Endogenous Altruism: Theory and Evidence from Chinese Twins

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This paper studies the endogenous formation of intersibling altruism. The theory suggests that parental incentive to foster children's fraternal love is positively related to efficiency gains from more human capital investment in the more gifted child. The empirical analyses explore the plausibly exogenous within-twin difference in birth weight, a proxy for prenatal endowment. Consistent with the theory, the estimation results show that a larger difference in children's birth weight leads to more intensive parenting practice to foster children's fraternal love and that when such practice is more intensive, the heavier child obtains more investment relative to the other child.

> The formation of preferences is rational in the sense that parental spending on children partly depends on the anticipated effects of childhood experiences on adult attitudes and behavior. (Gary Becker, Nobel lecture, 1992)
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> Filial piety (*xiao*) and fraternal love (*ti*) are the root of all benevolent actions. (Confucius, chap. 2, *The Analects*, 475 BC)

I. Introduction

Many economists agree that preferences can be influenced by examples and persuasion as opposed to being fixed and immutable, as conventionally as-

The idea for this paper is based on my early experience of living with my parents and brother in a remote village in rural China. I am grateful to Gary Becker, James Heckman, and Junsen Zhang for their encouragement, guidance, and extremely helpful suggestions. I thank Pierre-André Chiappori for helpful comments on the robustness analysis. Collection of the data used in this paper was financed by the Chinese University of Hong Kong. I acknowledge financial support from the National University of Singapore (FASS start-up grant R-122-000-211-133, HSS grant R-122-000-232-646, and FRC grant R122-000-247-115). The usual disclaimer applies. Con-

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sumed (Pollak 1978). In particular, families play a crucial role in developing children's human capital and, more importantly, in shaping their preferences, as children are most malleable at the early stages when living with their parents (Heckman 2007, 2008). This paper studies the endogenous formation of intersibling altruistic preference and its implications for intrahousehold allocation of human capital investment among children. It has two novel features. First, it builds a theory to demonstrate that parental incentive to foster children's intersibling altruism is closely related to family human capital investment decisions. Second, it offers consistent empirical evidence on the endogenous formation of preferences, in contrast to existing studies, which are almost all theoretical.

The theoretical analysis incorporates intersibling transfers into a standard model of intrahousehold human capital investment between children, reflecting a crucial rule of how parents foster children's preferences. Consider the conflict between efficiency and equality in a model of intrahousehold human capital investment in two children (Becker and Tomes 1976; Behrman, Pollak, and Taubman 1982; Sheshinski and Weiss 1982; Behrman 1997; Browning, Chiappori, and Weiss 2014).[1] In this setting, parents with a fixed amount of resources have two children. One child is more gifted than the other. Parents want to maximize the total wealth of the family (efficiency); at the same time, they want their children to share family wealth equally (equality). The literature concludes that child endowment and family investment are complementary inputs in the human capital production function (Pitt, Rosenzweig, and Hassan 1990; Cunha and Heckman 2007; Heckman 2007).[2] So if parents invest more in the more gifted child, attempting to maximize the total return by equalizing the marginal productivity of human capital investment between children, efficiency increases but at the expense of greater inequality. Alternatively, if parents invest more in the less gifted child, equality improves but at the expense of less efficiency. In real life, many parents—especially those in developing countries, where the public education system is not well established—face this dilemma. To achieve the dual goals of efficiency and equality, how do parents allocate resources among children?

The parental strategy proposed in the literature appears intuitive but not tenable, because the relevant empirical results imply that parents do not seem to care about their less gifted children. Specifically, the strategy is to invest more in the more gifted child for a higher marginal return when children are young and to leave more bequests to the less gifted child when children become adults (Becker and Tomes 1976; Behrman 1997). As such, family hu-

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[1] Throughout the paper, efficiency is defined as maximizing the total return from family investment in children's human capital, and inequality refers to the gap in consumption among children.

[2] Cunha and Heckman (2007) and Heckman (2007) explore this complementarity, which generates a dynamic multiplier in the formation of child human capital.

man capital investment reinforces the gap in children's endowment or wealth, while bequests compensate for it. The empirical evidence shows that parents indeed invest more in the more gifted child (Behrman, Rosenzweig, and Taubman 1994; Rosenzweig and Zhang 2009). However, not many families leave bequests, and among those that do, bequests are usually divided equally (Stark and Zhang 2002). This inconsistency is a major puzzle in the literature on intrahousehold resource allocation.

This paper hypothesizes a novel strategy. The theoretical foundation is that parental incentive to foster intersibling altruistic preference is positively related to the efficiency gains from more human capital investment in the more gifted child. Consider a hypothetical case in which parents and children commit to an agreement. The more gifted child receives more investment, and he promises to directly transfer wealth to his less gifted sibling in adulthood. This scheme looks ideal, as the dual goals of efficiency and equality could be achieved. However, the more gifted child who benefits from human capital investment may not transfer as much wealth as expected by his parents. Since parents cannot control the actions of the gifted child, who is the second mover, a limited-commitment problem would arise, which reflects intrahousehold transaction costs (Pollak 1985). To enforce such an agreement in practice, this paper proposes a theoretical model where parents teach their children to be altruistic toward each other. Specifically, parents make two decisions simultaneously when their children are young: (i) invest more in the more gifted child, consistent with the empirical evidence, and (ii) educate children to be altruistic, which could ensure transfers from the more gifted child to the less gifted one. In this sense, the endogenous formation of intersibling altruism is rational, echoing Becker's quote at the beginning of the paper.

China provides an excellent context for testing the hypotheses derived from the model, as intersibling altruism and transfers have been ingrained and practiced for centuries. As stated in Confucius's quote at the beginning of this paper, fraternal love (*ti*) is emphasized as one of the two core virtues in Confucian philosophy.[3] Also, transfers among family members constitute a large share of family income. The share of family income comprising intersibling transfers was more than 9% in 2003, according to the Chinese Adult Twin Survey (Li, Rosenzweig, and Zhang 2010). Transfers among relatives are even larger, representing about 18% of family income in 2010, as inferred from the nationally representative China Family Panel Studies survey. Moreover, it is not rare in China that families sacrifice the education of some children for the sake of other children. Many children join the labor market early and remit part of their resources to relax constraints on the family budget, which enables their siblings to continue with their schooling (Chu, Xie, and Yu 2007).[4]

[3] In this paper, I use fraternal love (*ti*) and intersibling altruism interchangeably.

[4] Although China has implemented strict population controls since 1979, many families have two or more children. For example, the 2010 population census data show that the average number of survived children is 1.8 for 44-year-old women,

I empirically test the model predictions in China's context using twinning as a natural experiment. I explore the plausibly exogenous within-twin difference in birth weight, which is a proxy for prenatal endowment.[5] This difference in birth weight creates an efficiency incentive for parents to invest more in the heavier child. A larger difference in human capital investment between twins would enhance parental incentive to educate their children on the importance of fraternal love, as altruistic education could increase intersibling transfers and thus decrease the gap in children's consumption. Specifically, the empirical analyses require four types of data: (i) children's endowment, (ii) family investment in children's human capital, (iii) parenting practice in childhood to foster children's intersibling altruism, and (iv) transfers between siblings in adulthood.

The empirical tests draw on data from the Longitudinal Chinese Child Twin Survey (LCCTS), which is designed to collect all needed information. In particular, this survey provides data on exogenous variation in birth weight between twins to carry out the identification. More importantly, I carefully measured parenting practice to foster children's fraternal love, using the frequency with which parents told their children the story "Kong Rong Giving Up Pears," the most popular example used to demonstrate the importance of fraternal love in China. Lévy-Garboua, Meidinger, and Rapoport (2006) conclude that using examples is one of the best methods to educate children. Therefore, this variable effectively measures parenting practice to foster children's fraternal love.

The empirical results based on the LCCTS data are consistent with the theoretical predictions. First, the results for the family altruistic education equation show that a larger gap in children's birth weight leads to a more intensive parenting practice to foster children's fraternal love. Second, the results for the intrahousehold human capital investment equation show that conditional on the gap in birth weight, the heavier child obtains more human capital investment relative to the other child when parents are more likely to educate their children about intersibling altruism. Third, the results for the intersibling transfer equation suggest that transfers between adult siblings are indeed larger if their parents put more efforts into fostering fraternal love in childhood.

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which is the average age of mothers of twin children used in the empirical analyses below (National Bureau of Statistics 2012). See Huang (2016) and Huang and Zhou (2015) for the consequences of China's one-child policy. Moreover, China officially terminated the one-child policy in both urban and rural areas in 2015. In the future, there will likely be more families with two or more children.

[5] Within-twin variation in birth weight provides an ideal empirical setting to examine intrahousehold human capital investment based on endowments. For ordinary siblings, even with available longitudinal data, it is not possible to distinguish between the endowment effect and the time effect or the age effect since it is impossible to observe human capital investment at the same age and at the same time (Todd and Wolpin 2003).

The remainder of this paper is organized as follows. Section II reviews the literature. Section III builds the theoretical model. Section IV describes the data. Section V shows the estimation results, while Section VI discusses the robustness of the empirical findings. Section VII concludes with a policy discussion.

II. Literature

The economics literature on the endogenous formation of preferences is burgeoning (Stigler and Becker 1977; Becker 1996; Becker and Mulligan 1997; Mulligan 1998; Stark and Falk 1998). Recent theoretical developments include Becker, Murphy, and Spenkuch's (2016) model of intrahousehold investment in children's human capital, parental manipulation of children's preferences, and old-age support as well as Doepke and Zilibotti's (2015) model of rationalizing the choice between alternative parenting styles, which affects children's preferences. However, the existing literature contains little on the relationship between parental incentive to influence children's preferences and intrahousehold resource allocation among children. Empirical evidence on endogenous preference formation is also rare. This paper examines the endogenous formation of altruism toward siblings and provides robust empirical results. Moreover, parents fostering of children's fraternal love may enhance our understanding of the intergenerational transition of culture within households (Bisin and Verdier 2000).

The paper is also closely related to the literature on the historical origin of preferences and the interaction between institutions and cultures (Alesina and Giuliano 2015; Galor and Özak 2016).[6] My study suggests that the persistence of the strong emphasis on fraternal love for thousands of years in Confucianism could be attributed to several culture-specific socioeconomic factors, including (i) high fertility, (ii) high returns to education due to the examination system (*ke ju*), and (iii) household credit constraints in educational investment. Over recent decades, however, these factors might have changed with the market-oriented economic reform, influencing parental incentive to foster their children's preferences. In particular, the decrease in fertility and the availability of public education may weaken parental incentive for altruistic education.

This paper models the formation of intersibling altruism as the endogenous response to a commitment problem, contributing to the literature on altruism. Becker's (1974) famous rotten kid theorem, which shows that altruistic parents make efficient decisions to allocate family resources even if children are selfish, is challenged because of the potential commitment problem (Hirshleifer 1977; Bernheim and Stark 1988; Lindbeck and Weibull

[6] Bowles (1998) concludes, e.g., that "markets and other economic institutions do more than allocate goods and services: They also influence the evolution of values, tastes, and personalities" (75).

1988; Bergstrom 1989). In particular, Hirshleifer (1977) points out that Becker's idea works only if parents can control the last move. This paper suggests that family altruistic education could ensure efficient and equitable human capital investment without relying on parents directly controlling the last move. This analysis is also among the first empirical studies of altruism.[7]

Finally, this study solves the major puzzle described earlier, advancing the literature on intrahousehold resource allocation (Becker and Tomes 1976; Griliches 1979; Behrman, Pollak, and Taubman 1982; Behrman 1997). I show that when making intrahousehold human capital investment decisions, parents take into consideration transfers among their children and attempt to influence these future transfers by fostering children's altruism. The analysis implies that prior literature that omits intersibling transfers underestimates the degree of parental aversion to inequality among children. The results in this paper demonstrate that parents are indeed concerned with such inequality, as manifested by parents' emphasis on altruistic education.

III. Parental Incentive for Family Altruistic Education

This section presents a simple model to illustrate the intuition underlying the parental incentive to influence children's altruism and to explore the implications of the endogenous formation of intersibling altruism for intrahousehold allocation of human capital investment between children. Relative to the standard model in the literature (Becker and Tomes 1976; Behrman, Pollak, and Taubman 1982; Behrman, Rosenzweig, and Taubman 1994; Behrman 1997; Li, Rosenzweig, and Zhang 2010; Browning, Chiappori, and Weiss 2014), this model has two prominent features. First, parents consider transfers between their children when making decisions to invest in children's human capital. Second, parents can affect transfers between children by fostering children's altruism.

A. Model Setup

The model is set in two stages. In the first stage, parents make decisions to invest in their children's human capital and to foster their children's altruism. In the second stage, children make decisions to transfer wealth to siblings, taking their human capital and degree of intersibling altruism as given. I begin with examining the problem of parents who have two children, i and j. Parents are altruistic and care about each child's consumption, c_i and c_j. I denote parental utility from children's consumption as $V = V(c_i, c_j)$, where $\partial_V/\partial_{c_\tau} \geq 0$ and $\partial^2_v/\partial^2_{c_\tau} \leq 0$ $(\tau = i, j)$. Parents are concerned about the level of inequality in children's consumption, which requires two assumptions in the model. First, c_i and c_j are not perfect substitutes, and thus $V(c_i, c_j)$ is not a linear function. Second, parents may teach their children to be altruistic

[7] Foster and Rosenzweig (2001) and Li, Rosenzweig, and Zhang (2010) involve empirical analyses, but they treat altruism as exogenous.

toward each other, which enhances transfers between children and decreases inequality in children's consumption in adulthood. Therefore, I assume that the parental utility function is as follows:[8]

$$U_p = V(c_i, c_j) - \eta\alpha, \tag{1}$$

where α is the degree of intersibling altruism and η is the value of disutility associated with parental efforts to foster children's intersibling altruism ($\eta > 0$).[9]

I denote the price of family human capital investment as p_I and family income as Y. Utility-maximizing parents make human capital investment in their children, denoted by I_τ. The parents' budget constraint is

$$p_I(I_i + I_j) = Y. \tag{2}$$

Parents choose α, I_i, and I_j to maximize their utility (eq. [1]), subject to the budget constraint (eq. [2]).

I then consider children's decisions. With parental altruistic education, children care not only about their own consumption but also about their sibling's consumption in adulthood. Child τ's utility function is as follows:[10]

$$U_\tau = U_\tau(c_\tau, c_{-\tau}) = \ln c_\tau + \alpha \ln c_{-\tau}. \tag{3}$$

A child's consumption c_τ depends on his own labor market earnings E_τ and intersibling transfer T ($T \geq 0$):

$$c_\tau = E_\tau \pm T. \tag{4}$$

A child τ making transfers to his sibling $-\tau$ has a consumption of $E_\tau - T$, and a child τ receiving transfers from his sibling $-\tau$ has a consumption of

[8] The model does not take into account parental consumption and the labor-leisure trade-off, following the standard practice in the literature on intrahousehold resource allocation between children (Behrman, Pollak, and Taubman 1982; Behrman, Rosenzweig, and Taubman 1994; Rosenzweig and Zhang 2009; Li, Rosenzweig, and Zhang 2010). Behrman, Pollak, and Taubman (1982) demonstrate that with a separability assumption in parental utility function, the introduction of parental consumption and labor-leisure trade-off does not qualitatively affect the comparative static analysis of intrahousehold investment between children. Under certain functional form assumptions, the remark in app. A mathematically proves that introducing parental consumption and the labor-leisure trade-off does not change the parental decisions on fostering children's fraternal love and on human capital investment between children, although it changes the level of investment.

[9] For the sake of analytical convenience, I incorporate the cost associated with parental efforts to foster intersibling altruism as a disutility in the parental utility function. The disutility η may vary across families. To account for heterogeneity, I control for a series of parental and household characteristics in the empirical analyses.

[10] I assume that family altruistic education is a public good, so both children have the same degree of altruism α. This assumption can be justified by a sufficient large-scale effect of family altruistic education, as supported by the empirical evidence given below.

$E_\tau + T$. Child τ's labor market earnings E_τ are determined by wage rate ω and the child's human capital h_τ, where h_τ is produced by his prenatal endowment e_τ and received human capital investment I_τ, such that $E_\tau = \omega h_\tau(e_\tau, I_\tau)$. As is standard, I assume that $\partial h_\tau/\partial e_\tau \geq 0$, $\partial h_\tau/\partial I_\tau \geq 0$, $\partial^2_{h_\tau}/\partial_{e_\tau^2} \leq 0$, and $\partial^2_{h_\tau}/\partial_{I_\tau^2} \leq 0$. Following the literature (Cunha and Heckman 2007; Heckman 2007), I further assume that child endowment e_τ and family investment I_τ are complementary inputs in the human capital production function, such that $\partial^2_{h_\tau}/\partial_{e_\tau}\partial_{I_\tau} \geq 0$. Without loss of generality, the heavier child is denoted by i, and the lighter child is denoted by j. So $e_i \geq e_j$ throughout. I define the total earnings of the two children as $E = E_i + E_j$.

For children, the degree of altruism α and the human capital h_τ are taken as given. Therefore, the child's problem is to choose the optimal level of transfer, T, to maximize his utility (eq. [3]), subject to the budget constraint (eq. [4]).

B. Decision on Family Altruistic Education

This section analyzes the parental decision on educating their children to be altruistic toward each other. For illustrational simplicity, I assume that parents make a discrete choice of either educating their children to be altruistic or not, that is, α equals 1 or 0.[11] The utility cost of parental altruistic education is η. In the following, I analyze what the corresponding gain is.

If parents choose $\alpha = 0$, the equilibrium intersibling transfer $T_0^* = 0$, which implies $c_{\tau,0}^* = E_{\tau,0}^*$. The intrahousehold human capital investment decision is then reduced to the classic problem considered in the literature (Becker and Tomes 1976; Behrman, Pollak, and Taubman 1982; Behrman 1997). The equilibrium condition is

$$\frac{\partial V}{\partial c_i}\frac{\partial h_i}{\partial I_i} = \frac{\partial V}{\partial c_j}\frac{\partial h_j}{\partial I_j}. \tag{5}$$

The assumption $e_i > e_j$ implies $c_{i,0}^* > c_{j,0}^*$. Moreover, $\partial V/\partial c_i > \partial V/\partial c_j$, and thus $\partial h_i/\partial I_i > \partial h_j/\partial I_j$. The total earnings of the two children in this case is $E_0^* = E_{i,0}^* + E_{j,0}^*$. Finally, I define

$$(c_{i,0}^*, c_{j,0}^*) = \arg\max_{I_i, I_j}\{V(c_i, c_j) | p_I(I_i + I_j) \leq Y\}.$$

I illustrate this case in figure 1. The horizontal line is child i's earnings or consumption, and the vertical line is child j's. The concave curve is the production possibility frontier (PPF) $\{(E_i, E_j) \in \mathcal{R}^2 : p_I(I_i + I_j) = Y\}$. Because $e_i > e_j$ and e_τ and I_τ are complementary inputs in the human capital production function, the PPF skews toward child i. The convex curve V_0 is the in-

[11] This assumption is for illustrational convenience only. In the following empirical analyses, I treat the intensity of family altruistic education as a continuous variable.

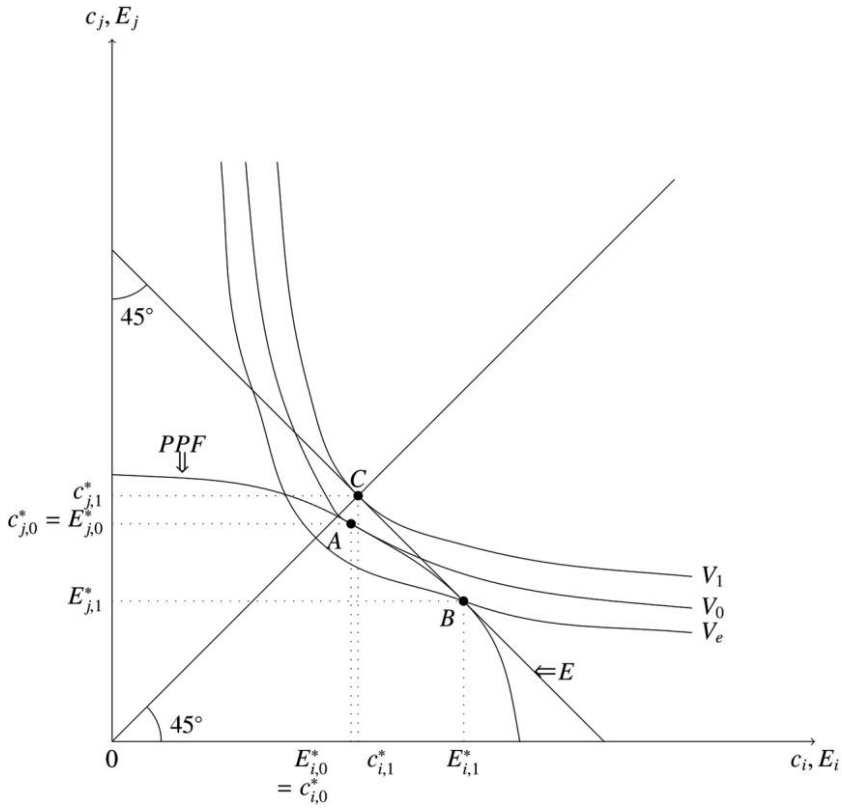

FIG. 1.—Gains from family altruistic education.

difference curve $\{(c_j, c_j) \in \mathcal{R}^2 : V_0 = V(c^*_{i,0}, c^*_{j,0})\}$. The equilibrium occurs at point A, which is the tangency of the PPF and V_0. The figure shows $c^*_{i,0} > c^*_{j,0}$, which results from the assumption $e_i > e_j$.

However, at point A the total earnings of the two children are not maximized. The equilibrium condition that maximizes total earnings E is

$$\frac{\partial h_i}{\partial I_i} = \frac{\partial h_j}{\partial I_j}. \tag{6}$$

In this efficient case, I define the maximum total earnings of the two children as $E^e = E^e_i + E^e_j$, such that

$$\left(E^e_i, E^e_j\right) = \arg\max_{I_i, I_j} \left\{E^e_i + E^e_j | p_I\left(I_i + I_j\right) \le Y\right\}.$$

This case corresponds to point B in figure 1, which is the tangency of the PPF and the straight line E. As $E^*_0 < E^e$, total earnings are not maximized at point A.

Comparison between points A and B illustrates the classical trade-off between efficiency and equality in the literature (Becker and Tomes 1976; Behrman 1997; Behrman, Pollak, and Taubman 1982; Sheshinski and Weiss 1982). On one hand, $E_0^* < E^e$. Total earnings are smaller at point A than at point B. On the other hand, $E_i^e - E_j^e > c_{i,0}^* - c_{j,0}^*$. The gap in consumption between the two children is smaller at point A than at point B. As the indifference curve tangent to the PPF (V_0) is higher than the one across point B (V_e), parents prefer point A to point B, which means that parents sacrifice some efficiency to achieve a decrease in the gap in consumption between the two children.

This efficiency-equality trade-off disappears when parents choose $\alpha = 1$. In this case, the parental human capital investment decision does not affect the gap in children's consumption. Specifically, when $\alpha \neq 0$, child i has to make the transfer decision, and the decision rule is $\alpha c_i = c_j$. As $c_i + c_j = E$, it follows that $c_i = E/(1 + \alpha)$ and $c_j = \alpha E/(1 + \alpha)$. In the special case where $\alpha = 1$, $c_i = c_j = E/2$, so the parents' problem reduces to a total earnings maximization problem.[12] Given their budget constraint (eq. [2]), $E_{\tau,1}^* = E_\tau^e$, $c_{i,1}^* = E^e/2$, and $T^* = |E_{\tau,1}^* - c_{\tau,1}^*|$.

I again illustrate this case in figure 1. The equilibrium when $\alpha = 1$ occurs at point C, which is the tangency of line E and curve V_1, where V_1 is the indifference curve $\{(c_i, c_j) \in \mathcal{R}^2 : V_1 = V(c_{i,1}^*, c_{j,1}^*)\}$. Note that in the presence of intersibling transfers, the allocation of consumption between the two children does not depend on the respective earnings or human capital investment of the two children.

In summary, the gain from family altruistic education is $\Delta = V_1 - V_0$. Parental decision on whether to teach their children to be altruistic is determined by the relative magnitude of Δ and the cost η. When $\Delta > \eta$, $\alpha = 1$; when $\Delta < \eta$, $\alpha = 0$; and when $\Delta = \eta$, parents are indifferent between educating their children to be altruistic or not.

C. Gap in Child Endowment and Family Altruistic Education

This section shows that when the gap in child endowment is larger, parents are more likely to teach their children to be altruistic because they gain more from doing so. Figure 2 illustrates the comparative static analysis. I replicate the case considered in figure 1 using solid curves. I then consider an increase in child I's endowment, with the total endowment held constant.

[12] This conclusion holds more generally and is not specific to the case considered in the paper. Without any functional form assumptions in child utility, when $\alpha \neq 0$, $c_\tau = c_\tau(E, \alpha)$. In other words, in the presence of intersibling transfers, a child's consumption does not depend on his own earnings conditional on total earnings E and the degree of altruism α. So the parents' problem is simply to maximize total earnings (Becker 1974).

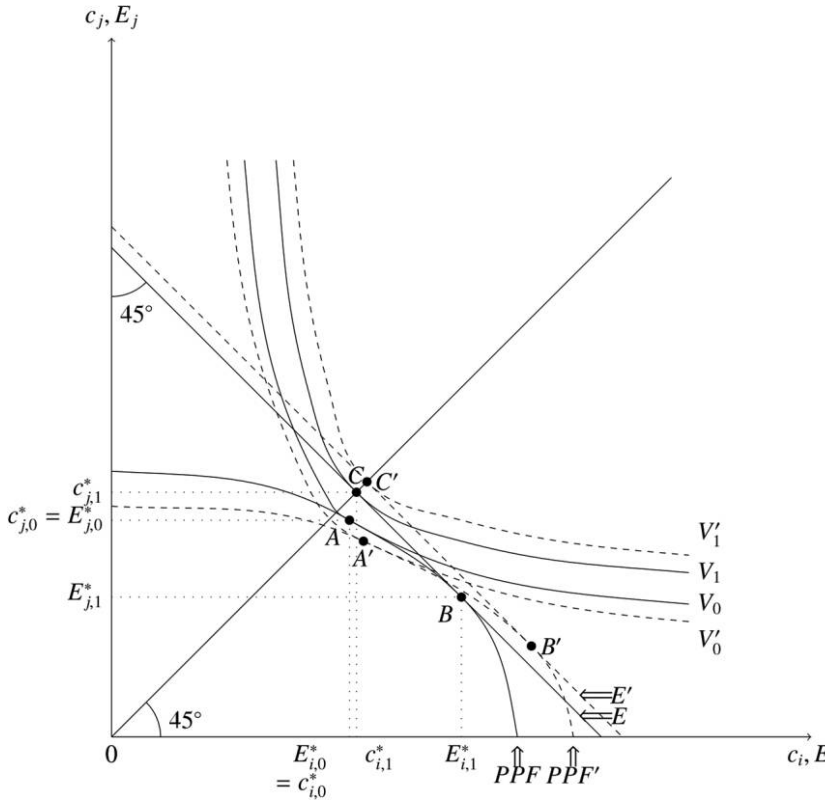

FIG. 2.—Gap in child endowment and gains from family altruistic education.

When child I's endowment increases, the PPF changes to PPF′, skewing toward this child more. If $\alpha = 0$, the new equilibrium occurs at point A', the tangency of PPF′ and V_0'. It is clear from the figure that $V_0' < V_0$. The new maximum total earnings occurs at point B', the tangency of PPF′ and E'. It is again clear that $E' > E$. If $\alpha = 1$, the new consumption point occurs at point C', the tangency of E' and V_1', where $V_1' > V_1$. Based on this figure, $\Delta' > \Delta$, where $\Delta' = V_1' - V_0'$.

Assuming a constant elasticity of substitution (CES) utility function V and a Cobb-Douglas human capital production function h_τ, I derive a clean comparative static result:[13]

$$\frac{d(V_1 - V_0)}{d\ln \frac{e_i}{e_j}} > 0.$$

[13] See app. A for a rigorous derivation.

The larger the gap in child endowment, the larger the gain from altruistic education, and parents thus have more incentive to teach their children to be altruistic. Figure 3 depicts the positive relationship between the gap in child endowment and the gain from parental altruistic education. Accordingly, I predict that parents are more likely to foster their children's altruism toward each other the larger the gap in children's endowment. This is the main prediction that the empirical analyses aim to test.

D. Model Implications

This model has empirical implications as well as welfare implications. I first discuss the empirical implications. The theory developed in this paper implies that omitting the variable of parental altruistic education from the intrahousehold human capital investment equation, as is common in the lit-

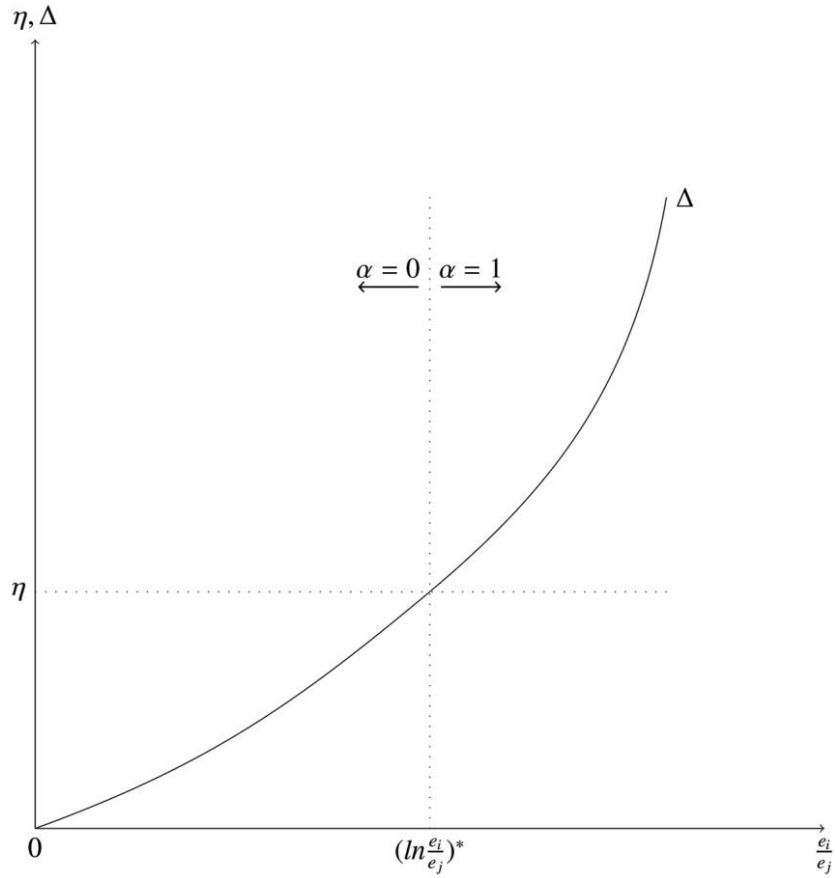

FIG. 3.—Gap in child endowment and decision on family altruistic education.

erature, understates the level of parental aversion to inequality (Becker and Tomes 1976; Behrman, Pollak, and Taubman 1982; Behrman, Rosenzweig, and Taubman 1994; Behrman 1997; Li, Rosenzweig, and Zhang 2010). Specifically, in the literature on family economics, the regular exercise uses the gap in intrahousehold investment in children's human capital as the dependent variable and the gap in child endowment as the independent variable. The researchers then infer the degree of parental aversion to inequality from the estimated coefficient on the gap in child endowment. Although the within-family difference in child endowment is arguably exogenous, I argue that this common practice of inference suffers from an omitted variable bias.

On one hand, my theory predicts a positive relationship between the gap in child endowment and parental altruistic education. On the other hand, the gap in intrahousehold investment in children's human capital is larger when parents more frequently teach their children to be altruistic,[14] that is, altruistic education is positively correlated with the gap in child human capital investment. Therefore, omitting the variable of parental altruistic education when regressing the gap in child investment on the gap in child endowment would lead to an upward bias of the coefficient estimate, implying that the level of parental aversion to inequality is underestimated.

I now discuss the welfare implications. Family altruistic education may move parents closer to their dual goals of efficiency and equality. With perfect intersibling altruism, parental human capital investment maximizes children's total earnings. Therefore, the efficiency distortion due to parental concerns of equality is internalized. In addition, intersibling transfers would decrease the difference in children's consumption. Thus, the welfare loss induced by parental aversion to inequality is also internalized, through the channel of fostering intersibling altruism.

Although the welfare gain seems obvious, parents still need to exert effort in teaching children the importance of fraternal love, which decreases parental utility. As such, the parental decision on altruistic education depends on the effectiveness of encouraging children's fraternal love. In China, as fraternal love has been traditionally emphasized by Confucian culture, the encouragement of intersibling altruism is expected to be effective. In the rest of the paper, I empirically investigate the endogenous formation of children's altruism and its implications for intrahousehold allocation of human capital investment between children. I also verify the effectiveness of family altruistic education.

IV. Longitudinal Chinese Child Twin Survey

The data used in the empirical analyses are derived from the LCCTS, the same data used in Rosenzweig and Zhang (2009), Yi et al. (2015), and Guo, Yi, and Zhang (2017). To the best of my knowledge, the LCCTS is the first

[14] See app. A for a detailed discussion.

census-type longitudinal household survey of twin children. The survey was conducted in Kunming, China, which is the capital of Yunnan, an underdeveloped province located in the far southwestern corner of China. Kunming has 14 county-level units and a total population of approximately 5 million.[15]

The first wave of the survey was designed by Mark Rosenzweig and Junsen Zhang in collaboration with experts from the National Bureau of Statistics. The Urban Survey Unit of the National Bureau of Statistics carried out the survey in late 2002 and early 2003. The survey targeted all households with twin children between the ages of 6 and 18 in Kunming. These households were initially identified by the Urban Survey Unit based on the 2000 population census according to whether children had the same birth year and month and whether they had the same relationship with the household head. Their addresses were then obtained from the census office, and visits to these households further verified the presence of twins.

The second wave, carried out by the same survey unit as the first wave, was designed by James Heckman, Mark Rosenzweig, Junsen Zhang, and me, with the help of experts from local bureaus of statistics. The follow-up survey conducted in 2013 tracked households in the first wave; households were restricted to those with twin children between the ages of 16 and 22, as children above the age of 22 are likely to have graduated from college and be living apart from their parents, which makes it difficult to track them. Although the empirical analyses are cross sectional, I use information from both waves. I have a total of 747 pairs of twins with complete information across both waves.

The LCCTS provides an ideal opportunity to test the theoretical predictions for several reasons. First, within-twin difference in birth weight facilitates identification. Second, the survey questionnaire is carefully designed to collect all information needed in the empirical analyses: child endowment at birth (e_τ), family investment in children's human capital (I_τ), and transfers between siblings in adulthood (T). More importantly, the survey contains information on the parenting practice of altruistic education in childhood, which is denoted by t and regarded as the empirical counterpart of parental input to foster children's intersibling altruism (α). Finally, the survey contains an extensive range of information on demographic, social, and economic characteristics at both the individual level and the household level. Outcome variables of interest are thus readily linked with potential covariates, enabling systematic empirical analyses.

[15] The specifics of the one-child policy and its enforcement varied from one place to another in China. In Kunming, as in the rest of China, the one-child policy was strictly enforced in urban areas. Rural households in the sampling sites, however, were encouraged to have one child but were exempted from the strict one-child policy (Family Planning Commission of Yunnan Province 2003; Rosenzweig and Zhang 2009).

A. Measuring Family Altruistic Education

I construct a variable based on the LCCTS survey questions as a proxy for family altruistic education (t).[16] It measures the frequency with which parents told their children the well-known story "Kong Rong Giving Up Pears" before the children turned 12.[17] The story involves the 4-year-old Kong Rong, a twentieth-generation descendant of Confucius, giving his elder and younger brothers the larger pears and keeping the smallest pear for himself. Appendix B describes the story in detail. This classic story is the most famous example used in China to demonstrate intersibling altruism. It has been used to teach children the importance of fraternal love since the Song dynasty (AD 960–1279) and is still used in contemporary times. This variable is indicative of family altruistic education because one of the most effective methods of teaching children is through the use of examples (Lévy-Garboua, Meidinger, and Rapoport 2006).

The survey question was answered by parents and each child separately, based on a 5-point Likert scale from 1 (never) to 5 (always). The mean of the frequencies reported by parents and children is formally employed as the measure of family altruistic education in the empirical analyses.[18] Notably, the correlation coefficient of family altruistic education practice reported by each twin is as high as 0.92, suggesting that parents probably educate their children on the importance of fraternal love on the same occasions.

This measure of family altruistic education is of high quality. Its explanatory power for intersibling transfers is empirically examined in Section V. Importantly, classic measurement error is minimized, due to the use of the mean frequency from all family members. Section VI further shows that the empirical findings in this paper are least likely to be biased by potential nonclassic measurement error associated with family altruistic education and cross-household heterogeneity.

Although this measure might be highly cultural specific, my work still has general implications for other societies. The case study considered in this paper aims to show that parental incentive to educate children using examples, regardless of the specifics, depends on the anticipated effects of childhood

[16] It is very difficult to measure the parenting practice of altruistic education. In designing the questionnaire for the second wave of the LCCTS, I spent several months and consulted many psychologists, educators, and child development experts on this issue. In 2011, I conducted a workshop on the survey questionnaire in the Department of Economics, University of Chicago. I am thankful to suggestions and comments given by Gary Becker, Angela Duckworth, James Heckman, Robert Michael, Brent Roberts, Mark Rosenzweig, and Junsen Zhang, among others.

[17] In China, children generally graduate from primary school at the age of 12. So it is more effective to teach children by telling stories before this age.

[18] Using factor analysis to generate a score of the intensity of family altruistic education yields qualitatively the same results.

experiences on adult attitudes, preferences, and behavior, as illustrated in Becker's quote at the beginning of the paper (Becker 1993).

B. Birth Weight and Within-Twin Variation

Following common practice, the empirical analyses use birth weight as a proxy for children's prenatal endowment (e_τ) and explore within-twin variation in birth weight to carry out the identification. Birth weight is typically used to measure prenatal endowment in health economics, economics of human capital, and family economics (Behrman and Rosenzweig 2004; Almond, Chay, and Lee 2005; Conley, Strully, and Bennett 2006; Black, Devereux, and Salvanes 2007). However, birth weight is not, strictly speaking, exogenous and can be affected not only by prenatal endowment but also by parental behavior during pregnancy (Currie and Cole 1993; Rosenzweig and Wolpin 1995). To deal with this problem, within-twin difference in birth weight, which can be arguably regarded as random, has been widely used for causal identification. For instance, Behrman and Rosenzweig (2004), Almond, Chay, and Lee (2005), Black, Devereux, and Salvanes (2007), and Oreopoulos et al. (2008) use a within-twin-pair fixed effects estimator to identify the causal effects of birth weight on children's human capital accumulation and their later life-cycle outcomes. Behrman, Pollak, and Taubman (1982) and Li, Rosenzweig, and Zhang (2010) explore within-twin variation in birth weight to identify the behavioral motives in intrahousehold resource allocation. This practice has also been widely applied in other fields, such as medical science, behavioral genetics, and psychology (Hübinette et al. 2001).

Table 1 correlates birth weight and within-twin difference in birth weight with a series of child and parental characteristics.[19] The upper panel reports the ordinary least square (OLS) estimates of the potential determinants of birth weight.[20] As expected, child birth weight is correlated with age, birth order, and maternal ethnicity. The lower panel reports the OLS estimates of the potential determinants of within-twin variation in birth weight. All coefficient estimates turn out to be statistically insignificant. Note that the statistical insignificance is exclusively due to a decrease in the magnitudes of the estimated coefficients (in terms of absolute value) rather than an increase in the magnitudes of standard errors. Moreover, the joint *F*-statistics reported at the bottom of this panel are not significant in any of the specifications. These results suggest that in the main sample, the listed child and parental characteristics are most likely unrelated to within-twin difference in birth weight.

[19] The sample size in table 1 is larger than my main sample, as table 1 is based on only the first wave of LCCTS.

[20] The relationship between birth weight and later outcomes may not be linear in general (Strauss and Thomas 1998). Specifically, prenatal endowment is regarded to be inferior if birth weight is either too low or too high. However, since the birth weight of children born in developing countries tends to be in the lower tail of the distribution, the relationship becomes approximately linear in this setting.

Table 1
Ordinary Least Square Estimates for Potential Determinants of Birth Weight and Within-Twin Difference in Birth Weight

	Birth Weight				
	(1)	(2)	(3)	(4)	(5)
Age	.005	.005	.005*	.005	.005*
	(1.61)	(1.62)	(1.65)	(1.59)	(1.70)
Birth order	.093***	.092***	.095***	.098***	.084***
	(4.07)	(4.03)	(4.42)	(4.55)	(3.58)
Maternal age at twin birth	.002	.002	.002	.002	.002
	(.76)	(.76)	(.82)	(.71)	(.95)
Rural	.021				.006
	(1.11)				(.30)
Maternal schooling years		−.004			−.003
		(1.45)			(.82)
Maternal ethnicity (Han = 1)			−.063**		−.059**
			(2.50)		(2.34)
Maternal employment sector (public = 1)				−.036	−.016
				(1.17)	(.48)
Joint *F*-statistics	6.88	7.33	7.86	6.98	4.90
p-values	.00	.00	.00	.00	.00
Observations	2,912	2,912	2,912	2,912	2,912
R^2	.009	.009	.011	.009	.011
	Within-Twin Difference in Birth Weight				
	(6)	(7)	(8)	(9)	(10)
Age	−.002	−.001	−.002	−.001	−.002
	(.53)	(.50)	(.55)	(.52)	(.56)
Birth order	.010	.004	.008	.006	.011
	(.43)	(.20)	(.40)	(.29)	(.47)
Maternal age at twin birth	.002	.002	.002	.002	.002
	(.86)	(.94)	(.86)	(.91)	(.79)
Rural	−.013				−.010
	(.66)				(.51)
Maternal schooling years		.000			−.002
		(.01)			(.47)
Maternal ethnicity (Han = 1)			.035		.033
			(1.50)		(1.41)
Maternal employment sector (public = 1)				.017	.022
				(.55)	(.59)
Joint *F*-statistics	.53	.38	.88	.45	.61
p-values	.72	.82	.48	.77	.75
Observations	1,456	1,456	1,456	1,456	1,456
R^2	.001	.001	.002	.001	.003

NOTE.—Absolute values of robust *t*-statistics are in parentheses.
* $p < .10$.
** $p < .05$.
*** $p < .01$.

Table 2
Descriptive Statistics of Main Variables

Theoretical Variable	Empirical Counterpart	Mean	SD
t	Family altruistic education[a]	4.283	.906
e	Birth weight (kg)	2.473	.469
I	Educational investment (¥/year)	923.921	1,384.787
T	Intersibling transfer[b]	.572	.236
Y	Household assets (score)	.007	1.757
ω, p_I	Child characteristics (κ):		
	Male (dummy)	.502	.500
	Twin pair characteristics (π^t):		
	Age	21.242	3.137
	Both male (dummy)	.371	.483
	Both female (dummy)	.394	.489
	Parental characteristics (π^P):		
	Maternal age	46.861	4.891
	Maternal ethnicity (dummy: Han = 1)	.863	.344
	Maternal schooling years	8.696	3.298
	Maternal working section (dummy: public = 1)	.086	.280
	Household characteristics (π^h)		
	Rural (dummy)	.547	.498

NOTE.—The sample includes 724 pairs of twins.
[a] The frequency with which parents told their children that having fraternal love among siblings is a virtue, such as telling them the story "Kong Rong Giving Up Pears" before they turned 12. The frequency is measured using a 5-point Likert scale from 1 (never) to 5 (always).
[b] The percentage of the reward that the child transferred to his twin sibling in the dictatorship game.

C. Other Main Variables

Table 2 reports the descriptive statistics of the other main variables. These variables are empirical counterparts of the parameters in the theoretical analysis. One major dependent variable in the empirical work is family investment in children's human capital (I_τ). This variable is measured using family expenditure in the 12 months prior to the first wave of the LCCTS on the education of children, who were on average 9 years old. The survey data record school tuition fees plus money spent on buying books and stationery, hiring home tutors, and attending tuition classes for each child.[21] Notably, educational investment in children constitutes a substantial fraction of family income. In particular, educational investment in a child amounts to RMB 924 per year, out of per capita family income of RMB 3,030. See Li et al. (2012) and Xie and Zhou (2014) for discussions on high family investment in children's education and the role of family in inequality in today's China.

[21] During the survey, parents are asked the following question: "In the past 12 months, how much was spent on each child for the following six items separately: (1) clothing; (2) school tuition; (3) buying magazines and books; (4) buying stationery; (5) hiring a tutor; and (6) training-class expenses?" To construct the measure of parental investment in each child's education, I sum parental expenditure on items 2–6.

To measure intersibling transfer (T), I designed a small dictatorship game during the second wave of the LCCTS. Specifically, I conducted a math test in the survey that all children had to take. One child in each twin pair was randomly chosen to receive a monetary reward. After receiving the money, the rewarded child was asked how much he wanted to share with his twin sibling and that amount of money was actually transferred to his sibling by survey interviewers. The percentage of the child's total reward that he gave to his twin sibling is used to measure intersibling transfer. I designed this game to construct the transfer variable because children in the second wave of the survey were about 20 years old and most were still in school, among whom no real transfers occurred.[22]

Family wealth (Y) is proxied by a household asset score, which is generated by factor analysis using data from the first wave of the survey. The durable goods used to generate the score include washing machine, refrigerator, air conditioner, shower heater, water dispenser, sterilized cupboard, motorcycle, radio recorder, color television, video recorder, video player, hi-fi, camera, telephone, and mobile phone.

For wage (ω) and the price of family human capital investment (p_I), the empirical analyses use child (κ), twin pair (π_t), parental (π_p), and household (π_h) characteristics as proxies. At the time of the survey, although public education is not freely accessible for both urban and rural residents, the quality of education for urban residents is generally higher (Li et al. 2012). In addition, the mother's employment sector is a good proxy for the price of human capital investment. The government usually subsidizes children's education if their mothers are employed in the public sector. Note that the exogeneity of the human capital investment price is assured since Chinese females rarely switch between the public sector and the private sector (Cai, Park, and Zhao 2008).

V. Empirical Analyses

This section empirically tests the model predictions. I estimate three equations: the family altruistic education equation, the intrahousehold human capital investment equation, and the intersibling transfer equation.

A. Within-Twin Variation in Endowment and Family Altruistic Education

The first empirical exercise examines the effect of the gap in children's prenatal endowment on family altruistic education. Specifically, I estimate the family altruistic education equation as follows:

$$t_\iota = \gamma_0 + \gamma_1 \Delta e_\iota + \pi_\iota^t \gamma_2 + \pi_\iota^p \gamma_3 + \pi_\iota^h \gamma_4 + \varepsilon_\iota, \tag{7}$$

[22] Future studies may explore data on real transfers among adult siblings instead of relying on a monetarily incentivized experiment designed for young children, which may be sensitive to field conditions and the parameters used (Bardsley 2008).

where the dependent variable t_ι is a measure of family altruistic education in household ι; e is child birth weight, which is used as a proxy for prenatal endowment; Δ is an operator of within-twin difference, and thus $\Delta e_\iota = e_i - e_j$, representing the birth weight of the heavier twin child minus that of the lighter one; π_ι^t, π_ι^p, and π_ι^h are twin pair–, parent-, and household-specific characteristics; and ε_ι is an error term, which captures any measurement error in family altruistic education.

To test the theoretical prediction, I am interested in the estimate of γ_1, which measures the effect of the gap in child birth weight on family altruistic education. The estimate of γ_1 is expected to be positive, as the theory predicts that parental desire to foster intersibling altruism increases with the gap in children's prenatal endowment. The larger the gap in children's birth weight, the greater the parental incentive to invest in the more gifted child for efficiency reasons. To compensate for the resulting gap in children's earnings, parents are more likely to teach children about the value of altruism. Because within-twin difference in birth weight (Δe_ι) is plausibly exogenous, the estimate of γ_1 can be interpreted as causal.

The estimation results reported in table 3 are consistent with the theoretical prediction. Columns 1 and 2 in panel A use the total sample. The variable of family altruistic education is the only regressor in column 1, while the specification in column 2 controls for all twin pair–, parent-, and household-specific characteristics. In both columns, the estimated coefficients on the gap in children's birth weight γ_1 are positive and statistically significant, indicating that lessons on intersibling altruism are more frequent the greater the gap in children's birth weight. In addition, the empirical results in this table verify the exogeneity of within-twin difference in birth weight. The estimated γ_1 changes little when I include twin pair–, parent-, and household-specific characteristics in the regression equation, as shown in column 2. More rigorously, the Durbin-Wu-Hausman test statistic between columns 1 and 2 is statistically insignificant. These patterns support the likelihood that within-twin difference in birth weight is exogenous.

There exist significant regional differences in the effect of the gap in children's birth weight on family altruistic education. Columns 3 and 4 and columns 5 and 6 replicate the estimations in columns 1 and 2 using rural and urban subsamples, respectively. While the estimates of γ_1 are positive for both rural and urban areas, the magnitude is larger for rural areas. In addition, the estimates are statistically insignificant for urban areas. I suggest two potential explanations for the regional differences. First, the traditional fraternal love emphasized by Confucian culture is better preserved in rural areas. Relative to urban parents, rural parents find it more effective to teach their children to be altruistic toward each other. This argument is supported by the empirical evidence presented in Section V.C below. Second, public education is more prevalent in urban areas, especially when parents are working in the government or state-owned enterprises. So these parents are less likely to suf-

Table 3
Ordinary Least Square Estimates for Effects of Difference in Children's Birth Weight on Family Altruistic Education

	Dependent Variable: Family Altruistic Education					
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A					
	Total		Rural		Urban	
Difference in birth weight	.485***	.443***	.650***	.615***	.282	.291
	(3.73)	(3.38)	(4.20)	(3.62)	(1.31)	(1.45)
Controls	No	Yes	No	Yes	No	Yes
Observations	724	724	396	396	328	328
R^2	.02	.07	.03	.09	.02	.07
	Panel B					
	Male		Female		Mixed	
Difference in birth weight	.579***	.528**	.451*	.468*	.367*	.311*
	(2.98)	(2.36)	(1.75)	(1.96)	(1.71)	(1.66)
Controls	No	Yes	No	Yes	No	Yes
Observations	268	268	285	285	171	171
R^2	.02	.09	.02	.10	.01	.05

NOTE.—Absolute values of robust *t*-statistics are in parentheses. Control variables include child age, household assets (score), a rural dummy, maternal age, schooling years, ethnicity (Han = 1), and employment sector (public = 1). The dependent variable is family altruistic education, i.e., the frequency with which parents told their children that having fraternal love among siblings is a virtue, such as telling them the story "Kong Rong Giving Up Pears" before they turned 12. The frequency is measured using a 5-point Likert scale from 1 (never) to 5 (always). The independent variable is the difference in birth weight between the heavier and lighter children. In panel A, cols. 1 and 2, 3 and 4, and 5 and 6 use the total sample, rural subsample, and urban subsample, respectively. In panel B, cols. 1 and 2, 3 and 4, and 5 and 6 use the male, female, and mixed-gender twin subsamples, respectively.

* $p < .10$.
** $p < .05$.
*** $p < .01$.

fer from credit constraints and the efficiency-equality trade-off discussed above.

I also observe significant gender differences. Columns 1 and 2, 3 and 4, and 5 and 6 in panel B replicate the estimations in columns 1 and 2 in panel A using male, female, and mixed-gender twin subsamples, respectively. If both twins are of the same gender (cols. 1–4), the magnitudes of the estimates of γ_1 are comparable to those obtained using the total sample. The estimates are statistically significant at least at the 10% level. However, for twin pairs of the opposite gender (cols. 5 and 6), the estimates of γ_1 are smaller in magnitude than those obtained using male or female twin subsamples but are statistically significant at the 10% level.

B. Family Altruistic Education and Intrahousehold Human Capital Investment

The second empirical exercise examines the implications of intersibling altruism for intrahousehold allocation of human capital investment between

children. It also shows that omitting the variable of family altruistic education will lead to a downward bias in the estimated degree of parental aversion to inequality. Specifically, I estimate the intrahousehold human capital investment equation as follows:

$$\Delta I_\iota = \delta_0 + \delta_1 \Delta e_\iota + \delta_2 t_\iota + \Delta \kappa_\iota \delta_3 + \Delta \mu_\iota, \tag{8}$$

where the dependent variable ΔI_ι ($= I_i - I_j$) is the educational investment of the heavier twin child minus that of the lighter one in family ι, Δe_ι ($= e_i - e_j$) is the birth weight of the heavier twin child minus that of the lighter one, t_ι is a measure of the intensity of family altruistic education, $\Delta \kappa_\iota$ is a vector of within-twin differences in other individual characteristics, and $\Delta \mu_\iota$ is an error term. While similar to the standard regression specification adopted in the empirical literature, equation (8) has a distinct feature of the inclusion of an altruistic education variable. For comparability with the literature, I estimate equation (8) both without and with controlling for family altruistic education.

The estimation results obtained using the intrahousehold human capital investment equation are reported in table 4. Columns 1–3 are based on the total sample. In column 1, the only regressor is the difference in children's birth weight. Figure C1 in appendix C clearly shows a positive relationship between the difference in birth weight (the *X*-axis) and the difference in parental expenditure on child education (the *Y*-axis). Column 1 confirms this finding: the estimated coefficient on the birth weight gap δ_1 is positive and statistically significant, indicating that parents take a reinforcing intrahousehold human capital investment strategy between children. The result is consistent with the literature (Rosenzweig and Zhang 2009; Li, Rosenzweig, and Zhang 2010). I then classified parental expenditure on child education into three types: (1) school tuition, (2) books and stationery, and (3) tutoring and training. Figure C2 shows a positive relationship between the difference in birth weight and the difference in school tuition, although the relationship is weak. Figure C3 shows no relationship between the difference in birth weight and the difference in parental expenditure on books and stationery, perhaps because twin children within a family usually share these resources. Figure C4 shows a strongly positive relationship between the difference in birth weight and the difference in parental expenditure on tutoring and training classes. Finally, I divided the sample into two subsamples. One contains twin children in primary school (fig. C5), and the other contains those in secondary school (fig. C6). Comparing figure C6 with figure C5, I find positive relationships between the difference in birth weight and the difference in parental expenditure on child education using both subsamples, and the slope is steeper for twin children in secondary school. In summary, parents allocate more educational resources, particularly those related to tutoring and attending training

Table 4
Ordinary Least Square (OLS) and Two-Stage Least Square (2SLS) Estimates for Effects of Family Altruistic Education on Intrahousehold Human Capital Investment

	Dependent Variable: Within-Twin Difference in Educational Investment								
	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	OLS (5)	2SLS (6)	OLS (7)	OLS (8)	2SLS (9)
	Panel A								
	Total			Rural			Urban		
Difference in birth weight	58.812***	41.893***	45.237***	78.219***	60.214***	69.891***	32.894**	20,007	26.899*
	(2.91)	(2.79)	(3.00)	(5.23)	(4.21)	(5.19)	(2.41)	(1.12)	(1.75)
Family altruistic education		16.542**	32.697**		22.719**	37.811**		12.778*	19.993*
		(2.02)	(2.31)		(2.45)	(2.15)		(1.77)	(1.89)
Observations	724	724	724	396	396	396	328	328	328
R^2	.05	.06		.06	.07		.03	.03	
	Panel B								
	Male			Female			Mixed		
Difference in birth weight	72.683***	51.084**	59.321***	42.332**	26.882*	24.336*	18.997	12.42	16.336*
	(2.99)	(2.12)	(3.22)	(2.70)	(1.88)	(1.68)	(.98)	(1.21)	(1.82)
Family altruistic education		22.776**	40.038**		12.43	20.206**		4.28	8.66
		(2.22)	(2.17)		(.88)	(2.22)		(.88)	(.65)
Observations	268	268	268	285	285	285	171	171	171
R^2	.07	.08		.04	.05		.02	.02	

NOTE.—Absolute values of robust *t*-statistics are in parentheses. The dependent variable of within-twin difference in education investment is defined as the difference in educational investment between the heavier and lighter children. The independent variable of within-twin difference in birth weight is the difference in birth weight between the heavier and lighter children. The independent variable of family altruistic education is the frequency with which parents told their children that having fraternal love among siblings is a virtue, such as telling them the story "Kong Rong Giving Up Pears" before they turned 12. The frequency is measured using a 5-point Likert scale from 1 (never) to 5 (always). Family altruistic education is the endogenous variable in cols. 3, 6, and 9 in both panel A and panel B. The instrumental variables are maternal age, schooling years, and employment sector. In panel A, cols. 1–3, 4–6, and 7–9 use the total sample, rural subsample, and urban subsample, respectively. In panel B, cols. 1–3, 4–6, and 7–9 use the male, female, and mixed-gender twin subsamples, respectively.

* $p < .10$.
** $p < .05$.
*** $p < .01$.

classes, to the heavier twin child when the gap in birth weight between the pair is large. These gaps in educational expenditure between twins are greater when they are in secondary school than in primary school.

The theoretical analysis suggests that column 1 might be misspecified, as it assumes that parents do not consider intersibling transfers when investing in children's human capital. Econometrically, the estimated δ_1 in column 1 may be suffering from omitted variable bias, although the difference in children's birth weight is arguably random. Specifically, the difference in children's birth weight may affect parental incentive to teach their children to be altruistic, which in turn may affect intrahousehold human capital investment. Therefore, the inference drawn from column 1 might not be precise.

To examine the implication of parental altruistic education for intrahousehold human capital investment, column 2 includes the variable of family altruistic education as an additional regressor. The estimate of its coefficient δ_2 is positive and statistically significant, indicating that conditional on the gap in children's birth weight, the heavier child receives more human capital investment relative to the lighter child when family altruistic education is more intensive. The result is consistent with the theoretical analysis, confirming that parents take intersibling transfers into account when making decisions on human capital investment. Moreover, a comparison of columns 1 and 2 shows that the magnitude of the estimated coefficient on the birth weight gap δ_1 decreases after controlling for family altruistic education. This pattern implies that the omission of intersibling altruism, or family altruistic education, leads to an upward bias of the estimated coefficient on the endowment difference, thus understating the degree of parental aversion to inequality.

Family altruistic education t_ι in equation (8) is an endogenous variable because it is a parental choice outcome. I use three strategies to address this issue. Following the practice in the empirical literature (Rosenzweig and Wolpin 1995), I use household-level variables as instrumental variables (IVs) for the endogenous regressor in a difference equation. The validity of this method relies on the functional form assumptions. Following the common practice in the literature, I assume a CES utility function and a Cobb-Douglas human capital production function in appendix A. In this case, wage (ω) and the price of family human capital investment (p_I) qualify as good IVs for t_ι in equation (8) because these variables could affect family altruistic education but do not directly affect the difference in human capital investment between the two children.[23] The empirical analyses use maternal age, schooling years, and employment sector as proxies for these IVs. In particular, differential maternal employment sector induces variation in the price of children's education because the government largely covers children's educational costs if the

[23] Equations (A1) and (A2) in app. A show that ω and p_I do not directly affect the difference in human capital investment between the two children.

mother is employed in the public sector. The results from an IV regression are presented in column 3 of panel A.[24] The two-stage least square (2SLS) estimates are qualitatively the same as the OLS estimates.

Yet it is recognized that the validity of these instruments for family altruistic education crucially hinges on the functional form assumptions in the theoretical analysis. I carry out the second strategy in two steps. In the first step, I estimate equation (8) using five subsamples, without including family altruistic education. Columns 4 and 7 in panel A report the estimates for the rural and urban subsamples, while columns 1, 4, and 7 in panel B report those for the male, female, and mixed-gender twin subsamples. In the second step, I correlate the estimated coefficients on the birth weight gap δ_1 in equation (8), which regresses the human capital investment difference without including family altruistic education (reported in table 4), with the estimated coefficients on the birth weight gap γ_1 in equation (7), which regresses altruistic education (reported in table 3), for the five subsamples. The theory predicts that the gap in children's birth weight incentivizes parents to encourage intersibling altruism, which leads to intrahousehold human capital investment that reinforces children's endowment. Thus, I expect to empirically observe a positive correlation between γ_1 and δ_1 for different subsamples. Figure C7 plots δ_1 against γ_1. The figure clearly shows a positive relationship between these two sets of estimated coefficients, in line with the theoretical prediction.

In the final strategy, I present a more detailed robustness discussion in Section VI below showing that the empirical findings cannot be primarily attributed to omitted variables, such as unobservable cross-household heterogeneity in the background of Confucian culture and heterogeneity in parental preference, or to measurement error in the variable of family altruistic education.

In summary, the results reported in table 4 are consistent with the theoretical prediction. Parents do consider transfers among their children when making decisions regarding human capital investment; they invest more in the more gifted child relative to the other child when family altruistic education is more intensive. Moreover, the degree of parental aversion to inequality among children would be understated if family altruistic education is omitted from the intrahousehold human capital investment equation.

C. Effectiveness of Family Altruistic Education

The final empirical test investigates the effectiveness of family altruistic education, regressing intersibling transfers in adulthood on family altruistic education in childhood. Specifically, I estimate the following intersibling transfer equation:

[24] Table D1 in app. D reports the first-stage estimation results.

$$T_{\tau,\iota} = \eta_0 + \eta_1 \Delta e_\iota + \eta_2 t_\iota + \Delta \kappa_\iota \eta_3 + \upsilon_\iota, \quad (9)$$

where the dependent variable $T_{\tau,\iota}$ is the experimentally measured transfer from child τ to his sibling $-\tau$ in household ι, Δe_ι is the birth weight of the heavier twin child minus that of the lighter one, t_ι is a measure of the intensity of family altruistic education, $\Delta \kappa_\iota$ is a vector of within-twin differences in other individual characteristics, and υ_ι is an error term. In particular, the variable of intersibling transfer T is the percentage of the child's total reward that he gave to his twin sibling in the dictatorship game described above.

Table 5 presents the estimation results based on the intersibling transfer equation (9). Column 1 in panel A includes the difference in birth weight between twin siblings as the only independent variable and uses the total sample. The positive estimate indicates that child τ transfers more to his sibling $-\tau$ when child τ has better prenatal endowment as measured by birth weight. Column 2 includes family altruistic education. The estimate of the coefficient on family altruistic education η_2, which measures the effectiveness of such practice, is of primary interest. If family altruistic education is effective in fostering children's altruism in the sense of enhancing intersibling transfers, the estimated η_2 is predicted to be positive. Indeed, the estimate of η_2 is positive and statistically significant, meaning that the greater the intensity of family altruistic education, the larger the intersibling transfer, conditional on the gap in children's birth weight.

As family altruistic education t_ι is a parental choice in the model, I follow the three strategies introduced above to address the endogeneity issue. Column 3 reports the 2SLS estimates, using maternal age, schooling years, and employment sector as IVs. The pattern of the results remains qualitatively similar to the OLS estimates (col. 2). Moreover, I estimate equation (9) based on five subsamples without adding family altruistic education. Columns 4 and 7 in panel A report the estimates for the rural and urban subsamples, while columns 1, 4, and 7 in panel B report those for the male, female, and mixed-gender twin subsamples. I then correlate the estimated coefficients on the birth weight gap η_1 in equation (9), which regresses intersibling transfer without adding family altruistic education (reported in table 5), with the estimated coefficients on the birth weight gap γ_1 in equation (7), which regresses altruistic education (reported in table 3). The theory predicts that the gap in children's birth weight incentivizes parents to encourage intersibling altruism, which leads to more intersibling transfers in adulthood. Figure C8 confirms this prediction by plotting η_1 against γ_1, showing a positive relationship. I discuss the robustness of the results in Section VI.

In summary, the results in table 5 indicate that more intensive family altruistic education leads to larger intersibling transfers. Moreover, the valid-

Table 5
Ordinary Least Square (OLS) and Two-Stage Least Square (2SLS) Estimates for Effects of Family Altruistic Education on Intersibling Transfers

	Dependent Variable: Intersibling Transfer								
	OLS (1)	OLS (2)	2SLS (3)	OLS (4)	OLS (5)	2SLS (6)	OLS (7)	OLS (8)	2SLS (9)
	Panel A								
	Total			Rural			Urban		
Difference in birth weight	.104**	.071**	.098***	.201***	.145***	.187**	.086	.062	.071*
	(2.42)	(2.11)	(3.30)	(2.77)	(2.97)	(2.22)	(1.33)	(.85)	(1.73)
Family altruistic education		.137**	.153**		.190***	.214**		.090*	.112**
		(2.02)	(2.28)		(3.01)	(2.35)		(1.69)	(2.46)
Observations	724	724	724	396	396	396	328	328	328
R^2	.03	.03		.04	.04		.02	.02	
	Panel B								
	Male			Female			Mixed		
Difference in birth weight	.183**	.122*	.174**	.087	.042	.072	.128*	.099*	.115*
	(1.81)	(1.68)	(2.42)	(.72)	(.68)	(.37)	(1.76)	(1.66)	(1.92)
Family altruistic education		.192**	.267*		.092*	.102*		.154*	.172*
		(2.36)	(2.31)		(1.69)	(1.93)		(1.82)	(1.91)
Observations	268	268	268	285	285	285	171	171	171
R^2	.03	.03		.02	.02		.02	.02	

NOTE.—Absolute values of robust *t*-statistics are in parentheses. The dependent variable, intersibling transfer, is measured using the percentage of the reward that the child transferred to his twin sibling in the dictatorship game during the survey. The independent variable of within-twin difference in birth weight is the difference in birth weight between the heavier and lighter children. The independent variable of family altruistic education is the frequency with which parents told their children that having fraternal love among siblings is a virtue, such as telling them the story "Kong Rong Giving Up Pears" before they turned 12. The frequency is measured using a 5-point Likert scale from 1 (never) to 5 (always). Family altruistic education is the endogenous variable in cols. 3, 6, and 9 in both panel A and panel B. The instrumental variables are maternal age, schooling years, and employment sector. In panel A, cols. 1–3, 4–6, and 7–9 use the total sample, rural subsample, and urban subsample, respectively. In panel B, cols. 1–3, 4–6, and 7–9 use the male, female, and mixed-gender twin subsamples, respectively.

* $p < .10$.
** $p < .05$.
*** $p < .01$.

ity of the constructed measure of family altruistic education is verified because the relevant family activities appear effective in enhancing transfers among children.

VI. Discussion

A. Measurement Error and Cross-Household Heterogeneity

This section discusses the robustness of the main empirical findings. The primary concern is about the measure of family altruistic education and the potential cross-household heterogeneity in the background of Confucian culture, in the sense that some families may be more traditional than others. I use the frequency with which parents told their children the well-known story "Kong Rong Giving Up Pears" before the children turned 12 to measure family altruistic education. This story has been widely used for Confucianism education for more than a thousand years. Telling children the story may have functions other than fostering fraternal love, such as transmitting Confucianism and other traditional Chinese values. Therefore, the measure of family altruistic education may be contaminated with measurement error. Moreover, the measurement error may not be classic, because unobservable cross-household heterogeneity in the background of Confucian culture may be correlated with the constructed measure of family altruistic education, biasing the estimates of interest.

The empirical patterns shown in Section V are less likely to be driven by cross-household heterogeneity in the background of Confucian culture and measurement error in family altruistic education. Confucian values and traditional Chinese culture emphasize equality between children. For example, an old Chinese saying goes, "Sons should be treated as a pair of chopsticks." More traditional parents, guided by these values, would tell their children the story more frequently and invest in children's human capital more equally. This implication contradicts the reported positive correlation between the gap in intrahousehold investment in children's human capital and family altruistic education.

Another source of heterogeneity comes from the degree of parental aversion to inequality in the distribution of children's consumption. The simple model assumes a common degree of inequality aversion, but in practice different families may have different degrees. Parents who are less averse to inequality would invest more in the more gifted child relative to the less gifted child, generating a larger gap in children's human capital investment; meanwhile, these parents are less likely to teach their children the importance of fraternal love. The inequality aversion heterogeneity thus implies a negative correlation between the gap in children's human capital investment and family altruistic education. The estimation results, however, show the opposite. Thus, the empirical findings cannot be attributed to the unobservable cross-household heterogeneity in parental aversion to inequality.

B. Samaritan's Dilemma

For simplicity, the model assumes that the less gifted child is passive and does not make any decision. This assumption may be less appealing in the presence of the Samaritan's dilemma (Bruce and Waldman 1990). That is, selfish beneficiaries may take advantage of altruistic donors (Buchanan 1975). In the context of this paper, intersibling transfers may induce the less gifted child to shirk. Specifically, it is possible that the less gifted child who expects more transfers from his sibling exerts less effort or consumes overly. So in the presence of the Samaritan's dilemma, parents fostering children's altruism may lead to efficiency losses rather than gains.

However, the Samaritan's dilemma is least likely to be present in my study because both siblings are altruistic toward each other. That is, both the beneficiary and the donor in this setting are altruistic. This hypothesis is supported by the empirical evidence from the LCCTS data. Specifically, the survey question on family altruistic education was answered by each child separately. The correlation coefficient of family altruistic education practice reported by each twin is 0.92. The less gifted child would probably not take advantage of expected transfers, as he is also altruistic toward his sibling.[25]

C. Filial Piety and Fraternal Love

As emphasized in Confucius's quote at the beginning of the paper, Confucianism regards both filial piety and fraternal love as the root of all benevolent actions. Accordingly, two closely related types of interfamily transfers coexist in reality. One is transfers between parents and children, including intervivo transfers and bequests; the other is transfers among children. Prior literature has extensively investigated transfers between parents and children (Bernheim, Shleifer, and Summers 1985; Cox 1987, 1990; Pollak 1988; Altonji, Hayashi, and Kotlikoff 1992, 1997; Li, Rosenzweig, and Zhang 2010) but not transfers among children. The current paper strongly complements this strand of literature. As described in the introduction, transfers among siblings are important in many societies (Li, Rosenzweig, and Zhang 2010). In addition, the two types of interfamily transfers are closely related. For example, parents fostering children's altruism may be an alternative mechanism for compensatory bequests to alleviate parental concerns about inequality. Because of data limitation, this paper focuses on intersibling transfers. Future research should incorporate both types of preferences (filial piety and fraternal love) and both types of interfamily transfers.

[25] The high degree of correlation suggests that parents probably educate their children on the importance of fraternal love on the same occasions. Two hypotheses could explain such a big correlation coefficient. One is that the scale effect of parents fostering children's altruism is sufficiently large. The other is more interesting. Parents probably expect the potential Samaritan's dilemma; they thus rationally foster both children's altruism.

VII. Conclusion

This paper investigates parental incentive for altruistic education, that is, teaching children to be altruistic toward each other. Such incentive is shown to be closely related to parental decisions on intrahousehold allocation of human capital investment between children. Specifically, by fostering their children's altruism, parents could enhance total gains from family investment and, at the same time, decrease the gap in their children's wealth. Family altruistic education is thus driven by parents' dual goals of efficiency and equality in human capital investment. One major implication is that family altruistic education serves as a device to release the commitment constraint within a household.

Given the importance of transfers between siblings in many societies, this paper has major policy implications. Specifically, it enhances the understanding of Ricardian equivalence. Inspired by Ricardo's (1820) speculation, Barro (1974) concludes that if households are intergenerationally linked in an altruistic manner, the effect on aggregate demand of governmental expenditures, which may crowd out private consumption, would be mitigated. But later studies challenge the altruistic motive of intergenerational transfers (Bernheim, Shleifer, and Summers 1985; Pollak 1988). The related empirical evidence is not conclusive either (Cox 1987, 1990; Altonji, Hayashi, and Kotlikoff 1992; Hayashi 1995; Altonji et al. 1997). The analysis in this paper gives rise to a notion of cross-sectional Ricardian equivalence. This paper shows that interfamily transfers could partly compensate for inequality in earnings generated by intrahousehold human capital investment decisions. These private transfers may be crowded out by government programs, such as taxing the rich to help the poor. Accordingly, such programs would have a small or no real effect on the economy. Ignoring intersibling transfers, which are arguably prevalent in many societies, may overstate the effectiveness of relevant fiscal policies.

Appendix A

A Simple Model of Endogenous Altruism

I assume that the parental utility function derived from their children's level of consumption is as follows:

$$V(c_i, c_j) = \left(c_i^{\rho} + c_j^{\rho}\right)^{1/\rho},$$

where $-\infty \leq \rho \leq 1$. For simplicity, it is assumed that both children are symmetrically treated in the parental utility function. Relaxing the symmetry assumption does not affect the comparative static analysis below. The compelling feature of the CES function is that a single parameter ρ effectively

captures the degree of parental aversion to inequality between their children. When ρ equals 1, the CES function becomes linear. Parents are not averse to inequality and care only about their children's total consumption. When ρ approaches negative infinity, the CES function becomes a Leontief function. Parents are infinitely averse to inequality and care only about the inequality between their children's consumption. When ρ is between negative infinity and 1, parents care about both their children's total consumption and the gap in children's consumption. A smaller ρ indicates that parents are more sensitive to the gap in their children's consumption.

I further assume a Cobb-Douglas human capital production function. Thus, the earnings function becomes

$$E_\tau = \omega e_\tau^{\beta_e} I_\tau^{\beta_I},$$

where $0 < \beta_e < 1$. Note that in this human capital production function, child endowment e_τ and family investment I_τ are complementary inputs, as in Cunha and Heckman (2007) and Heckman (2007).

First, I have

$$\frac{\partial U_p}{\partial c_\tau} = \frac{1}{\rho}\left(c_i^\rho + c_j^\rho\right)^{(1-\rho)/\rho}\rho c_i^{\rho-1} = \left(\frac{U_p}{c_\tau}\right)^{1-\rho},$$

$$\frac{\partial E_\tau}{\partial I_\tau} = \phi e_\tau^{\beta_e}\beta_I I_\tau^{\beta_I-1}.$$

If $\alpha = 0$,

$$\frac{\partial U_p}{\partial c_i}\frac{\partial E_i}{\partial I_i} = \frac{\partial U_p}{\partial c_j}\frac{\partial E_j}{\partial I_j},$$

$$\left(\frac{U_p}{c_i}\right)^{1-\rho} e_i^{\beta_e} I_i^{\beta_I-1} = \left(\frac{U_p}{c_j}\right)^{1-\rho} e_j^{\beta_e} I_j^{\beta_I-1},$$

$$\left(\frac{c_i}{c_j}\right)^{1-\rho} = \left(\frac{e_j}{e_i}\right)^{\beta_e}\left(\frac{I_j}{I_i}\right)^{\beta_I-1},$$

$$\left(\frac{e_j}{e_i}\right)^{\beta_e(1-\rho)}\left(\frac{I_j}{I_i}\right)^{\beta_I(1-\rho)} = \left(\frac{e_j}{e_i}\right)^{\beta_e}\left(\frac{I_j}{I_i}\right)^{\beta_I-1},$$

$$\left(\frac{I_j}{I_i}\right)^{\beta_I(1-\rho)+(1-\beta_I)} = \left(\frac{e_j}{e_i}\right)^{\rho\beta_e},$$

$$\frac{\partial \ln\left(I_j/I_i\right)}{\partial \ln\left(e_j/e_i\right)} = \frac{\rho\beta_e}{1-\rho\beta_I}.$$

So when $\alpha = 0$,

$$\frac{I_j}{Y - I_j} = \left(\frac{e_j}{e_i}\right)^{\rho\beta_e/(1-\rho\beta_I)},$$

$$\left[1 + \left(\frac{e_j}{e_i}\right)^{\rho\beta_e/(1-\rho\beta_I)}\right] I_j = Y\left(\frac{e_j}{e_i}\right)^{\rho\beta_e/(1-\rho\beta_I)},$$

$$I_j = \frac{e_j^{\rho\beta_e/(1-\rho\beta_I)}}{e_i^{\rho\beta_e/(1-\rho\beta_I)} + e_j^{\rho\beta_e/(1-\rho\beta_I)}} Y,$$

$$I_i = \frac{e_i^{\rho\beta_e/(1-\rho\beta_I)}}{e_i^{\rho\beta_e/(1-\rho\beta_I)} + e_j^{\rho\beta_e/(1-\rho\beta_I)}} Y,$$

$$c_i = E_i = \phi \frac{e_i^{\beta_e/(1-\rho\beta_I)}}{\left(e_i^{\rho\beta_e/(1-\rho\beta_I)} + e_j^{\rho\beta_e/(1-\rho\beta_I)}\right)^{\beta_I}} Y^{\beta_I},$$

$$c_j = E_j = \phi \frac{e_j^{\beta_e/(1-\rho\beta_I)}}{\left(e_i^{\rho\beta_e/(1-\rho\beta_I)} + e_j^{\rho\beta_e/(1-\rho\beta_I)}\right)^{\beta_I}} Y^{\beta_I},$$

$$V_0 = \frac{\phi Y^{\beta_I}}{\left(e_i^{\rho\beta_e/(1-\rho\beta_I)} + e_j^{\rho\beta_e/(1-\rho\beta_I)}\right)^{\beta_I}} \left(e_i^{\rho\beta_e/(1-\rho\beta_I)} + e_j^{\rho\beta_e/(1-\rho\beta_I)}\right)^{1/\rho},$$

$$V_0 = \phi Y^{\beta_I} e_j^{\beta_e} \left[\left(\frac{e_j}{e_i}\right)^{\rho\beta_e/(1-\rho\beta_I)} + 1\right]^{(1-\rho\beta_I)/\rho}.$$

If $\alpha = 1$,

$$\frac{\partial E_i}{\partial I_i} = \frac{\partial E_j}{\partial I_j},$$

$$e_i^{\beta_e}\beta_I I_i^{\beta_I - 1} = e_j^{\beta_e}\beta_I I_j^{\beta_I - 1},$$

$$\left(\frac{I_j}{I_i}\right)^{1-\beta_I} = \left(\frac{e_j}{e_i}\right)^{\beta_e},$$

$$\frac{\partial \ln(I_j/I_i)}{\partial \ln(e_j/e_i)} = \frac{\beta_e}{1 - \beta_I}.$$

So when $\alpha = 1$,

$$\frac{I_j}{Y - I_j} = \left(\frac{e_j}{e_i}\right)^{\beta_e/(1-\beta_I)},$$

$$\left[1 + \left(\frac{e_j}{e_i}\right)^{\beta_e/(1-\beta_I)}\right] I_j = Y\left(\frac{e_j}{e_i}\right)^{\beta_e/(1-\beta_I)},$$

$$I_j = \frac{e_j^{\beta_e/(1-\beta_I)}}{e_i^{\beta_e/(1-\beta_I)} + e_j^{\beta_e/(1-\beta_I)}} Y,$$

$$I_i = \frac{e_i^{\beta_e/(1-\beta_I)}}{e_i^{\beta_e/(1-\beta_I)} + e_j^{\beta_e/(1-\beta_I)}} Y,$$

$$E_i = \phi \frac{e_i^{\beta_e/(1-\beta_I)}}{\left(e_i^{\beta_e/(1-\beta_I)} + e_j^{\beta_e/(1-\beta_I)}\right)^{\beta_I}} Y^{\beta_I},$$

$$E_j = \phi \frac{e_j^{\beta_e/(1-\beta_I)}}{\left(e_i^{\beta_e/(1-\beta_I)} + e_j^{\beta_e/(1-\beta_I)}\right)^{\beta_I}} Y^{\beta_I},$$

$$E = E_i + E_j = \phi Y^{\beta_I}\left(e_i^{\beta_e/(1-\beta_I)} + e_j^{\beta_e/(1-\beta_I)}\right)^{1-\beta_I}.$$

For the optimal solution, I should have

$$c_i = c_j = \frac{E}{2} = \frac{1}{2}\phi Y^{\beta_I}\left(e_i^{\beta_e/(1-\beta_I)} + e_j^{\beta_e/(1-\beta_I)}\right)^{1-\beta_I},$$

$$V_1 = E2^{(1-\rho)/\rho} = 2^{(1-\rho)/\rho}\phi Y^{\beta_I}\left(e_i^{\beta_e/(1-\beta_I)} + e_j^{\beta_e/(1-\beta_I)}\right)^{1-\beta_I}.$$

In summary,

$$V_0 = \omega Y^{\beta_I} e_j^{\beta_e}\left[\left(\frac{e_i}{e_j}\right)^{\rho\beta_e/(1-\rho\beta_I)} + 1\right]^{(1-\rho\beta_I)/\rho}$$

and

$$V_1 = \omega Y^{\beta_I} 2^{(1-\rho)/\rho} e_j^{\beta_e}\left[\left(\frac{e_i}{e_j}\right)^{\beta_e/(1-\beta_I)} + 1\right]^{1-\beta_I}.$$

So I have

$$\frac{d\ln(V_1/V_0)}{d\ln(e_i/e_j)} = \beta_e\left[\frac{\left(\frac{e_i}{e_j}\right)^{\beta_e/(1-\beta_I)}}{1 + \left(\frac{e_i}{e_j}\right)^{\beta_e/(1-\beta_I)}} - \frac{\left(\frac{e_i}{e_j}\right)^{\rho\beta_e/(1-\rho\beta_I)}}{1 + \left(\frac{e_i}{e_j}\right)^{\rho\beta_e/(1-\rho\beta_I)}}\right]. \tag{A1}$$

As $e_i/e_j > 1$,

$$\frac{d\ln(V_1/V_0)}{d\ln(e_i/e_j)} > 0.$$

Moreover, because $V_1 > V_0$, $\partial V_0/\partial \ln(e_i/e_j) > 0$, and $\partial V_1/\partial \ln(e_i/e_j) > 0$,

$$\frac{d(V_1 - V_0)}{d\ln(e_i/e_j)} > 0.$$

Finally, when $\alpha = 0$,

$$\ln(I_i^*/I_j^*) = \frac{\rho\beta_e}{1 - \rho\beta_I}\ln(e_i/e_j); \tag{A2}$$

when $\alpha = 1$,

$$\ln(I_i^*/I_j^*) = \frac{\beta_e}{1 - \beta_I}\ln(e_i/e_j). \tag{A3}$$

As $\beta_e/(1 - \beta_I) > \rho\beta_e/(1 - \rho\beta_I)$, parents invest more in child i, the gifted one, when parents teach their children to be altruistic ($\alpha = 1$). Econometrically, it implies that if family choice of altruistic education (α) is omitted, the parameter ρ is biased upward, and thus the degree of parental inequality aversion is biased downward.

Remark. The results of the model described above remain the same when I introduce parental consumption and labor-leisure trade-off, with the additional separability assumption. That is, parental utility is separable between consumption and leisure, and children's consumption is as follows:

$$\max U_p(c_p, c_i, c_j, l) = v(c_p, l)^{\chi}\left[\left(c_i^{\rho} + c_j^{\rho}\right)^{1/\rho}\right]^{1-\chi},$$
$$\text{s.t.} \quad p_I(I_i + I_j) + pc_p + \omega_p l = \tilde{Y} + \omega_p T.$$

The problem described above can be transformed into the following problem:

$$\max \ln U_p(c_p, c_i, c_j, l) = \chi\ln v(c_p, l) + (1 - \chi)\ln\left(\left(c_i^{\rho} + c_j^{\rho}\right)^{1/\rho}\right),$$
$$\text{s.t.} \quad p_I(I_i + I_j) + pc_p + \omega_p l = \tilde{Y} + \omega_p T.$$

I can apply the two-stage budgeting in this case. The household first decides how much to spend on each category of goods and then allocates expenditure between goods within a category (Behrman, Pollak, and Taubman 1982). In

this case, the marginal utility derived from the last dollar spent on the two categories of consumption should be the same under the optimal solution.

I argue that households allocate the same amount of resources to children's human capital investment under two scenarios: no altruism and full altruism between children. To see this, suppose households allocate $\hat{Y}$ to children's human capital investment under the case of no altruism. Given the fixed budget $\hat{Y}$, I can calculate the parental utility from children's consumption in a way similar to that described above and derive the marginal utility from the last dollar spent on children's consumption:

$$(1-\chi)\ln\left[\left(c_i^{\rho}+c_j^{\rho}\right)^{1/\rho}\right] = (1-\chi)\ln\left\{\omega\hat{Y}^{\beta_I}e_j^{\beta_e}\left[\left(\frac{e_i}{e_j}\right)^{\rho\beta_e/(1-\rho\beta_I)}+1\right]^{(1-\rho\beta_I)/\rho}\right\},$$

$$\frac{\partial(1-\chi)\ln\left[\left(c_i^{\rho}+c_j^{\rho}\right)^{1/\rho}\right]}{\partial Y|_{Y=\hat{Y}}} = (1-\chi)\frac{\beta_I}{\hat{Y}}.$$

As the marginal utility derived from the last dollar should be the same for the two categories of goods, I should have

$$\frac{\partial\chi\ln v(c_p,l)}{\partial Y|_{Y=\bar{Y}+\omega_p T-\hat{Y}}} = (1-\chi)\frac{\beta_I}{\hat{Y}}.$$

Now, with the same budget $\hat{Y}$ on children's investment, if there is full altruism among children, I can calculate the utility from children's consumption and the marginal utility from the last dollar spent on children's consumption:

$$(1-\chi)\ln\left[\left(c_i^{\rho}+c_j^{\rho}\right)^{1/\rho}\right] = (1-\chi)\ln\left\{\omega\hat{Y}^{\beta_I}2^{(1-\rho)/\rho}e_j^{\beta_e}\left[\left(\frac{e_i}{e_j}\right)^{(1-\beta_e)/(1-\beta_I)}+1\right]^{1-\beta_I}\right\},$$

$$\frac{\partial(1-\chi)\ln\left[\left(c_i^{\rho}+c_j^{\rho}\right)^{1/\rho}\right]}{\partial Y|_{Y=\hat{Y}}} = (1-\chi)\frac{\beta_I}{\hat{Y}}.$$

As there is no difference in the category of parental consumption and leisure, I still have the following equality. Thus, the marginal utility of the last dollar between the two categories of goods are the same. And $\hat{Y}$ is still the optimal amount allocated to children's human capital investment with full altruism.

$$\frac{\partial\chi\ln v(c_p,l)}{\partial Y|_{Y=\bar{Y}+\omega_p T-\hat{Y}}} = (1-\chi)\frac{\beta_I}{\hat{Y}}.$$

All of the remaining analyses are the same as above. Parental decision on fostering children's fraternal love (eq. [A1]) and the decision on intrahousehold allocation of human capital investment between children (eqq. [A2], [A3]) remain identical to the simple case derived above.

Appendix B

The Story "Kong Rong Giving Up Pears"

Kong Rong (AD 153–208) was a politician and scholar at the end of the Eastern Han dynasty (AD 25–220). He was a twentieth-generation descendant of Confucius. A well-known story commonly used to teach children the importance of comity and fraternal love involves the 4-year-old Kong Rong giving his elder and younger brothers the larger pears and keeping the smallest pear for himself. Kong Rong had five elder brothers and one younger brother. One day, his father bought some pears and asked him to be the first to choose a pear. Kong Rong picked the smallest pear. His father was pleasantly surprised to see this behavior and asked, "There are plenty of pears here. I asked you to be the first to choose a pear. Why did you choose the smallest pear?" Kong Rong answered, "I am younger, so I should have a smaller pear. Please give the bigger pears to my elder brothers." His father was surprised and challenged him again: "Your little brother is younger than you." Kong Rong said, "My little brother is younger, so I should give him a bigger pear." His father laughed loudly. Four-year-old Kong Rong knew the courtesy of giving precedence to others, which is a very important Chinese virtue.

Appendix C

Additional Figures

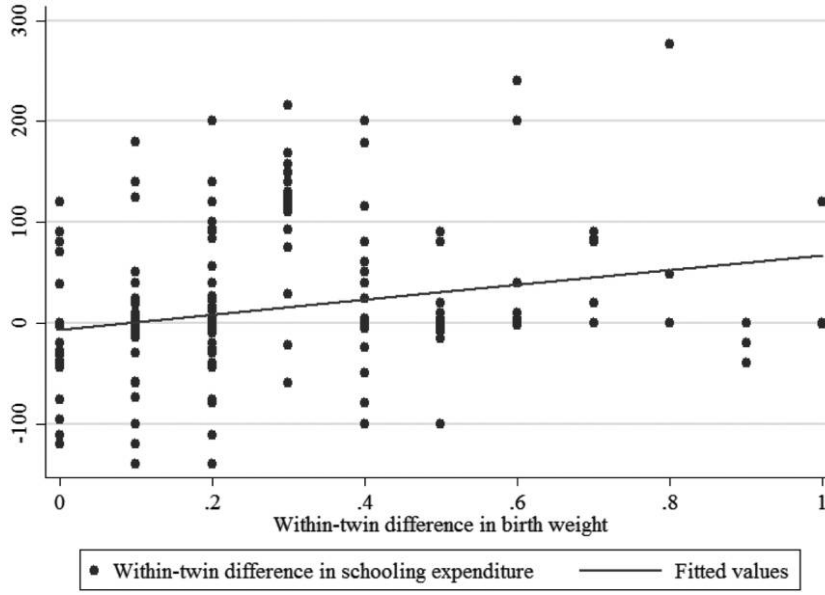

FIG. C1.—Within-twin differences in birth weight and within-twin differences in parental expenditure on children's education. The graph shows the difference in birth weight between the heavier twin child and the lighter one on the *X*-axis and the difference in parental expenditure on child education between the heavier twin child and the lighter one on the *Y*-axis. During the survey, parents were asked to answer the following question: "In the past 12 months, how much was spent on each child for the following six items separately: (1) clothing; (2) school tuition; (3) buying magazines and books; (4) buying stationery; (5) hiring a tutor; and (6) training-class expenses?" To construct the measure of parental expenditure on each child's education, I sum parental expenditure on items 2–6. A color version of this figure is available online.

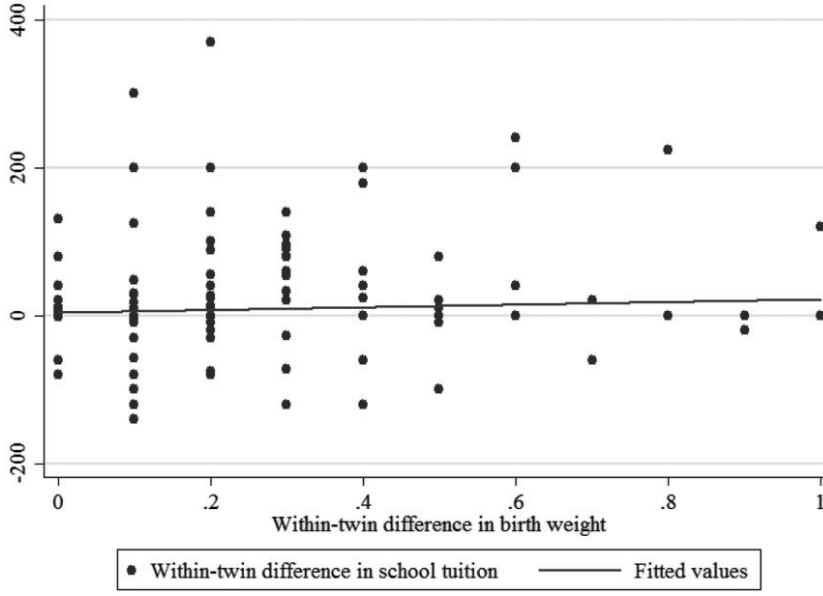

FIG. C2.—Within-twin differences in birth weight and within-twin differences in parental expenditure on school tuition. The graph shows the difference in birth weight between the heavier twin child and the lighter one on the *X*-axis and the difference in parental expenditure on school tuition between the heavier twin child and the lighter one on the *Y*-axis. During the survey, parents were asked the following question: "In the past 12 months, how much was spent on each child for the following six items separately: (1) clothing; (2) school tuition; (3) buying magazines and books; (4) buying stationery; (5) hiring a tutor; and (6) training-class expenses?" To construct the measure of parental expenditure on each child's school tuition, I use parental expenditure on item 2. A color version of this figure is available online.

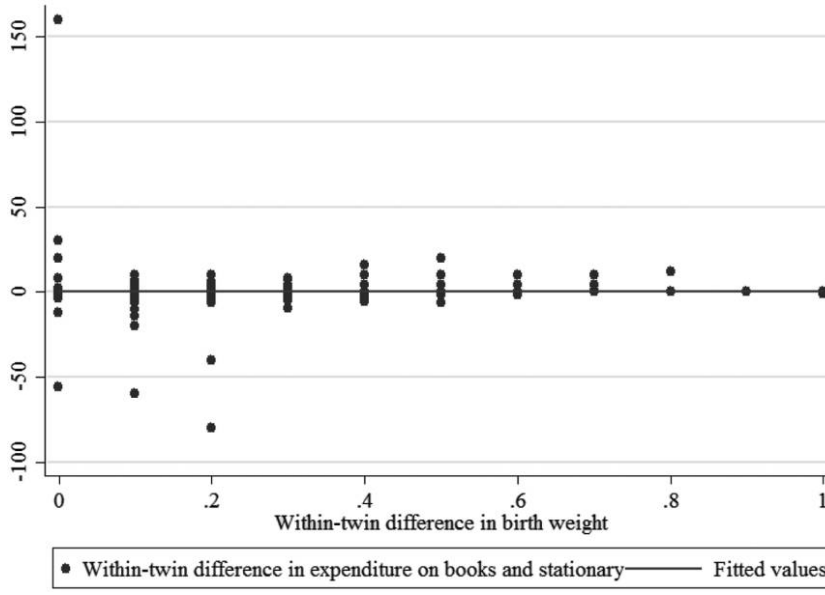

FIG. C3.—Within-twin differences in birth weight and within-twin differences in parental expenditure on books and stationery. The graph shows the difference in birth weight between the heavier twin child and the lighter one on the *X*-axis and the difference in parental expenditure on books and stationery between the heavier twin child and the lighter one on the *Y*-axis. During the survey, parents were asked the following question: "In the past 12 months, how much was spent on each child for the following six items separately: (1) clothing; (2) school tuition; (3) buying magazines and books; (4) buying stationery; (5) hiring a tutor; and (6) training-class expenses?" To construct the measure of parental expenditure on each child's books and stationery, I sum parental expenditure on items 3 and 4. A color version of this figure is available online.

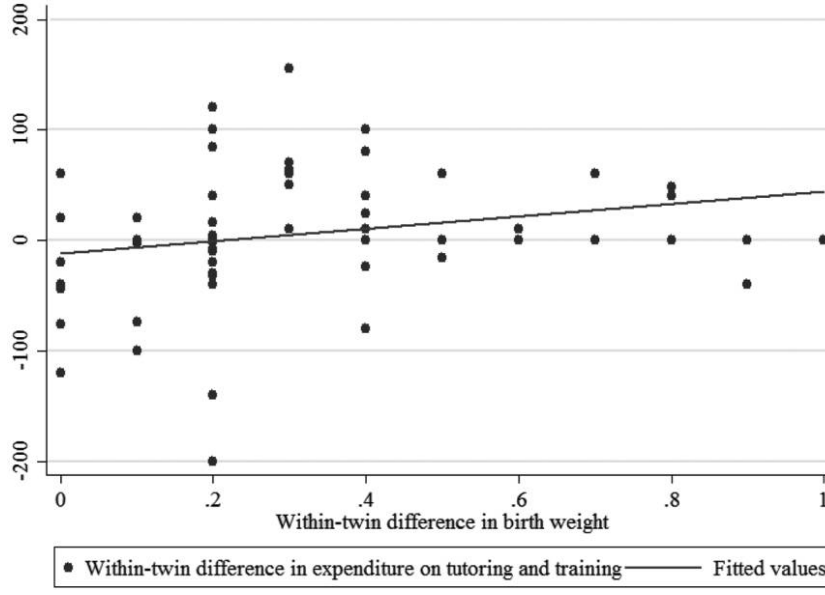

FIG. C4.—Within-twin differences in birth weight and within-twin differences parental expenditure on tutoring and training. The graph shows the difference in birth weight between the heavier twin child and the lighter one on the *X*-axis and the difference in parental expenditure on tutoring and training between the heavier twin child and the lighter one on the *Y*-axis. During the survey, parents were asked the following question: "In the past 12 months, how much was spent on each child for the following six items separately: (1) clothing; (2) school tuition; (3) buying magazines and books; (4) buying stationery; (5) hiring a tutor; and (6) training-class expenses?" To construct the measure of parental expenditure on each child's tutoring and training, I sum parental expenditure on items 5 and 6. A color version of this figure is available online.

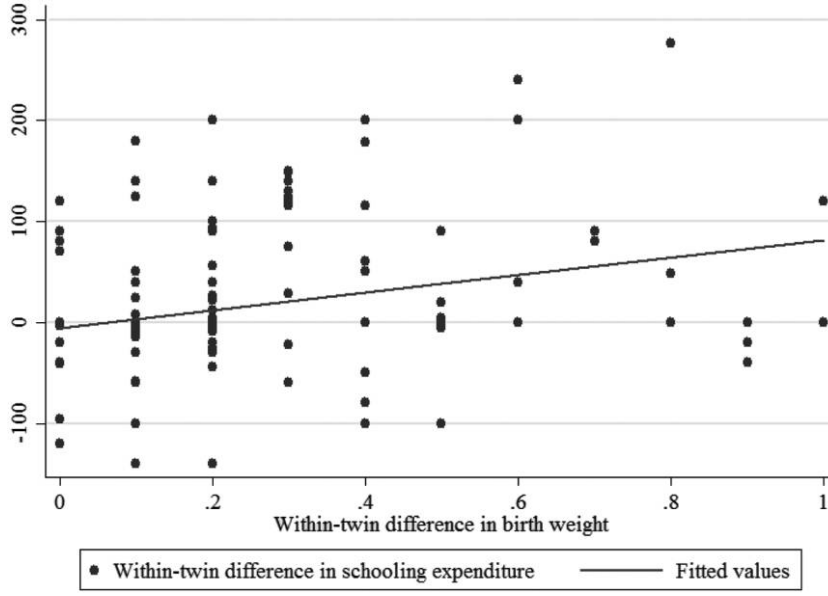

FIG. C5.—Within-twin differences in birth weight and within-twin differences in parental expenditure on children's education (in primary school). The graph shows the difference in birth weight between the heavier twin child and the lighter one on the *X*-axis and the difference in parental expenditure on child education between the heavier twin child and the lighter one on the *Y*-axis. During the survey, parents were asked to answer the following question: "In the past 12 months, how much was spent on each child for the following six items separately: (1) clothing; (2) school tuition; (3) buying magazines and books; (4) buying stationery; (5) hiring a tutor; and (6) training-class expenses?" To construct the measure of parental expenditure on each child's education, I sum parental expenditure on items 2–6. A color version of this figure is available online.

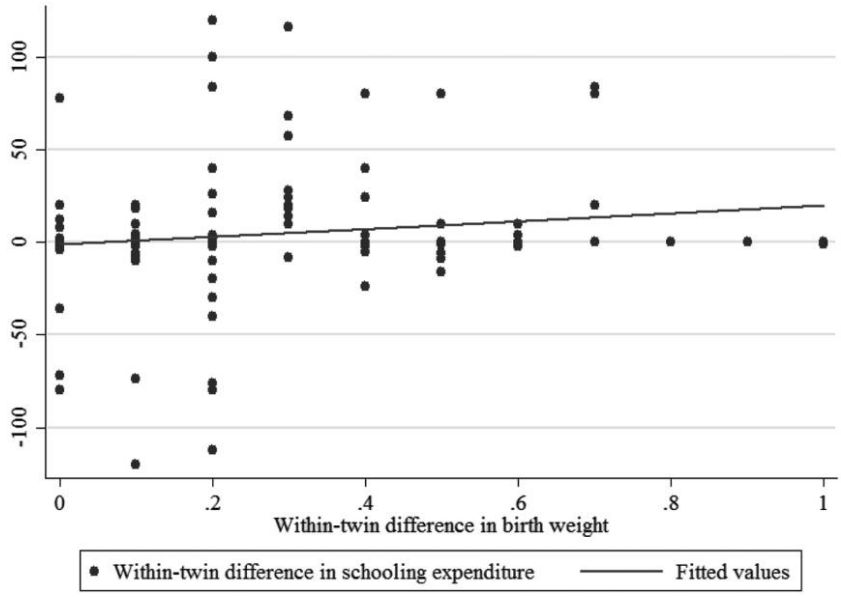

FIG. C6.—Within-twin differences in birth weight and within-twin differences in parental expenditure on children's education (in secondary school). The graph shows the difference in birth weight between the heavier twin child and the lighter one on the *X*-axis and the difference in parental expenditure on child education between the heavier twin child and the lighter one on the *Y*-axis. During the survey, parents were asked to answer the following question: "In the past 12 months, how much was spent on each child for the following six items separately: (1) clothing; (2) school tuition; (3) buying magazines and books; (4) buying stationery; (5) hiring a tutor; and (6) training-class expenses?" To construct the measure of parental expenditure on each child's education, I sum parental expenditure on items 2–6. A color version of this figure is available online.

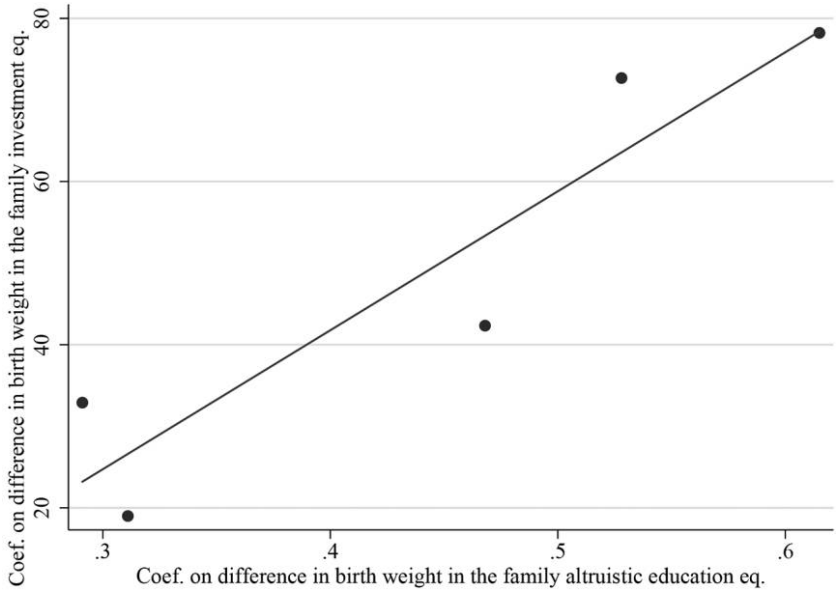

FIG. C7.—Coefficients on birth weight gap regressing human capital investment difference versus coefficients on birth weight gap regressing altruistic education. The figure plots the estimated coefficients on the birth weight gap δ_1 in equation (8), which regresses the human capital investment difference (reported in table 4), against the estimated coefficients on the birth weight gap γ_1 in equation (7), which regresses altruistic education (reported in table 3), for five subsamples: rural, urban, male, female, and gender-mixed twin subsamples. A color version of this figure is available online.

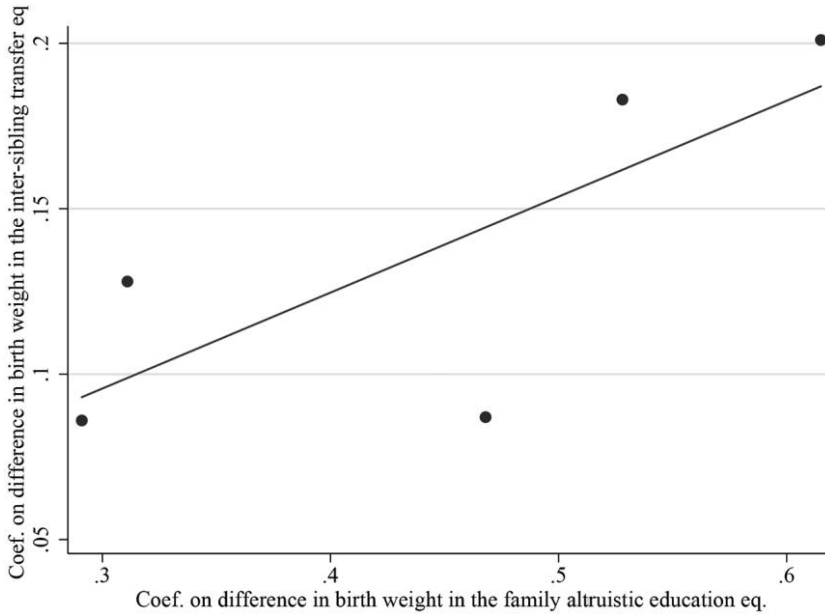

FIG. C8.—Coefficients on birth weight gap regressing intersibling transfer versus coefficients on birth weight gap regressing altruistic education. This figure plots the estimated coefficients on the birth weight gap η_1 in equation (9), which regresses intersibling transfer (reported in table 5), against the estimated coefficients on the birth weight gap γ_1 in equation (7), which regresses altruistic education (reported in table 3), for five subsamples: rural, urban, male, female, and gender-mixed twin subsamples. A color version of this figure is available online.

Appendix D

First-Stage Estimation

Table D1
First-Stage Estimation Results

	Dependent Variable: Family Altruistic Education	
	(1)	(2)
Difference in birth weight	.485***	.441***
	(3.73)	(3.41)
Maternal age		.026*
		(1.74)
Maternal years of schooling		.047**
		(1.99)
Maternal employment sector (public = 1)		−.541***
		(2.72)

Table D1 (*Continued*)

	Dependent Variable: Family Altruistic Education	
	(1)	(2)
F-statistic		14.27
R^2	.02	.07
Observations	724	724

NOTE.—Absolute values of robust *t*-statistics are in parentheses. Control variables include child age, household assets (score), a rural dummy, maternal age, schooling years, ethnicity (Han = 1), and employment sector (public = 1). The dependent variable is family altruistic education, i.e., the frequency with which parents told their children that having fraternal love among siblings is a virtue, such as telling them the story "Kong Rong Giving Up Pears" before they turned 12. The frequency is measured using a 5-point Likert scale from 1 (never) to 5 (always). The independent variable is the absolute value of the difference in children's birth weight. The *F*-statistic shows the joint statistical significance of the excluded variables of maternal age, years of schooling, and employment sector.

* $p < .10$.
** $p < .05$.
*** $p < .01$.

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