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Why do Parents Underinvest in their Children's Education? Evidence from China*

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Abstract

In this paper we study whether the presence of binding liquidity constraints and the existence of fixed costs can explain the underinvestment of parents in their children's human capital. We first incorporate these two potential mechanisms into the theoretical model of [Raut & Tran \(2005\)](#) and then we test their empirical relevance using data from the China Health and Retirement Longitudinal Study (CHARLS). Our results show that especially fixed costs play an important role in explaining human capital underinvestment.

Keywords: Two-Sided Altruism; Human Capital; Liquidity Constraints; Fixed Costs

JEL Codes: J24, J31, I2

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1 Introduction

Human capital accumulation is of crucial importance for both individual welfare and economic growth (Schultz 1961). Besides the governments' efforts in increasing human capital investment, parental investment in children's human capital is also important (see e.g. Barro 1974). The traditional theory predicts that the optimal amount of human capital investments is determined by equating its marginal returns to the market return (see e.g. Becker 2009). Many papers, however, found that parents often underinvest in the human capital of their children, especially in developing countries such as China (Psacharopoulos 1985, Heckman 2005).

Raut & Tran (2005) model the human capital investment behavior of (extended) families living in developing countries. In such countries with rudimentary pension systems and not well developed capital markets, there exists a link between the parental investment in the human capital of children and the old-age financial support provided by children. Raut & Tran (2005) take this link explicitly into account by formulating two alternative two-sided altruism models of parental investment of children in which it is assumed that the parents are altruistic towards children and *vice versa*.¹ According to the first model, parents and children have a pure loan contract in which the parental investment in education is paid back by means of old age support by the child. Children will take out the loan from the parents, as long as they are not made worse-off by the terms of the contract. The first model assumes that the intergenerational contract is enforced by means of social norms. By contrast, the second model is based on reciprocity and the child autonomously decides how much she transfers to parents. In the second model, the level of parental investment in children's education and the amount of transfers from children to old parents are determined simultaneously in a Nash equilibrium. In the empirical part of their paper using data from the Indonesian Family Life Survey, Raut & Tran (2005) rejects the pure loan model against the alternative reciprocity model.

Raut & Tran (2005) do not allow for corner solutions in human capital investment because they use the number of years of schooling as a measure of human capital investment, which is usually positive. However, not allowing for corner solutions becomes problematic when using more precise measures, such as the amount of money that the parents have invested in their children's education. In the Chinese context, corner solutions are often observed in tertiary schooling because most Chinese youths have not attended any form of colleges/university.

In China, most highly ranked universities/colleges are public and financed by the central or

¹Alternative explanations have been offered in the literature. Brown et al. (2011), for example, find that the parents will rationally underinvest in their children's human capital strategically because the parents might not be able to claim returns from strategic-concerned children. Parental risk aversion is also revealed to have a negative impact on the children's human capital investment (see Checchi et al. 2014).

local government. However, they are not free: in addition to accommodation and transportation costs, there are also tuition fees that range from 3500 to 28000 China *yuan* (around 500 to 4000 *euros*) per year. High school graduates can apply for colleges/universities *via* the so-called college entrance examination held once per year. In principle, each high school graduate can only attend the examination once. To prepare for the examination, the family has to invest substantial money and energy and these fixed costs hinder parents from sending children to colleges/universities. There is strong inequality in education as most good quality high schools are located in urban areas and are more accessible to students with a non-agricultural *hukou* status.

In this paper, we extend the theoretical model of [Raut & Tran \(2005\)](#) by including parental liquidity constraints and fixed costs of investment as two potential explanations for the underinvestment in education. First, binding liquidity constraints might prevent the parents to invest sufficiently in the education of their children (see e.g. [Barham et al. \(1995\)](#)). Second, parents might face fixed costs when they perform such investments. One can think of the costs when the households have to pay for the children's preparation for the college entrance examination. We construct a two-period theoretical model in which children and parents are both altruistic. In the first period, parents decide how much to invest in their children's education, subject to liquidity constraints and a fixed cost of investment. In the second period, children can provide old-age financial support to their parents. We then test the theoretical predictions of our model on data from the China Health and Retirement Longitudinal Study (CHARLS). The 2013 wave and the retrospective life-history survey provide us with very rich information on 17,311 children and their older parents, aged 45 and over.

The rest of the paper is structured as follows. In Section 2, the theoretical model and its corresponding predictions will be presented. Section 3 provides information on the CHARLS data and on the variables of interest. Section 4 summarizes our estimation strategies, and Section 5 the empirical results. Section 6 concludes.

2 Model

In this subsection we extend the two-period model of [Raut & Tran \(2005\)](#) by allowing for liquidity constraints and fixed costs. The model distinguishes two types of agents: parents and children who are both altruistic. No distinction is made between father and mother so that they are treated as a single representative parent. Moreover, the parent has n children which are assumed to be identical in preferences, endowment of abilities and in altruism towards parents.

Parents and children both live for three periods but we focus on two overlapping periods

between the parent and child. Figure 1 provides a description of the timing structure of the model. In the first period, the parent is in the labour market and the child is at school age. In the second period the parent is retired and the child has joined the labour market. In the first period, the parent earns E_{p1} , consumes c_{p1} and invests T_1 in each child's schooling. If $T_1 > 0$, the parent faces also fixed costs C of education. In this model, the fixed cost C of education includes the expenditures incurred on parental side when their children were preparing for the college entrance examination. For example, the amount of money parents have spent on study materials, extra nutrition supplies, and cram schools. In the second period, the parent receives E_{p2} as pension benefits and consumes c_{p2} , and each child is liquidity constrained, i.e. she earns E_{k2} , consumes c_{k2} , transfers T_2 to support her parent and does not save.

[Place Figure 1 about here]

Raut & Tran (2005) construct two models where in the first model the parent is the dominant decision maker: she makes every choice, including parental and child's consumption across two periods, parental human capital investment to children (T_1) and the children's old-age transfer to parents (T_2). The second model allows for some bargaining power for the children in the second period so they can decide on T_2 and c_{k2} in a Nash equilibrium framework. By using a data set from Indonesia, they find that the second model fits the data better. We therefore only consider the second model in this study. We extend this model by allowing for fixed costs and a liquidity constraint. In other words, we assume that the parent takes the child's decision on T_2 and c_{k2} as given, and that she solves the following optimization problem:

$$\max_{c_{p1}, c_{p2}, T_1} u(c_{p1}) + \beta[u(c_{p2}) + \gamma_p \nu_p(c_{k2})] \quad (1a)$$

$$\text{s.t. } c_{p1} = E_{p1} - (s + nT_1 + nC\mathbf{1}(T_1 > 0)) \quad (1b)$$

$$c_{p2} = (1 + r)s + E_{p2} + nT_2 \quad (1c)$$

$$s \geq 0 \quad (1d)$$

$$T_1 \geq 0, \quad (1e)$$

where β is the time preference parameter and $\mathbf{1}(T_1 > 0)$ is an indicator function being equal 1 if the parent invests and 0 if she does not, and C is the fixed costs. s denotes net worth at the end of period 1. The parameters γ_p and γ_k measure the degree of the parent's and child's altruism respectively. Due to imperfect altruism, the parameters γ_p and γ_k are strictly positive but smaller than one. $\nu_p(c_{k2})$ represents the parent's perception of child's utility from her

consumption in period 2. Liquidity constraint (1d) says that the parent cannot borrow without collateral. Constraint (1e) says that human capital investment cannot be negative.

Taken her parent's decision on T_1 and c_{p1} as given, each child solves the utility maximization problem subject to the budget constraint only in the second period:

$$\max_{c_{k2}, T_2 \geq 0} \nu(c_{k2}) + \gamma_k u_k(c_{p2}) \quad (2a)$$

$$\text{s.t. } c_{k2} = E_{k2}(T_1, \tau) - T_2, \quad (2b)$$

where $E_{k2}(T_1, \tau)$ denotes a Mincerian earnings function and τ is the talent of the child. $u_k(c_{p2})$ denotes the child's perception of her parent's utility of consumption at old age. The model above represents a sequential game and we solve it by using the backward induction approach, namely the child first optimizes her problem with respect to her consumption and the transfer amount to the parent and then the parent solves her optimization problem given the child's optimal decisions.

2.1 Closed Form Solution

To provide the intuition behind the model, we follow [Raut & Tran \(2005\)](#) in making several additional assumptions. First, we assume that both the children and the parents have the perfect perception on each others' utilities, namely $u_k(c_p) = u(c_p)$ and $\nu_p(c_k) = \nu(c_k)$. Second, we impose the restriction that parents and children have the same within period utility function of the Cobb-Douglas type: $u(c) = \nu(c) = \alpha \ln c$, with preference parameter $\alpha > 0$.

With this assumption, we restrict the degree of CRRA (Constant Relative Risk Aversion) of all households to be one.² Third, we assume a Mincerian earnings function of the children, that is, the log earnings is a function of school-related human capital investment and has a hump-shaped relationship with working experience. Contrary to [Raut & Tran \(2005\)](#), we do not impose the Inada conditions. Consequently, we allow for corner solutions for the human capital investment T_1 . Intuitively, those with no human capital investment could also work and earn some money.

If the liquidity constraint (1d) is not binding in the first period and no fixed costs appear ($C = 0$) in (1b), then we will obtain the benchmark predictions as [Raut & Tran \(2005\)](#) on the optimal human capital investment and the optimal old-age transfers. The optimal investment

²We leave the general risk averse cases in future research. Some researchers such as [Checchi et al. \(2014\)](#) have shown that parental risk aversion has a negative impact on the children's human capital investment.

amount is reflected in the corresponding marginal returns of T_1 , which is equal to

$$\frac{\partial E_{k2}}{\partial T_1} = \frac{1+r}{\gamma_k \gamma_p}, \quad (3)$$

where the numerator denotes the market returns. The general marginal returns to human capital investment are higher since both the parent and the child are assumed to be imperfectly altruistic ($0 < \gamma_k \gamma_p < 1$). The marginal returns are negatively associated with the level of human capital investment due to the rule of a diminishing rate of returns, see Figure 2.

[Place Figure 2 about here]

The underinvestment is a consequence of the bargaining between the child and the parent. If the parent's bargaining power is large enough to determine both T_1 and T_2 , then the marginal returns are equal to $1+r$. If the parents solely make the choices of T_1 and T_2 (see the first model of [Raut & Tran \(2005\)](#)), the rate of returns to children's human capital investment equals the market rate $1+r$, and therefore no efficiency loss occurs. In the model which gives children the power to decide T_2 , the rate of returns becomes $(1+r)/\gamma_p \gamma_k$. The optimal human capital investment level is therefore lower. The potential efficiency loss is due to the bargaining process between imperfectly altruistic parents and their children. If they are both perfectly altruistic, the marginal return to the human capital investment becomes the market rate $1+r$.

Another prediction of [Raut & Tran \(2005\)](#) is that the optimal level of old-age transfer from the child to the parent is equal to:

$$T_2 = \left[\frac{\gamma_k}{\alpha\beta + \gamma_k} \right] E_{k2} + \left[\frac{(1+r)\alpha\beta}{\alpha\beta + \gamma_k} \right] \left[T_1 - \frac{E_{p1} + \frac{E_{p2}}{1+r}}{n} \right]. \quad (4)$$

This equation deserves some explanation. First, notice that the child's transfer to the parent does not depend on the degree of parental altruism γ_p . Second, equation (4) also says that T_2 is positively related to the income of the child E_{k2} . The impact of E_{k2} is larger if the child is more altruistic. There is also a positive effect of human capital investment T_1 on T_2 : parents who invested in their children's human capital will receive financial support from their children during retirement. This effect is negatively related to γ_k . Third, the higher the lifetime income of the parents ($E_{p1} + \frac{E_{p2}}{1+r}$), the less will be transferred. Finally, the model predicts zero transfers by the child if $\gamma_k = 0$.

2.2 Binding Liquidity Constraint

We now add an extra liquidity constraint (1d) to the optimization problem which says that the parents cannot borrow against future income due to imperfect capital markets.

The extended model produces the following prediction on human capital investment T_1 (see appendix C for details):

$$\frac{\partial E_{k2}(T_1, \tau)}{\partial T_1} = \frac{1+r}{\gamma_p \gamma_k} + \frac{\mu}{\nu'(c_{p2}) \beta \gamma_p \gamma_k}, \quad (5)$$

where μ denotes the Kuhn-Tucker multiplier for the restriction (1d). The second term on the right hand side is therefore positive if the liquidity constraint is binding. This implies that the optimal human capital investment level is even lower for liquidity constrained households.

As we will argue in section 4, we can empirically test for the existence of binding liquidity constraints by following a similar approach as in [Zeldes \(1989\)](#). Equation (5) forms the basis of this test.

2.3 Fixed Costs

If human capital investment involves fixed costs, i.e. $C > 0$ in equation (1b), then the choice problem is not standard due to the fact that the choice set is non-convex. Existing research has also investigated how fixed costs affect school choice. For example, [Nishimura & Raut \(2007\)](#) demonstrate that non-concavity also occurs in children's earnings profile with respect to parental human capital investment when the fixed costs for parents depend on the quality of the school. They show that if parents face higher fixed costs when choosing better schools, there will be multiple equilibria. Low-income families will converge to an inferior equilibrium where children receive a low level of human capital investment. In this paper, the fixed costs occur when the parents are deciding whether to send their children to college/university.

Finding the optimal solution requires several steps (see e.g. [Hausman \(1980\)](#) and [Cogan \(1981\)](#)). First, one solves the Nash bargaining problem presented above under the restriction that the parent does not invest in the human capital of the child ($T_1 = 0$). In that case the parent does not incur any fixed costs and obtains a maximum intertemporal utility level of U_p^0 . Then one solves the same problem imposing the condition that the parent invests in the schooling of the child ($T_1 > 0$) and as a consequence faces fixed costs. Let U_p^1 and T_1^* the optimal solution in case of investment. The decision to invest in the education of the children involves a utility comparison: if $U_p^1 > U_p^0$, the parent invests T_1^* , otherwise not.

The child's decision on the old-age transfer T_2 depends on the parent's decision on human

capital investment in the following way:

$$T_2 = \left[\frac{\gamma_k}{\alpha\beta + \gamma_k} \right] E_{k2} + \left[\frac{(1+r)\alpha\beta}{\alpha\beta + \gamma_k} \right] \left[T_1 - \frac{E_{p1} + \frac{E_{p2}}{1+r}}{n} + C \cdot \mathbf{1}(T_1 > 0) \right], \quad (6)$$

and it holds if the parental liquidity constraint (1d) is not binding. If the parents face a binding liquidity constraint, T_2 only depends on income of the children and parents in the second period and not on fixed costs C (see equation (19) in appendix C). Compared with (4), equation (6) contains one extra term which reflects the impact of fixed costs associated with human capital investment. Notice that T_2 is positively related to fixed costs C if T_1 is positive. Parents who have invested positively in T_1 , also faced fixed costs C because children with college degrees must have experienced the college entrance examination preparations. Since children are altruistic, they will transfer more to their parents. As before, $T_2 = 0$ if the child is not altruistic. Empirically, we can just test whether the estimated coefficient corresponding to the dummy for positive human capital investment ($\mathbf{1}(T_1 > 0)$) is positive and significant. Since transfers from children to parents are often observed with corner solutions and children also might face fixed costs if they transfer money to the parents, it is worthwhile to consider both the intensive and extensive margins. In section 4 we will discuss the empirical strategy in more detail.

3 Data

We draw data from the China Health and Retirement Longitudinal Study (CHARLS), which collects information on a nationally representative sample of Chinese residents aged 45 and older. The baseline wave of CHARLS was fielded in 2011 and includes about 10,000 households and 17,500 individuals in 150 counties/districts and 450 villages/resident committees.³ The individuals are then followed every two years. Currently, four waves of CHARLS are available, in addition to a life history survey which was administered to the households interviewed in the first two waves. In this paper, we use data from the second wave⁴ and the life history survey of CHARLS, which were collected in 2013 and 2014 respectively. From the second wave we obtain information on parental investment in children's human capital, cash transfers that parents receive from their children, and socio-demographic characteristics, while we use the life history of CHARLS to construct a measure of permanent income and gather data on the financial situation of the household when the children were at college ages.

We first construct a child-level data set from CHARLS 2013 where each observation is a child and then we merge it with data from the life history survey. After dropping observations

³Detailed information on the data and sampling procedure can be found in [Zhao et al. \(2012\)](#).

⁴We also conduct a sensitivity analysis using data from the first wave (results available upon request).

with missing values on some key variables, and keeping only children with completed education, we obtain a sample of 17,311 children.⁵

The main variables of interest for our analysis (Raut & Tran 2005) are the parental investment in children's human capital (T_1), financial transfers from children to their ageing parents (T_2), children's current income and parental lifetime income. The human capital investment variable is obtained by asking the main respondent⁶ how much money (s)he and her(his) spouse have invested in each of their children's college education. As an alternative, we also include the child's number of years of college education as a proxy for the human capital investment. Old-age transfers are measured in net values and are obtained by asking the parents how much they received in total from each non-coresiding child in the last year. The dependent variable, old-age transfer, allows for both positive and negative values as it measures the net transfer from children to parents. Negative values imply that the parents are financially supporting their children, rather than *vice versa*. Another proxy for the transfer term is a dummy ("Depend on This Child") which is equal to 1 if the respondent plans to rely on the child as a source of financial support during retirement. The income of the child is obtained by directly asking the parents how much each of their children earned last year.

The permanent income of the parents is more difficult to measure. We use four measures to proxy for it: net financial wealth, net real wealth, net total wealth, net income, and lifetime income. Net financial wealth is the sum of cash, deposits, stocks, bonds and other financial holdings subtracted by financial debts. Net real wealth considers housing assets minus debts, gold, treasures and antiques. We only include those housing assets which can be sold immediately on the market,⁷ and we do not include other durable goods such as vehicles and televisions since the depreciation rates of these assets are extremely high and hard to evaluate and are determined by the complexity of the local second-hand markets. Net total wealth is the sum of financial and real wealth. Net income consists of the wage income and the pension income for employed and retired workers respectively, and the net income of the farmers and self-employers. Lifetime income is drawn from the life history survey of CHARLS and are calculated by summing up the inflation-adjusted wages during the working years (see e.g. Alessie et al. 2013).⁸ The correlations between different measures of lifetime income is displayed in Table 1.

[Place Table 1 about here]

⁵The detailed sample selection strategies can be found in Appendix D.

⁶The main respondent is randomly selected among all age-eligible respondents in the household.

⁷In the last century, many housings are allocated by the employers in urban areas such as governments and state-owned enterprises. Some of them can be traded while some can not.

⁸We use urban/rural specific CPI data from 1950-2015 across 31 provinces from Chinese National Statistics Bureau as the earnings deflator. Some data points in the early years are missing and we use local general cpi or nationwide rural/urban cpi in those cases.

The core explanatory variables are the liquidity constraint dummies.⁹ Liquidity constraints are measured by six indicators, namely (1) whether the family lived in a shack when the child was at college ages; (2) whether the income of the respondent was in the lowest 25% group of the sample when the child was at college ages; (3) whether the family had a shared toilet or a private one; (4) whether the family had a water closet or not; (5) whether the family was using clean water or not; (6) whether the family used electricity or not. The correlations among the liquidity dummies are shown in Table 2. We construct a liquidity constraint index by using the Principle Component Analysis (PCA) approach to combine all six liquidity constraint indicators. The index is taken from the first component of the PCA. The descriptive statistics of the index can be found in the last row of Table 3.

[Place Table 2 about here]

In addition, we construct also several socio-demographic controls, such as the number of children of both the main respondents and her or her children, their genders, the household registration types (*Hukou*), the marital status of the main respondents and their children, the ages of the individuals and cohort dummies. The descriptive statistics can be found in Table 3.

[Place Table 3 about here]

4 Empirical Strategy

To test against the prediction of the presence of binding liquidity constraint, we first need to predict the marginal returns on human capital based on the estimation of children's earnings function (see equations (3) and (5)). For the earnings function, we estimate the following model by gender separately:

$$\ln(ChildInc_i) = \alpha_0 + \alpha_1 HCinvest_i + \alpha_2 Ability_i + \alpha_3 Exp_i + \alpha_4 ExpSq_i + \mathbf{x}'_i \delta + \varepsilon_i, \quad (7)$$

where $ChildInc_i$ is the current income of a child and $HCinvest_i$ is the human capital investment during school for which we use two measures: the logarithm of one plus the actual money invested in college education and the number of years of schooling. To mitigate the selection bias, we control for the $Ability_i$ of the child, which is proxied by the parental years of schooling.

⁹When constructing liquidity constraints indicators, we employ the basic idea from Zeldes (1989), who proposes splitting the whole sample into liquidity constrained sub-sample and the unconstrained sub-sample using whether households with low savings or financial wealth as the classification criterion. Jappelli et al. (1998) criticize this approach and introduce whether the households were refused loans or discouraged from borrowing as the proxy for liquidity constraints. Guiso et al. (1996) provide a similar proxy, namely the credit status of the individuals, to test the impact of liquidity constraints on income uncertainty.

In addition, we employ [Mincer \(1974\)](#)'s idea to incorporate the working experience Exp_i which is equal to the current age minus years of schooling and 6, and $ExpSq_i$ is the squared term of experience. Other demographic controls are contained in \mathbf{x}_i such as job categories and *hukou* status. Notably, the children's earnings function is for approximation and prediction and not for causal inference purposes. The estimated parameter $\hat{\alpha}_1$ is employed to predict the marginal returns to human capital investment. The detailed estimates of the earnings equation and MR calculation can be found in appendix E. It can be shown that the marginal return in specification (7) is $MR_i = \frac{\hat{\alpha}_1 \times ChildInc_i}{1 + HCinvest_i}$ when we use the logarithm of one plus the actual amount invested as a measure of human capital. When we use the number of years of schooling instead, the marginal return is $MR_i = \hat{\alpha}_1 \times ChildInc_i$. The summary statistics on the predicted marginal returns for each individual can be found in Table 3. Then we first test whether the binding liquidity constraint induces underinvestment of human capital. According to equation (5), the liquidity constrained child has positive excess return. [Raut \(2018\)](#) argues that a higher rate of return does not imply that disadvantaged households are liquidity constrained, because the United States provide them with loan programmes with an interest rate lower than the market rate. However, in China, loan programmes with low interest rates are relatively scarce. Therefore, in our context we believe that a higher rate of return could be a good signal that poor households are liquidity constrained. Therefore, we estimate the following model:

$$MR_i = \beta_0 + \beta_1 HHIInc_i + \beta_2 Num_i + \beta_3 NumSq_i + \mathbf{z}'_i \theta + \beta_4 * Cons_i + Cons_i \times (\beta_5 HHIInc_i + \beta_6 Num_i + \beta_7 NumSq_i + \mathbf{z}'_i \delta) + u_i, \quad (8)$$

where MR_i represents the marginal returns to college human capital investment, $HHIInc_i$ is the household income when the child was at college age, Num_i is the number of children in the household and $NumSq_i$ is the squared term which proxies for the altruistic parameters $\gamma_p \gamma_k$, and the vector \mathbf{z}_i contains demographic and socio-economic control variables such as age, gender, *hukou* and marriage status of both parent and child, and parental education. The liquidity constraint index is represented by $Cons_i$ which is the first PCA component constructed based on the six indicators in section 3.

The final step is to estimate the transfer equation with fixed costs namely equation (6). The dependent variable, old-age transfer, allows for both positive and negative values as it measures the net transfer from children to parents. Negative values imply that the parents are financially supporting their children, rather than *vice versa*. In this paper, we care about the children's decisions of positive transfers to their parents, hence we transform the transfer variable into a corner solution response which is censored at zero. Theoretically, the fixed costs will prevent the

parents from making investment decisions, while whether the fixed costs matter for both the intensive and extensive margins is unclear. Therefore, empirically, it is important to investigate which decision is affected by the fixed costs. We will estimate a double hurdle (two-part) model as our main model for the transfer equation, demonstrating the marginal effects at both the extensive margins (children deciding on whether to transfer to parents) and the intensive margins (if the children decide to transfer, then how much to transfer). The participation equation is a Probit specification, and the second part is a log-linear specification since the positive transfer is highly skewed.¹⁰

According to equation (6), the estimated coefficients for the child’s income and the human capital investment are expected to be positive, and the one for household lifetime income is expected to be negative. The coefficient on the fixed costs term, both at the extensive and intensive margins, is expected to be positive if fixed costs are relevant in explaining the underinvestment in human capital.

5 Results

5.1 Binding Liquidity Constraints

We first estimate equation (7) by gender and use $\hat{\alpha}_1$, which is the estimated coefficient on human capital investment, to predict the marginal returns MR_i . We use two measures of human capital investment, namely the number of years of schooling and the logarithm of one plus the money invested by the parents in the college education of their children. By drawing six liquidity indicators from the life history of CHARLS, we further test the role of liquidity constraints in explaining the underinvestment of human capital. We conduct the Principle Component Analysis (PCA) and construct a liquidity constraint index from the six liquidity indicators. Then we apply the approach in [Zeldes \(1989\)](#) to test whether the presence of binding liquidity constraint affects the human capital investment decisions of parents.

We estimate model (8) by assuming that the selection of liquidity constrained behaviour is uncorrelated with the error term. The liquidity index and its interaction terms with other variables are introduced to examining whether liquidity constraint plays a role in increasing the marginal returns and, hence, decreasing the human capital investment. Therefore, Chow tests are carried out to check whether the slope coefficients of the two subsamples are the same. The Chow statistics and corresponding p -values can be found in the last two rows of Table 4. Table 4

¹⁰Even though we take the log transformation of the positive transfer, we do not assume the log-terms to be normally distributed. Therefore, in estimating the marginal effects, we use the smearing estimator of [Duan \(1983\)](#) to overcome the potential bias. When estimating standard errors of the smearing estimator, we use the bootstrapping method with 200 replications.

also shows the estimates of equation (8). Column (1) shows the results when we use years of college schooling as the measure of human capital investment to predict marginal returns, while column (2) exhibits the results when we use the actual amount of money parents have invested in their children's college education. The Chow tests are performed on each specification, and the F statistics and p-values of the tests can be found in the last rows of the table. The p-values are very small, suggesting that the liquidity constraint index plays a role. However, the sign of its marginal effect is negative, which is contrary to the predictions of our theoretical model. This could be due to the fact that we do not have a very good proxy of liquidity constraints."

[Place Table 4 about here]

5.2 Fixed Costs

In this section we discuss whether fixed costs affect the human capital investment decisions of parents on their children. In theory, fixed costs affect human capital investment through the old-age transfer equation. The expected sign of the coefficient on the fixed costs is positive. As usual, we show the results for two different measures of the human capital investment: the actual years of college schooling and the money that parents invested in their children's college education. Table 5 shows the estimation results using investment amount as the measure of human capital, while Table 6 provides the results using years of college schooling.

[Place Table 5 and Table 6 about here]

The first column in Tables 5 and 6 show the marginal effects of the Probit estimation using the "Depend on This Child" indicator. Column (2) reports the coefficient estimates from the Tobit model in which the dependent variable is the value of the monetary transfers received by parents from their children. Columns (3-4) exhibit the marginal effects of the participation equation and the amount equation, and the unconditional marginal effects in the two-part models. Notably again, the transfers are in log forms.

We first consider the marginal effects using the parental investment measure, which is shown in Table 5. As expected, the probability to depend on children for support during retirement decreases with parental income and increases with the income of the children. Interestingly, parents who invested in their children's human capital are significantly more likely to receive financial transfers from the children at older ages. The marginal effect for fixed costs, however, is not significant which does not support the fixed costs argument. The Tobit estimation is shown in column (2) and we find that marginal effects of both the human capital investment

and the fixed costs are not significant. One possible explanation for the insignificant effect of fixed costs on T_2 is that many parents faced a binding liquidity constraint. As equation (19) in appendix C shows, T_2 will only depend on the child and parental income in the second period if the parental liquidity constraint (1d) was binding in the first period.

However, the Tobit specification is arguably too restrictive in explaining the difference between extensive and intensive margins. Therefore, we focus on the double hurdle model in columns (3) and (4). The results for the probability that parents receive financial transfers from their children in old age are broadly consistent with those obtained using "Depend on this Child" as the dependent variable. The effect of human capital investment, though, is not significant and fixed costs only play a role when looking at the amount transferred. These results follow the theoretical prediction on fixed costs only at the intensive margin.

In Table 6 we report the results using the number of years of schooling measure. The structure and specifications are the same as in Table 5. In column (1), we find that except for fixed costs, all the other marginal effects follow the theory. In the double hurdle model, we find that, in the participation equation, the marginal effect of the fixed costs is positive and significant. The human capital investment is negative and insignificant, which does not follow the theory. However, human capital investment has a positive and significant effect on the amount of money transferred, while fixed costs do not play a significant role. The general results support the theoretical prediction with fixed costs at the extensive margin only when using the years of college schooling measure.

6 Conclusion

At both the macro and micro levels, there is evidence of substantial underinvestment in human capital for the cohorts who are now the backbone of the labour market in China. In this paper we investigate the role of parental liquidity constraints and fixed costs of education in explaining this underinvestment. We first extend the theoretical model by [Raut & Tran \(2005\)](#) and we then empirically test the model predictions using data from the 2013 China Health and Retirement Longitudinal Study (CHARLS).

From the benchmark theoretical models, we know that there is always human capital underinvestment in presence of bargaining between the parent and the children. The binding liquidity constraint would further reduce the optimal investment amount, and it is reflected through an increase in the marginal returns on the investment. To empirically test whether liquidity constraints matter for the parents, we employ the methods in [Zeldes \(1989\)](#) by testing the difference in the marginal returns between the constrained and unconstrained sample. We

measure the degree of binding liquidity constraints by an index constructed by performing a PCA on the six indicators drawn from the life history survey of CHARLS. The results are ambiguous as we find some evidence that liquidity constraints play a role but the sign of the effect is not in line with the predictions of our theoretical model, probably due to the quality of our proxy for liquidity constraints.

We further examine the role of fixed costs, such as the costs parents have to pay when their children are preparing for the college entrance examination, in explaining the underinvestment in human capital. From the theory we find that if fixed costs affect the parental investment decision in the first period, then this is also reflected in the children's old-age transfer decisions during the second period. Empirically we then test the relevance of fixed costs in the old-age transfer decision at both the extensive and intensive margin. When using actual years of college schooling as a measure for human capital investment, we find that fixed costs only affect the extensive margin. However, if we employ the actual amount of money invested by the parents, then the intensive margin is significantly affected. The sensitivity of the effects using various measures might be explained by the fact that some parents did not face binding liquidity constraints when their children were at schooling ages. In general, the results provide support for the importance of fixed costs in human capital investment decisions: removing them can improve children's educational outcomes.

In terms of easing household liquidity constraints, the current poverty alleviation programs (see, e.g., [Meng 2013](#)) implemented nationwide might increase children's educational attainment from low-income families. In terms of removing the fixed costs of human capital investment, it is crucial to reduce preparation costs for the college entrance examination, for example by providing subsidized preparation classes for poor households. If the human capital investment level increases towards its optimum, the paper suggests that old-age transfers to parents will also increase. This is important as in a country with a not well-developed pension system, such as China, older people strongly rely on financial support from their children.

In addition to fixed costs and binding liquidity constraints, several other mechanisms might contribute to explaining human capital underinvestment, most notably the low level of early-life cognitive and non-cognitive abilities that children from low-income families acquire in the first years of life ([Heckman 2000](#), [Raut 2018](#), [Heckman & Raut 2016](#)). These mechanisms are worth investigating also in the context of a developing country such as China, and provide a promising avenue for future research.

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A Figures in Main Texts

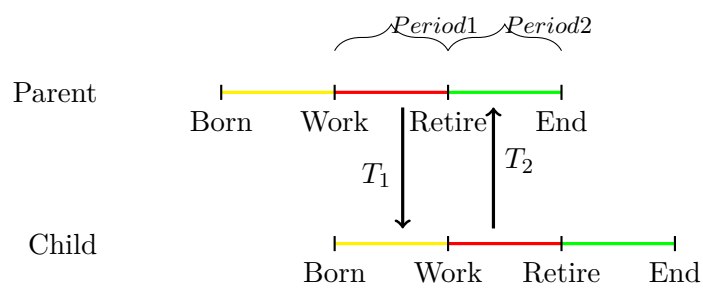


Figure 1: Parent-Child Transfer Scheme

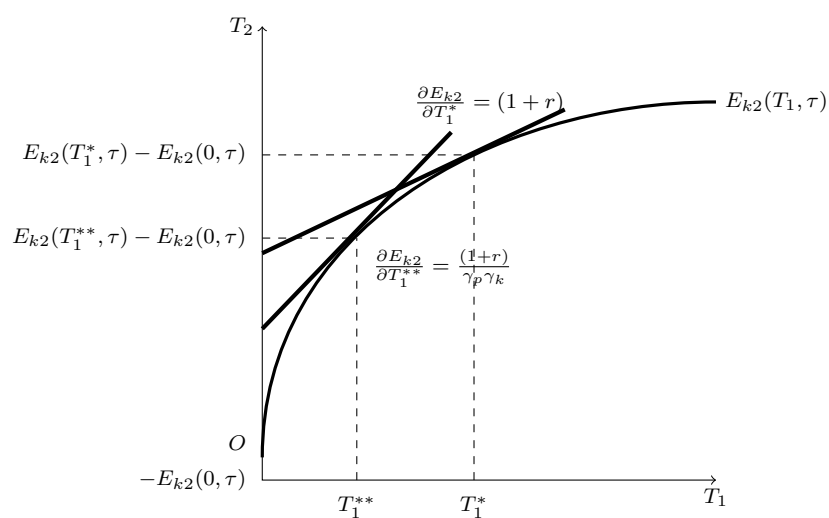


Figure 2: Rate of Returns on Human Capital Investment

B Tables in Main Texts

Table 1: Correlation across Wealth Variables

| VARIABLES | Net Durable Wealth | Net Total Wealth | Net Income | Lifetime Income | Net Financial Wealth |
|----------------------|--------------------|------------------|------------|-----------------|----------------------|
| Net Durable Wealth | 1.000 | | | | |
| Net Total Wealth | 1.000 | 1.000 | | | |
| Net Income | 0.025 | 0.035 | 1.000 | | |
| Lifetime Income | 0.003 | 0.006 | 0.241 | 1.000 | |
| Net Financial Wealth | -0.078 | -0.061 | 0.082 | 0.014 | 1.000 |

Note: In the estimation, we use only financial wealth and total wealth instead of durable wealth, since as the table shows, the correlation between total wealth and durable wealth is almost perfect. This also implies that the durable assets are the majority of the total assets in elderly Chinese households. The net financial assets are more fluctuated and therefore negatively correlated with the total wealth.

Table 2: Correlation across Liquidity Variables

| VARIABLES | Income in Bottom Quartile | Living in a Shack | Shared Toilet | No Water Closet | No Clean Water | No Electricity |
|---------------------------|---------------------------|-------------------|---------------|-----------------|----------------|----------------|
| Income in Bottom Quartile | 1.000 | | | | | |
| Living in a Shack | 0.088 | 1.000 | | | | |
| Shared Toilet | 0.058 | 0.139 | 1.000 | | | |
| No Water Closet | 0.118 | 0.264 | 0.398 | 1.000 | | |
| No Clean Water | 0.136 | 0.271 | 0.178 | 0.395 | 1.000 | |
| No Electricity | 0.058 | 0.184 | 0.027 | 0.058 | 0.185 | 1.000 |

Note: Living in a shack, earning the income in bottom quartile, using shared toilet, having no water closet, having no access to clean water, and having no access to electricity indicate that liquidity constraints are binding.

Table 3: Descriptive Statistics of Child Level Data

| | VARIABLES | N | Mean | S.D. | Min | Max | Quartile 1 | Median | Quartile 3 | |
|---|---|--------|---------|--------|--------|--------|------------|--------|------------|----|
| Parent (Every Respondent Answer) | Female | 17,311 | 0.511 | 0.500 | 0 | 1 | 0 | 1 | 1 | |
| | Age | 17,311 | 64.53 | 10.29 | 36 | 95 | 57 | 64 | 72 | |
| | Agric. Hukou | 17,311 | 0.801 | 0.399 | 0 | 1 | 1 | 1 | 1 | |
| | Married or Cohabited | 17,311 | 0.785 | 0.411 | 0 | 1 | 1 | 1 | 1 | |
| | Num. of Children | 17,311 | 3.384 | 1.616 | 0 | 16 | 2 | 3 | 4 | |
| | Years of Schooling ¹ | 17,311 | 5.758 | 4.303 | 0 | 19 | 2 | 6 | 9 | |
| | HH Income ² | 17,311 | 1.166 | 4.578 | -299.7 | 92 | 0 | 0.192 | 1.595 | |
| | Financial Wealth ³ | 17,311 | -0.0215 | 8.854 | -289.9 | 210.5 | 0 | 0.050 | 0.500 | |
| | Durable Wealth | 17,311 | 73.13 | 539.4 | -2,999 | 28,000 | 0 | 0.010 | 0.150 | |
| | Total Wealth | 17,311 | 74.27 | 539.1 | -3,035 | 27,992 | 0.090 | 0.635 | 3.530 | |
| | HH Income Children at College Age | 17,311 | 1.175 | 4.585 | -299.7 | 92 | 0 | 0.190 | 1.600 | |
| | HH Lifetime Income (Life history CHARLS) | 17,311 | 31.93 | 91.53 | 0 | 4,932 | 4.481 | 12.22 | 30.32 | |
| | Child (Family Respondent Answer) | Female | 17,311 | 0.461 | 0.498 | 0 | 1 | 0 | 0 | 1 |
| | | Age | 17,311 | 35.75 | 9.682 | 16 | 77 | 28 | 35 | 42 |
| No Work | | 17,311 | 0.161 | 0.363 | 0 | 1 | 0 | 0 | 0 | |
| Urban Jobs | | 17,311 | 0.148 | 0.355 | 0 | 1 | 0 | 0 | 0 | |
| Public Servants | | 17,311 | 0.243 | 0.429 | 0 | 1 | 0 | 0 | 0 | |
| Rural Jobs | | 17,311 | 0.445 | 0.497 | 0 | 1 | 0 | 0 | 1 | |
| Num. of Children | | 17,311 | 1.280 | 0.915 | 0 | 6 | 1 | 1 | 2 | |
| Depend on This Child | | 17,311 | 0.496 | 0.500 | 0 | 1 | 0 | 0 | 1 | |
| Coresiding with Family ⁴ | | 17,311 | 0.266 | 0.442 | 0 | 1 | 0 | 0 | 1 | |
| Years of Schooling | | 17,311 | 8.544 | 4.096 | 0 | 23 | 6 | 9 | 12 | |
| Years of College Schooling | | 17,311 | 0.263 | 0.860 | 0 | 10 | 0 | 0 | 0 | |
| Agric. Hukou | | 17,311 | 0.759 | 0.428 | 0 | 1 | 1 | 1 | 1 | |
| Married or Cohabited | | 17,311 | 0.810 | 0.392 | 0 | 1 | 1 | 1 | 1 | |
| Biological Child | | 17,311 | 0.991 | 0.0933 | 0 | 1 | 1 | 1 | 1 | |
| Work Experience ⁵ | | 17,311 | 21.20 | 11.41 | 0 | 67 | 12 | 20 | 29 | |
| Have Received Transfer | | 17,311 | 0.500 | 0.500 | 0 | 1 | 0 | 0 | 1 | |
| Positive Net Transfer | | 8,654 | 0.213 | 0.613 | 0 | 30 | 0.035 | 0.090 | 0.200 | |
| Net Transfer from Child | | 17,311 | 0.0131 | 3.152 | -394.6 | 30 | 0 | 0 | 0.090 | |
| Have Received Investment | | 17,311 | 0.102 | 0.303 | 0 | 1 | 0 | 0 | 0 | |
| Hum. Cap. Cons. ⁶ | | 1,770 | 0.0689 | 0.0754 | 0 | 1.514 | 0.036 | 0.058 | 0.085 | |
| Income | 17,311 | 3.040 | 3.449 | 0 | 30 | 0.750 | 1.500 | 3.500 | | |
| Marginal Returns of Human Capital(Predicted) | Schooling Based | 17,311 | 0.542 | 0.615 | 0 | 5.350 | 0.134 | 0.267 | 0.624 | |
| | Investment Based | 17,311 | 0.0475 | 0.0566 | 0 | 0.616 | 0.012 | 0.031 | 0.072 | |
| Liquidity Constraints (Life history CHARLS) | No Access to Electricity | 17,311 | 0.743 | 0.437 | 0 | 1 | 0 | 1 | 1 | |
| | Private Toilet | 17,311 | 0.140 | 0.347 | 0 | 1 | 0 | 0 | 0 | |
| | Water Closet | 17,311 | 0.118 | 0.322 | 0 | 1 | 0 | 0 | 0 | |
| | Clean Water | 17,311 | 0.279 | 0.449 | 0 | 1 | 0 | 0 | 1 | |
| | Income in Bottom Quartile | 17,311 | 0.211 | 0.408 | 0 | 1 | 0 | 0 | 0 | |
| | Living in a Shack ⁷ | 17,311 | 0.425 | 0.494 | 0 | 1 | 0 | 0 | 1 | |
| Liquidity Index ⁸ | 17,311 | 0 | 1.394 | -0.393 | 1.999 | -0.581 | 0.057 | 0.914 | | |

Note: 1. Years of schooling is calculated based on the legislated years at each education level. 2. All the monetary amounts are at 2010 constant price of ten thousand China yuan which is approximately 1296.546 euros. 3. All wealth are in net terms and at the household level. 4. Coresiding means that the child is living with the parents, regardless whether the child is economic independent or not. 5. Work experience is calculated based on [Mincer \(1974\)](#), namely age minus years of schooling and 6. Human capital investment at constant price of ten thousand 2010 China yuan. 7. This dummy equals 0 if the family lived in houses constructed with concrete structure or built with bricks and wood, while it equals 1 if lived in adobe, thatched house, cave, Mongolian yurt or boat house. 8. The liquidity index is constructed by taking the first component *via* the Principle Component Analysis from the six liquidity dummies.

Table 4: Testing for Binding Liquidity Constraint

| VARIABLES | (1) MR (Years of College Schooling) | (2) MR (Investment) |
|--|--|------------------------|
| <i>Child Characteristics</i> | | |
| Liquidity Index | 0.219 (0.158) | -0.240 (3.166) |
| Coresiding with Family | -0.160*** (0.00995) | -2.245*** (0.189) |
| Biological Child | 0.0825** (0.0365) | 1.573** (0.736) |
| Num. Children Squared \times Liquidity Index | 0.0176** (0.00793) | -0.0278 (0.137) |
| Biological Child \times Liquidity Index | 0.0181 (0.0233) | 0.0816 (0.458) |
| <i>Characteristics of Main Parent and Family</i> | | |
| Married | 0.0200 (0.0173) | 0.386 (0.350) |
| HH Income | 0.00981 (0.00637) | 0.175* (0.102) |
| Years of Schooling | 0.00946*** (0.00171) | 0.0892*** (0.0334) |
| Num. of Children | -0.0573*** (0.0119) | -0.709*** (0.255) |
| Num. Children Squared | 0.00579*** (0.00156) | 0.0808** (0.0352) |
| Married \times Liquidity Index | -0.0163 (0.0127) | -0.252 (0.250) |
| HH Income \times Liquidity Index | -0.00223 (0.00241) | -0.0351 (0.0407) |
| Years of Schooling \times Liquidity Index | -0.000968 (0.00127) | 0.0205 (0.0254) |
| Num. Children \times Liquidity Index | 0.00752 (0.00930) | -0.165 (0.178) |
| Num. Children Squared \times Liquidity Index | -0.00106 (0.00131) | 0.00762 (0.0278) |
| <i>Macroeconomic Control</i> | | |
| Admission Rate | 0.176*** (0.0666) | -1.165 (1.261) |
| Admission Rate \times Liquidity Index | -0.0736 (0.0613) | 1.016 (1.013) |
| Observations | 17,311 | 17,311 |
| R-squared | 0.125 | 0.091 |
| Log likelihood | -14993 | -66456 |
| Chow Test (F-statistic) | 2.884 | 3.820 |
| P-value Chow Test | 0.0000 | 0.0000 |

Note: 1. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Chow tests (F statistics) and corresponding p-values are given in the last two lines. 2. The dependent variable is the marginal returns to human capital investment and it is predicted by using the years of college schooling as the human capital investment T_1 . 3. *Liquidity Index* is the first PCA component constructed from the following six dummies: whether the household income was in the bottom quartile of the sample, lived in a shack, had a private toilet, had a water closet, had access to clean water, and had electricity. Higher value of *Liquidity Index* indicates a higher level of binding liquidity constraint faced by a household. 4. Other control variables are: age and its squared terms for both the main parent and child, gender and hukou status for both parent and child.

Table 5: Estimation on T_2 Equation Using Investment as T_1

| VARIABLES | (1) | (2) | (3) | (4) |
|---------------------------------------|--------------------------|---------------------------|-------------------------------------|---|
| | ME DependOnChild | Parameter Estimates | $P(\text{transfer} > 0 \mathbf{x})$ | $E(\ln(\text{transfer}) \mathbf{x}, \text{transfer} > 0)$ |
| Age | -0.00194 (0.00820) | 0.518*** (0.0851) | 0.0418*** (0.00704) | -0.00751 (0.0259) |
| Age Squared | -8.49e-06 (6.14e-05) | -0.00366*** (0.000625) | -0.000289*** (5.28e-05) | -3.89e-05 (0.000188) |
| Female | 0.0491*** (0.0136) | 0.0809 (0.124) | 0.00833 (0.0112) | 0.0171 (0.0359) |
| Years of Schooling | -0.00647*** (0.00173) | -0.0436*** (0.0168) | -0.00473*** (0.00150) | 0.0209*** (0.00482) |
| Parent HH Net Income/Num. of Children | -0.0721*** (0.00992) | -0.204** (0.0799) | -0.0257*** (0.00726) | 0.00375 (0.00697) |
| HH Net Wealth/Num. of Children | -3.88e-05 (2.87e-05) | -0.000216 (0.000228) | -1.86e-05 (1.79e-05) | 9.10e-05* (4.94e-05) |
| HH Lifetime Income/Num. of Children | 2.52e-06 (0.000337) | -0.00199 (0.00264) | -0.000191 (0.000205) | 0.00101* (0.000562) |
| Age | -0.0125*** (0.00442) | 0.247*** (0.0499) | 0.0211*** (0.00413) | -0.0167 (0.0139) |
| Age Squared | 0.000111** (5.25e-05) | -0.00301*** (0.000595) | -0.000254*** (4.99e-05) | 0.000142 (0.000160) |
| Female | -0.189*** (0.00901) | 1.321*** (0.101) | 0.134*** (0.00875) | -0.236*** (0.0298) |
| Num. of Children | 0.0301*** (0.00687) | 0.265*** (0.0694) | 0.0306*** (0.00642) | -0.130*** (0.0206) |
| Child Agric. Hukou | 0.159*** (0.0149) | 0.0774 (0.147) | 0.0246* (0.0129) | -0.262*** (0.0442) |
| Income | 0.00914*** (0.00154) | 0.231*** (0.0156) | 0.0168*** (0.00176) | 0.0839*** (0.00437) |
| Human Capital Investment | 0.00887** (0.00451) | -0.0548 (0.0590) | -0.00256 (0.00443) | -0.00621 (0.00824) |
| Fixed Costs ($T_1 > 0$) | 0.0140 (0.0277) | 0.288 (0.338) | -0.00325 (0.0267) | 0.485*** (0.0662) |
| Observations | 12,700 | 12,700 | 12,700 | 8,056 |
| lnL | -8049.102 | -28363.358 | -7805.221 | -12575.384 |

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Clustered robust standard errors are at the household level in parentheses. Column (1) contains the marginal effects using the dummy of “whether a household member would like to rely on children” as dependent variable. Column (2) contains the parameter estimates of the Tobit model using log transfer as dependent variable. Column (3-4) are the marginal effects of the participation decision and the amount decision of transfers.

Table 6: Estimation on T_2 Equation Using Years of College Schooling as T_1

| VARIABLES | (1) | (2) | (3) | (4) |
|---------------------------------------|----------------------------|------------------------------|-------------------------------------|--|
| | ME DependOnChild Probit | Parameter Estimates Tobit | $P(\text{transfer} > 0 \mathbf{x})$ | ME Two-part $E(\ln(\text{transfer}) \mathbf{x}, \text{transfer} > 0)$ |
| Age | -0.00108 (0.00819) | 0.532*** (0.0850) | 0.0423*** (0.00705) | 0.00133 (0.0256) |
| Age Squared | -1.46e-05 (6.14e-05) | -0.00374*** (0.000624) | -0.000292*** (5.29e-05) | -0.000102 (0.000186) |
| Female | 0.0480*** (0.0136) | 0.0718 (0.123) | 0.00787 (0.0112) | 0.0124 (0.0354) |
| Years of Schooling | -0.00826*** (0.00176) | -0.0587*** (0.0171) | -0.00542*** (0.00152) | 0.0117** (0.00487) |
| Parent HH Net Income/Num. of Children | -0.0681*** (0.0110) | -0.212*** (0.0817) | -0.0262*** (0.00727) | 0.00206 (0.00655) |
| HH Net Wealth/Num. of Children | -4.51e-05 (2.96e-05) | -0.000228 (0.000234) | -1.88e-05 (1.81e-05) | 7.05e-05 (4.70e-05) |
| HH Lifetime Income/Num. of Children | -2.15e-05 (0.000330) | -0.00212 (0.00267) | -0.000197 (0.000207) | 0.00104* (0.000557) |
| Age | -0.0127*** (0.00441) | 0.245*** (0.0499) | 0.0206*** (0.00412) | -0.0133 (0.0138) |
| Age Squared | 0.000119** (5.25e-05) | -0.00291*** (0.000595) | -0.000243*** (4.98e-05) | 0.000116 (0.000160) |
| Female | -0.181*** (0.00917) | 1.435*** (0.103) | 0.141*** (0.00888) | -0.184*** (0.0303) |
| Num. of Children | 0.0330*** (0.00692) | 0.297*** (0.0693) | 0.0314*** (0.00643) | -0.107*** (0.0206) |
| Child Agric. Hukou | 0.178*** (0.0151) | 0.251* (0.151) | 0.0315** (0.0133) | -0.159*** (0.0455) |
| Income | 0.00839*** (0.00154) | 0.220*** (0.0155) | 0.0163*** (0.00175) | 0.0798*** (0.00430) |
| Human Capital Investment | 0.00815*** (0.00173) | 0.0405** (0.0172) | -0.000267 (0.00156) | 0.0566*** (0.00504) |
| Fixed Costs ($T_1 > 0$) | 0.0348 (0.0271) | 1.198*** (0.254) | 0.118*** (0.0238) | -0.0869 (0.0721) |
| Observations | 12,700 | 12,700 | 12,700 | 8,056 |
| lnL | -8035.951 | -28339.656 | -7788.606 | -12525.309 |

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Clustered robust standard errors are at the household level in parentheses. Column (1) contains the marginal effects using the dummy of “whether a household member would like to rely on children” as dependent variable. Column (2) contains the parameter estimates of the Tobit model using log transfer as dependent variable. Column (3-4) are the marginal effects of the participation decision and the amount decision of transfers.

C Model Derivations

In this appendix, we solve the models discussed in Section 2 and derive for the optimal human capital investment decision T_1 (from parent to child) and the optimal old-age transfer decision T_2 (from child to parent). We extend the bargaining model in [Raut & Tran \(2005\)](#) by incorporating the parental liquidity constraint and educational fixed costs. The parent first make investment T_1 in the first period, then the child react by making T_2 in the second period. The parent first solves the following optimization problem:

$$\max_{s, T_1} \quad u(E_{p1} - (s + nT_1 + nC\mathbf{1}(T_1 > 0))) + \beta[u((1+r)s + E_{p2} + nT_2) + \gamma_p \nu_p(E_{k2}(T_1, \tau) - T_2)] \quad (9a)$$

$$\text{s.t. } s \geq 0 \quad (9b)$$

$$T_1 \geq 0, \quad (9c)$$

then the children solve the following problem in the second period:

$$\max_{T_2} \quad \nu(c_{k2}) + \gamma_k u(c_{p2}) \quad (10)$$

$$\text{s.t. } c_{k2} = E_{k2}(T_1, \tau) - T_2 \quad (11)$$

$$c_{p2} = (1+r)s + E_{p2} + nT_2. \quad (12)$$

Using backward induction, we first solve the optimization problem for the child. We can derive the optimal consumption allocation between the parent and child which is decided by the child:

$$u'(c_{p2}) = \frac{u'(c_{k2})}{n\gamma_k}. \quad (13)$$

The parent foresees this result when she solves her optimization problem (9). She faces a non-convex choice set because investment in children's human capital involves fixed costs. Again, the parental decision whether or not to invest in human capital is made on basis of a comparison of lifetime utilities U_p^1 and U_p^0 .

In the case that the parents decide to invest in their children's human capital, the first order conditions (F.O.Cs) imply the following equalities:

$$u'(c_{p1}) - \mu = (1+r)\beta u'(c_{p2}) \quad (14)$$

$$\frac{\partial E_{k2}(T_1, \tau)}{\partial T_1} = \frac{(1+r)}{\gamma_p \gamma_k} + \frac{\mu}{(n u'(c_{p2}) \beta \gamma_p \gamma_k)} \geq \frac{(1+r)}{\gamma_p \gamma_k}. \quad (15)$$

Equation (14) is the Euler equation. If the liquidity constraint is not binding, equation (15) simplifies to

$$\frac{\partial E_{k2}(T_1, \tau)}{\partial T_1} = \frac{(1+r)}{\gamma_p \gamma_k}. \quad (16)$$

According to the bargaining model, parents invest less in their children's human capital than according to the dictator model because parents and children are typically imperfectly altruistic ($0 < \gamma_p < 1$, $0 < \gamma_k < 1$). We observe that with a binding liquidity constraint causes parents to invest even less in their children.

Then we need to derive an explicit solution for T_2 . Notice that equations (13) and (14) also hold if $T_1=0$. As we stated in Section 2, we assume logarithmic utility and $\alpha + \alpha\beta = 1$. Under those assumptions, the closed form solution for c_{p2} is

$$c_{p2} = \begin{cases} (1+r)^{\frac{\beta}{1+\beta}} \Upsilon(T_1, T_2) = \alpha\beta(1+r)\Upsilon(T_1, T_2) & \text{if } \mu = 0 \ (s > 0) \\ E_{p2} + nT_2 & \text{if } \mu > 0 \ (s = 0), \end{cases} \quad (17)$$

where $\Upsilon(T_1, T_2) = E_{p1} + \frac{E_{p2}}{1+r} - nT_1 + \frac{nT_2}{1+r} - nC \cdot \mathbf{1}(T_1 > 0)$. In addition, the first order condition (13) can be rewritten as:

$$c_{k2} = \frac{c_{p2}}{n\gamma_k}. \quad (18)$$

After combining this result with equation (17) and by rearranging, we obtain the following explicit solution for T_2 :

$$T_2 = \begin{cases} \frac{\gamma_k}{\alpha\beta + \gamma_k} E_{k2} + \frac{(1+r)\alpha\beta}{\gamma_k + \alpha\beta} \left[T_1 - \frac{E_{p1} + \frac{E_{p2}}{1+r}}{n} + C \cdot \mathbf{1}(T_1 > 0) \right] & \text{if } \mu = 0 \ (s > 0) \\ \frac{\gamma_k}{\gamma_k + 1} E_{k2} - \frac{1}{\gamma_k + 1} \frac{E_{p2}}{n} & \text{if } \mu > 0 \ (s = 0). \end{cases} \quad (19)$$

Notably, the coefficients in equation (19) are only determined by the children's altruism.

D Detailed Sample Selection

We first construct a child-level data set from CHARLS 2013 where each observation is a child.¹¹ After deleting the dead children and those observations with missing values on the gender (174 missing), date of birth (3,030 missing), education (2,551 missing), *Hukou* status¹² (1,132 missing), marriage (1,506 missing), coresiding with family (1,584 missing), income (9,003 missing¹³) and the number of alive children (6,141 missing), in total 19,540 observations are left (Originally, 30,051 alive children with missing values in covariates are available).

Then we merge the child-level data with the household information. We choose the family respondent as the representative of the household and consider also the information on his/her spouse if married. For instance, the gender and age information of the household is from the family respondent while the education level of the household is taken from the highest one from the couple,¹⁴ and the household wealth is the total wealth of the couple. At this stage, 10,787 out of 10,803 households are retained. After merging the child information with household information, we further conduct a sample collection as follows. First, the children from those household members who are not family respondent or spouse are dropped,¹⁵ retaining 19,540 observations in total. Second, we drop those observations with missing values on some important variables of the households and drop those children who are still at school. At this stage, 18,995 observations are left. We do not drop those children who are still coresiding with the family even though the directions of the transfers could be ambiguous.¹⁶

Finally, in order to obtain information on liquidity constraints and alternative measures of permanent income, we merge the data with the life history data set¹⁷ based on household ID and

¹¹We choose the second wave because it is more updated. Nevertheless, we also conduct robustness check using the first wave and the third wave. We do not choose the third wave namely CHARLS 2015 as our main data set because we also need information in the life history survey in 2014 therefore the retrospective information on the new households in the third wave are not available.

¹²*Hukou* is a institutional arrangement to identify the origins of households. In general, two kinds of *Hukou* are frequently discussed: the agricultural one and the non-agricultural one. It is a very important institution for Chinese households, since non-agricultural *Hukou* brings about more social advantages than the agricultural one, and the costs of altering the *Hukou* are substantial.

¹³The number of observations with missing values in income is nontrivial, hence it deserves more investigation. Actually, no information on the reasons of the missing is given in either CHARLS 2013 or 2015. CHARLS 2011 provides some hints. In that wave, the number of observations with missing values is 4,212, among which 4,032 observations are due to "don't know", and 69 observations are due to "refuse to answer". Therefore, the majority of observations with missing values in CHARLS 2013 are also likely to be "don't know".

¹⁴We only consider the main respondent and his/her spouse in the households and delete the other household members (if any).

¹⁵In CHARLS, it is possible to have children from multiple couples in a household. The sampling strategy at the household level employs a screening method, namely ask all the household member aged 45 above and his/her spouses.

¹⁶No consensus has been reached on this issue. Raut & Tran (2005) only have data of non-coresiding parents and children, so they don't consider coresiding in the empirical analysis (page 397, the last sentence is section 2.1). Oliveira (2016) assumes that coresiding is the transfer from children to parents, therefore coresiding is considered as a transfer in the study (page 5, footnote 25). Ham & Song (2014) drop the coresiding children as the paper thinks the directions of transfers in coresiding families unclear (page 81, line 3 of paragraph 2 in Data section).

¹⁷We first transform the life history data into an informative unbalanced panel data, then we construct the

the year when each child reached the college age of 18. At last we reach a sample size of 17,311.

liquidity variables and calculate lifetime earnings.

E Children’s Earnings and Marginal Returns

The results of estimation of children’s earnings equation (7) are demonstrated in Table 7 of this appendix.¹⁸ In column (1) and (3), estimation are performed on male subsample, while column (2) and (4) exhibit the estimates on the female subsample. Column (1) employs years of college schooling as measure of human capital investment, and column (3) uses the log of human capital investment amount as the measure.

[Place Table 7 about here]

Chow tests are posed on the null hypotheses that the male sample, namely column (1) or (3), and the female sample, namely column (2) or (4), produce the same estimates of all slope coefficients. The evidence significantly rejects the null hypotheses. It implies that, given certain level of talent, human capital investment or job category, male children receive significantly different marginal earnings from the females.

We predict the marginal returns to human capital using the estimated coefficient $\hat{\alpha}_1$ for $\ln(1 + investment)$ or $Schooling$ in Table 7. The marginal return in specification (7) is $MR_i = \frac{\hat{\alpha}_1 \times ChildInc_i}{1 + HCinvest_i}$ when we use the logarithm of one plus the actual amount invested as a measure of human capital. When we use the number of years of college schooling instead, the marginal return is $MR_i = \hat{\alpha}_1 \times ChildInc_i$. The descriptive statistics of the marginal returns can be found in Table 3 of the main paper.

¹⁸When estimating children’s earnings equation, we employ the Mincerian equation by [Mincer \(1974\)](#), which has also been extensively discussed by [Willis \(1986\)](#). Similar to [Raut & Tran \(2005\)](#), in this paper, we measure the working experience using years of working which is calculated as age minus years of education and 6.

Table 7: Children's Earnings Function

| VARIABLES | Dependent Variable: Log Earnings | | | |
|--|----------------------------------|-----------------------------|----------------------------|----------------------------|
| | (1) | (2) | (3) | (4) |
| | Schooling | | Investment | |
| | Male | Female | Male | Female |
| Work Experience ¹ | 0.0652*** (0.00397) | 0.0634*** (0.00458) | 0.0599*** (0.00413) | 0.0588*** (0.00458) |
| Experience Squared | -0.00120*** (8.08e-05) | -0.00114*** (9.13e-05) | -0.00112*** (8.31e-05) | -0.00107*** (9.11e-05) |
| Parental Schooling ² | 0.0155*** (0.00331) | 0.0202*** (0.00389) | 0.0154*** (0.00334) | 0.0205*** (0.00393) |
| Urban Jobs ³ | 1.486*** (0.0501) | 1.134*** (0.0506) | 1.539*** (0.0501) | 1.196*** (0.0502) |
| Public Servants | 1.379*** (0.0487) | 0.931*** (0.0410) | 1.396*** (0.0490) | 0.938*** (0.0411) |
| Rural Jobs | 1.090*** (0.0462) | 0.641*** (0.0401) | 1.098*** (0.0462) | 0.648*** (0.0401) |
| Agric. Hukou ⁴ | -0.175*** (0.0324) | -0.233*** (0.0373) | -0.246*** (0.0320) | -0.273*** (0.0367) |
| Years College Schooling⁵ | 0.212*** (0.0151) | 0.134*** (0.0178) | | |
| ln(1+Investment) | | | 4.482*** (0.609) | 2.604*** (0.688) |
| Constant | -1.255*** (0.0708) | -0.705*** (0.0767) | -1.128*** (0.0717) | -0.614*** (0.0759) |
| Observations | 9,333 | 7,978 | 9,333 | 7,978 |
| R-squared | 0.216 | 0.179 | 0.207 | 0.174 |
| lnL | -13281 | -11910 | -13331 | -11930 |
| Chow Test | F(8,7598)=10.34 | | F(8,7598)= 9.942 | |
| Prob ≥ F | 0 | | 0 | |

Note: 1. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. 2. Robust standard errors are clustered at the household level in parentheses. Column (1) estimates the earnings equation on male subsample using years of college schooling as the measure for human capital, while column (3) estimates earnings equation using actual investment amounts as the measure. Column (2) and (4) estimate earnings equation on female subsample. 3. The variable years of working experience equals age minus years of education and 6. 4. Parental schooling is a proxy for the child's talent τ .