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Sibling Rivalry and Strategic Parental Transfers

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This paper develops a noncooperative Nash model in which two siblings compete for their parents' financial transfers. Treating sibling rivalry as a "rent-seeking contest" and using a Tullock-Skaperdas contest success function, we derive the conditions under which more financial resources are transferred to the sibling with lower earnings. We find that parental transfers are *compensatory* and that the family as an institution serves as an "income equalizer." Within a sequential game framework, we characterize the endogeneity of parental transfers and link it to parents' income, altruism, and children's supply of merit goods (e.g., parent-child companionship or child services). We show that merit goods are subject to a "moral hazard" problem from the parents' perspective.

JEL Classification: D1, H3, C7

1. Introduction

Beginning with the seminal works of Becker (1974, 1981), considerable attention has been paid to analyzing the relationship between parental transfers and the recipient child's earnings. Several empirical studies of *inter vivos* transfers (i.e., transfers between living persons) have documented that financial resources are more likely to be transferred to children with low rather than high income (McGarry and Schoeni, 1995; Hochguertel and Ohlsson, 2000). This inverse relationship between transfer amounts and recipient earnings lends support to Becker's model of purely altruistic transfers.

Another prominent study on parents and children is by Becker and Tomes (1976). They examine investment in the human capital of children and its implications for earnings capabilities and for the intrafamily distribution of income among children. Specifically, they show that parents invest more in children with larger endowments to achieve "efficiency" in human capital investment and then use transfers (e.g., *inter vivos* gifts) to achieve "equity" in income distribution.

The seminal works of Becker (1974, 1976, 1981) and Becker and Tomes (1976), however, do not allow for "merit goods" that children render to their parents (e.g., services, visits, or parental care). The pioneering studies of Bernheim, Shleifer, and Summers (1985) and Cox (1987) further argue that intergenerational transfers are related to the exchange between parent and a child for

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family-specific merit goods such as child companionship or services. This consideration parallels Pollak's (1988) finding that parental transfers are tied to a child's consumption of particular goods or services that parents value. Kotlikoff and Morris (1989) contend that parents attempt to manipulate the behavior of their children by offering a "bribe" to induce them to provide services. Moreover, Cox and Rank (1992) contend that parental transfers can be interpreted as a way of "buying" child services. Empirical studies of *inter vivos* transfers and strategic exchange provide evidence that transfers and recipient earnings may be positively related (e.g., Cox 1987; Cox and Rank 1992; Cox and Jakubson 1995; Lillard and Willis 1997).

Most theoretical models of intergenerational transfers emphasize the relationship between parents and children without explicitly considering interactions between the children. In this paper, we develop an alternative approach that emphasizes not only *intergenerational* interactions between parents and children, but also strategic *intragenerational* interactions between siblings. We incorporate into the analysis a "contest success function," which is common in the rent-seeking literature, to examine "transfer-seeking" activities by children within the family. We attempt to examine the role of parental transfers in redistributing income among siblings and in affecting offspring behavior. We also characterize the parents' choice of a financial transfer and link it to parents' income, altruism, and children's supply of merit goods to parents.

Based on the underlying premise that siblings are equally altruistic toward their parents, the sibling-rivalry model developed in this study implies that children whose earning capabilities or earnings are higher supply less services (or exert less effort) in acquiring financial resources from their parents. In other words, parents transfer more resources to children with lower earnings. In this case, parental transfers are *compensatory* in the Beckerian sense, despite the fact that the models of Becker (1974, 1981) and Becker and Tomes (1976) do not allow for merit goods. We compare differences in income between siblings before and after parental transfers and find that in equilibrium the income differential is reduced. This finding supports the proposition that the family as an institution serves as an "income equalizer." If earnings capability is a reasonably good proxy for a child's ability, other factors (e.g., good fortune in labor markets) being equal, then parents provide a type of "insurance" for the lower ability child by transferring proportionately more resources to that child. We also discuss conditions under which the transfer amount and a recipient child's earnings may be positively related.

In addition to examining sibling rivalry for parental transfers, we also analyze utility maximizing altruistic financial transfers by the parents. We further compare the noncooperative Nash equilibrium with the cooperative solution in transfers and children's services. Special attention is paid to moral hazard problems with merit goods.

The remainder of the paper is organized as follows. Section 2 develops a simple model of sibling competition for parental resources in a noncooperative Nash game. In this section, we discuss implications of parental transfers for income differentials between siblings. In section 3, we characterize the endogeneity of parents' financial transfers and compare the outcomes of the two alternative games that parents and children may play. Section 4 summarizes and concludes.

2. A Nash Model of Sibling Rivalry for Parental Transfers

Consider a family in which two siblings compete for financial transfers from their parents. The parents have a total amount of M dollars to distribute to the siblings. The parents, however, do not make their transfers unconditionally. Rather, the parents divide the "prize" M according to the proportion of time that each sibling expends in rendering services to their parents. Specifically, let e_i denote the amount of time that sibling i, $i = 1, 2$, devotes to his parents.[1] For sibling 1, the share of the prize is $p_1(e_1,e_2)$, and for sibling 2, it is $p_2(e_1,e_2) = 1 - p_1(e_1,e_2)$, where

$$p_1(e_1, e_2) = \frac{e_1}{e_1 + e_2}. \tag{1}$$

Equation 1 is a "contest success function" similar to those commonly used in the rent-seeking literature (e.g., Tullock 1980; Skaperdas 1996). In other words, parents orchestrate a "transfer-seeking contest" between siblings to induce their supply of services and to determine the distribution of the financial transfer.

According to Equation 1, sibling 1's share of the prize, M, depends positively on his time of services, e_1, and negatively on sibling 2's time of services, e_2. Similarly, sibling 2's share depends positively on e_2 and negatively on e_1. It can easily be verified that the marginal effect of e_i on p_i, $p_i' \equiv \partial p_i(e_1,e_2)/\partial e_i = e_j/(e_1 + e_2)^2$, is positive but is subject to diminishing returns, where $i, j = 1, 2$, $i \neq j$.

For analytical simplicity, each sibling is assumed to be risk neutral and has T units of time available for working outside of the family and for providing services to the parents.[2] Earning capabilities of the siblings are reflected by the wage rates they command in the labor markets. Let the market wage rate for sibling i be $w_i > 0$.

The siblings choose their service allocations to maximize their individual expected incomes, which are given by

$$Y_1 = (T - e_1)w_1 + p_1(e_1, e_2)M + \alpha_1 e_1, \tag{2}$$

and

$$Y_2 = (T - e_2)w_2 + [1 - p_1(e_1, e_2)]M + \alpha_2 e_2, \tag{3}$$

where the altruism coefficient, α_i, represents the monetary valuation that sibling i places on each unit of time spent with the parents. Note that if $\alpha_i > 0$, sibling i "enjoys" spending time with the parents. We assume that $0 \leq \alpha_i < w_i$, which ensures an interior solution ($e_i > 0$). The first-order conditions (FOCs) for sibling 1's and sibling 2's optimization problems are given respectively by

$$\frac{\partial Y_1}{\partial e_1} = \frac{e_2}{(e_1 + e_2)^2} M - w_1 + \alpha_1 = 0, \tag{4}$$

and

$$\frac{\partial Y_2}{\partial e_2} = \frac{e_1}{(e_1 + e_2)^2} M - w_2 + \alpha_2 = 0. \tag{5}$$

The FOCs indicate that each sibling's service time is optimally chosen so that the expected marginal benefit of exerting one more unit of service time equals its marginal cost (in terms of wage income forgone) net of the altruistic coefficient (i.e., $p_i'M = w_i - \alpha_i$). The sufficient, second-order conditions for a maximum are satisfied as a result of the strict concavity of the contest success functions.

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[1] The variable e_i may be variously interpreted as time, frequency of parental visits, or the level of care supplied to parents.

[2] The results of the analysis will not be affected if T is normalized to unity.

It follows from Equations 4 and 5 that

$$\frac{e_2}{e_1} = \frac{w_1 - \alpha_1}{w_2 - \alpha_2}. \tag{6}$$

Equation 6 implies that, given the altruism coefficients, the relative amount of services supplied by the siblings is negatively related to their relative market wage. Furthermore, it follows from Equations 4 and 5 that if $w_1 - \alpha_1 > w_2 - \alpha_2$ then

$$\frac{e_2}{(e_1 + e_2)^2} M > \frac{e_1}{(e_1 + e_2)^2} M, \tag{7}$$

which implies that

$$e_1 < e_2. \tag{8}$$

Hence, the amount of child services is inversely related to the market wage (net of the altruism coefficient).

Next, we examine the equilibrium behavior of the siblings and its economic implications. The FOCs in Equations 4 and 5 implicitly define the reaction functions for sibling 1 and sibling 2, respectively, $e_1 = e_1(e_2;M,w_1,\alpha_1)$ and $e_2 = e_2(e_1;M,w_2,\alpha_2)$. The two reaction functions jointly determine the noncooperative Nash equilibrium solution, denoted by the two-tuple (e_1^*,e_2^*). Using Equations 4 and 5, we solve for the Nash equilibrium levels of child services:

$$e_1^* = \frac{w_2 - \alpha_2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} M, \tag{9}$$

and

$$e_2^* = \frac{w_1 - \alpha_1}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} M. \tag{10}$$

It follows from Equations 9 and 10 that

$$e_1^* - e_2^* = \frac{(w_2 - w_1) + (\alpha_1 - \alpha_2)}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} M. \tag{11}$$

Equations 9 and 10 further imply the following comparative static derivatives:

$$\frac{\partial e_i^*}{\partial w_i} < 0, \quad \frac{\partial e_i^*}{\partial w_j} > (=) < 0, \quad \frac{\partial e_i^*}{\partial \alpha_i} > 0, \quad \frac{\partial e_i^*}{\partial \alpha_j} > (=) < 0, \quad \frac{\partial e_i^*}{\partial M} > 0, \tag{12}$$

where $i, j = 1, 2, i \neq j$. This analysis suggests our first proposition.

PROPOSITION 1. In a noncooperative Nash game in which two siblings compete for a financial transfer from their parents according to a Tullock-Skaperdas contest success function, we have the following results:

(a) The supply of services by a sibling decreases with his wage rate and increases with his altruism coefficient, *ceteris paribus*.
(b) An increase in the total amount of parental transfer encourages both siblings to increase their supply of services, *ceteris paribus*.

The findings in Proposition 1 imply that the supply of child services to parents is inversely related to a child's earnings capability but is positively related to the child's altruism toward the parents. Also, parents who have a greater ability to allocate more resources to their children can strategically induce ("bribe") their children to supply more services.

Given that the expected parental transfer to sibling i is $M_i^* = p_i^* M$, where $p_i^* = e_i^*/(e_1^* + e_2^*)$, it follows from Equations 9 and 10 that

$$M_1^* = \frac{(w_2 - \alpha_2)}{(w_1 - \alpha_1) + (w_2 - \alpha_2)} M, \tag{13}$$

and

$$M_2^* = \frac{(w_1 - \alpha_1)}{(w_1 - \alpha_1) + (w_2 - \alpha_2)} M. \tag{14}$$

Equations 13 and 14 yield the following comparative static derivatives:

$$\frac{\partial M_i^*}{\partial w_i} < 0, \quad \frac{\partial M_i^*}{\partial w_j} > 0, \quad \frac{\partial M_i^*}{\partial \alpha_i} > 0, \quad \frac{\partial M_i^*}{\partial \alpha_j} < 0, \quad \frac{\partial M_i^*}{\partial M} > 0, \tag{15}$$

where $i, j = 1,2$, $i \neq j$. Inspection of Equations 13 and 14 reveals that

$$M_1^* - M_2^* = \frac{(w_2 - w_1) + (\alpha_1 - \alpha_2)}{(w_1 - \alpha_1) + (w_2 - \alpha_2)} M. \tag{16}$$

There are three cases of interest:

$$\text{(i) If } w_1 > w_2 \text{ and } \alpha_1 = \alpha_2, \text{then } e_1^* < e_2^* \text{and } M_1^* < M_2^*. \tag{17}$$

$$\text{(ii) If } w_1 > w_2 \text{ and } \alpha_1 < \alpha_2, \text{then } e_1^* < e_2^* \text{and } M_1^* < M_2^*. \tag{18}$$

$$\text{(iii) If } w_1 > w_2 \text{ and } \alpha_1 > \alpha_2 + (w_1 - w_2), \text{then } e_1^* > e_2^* \text{ and } M_1^* > M_2^*. \tag{19}$$

One observation is that the expected equilibrium compensation for each unit of time spent with parents is equalized across the siblings. To see this, divide M_i^* ($= p_i^* M$) by e_i^* to obtain the following result:

$$\frac{M_1^*}{e_1^*} = \frac{M_2^*}{e_2^*} = (w_1 - \alpha_1) + (w_2 - \alpha_2) > 0. \tag{20}$$

We summarize these findings in the following proposition.

Proposition 2.

(i) If both the high-wage and the low-wage siblings are equally altruistic toward their parents, the parents transfer more resources to the low-wage child than the high-wage child.
(ii) If the high-wage child is less altruistic toward his parents than the low-wage child, the result in (i) is compounded.
(iii) If the high-wage child is "sufficiently" more altruistic toward the parents than the low-wage child, the parents transfer more resources to the high-wage sibling.
(iv) Parents that have a greater ability to offer a larger prize, transfer more resources to their children, or $\partial M_i^*/\partial M > 0$.
(v) In the noncooperative Nash equilibrium with a transfer-seeking contest, the financial compensation per unit of time of child services is equalized across the children.

The findings in (i) and (ii) of Proposition 2 imply that there is a *negative* relationship between parental transfers and a recipient child's earnings. Parents compensate for labor earnings differentials resulting from ability and human capital differentials by transferring more financial resources to the less-endowed children. Under these circumstances, parental transfers are compensatory in the Beckerian sense. The economic intuition behind this finding is straightforward. The opportunity cost of rendering services to parents is higher for the high-wage child. Consequently, the high-wage child supplies proportionately less time in caring for the parents and concomitantly receives a lower parental transfer.

The finding in Proposition 2(iii) implies that there can be a *positive* relationship between parental transfers and the earnings of the recipient child when the high-ability child is sufficiently altruistic toward his parents. In this special case, parental transfer are less compensatory and more reflective of simple payments to the child for services rendered to the parents.

The finding in Proposition 2(iv) indicates that high-income parents tend to transfer more resources to their children than do the low-income parents. Moreover, within the framework of sibling rivalry for parental transfers, parents are "unbiased" toward their children. This nondiscrimination result derives from the fact that the "equilibrium price" of child services—measured in terms of compensation to the child for each unit of time spent with the parents—is *identical* for the siblings.

Finally, we compare each sibling's income before and after the financial transfer to determine whether the implied participation constraints are satisfied. Let the posttransfer income for child *i* be denoted by Y_i^*. Substituting e_1^* and e_2^* in Equations 9 and 10 into the objective functions in Equations 2 and 3 yields

$$Y_1^* = Tw_1 + \frac{(w_2 - \alpha_2)^2 M}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} > Tw_1, \tag{21}$$

$$Y_2^* = Tw_2 + \frac{(w_1 - \alpha_1)^2 M}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} > Tw_2. \tag{22}$$

Equations 21 and 22 indicate that each sibling has a financial incentive to participate in the "contest" provided that $w_i > \alpha_i$. Under these conditions, each sibling's posttransfer expected income increases, or $Y_i^* > Tw_i$.

It is instructive to examine how the income differentials between the siblings are affected by the parental transfers. Prior to the transfer-seeking contest, the income differential between the siblings is simply $Tw_1 - Tw_2$. After the transfer-seeking contest, the income differential is $Y_1^* - Y_2^*$. It follows from Equations 20 and 21 that

$$(Y_1^* - Y_2^*) - (Tw_1 - Tw_2) = \frac{[(w_2 - w_1) + (\alpha_1 - \alpha_2)]M}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]}. \tag{23}$$

For the case in which $w_1 > w_2$ and $\alpha_1 \leq \alpha_2$, the sign of the expression in Equation 23 is negative. This implies that the income differential between the siblings is reduced by the transfer-seeking contest. Conversely, for the case in which $w_1 > w_2$ and $\alpha_1 > \alpha_2 + (w_1 - w_2)$, the income differential between the siblings actually widens. We thus have the following.

PROPOSITION 3. If sibling rivalry for a financial transfer from their parents is based on a Tullock-Skaperdas contest success function, parental transfers may or may not reduce the income differential between the siblings, depending upon their wage differential and the difference in the degree of altruism toward the parents.

For the symmetric case in which $\alpha_1 = \alpha_2$ and $w_1 = w_2$, we have $e_1^* = e_2^*$ and $p_1^* = p_2^*$. In this case, $M_1^* = M_2^*$ and $Y_1^* = Y_2^*$. These results imply that parental transfers are equally divided among children when the children are equally productive in the labor markets and are equally altruistic toward the parents. Using the symmetric case as a benchmark, our findings in Propositions 2 and 3 suggest interesting behavioral implications for the role of the family. Assuming that children are equally altruistic toward their parents, the design of a contest in the Tullock-Skaperdas sense leads the parents to transfer more financial resources to the child with lower earnings capabilities. This finding of compensating transfers supports the idea that the family as an institution may serve as an income equalizer.

Another potentially interesting implication is that parents provide a type of "insurance" or protection for children with differential abilities. Given that the ability of a child is a random draw from nature, the high-wage child is also the high-ability child. If the parents compensate the low-ability child proportionately more than the high-ability child because the former is exogenously disadvantaged by nature, then parental transfers serve as an intrahousehold or nonmarket insurance or financial protection for lower wage (ability) children.

Finally, if high-wage children are more altruistic toward their parents then low-wage children, parents may instead transfer more resources to the high-wage children. In this case, there exists a positive relationship between the amount of the parental transfer and the recipient child's earnings.

3. Endogeneity of Parental Transfers in a Sequential Game

In the previous analysis, we assumed that parental transfers are exogenous in the model. In reality, parents have the discretion to determine the amount of a financial transfer that maximizes their utility. Consequently, it is important to endogenize the total transfer amount in a utility-maximizing framework. We employ a sequential game to characterize the endogeneity of the financial prize in sibling contest.[3] The timing of the sequential or two-stage game is as follows. In the first stage, the parents *commit* a specified amount of money that will be distributed to their children according to a Tullock-Skaperdas contest success function. In the second stage, the children compete for the transfer and simultaneously choose the levels of services that maximize their objective functions. The parents do not distribute the prize until after they have received services from their children. This, in essence, is the basic idea that Hirshleifer (1977) stressed: Parents have the "last word."

As is standard in game theory, we use backward induction to solve for the subgame perfect Nash equilibrium in the sequential game. Consistent with backward induction, we first solve for the children's subgame equilibrium choice of services, and then solve for the total transfer amount that the parents commit in the first stage of the game. As such, the second stage of the game is identical to the analysis in the previous section. We then proceed to the first stage of the game to examine the altruistic parents' decision on the size of the prize, M.

For analytical simplicity, assume that the parents collectively have the following altruistic preference function[4]:

$$U = u(y_p - M, e_1, e_2) + \beta\gamma Y_1 + \beta\gamma Y_2, \tag{24}$$

where y_p is the parents' initial income, $u(y_p - M, e_1, e_2)$ is their own utility as a function of income after transfer and children's services, β ($0 < \beta < 1$) is the altruism coefficient attached to each child's utility, and γ represents the utility valuation that the parents place on each child's income.[5] Define income after

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[3] This section is the result of a suggestion by an anonymous referee and the editor that we include an analysis of parents' choice of a financial transfer in a sequential game.

[4] An additively separable utility function has been widely adopted to analyze various issues such as the "rise and fall of families" (Becker and Tomes 1979, 1986), the economic analysis of fertility (Becker and Barro 1988), the biological origin of altruism (Mulligan 1997), and residential choice of family members (Konrad, et al. 2002).

[5] Parents may be "biased" in that they place different values of β and γ across children. We rule out this possibility and focus the analysis on differences in children's earnings capabilities and their implications for parental transfers.

transfer as I, where $I = y_p - M$. We assume that there is a Hicksian composite good whose price is normalized to 1. For the parents' own utility function, $u(y_p - M, e_1, e_2) = u(I, e_1, e_2)$, we assume that it is strictly concave in I, e_1, and e_2. We further adopt the following notation and assumptions:

$$u_I \equiv \partial u/\partial I > 0, \quad u_{II} \equiv \partial^2 u/\partial I^2 < 0, \quad u_{e_i} \equiv \partial u/\partial e_i > 0, \quad u_{e_i e_i} \equiv \partial^2 u/\partial e_i^2 < 0,$$
$$u_{Ie_i} \equiv \partial^2 u/\partial I \partial e_i \geq 0,$$

where $i = 1,2$. The marginal utility of consumption of either the private good or the merit good is positive but diminishing. The assumption that u_{Ie_i} is nonnegative implies that the parents' marginal utility of consuming the private good is nondecreasing in the merit good supplied by child i.

The objective of the parents is to choose M to maximize the altruistic preference function in Equation 24, where e_1 and e_2 are given by Equations 9 and 10, and Y_1 and Y_2 are given by Equations 21 and 22. The parents' FOC is

$$\frac{\partial U}{\partial M} = -u_I + u_{e_1}\frac{\partial e_1}{\partial M} + u_{e_2}\frac{\partial e_2}{\partial M} + \beta\gamma\frac{\partial Y_1}{\partial M} + \beta\gamma\frac{\partial Y_2}{\partial M} = 0, \tag{25}$$

where

$$\frac{\partial e_1}{\partial M} = \frac{w_2 - \alpha_2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2},$$
$$\frac{\partial e_2}{\partial M} = \frac{w_1 - \alpha_1}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2},$$
$$\frac{\partial Y_1}{\partial M} = \frac{(w_2 - \alpha_2)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} > 0,$$

and

$$\frac{\partial Y_2}{\partial M} = \frac{(w_1 - \alpha_1)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} > 0.$$

Assuming an interior and unique solution for M, the SOC (denoted as J) requires that

$$J = u_{II} - 2u_{Ie_1}\frac{\partial e_1}{\partial M} - 2u_{Ie_2}\frac{\partial e_2}{\partial M} + u_{e_1e_1}\left(\frac{\partial e_1}{\partial M}\right)^2 + 2u_{e_1e_2}\frac{\partial e_1}{\partial M}\frac{\partial e_2}{\partial M} + u_{e_2e_2}\left(\frac{\partial e_2}{\partial M}\right)^2 < 0. \tag{26}$$

Let the equilibrium amount of the prize that the parents commit be denoted as M^*.

It follows from the FOC in Equation 25 that the effect of changes in the parents' income y_p on the prize is

$$\frac{\partial M^*}{\partial y_p} = \frac{1}{J}\left\{u_{II} - \frac{u_{e_1I}(w_2 - \alpha_2) + u_{e_2I}(w_1 - \alpha_1)}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2}\right\} > 0. \tag{27}$$

It is straightforward to show that

$$\frac{\partial M^*}{\partial \beta} = -\frac{\gamma}{J}\left\{\frac{(w_2 - \alpha_2)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} + \frac{(w_1 - \alpha_1)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2}\right\} > 0. \tag{28}$$

The findings of the analysis are summarized by the following proposition.[6]

[6] See the Appendix for detailed derivations of the results in Proposition 4.

PROPOSITION 4. Higher income parents offer more financial resources to induce services by their children than lower income parents do. Also, more altruistic parents transfer more resources to their children than less altruistic parents do.

Note that the parents do *not* choose the actions of the child in the noncooperative Nash game we consider. Moreover, the noncooperative game has the property of self-enforcement because each individual pursues behavior that maximizes self-interest.[7]

How does the two-stage sequential Nash equilibrium compare with the cooperative-utilitarian, or Benthamite solution?[8] To answer this question, we first characterize the solution to a cooperative game in which the parents simultaneously choose M, e_1, and e_2 to maximize the altruistic preference function in Equation 24. The parents' FOCs are given respectively by

$$\frac{\partial U}{\partial M} = -u_l + \beta\gamma = 0, \tag{29}$$

$$\frac{\partial U}{\partial e_1} = u_{e_1} + \beta\gamma\left[\frac{e_2}{(e_1+e_2)^2}M - w_1 + \alpha_1\right] - \frac{\beta\gamma e_2 M}{(e_1+e_2)^2} = 0, \tag{30}$$

and

$$\frac{\partial U}{\partial e_2} = u_{e_2} + \beta\gamma\left[\frac{e_1}{(e_1+e_2)^2}M - w_2 + \alpha_2\right] - \frac{\beta\gamma e_1 M}{(e_1+e_2)^2} = 0. \tag{31}$$

Denote the solution to the cooperative game as $(\tilde{M}, \tilde{e}_1, \tilde{e}_2)$. To see how the cooperative transfer, $\tilde{M}$, compares to the Nash equilibrium transfer, M^*, we rewrite the parents' FOC in Equation 25 as follows:

$$\begin{aligned}\frac{\partial U}{\partial M} &= -u_l(y_p - M^*, e_1^*, e_2^*) + u_{e_1}\frac{\partial e_1^*}{\partial M^*} + u_{e_2}\frac{\partial e_2^*}{\partial M^*}\\ &+ \beta\gamma\left[-(w_1-\alpha_1)\frac{\partial e_1^*}{\partial M^*} + \frac{e_1^*}{e_1^*+e_2^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_1^*}{e_1^*+e_2^*}\right)\right]\\ &+ \beta\gamma\left[-(w_2-\alpha_2)\frac{\partial e_2^*}{\partial M^*} + \frac{e_2^*}{e_1^*+e_2^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_2^*}{e_1^*+e_2^*}\right)\right] = 0.\end{aligned} \tag{25$'$}$$

Evaluating the derivative $\partial U/\partial M$ in Equation 29 at the Nash equilibrium, (M^*, e_1^*, e_2^*), taking into account Equation 25′, we have:

$$\begin{aligned}\left.\frac{\partial U}{\partial M}\right|_{(M^*,e_1^*,e_2^*)} &= -\left\{u_{e_1}\frac{\partial e_1^*}{\partial M^*} + u_{e_2}\frac{\partial e_2^*}{\partial M^*} + \beta\gamma\left[-(w_1-\alpha_1)\frac{\partial e_1^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_1^*}{e_1^*+e_2^*}\right)\right]\right.\\ &\left.+\beta\gamma\left[-(w_2-\alpha_2)\frac{\partial e_2^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_2^*}{e_1^*+e_2^*}\right)\right]\right\} < 0.\end{aligned} \tag{32}$$

It follows from Equation 32 and the strict concavity of the altruistic utility function that

$$\tilde{M} < M^*. \tag{33}$$

[7] Becker (1974) was the first to introduce parental altruistic preferences into the analysis of family economics. Becker (1991, p. 279) further observes that because parents maximize their own utility subject to the family constraints, they may be labeled "selfish," not altruistic, in terms of utility maximization. Pollak (1988) proposes the use of "paternalistic" preferences to replace altruistic preferences in analyzing parent-child relationships and tied transfers.

[8] We are grateful to an anonymous referee for suggesting that we examine this important question.

As for children's services, we compare Equations 4 and 30 and find that

$$\tilde{e}_1 > e_1^* \quad \text{if } u_{e_1^*} > \frac{\beta\gamma e_2^* M}{(e_1^* + e_2^*)^2}. \tag{34}$$

Similarly, a comparison between Equations 5 and 31 reveals that[9]

$$\tilde{e}_2 > e_2^* \quad \text{if } u_{e_2^*} > \frac{\beta\gamma e_1^* M}{(e_1^* + e_2^*)^2}. \tag{35}$$

We thus have the following:

PROPOSITION 5. If parental transfers are based on the proportion of services that each sibling renders, then the total amount transferred under a cooperative game is less than under a noncooperative Nash game. If the parents' marginal utility of enjoying children's services is critically "high," other things being equal, the levels of services that the parents choose in the cooperative game are greater than those in the noncooperative Nash game.

The finding in Proposition 5 implies that parents allocate more financial resources to induce children's services when they behave in a noncooperative manner, compared to the case when the children simply accept whatever their parents' decisions on transfers and the supply of services. For the case in which parents have the power to determine merit goods and their utility gains from consuming the goods are critically "large," the amounts of the goods set by the parents are greater than those in a noncooperative Nash game. Alternatively, if the sufficient conditions in Equations 34 and 35 are satisfied, merit goods are undersupplied in a noncooperative Nash game. Consequently, the supply of merit goods is subject to a "moral hazard" problem from the parents' perspective. It is perhaps not completely surprising that a conflict of interest between parents and children may arise despite parental altruism.

Becker (1974, 1976, 1981, and 1991) contends that a child, no matter how selfish, is induced by his altruistic parent or family head to *internalize* the effects of his actions on the parent's resource allocation decisions. In reply to the comments of Hirshleifer (1977) and other economists on the validity of the "Rotten Kid Theorem," Becker (1977) argues that the theorem is the solution to a Cournot-Nash noncooperative game. Becker (1977) states that

> The solution in my paper is most simply interpreted as a static Cournot-Nash noncooperative equilibrium position. If an altruist and each beneficiary maximized the social income of the altruist, each would be maximizing his own utility, given the behavior of the others; hence the solution would be a noncooperative equilibrium. (p. 506)

Nevertheless, Pollak (1985) contends that Becker's Rotten Kid Theorem should be interpreted as a family "ultimatum game" with a *take-it-or-leave-it commitment.* Becker (1991) in the enlarged edition of his *Treatise* responds to the critiques by concluding that

> The most unsatisfactory aspect of my discussion, however, is not incorrect application of the Rotten Kid Theorem — however lamentable they may be — but the failure to combine the discussions of "merit goods" and altruism. By "merit goods," I mean particular traits or behavior of children that parents care about: whether they are lazy, study hard at school, visit often, drink excessively, marry well . . . (p. 10)

[9] See the Appendix for the detailed derivations of the results that lead to Proposition 5.

In reviewing Becker's contributions to family economics, Pollak (2003) contends that Becker never formulates the altruist model as a game.

The advantage of employing a noncooperative Nash game in a sequential move for analyzing sibling rivalry, parent-child interactions, and transfers is twofold. First, the analysis essentially follows Becker's (1977) response to the critiques that the Cournot-Nash noncooperative equilibrium is relevant for characterizing interactions between family members. Second, the parents have what Hirshleifer (1977) refers to as the "last word" in choosing a financial transfer in the sequential game. We further consider the case that the children make their own decisions independently on the supply of the merit good. Compared to the standard principal-agent methodology, the parents do *not* choose actions of their children in the sequential move analysis. Alternatively, one can use a cooperative or bargaining game. But these two games generally require a well-defined mechanism for "contract" enforcement because there is no endogenously determined incentive mechanism to move to the cooperative or bargaining solution. The advantage of a noncooperative Nash game in a sequential move framework for examining family behavior with distinct preferences lies in the realization that the Nash game of sibling rivalry is *self-enforcing* and the parents have the discretion to make a financial transfer.

Becker's (1974) assertion that parental altruism necessarily ensures efficient family choices by all members, however, is not generally valid. As a matter of fact, on the first page of his book *A Treatise on the Family*, Becker (1981) observes that "Conflict between the generations has become more open, and parents are now less confident that they can guide the behavior of their children." Our findings suggest that *parental altruism is not immune to conflict or moral hazard problems*, an implication consistent with Stark (1995), Chami (1998), Bergstrom and Bergstrom (1999), and Cox (2002). By explicitly taking into account a merit good in a sequential game, our analysis of sibling rivalry and moral hazard problems may offer an alternative and potentially promising approach to the analysis of parent-child interactions. Our findings complement the studies by Lindbeck and Weibull (1988), Bergstrom (1989, 1996), Bruce and Waldman (1990), and Pollak (2003), that show that altruism does not automatically imply efficiency for child behavior and intergenerational interactions from the parent's perspective.

4. Concluding Remarks

This paper examines the role of parental transfers in redistributing income among siblings and in affecting offspring behavior. In this analysis, we apply a rent-seeking or contest approach to characterizing the nature of sibling competition for parental transfers in a noncooperative Nash game.[10] In addition to focusing on intergenerational interactions between parents and children, which is emphasized in the literature on family economics, we also investigate intragenerational interactions between siblings and their incentives to compete for parental transfers. Our findings suggest that parental transfers to children vary inversely with the children's earnings ability and directly with their altruism toward the parents.

Though based on a simple model of a contest within the family, the sibling-rivalry analysis offers some unique perspectives linking parental transfers to children's earnings and altruism. The analysis also has implications for the design of effort-inducing schemes (or contests) for the role of parents in redistributing financial resources between children, and for intergenerational family relations

[10] An extension of the analysis for the case of $N > 2$ siblings is straightforward. In this case, the contest success function takes the form of $p_i(e_1, \ldots, e_N) = e_i/(e_1 + \ldots + e_N)$, where $i = 1, 2, \ldots, N$.

(i.e., parent-child interaction). It is noteworthy that for equally altruistic children, equilibrium parental transfers serve to reduce income differentials between children.

In the analysis of a sequential game that determines the parent's choice of a financial transfer, we find that the amount of financial resources used to induce the children's merit goods is an increasing function of parental income. Also, more altruistic parents transfer more resources to their children than less altruistic parents. We also compare the Nash equilibrium in a noncooperative game with a cooperative game in which parents determine both the transfer amount and the levels of children's merit goods. We find that the amount of resources required to induce children's supply of merit goods is greater under a noncooperative Nash game than under a cooperative game. There are conditions under which moral hazard problems arise within the family in that children's merit goods are undersupplied from the parent's perspective. Thus, despite the fact that the family serves an income equalizer for children with different abilities, parental altruism is not immune to moral hazard problems in the supply of merit goods from children to their parents.

Appendix

PROOF OF PROPOSITION 4. To prove Proposition 4 for the comparative static results of the sequential game, we rewrite the parents' FOC in Equation 25 as

$$-u_I(y_p - M, e_1, e_2) + u_{e_1}(y_p - M, e_1, e_2)\frac{\partial e_1}{\partial M} + u_{e_2}(y_p - M, e_1, e_2)\frac{\partial e_2}{\partial M} + \beta\gamma\frac{\partial Y_1}{\partial M} + \beta\gamma\frac{\partial Y_2}{\partial M} = 0.$$

Taking the partial derivative of the FOC with respect to y_p yields

$$\frac{\partial M^*}{\partial y_p} = -\frac{1}{J}\left[-u_{II} + u_{e_1 I}\left(\frac{\partial e_1}{\partial M}\right) + u_{e_2 I}\left(\frac{\partial e_2}{\partial M}\right)\right], \tag{A1}$$

where M^* is the Nash equilibrium transfer. Substituting

$$\frac{\partial e_1}{\partial M} = \frac{w_2 - \alpha_2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2}$$

and

$$\frac{\partial e_2}{\partial M} = \frac{w_1 - \alpha_1}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2}$$

into (A1) yields

$$\frac{\partial M^*}{\partial y_p} = \frac{1}{J}\left\{u_{II} - \frac{u_{e_1 I}(w_2 - \alpha_2) + u_{e_2 I}(w_1 - \alpha_1)}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2}\right\} > 0.$$

Next, taking the partial derivative of the parents' FOC with respect to β yields

$$\frac{\partial M^*}{\partial y_p} = -\frac{1}{J}\left[\gamma\left(\frac{\partial Y_1}{\partial M}\right) + \gamma\left(\frac{\partial Y_2}{\partial M}\right)\right]. \tag{A2}$$

Substituting

$$\frac{\partial Y_1}{\partial M} = \frac{(w_2 - \alpha_2)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} > 0$$

and

$$\frac{\partial Y_2}{\partial M} = \frac{(w_1 - \alpha_1)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} > 0$$

into (A2) yields

$$\frac{\partial M^*}{\partial \beta} = -\frac{\gamma}{J}\left\{\frac{(w_2 - \alpha_2)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} + \frac{(w_1 - \alpha_1)^2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2}\right\} > 0. \qquad \textit{QED}.$$

PROOF OF PROPOSITION 5. To prove Proposition 5, we first compare parental transfers in the two alternative games. In the cooperative game, the parents' choice of a financial transfer $\tilde{M}$ satisfies the following FOC (see Eqn. 29):

$$\frac{\partial U}{\partial M} = -u_l(y_p - \tilde{M}, \tilde{e}_1, \tilde{e}_2) + \beta\gamma = 0. \tag{A3}$$

In the sequential game, the parents' choice of a financial transfer M^* satisfies the following FOC (see Eqn. 25):

$$\begin{aligned}\frac{\partial U}{\partial M} &= -u_l(y_p - M^*, e_1^*, e_2^*) + u_{e_1}\frac{\partial e_1^*}{\partial M^*} + u_{e_2}\frac{\partial e_2^*}{\partial M} + \beta\gamma\left[-(w_1-\alpha_1)\frac{\partial e_1^*}{\partial M^*} + \frac{e_1^*}{e_1^*+e_2^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_1^*}{e_1^*+e_2^*}\right)\right] \\ &\quad + \beta\gamma\left[-(w_2-\alpha_2)\frac{\partial e_2^*}{\partial M^*} + \frac{e_2^*}{e_1^*+e_2^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_2^*}{e_1^*+e_2^*}\right)\right] \\ &= -u_l(y_p - M^*, e_1^*, e_2^*) + \beta\gamma + u_{e_1}\frac{\partial e_1^*}{\partial M^*} + u_{e_2}\frac{\partial e_2^*}{\partial M^*} + \beta\gamma\left[-(w_1-\alpha_1)\frac{\partial e_1^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_1^*}{e_1^*+e_2^*}\right)\right] \\ &\quad + \beta\gamma\left[-(w_2-\alpha_2)\frac{\partial e_2^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_2^*}{e_1^*+e_2^*}\right)\right] = 0.\end{aligned} \tag{A4}$$

Evaluating the derivative $\partial U/\partial M$ in Equation A3 at the Nash equilibrium (M^*, e_1^*, e_2^*) and subtracting Equation A4 from the resulting expression, we have

$$\begin{aligned}\left.\frac{\partial U}{\partial M}\right|_{(M^*,e_1^*,e_2^*)} &= -u_{e_1}\frac{\partial e_1^*}{\partial M^*} - u_{e_2}\frac{\partial e_2^*}{\partial M} - \beta\gamma\left[-(w_1-\alpha_1)\frac{\partial e_1^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_1^*}{e_1^*+e_2^*}\right)\right] \\ &\quad - \beta\gamma\left[-(w_2-\alpha_2)\frac{\partial e_2^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_2^*}{e_1^*+e_2^*}\right)\right].\end{aligned} \tag{A5}$$

The first two terms on the right-hand side of Equation A5 are negative. To show that the derivative

$$\left.\frac{\partial U}{\partial M}\right|_{(M^*,e_1^*,e_2^*)}$$

in Equation A5 is negative, it suffices to show that both the third and the fourth terms are negative. First, we look at the third term, which is

$$\begin{aligned}&-\beta\gamma\left[-(w_1-\alpha_1)\frac{\partial e_1^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_1^*}{e_1^*+e_2^*}\right)\right] \\ &= -\beta\gamma\left\{-(w_1-\alpha_1)\frac{w_2-\alpha_2}{[(w_1-\alpha_1)+(w_2-\alpha_2)]^2} + M^*\frac{w_2-\alpha_2}{(w_1-\alpha_1)+(w_2-\alpha_2)}\right\} \\ &= -\beta\gamma(w_2-\alpha_2)\left\{-\frac{w_1-\alpha_1}{[(w_1-\alpha_1)+(w_2-\alpha_2)]^2} + \frac{M^*}{(w_1-\alpha_1)+(w_2-\alpha_2)}\right\} \\ &= -\beta\gamma(w_2-\alpha_2)\left\{\frac{M^*[(w_1-\alpha_1)+(w_2-\alpha_2)]-(w_1-\alpha_1)}{[(w_1-\alpha_1)+(w_2-\alpha_2)]^2}\right\} \\ &= -\frac{\beta\gamma(w_2-\alpha_2)}{(w_1-\alpha_1)+(w_2-\alpha_2)}\left(M^* - \frac{M_2^*}{M^*}\right) < 0,\end{aligned} \tag{A6}$$

given that

$$\frac{\partial}{\partial M^*}\left(\frac{e_1^*}{e_1^*+e_2^*}\right) = \frac{w_2-\alpha_2}{(w_1-\alpha_1)+(w_2-\alpha_2)}$$

and that the Nash equilibrium transfer to sibling 2 is

$$M_2^* = \frac{(w_1-\alpha_1)}{(w_1-\alpha_1)+(w_2-\alpha_2)}M^*$$

(see Eqn. 14). Because $(M^*)^2 > M^* > M_2^*$ implies that $M^* - (M_2^*/M^*) > 0$, the sign in Equation A6 is unambiguously negative.

Similarly, we look at the last term in Equation A5, which is

$$
\begin{aligned}
& - \beta\gamma\left[-(w_2 - \alpha_2)\frac{\partial e_2^*}{\partial M^*} + M^*\frac{\partial}{\partial M^*}\left(\frac{e_2^*}{e_1^* + e_2^*}\right)\right] \\
& = -\beta\gamma\left\{-(w_2 - \alpha_2)\frac{w_1 - \alpha_1}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} + M^*\frac{(w_1 - \alpha_1)}{(w_1 - \alpha_1) + (w_2 - \alpha_2)}\right\} \\
& = -\beta\gamma(w_1 - \alpha_1)\left\{-\frac{w_2 - \alpha_2}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2} + \frac{M^*}{(w_1 - \alpha_1) + (w_2 - \alpha_2)}\right\} \\
& = -\beta\gamma(w_1 - \alpha_1)\left\{\frac{M^*[(w_1 - \alpha_1) + (w_2 - \alpha_2)] - (w_2 - \alpha_2)}{[(w_1 - \alpha_1) + (w_2 - \alpha_2)]^2}\right\} \\
& = -\frac{\beta\gamma(w_1 - \alpha_1)}{(w_1 - \alpha_1) + (w_2 - \alpha_2)}\left(M^* - \frac{M_1^*}{M}\right) < 0,
\end{aligned}
\tag{A7}
$$

given that

$$\frac{\partial}{\partial M^*}\left(\frac{e_2^*}{e_1^* + e_2^*}\right) = \frac{w_1 - \alpha_1}{(w_1 - \alpha_1) + (w_2 - \alpha_2)}$$

and that the Nash equilibrium transfer to sibling 1 is

$$M_1^* = \frac{(w_2 - \alpha_2)}{(w_1 - \alpha_1) + (w_2 - \alpha_2)}M^*$$

(see Eqn. 13). Because $(M^*)^2 > M^* > M_1^*$ implies that $M^* - (M_1^*/M^*) > 0$, the sign in Equation A7 is unambiguously negative.

It follows from Equations A5, A6, and A7 that

$$\left.\frac{\partial U}{\partial M}\right|_{(M^*, e_1^*, e_2^*)} < 0. \tag{A8}$$

Strict concavity of the parents' altruistic preference function implies that

$$\tilde{M} < M^*. \tag{A9}$$

Next, we compare children's services in the two alternative games. In the cooperative game, the amounts of services by the children satisfy the following FOCs (see Eqns. 30 and 31):

$$\frac{\partial U}{\partial e_1} = u_{\tilde{e}_1} + \beta\gamma\left[\frac{\tilde{e}_2}{(\tilde{e}_1 + \tilde{e}_2)^2}\tilde{M} - w_1 + \alpha_1\right] - \frac{\beta\gamma\tilde{e}_2\tilde{M}}{(\tilde{e}_1 + \tilde{e}_2)^2} = 0, \tag{A10}$$

and

$$\frac{\partial U}{\partial e_2} = u_{\tilde{e}_2} + \beta\gamma\left[\frac{\tilde{e}_1}{(\tilde{e}_1 + \tilde{e}_2)^2}\tilde{M} - w_2 + \alpha_2\right] - \frac{\beta\gamma\tilde{e}_1\tilde{M}}{(\tilde{e}_1 + \tilde{e}_2)^2} = 0. \tag{A11}$$

In the sequential game, the amounts of children's services satisfy the following FOCs (see Eqns. 4 and 5):

$$\frac{e_2^*}{(e_1^* + e_2^*)^2}M^* - w_1 + \alpha_1 = 0, \tag{A12}$$

and

$$\frac{e_1^*}{(e_1^* + e_2^*)^2}M^* - w_2 + \alpha_2 = 0. \tag{A13}$$

Evaluating the derivatives $\partial U/\partial e_1$ and $\partial U/\partial e_2$ in Equations A10 and A11 at the Nash equilibrium (M^*, e_1^*, e_2^*), taking into account Equations A12 and A13, we have

$$\left.\frac{\partial U}{\partial e_1}\right|_{(M^*, e_1^*, e_2^*)} > (=)(<) 0 \quad \text{if } u_{e_1^*} > (=)(<) \frac{\beta\gamma e_2^* M^*}{(e_1^* + e_2^*)^2},$$

and

$$\left.\frac{\partial U}{\partial e_1}\right|_{(M^*, e_1^*, e_2^*)} > (=)(<) 0 \quad \text{if } u_{e_2^*} > (=)(<) \frac{\beta\gamma e_1^* M^*}{(e_1^* + e_2^*)^2}.$$

Strict concavity of the parents' altruistic preference function implies that

$$\tilde{e}_1 > e_1^* \quad \text{if } u_{e_1} > \frac{\beta\gamma e_2^* M}{(e_1^* + e_2^*)^2},$$

and

$$\tilde{e}_2 > e_2^* \qquad \text{if } u_{e_2} > \frac{\beta\gamma e_1^* M}{(e_1^2 + e_2^*)^2}. \qquad QED.$$

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