Substitution Effects in Parental Investments

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Draft of May, 2008

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Abstract

Parents have to decide how much and how to invest in each of their children. Becker proposed that parents choose among different types of investments for each child efficiently and that they also choose investments to equalize wealth across their children. Existing empirical tests of this hypothesis using across family variations in investments suffer from unobserved family heterogeneity. Family fixed effects methods have been suggested and used, although their interpretation has not been well articulated.

The contributions of this paper are two fold. First, we provide an empirical framework to study substitution effects in parental investments in the presence of unobserved family heterogeneity, unequal parental valuations of their investments across children, and unobserved differences in child abilities. Second, we implement this framework using a unique data set on parental investments in education and marital transfers in rural China.

Our household fixed effect regressions show that marital transfer is negatively correlated with educational investment. If the educational investment in one son is lower than that of his brothers by 1 yuan, he will be compensated by receiving 33 cents more than his brothers in marital transfers; the corresponding result for daughters is 12 cents. Differences in marital transfers across children do not fully compensate for differences in educational investments. These results cannot be explained by unequal valuations by parents or measurement problems. Instead they suggest that there are strategic considerations within the family.

We also find evidence against equal valuations across parental investments for different children in the same family. Across daughters, parents invest more in their older daughters. This first child bias is not present among sons.

Keywords: Intergenerational Transfer; Equal Concern; Within Sibling Variation;

JEL classification: D13, J12

1 Introduction

Parental investment in children is a ubiquitous phenomenon with important social implications. At the micro level, it contributes to the younger generation's educational achievements and future employment trajectories; at the macro level, it affects the dynamics of inter-generational class mobility and overall welfare inequality. A better understanding of parental investment behavior can be helpful in the design of more efficient government policies targeting outcomes such as the accumulation of human capital or improvement of income distribution.

The economics literature distinguishes two types of parental transfers: (1) human capital in the form of education expenditure, and (2) non-human capital investment, including inter-vivos transfers and bequests. Scholars have long been interested in the motivations behind and determinants of each one of these transfers. Nevertheless, less attention has been paid to investigating the relationship between them. How do parents trade off different transfers among heterogeneous children, given the limited resources they possess?

Becker and Tomes's (1976) model has made clear arguments on this issue[1]: (1) human capital investment should be made efficiently, thereby accentuating innate differences in ability; (2) non-human capital transfers, on the contrary, should be used to offset the welfare differences among siblings. Our study intends to test the second argument. More specifically, we want to see if children who receive less in schooling investment relative to their siblings receive more in the way of inter-vivos transfers as compensation.

In order to test for the implications of the Beckerian model, consider a family h with two children of the same gender, i and j. Let t_{ih} be the inter-vivos transfer to child i, s_{ih} be schooling investment to child i, and y_h be family wealth.

Consider the following pair of siblings' inter-vivos transfer regressions for a random

[1] Also summarized in Becker (1991).

sample of H households, $h = 1, ..H$:

$$t_{ih} = \beta_0 + \beta_1 s_{ih} + \beta_2 s_{jh} + \beta_y y_h + \varepsilon_{ih} \quad (1)$$

$$t_{jh} = \beta_0 + \beta_1 s_{jh} + \beta_2 s_{ih} + \beta_y y_h + \varepsilon_{jh} \quad (2)$$

where ε_{ih} is the error term of each regression. Becker's theory implies that $\beta_1 < 0$ and $\beta_2 > 0$.

There is a problem in estimating the above equations using OLS due to measurement errors in family wealth. If we cannot perfectly observe y_h (which is usually the case), β_y will be biased towards zero. Furthermore, since s_{ih} and s_{jh} are correlated with y_h, their coefficients will be contaminated as well. Specifically, it could shown that both β_1 and β_2 will be biased upwards.

y_h is a family level attribute. As suggested by previous studies, we can eliminate all family fixed effects through a sibling differences regression. Taking the difference of equations (1) and (2) yields

$$t_{ih} - t_{jh} = (\beta_1 - \beta_2)(s_{ih} - s_{jh}) + (\varepsilon_{ih} - \varepsilon_{jh})$$

with the corresponding regression form

$$\Delta t_h = \beta_s \Delta s_h + \Delta \varepsilon_h \quad (3)$$

where $\Delta x_h = x_{ih} - x_{jh}$ for $x = s, t, \varepsilon$, and $\beta_s = \beta_1 - \beta_2$. Now β_s can be consistently estimated. This approach has been widely used in previous studies. Researchers have suggested that $\beta_s < 0$ implies that inter-vivos transfers compensate for differences in schooling investments across siblings. In fact, β_s also has an intuitive interpretation. Its magnitude measures the wealth return to each dollar of education expenditure, i.e. $|\beta_s| = \frac{dE_{ih}}{ds_{ih}}$, where E_{ih} denotes the labor earning of child i. This implies that not only should β_s be negative, but it should also be of magnitude greater than or equal to one.

However, two strong assumptions are needed to rationalize the above sibling differences regression and the parameter interpretations. First of all, we have to assume that parents care equally about the wealth of their children, which is often referred to as the "equal concern" assumption in the Beckerian model. If this is not the case, parents will provide more human capital and non-human capital investments to their favored child. Ignoring this preference bias makes $cov(\Delta s_h, \Delta\varepsilon_h) > 0$, resulting in an upward bias in the estimate of β_s.

We will show that, assuming a particular CES form for the parents' utility function, we can accommodate "unequal concern" of parents towards their children. Under this setup, our model delivers a sibling differences regression in logarithms on both sides:

$$\Delta \ln t_h = \theta_0 + \theta_s \Delta \ln s_h + \Delta\varepsilon_h \tag{4}$$

where $\Delta \ln x_h = \ln x_{ih} - \ln x_{jh}$ for $x = s, t$. The log-log functional form is frequently used as a robustness check to the level-level regression (3). A negative θ_s supports the compensation argument and its magnitude can be interpreted as the elasticity of changes in non-human capital investment as a response to changes in human capital investment.

Besides its convenience, we argue that the log-log form can be employed to test for preference bias of parents towards their children. More specifically, suppose that there are two children in every family, and a dummy variable is set equal to one if a particular child is the older one (zero otherwise). In this setup, the coefficient on this dummy variable would be θ_0 in the sibling differences regression. Our theoretical framework suggests that all information regarding preference bias is contained in this parameter, hence $cov(\Delta \ln s_h, \Delta\varepsilon_h) = 0$ is ensured. Specifically, a positive θ_0 means parents put more weight on children born earlier; a negative sign means the opposite; while a zero value of θ_0 is an indicator of "equal concern".

The preference bias associated with birth order is just one example of a factor that might motive parents' preference bias. By the same token, we can construct dummy variables such as whether the child lives away from home (due to schooling or work), or whether the child remits his/her income to the parents. We can test if these are the factors that may lead to parents' unequal treatment of their children[2].

The second assumption imposed by regression (3) is that education expenditure should be exogenous when parents make their inter-vivos transfer decisions. This assumption not only makes $cov(\Delta s_h, \Delta\varepsilon_h) = 0$, but also ensures that β_1 and β_2 are

[2] Of course, the identification only comes from those families with within-household variations in these dummy variables.

level-independent. To see why this is important, consider a model that endogenizes education investment decisions while maintaining the "equal concern" assumption. Children are endowed with different inherited abilities. Education investments are efficient in the sense that parents will keep investing until the marginal benefit from schooling is equalized to the marginal cost for each child[3]. Inter-vivos transfers are used to compensate for the difference in children's welfare due to the difference in their human capital investment until wealth equalization is achieved.

Introducing heterogeneity in children's abilities to the model affects the empirical strategy in a non-trivial way. Each coefficient in equation (1) and (2) becomes ability-dependent. For families with two children, the inter-vivos transfer equations are:

$$t_{ih} = \beta_0 + \beta_{ii} s_{ih} + \beta_{ij} s_{jh} + \beta_{yi} y_h + \varepsilon_{ih} \quad (5)$$

$$t_{jh} = \beta_0 + \beta_{ji} s_{ih} + \beta_{jj} s_{jh} + \beta_{yj} y_h + \varepsilon_{jh} \quad (6)$$

The values of β_{kk}, β_{kl} and β_{yk} depend on the ability of child k, where $k, l = i, j$ and $k \neq l$. There are two challenges in the estimation. The first issue is that, when $\beta_{yi} \neq \beta_{yj}$, the effect of imprecise family wealth measures cannot be completely eliminated in the sibling differences regression, leading to an identification problem. Fortunately, there is a way to get around this problem. By imposing a conventional functional form (used in Card (1999)) for the children's wealth determination equation, we can show that $\beta_{yi} = \beta_{yj} = \beta_y$, regardless of the difference in children's abilities.

The second issue concerns the regression specification. Given that $\beta_{11} - \beta_{21} \neq -(\beta_{12} - \beta_{22})$ in general, we cannot obtain a difference-difference functional form as in equation (3). To deal with this problem, we propose a difference-level regression:

$$\Delta t_h = \gamma_i s_{ih} + \gamma_j s_{jh} + u_h \quad (7)$$

[3] This efficiency result is important for identification of the model. When education investment is efficient, parents will invest more in children with higher ability. This one-to-one mapping between education expenditure and children's abilities makes the former a perfect proxy for the latter. Therefore, even though children's abilities are unobservable, we still have $cov(s_{ih}, \varepsilon_{ih}) = 0$, for the inclusion of an education expenditure variable is sufficient to control for heterogeneity in abilities.

where $\Delta t_h = t_{ih} - t_{jh}$. This regression can be estimated through OLS. The hypotheses we want to test here are $\gamma_i < 0$, $\gamma_j > 0$, and $|\gamma_i| = |\gamma_j|$.

The above discussions on estimation issues are summarized in Table A1. Empirically, we implement this framework on a unique data set we collected on parental investments on education and marital transfers in rural China. Our main findings are as follows. Household fixed-effect regressions confirm the compensatory role played by non-human capital investment: if education investment in one son is lower than his brothers by 1 yuan, he will be compensated by receiving 33 cents more than his brothers in his marital transfers; the same result for daughters is 12 cents. Differences in marital transfers across children do not fully compensate for differences in education investments. This finding cannot be attributed to unequal valuations by parents or measurement problems. Rather, they suggest that there may be strategic considerations within the family. Furthermore, there is evidence against equal valuations across parental investments for different children. Among daughters, parents invest more in the oldest one. This first child bias is not present among sons. In the difference-level specification, we cannot reject that coefficients on schooling expenditure of the children have the same magnitude, which suggests that ability differences among siblings are low.

This paper is organized as follows. Section 2 provides a literature review and some background information. Section 3 presents a model of the parental investment decision, derives the testable implications, and discusses identification issues. Section 4 introduces the data and the descriptive results. Section 5 reports the estimation results and provides an interpretation in line with the theoretical model. Section 6 concludes the paper.

2 Literature and Background

Most existing studies addressing compensatory inter-vivos transfers do not address schooling investment, instead analyzing whether recipients of higher transfers are those with more income. McGarry and Schoeni (1995), Dunn and Phillips (1997), McGarry (2006), and Hochguertel and Ohlsson (2007) report that noneducational transfers are targeted toward children with lower earnings. In contrast, Cox (1987) and Cox and Rank (1992) find that respondent earnings positively affect the amount of transfers. They claim that it is exchange, rather than altruism, that dominates the incentive to provide inter-vivos transfers.

Only rarely do empirical studies directly investigate the relationship between different transfers, mainly because of the lack of suitable data. First, measuring human capital investment made by parents is difficult, especially in developed countries where college expenditure is often mixed with a considerable self-financed component from the children. In addition, inter-vivos transfers are always underestimated, as it is almost impossible to keep track of every transfer a person receives from his parents over his entire life. A typical survey only asks the interviewees to report the transfers they received over a certain time span, most commonly just the most recent years. Lastly, it is important to have information on sibling variation in order to control for unobservable household level heterogeneity. However, for most datasets, transfer recipients are randomly selected across families, making it technically difficult to trace the same information for their siblings.

In this paper, we try to tackle all of the aforementioned empirical difficulties. Our study improves upon the existing literature in the following respects:

1. Direct parental education investment measure

We apply our analysis to rural Chinese villages, where children usually do not work formally before they finish their schooling. It is their parents who shoulder most of their education fees. Through interviews with parents, we obtain a relatively good measure of educational investment for all children within the family.

Other datasets with information both on inter-vivos transfers and human capital investments include the Wisconsin Longitudinal Study (WLS) and the Health and Retirement Study (HRS). WLS asks the respondent to report all transfers (in any form with value more than $1000) that they have ever received from their parents. The purpose of each transfer is also recorded, so total education investment can thereby be identified. However, the survey suffers from serious under-reporting problems: less than 2% of the whole sample report a positive education transfer from parents (Kim, 2005). Consequently, it cannot be used to deliver any convincing result.

Information on education transfers in HRS comes from its supplementary survey, the Human Capital and Education Expense Mail Survey (HUMS), through which the dollar amount of parental payment to education starting from college is available for each individual. Using this dataset, Haider and McGarry (2006) estimate a specification similar to ours. According to their OLS result, inter-vivos transfers are positively correlated with parental investment in education, which suggests evidence against the compensatory story. However, this result does not survive in their household fixed effect regression, where no significant relationship between the two transfers is observed.

2. Marital transfers as a significant form of non-human capital investment

We focus on a particular but significant inter-vivos transfer for individuals in China–the marital transfers. Currently a large part of the marital transfers in China is given by parents to their marrying children. In this sense, it is an intergenerational transfer rather than an inter-familial transfer as one usually observes in India or Bangladesh, where marital transfers are made between the groom's and bride's family. In addition, rural Chinese marital transfers involve a significant amount of wealth transmission. At the time of the marriage, both the groom's and bride's families provide furniture, major home appliances, agricultural equipment, and sometimes cash payments to the newlywed couple. Parents generally have to save for years in order to finance such expenditure. Escalating marital expenses in Chinese villages during the past two decades have been well documented (e.g. Siu, 1993; Min and Eades, 1995; Zhang, 2000). The burden is heavier for the groom's side because traditionally the groom is responsible for building a new house.

Data from rural China provide an excellent opportunity to test the proposed hypothesis, as by focusing our attention on the sizeable wealth transfer at the time of marriage and relating it to pre-marital education expenditure paid by parents, we shall expect to see more significant compensation effects of non-human capital investment, if any, compared to other studies.

3. Discussions on identification issues using sibling data

One important dimension of our dataset is that it is based on reports from the parents, which provides us with the necessary information for all children in the family. Using sibling variation within a household to control for unobservable family level characteristics has been widely employed in the empirical literature, for instance in studies on returns to education. Griliches (1979) discusses the strengths and limitations of this approach. He emphasizes two problems that can bias the within-family estimates: (1) there might be measurement errors in the independent variables and correlation between independent variables and the error term; (2) unobservable variables may be different across siblings rather than a common factor within the family.

We build a model where a family is an economic decision unit that transfers both human and non-human capital to its members in order to achieve its maximum welfare. Based on this framework, we address both of the problems concerned by Griliches (1979). In our context, measurement error in family level variables, such as family wealth, can contaminate the coefficient estimation of the other independent variables in OLS. Moreover, once we introduce unobservable heterogeneities among children, the family fixed effect generally cannot be eliminated through the differencing approach, because the effect of family wealth on inter-vivos transfers will be different across siblings. We show that this problem can be resolved through a reasonable functional form assumption on the children's wealth determination equation.

3 Theoretical Framework

3.1 Basic Model and Identification Issues

Consider a household h with two children, denoted by $i = 1, 2$ respectively. Each child's wealth is determined by

$$w_{ih} = \mu s_{ih} + t_{ih} + \varepsilon_{ih} \tag{8}$$

where s_{ih} is the schooling expenditure on child i, μ represents the contribution to wealth from each unit of education investment, which usually takes values larger than 1, t_{ih} is the inter-vivos transfer to child i, and ε_{ih} represents child i's attributes observable to the parents but unobservable to researchers. Parents value both their own consumption and their children's wealth. The utility function of the parents takes the form:

$$\widetilde{U}(c_h, w_{1h}, w_{2h}) = U(c_h, g(w_{1h}, w_{2h})) \tag{9}$$

where $g(\cdot,\cdot)$ is a symmetric and concave function, which amounts to the "equal concern" assumption usually made in the literature: parents value the welfare of each of their children identically.[4] This assumption implies that parents' indifference curves, in (w_{1h}, w_{2h}) space, are symmetric with respect to the 45 degree line.

In this basic setup, we shall assume initially that the schooling expenditure of the children is an exogenous variable. Although this is a strong restriction, it can simplify our analysis significantly. Analogous to a firm making a decision on short-run labor demand while its capital input is fixed, a family may choose how to allocate marital transfers among its children, while taking their already-allocated education investments as given.[5] In section 2.3, this assumption of exogeneity will

[4]Actually, parents may care not only about the wealth level of their own children, but also about with whom they are married. For example, we can consider a family h thinking of marrying out its two daughters 1 and 2 by equipping them with wealth level w^b_{1h} and w^b_{2h} so that they can attract potential grooms with expected wealth levels of $\widehat{w}^g_{1h}$ and $\widehat{w}^g_{2h}$ respectively. Here we use superscript b and g to denote the bride and groom. The parental utility function is then

$$\overline{U}(c_h, w^b_{1h}, \widehat{w}^g_{1h}, w^b_{2h}, \widehat{w}^g_{2h}) \tag{10}$$

But this can be simplified to equation (9) by assuming assortative matching in the marriage market. To illustrate this point, assume that the matching function takes the form

$$w^g_{ih} = \phi_0 + \phi_1 w^b_{ih} + \nu_{ih} \tag{11}$$

where $i = 1, 2$ and ν_{ih} is the deviation (with zero mean) from positive assortative matching in wealth due to love and other match-specific factors. From the parents' point of view, the expected son-in-law should possess

$$\widehat{w}^g_{ih} = \phi_0 + \phi_1 w^b_{ih} \tag{12}$$

Plugging (12) into (10) yields

$$\overline{U}(c_h, w^b_{1h}, \widehat{w}^g_{1h}, w^b_{2h}, \widehat{w}^g_{2h}) = \overline{U}(c_h, w^b_{1h}, \phi_0 + \phi_1 w^b_{1h}, w^b_{2h}, \phi_0 + \phi_1 w^b_{2h}) = \widetilde{U}(c_h, w^b_{1h}, w^b_{2h})$$

which is the utility function (9) we use in the model.

[5]Note that educational expenditure can also be seen as exogenous in that given parents'

be relaxed.

Parents choose their own consumption and the inter-vivos transfer given to their children in order to maximize their utility function, subject to the household budget constraint $c_h + t_{1h} + t_{2h} = y_h$, where y_h is a measure of family wealth. Due to the symmetry and concavity of the function $g(.,.)$, it can be shown that, at the optimum, children's wealth should be equalized, i.e.,

$$w_{1h} = \mu s_{1h} + t_{1h} + \varepsilon_{1h} = \mu s_{2h} + t_{2h} + \varepsilon_{2h} = w_{2h} \tag{13}$$

which implies

$$\frac{\partial t_{ih}}{\partial s_{ih}} < 0 \tag{14}$$

$$\text{and } \frac{\partial t_{ih}}{\partial s_{jh}} > 0, \tag{15}$$

where $i, j = 1, 2$, $j \neq i$. Refer to Appendix A for the formal derivation of the above results. Equation (14) and (15) state that a child's inter-vivos transfer should be negatively correlated with spending on her own education, but positively correlated with spending on her sibling's education. The former result stems from the nature of substitution between t_{ih} and s_{ih} in the wealth determination equation, while the latter reflects parents' desire to compensate their less well off child through non-human capital investment. An empirical test for wealth equalization can be written as

$$t_{ih} = \beta_0 + \beta_1 s_{ih} + \beta_2 s_{jh} + \beta_3 y_h + \varepsilon_{ih} \tag{16}$$

where inter-vivos transfer for child i in family h is regressed on her own schooling expenditure s_{ih}, her sibling's expenditure s_{jh} and family wealth y_h. Wealth equalization predicts that $\beta_1 < 0$ and $\beta_2 > 0$.

There is, however, a problem of estimating (16) through OLS, as family wealth (y_h) is usually measured with error. This imprecision in measurement will contaminate all least square estimates on variables that are correlated with family wealth. As shown in Appendix B, coefficients on family wealth will suffer from attenuation bias, while those on education expenditure will be biased upwards.

decision of whether or not to send a child to school, the required tuition fees often constitute a given lump sum payment specific to location (rural families are generally constrained as to choice of school) and time period, and is out of the control of parents.

One way to get around this problem is to make use of variation within families by calculating sibling differences in order to eliminate the effect of family wealth.[6] By solving the parents' optimization problem, it can be shown that

$$t_{1h} = (\lambda_y - 1)\mu s_{1h} + \lambda_y \mu s_{2h} + \lambda_y y_h + (\lambda_y - 1)\varepsilon_{1h} + \lambda_y \varepsilon_{2h} \quad (17)$$

$$t_{2h} = \lambda_y \mu s_{1h} + (\lambda_y - 1)\mu s_{2h} + \lambda_y y_h + \lambda_y \varepsilon_{1h} + (\lambda_y - 1)\varepsilon_{2h} \quad (18)$$

where

$$\begin{aligned} \lambda_y &= \frac{\partial t_i}{\partial y} > 0 \\ \mu(\lambda_y - 1) &= \frac{\partial t_i}{\partial s_i} = \mu \frac{\partial t_i}{\partial \varepsilon_i} < 0 \\ \mu \lambda_y &= \frac{\partial t_i}{\partial s_j} = \mu \frac{\partial t_i}{\partial \varepsilon_j} > 0 \end{aligned}$$

and $i, j = 1, 2,\ j \neq i$. Subtracting (17) from (18) yields

$$\Delta t_h = -\mu \Delta s_h - \Delta \varepsilon_h \quad (19)$$

where $\Delta z_h \equiv z_{1h} - z_{2h}$, for $z = s, t, \varepsilon$. Equation (19) tells us that as long as $\Delta \varepsilon_h$ is uncorrelated with Δs_h, wealth equalization, or the compensatory effect of inter-vivos transfers, can be tested through sibling differences or family fixed effect regression. The coefficient on schooling expenditure should be negative and its magnitude identifies the return of each unit of education investment to wealth (the parameter μ), which we expect to be larger than or equal to 1.

3.2 Relaxing the "Equal Concern" Assumption

The fact that parents love their children equally is crucial to the wealth equalization results. But it is not crucial that this is true in order for inter-vivos transfers to be compensatory. To illustrate this idea, we shall work with a specific functional form for parents' utility that relaxes the "equal concern" assumption: an augmented constant elasticity of substitution (CES) function

$$\tilde{U}(c_h, w_{1h}, w_{2h}) = [z c_h^{\rho} + \alpha w_{1h}^{\rho} + (1-\alpha) w_{2h}^{\rho}]^{1/\rho} \quad (20)$$

[6] The other solution would be to find an instrumental variable that affects schooling investment without being affected by family wealth. However, such a variable is not available in our dataset.

where $z > 0$ is a parameter indicating how parents value their own consumption relative to their children's wealth; $0 < \alpha < 1$ is a weight put by parents on their children's relative wealth, and $-\infty \leq \rho \leq 1$ determines the degree of substitutability of c_h, w_{1h} and w_{2h}.

As shown in appendix C, the optimal wealth level of the children has a closed form solution under this setup

$$w_{1h} = \alpha^{\frac{1}{1-\rho}} \frac{\tilde{y}_h}{p_h} \tag{21}$$

$$w_{2h} = (1-\alpha)^{\frac{1}{1-\rho}} \frac{\tilde{y}_h}{p_h} \tag{22}$$

where $\tilde{y}_h = y_h + \mu s_{1h} + \varepsilon_{1h} + \mu s_{2h} + \varepsilon_{2h}$ and $p_h = z^{\frac{1}{1-\rho}} + \alpha^{\frac{1}{1-\rho}} + (1-\alpha)^{\frac{1}{1-\rho}}$. It is apparently that $w_{1h} \neq w_{2h}$ unless $\alpha = 1/2$, and therefore that wealth equalization does not hold anymore. Here, the more weight that parents put on one child in the utility function, the more wealth that s/he will possess. In addition, notice that both $\tilde{y}_h$ and p_h are parameters that are common to all children within the same family, so they can be eliminated through sibling differences. After log-linearization, it can be shown that

$$\Delta \ln t_h = \frac{\mu\bar{s} + \bar{t}}{\bar{t}} \frac{1}{1-\rho} \ln \frac{\alpha}{1-\alpha} - \frac{\bar{s}}{\bar{t}} \mu \Delta \ln s_h - \frac{1}{\bar{t}} \Delta \varepsilon_h \tag{23}$$

where $\bar{s}$ and $\bar{t}$ are the overall sample means. This equation can be tested by the regression

$$\Delta \ln t_h = \theta_0 + \theta_1 \Delta \ln s_h + u_h \tag{24}$$

Compensatory inter-vivos transfers imply that $\theta_1 < 0$.

Equation (24) allows us to test the "equal concern" hypothesis as well. If we want to test if parents favor their older children, for example, we can put a dummy variable into the individual-level regression, equal to one for the older child and zero for the younger child in the family. The difference of this dummy variable within the same household would be one, and its coefficient in the sibling differences or the household fixed effect regression would be θ_0. Given that

$$\begin{aligned} \theta_0 &> 0 \text{ when } \alpha > 1/2; \\ \theta_0 &= 0 \text{ when } \alpha = 1/2; \\ \text{and } \theta_0 &< 0 \text{ when } \alpha < 1/2, \end{aligned}$$

the sign of the coefficient on this birth-order dummy variable would tell us if parents' preferences are biased towards the older child or the younger child, or are unbiased with respect to birth order.

3.3 Endogenous Educational Investment

In this section, we shall enrich the model to incorporate parents' decision about the level of schooling investment. Assume that child i in family h is endowed with ability a_{ih}. The wealth level of this child is determined by

$$w_{ih} = E(a_{ih}, y_h, s_{ih}) + t_{ih} + \varepsilon_{ih} \quad (25)$$

where $E(\cdot,\cdot,\cdot)$ is an earning function which depends on the schooling investment, ability and family income of the child. Assume that $E(\cdot,\cdot,\cdot)$ is concave and let

$$E_{sa} > 0 \text{ and } E_{sy} > 0$$

which means that the marginal benefit of schooling is higher for children with higher ability and higher household wealth.

For simplicity, we maintain the "equal concern" assumption throughout this section. Parents' payoff function takes the same form as (9), while the budget constraint changes to $c_h + s_{1h} + s_{2h} + t_{1h} + t_{2h} = y_h$. Both s_{ih} and t_{ih} are decision variables. The properties of the optimal decisions can be summarized in the following proposition:

Proposition 1 Parents will choose the level of education investment (s_{ih}) and inter-vivos transfer (t_{ih}) such that:

1. Efficiency of education investment. The level of investment equalizes the marginal gain and marginal cost of education expenditure for each child, i.e.

$$E_{s_{1h}} = 1 = E_{s_{2h}} \quad (26)$$

2. Wealth equalization. Once education investments are decided, parents use inter-vivos transfers to equalize their children's wealth. i.e.,

$$w_{1h} = E(s_{1h}, a_{1h}, y_h) + t_{1h} + \varepsilon_{1h} = E(s_{2h}, a_{2h}, y_h) + t_{2h} + \varepsilon_{2h} = w_{2h} \quad (27)$$

Proof Refer to Appendix D.

Equation (26) has important implications. First, given that the marginal benefit from schooling is higher for children in richer families and children with higher ability, these children tend to receive more schooling investment ($\partial s_{ih}/\partial y_h > 0$ and $\partial s_{ih}/\partial a_{ih} > 0$)[7]. Second, educational investment in one child is independent of her sibling's ability ($\partial s_{ih}/\partial a_{jh} = 0$). Third, any unobservable individual attribute that does not enter the wealth return function for schooling $E(.,.,.)$ has no influence on the education expenditure an individual receives ($\partial s_{ih}/\partial \varepsilon_{ih} = 0$ and $\partial s_{ih}/\partial \varepsilon_{jh} = 0$). In this case, then, leaving these attributes in the regression's error term will not bias the coefficients on the schooling expenditure.

Note that each child's schooling expenditure should only be a function of the child's own ability and family income, i.e., $s_{ih} = S(a_{ih}, y_h)$; by contrast, their inter-vivos transfer is a function of all exogenous variables, i.e., $t_{ih} = T_{ih}(a_{1h}, a_{2h}, y_h, \varepsilon_{1h}, \varepsilon_{2h})$. So even though the abilities of the children are not directly observed, they can be solved for by inverting the schooling expenditure function S. Substituting the expressions for abilities into the transfer function T, we obtain equations relating inter-vivos transfer and educational investment:

$$t_{1h} = \gamma_{11} s_{1h} + \gamma_{12} s_{2h} + \gamma_{1y} y_h + \lambda_{t_1 \varepsilon_1} \varepsilon_{1h} + \lambda_{t_1 \varepsilon_2} \varepsilon_{2h} \quad (28)$$

$$t_{2h} = \gamma_{21} s_{1h} + \gamma_{22} s_{2h} + \gamma_{2y} y_h + \lambda_{t_2 \varepsilon_1} \varepsilon_{1h} + \lambda_{t_2 \varepsilon_2} \varepsilon_{2h} \quad (29)$$

where $\lambda_{xz} \equiv \partial x/\partial z$ and for $i, j = 1, 2$

$$\gamma_{ij} = \lambda_{t_i a_j}/\lambda_{s_i a_j},$$
$$\gamma_{iy} = \lambda_{t_i y} - \frac{\lambda_{t_i a_1} \cdot \lambda_{s_1 y}}{\lambda_{s_1 a_1}} - \frac{\lambda_{t_i a_2} \cdot \lambda_{s_2 y}}{\lambda_{s_2 a_2}}.$$

It can be shown that

$$\gamma_{ii} < 0 \quad (30)$$

$$\text{and } \gamma_{ij} > 0, \quad (31)$$

This is a counterpart of (14) and (15) that can be tested through OLS. However, given that family wealth is usually mis-measured, the same identification problem as in section 3.1 also exists here.

[7] This is consistent with empirical studies such as Behrman et al. (1994; 1996), and Miller et al. (1995), which find that allocation of schooling is targeted toward abler children.

Moreover, this identification problem cannot be solved through sibling differences. Notice that, in (28) and (29), even though the coefficients on family wealth (γ_{iy}) share the same functional form, they are evaluated at different ability levels (a_1 and a_2). Therefore, $\gamma_{1y} \neq \gamma_{2y}$ unless $a_1 = a_2$.

Fortunately, certain restrictions on the functional form of $E(\cdot, \cdot, \cdot)$ can ensure $\gamma_{1y} = \gamma_{2y}$ regardless of the value of a_1 and a_2. We state this result in proposition 2.

Proposition 2 In (28) and (29), $\gamma_{1y} = \gamma_{2y}$ $\forall a_1$ and a_2 when

$$E_y|_{s,a} - E_a \frac{E_{sy}}{E_{sa}} = b, \tag{32}$$

where b is a constant.

Proof Refer to Appendix D.

Two examples that satisfy (32) are, for child i in family h:

$$(3.1)\ E(s_{ih}, a_{ih}, y_h) = f(a_{ih}, y_h)e(s_{ih})$$

where $f(\cdot, \cdot)$ and $e(\cdot)$ are both concave; or

$$(3.2)\ E(s_{ih}, a_{ih}, y_h) = \delta_{ih}s_{ih} - \frac{1}{2}s_{ih}^2$$

where $\delta_{ih} = \alpha y_h + a_{ih}$, $\alpha > 0$. In the first example, the ability of the child (a_{ih}) and the wealth of the family (y_h) affect the efficiency of the return to human capital investment $e(s_{ih})$ through the function $f(\cdot, \cdot)$. In the second example, wealth return to schooling takes a quadratic form. Here we use δ_{ih} to denote children's absolute ability, which is equal to a mean level determined by family income y_h plus a random deviation a_{ih}. The latter type of functional form has frequently been used in the literature on the causal relationship between education and earnings (e.g. Card (1999)).

Assuming (32), subtracting (28) from (29) yields

$$\Delta t_h = (\gamma_{11} - \gamma_{21})s_{1h} + (\gamma_{12} - \gamma_{22})s_{2h} - \Delta\varepsilon_h \tag{33}$$

with $\gamma_{11} - \gamma_{21} < 0$ and $\gamma_{12} - \gamma_{22} > 0$. For the same reason as before, $\gamma_{11} - \gamma_{21} \neq -(\gamma_{12} - \gamma_{22})$ unless $a_{1h} = a_{2h}$. We cannot simplify (33) to a difference-difference specification as with (24).

To sum up, in a model with endogenous human capital investments, a functional form assumption on the return to schooling investments is required for identification in the test for compensatory inter-vivos transfer. In addition, a standard siblings difference or household fixed effect regression is mis-specified under this setup. Instead, to test the hypothesis, differences between siblings' inter-vivos transfer should be regressed on the *levels* of their educational investments, rather than the *difference* between them.

4 Data

4.1 The Sample

We use data from the "Survey on Family and Marriage Dynamics in Hebei Province", which was carried out in the summer of 2005 by the authors and Chinese colleagues. Hebei province is representative of North China culturally, economically, and socially. We focus on its rural villages where marriage traditions are best preserved. (Refer to Figure 1 for a map and detailed sampling strategy.)

We designed the survey so as to address the empirical hypotheses discussed in the previous section. Each household had to have at least one married child in order to be selected. Parents were interviewed for information on their children, which provided us with a unique opportunity to explore within-household variation. To alleviate the burden of the interview, for households with more than three married children, three of them were selected.[8] For each child, significant events over his/her life time were recorded, including (1) education, (2) premarital work experience, (3) marriage process and information on in-laws, (4) fertility and post-marriage intra-family arrangements and (5) pre-mortem household division if applicable. Altogether, the dataset contains 600 households with 1688 children, among which 1276 have been married.

[8]The selection criteria were: (1) Choose the children who married first and last; (2) If the two selected children are of the same sex, choose a third of the opposite sex; (3) If the two selected children are of different sex, choose a third one about whom the parents were most worried when s/he was 15; (4) If none of these criterion are applicable, daughters are preferred.

Several restrictions have to be imposed on the sample for purposes of analysis. Table 1 reports the sample attrition caused by each step, at the individual and household levels. First of all, children with missing values for education expenditure or marital transfers are dropped. In addition, there are 16 abnormal cases when the groom's family did not pay any bride-price. We exclude them in our analysis, as they do not represent the marriage arrangement we usually observe. We also exclude 25 matrilocal marriages[9] since this marriage pattern deviates from the mainstream patrilocal custom in the studied regions. We keep all households with more than 2 married children surviving after the above criteria are imposed. In the end, 127 households with multiple sons and 173 households with multiple daughters are used in the analysis of this paper.[10] Table 2 presents descriptive information on the characteristics of these households and their children. Given that we would like to explore the between-sibling variation in the dataset, for variables at the individual level, within-household standard deviations are also reported.

4.2 Education Investment

For each child in our dataset, education expenditure is reported since middle school (grade 7). It includes tuition fees, boarding expenses and other living expenses, deflated to 1980 price levels. We do not record expenditure in elementary schools, as most parents could not accurately recall this information, and so measurement error could be a significant problem. Instead, we impute the spending on elementary school for each child. A recent study by Liu et al. (2006) shows that the total cost of elementary education is about half the cost of middle school education in rural China. In light of this, we regress observed middle school expenses on gender, cohort and village dummies, and halve the predicted value before using it as imputed elementary schooling expenditure.[11]

According to Table 2, boys usually have a higher level of schooling and spend

[9] Refers to marriages where newlywed couples live in or near the household of the bride's natal family.

[10] The number of households with multiple daughters is larger than that of households with multiple sons because our sampling rule is to bias towards daughters. Refers to footnote 9 for details.

[11] The mean of this imputed variable is around 300 yuan.

more for education than girls do, but the difference is not significant. The within household variation in education expenditure is large, and accounts for about 68 percent of the total variation in the sample.

4.3 Marital Transfers

As mentioned in the introduction, marital transfers in rural China usually includes cash and items, such as furniture, home appliances and agricultural equipment, etc. The groom's family is responsible for preparing a new house. In our dataset, for each marriage, we have a complete inventory of marital transfers along with their monetary value. The dependent variable in our regressions is defined by the total value of the bride-price if the child in question is a son or dowry if the child is a daughter.

As shown in table 2, marital transfers are considerable in value. On average, marital transfers received by sons are three times larger than their education investment; for daughters, their dowries are smaller than their schooling expenditure. Bride-price is much larger than dowry because it normally includes the value of housing.

4.4 Wealth Measure

Family wealth is information important for controlling for household heterogeneity. For each interviewed household, we have a complete list of the houses built by parents since they were married. Furthermore, we know all agricultural investment in livestock and equipment ever made by the household. In practice, we use average real value of housing and total value of agricultural investment as proxies for family wealth.[12]

[12] The reason we use average value of housing instead of total value is as follows. It appears as if families with multiple sons have more wealth than those with multiple daughters if wealth is measured by total housing value. (The mean of total housing for the multiple sons sample is 11952 yuan, and for the multiple daughters sample is 7922.) This is due to the fact that the likelihood of building more houses as part of the bride-price is higher for families with more

4.5 Other Control Variables

Table 2 shows that, except for differences in height, sons have no significant differences from daughters in terms of individual attributes, including birth year, age at marriage and pre-marital activities. Children examined in this paper were born between the 1950s and the 1990s, and most marriages took place between 1980 and 2000. Age at marriage is 23 on average. Before marriage, children tend to participate in more agricultural activities than non-agricultural activities. Also, less than half of the sampled children earn income and remit it to their parents before their marriages.

Families with multiple sons are insignificantly different from families with multiple daughters, in terms of parents' education, family wealth and size. Compared with their children, parents have many fewer years of schooling, and difference in education by gender is larger for parents. The illiteracy rate is 35% for fathers and 67% for mothers.

5 Empirical Results

5.1 Test of Model with Exogenous Education Investment and "Equal Concern" Assumption

Tables 3.1 and 3.2 test the model with exogenous education investment and the "equal concern" assumption. To control for gender difference, we implement the estimation using the multiple sons (Table 3.1) and multiple daughters (Table 3.2) samples separately. In both tables, we start by regressing each child's marital transfers on his/her schooling expenditure (column 1). In column 2, we add in total value of housing and agricultural equipment as indicators of family wealth. In column 3, siblings' characteristics are included to make the regression consist-

sons. In order to address this problem, we use the average value of housing instead of total value when we conduct our estimation. In any case, the empirical results are not sensitive to different measures of housing value.

ent with equation (16). In column 4, family fixed effect regressions are used to implement a test of the differenced model (19). In all regressions, standard errors are clustered at the household level. For the daughters' sample, as the dependent variable is left censored at zero, standard fixed effect estimates could be biased.[13] Moreover, since we only use variation among two to three children within each family, Tobit results controlling for household dummies could be biased as well due to the well-known incidental parameter problem (Neyman and Scott, 1948). To deal with this problem, we employ an estimator that is shown to be asymptotically consistent in Honore (1992) and report the results in column 5 of Table 3.2.

In OLS regressions, coefficients on own education investment are significantly negative in the sons sample, but insignificantly different from zero in the daughters sample. Wealth measures have significant effects on the dependent variable: richer families tend to give more marital transfers. The effects of siblings' education investment are significantly positive in the daughters sample, but not significant in the sons sample.

Once we control for household heterogeneity, the coefficients on education investment decrease substantially, which confirms that OLS estimates are biased upwards, presumably due to imprecise measurement of family wealth (see column 4 in Table 3.1 and column 5 in Table 3.2). The estimates suggest that if education investment in one son is lower than his brothers by 1 yuan, he will be compensated by receiving 33 cents more than his brothers in his marital transfers; the same result for daughters is 12 cents.

It seems that differences in marital transfers across children do not fully compensate for differences in education investments. According to equation (19), the coefficients on education expenditure in household fixed regressions can be interpreted as the wealth return of human capital investment (the parameter μ), which we usually expect to have a magnitude greater than 1. Nevertheless, the empirical results turn out to be much lower than that. In the following sections, we shall discuss several possibilities that could give rise to the underestimation of μ.

[13] Censoring is not an issue for the sons sample due to our sample restrictions (refers to Section 4.1). Therefore, analysis of sons sample will be based on the household fixed effect regressions.

5.2 Test on Model with Exogenous Education Investment and "Unequal Concern" Assumption

Recall that in section 3.2, we discussed a model with exogenous education investment and an "unequal concern" assumption. As suggested in equations (21) and (22), when parents' preference is biased towards one child, wealth equalization will not hold: parents tend to provide their "preferred" child with more human and non-human capital investment. In the absence of preference bias control variables, the compensatory effect of marital transfers would be biased downwards. By adopting the double log functional form, equation (24) tests for the compensation effect when the "equal concern" assumption is relaxed. Here, coefficients on control variables will suggest with which dimension unequal affection towards children is associated.

Tables 4.1 and 4.2 are organized in the same manner as Tables 3.1 and 3.2. The only difference is that all transfer variables and wealth measures are in log form. The upward bias in OLS without controlling for household fixed effects is confirmed again. Accordingly, we shall focus our discussion on household fixed effect regressions.

The compensatory effect of marital transfers is robust in the log form regressions. We can interpret the coefficients in terms of elasticity. For sons, if one's brother's education investment is increased by 1 percent, *ceteris paribus*, one's own marital transfers will increase by 0.30 percent; the same result for daughters is 0.49 percent. Still, full compensation is not achieved.

Some interesting results in Table 4.2 warrant detailed discussion. In column 5, the coefficient on the first born daughter dummy is positive and significant, implying that parents' preference is biased towards the first born daughter. However, we do not observe unequal affection along other dimensions, such as height, agricultural or non-agricultural experience, indicator of remitted income or living away from home before marriage.[14] In column 6 of Table 4.2, we exclude all individual vari-

[14]Not all individual control variables are informative about parental preference bias. Given that the dependent variable is marital transfer, coefficients on any attributes that are valued by the marriage market would have a hazy interpretation. For example, suppose that younger

ables that might relate to parental preference, only keeping the age of the child to control the for the time effect. We find that the coefficient on education expenditure becomes smaller in magnitude. This is expected given that parental preference bias is an important issue among daughters, ignoring it would bias the estimated compensatory effect downwards. It should be mentioned that we do not observe any evidence showing that parents unequally love their sons (refer to column 4 of Table 4.1), and therefore the coefficient on education expenditure does not change much when we exclude all individual control variables (column 5 of Table 4.1).[15]

5.3 Measurement Errors in Education Transfer

A low value of the coefficient on education expenditure may be due to attenuation bias. Given that our education expenditure variable comes from recalled and imputed data, measurement error might exist, which could bias OLS estimates towards zero. One way to correct for this bias is to use an instrumental variable approach. "Years of schooling" is an ideal candidate to serve as an instrument for education expenditure: (1) it is positively correlated with education expenditure and (2) its measurement error, if there is any, is not likely to be correlated with that of education expenditure.

In Tables 5.1 and 5.2 we replicate all specifications in Tables 3 and 4 using 2SLS estimation. Only the coefficients on the variable of interest are reported. Results from the first stage regressions are presented as well.

Unsurprisingly, "years of schooling" is a good predictor of education expenditure in the first stage. However, the second stage blows up the standard errors and leads to a loss of significance of all the coefficients. Comparing with the OLS results, the magnitudes of the IV estimates are somewhat smaller, but the difference is not statistically significant. We conclude that our OLS results are not likely to suffer

brides are preferred in the marriage market, then parents would have to pay more in order to marry out their older daughters. If this were the case, and we observed that the coefficient on age at marriage was significantly positive in our regression for daughters, we could not tell whether this was due to the marriage market clearing condition or parental preference for daughters who marry later.

[15] We shall add in some literature in birth order preference.

from an attenuation bias problem.

5.4 Alternative Explanations to the Low Point Estimates

Is there any additional problem with our data and methods that can reconcile the low point estimates with the full compensation predicted by our model? One possibility is that parents might use inter-vivos transfers other than marital transfers to make up for the difference in human investment between their children. Even though marital transfers in rural China are considerable in magnitude, it is still just a part of the total lifetime transfer. Considering the possible financial constraints faced by parents, they might not be able to fully offset the wealth difference among their children with just one lump sum transfer.

A second issue leading to the low compensation effect concerns strategic behaviors between parents and children. Wealth equalization amounts to full insurance provided to children. If the return to education depends on the effort level that children spend on their study, two problems would result: free riding (among siblings) and moral hazard. Both of these would cause children to exert less effort than the optimal levels. To avoid these problems, parents might break the linkage between education achievement and inter-vivos transfer by committing an equal fixed amount transfer to each of their children. In this case, wealth equalization would be violated; efficiency, however, could be achieved. Such strategic behaviors tend to drive the coefficient on education investment towards zero in our regression.

5.5 Test of Model with Endogenous Education Investment and "Equal Concern" Assumption

We now present in Table 6 the estimates of the model with endogenous education investment while maintaining the "equal concern" assumption. The regressions were conducted using the multiple sons and multiple daughters samples in turn. Unlike in standard sibling differences or household fixed effect regressions, the ordering of children matters here. If we sort the children in such a way that child

1, on average, has higher ability than child 2, then we expect to observe that $\gamma_{11} - \gamma_{21} \neq -(\gamma_{12} - \gamma_{22})$. In practice, we sort sons and daughters according to their birth order (column 1 and 4), conditional years of schooling (column 2 and 5), or conditional education investment (column 3 and 6) and then estimate the model separately.[16]

Comparing across different columns in table 6, the coefficient on child 1's education investment is consistently negative but generally not statistically significant. By contrast, the coefficient on child 2's education investment is generally significantly positive as expected. These two coefficients are jointly significant except for the last two specifications with the multiple daughters sample, which provides evidence supporting the compensatory effect hypothesis. Regarding their relative magnitudes, we cannot reject that these two coefficients have the same magnitude even at the 10% level (refer to the p-value in the last row). This finding is inconsistent with what we have discussed in section 3.3. There are several possible interpretations. Firstly, it may be due to the limited sample size and resulting large standard errors in our estimates. Secondly, years of schooling and education expenditure may be poor predictors of true ability, and there is no significant difference in abilities between the siblings by the way we sort them. Lastly, the result might suggest that parents actually take human capital investment as given when they make decisions on marital transfers; in other words, that the model with exogenous education investments is valid and the standard sibling differences or family fixed effect regressions can fit the data well.

6 Conclusion

Parents make various transfers to children over their lifetimes. They also decide how to allocate these transfers across heterogeneous children. Theoretical economists have developed models to predict the pattern of intergenerational transfer behaviors; yet little attention has been paid to empirically investigate the relation-

[16] Conditional variables are generated in the following way: we first regress years of schooling or education investment on birth year and household dummies. Then, we calculate the residuals, which we use later to order children within a family.

ship among different forms of investment toward children.

To better address this issue, we construct a model which captures unobserved family heterogeneity, unequal parental valuations of their investments across children, and unobserved differences in child abilities. To control for unobserved family characteristics, level-on-level fixed effect regressions have been suggested and applied in previous literature. However, our framework shows that such a specification can only be rationalized by a model with the "equal concern" assumption and exogenous education investment. These restrictive assumptions can be relaxed, but certain adjustments to the regression equations need to be made accordingly. When we loosen the "equal concern" assumptions, fixed effect regressions with both dependent and independent variables in logarithm form should be applied. When we endogenize the education investment decision, on the other hand, an assumption on functional form has to be imposed on the return to education equation in order to generate identification in the sibling differences regressions. In this case, we propose a regression in which differences in sibling's inter-vivos transfer are regressed on the levels of their education investments. Our findings in compensatory effects are robust to the new specifications.

Our level-on-level fixed effect regressions suggest that more marital transfers are allocated to children receiving less education investment. Specifically, if education investment in one son is lower than his brothers by 1 yuan, he will be compensated by receiving 33 cents more than his brothers in his marital transfers; the same result for daughters is 12 cents. When interpreted as the wealth return to education investment, the coefficient seems to be a lower than expected. We discuss several possibilities to explain the underestimation of this compensation effect. We argue that the underestimation problem is not due to unequal valuations on children by parents or any measurement problems; rather, it comes from the strategic considerations within the family. Parents would not fully compensate their children in the presence of free riding and moral hazard problems.

Furthermore, evidence is found against equal valuations across parental investments for different children in our log-on-log fixed effect regressions. Across daughters, parents tend to invest more in the oldest. This first child bias is not present among sons.

Facing heterogeneous children, parents will make higher education investments in children with higher ability due to it being more efficient. Given the divergence in children's welfare induced by unequal human capital investment, how would parents make decisions on non-human capital investments towards their children? Firstly, parents would prefer all their children to enjoy comparable levels of wealth, which implies that the non-human capital investment will compensate for the differences in human capital investment. Secondly, parents might put more weight on their favorite child, which would lead to non-human capital investment reinforcing these differences. Lastly, potential free riding and moral hazard in children's behavior make the parents unable to commit full compensation, which tends to break the linkage between human and non-human capital investment. The observed pattern of trade-offs among different forms of investments is a consequence of these three distinct concerns of parents. Our model successfully incorporates the first concern of parents, while controlling the second one. The third concern cannot be controlled for in our model due to data limitations. However, the significant negative correlation that we observe between different transfers suggests that our empirical results are in favor of the compensation role played by non-human capital investment as predicted by the Beckerian model.

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Appendix A: Optimization of Model with (1) Two Children, (2) "Equal Concern" and (3) Exogenous Education Investment

For notational simplicity, we shall omit the family index h in the following derivations. Consider a family with two children 1 and 2. The parents solve the problem

$$\max_{c,t_1,t_2} U(c, g(w_1, w_2)) \qquad \text{subject to } w_i = \mu s_i + t_i + \varepsilon_i, i = 1, 2$$
$$\text{and } c + t_1 + t_2 = y$$

where $g(.,.)$ is a symmetry function and concave in its arguments. This problem is equivalent to

$$\max_{t_1,t_2} U(y - t_1 - t_2, g(\mu s_1 + t_1 + \varepsilon_1, \mu s_2 + t_2 + \varepsilon_2))$$

The first order conditions are

$$U_c = U_g g_{w_1}$$
$$U_c = U_g g_{w_2}$$

which implies

$$g_{w_1} = g_{w_2}$$

Given the symmetry and concavity of $g(.,.)$, we obtain the wealth equalization result

$$w_1 = \mu s_1 + t_1 + \varepsilon_1 = \mu s_2 + t_2 + \varepsilon_2 = w_2$$

Let $e_i = \mu s_i + \varepsilon_i, i = 1, 2$. Given that $w_1 = w_2 = w$, the parents' problem can be rewritten as

$$\max_{w} \hat{U}(y - (2w - e_1 - e_2), w)$$

The first order condition is

$$-2\hat{U}_c + \hat{U}_w = 0$$

We shall assume complementarity between c and w in parents' utility function, i.e.,

$$\hat{U}_{cw} \geq 0$$

This assumption along with the concavity of $\hat{U}$ ensures the second order condition to be satisfied:

$$4\hat{U}_{cc} - 4\hat{U}_{cw} + \hat{U}_{ww} < 0$$

Now consider the comparative statics. Differentiation of both sides of the first order condition yields

$$2\hat{U}_{cc}(\partial y - (2\partial w - \partial e_1 - \partial e_2)) = \hat{U}_{cw}(-2\partial w + \partial y - (2\partial w - \partial e_1 - \partial e_2)) + \hat{U}_{ww}\partial w$$

$$\partial w = \frac{(2\hat{U}_{cc} - \hat{U}_{cw})(\partial y + \partial e_1 + \partial e_2)}{4\hat{U}_{cc} - 4\hat{U}_{cw} + \hat{U}_{ww}}$$

Since $w = t_1 + e_1 = t_2 + e_2$

$$\begin{aligned}
\partial t_1 &= \frac{(2\hat{U}_{cc} - \hat{U}_{cw})(\partial y + \partial e_1 + \partial e_2)}{4\hat{U}_{cc} - 4\hat{U}_{cw} + \hat{U}_{ww}} - \partial e_1 \\
\partial t_2 &= \frac{(2\hat{U}_{cc} - \hat{U}_{cw})(\partial y + \partial e_1 + \partial e_2)}{4\hat{U}_{cc} - 4\hat{U}_{cw} + \hat{U}_{ww}} - \partial e_2
\end{aligned}$$

Therefore, for $i, j = 1, 2$ and $i \neq j$,

$$\begin{aligned}
\partial t_i / \partial y &= \frac{2\hat{U}_{cc} - \hat{U}_{cw}}{4\hat{U}_{cc} - 4\hat{U}_{cw} + \hat{U}_{ww}} \equiv \lambda_y > 0 \\
\partial t_i / \partial s_i &= \mu \cdot \partial t_i / \partial \varepsilon_i = \frac{-2\hat{U}_{cc} + 3\hat{U}_{cw} - \hat{U}_{ww}}{4\hat{U}_{cc} - 4\hat{U}_{cw} + \hat{U}_{ww}} = \mu(\lambda_y - 1) < 0 \\
\partial t_i / \partial s_j &= \mu \cdot \partial t_i / \partial \varepsilon_j = \mu \lambda_y > 0
\end{aligned}$$

The decision variables t_1 and t_2 can therefore be written as:

$$\begin{aligned}
t_1 &= (\lambda_y - 1)\mu s_1 + \lambda_y \mu s_2 + \lambda_y y + (\lambda_y - 1)\varepsilon_1 + \lambda_y \varepsilon_2 \\
t_2 &= \lambda_y \mu s_1 + (\lambda_y - 1)\mu s_2 + \lambda_y y + \lambda_y \varepsilon_1 + (\lambda_y - 1)\varepsilon_2
\end{aligned}$$

Subtracting these two equations yields

$$t_1 - t_2 = -\mu(s_1 - s_2) - (\varepsilon_1 - \varepsilon_2)$$

which can be estimated through OLS.

Appendix B Bias of OLS in Case of Mis-measured Independent Variable

For simplicity, consider a single child case. Let the true determination of the inter-vivos transfer is given by:

$$t_{ih} = \beta_0 + \beta_{1h} s^*_{ih} + \beta_y y^*_h + \varepsilon_{ih}$$

where $\beta_{1h} < 0$, $\beta_y > 0$, and ε_{ih} is i.i.d. drawn from a normal distribution. In practice, family wealth is measured with classic errors-in-variables.

$$y_h = y^*_h + u_h$$

where u_h is an i.i.d. random variable and uncorrelated with y^*_h. We shall work with the demean version of the model:

$$\begin{aligned} t_{ih} - \bar{t} &= \beta_s (s^*_{ih} - \bar{s}^*) + \beta_y (y^*_h - \bar{y}^*) + \bar{\varepsilon} \quad &\text{(True model)} \\ y_h - \bar{y} &= (y^*_h - \bar{y}^*) + u \quad &\text{(Measured)} \end{aligned}$$

where $\bar{x}$ is the sample mean of x. Now every limit can be written as the variance and covariance of the variables. The corresponding matrix notation is

$$\begin{aligned} T &= X^* \beta + \varepsilon \\ X &= X^* + U \end{aligned}$$

where $X = \begin{bmatrix} s^*_{ih} - \bar{s}^* & y^*_h - \bar{y}^* \end{bmatrix}$; $\beta = \begin{bmatrix} \beta_s \\ \beta_y \end{bmatrix}$; $U = \begin{bmatrix} 0 & u \end{bmatrix}$.

$$\begin{aligned}
\text{plim}\frac{1}{n}X^{*\prime}X^* &= \text{plim}\frac{1}{n}\begin{bmatrix} (s^*_{ih} - \bar{s}^*)' \\ (y^*_h - \bar{y}^*)' \end{bmatrix}\begin{bmatrix} s^*_{ih} - \bar{s}^* & y^*_h - \bar{y}^* \end{bmatrix} \\
&= \begin{bmatrix} \sigma^2_{s^*} & \sigma_{s^*y^*} \\ \sigma_{s^*y^*} & \sigma^2_{y^*} \end{bmatrix} \\
&\equiv Q^* \\
\sum\nolimits_{UU} &= \text{plim}\frac{1}{n}U'U = \text{plim}\frac{1}{n}\begin{bmatrix} 0 \\ u' \end{bmatrix}\begin{bmatrix} 0 & u \end{bmatrix} \\
&= \begin{bmatrix} 0 & 0 \\ 0 & \sigma^2_u \end{bmatrix} \\
\text{plim}\frac{1}{n}X'X &= \text{plim}\frac{1}{n}X^{*\prime}X^* + \sum\nolimits_{UU} \\
&= Q^* + \sum\nolimits_{UU} \\
\text{plim}\frac{1}{n}X'T &= \text{plim}\frac{1}{n}(X^{*\prime} + U')(X^*\beta + \varepsilon) \\
&= \text{plim}\frac{1}{n}X^{*\prime}X^* \cdot \beta \\
&= Q^*\beta
\end{aligned}$$

Hence

$$\begin{aligned}
\text{plim}\beta^{OLS} &= \text{plim}(\frac{1}{n}X'X)^{-1}(\frac{1}{n}X'T) \\
&= [Q^* + \sum\nolimits_{UU}]^{-1}Q^*\beta \\
&= \begin{bmatrix} \sigma^2_{s^*} & \sigma_{s^*y^*} \\ \sigma_{s^*y^*} & \sigma^2_{y^*} + \sigma^2_u \end{bmatrix}^{-1}\begin{bmatrix} \sigma^2_{s^*} & \sigma_{s^*y^*} \\ \sigma_{s^*y^*} & \sigma^2_{y^*} \end{bmatrix}\begin{bmatrix} \beta_s \\ \beta_y \end{bmatrix} \\
&= \frac{1}{\sigma^2_{s^*}(\sigma^2_{y^*} + \sigma^2_u) - \sigma^2_{s^*y^*}}\begin{bmatrix} \sigma^2_{y^*} + \sigma^2_u & -\sigma_{s^*y^*} \\ -\sigma_{s^*y^*} & \sigma^2_{s^*} \end{bmatrix}\begin{bmatrix} \beta_s\sigma^2_{s^*} + \beta_y\sigma_{s^*y^*} \\ \beta_y\sigma^2_{y^*} + \beta_s\sigma_{s^*y^*} \end{bmatrix} \\
&= \frac{1}{\sigma^2_{s^*}(\sigma^2_{y^*} + \sigma^2_u) - \sigma^2_{s^*y^*}}\begin{bmatrix} [\sigma^2_{s^*}(\sigma^2_{y^*} + \sigma^2_u) - \sigma^2_{s^*y^*}]\beta_s + \sigma^2_u\sigma_{s^*y^*}\beta_y \\ (\sigma^2_{s^*}\sigma^2_{y^*} - \sigma^2_{s^*y^*})\beta_y \end{bmatrix}
\end{aligned}$$

Therefore

$$\begin{aligned}
\text{plim}\beta_y^{OLS} &= \frac{(\sigma_{s^*}^2\sigma_{y^*}^2 - \sigma_{s^*y^*}^2)\beta_y}{\sigma_{s^*}^2(\sigma_{y^*}^2 + \sigma_u^2) - \sigma_{s^*y^*}^2} \\
&= \beta_y \frac{1}{1 + \sigma_u^2 \frac{\sigma_{s^*}^2}{\sigma_{s^*}^2\sigma_{y^*}^2 - \sigma_{s^*y^*}^2}} \\
&= \beta_y \frac{1}{1 + \frac{\sigma_u^2}{\sigma_{y^*}^2}\frac{1}{1 - R_{s^*y^*}^2}}
\end{aligned}$$

The coefficient on the mis-measured family wealth will be biased towards zero, which is a standard argument of attenuation bias. In addition, for a variable that is correlated with y,

$$\begin{aligned}
\text{plim}\beta_s^{OLS} &= \beta_s + \beta_y \frac{\sigma_u^2\sigma_{s^*y^*}}{\sigma_{s^*}^2(\sigma_{y^*}^2 + \sigma_u^2) - \sigma_{s^*y^*}^2} \\
&= \beta_s + \beta_y \frac{\sigma_u^2\sigma_{s^*y^*}}{\sigma_{s^*}^2\sigma_{y^*}^2(1 - \frac{\sigma_{s^*y^*}^2}{\sigma_{s^*}^2\sigma_{y^*}^2}) + \sigma_u^2\sigma_{s^*}^2} \\
&= \beta_s + \beta_y \frac{\sigma_u^2\sigma_{s^*y^*}}{\sigma_{s^*}^2\sigma_{y^*}^2(1 - R_{s^*y^*}^2) + \sigma_u^2\sigma_{s^*}^2}
\end{aligned}$$

where $R_{s^*y^*}^2$ is the R-squared from regressing s_{ih} on y_h. From the theoretical model we know that $\beta_y > 0$ and $cov(s_{ih}, y_h) > 0$; therefore β_s^{OLS} will be biased upwards.

Appendix C Optimization of Model with (1) Two Children, (2) "Unequal Concern" and (3) Exogenous Education Investment

Parents solve the problem

$$\begin{aligned}
\max_{c,t_1,t_2} \quad & \tilde{U}(c, w_1, w_2) = [zc^\rho + \alpha w_1^\rho + (1-\alpha)w_2^\rho]^{1/\rho} \\
& \text{subject to } w_i = \mu s_i + t_i + \varepsilon_i,\ i = 1, 2 \\
& \text{and } c + t_1 + t_2 = y
\end{aligned}$$

where utility function takes a CES functional form; α represents the relative weights that parents put on the wealth of child i; z represents the weight that parents put on their own consumption relative to the wealth of their children. The first order conditions are

$$\begin{aligned}
\frac{1}{\rho}\tilde{U}^{1-\rho}\rho\alpha w_1^{\rho-1} &= \lambda \\
\frac{1}{\rho}\tilde{U}^{1-\rho}\rho(1-\alpha)w_2^{\rho-1} &= \lambda \\
\frac{1}{\rho}\tilde{U}^{1-\rho}\rho z c^{\rho-1} &= \lambda
\end{aligned}$$

Hence

$$w_1 = \mu s_1 + t_1 + \varepsilon_1 = \alpha^{\frac{1}{1-\rho}}\lambda^{\frac{1}{\rho-1}}\tilde{U} \quad (34)$$

$$w_2 = \mu s_2 + t_2 + \varepsilon_2 = (1-\alpha)^{\frac{1}{1-\rho}}\lambda^{\frac{1}{\rho-1}}\tilde{U} \quad (35)$$

$$c = z^{\frac{1}{1-\rho}}\lambda^{\frac{1}{\rho-1}}\tilde{U} \quad (36)$$

Note that wealth equalization does not hold anymore. Solving for t_1 and t_2 and substituting into the budget constraint yields

$$\lambda^{\frac{1}{\rho-1}}\tilde{U} = \frac{y + \mu s_1 + \varepsilon_1 + \mu s_2 + \varepsilon_2}{z^{\frac{1}{1-\rho}} + \alpha^{\frac{1}{1-\rho}} + (1-\alpha)^{\frac{1}{1-\rho}}} \equiv \frac{\tilde{y}}{p} \quad (37)$$

From (34), (35) and (37), we know that

$$\begin{aligned}
w_1 &= \alpha^{\frac{1}{1-\rho}}\frac{\tilde{y}}{p} \\
w_{2h} &= (1-\alpha)^{\frac{1}{1-\rho}}\frac{\tilde{y}}{p}
\end{aligned}$$

Taking logs on both sides and taking the difference yields

$$\ln(\mu s_1 + t_1 + \varepsilon_1) - \ln(\mu s_2 + t_2 + \varepsilon_2) = \frac{1}{1-\rho}\ln\frac{\alpha}{1-\alpha} \quad (38)$$

Approximating the left hand side of the above equation around the logarithms of the sample means $\ln\bar{s}$, $\ln\bar{t}$, $\varepsilon_1 = 0$, and $\varepsilon_2 = 0$. For $i = 1, 2$:

$$\begin{aligned}
\ln(\mu s_i + t_i + \varepsilon_i) &= \ln(\mu e^{\ln s_i} + e^{\ln t_i} + e^{\ln \varepsilon_i}) \\
&\simeq \ln(\mu\bar{s} + \bar{t}) + \frac{\bar{t}}{\mu\bar{s}+\bar{t}}(\ln t_i - \ln\bar{t}) + \frac{\mu\bar{s}}{\mu\bar{s}+\bar{t}}(\ln s_i - \ln\bar{s}) \\
&\quad + \frac{1}{\mu\bar{s}+\bar{t}}\varepsilon_i
\end{aligned}$$

(38) becomes

$$\frac{\bar{t}}{\mu\bar{s}+\bar{t}}\Delta\ln t + \frac{\mu\bar{s}}{\mu\bar{s}+\bar{t}}\Delta\ln s + \frac{1}{\mu\bar{s}+\bar{t}}\Delta\varepsilon = \frac{1}{1-\rho}\ln\frac{\alpha}{1-\alpha}$$

where $\Delta x \equiv x_1 - x_2$. Rearranging this equation yields the empirical specification

$$\Delta\ln t = \frac{\mu\bar{s}+\bar{t}}{\bar{t}}\frac{1}{1-\rho}\ln\frac{\alpha}{1-\alpha} - \frac{\bar{s}}{\bar{t}}\mu\Delta\ln s - \frac{1}{\bar{t}}\Delta\varepsilon$$

Appendix D Optimization for Model with (1) Two Children, (2) "Equal Concern" and (3) Endogenous Education Investment

The parents' problem is

$$\max_{\substack{c,s_1,t_1\\ s_2,t_2}} U(c, g(w_1, w_2)) \quad \text{subject to } w_i = E(a_i, y, s_i) + t_i \quad +\varepsilon_i,\ i = 1, 2$$
$$\text{and } c + s_1 + s_2 + t_1 + t_2 = y$$

The difference with the model in appendix A is that here wealth return to educational expenditure is not a linear function but a function $E(.,.,.)$ that depends on children's abilities, family wealth, and education expenditure.

Proof of Proposition 1

The first order conditions are

$$s_1 \;:\; U_c g_{w_1} E_{s_1} - \lambda = 0 \tag{39}$$
$$s_2 \;:\; U_c g_{w_2} E_{s_2} - \lambda = 0 \tag{40}$$
$$t_1 \;:\; U_g g_{w_1} - \lambda = 0 \tag{41}$$
$$t_2 \;:\; U_g g_{w_2} - \lambda = 0 \tag{42}$$
$$c \;:\; U_c - \lambda = 0 \tag{43}$$

From (41) and (42),

$$g_{w_1} = g_{w_2},$$

which implies that

$$w_1 = w_2, \tag{44}$$

given the concavity and symmetry of $g(\cdot, \cdot)$. Since $U_g g_{w_1} = U_g g_{w_2} = \lambda$, (39) and (40) imply

$$E_{s_1} = E_{s_2} = 1 \tag{45}$$

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From (45) we know that $\frac{\partial s_1}{\partial a_2} = \frac{\partial s_2}{\partial a_1} = 0$. The linearized functions of the decision variables are

$$s_1 = \lambda_{s_1 a_1} a_1 + \lambda_{s_1 y} y \tag{46}$$

$$s_2 = \lambda_{s_2 a_2} a_2 + \lambda_{s_2 y} y \tag{47}$$

$$t_1 = \lambda_{t_1 a_1} a_1 + \lambda_{t_1 a_2} a_2 + \lambda_{t_1 y} y + \lambda_{t_1 \varepsilon_1} \varepsilon_1 + \lambda_{t_1 \varepsilon_2} \varepsilon_2 \tag{48}$$

$$t_2 = \lambda_{t_2 a_1} a_1 + \lambda_{t_2 a_2} a_2 + \lambda_{t_2 y} y + \lambda_{t_2 \varepsilon_1} \varepsilon_1 + \lambda_{t_2 \varepsilon_2} \varepsilon_2 \tag{49}$$

where $\lambda_{xz} \equiv \partial x / \partial z$. Solving a_1 and a_2 from the schooling expenditure functions and then plugging into the transfer functions yields

$$t_1 = \gamma_{11} s_1 + \gamma_{12} s_2 + \gamma_{1y} y + \lambda_{t_1 \varepsilon_1} \varepsilon_1 + \lambda_{t_1 \varepsilon_2} \varepsilon_2 \tag{50}$$

$$t_2 = \gamma_{21} s_1 + \gamma_{22} s_2 + \gamma_{2y} y + \lambda_{t_2 \varepsilon_1} \varepsilon_1 + \lambda_{t_2 \varepsilon_2} \varepsilon_2 \tag{51}$$

where $\gamma_{ij} = \frac{\lambda_{t_i a_j}}{\lambda_{s_i a_j}}$ and $\gamma_{iy} = \lambda_{t_i y} - \frac{\lambda_{t_i a_1} \cdot \lambda_{s_1 y}}{\lambda_{s_1 a_1}} - \frac{\lambda_{t_i a_2} \cdot \lambda_{s_2 y}}{\lambda_{s_2 a_2}}$, where $i, j = 1, 2$. Take the difference of the above two equations:

$$\begin{aligned} \Delta t &= (\gamma_{11} - \gamma_{21}) s_1 + (\gamma_{12} - \gamma_{22}) s_2 + (\gamma_{1y} - \gamma_{2y}) y \\ &\quad + (\lambda_{t_1 \varepsilon_1} - \lambda_{t_2 \varepsilon_1}) \varepsilon_1 + (\lambda_{t_1 \varepsilon_2} - \lambda_{t_2 \varepsilon_2}) \varepsilon_2 \end{aligned} \tag{52}$$

We shall work out the conditions on which (1) $\gamma_{1y} - \gamma_{2y} = 0$, and (2) $\gamma_{11} - \gamma_{21} = -(\gamma_{12} - \gamma_{22})$ will hold. We shall also determine the coefficients on ε_1 and ε_2.

Proof of Proposition 2

From (45), we know that

$$\frac{\partial s_i / \partial y}{\partial s_i / \partial a_i} = \frac{E_{s_i y}}{E_{s_i a_i}} \tag{53}$$

$$\frac{\partial s_i}{\partial a_j} = 0 \tag{54}$$

$$\frac{\partial s_i}{\partial \varepsilon_j} = 0 \tag{55}$$

$$\frac{\partial s_i}{\partial \varepsilon_i} = 0 \tag{56}$$

where $i, j = 1, 2$ and $i \neq j$. Differentiating (44) with different parameters yields

$$\begin{aligned}
y &: \quad E_{s_1}\frac{\partial s_1}{\partial y} + E_y|_{s_1,a_1} + \frac{\partial t_1}{\partial y} = E_{s_2}\frac{\partial s_2}{\partial y} + E_y|_{s_2,a_2} + \frac{\partial t_2}{\partial y} \\
a_1 &: \quad E_{s_1}\frac{\partial s_1}{\partial a_1} + E_{a_1} + \frac{\partial t_1}{\partial a_1} = E_{s_2}\frac{\partial s_2}{\partial a_1} + \frac{\partial t_2}{\partial a_1} \\
a_2 &: \quad E_{s_1}\frac{\partial s_1}{\partial a_2} + \frac{\partial t_1}{\partial a_2} = E_{s_2}\frac{\partial s_2}{\partial a_2} + E_{a_2} + \frac{\partial t_2}{\partial a_2} \\
\varepsilon_1 &: \quad E_{s_1}\frac{\partial s_1}{\partial \varepsilon_1} + \frac{\partial t_1}{\partial \varepsilon_1} + 1 = E_{s_2}\frac{\partial s_2}{\partial \varepsilon_1} + \frac{\partial t_2}{\partial \varepsilon_1} \\
\varepsilon_2 &: \quad E_{s_1}\frac{\partial s_1}{\partial \varepsilon_2} + \frac{\partial t_1}{\partial \varepsilon_2} = E_{s_2}\frac{\partial s_2}{\partial \varepsilon_2} + \frac{\partial t_2}{\partial \varepsilon_2} + 1
\end{aligned}$$

Rearranging

$$\frac{\partial t_1}{\partial y} - \frac{\partial t_2}{\partial y} = E_{s_2}\frac{\partial s_2}{\partial y} - E_{s_1}\frac{\partial s_1}{\partial y} + E_y|_{s_2,a_2} - E_y|_{s_1,a_1} \tag{57}$$

$$\frac{\partial t_1}{\partial a_1} - \frac{\partial t_2}{\partial a_1} = -E_{s_1}\frac{\partial s_1}{\partial a_1} - E_{a_1} \tag{58}$$

$$\frac{\partial t_1}{\partial a_2} - \frac{\partial t_2}{\partial a_2} = E_{s_2}\frac{\partial s_2}{\partial a_2} + E_{a_2} \tag{59}$$

$$\frac{\partial t_1}{\partial \varepsilon_1} - \frac{\partial t_2}{\partial \varepsilon_1} = -1 \tag{60}$$

$$\frac{\partial t_1}{\partial \varepsilon_2} - \frac{\partial t_2}{\partial \varepsilon_2} = 1 \tag{61}$$

where we use the fact that $\frac{\partial s_i}{\partial a_j} = 0$, $\frac{\partial s_i}{\partial \varepsilon_i} = 0$ and $\frac{\partial s_i}{\partial \varepsilon_j} = 0$ for $i, j = 1, 2$ and $i \neq j$.

The coefficient on y in equation (52) is

$$\begin{aligned}
\gamma_{1y} - \gamma_{2y} &= [\frac{\partial t_1}{\partial y} - \frac{\partial t_2}{\partial y}] - \frac{\partial s_1/\partial y}{\partial s_1/\partial a_1}[\frac{\partial t_1}{\partial a_1} - \frac{\partial t_2}{\partial a_1}] - \frac{\partial s_2/\partial y}{\partial s_2/\partial a_2}[\frac{\partial t_1}{\partial a_2} - \frac{\partial t_2}{\partial a_2}] \\
&= E_{s_2}\frac{\partial s_2}{\partial y} - E_{s_1}\frac{\partial s_1}{\partial y} + E_y|_{s_2,a_2} - E_y|_{s_1,a_1} + \frac{\partial s_1/\partial y}{\partial s_1/\partial a_1}\left(E_{s_1}\frac{\partial s_1}{\partial a_1} + E_{a_1}\right) \\
&\quad - \frac{\partial s_2/\partial y}{\partial s_2/\partial a_2}\left(E_{s_2}\frac{\partial s_2}{\partial a_2} + E_{a_2}\right) \\
&= \left(E_y|_{s_2,a_2} - E_{a_2}\frac{E_{s_2 y}}{E_{s_2 a_2}}\right) - \left(E_y|_{s_1,a_1} - E_{a_1}\frac{E_{s_1 y}}{E_{s_1 a_1}}\right),
\end{aligned}$$

which is equal to zero when

$$E_y|_{s_i,a_i} - E_{a_i}\frac{E_{s_i y}}{E_{s_i a_i}} = b \ \forall (s_i, a_i, y) \tag{62}$$

where b is a constant.

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Taking $b = 0$, (62) becomes

$$E_y|_{s_i,a_i} = E_{a_i}\frac{E_{s_i y}}{E_{s_i a_i}}$$

Therefore

$$\begin{aligned} \frac{E_y E_{a_i s_i} - E_{y s_i} E_{a_i}}{E_y^2} &= 0 \\ \text{and } \frac{E_{y s_i} E_{a_i} - E_y E_{a_i s_i}}{E_{a_i}^2} &= 0 \end{aligned}$$

i.e.,

$$\begin{aligned} \frac{\partial(E_y/E_{a_i})}{\partial s_i} &= 0 \\ \text{and } \frac{\partial(E_{a_i}/E_y)}{\partial s_i} &= 0 \end{aligned}$$

Function that satisfies the above condition should takes the form

$$E(s_i, a_i, y) = f(a_i, y)e(s_i) + g(s_i) \tag{63}$$

Two examples are

(3.1) $E(s_i, a_i, y) = f(a_i, y)e(s_i)$ where $f(\cdot,\cdot)$ and $e(\cdot)$ are both concave;

or

(3.2) $E(s_i, a_i, y) = \delta_i s_i - \frac{1}{2}s_i^2$ where $\delta_i = \alpha y + a_i$, $\alpha > 0$.

Now consider the coefficients on schooling expenditure in (52):

$$\begin{aligned} \gamma_{11} - \gamma_{21} &= \frac{\lambda_{t_1 a_1}}{\lambda_{s_1 a_1}} - \frac{\lambda_{t_2 a_1}}{\lambda_{s_1 a_1}} \\ &= \frac{1}{\partial s_1/\partial a_1}[\frac{\partial t_1}{\partial a_1} - \frac{\partial t_2}{\partial a_1}] \\ &= (-E_{s_1}\frac{\partial s_1}{\partial a_1} - E_{a_1})\frac{1}{\partial s_1/\partial a_1} \\ &= -E_{s_1} + E_{a_1}\frac{E_{s_1 s_1}}{E_{s_1 a_1}} < 0 \end{aligned}$$

By the same logic

$$\gamma_{12} - \gamma_{22} = E_{s_2} - E_{a_2}\frac{E_{s_2 s_2}}{E_{s_2 a_2}} > 0$$

$\gamma_{11} - \gamma_{21} = -(\gamma_{12} - \gamma_{22})$ when

$$E_{s_i} - E_{a_i} \frac{E_{s_i s_i}}{E_{s_i a_i}} = c \neq 0 \ \forall (s_i, a_i, y), i = 1, 2 \tag{64}$$

where c is a non-zero constant. From (45), the above can be simplified to

$$E_{a_i} \frac{E_{s_i s_i}}{E_{s_i a_i}} = d \neq 1 \ \forall (s_i, a_i, y), i = 1, 2 \tag{65}$$

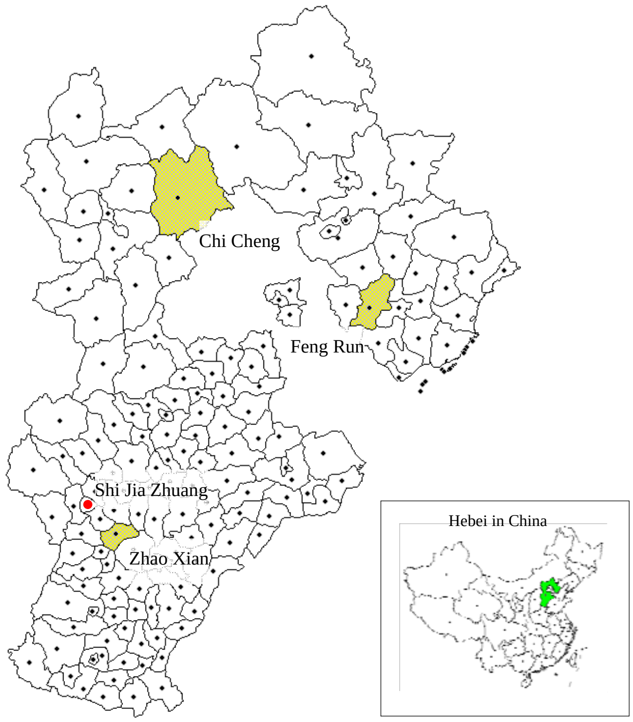
where d is a constant not equal to 1.

It is easy to see that when we assume that $E(., ., .)$ is of the form as in (63), then (64) and (65) will not necessarily hold. With (60) and (61), equation (52) becomes

$$\Delta t = (\gamma_{11} - \gamma_{21}) s_1 + (\gamma_{12} - \gamma_{22}) s_2 - \Delta \varepsilon$$

where $\Delta x \equiv x_1 - x_2$.

Figure 1 Survey Counties



Notes:

The survey was conducted in Hebei province, which has a cultural environment typical of North China. Three counties (Feng Run, Zhao Xian, and Chi Cheng) are selected after extensive analysis of county and township-level economic and demographic information from the 1980s and 1990s. Among them, Feng Run is the richest county in terms of GDP per capita, while Chi Cheng is the poorest. Within each county, five townships were selected from each economic quintile. Two villages were randomly selected in each township, one from the upper half of the township income distribution and one from the lower half. Finally, from each village, 20 households were randomly selected.

Table 1 Sample Restrictions

Panel 1 Sample Attrition with each Restriction: Individual Observations

	Observation Number			Attrition		
Restrictions	Sons	Daughters	Total	Sons	Daughters	Total
1. Married	628	648	1276			
2. Non-missing Value	601	646	1247	-27	-2	-29
3. Patrilocal Marriage	583	639	1222	-18	-7	-25
4. Mulitiple Children	499	561	1060	-84	-78	-162
5. Mulitiple Sons/Daughters	369	431	800	-130	-130	-260

Panel 2 Sample Attrition with Each Restriction: Household Observations

Restriction 1: Married Children

		# of Daughters				
		0	1	2	3	Total
# of Sons	0	0	64	50	20	134
	1	80	129	110	0	319
	2	57	75	0	0	132
	3	15	0	0	0	15
	Total	152	268	160	20	600

Restriction 2: Non-missing Value

		# of Daughters				
		0	1	2	3	Total
# of Sons	0	0	73	53	20	146
	1	84	123	106	0	313
	2	57	72	0	0	129
	3	10	0	0	0	10
	Total	151	268	159	20	598

Restriction 3: Patrilocal Marriages

		# of Daughters				
		0	1	2	3	Total
# of Sons	0	0	78	48	20	146
	1	84	130	105	0	319
	2	52	65	0	0	117
	3	10	0	0	0	10
	Total	146	273	153	20	592

Restriction 4: Multiple Children

		# of Daughters				
		0	1	2	3	Total
# of Sons	0	0	0	48	20	68
	1	0	130	105	0	235
	2	52	65	0	0	**117**
	3	10	0	0	0	**10**
	Total	62	195	**153**	**20**	430

Notes：

This table outlines the procedure of sample construction from the original dataset, reporting the amount of sample attrition after each restriction. Information on gender composition is also provided. Panel 1 reports at the individual level, while panel 2 reports at the household level.

Table 2. Summary Statistics of the Restricted Sample

	Multiple Sons Sample				Multiple Daughters Sample			
	Obs[1]	Mean	Std	Std w/i HH	Obs[1]	Mean	Std	Std w/i HH
Key Variables								
Years of schooling (years)	264	8.42	(2.90)	(1.62)	366	8.23	(3.23)	(1.80)
Edu. expenditure (yuan[2])	259	1219	(2803.80)	(1933.10)	365	1124	(2217.84)	(1499.09)
Edu. exp. imputed (yuan[2])	264	1556	(2784.61)	(1916.87)	366	1421	(2230.80)	(1505.62)
Marital transfer (yuan)	264	5085	(5151.35)	(2468.90)	366	1067	(1515.46)	(697.48)
Children's Attributes								
Age	264	33.87	(5.68)	(2.83)	366	32.58	(5.97)	(3.07)
Age at marriage	264	22.72	(2.53)	(1.64)	366	22.28	(2.48)	(1.53)
Height (cm)	264	170.34	(5.80)	(2.82)	366	161.21	(5.49)	(2.95)
Activities before Marr.								
Ag. experience (years)	264	3.60	(4.60)	(2.26)	366	3.24	(3.47)	(2.04)
Non-ag. experience (years)	264	2.91	(3.04)	(1.60)	366	2.07	(2.73)	(1.60)
Remit income or not	264	0.42	(0.50)	(0.29)	366	0.34	(0.50)	(0.25)
Live away from home	264	0.37	(0.48)	(0.28)	366	0.27	(0.45)	(0.27)
Parental Attributes								
Father's schooling (years)	127	5.32	(3.11)		173	5.46	(3.29)	
Mother's schooling (years)	127	3.06	(2.77)		173	2.43	(2.76)	
Literacy - father	127	0.64	(0.48)		173	0.64	(0.48)	
Literacy - mother	127	0.31	(0.47)		173	0.22	(0.42)	
Number of sons	127	2.42	(0.76)		173	0.99	(0.75)	
Numebr of daughters	127	0.76	(0.82)		173	2.50	(0.77)	
Wealth Measures								
Avg. housing value (yuan)	127	4846	(5314)		173	4417	(4218)	
Total ag. equipments (yuan)	127	2224	(5085)		173	2546	(6949)	
Residence								
Fengrun	127	0.35	(0.48)		173	0.24	(0.43)	
Zhaoxian	127	0.29	(0.45)		173	0.41	(0.49)	
Chicheng	127	0.36	(0.48)		173	0.35	(0.48)	

Notes:
1. For the "key variables", "children's attributes" and "activities before marriage" categories, this number refers to the number of non-missing individual observations; for the "parental attributes", "wealth measure" and "residence" categories, this number refers to the number of households. 2. All monetary values have been deflated to 1980 price levels.

Table 3.1 Test of Model with Exogenous Educational Expenditure and Equal Concern Assumption
Sons Sample (w/o zero in marital transfer) ; Independent Var.: Educational Expenditure

Dep. Var.:	(1)	(2)	(3)	(4)	(5)
Mar. Transfer	OLS	OLS	OLS	HH FE	HH FE
Variable of Interest					
Edu. Expenditure	-0.208	-0.189	-0.204	-0.334	-0.376
- Self	[0.079]***	[0.072]***	[0.072]***	[0.113]***	[0.104]***
Edu. Expenditure			0.128		
- Sibling			[0.098]		
Individual Attributes					
Age	-386.261	-266.088	-251.412	-122.19	-180.23
	[88.567]***	[74.821]***	[78.014]***	[92.711]	[66.170]***
Age at marriage	-38.284	-99.896	-115.48	-139.497	
	[116.296]	[89.692]	[91.644]	[128.091]	
Height	-10.858	-12.413	-21.74	-40.693	
	[19.660]	[16.244]	[17.691]	[24.513]*	
Height2	0	0	0.001	0.001	
	[0.001]	[0.000]	[0.001]	[0.001]*	
1st Son/Daughter	590.083	-0.25	-217.405	-571.024	
	[556.879]	[518.044]	[565.855]	[632.863]	
Pre-marital Activities					
Ag. Exp.	-56.248	-35.211	-40.733	-53.706	
	[66.558]	[64.043]	[65.123]	[89.859]	
Non-Ag. Exp.	204.006	148.755	111.177	21.129	
	[133.965]	[114.565]	[117.181]	[134.667]	
Remit income or not	-497.858	-235.281	-369.834	-548.723	
	[749.687]	[649.844]	[630.082]	[788.099]	
Live away from home	-1103.685	-1341.798	-1221.763	-651.259	
	[822.574]	[749.175]*	[722.279]*	[709.046]	
Parental Attributes					
Father's Year of Sch.	-17.378	12.266	14.93		
	[117.553]	[91.842]	[93.873]		
Mother's Year of Sch.	-263.45	-199.254	-218.984		
	[139.271]*	[115.959]*	[115.023]*		
# of Sons	-110.192	-358.195	-452.612		
	[368.493]	[318.758]	[321.143]		
# of Daughters	89.548	-299.547	-336.807		
	[381.101]	[345.511]	[358.900]		
County Zhao Xian	-1,445.98	-988.71	-1,014.05		
	[1,028.747]	[924.267]	[991.206]		
County Chi Cheng	-2,396.14	-1,203.08	-1,085.88		
	[816.732]***	[758.060]	[870.788]		
Wealth Control					
Housing Exp.		0.128	0.129		
		[0.044]***	[0.044]***		
Ag. Equipment Exp.		0.211	0.212		
		[0.059]***	[0.063]***		
R-squared	0.26	0.39	0.4	0.17	0.14
Observations	264	264	264	264	264
# of Households	127	127	127	127	127

Note:
This table reports the results of estimating equation (16) with the multiple sons sample

$$t_{ih} = \beta_0 + \beta_1 s_{ih} + \beta_2 s_{jh} + \beta_y y_h + X'\beta + \varepsilon_{ij}$$

Marital transfer of the son i in family h is regressed on his own and siblings' educational expenditure, family wealth and other control variables. Column (1) includes only s_{ih} and X; column (2) adds in y_h; column (3) adds in s_{jh}; column (4) is estimated with family fixed effect while imposing $\beta_1=-\beta_2$; column (5) is the fixed effect controlling for the year effect only.

Standard errors are clustered at the household level and reported in brackets. * significant at 10%; ** significant at 5%; ***

Table 3.2 Test on Model with Exogenous Educational Expenditure and Equal Concern Assumption

Daughters Sample ; Independent Var.: Educational Expenditure

Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)
Mar. Transfer	OLS	OLS	OLS	HH FE	Honore	Honore
Variable of Interest						
Edu. Expenditure	0.001	0.01	0.001	-0.091	-0.12	-0.083
- Self	[0.044]	[0.044]	[0.041]	[0.044]**	[0.05706]**	[0.05159]
Edu. Expenditure			0.099			
- Sibling			[0.040]**			
Individual Attributes						
Birth Year	-77.859	-75.644	-73.053	-93.915	-269.1	-157.7
	[16.737]***	[16.615]***	[16.487]***	[29.264]***	[66.29]***	[32.69]***
Age at marriage	-6.402	-12.685	0.589	63.161	173	
	[33.223]	[32.674]	[29.934]	[34.188]*	[89.52]*	
Height	217.798	251.077	267.311	345.745	885.2	
	[426.434]	[431.688]	[392.319]	[390.213]	[992.2]	
Height2	-0.627	-0.743	-0.812	-1.087	-2.847	
	[1.311]	[1.329]	[1.215]	[1.218]	[3.032]	
1st Son/Daughter	97.937	85.678	77.788	160.642	726.6	
	[120.627]	[122.054]	[125.127]	[167.132]	[356.6]**	
Pre-marital Activities						
Ag. Exp.	20.182	27.483	17.201	-10.401	6.212	
	[24.860]	[24.760]	[20.943]	[22.578]	[34.18]	
Non-Ag. Exp.	71.103	71.965	47.593	-20.899	26.9	
	[39.456]*	[39.941]*	[32.384]	[33.648]	[63.32]	
Remit income or not	-104.036	-138.008	-33.984	207.526	-3.776	
	[233.504]	[233.408]	[186.937]	[193.364]	[365.8]	
Live away from home	-146.775	-108.489	-94.567	-57.587	-79.67	
	[215.573]	[218.638]	[207.063]	[225.260]	[342]	
Parental Attributes						
Father's Year of Sch.	46.176	43.244	44.806			
	[27.410]*	[26.187]	[26.239]*			
Mother's Year of Sch.	18.71	19.259	18.352			
	[31.985]	[31.175]	[31.823]			
# of Sons	80.158	9.092	50.738			
	[92.969]	[96.781]	[97.906]			
# of Daughters	-104.161	-96.692	-97.487			
	[87.283]	[83.304]	[83.448]			
County Zhao Xian	853.42	883.42	955.92			
	[224.368]***	[213.146]***	[206.395]***			
County Chi Cheng	-708.55	-588.50	-535.42			
	[177.089]***	[173.157]***	[202.508]***			
Wealth Control						
Housing Exp.		0.023	0.025			
		[0.008]***	[0.008]***			
Ag. Equipment Exp.		0.024	0.023			
		[0.014]*	[0.015]			
R-squared	0.36	0.39	0.4	0.14		
Observations	366	366	366	366	366	366
# of Households	173	173	173	173	173	173

Note:

This table reports results of estimating equation (16) with the multiple daughters sample

$$t_{ih} = \beta_0 + \beta_1 s_{ih} + \beta_2 s_{jh} + \beta_y y_h + X'\beta + \varepsilon_{ij}$$

Marital transfer of the daughter i in family h is regressed on her own and siblings' educational expenditure, family wealth and other control variables. Column (1) include only s_{ih} and X; column (2) adds in y_h; column (3) adds in s_{jh}; column (4) is estimated with family fixed effect while imposing β_1=-β_2; column (5) is Honore (92) estimates, which estimates a fixed effect model while taking into account the censoring of the dependent variable at zero; column (6) is Honore (92) estimates while controlling for the year effect only.

Table 4.1 Test of Model with Exogenous Educational Expenditure and Unequal Concern Assumption

Sons Sample (w/o zero in marital transfer) ; Independent Var.: Log of Educational Expenditure

Dep. Var.: ln(Mar. Transfer)	(1) OLS	(2) OLS	(3) OLS	(4) HH FE	(5) HH FE
Variable of Interest					
ln(Edu. Expenditure)	0.049	0.026	-0.074	-0.302	-0.297
- Self	[0.097]	[0.079]	[0.077]	[0.115]***	[0.110]***
ln(Edu. Expenditure)			0.254		
- Sibling			[0.079]***		
Individual Attributes					
Birth Year	-0.074	-0.04	-0.037	-0.037	-0.02
	[0.023]***	[0.019]**	[0.019]*	[0.040]	[0.023]
Age at marriage	-0.031	-0.031	-0.031	-0.035	
	[0.040]	[0.032]	[0.030]	[0.041]	
Height	-0.001	-0.003	-0.003	-0.004	
	[0.005]	[0.004]	[0.004]	[0.005]	
Height2	0	0	0	0	
	[0.000]	[0.000]	[0.000]	[0.000]	
1st Son/Daughter	0.266	0.115	0.036	0.067	
	[0.159]*	[0.140]	[0.147]	[0.215]	
Pre-marital Activities					
Ag. Exp.	0.003	0.015	0.002	-0.027	
	[0.022]	[0.022]	[0.021]	[0.029]	
Non-Ag. Exp.	0.042	0.016	0.001	-0.002	
	[0.041]	[0.038]	[0.034]	[0.035]	
Remit income or not	0.076	0.112	0.093	-0.036	
	[0.231]	[0.200]	[0.186]	[0.232]	
Live away from home	-0.405	-0.379	-0.315	-0.207	
	[0.187]**	[0.160]**	[0.162]*	[0.227]	
Parental Attributes					
Father's Year of Sch.	-0.019	-0.024	-0.028		
	[0.035]	[0.031]	[0.031]		
Mother's Year of Sch.	-0.071	-0.062	-0.068		
	[0.033]**	[0.027]**	[0.026]**		
# of Sons	-0.235	-0.226	-0.258		
	[0.135]*	[0.091]**	[0.090]***		
# of Daughters	0.127	0.012	-0.004		
	[0.096]	[0.080]	[0.083]		
County Zhao Xian	-0.58	-0.50	-0.49		
	[0.189]***	[0.156]***	[0.162]***		
County Chi Cheng	-0.75	-0.41	-0.37		
	[0.239]***	[0.207]*	[0.201]*		
Wealth Control					
Housing Exp.		0.549	0.539		
		[0.075]***	[0.072]***		
Ag. Equipment Exp.		0.086	0.09		
		[0.065]	[0.062]		
R-squared	0.25	0.44	0.47	0.1	0.07
Observations	264	264	264	264	264
# of Households	127	127	127	127	127

Note:

This table reports the results of estimating the following equation with the multiple sons sample

$$\ln t_{ih} = \beta_0 + \beta_1 \ln s_{ih} + \beta_2 \ln s_{jh} + \beta_y \ln y_h + X'\beta + \varepsilon_{ij}$$

Log of marital transfer of son i in family h is regressed on his own and siblings' log educational expenditure, log of family wealth and other control variables. Column (1) includes only s_{ih} and X; column (2) puts in y_h; column (3) adds s_{jh}; column (4) is estimated with family fixed effect while imposing β_1=-β_2; column (5) is the fixed effect controlling for the year effect only.

Standard errors are clustered at the household level and reported in brackets. * significant at 10%; ** significant at 5%; ***

Table 4.2 Test of Model with Exogenous Educational Expenditure and Unequal Concern Assumption
Daughters Sample ; Independent Var.: Log of Educational Expenditure

Dep. Var.: ln(Mar. Transfer)	(1) OLS	(2) OLS	(3) OLS	(4) HH FE	(5) Honore	(6) Honore
Variable of Interest						
ln(Edu. Expenditure)	-0.04	-0.032	-0.061	-0.415	-0.489	-0.342
- Self	[0.135]	[0.134]	[0.132]	[0.180]**	[0.1956]**	[0.1794]*
ln(Edu. Expenditure)			0.228			
- Sibling			[0.130]*			
Individual Attributes						
Birth Year	-0.102	-0.097	-0.09	-0.167	-0.2219	-0.1077
	[0.030]***	[0.031]***	[0.030]***	[0.061]***	[0.06588]***	[0.03638]***
Age at marriage	-0.064	-0.076	-0.058	0.092	0.1237	
	[0.067]	[0.066]	[0.063]	[0.075]	[0.08811]	
Height	0.282	0.392	0.565	0.945	0.6498	
	[0.765]	[0.788]	[0.822]	[0.927]	[1.093]	
Height2	-0.001	-0.001	-0.002	-0.003	-0.00208	
	[0.002]	[0.002]	[0.003]	[0.003]	[0.003319]	
1st Son/Daughter	0.284	0.267	0.239	0.564	0.8761	
	[0.234]	[0.240]	[0.232]	[0.366]	[0.4114]**	
Pre-marital Activities						
Ag. Exp.	0.083	0.093	0.068	-0.018	-0.02217	
	[0.044]*	[0.043]**	[0.036]*	[0.045]	[0.05007]	
Non-Ag. Exp.	0.114	0.126	0.095	-0.031	-0.01752	
	[0.067]*	[0.066]*	[0.063]	[0.084]	[0.09385]	
Remit income or not	-0.135	-0.215	-0.146	0.096	0.02936	
	[0.295]	[0.306]	[0.310]	[0.466]	[0.5386]	
Live away from home	-0.494	-0.435	-0.366	-0.136	-0.06318	
	[0.316]	[0.309]	[0.314]	[0.374]	[0.4436]	
Parental Attributes						
Father's Year of Sch.	0.153	0.159	0.168			
	[0.047]***	[0.045]***	[0.047]***			
Mother's Year of Sch.	0.062	0.069	0.08			
	[0.054]	[0.054]	[0.054]			
# of Sons	-0.025	-0.165	-0.114			
	[0.219]	[0.238]	[0.247]			
# of Daughters	0.093	0.109	0.092			
	[0.147]	[0.142]	[0.142]			
County Zhao Xian	0.71	0.50	0.58			
	[0.360]**	[0.337]	[0.343]*			
County Chi Cheng	-2.94	-2.78	-2.77			
	[0.418]***	[0.410]***	[0.419]***			
Wealth Control						
Housing Exp.		0.338	0.371			
		[0.116]***	[0.117]***			
Ag. Equipment Exp.		0.164	0.12			
		[0.154]	[0.160]			
R-squared	0.46	0.48	0.49	0.06		
Observation	366	366	366	366	366	366
# of Households	173	173	173	173	173	173

Note:

This table reports the results of estimating the following equation with the multiple daughters sample

$$\ln t_{ih} = \beta_0 + \beta_1 \ln s_{ih} + \beta_2 \ln s_{jh} + \beta_y \ln y_h + X'\beta + \varepsilon_{ij}$$

Log of marital transfer of daughter i in family h is regressed on her own and siblings' log of educational expenditure, log of family wealth and other control variables. Column (1) includes only s_{ih} and X; column (2) adds in y_h; column (3) adds in s_{jh}; column (4) is estimated with family fixed effect while imposing β_1=-β_2; column (5) is Honore (92) estimates, which estimates a fixed effect model while taking into account the censoring of the dependent variable at zero; column (6) is Honore (92) estimates controlling for the year effect only.

Table 5.1 Instrumentation of Educational Expenditure with Years of Schooling (levels)

	Sons Sample				Daughters Sample			
Dep. Var.:	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)
Mar. Transfer	IV	IV	IV	IV w/ HH FE	IV	IV	IV	IV w/ HH FE
Variable of Interest								
Edu. Expenditure	-0.186	-0.276	-0.271	-0.24	0.066	0.060	0.081	-0.066
- Self	[0.201]	[0.179]	[0.183]	[0.205]	[0.093]	[0.094]	[0.098]	[0.068]
Edu. Expenditure			-0.027				0.142	
- Sibling			[0.178]				[0.099]	
1st Stage Result (Dep. Var: Edu. Expenditure)								
Year of schooling	537.917	536.73	587.566	727.132	364.057	365.048	384.773	491.184
- Self	[97.098]***	[97.933]***	[112.376]***	[179.533]***	[44.947]***	[44.987]***	[44.699]***	[62.008]***
R-squared	0.26	0.39	0.39		0.36	0.38	0.39	
Observations	264	264	264	264	366	366	366	366
# of Households	127	127	127	127	173	173	173	173

Note:

Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5.2 Instrumentation Educational Expenditure with Years of Schooling (logs)

	Sons Sample				Daughters Sample			
Dep. Var.:	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)
ln(Mar. Transfer)	IV	IV	IV	IV w/ HH FE	IV	IV	IV	IV w/ HH FE
Variable of Interest								
ln(Edu. Expenditure)	-0.008	-0.03	-0.076	-0.233	-0.110	-0.165	-0.164	-0.356
- Self	[0.120]	[0.111]	[0.118]	[0.156]	[0.210]	[0.211]	[0.212]	[0.236]
ln(Edu. Expenditure)			0.181				0.129	
- Sibling			[0.104]*				[0.209]	
1st Stage Result (Dep. Var: Log of Edu. Expenditure)								
Years of schooling	0.289	0.289	0.288	0.273	0.249	0.249	0.256	0.295
- Self	[0.023]***	[0.024]***	[0.024]***	[0.033]***	[0.020]***	[0.019]***	[0.018]***	[0.019]***
R-squared	0.25	0.43	0.47		0.46	0.47	0.49	
Observations	264	264	264	264	366	366	366	366
# of Households	127	127	127	127	173	173	173	173

Note:

Robust standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

This table reports the results when educational expenditure is instrumented with years of schooling. Other covariates are the same as before but not shown. The first stage results are also indicated.

Table 6 Test of Model with Endogenous Educational Expenditure and Equal Concern Assumption

	Son			Daughter		
Ordering Variable	Birth Order	Yrs of Sch	Edu. Exp	Birth Order	Yrs of Sch	Edu. Exp
(Conditional)	(1)	(2)	(3)	(4)	(5)	(6)
Variable of Interest						
Edu. Expenditure_1	-0.237	-0.178	-0.784	-0.103	-0.019	-0.241
	[0.146]	[0.237]	[0.372]**	[0.065]	[0.083]	[0.161]
Edu. Expenditure_2	0.566	0.314	0.464	0.113	0.1	0.086
	[0.177]***	[0.124]**	[0.134]***	[0.047]**	[0.053]*	[0.055]
R-squared	0.20	0.25	0.25	0.2	0.19	0.2
# of Households	127	127	127	173	173	173
Test on β_1=0 and β_2=0 :						
F-Statistic	6.30	3.54	7.24	3.46	2.10	1.58
P-value	0.00	0.03	0.00	0.03	0.13	0.21
Test on β_1=-β_2 :						
F-Statistic	2.10	0.31	0.86	0.02	1.26	1.19
P-value	0.15	0.58	0.36	0.89	0.26	0.28

Note:

This table reports the result of estimating equation (33) in the paper:

$$\Delta t_h = \beta_1 s_{1h} + \beta_2 s_{2h} + X'\beta + \varepsilon_h$$

where $\Delta t_h = t_{1h} - t_{2h}$ and $X_h = [x'_{1h}\ x'_{2h}]$. The first three columns use the multiple sons sample, and the last three columns use the multiple daughters sample. Children within the same family are ordered according to (1) their birth order (columns 1 and 4), (2) conditional year of schooling (columns 2 and 5) and (3) conditional educational expenditure (columns 3 and 6). (Conditional values are residuals from regressing on birth year and household dummies.) Other individual control variables (X) in the regressions include (1) birth year, (2) age at marriage, (3) height (in quadratic form), (4) pre-marital agricultural experience, (5) pre-marital non-agricultural experience, (6) dummy for remitting income before marriage, (7) dummy of living outside the household before marriage, (8) indicator of being the first son/daughter. The coefficients on these controls are not reported.

For each regression, the joint significance of β_1 and β_2, and the hypothesis "β_1=-β_2" are tested. The corresponding F-statistics and P-values are reported.

Robust standard errors are reported in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A1 Summary of Regression Forms and the Corresponding Model Setups

Regression and Test for Compensation Effects	Assumptions in Economic Model	Advantages	Limitations
$t_{ih}=\beta_0+\beta_1 s_{ih}+\beta_2 s_{jh}+\beta_y y_h+\varepsilon_{ih}$ H_0: $\beta_1<0$ and $\beta_2>0$	1. Multiple children; 2. Exogenous education investment; 3. "Equal concern".		When y_h is measured with error, both β_1 and β_2 will be biased upwards.
$\Delta t_h=\beta_s \Delta s_h+\Delta\varepsilon_h$ H_0: $\beta_s<0$	1. Multiple children; 2. Exogenous education investment; 3. "Equal concern".	β_s identifies the wealth return to each dollar of schooling expenditure.	Strong assumptions are needed in the economic model.
$\Delta lnt_h=\theta_0+\theta_s \Delta lns_h+\Delta\varepsilon_h$ H_0: $\theta_s<0$	1. Multiple children; 2. Exogenous education investment; 3. Possible "unequal concern".	The sign of θ_0 can serve as a test for parents' preference bias towards their children.	Exogenous education investment is a strong assumption.
$\Delta t_h=\gamma_1 s_{ih}+\gamma_2 s_{jh}+u_h$ H_0: $\gamma_1<0$ and $\gamma_2>0$	1. Multiple children; 2. Endogenized education investment; 3. "Equal concern".	Endogenizes education investment decision and allows for unobservable heterogeneity in children's abilities.	A functional form assumption on children's wealth determination equation is necessary for identification. Ordering of the two children matters to the results.

Notation:

t denotes inter-vivos transfer; s denotes schooling expenditure; y denotes family wealth. Children are indexed by i *and* j; households are indexed by h; $\Delta x_h=x_{ih}-x_{jh}$.