2/4$; this is so because $p = t_1$ and $t_2 = \bar{t_2}$. Since the utility of child 1 is independent of t_1, the location of child 1 is indeterminate. We express child 1's location as $\bar{t_1}$. In this case, we have $g_1 = y/2 > g_2 = 0$.

(b) *When child 2's income is sufficiently higher than child 1's income ($\beta > 2$).*

We next consider the case where child 2 cares for his parents and child 1 free rides; this happens when $\beta > 2$. In the fourth stage, given $g_1 = 0$, child 2 chooses g_2 so as to maximize his utility; thus, we have

$$g_2 = G = \frac{\beta y}{2(1 + |t_2 - p|)}. \tag{13}$$

In the third stage, the parents maximize (13) with respect to p, implying that the parents live with child 2, $p = t_2$. Child 2 accounts for $p = t_2$ in the second stage, and his utility is given by $U_2 = \beta^2 y^2/4$; this does not depend on t_2, suggesting that the location of child 2 is indeterminate. We thus obtain $\bar{t_2}$ as child 2's location. Finally, in the first stage, with $p = t_2$ and $t_2 = \bar{t_2}$, child 1 chooses his location to maximize his utility, $U_1 = \beta y^2/2$. Since U_1 is independent of t_1, child 1's location is indeterminate. We express child 1's location as $\bar{t_1}$.

Summarizing the location pattern in case of corner solutions, we have the following proposition.

Proposition 3. (i) *When child 1's income is sufficiently higher than child 2's income ($\beta < 3/4$), the parents and child 1 live together somewhere in the unit space denoted by $\bar{t_1} \in [0, 1]$, $p = t_1 = \bar{t_1}$, and child 2 is the sole occupant of $\bar{t_2} \in [0, 1]$.*

(ii) *When child 2's income is sufficiently higher than child 1's income ($\beta > 2$), the parents and child 2 live together somewhere in the unit space denoted by $\bar{t_2} \in [0, 1]$, $p = t_2 = \bar{t_2}$, and child 1 is the sole occupant of $\bar{t_1} \in [0, 1]$.*

Corollary 3. (i) *When $\beta < 3/4$, $g_1 = y/2 = G$ and $g_2 = 0$;* (ii) *When $\beta > 2$, $g_1 = 0$ and $g_2 = \beta y/2 = G$.*

Figure 2 summarizes the results.

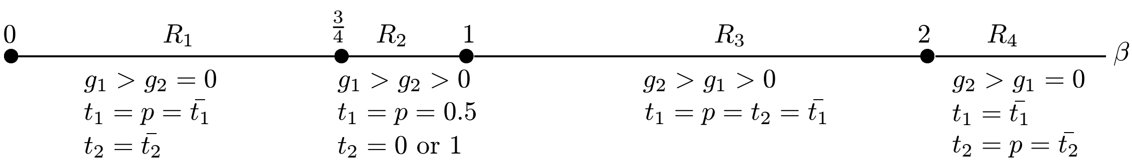

Figure 2. Equilibrium pattern

Note. $\bar{t_1}$ and $\bar{t_2}$ take arbitrary values in the unit space.

In range 1 (R_1), the parents live with the elder son and only he takes care of them; both sons are indifferent to their location. The mechanism of this result is interpreted as follows: since the first-born child has more income and the income gap is sufficiently large, he takes the whole responsibility of taking care of his parents. Knowing that only the first-born child takes care of them, the parents choose the same location as the first-born child to receive care from him. For the second-born child, the location choice does not matter since the large income gap enables him to avoid the duty of caregiving. For the first-born child, since his location choice does not affect his younger brother's caregiving behavior and because his parents follow him, he too is indifferent to the location choice.

Range 4 (R_4) applies to the opposite case of the corner solution result in range 1: the parents live with the second-born child and only he takes care of them; both sons are indifferent to their location choice. In this situation, only the rich younger son provides care for their parents, and in order to reduce the cost from distance to the larger caregiving son's provision, the parents choose to live in the same location of the second-born child. Knowing well that his elder brother will not take care of their parents and that they will follow him, the second-born child becomes indifferent to his location choice. Moreover, the first-born child too is indifferent because it does not affect the behavior of his parents and his younger brother's provision.

4 Discussion

4.1 Comparative statics

In this section, we consider how a change in the relative income of child 1 and child 2 influences overall care, G. For this analysis, we consider a change in β, that is, a change in the aggregate income of both children, keeping child 1's income constant.

We now redefine four regimes according to the level of β, namely, Regime 1 ($\beta < 3/4$), Regime 2 ($3/4 < \beta < 1$), Regime 3 ($1 < \beta < 2$), and Regime 4 ($2 < \beta$). The care provided, G^j, in each regime ($j = 1, 2, 3, 4$) is given by $G^1 = y/2, G^2 = (3 + 2\beta)y/9, G^3 = (1 + \beta)y/3$, and $G^4 = \beta y/2$, respectively. These outcomes clearly show that an increase in β leads to a rise in G^j except for Regime 1. This argument is summarized in Figure 3.

To interpret the effects of an increase in child 2's income on the total contribution, consider first Regime 1 where the income of child 2 is sufficiently small. When $\beta < 3/4$, the income of child 2 is so small that he does not take care of his parents, $g_2 = 0$, and free rides on the care provided by child 1. In this case, child 1 lives with his parents, $p = t_1$, and chooses $g_1 = y/2$. In this context, an increase in child 2's income, represented by an increase in β, changes neither the location pattern nor contribution level. Once β exceeds 3/4, however, child 2 takes care of his parents. Aware of child 2's incentives to take care of his parents, child 1 chooses t_1 in the first stage so that child 2 becomes more involved in the care of their parents. However, child 2 benefits from second-mover advantage and lives away from his parents and brother. Although an increase in child 2's income allows him to provide a positive amount of care, it reduces the contribution of child 1: An increase in g_2 allows child 1 to free ride on child 2's contribution and reduces his contribution. The positive effects of an increase in child 2's income on child 2's contribution outweighs the negative (substitution) effects on child 1's contribution, and thus the total amount of private contribution increases.

Once β exceeds 1, an increase in child 2's income increases the contribution through three channels, ultimately leading to discontinuity at $\beta = 1$. First, an increase in child 2's income increases the contribution of child 2 through the income effect channel. Second, once β exceeds 1, the parents change their location and decide to live with child 2, reducing the contribution of child 1, and therefore child 2 increases his contribution. Third, although child 1 tries to live away from his parents as well as child 2 in the first stage, child 2 follows child 1 and decides to live together so as to make child 1 take the burden of care, and thereby increases the care provided by child 1.

Finally, when β exceeds 2, child 1 free rides on child 2's contribution by choosing $g_1 = 0$. This leads child 2 to live with his parents, thereby reducing the cost of care. The reduction in cost enables child 2 to contribute more for the care of his parents, and thus the total amount of care increases.

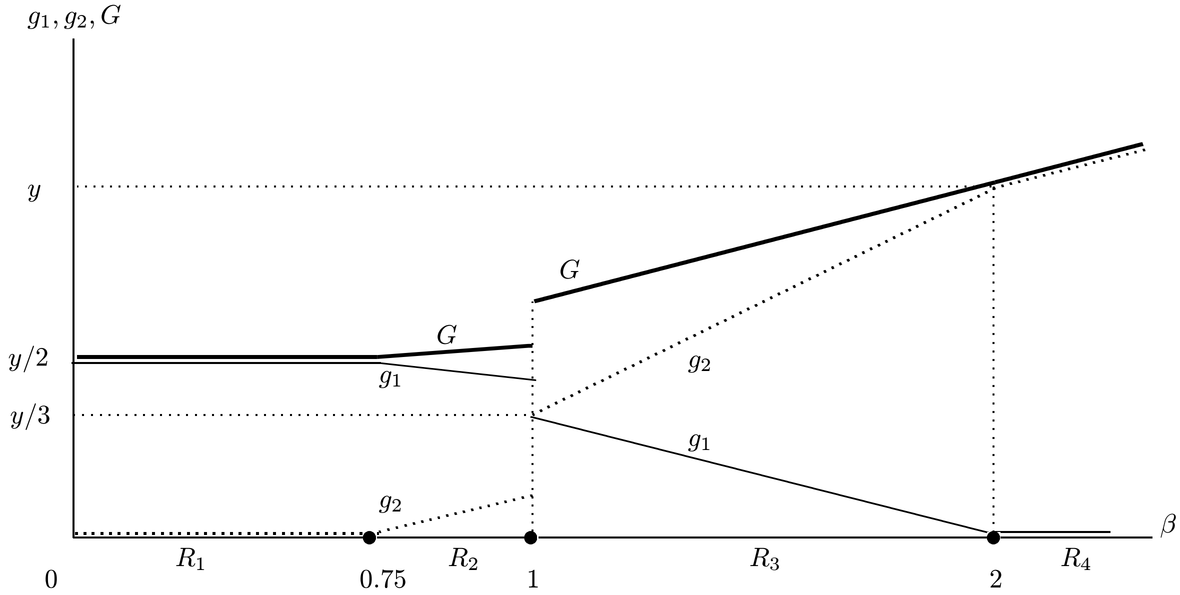

Figure 3. Total care provided by both children

4.2 Cooperation in provision of care

In this section, we analyze how the location pattern changes when the model is extended to incorporate cooperative behavior.[8] We derive the equilibrium when children cooperate in the fourth stage. Since the provision of care for parents has the property of public goods, the total amount of care for parents tends to be inefficiently low. This creates the scope for cooperation between siblings to care for parents.

Assume that, given the location pattern determined in the first, second, and third stages, the siblings cooperate to maximize their joint utilities when caring for their parents. The objective function in the first stage is, thus, given by $U_1 + U_2$. The maximization gives the following condition:

$$\begin{aligned} g_1 &= \frac{(1+\beta)y}{2(T_1+1)} \text{ and } g_2 = 0 \text{ if } T_2 > T_1, \\ g_2 &= \frac{(1+\beta)y}{2(T_2+1)} \text{ and } g_1 = 0 \text{ if } T_2 < T_1, \end{aligned}$$

where $T_1 \equiv |p - t_1|$ and $T_2 \equiv |t_2 - p|$.

The parents anticipate these outcomes in the third stage and choose their location; they choose to live with child 1 ($p = t_1$ and therefore $T_1 = 0$) if $T_2 > T_1$ and with child 2 ($p = t_2$ and therefore $T_2 = 0$) if $T_2 < T_1$. In the second stage, the utility of child 2 is given by $U_2 = \beta(1+\beta)y^2/2$ when $T_2 > T_1$ and $U_2 = (\beta - 1)(1+\beta)y^2/4$ when $T_2 < T_1$. In both cases, U_2 does not depend on t_2, and the location of child 2 in the second stage is not uniquely determined. In this case, the utility of child 1 in the first stage is given by $U_1 = (1+\beta)y^2/2$, indicating that the location choice does not change the utility, and t_1 is not determined.

The total amount of care provided jointly to parents is given by $G^c = (1+\beta)y/2 > G^j$ $(j = 1, 2, 3, 4)$, implying that cooperation between siblings increases the amount of care given to parents. This analysis reveals a slight change in location pattern. When the siblings do not cooperate in providing care, we have

[8] Reiner and Sielder (2009) also present an insightful model where the siblings negotiate at the fourth stage of care provision and their choice of employment and location affect their bargaining power.

four equilibrium patterns: see Figures 2 and 3 for regimes 1–4. However, when the siblings cooperate, only one child provides care and regimes 2 and 3 disappear.

4.3 When parents do not migrate

So far, we assumed that parents freely migrate after their children choose their location. This setting is plausible if the cost for parents' location change is sufficiently small. However, it could also be difficult for the parents to migrate because of the high migration cost attributable to age-related illnesses or attachment to home. In this section, we examine how the care provision and location choice change when the parents do not migrate. Since the analysis is based on the model already presented in section 3, we present a brief description of the model here.

The timing of the game is now given as follows: In the first stage, child 1 chooses location t_1; in the second stage, child 2 chooses location t_2; and in the final stage, both children decide on their levels of care (g_1, g_2) simultaneously.

Since no changes are needed in the final-stage outcome, (4)–(6) hold. Without any loss of generality, we assume that the parents locate at $p = 0$, indicating that t_i directly represents the distance of child i from the parents.

In the second stage, child 2 maximizes his utility, given by

$$U_2 = \frac{(1+t_2)+(1+t_1)\beta}{3(1+t_1)\sqrt{1+t_2}}y.$$

The first- and second-order conditions are respectively given as follows:

$$\frac{\partial U_2}{\partial t_2} = \frac{(1+t_2)-(1+t_1)\beta}{6(1+t_1)\left(\sqrt{1+t_2}\right)^3}y, \tag{14}$$

$$\frac{\partial^2 U_2}{\partial t_2^2} = \frac{y}{4\left(\sqrt{1+t_2}\right)^5}\left(\beta - \frac{1+t_2}{3(1+t_1)}\right) > 0. \tag{15}$$

The sign of (14) is ambiguous because the marginal benefit and marginal cost of living away from parents work in opposite directions. If child 2 lives away from his parents, he leaves to his older brother the responsibility to provide more caregiving, which thus increases the cost of caregiving. The last inequality in (15) comes from (4), which shows that the location choice of child 2 becomes the corner solution at either $t_2 = 0$ or $t_1 = 1$. Specifically, his choice is determined by the following equation:

$$U_2(t_2 = 1) - U_2(t_2 = 0) = \frac{y(2-\sqrt{2})}{6}\left(\frac{\sqrt{2}}{1+t_1} - \beta\right). \tag{16}$$

From (16), we have the reaction function of child 2 as follows:

$$t_2 = 0 \quad \text{if } \beta > \frac{\sqrt{2}}{1+t_1}, \tag{17}$$

$$t_2 = 0 \text{ or } 1 \quad \text{if } \beta = \frac{\sqrt{2}}{1+t_1}, \tag{18}$$

$$t_2 = 1 \quad \text{if } \beta < \frac{\sqrt{2}}{1+t_1}. \tag{19}$$

Equations (17)–(19) show that the location choice of child 1 in the first stage affects the location choice of child 2 in the second stage. Child 1 recognizes its influence on child 2's location choice and hence strategically chooses where to live before his younger brother does.

To examine the location choice of child 1, first, assume that child 1 chooses t_i to satisfy $\beta > \sqrt{2}/(1+t_1)$. This choice forces child 2 to live with his parents; that is, $t_2 = 0$. In this case, (4) is limited to

$$\frac{\sqrt{2}}{1+t_1} < \beta < \frac{2}{1+t_1}. \tag{20}$$

When (20) is satisfied, the care provided by each child can be given respectively by

$$g_1 = \frac{2-\beta(1+t_1)}{3(1+t_1)}y \text{ and } g_2 = \frac{2\beta(1+t_1)-1}{3(1+t_1)}y. \tag{21}$$

To derive the location of child 1 in the first stage, we insert (21) into the utility function of child 1. The objective function of child 1 in the first stage then becomes

$$U_1 = \frac{1+(1+t_1)\beta}{3\sqrt{1+t_1}}y.$$

The first- and second-order conditions for the maximization problem are thus obtained, respectively, by

$$\frac{\partial U_1}{\partial t_1} = \frac{(1+t_1)\beta - 1}{6\left(\sqrt{1+t_1}\right)^3}y, \tag{22}$$

$$\frac{\partial^2 U_1}{\partial t_1^2} = \frac{3-(1+t_1)\beta}{12\left(\sqrt{1+t_1}\right)^5}y > 0. \tag{23}$$

The last inequality in (23) comes from (20), indicating that the location choice of child 1 becomes the corner solution at either $t_1 = 0$ or $t_1 = 1$. To determine child 1's choice, we check the sign of

$$U_1(t_1 = 1) - U_1(t_1 = 0) = \frac{y(2-\sqrt{2})}{3\sqrt{2}}\left(\beta - \frac{\sqrt{2}}{2}\right).$$

We find that

$$t_1 = 1 \quad \text{if } \beta > \frac{\sqrt{2}}{2}, \tag{24}$$

$$t_1 = 0 \text{ or } 1 \quad \text{if } \beta = \frac{\sqrt{2}}{2}, \tag{25}$$

$$t_1 = 0 \quad \text{if } \beta < \frac{\sqrt{2}}{2}. \tag{26}$$

Since (17) and (24) can hold at the same time, $t_1 = 1$ and $t_1 = 0$ can be an equilibrium. In this case, from (20), $\sqrt{2}/2 < \beta < 1$ ensures that both children care for their parents. In contrast, (17) and (24) do not hold at the same time, and hence, $t_1 = 0$ and $t_2 = 0$ do not hold at equilibrium.

We can similarly derive the equilibrium location when (19) holds, and hence the equilibrium can be summarized as follows.[9]:

Proposition 4. *Suppose that the parents do not migrate.* (i) *If* $\sqrt{2}/2 < \beta < 1$, *then* $t_1 = 1$ *and* $t_2 = 0$. *In this case, the care provided by each child is given by* $g_1 = (1-\beta)y/3$ *and* $g_2 = (4\beta - 1)y/6$, *respectively;* (ii) *If* $1 < \beta < \sqrt{2}$, *then* $t_1 = 0$ *and* $t_2 = 1$. *In this case, the care provided by each child is given by* $g_1 = (4-\beta)y/6$ *and* $g_2 = (\beta - 1)y/3$, *respectively.*

[9]For the proof, see Komura and Ogawa (2015).

We now address the equilibrium pattern when $\sqrt{2}/2 < \beta < \sqrt{2}$ does not hold. Here, only one child cares for his parents and the other free rides. First, consider the case of $\beta < \sqrt{2}/2$. Here, child 2 does not have sufficient income to care for his parents, and hence, child 1 cares for his parents and child 2 free rides, $g_1 > 0$, and $g_2 = 0$. The care provided by each child is, respectively, $g_1 = 0.5y/(1+t_1)$ and $g_2 = 0$. Substituting these equations into the utility function of child 2, we have $U_2 = 0.5\beta y^2/(1+t_1)$. Because the utility of child 2 does not depend on his location, he is indifferent to choosing his location, implying that child 1 cannot choose his location in the first stage to control the location of child 2 determined in the second stage. We denote the location choice of child 2 as $\bar{t_2} \in [0,1]$. In this case, the utility of child 1 in the first stage is given by $U_1 = 0.25y^2/(1+t_1)$. Thus, child 1 chooses $t_1 = 0$ to maximize his utility.

When $\sqrt{2} < \beta$, the equilibrium location can be obtained in a similar manner. In this case, the income of child 1 is so small that he cannot care for his parents, and hence, child 2 cares for his parents while child 1 free rides, $g_1 = 0$, and $g_2 > 0$.

The equilibrium can be summarized as follows:

Proposition 5. *Suppose that the parents do not migrate.* (i) *If $\beta < \sqrt{2}/2$, then $t_1 = 0$ and $t_2 = \bar{t_2}$. In this case, the care provided by each child is $g_1 = \beta y/2$ and $g_2 = 0$, respectively;* (ii) *If $\sqrt{2} < \beta$, then $t_1 = \bar{t_1}$ and $t_2 = 0$. In this case, the care provided by each child is $g_1 = 0$ and $g_2 = \beta y/2$, respectively.*

When $\beta < \sqrt{2}/2$, child 2 has no preference on his location since he does not provide care to his parents. Child 1 cannot use his location to induce child 2 to choose a location he prefers. In addition, child 1 cares for his parents, and hence, he chooses to live with them to minimize the caregiving cost. A similar argument applies when $\beta > \sqrt{2}$.

The equilibrium pattern when parents do not migrate is depicted in Figure 4. When the income differential between the two siblings is large enough to satisfy $\beta < \sqrt{2}/2$ or $\beta \geq \sqrt{2}$ and one of the two cares for their parents and the other free rides, then child 1 cannot use his location as a strategic variable to control the location of his younger brother. In this case, the child who has the larger income lives with his parents and takes care of them while the other free rides.

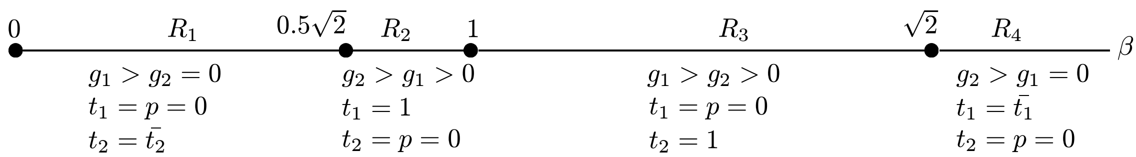

Figure 4. Equilibrium pattern when the parents do not migrate

Note. $\bar{t_1}$ and $\bar{t_2}$ take arbitrary values in the unit space.

When the income differential between the two siblings is sufficiently small to lead both children care for their parents, child 1 uses his location choice to induce his younger brother to choose the location he desires. If child 1's income is larger than child 2's income, that is, $\beta < 1$, he realizes that his younger brother provides less care for his parents. To make him provide more care, child 1 moves to live far away from the parents, thus caring less for his parents. This action induces the younger brother to take more care of their parents, since the brothers are in a situation of strategic substitution in terms of caregiving. Since the younger brother cares for their parents more, he lives with them. A similar argument explains the location pattern when $\beta > 1$, in which case child 1 lives with his parents.

5 Conclusion

In this study, we investigated the location choice and parents' care arrangements of two siblings considering their income differential. Specifically, we formulated a model wherein their caregiving decisions are influenced by their relative incomes as well as their distance from parents (i.e., the marginal caregiving cost), in line with Konrad et al. (2002)'s approach. We use this generalized model of income effects and examine two cases of care arrangements, given the income differential. First, when the income gap is sufficiently small, both children take part in caregiving. In this case, a strategic incentive exists to live far away from parents. This decision is taken because relative distance is a determinant of the care each child needs to provide and the older child can utilize his first-mover advantage (this case essentially corresponds to the result presented by Konrad et al. (2002)). Second, when the income differential is sufficiently large, the child earning more (either the older or younger child) takes the responsibility of caring for his parents irrespective of the other's location choice. This novel result makes a unique contribution to the body of knowledge on this topic; it partially explains the different care arrangements seen in Western and Eastern countries.

The possibility of the elder son taking care of his parents that this analysis found be partially supported by evidence from Japan. According to the National Institute of Population (1988), the first-born child tends to live with his/her parents in Japan. In case the parents have more than two children and they live with one of the children who married in the period 1955–1959, the ratio that the first-born son lived with his parents was 61.3%, whereas the ratio for other children was 32.9%. Although the ratio of the extended family declined over time, the tendency for parents to live with their first-born child has not changed.[10] In this sort of situation, the National Family Research of Japan (2003) observed the birth order effect that the elder child receives higher education on average.[11] We note this tendency from the case of two children born during the period 1956–1965, as an example. According to the data, the ratio of both children having the same education level was 54.2%, that of the elder child enjoying higher education level than the younger was 26.2%, and that of the opposite case was 19.5%. This trend of the elder child having higher education lasted up to the next cohort born in 1966–1975, showing that the ratio that the elder (younger) received higher education than the other was 26.7% (19.9%); for the cohort of 1976–85, this was 26.9% (21.3%). Studies have also explored the relationship between birth order and education level after controlling for the number of children in the household; many of them found that elder male children tend to receive higher education (Tomabechi, 2012). From the existing literature that showed a positive relationship between education and income, we can expect that the first-born child (son) enjoys higher income than the others, and, as stated, the first-born child tends to be the primary care giver in Japan.

Before concluding this study, some limitations need to be mentioned. First, we analyzed the behavior of siblings treating income as exogenous. However, future works should aim to endogenize income by including former decisions such as on educational and location choice. Second, distinguishing income into labor and non-labor income may enable a rich description of adult children's decisions, taking account of the price effect of the opportunity cost of caregiving, as in Byrne et al. (2009) and Antman (2012). Third, we specify the utility function to obtain analytical results. It is not surprising that our qualitative results hold in an appropriate range of preference parameters, but the results might be affected quantitatively if children have extreme preferences. Finally, considering the vast literature on care arrangements, future

[10] For instance, the ratio for the first-born son who married during the period 1985–1987 was 35.3% and that for others remained 23.0%. In the case of single child, the ratio that the child who married during 1955–1959 lived with his/her parents was 45.0%, which has consistently declined to 25.0% in 1985–1987.

[11] National Family Research of Japan (2003) is a report on a large research survey held by Japan Society of Family Sociology in 2004. This targeted the Japanese citizens living in Japan and born in 1926–1975, the period often used in analysis to understand Japanese families.

studies could introduce a new concept of cross-effect of incomes into the empirical analysis. Although some studies have investigated how one's educational level influences others' decisions on the caregiving for elderly parents (Fontaine et al., 2009), few authors have considered income itself as the element of cross-effect. If we consider the income effect as one possible scenario, it would be interesting to test our model to compare the customs prevalent in Western and Eastern countries.

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