Income Shocks and Parental Preference for Equality in Education Outcomes[i]

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Abstract

This paper examines the role of parental preferences in human capital accumulation and studies whether some children in the household are better insured than their siblings from income shocks. Using data from Indonesia around the time of the economic crisis in late 1990s, I estimate a structural model which describes the relationship between production of skills and investment allocation decisions, implied by a utility-maximization problem for households with two children. The main finding of this analysis is that, on average, parental investment in children does not reinforce differences in skills. Households who experienced a large income shock, however, allocated resources according to efficiency motives. Further, parents were more sensitive to the human capital of younger female children, penalizing them for low skills. The implication of this finding is that young female children are potentially less likely to be fully insured from the negative effects of an income shock compared to their older siblings of either gender.

Keywords: human capital, education spending, household allocation, Indonesia, income shock

JEL codes: I250, I220, D130

1. Introduction

Income shocks have been shown to have an important effect on the health and educational attainment of children in a variety of settings (Lundberg and Wuermli, 2012). While most studies on income shocks identify the effect on human capital based on variation between households, variation in resource allocations within households is known to be substantial (Behrman 1988; Pitt, Rosenzweig, and Hassan 1990; Ayalew 2005). A seminal paper by Behrman, Pollak, and Taubman (1982) shows that within a resource-constrained household, parents may choose to compensate by investing in a child with lower endowments, may reinforce differences between siblings, or may follow a neutral investment strategy. Whether parents choose to insure some children from the impact of an income shock more than other children may depend on the relative costs of education, expected returns to education, and parental preferences. Understanding how parents allocate resources between children has important policy implications, as it identifies potentially vulnerable groups of children that may need more protection from the government in times of economic hardship.

This paper uses data from the Indonesian Family Life Survey (IFLS) to investigate whether parents have efficiency or equity motives when they invest in their children. I take advantage of the availability of detailed school expenditure data and scores from cognitive tests administered in the IFLS to examine how resource allocation within the household is affected by child order, gender, and skills. In order to account for the simultaneity in skill production and investment allocation, I estimate a structural model for a utility-maximizing household with two children that links mathematics scores and education expenses for the year 2000, soon after the Asian Financial Crisis that hit Indonesia in late 1990s.

The effects of income shocks on child human capital accumulation are well documented (Ferreira and Schady 2009). In poor countries, children may drop out of school if parents are unable to pay school fees, or if they need to work and contribute to family income. Less is known, however, about investments at the intensive, rather than the extensive, margin and the effect of child characteristics on parental response to an income shock. In a recent paper on Uganda, Björkman (2013) uses district level data to show that rainfall shocks have a negative effect on female school enrollment. Importantly, the paper also shows that when parents need to pay for school, negative income shocks are associated with higher average test scores as parents pull the worst performing children out of school. When schooling is free of charge, however, only female test scores are negatively affected by resource constraints. The reason for this finding, Björkman (2013) speculates, is that girls are given fewer resources and are required to spend more time on household chores, which affects their performance. Using household-level data, I provide direct evidence on how parental resource allocations depend on child age and gender, and on the interactions of the demographic characteristics with child skills.

The effect of child age and gender on differential school attainment within the household has been extensively studied. Differences in outcomes have been used as proxies for differences in investments and have been shown to depend on parental preferences, returns and costs of schooling. They have also been shown to be context-dependent. For example, Parish and Willis (1993) show that in Taiwan having an older sister is associated with higher educational attainment, especially for older cohorts. Older sisters are the most disadvantaged in India, too (Ota and Moffatt 2007). Younger children in the Philippines have better educational outcomes compared to their older siblings (Ejrnaes and Portner 2004). In Tanzania, the number of sisters (whether younger or older) is positively correlated with number of years of schooling, while in

South Africa the sibling composition does not matter (Morduch 2000). In Indonesia, Pradhan (1998) finds that having younger siblings decreases the probability of delayed enrolment and thus the first-born in the family receive better education. I contribute to the literature on intra-household resource allocation by studying investments at the intensive margin for Indonesian siblings who continue to attend school during the economic crisis.

One of the key challenges of studying intra-household resource allocation decisions is the simultaneity in production of skills and allocation of investments. Using sibling fixed effects to deal with household-level unobserved heterogeneity, Akresh et al. (2011) find that in Burkina Faso children with higher test scores receive more discretionary school expenditures by parents. Further instrumenting the difference in sibling scores by handedness (in order to account for individual-level unobserved heterogeneity), Frijters et al. (2010) find similar evidence for reinforcing education investments in the US. An alternative approach (proposed by Pitt, Rosenzweig, and Hassan (1990) for health input allocations) is used by Ayalew (2005) in the context of both health and education inputs. He estimates unobserved child endowments from production functions and uses those in a sibling fixed-effects model to test if investments respond to endowments. Similar to the studies on Burkina Faso and the US, he shows that education spending in Ethiopia (proxied by child school enrollment) reinforces existing differences in cognitive skills. Following the methodology of Behrman (1988) who studied nutrient allocations in India, I use a structural approach to account for the endogeneity of test scores in an investment equation. I estimate cognitive production functions for all children in a two-child family jointly with an investment allocation equation, derived as the first-order condition of the household's utility maximization problem. The advantage of this approach over a fixed-effects estimation is that it accounts for unobserved heterogeneity at both the household and individual level, and all instruments are defined within the model. In addition, I identify an elasticity of substitution parameter and study the effect of child and household characteristics on parental preferences for equality of education outcomes. Finally, this approach to estimation is useful in providing information on the skills production function for children in a developing country setting.

Overall, this study adds to the research on parental response to economic shocks by exploring how investment decisions may be influenced by preferences to equalize outcomes between children or respond to child endowments. I focus on children with uninterrupted schooling and use information on education spending to examine whether some children in the household are likely to be better insured from an income shock than their siblings. I find that parents invest in their children by maximizing total returns of their investment, independent of their distribution between children. Contrary to previous studies on intra-household education investments, my analysis shows that, on average, parental resource allocation between children is not a function of the difference in the stocks of their children. Looking at the effects of child order and gender, however, I show that a 10% increase in the cognitive stocks of the older child is associated with a 2% higher investment in the older child only when the younger child is a female. This suggests that parents may have reinforcing investment motives if the younger child is a female. The paper proceeds as follows. In section 2, I present a brief overview of the Indonesian crisis and the data source I use. In section 3, I discuss the conceptual model that guides the estimation. Section 4 contains a description of the estimation methodology and the specification tests. The main results and robustness checks are discussed in section 5, while section 6 concludes.

2. Background and Data

In the two decades prior to the Asian Financial Crisis, the proportion of the population living under poverty in Indonesia fell from 40.1% in 1976 to 11.3% in 1996 (Lanjouw et al. 2001). During that time the government invested heavily in education, increasing the number of schools and improving enrollment rates of primary school students from 69% in 1973 to 83% in 1978 (Duflo 2001). By 1986, universal primary school enrollment was reached. Then, in late 1997, the Asian Financial Crisis hit. Inflation reached 80% in 1998, real wages fell by 40%, and per capita investments in health and education declined by 37% (Frankenberg, Smith, and Thomas 2003). Using data from the IFLS, Thomas et al. (2004) show that during the crisis parents pulled children out of school as a way to cope with the income shock. Other coping strategies may be at the intensive margin, such as reducing investments for children who attend school. While school fees in a given school are fixed, parents may adjust spending on extracurricular activities, or may move the child to a less expensive school. Indeed, Thomas et al. (2004) present some evidence that children changed schools during the crisis. They do not examine, however, how parents make decisions about which child to withdraw from school or move to a cheaper school, or what the effect of these actions on child development may be.

For my analysis, I use data from the IFLS 1997 and 2000 waves. The second wave of the survey, IFLS2, took place between July and November 1997, while the third wave, IFLS3, took place between June and December 2000. The survey follows households and individuals over time. It documents all children in the household and provides child-specific information on education attainment and parental education spending for the academic years 1997/1998 and 1999/2000, including annual registration fees, monthly fees, and other expenses for food, travel and extracurricular activities. Further, it collects data on cognitive tests from all individuals aged 7 to 25. For this study, I use data on mathematics test scores in 1997 and 2000. I restrict the sample to nuclear households from 1997 (excluding extended families or families where members under 25 were not children of the household head or spouse) that had children who were of school age (between 7 and 18 years of age) in both 1997 and 2000, attended school in both 1997/1998 and 1999/2000, and were interviewed in school year 2000/2001. This yields 2,234 households. Among those, I have considered only households with exactly two children meeting the criteria, which results in 617 households. Finally, observations with missing information on current or past stocks or investments of either child are excluded from the analysis, which leaves 499 households for the final estimation.

3. Conceptual model

Becker and Tomes (1976) and Behrman, Pollak, and Taubman (1982) were the first to model the important interactions within households comprised of heterogeneous individuals. In the wealth model developed by Becker and Tomes (1976), parents choose whether to invest in children so as to increase their adult earnings potential or whether to provide them transfers when they are adults to compensate for their low earnings. The model assumes that parents are concerned with total child wealth, rather than the sources of wealth. The main conclusion is that parents reinforce endowment differences in children by providing human capital investment for the more endowed child, but equalize wealth by providing more transfers to the less endowed child. An implicit assumption of the wealth model is that parents have enough resources to allocate between children (Behrman, Pollak, and Taubman 1995).

An alternative model was proposed by Behrman, Pollak, and Taubman (1982) who argued that parental preferences are separable in earnings and transfers (SET). In this setting, parents solve a two-stage problem where they allocate total resources between earnings and transfers in the first stage and then, in the second stage, allocate earnings investments (and transfers) among their children. This assumption allows for analyzing the distribution of human capital investments independent of any possible future transfers, and has been widely adopted in subsequent literature. In their SET model, parents maximize a constant elasticity of substitution (CES) utility function, where parents tradeoff between the earnings of different children. Using this formulation, even if parents have equal concern for all children, they may have investment patterns that vary across children and depend on whether parents have efficiency motives (i.e., invest in the child with higher returns) or equity motives (i.e., invest in the child who is lagging behind). Thus, Behrman, Pollak, and Taubman (1982) show that whether parents follow a compensatory, a reinforcing, or a neutral investment strategy depends on parental inequality aversion and on the properties of the earning function.

Following Behrman, Pollak, and Taubman (1982), I assume that the parental utility function is additively separable in consumption (Z) and human capital (C). It can therefore be represented as: $V = U^{*}(Z) + U(C)$. As in Behrman, Pollak, and Taubman (1982), I also assume the human capital subutility function $U(C)$ to be of the CES form: $U(C) = \left(\sum_{i}^{n} \pi_i C_i^{\rho}\right)^{1/\rho}$, where parents trade off the human capital of *n* different children. Parental preferences for one child over another are given by the π_i weights where $\sum_{i}^{n} \pi_i = 1$. The elasticity of substitution is a function of the parameter ρ and is defined by $1/(1 - \rho\ )$.

The model rests on three additional assumptions. First, I assume parents maximize a one-period model. This implies either that parents are not forward looking, or that under budget constraints, parents cannot place any value on future outcomes. Second, I assume that parents do not trade off investments across time periods. In other words, if parents reduced their investment in the first time period, they do not compensate for it by increasing investment in the next time period. Again, this is plausible in the case when parents are budget-constrained and cannot save or borrow. This seems particularly appropriate because my data (from 2000) are from soon after the crisis. Third, I assume that parents' utility is a function of the human capital accumulated in their children, rather than the value of that human capital (i.e., the potential earnings). This is valid if parents invest in the human capital of their children for altruistic reasons, or if returns to human capital do not vary between children. Either way, accounting for potential gender differences in returns, r_i, to human capital across children (i.e., modelling $r_i * C_i$ as opposed to C_i) does not affect the conclusions of the model. The reason is that under the log-linearization used in the estimation, the ratio of returns is absorbed in the intercepts of the production functions.

With these assumptions, I represent the parental problem as a utility maximization problem. In each time period t, parents choose levels of consumption and investment in the cognitive stocks of each child i subject to a budget constraint, that is binding in each period, and a cumulative human capital production technology given initial child endowments (η_i) at time $t = 0$:

$$\max_{Z_t, I_{i,t} \dots I_{n,t}} U^*(Z_t) + \left(\sum_i^n \pi_i C_{i,t}^{\rho} \right)^{1/\rho} \quad s.t. \quad \sum_i^n I_{i,t} + pZ_t = Y_t \;\; and \;\; C_{i,t} = f(I_{i,t}, I_{i,t-1}, \dots I_{i,0}, \eta_i)$$

where Y_t is household income at time t, p is the price of the consumption good, and $I_{i,t}$ represents investment in child i at time t.[1] If the shadow price of income is denoted by λ, then the remaining first-order conditions of this problem for a household with two children i and j can be represented as

$$\frac{\partial U(C)}{\partial C_{i,t}} \frac{\partial C_{i,t}}{\partial I_{i,t}} - \lambda = 0, \qquad \frac{\partial U(C)}{\partial C_{j,t}} \frac{\partial C_{j,t}}{\partial I_{j,t}} - \lambda = 0.$$

This implies that parental allocation of resources between child i and child j will be governed by the following relationship[2]:

$$\frac{\partial C_{i,t}}{\partial I_{i,t}} \Big/ \frac{\partial C_{j,t}}{\partial I_{j,t}} = \pi_i C_{i,t}^{\rho-1} / \pi_j C_{j,t}^{\rho-1}. \quad (1)$$

Given the assumption of separability of the utility function in consumption and human capital, the model is estimated as a parental utility maximization over the outcomes of both children. In this model, investments and outcomes are jointly determined because parental utility is a function of the outcomes of both children. Solving for the optimal ratio of parental investments between children then requires system estimation of the first-order conditions derived from the utility maximization problem, and the cognitive production functions of the children.

For estimation, a functional form for the cognitive production functions must be assumed. A standard form of the production function is a cumulative specification where current stocks of human capital depend on all past investments (I), the initial endowment (η), a constant term E that governs the efficiency of production in the current time period, and shocks to human capital in each time period (v) which are assumed to be identically and independently distributed (iid) (Todd and Wolpin 2003, 2007). In order to account for diminishing marginal returns to investments and the fact that investments are not perfectly substitutable over time, a quasi-Cobb-Douglas specification is assumed:

$$C_{i,t} = E_t * \eta_i \prod_{k=1}^{t} I_{i,k}^{\alpha_{t-k}} \, v_{i,k}.$$

Where logarithms are implicit, the linearly additive specification is:

$$C_{i,t} = \alpha_0 I_{i,t} + \phi_0 v_{i,t} + \alpha_1 I_{i,t-1} + \phi_1 v_{i,t-1} + \cdots + \alpha_{t-1} I_{i,1} + \phi_{t-1} v_{i,1} + \beta_t \eta_i + \kappa_t E_t + \epsilon_{i,t}, \quad (2)$$

where $\epsilon_{i,t}$ is the measurement error associated with the cognitive outcome at time t. In this model, the expected impact of investment at the beginning of time t on an outcome at the end of time t is given by the parameter α_0, and the impact of an investment at the beginning of time $t -$

1 is given by the parameter α_1. As shown in Todd and Wolpin (2003), the function for the outcome in time $t-1$ can be written similarly as:

$$C_{i,t-1} = \alpha_0 I_{i,t-1} + \phi_0 v_{i,t-1} + \alpha_1 I_{i,t-2} + \phi_1 v_{i,t-2} + \cdots + \alpha_{t-2} I_{i,1} + \phi_{t-2} v_{i,1} + \beta_{t-1}\eta_i + \kappa_{t-1}E_{t-1} + \epsilon_{i,t-1}.$$

Therefore, subtracting $\delta C_{i,t-1}$ from both sides of equation (2) for some constant δ obtains:

$$C_{i,t} - \delta C_{i,t-1} = \alpha_0 I_{i,t} + \phi_0 v_{i,t} + (\alpha_1 - \delta\alpha_0)I_{i,t-1} + (\phi_1 - \delta\phi_0)v_{i,t-1} + \cdots + (\alpha_{t-1} - \delta\alpha_{t-2})I_{i,1} + (\phi_{t-1} - \delta\phi_{t-2})v_{i,1} + (\beta_t - \delta\beta_{t-1})\eta_i + (\kappa_t E_t - \delta\kappa_{t-1}E_{t-1}) + (\epsilon_{i,t} - \delta\epsilon_{i,t-1})\,. \quad (3)$$

Under the assumption that the impacts of each input, shock, and the initial endowment deteriorate over time at the geometric rate of δ so that $\alpha_k = \delta\alpha_{k-1}, \phi_k = \delta\phi_{k-1}$, and $\beta_k = \delta\beta_{k-1}$, the production function (3) can be presented in the value-added form:

$$C_{i,t} = \delta C_{i,t-1} + \alpha_0 I_{i,t} + \phi_0 v_{i,t} + (\kappa_t E_t - \delta\kappa_{t-1}E_{t-1}) + (\epsilon_{i,t} - \delta\epsilon_{i,t-1})\,, \quad (4)$$

where the term $(\kappa_t E_t - \delta\kappa_{t-1}E_{t-1})$ is a constant.

If the $v_{i,t}$ shocks, which are assumed to be identically and independently distributed, are realized after the investment has been made so that the investment decision is not affected by the shock realization, then $Cov(I_{i,t}, v_{i,t}) = 0$. While this assumption is plausible, the unbiased estimation of equation (4) also requires that the measurement errors in the two time periods are correlated with correlation equal to δ so that $Cov(C_{i,t-1},\ \epsilon_{i,t} - \delta\epsilon_{i,t-1}) = 0$ (Todd and Wolpin 2003, 2007). While common in the human capital literature, this assumption is harder to justify. Consequently, the results presented here aim to account for the endogeneity of lagged stocks using instruments.

The data contains information on school expenses for the school years 1997/1998 and 1999/2000, and test scores from interviews in the fall of 1997 and fall of 2000. Assuming investments are lumpy and made annually, this leaves a gap of one year (academic year 1998/1999) with missing information on investments. Subtracting the term $\delta^2 C_{i,1997/1998}$ from both sides of equation (2), the value-added production function similar to (4) takes the form:

$$C_{i,2000} = \delta^2 C_{i,1997} + \alpha_0 I_{i,1999/2000} + \delta\alpha_0 I_{i,1998/1999} + (\phi_0 v_{i,1999/2000} + \delta\phi_0 v_{i,1998/1999}) + constant_{2000} + (\epsilon_{i,1999/2000} - \delta^2 \epsilon_{i,1997/1998}) \, .$$

I consider estimation of this equation when data for $I_{i,1998/1999}$ as well as $v_{i,1999/2000}$ and $v_{i,1998/1999}$ are missing. If the investments in academic years 1999/2000 and 1998/1999 are equal, then estimation does not suffer from omitted variable bias. The coefficient associated with current investment will represent the sum of current and lagged investment. At the other extreme, if $Cov(I_{i,1998/1999}, I_{i,1999/2000}) = 0$, omitted variable bias is also not present. While this assumption may seem implausible, it is not unlikely because the economic crisis of 1998 affected both the cost of schooling and parental ability to pay. Assuming that the correlation between investments in 1999/2000 and 1998/1999 is small, the omitted variable bias due to missing information on 1998/1999 investments will be small. Alternatively, investments in the academic year 1997/1998 can be used to proxy for investments in 1998/1999 since both academic years were affected by the crisis of 1998 (even though investment information reported in the 1997 survey is likely affected much less by the crisis or by expectations of the crisis).

Another problem that arises is that the error term now contains the shock to human capital in 1998/1999. Since the expected outcome in 2000 is a function of past stocks, parents are likely to respond to this when they make their investment decisions in 1999/2000. Solving the production functions and first-order conditions jointly accounts for the endogeneity in investment due to this simultaneous determination of investments and stocks.

The log-linearized first-order condition (1) for household h can be re-written as:

$$I_{i,1999/2000,h} - I_{j,1999/2000,h} = \rho\left(C_{i,2000,h} - C_{j,2000,h}\right) + constant_{2000},$$

where log notation for investments and stocks is suppressed, and the constant term is a function of parental preference weights π. The choice of current cognitive investments and other household consumption implied by this first-order condition will be affected by heterogeneity across households due to differences in income and circumstances including the age and gender of both children, their cognitive stocks accrued from past investments, urban versus rural area of residence, and household income. Similarly, children are heterogeneous in terms of age and gender, which may affect the formation of human capital. Based on these considerations, using GMM, I estimate the following system of equations for each household with two children of school age is:

$$C_{i,2000,h} = a_1 C_{i,1997,h} + a_2 I_{i,1999/2000,h} + a_3 I_{i,1997/1998,h} + a_4 age_{i,2000,h} + a_5 female_{i,h} + a_6 constant_{2000} + u_{i,2000,h}\ , \quad (5)$$

$$C_{j,2000,h} = b_1 C_{i,1997,h} + b_2 I_{j,1999/2000,h} + b_3 I_{j,1997/1998,h} + b_4 age_{j,2000,h} + b_5 female_{i,h} + b_6 constant_{2000} + \tau_{j,2000,h}\ , \quad (6)$$

$$I_{i,1999/2000,h} - I_{j,\frac{1999}{2000},h} = \rho \times \left(C_{i,2000,h} - C_{j,2000,h}\right) + d_1 age_{i,2000,h} + d_2 female_{i,h} + d_3 age_{j,2000,h} + d_4 female_{j,h} + d_5 urban_h + d_6 income_{2000,h} + d_7 constant_{2000} + \varsigma_{i,2000,h}. \quad (7)$$

The coefficient ρ in equation (7) represents substitution between the cognitive stocks of the two children in the parental utility function of human capital. Extensions of this base case model test for heterogeneity in the parameter ρ by different socio-economic characteristics of the household. If $\rho \rightarrow -\infty$, parents' valuation of child human capital is described by infinite inequality aversion, so that they will value improved cognitive stocks of one child, only if his or her cognitive stocks are lower than the cognitive stocks of the other child. If $\rho \cong 1$, then parental valuation of human capital is governed by efficiency motives so that they value improvements in cognitive stocks irrespective of the level of stocks of siblings. Investment in cognition of a child is higher if that investment is more efficient than investment in the sibling. If $\rho = 0$, then equity and efficiency motives are balanced and investments are allocated between children independently of the difference in child endowments.

4. Estimation

In order to avoid the problem of having a limited dependent variable in the production function estimation (since the number of correct and wrong answers is predetermined), I standardize mathematics test scores, as is common practice in the literature (Paxson and Schady 2007; Malamud and Pop-Eleches 2011). Since the sample of children includes children between the ages of 7 and 18, I standardize the scores by age in order to account for the non-linear relationship between scores and ages. Age-normed scores have previously been used by Todd and Wolpin (2007), Paxson and Schady (2007) and others. I control for gender in all regressions to account for the different distribution of scores by gender. In addition, investments are standardized by school level (primary, junior high school, and senior high school). Since these variables are then logged, as suggested by the model, they are standardized around a mean of 100 (with a standard deviation of 1). Associated coefficients thus represent percentage changes in the standardized dependent variable associated with 1% change in the standardized independent variable. Variables representing cognitive stocks and investments are standardized using the full, unrestricted sample.

I perform two specification tests to determine whether the log-linear value-added functional form of the cognitive production functions for child i and child j is supported by the data. First, I test whether past investment belongs in the production function. The p-values of the F-test are 0.063 for the older child and 0.073 for the younger child, which implies that at the 10%

level, I cannot reject the hypothesis that the unrestricted model fits the data better. As a result, I use the “value-added plus” specification for both production functions. This specification has been found to fit US data better as well (Todd and Wolpin 2007). In addition, it helps address issues of omitted variable bias due to missing information on school expenses in 1998/1999, as described above. Second, using the modified version of the model, I test whether the log-linear specification is correct by estimating a translog production function and testing whether the interaction terms are jointly significant. Overall, I cannot reject the null hypothesis that the production function is of the Cobb-Douglas form with p-values of 0.49 for the older child and 0.81 for the younger child.

In order to account for the potential endogeneity of the lagged cognitive stocks, I use instruments suggested by the production function for the lagged stock. Since current stocks are already a function of lagged investments, past investments are not excluded instruments. Instead, I use mother’s education as a proxy for the child’s initial endowment, as well as the age when the child started school (including kindergarten) to proxy for length of investment. In the first-stage regression, as expected, years of schooling of the mother are positively associated with each child’s math scores in 1997. Similarly, the effect of age of school entry is of the expected sign: the later the child starts school, the lower the test score. Age of school entry, however, is found to be a statistically significant determinant of cognitive stocks only for the younger children. The first-stage regressions have high explanatory power with R-squared statistics of 0.138 for the older and 0.144 for the younger child. The F-statistics for the excluded instruments are 15.5 and 22.0 for the older and younger child respectively. These results support the relevance of the instruments. The validity of the instruments rests on the specification of the production functions and the structural model presented above.

5. Results

Column (1) of Table 1 presents the results from the system estimation of the cognitive production functions for the two children in the household. Past mathematics scores are significant determinants of current mathematics score. Consistent with previous studies on dynamic production functions in the US (Cunha, Heckman, and Schennach 2010), the skill production function of older children in Indonesia is characterized by a greater degree of state dependence. For older children, a 10% increase in the standardized mathematics score in 1997 is associated with 3.1% higher mathematics score in 2000 compared to a 2.1% increase for younger children. The effect of education expenditures in younger children is not precisely estimated (a coefficient of 0.0562 with a standard error of 0.0595 for current investment and a coefficient of 0.0847 with a standard error of 0.0535 for lagged investment), but when tested jointly, given the high degree of correlation between the two variables, the two investment variables are significantly different from zero (p-value=0.0473). Further, the lagged education expenses for older children are significant determinants of current achievement (a coefficient of 0.0919, significant at the 10% level). This result implies that early investments are more productive.

Adding the first-order condition from the utility maximization problem to the system in column (2) does not lead to changes in the coefficients or standard errors in the production functions.[3] This suggests limited simultaneity between skill production and investment. The coefficient of interest, ρ, governing parental substitution between the stocks of different children is positive (0.0372) but close to zero. In particular, it is not significantly different from zero (with a standard error of 0.0348). This suggests that parental resource allocation between children is not a function of the difference in the stocks of their children. In other words, parents invest in children by maximizing the total returns of their investment, independent of their distribution between children. This finding is in contrast to previous studies in developing countries, which have shown that education spending is determined based on a reinforcing, rather than neutral, investment strategy (Akresh et al. 2011; Ayalew 2005). This suggests that both children would be equally well (or equally poorly) insured against the impact of a crisis; it would not be the case that children with poorer initial outcomes would, on average, suffer more from the crisis than their better performing siblings.

The main sample includes households who have two children of school age who attend school in both 1997 and 2000. If, however, there are other children in the household who are older and attend a university, or are younger and attend kindergarten, the estimation may be missing the children between which the substitution takes place. In order to check the robustness of results I subset the sample to families with only two children. The estimated parameter in column (3) is almost identical. Alternatively, due to various institutional constraints, substitution may take place between children at the same level of schooling (e.g., primary school) rather than between levels of schooling (e.g., primary vs. high school). If so, then the real substitution parameter would be underestimated by including children at different schooling levels. The estimated parameter in column (4) is again not significantly different from zero. The sample of households with children who attend the same level of schooling, however, is very small.

In column (5) I account for the potential endogeneity of the lagged cognitive outcome. The production functions of both children now exhibit an even higher state dependence. Again, younger children have a higher opportunity to reduce the impact of initial disadvantages because the importance of past stocks is almost twice as high for older children. The substitution parameter is once again not significantly different from zero ($\rho = 0.0412$ with a standard error of 0.0349).

One reason why parents may respond to children's skills in a reinforcing way is if children serve as an insurance mechanism for old age and higher education investments imply higher transfers by children later on (e.g., because of higher income, or because of reciprocity motives). In Indonesia, social norms obligate all children to provide old-age support to parents and even if parents live with one child, the other children should provide monetary assistance (Frankenberg, Lillard, and Willis 2002). Frankenberg, Lillard, and Willis (2002) show that the educational attainment of children is not a significant predictor of whether parents receive transfers from their adult children. On the other hand, the study finds that the amount received increases in the children's education. A study by Park (2003), however, finds no systematic relationship between education and transfer amounts, while Raut and Tran (2005) show that the result on the effect of education on transfers is sensitive to the empirical specification. Overall, for the case of Indonesia, no conclusive evidence exists that higher education investments are likely to elicit higher transfers to parents later on. This may be one possible reason why, unlike previous studies in other countries, I find no reinforcing investment motives on average.

Another potential explanation of my findings is that fertility is endogenous and parents only have as many children as they can afford to educate well, irrespective of their ability. The National Family Planning Coordinating Board, created in the 70s, promoted small families and, in particular, a two-child norm. Volunteer and village mid-wife services were used to promote and distribute different contraceptives, and those were made available free of charge during the 70s and 80s (Frankenberg, Sikoki, and Suriastini 2003). As a result, total fertility rates decreased from 5.6 children per woman in late 1960s to 3.4 in 1984-1987, and 2.8 in 1995-1997 (Permana and Westoff 1999). This suggests that parents had control over their fertility decisions and that smaller families were preferred. Maralani (2008) uses the IFLS data to test the relationship between family size and children's educational attainment for three cohorts: individuals born in 1948–1957, 1958–1967, and 1968–1977. She doesn't find household size to be significantly associated with school attainment in rural areas for any of the cohorts, although she finds a negative relationship for the most recent cohort in urban areas. This suggests that if parents of the children in my sample (born between 1982 and 1990) preferred smaller households, they may not have faced a trade-off between quantity and quality, investing equally in all children. Any differences in investment allocation patterns should only be visible in urban areas or more resource-constrained households.

Next, I test whether there is heterogeneity in the substitution parameter by various socio-economic characteristics. In Table 2 column (1), I include interaction terms between the difference in cognitive stocks of the two children and household per capita expenditure, as well as the dummy variable denoting urban area of residence. Poorer households, i.e., those with lower per capita expenditure, could be expected to be more likely to exhibit efficiency investment motives if they are budget constrained and they invest in the smarter child for whom investment may be more productive. The negative coefficient on the interaction term with per capita expenditure supports this hypothesis. It suggests that a decrease in income is associated with an increase in the substitution parameter. However, once again, the coefficient is statistically insignificant. At the same time, the interaction term with the urban dummy is positive (0.133) and significant at the 10% level. The positive coefficient implies that parents in urban areas are more likely to exhibit efficiency motives in investment, as expected. This result may be due to different preferences in urban areas or differences in infrastructure, schooling opportunities and labor market returns. For example, parents in urban areas may have more choices for the type of school their child attends and the types of extracurricular activities for the child, and thus may have more opportunities to discriminate between children.

In columns (2) and (3) I examine the role of child gender and age in parental investment decisions. Unlike many Asian countries, Indonesia shows no male gender bias in parental preferences in birth outcomes or nutrition, and the gender gap in educational attainment has been declining (Kevane and Levine 2000). Behrman and Deolalikar (1995) show that while wage rates for females are lower than for males, there is no evidence that females face lower rates of return to education. In addition, both females and males are expected to provide old-age transfers to parents and thus parental private expected benefits from investment in one child or another should not vary (Park 2003). A potential implication of these findings is that there should be no differences in education spending by gender in households where all children attend school. Despite equal returns, however, parents may be more responsive to the level of endowments of one child than another. Further, gender differences may exist in the opportunity cost of time. Pitt and Rosenzweig (1990) show that, at least in 1980, older sisters were more likely to stay home from school and care for sick siblings compared to their teenage brothers.

The results in column (2) show that the gender of the young child, but not the older child, is a significant factor in how parents choose to allocate education resources ($\rho = 0.211$, significant at the 5% level). Households where the younger child is a female have significantly higher elasticity of substitution between the two children compared to households where the younger child is a male. In this case, a 10% difference in the cognitive stocks of the older versus the younger child is associated with a 2.11% higher investment in the older child. Interestingly, heterogeneity is not indicated in the substitution parameter by age of either the older or the younger child (column 3). This suggests that parents reinforce initial differences between children only in the case when the younger child is a female. Assuming the older child has accumulated higher cognitive stocks, the implication of this finding is that, during an economic shock, young female children are more likely to see a reduction in education investments than their older siblings of either gender. If early investments are more productive than later investments, as suggested by the production function estimates, the long-term effect of the crisis on these girls will be large as they may not be able to make up for the lower investments in their early childhood.

5.1. Differences in the types of education investments

In order to better understand the source of the differences in investments, I decompose the investment variable into fees (comprised of monthly fees, registration fees, and exam fees) and other education expenses. In a sibling fixed-effects regression framework, I estimate a reduced-form version of the model for the investment problem only. I test whether the interaction between child gender and child order, as well as child gender, order and math scores is significant, as suggested by the structural model.[4] Table 3 presents the results of this analysis.

First, using total expenditures, I show that the results from this analysis are consistent with the previous findings. Being either a female or the younger child in the household is not a significant determinant of differences in investments (column 1). Younger children who are females, however, experience lower levels of total education investment once I allow for interaction between math scores and child order and gender. The coefficient on the interaction term between younger child and female gender in column (2) is -0.833, significant at the 5% level. This suggests that younger female children have 56% (= exp(-0.833) - 1) of a standard deviation lower education investment compared to their older sibling of either gender. The significance of the interaction term between child order, gender, and math scores in column (2) also suggests that when making investment decisions parents are most sensitive to the human capital of their young female children. While including an interaction term between gender and math scores in column (3) reduces the significance of these coefficients, their magnitude remains similar.

Next, I analyze differences in investment between siblings by type of investment. There are no significant differences in expenses for school supplies, transportation and pocket money, and special courses (grouped under the heading “other”). The main source for the differences in education spending between siblings appears to be monthly fees (columns (5) and (6)). This suggests that young female children are likely to attend schools with lower fees. If higher fees are an indication of better school inputs and are associated with better school performance (as suggested by Suryadarma et al. (2006)), this may imply that parents enroll young female children in worse schools.[5]

In order to test whether school choice was potentially affected by the crisis, I perform the same analysis using 1997 data on school spending and math scores. I find no significant differences in education spending in 1997 between siblings. This finding is consistent with parents being forced by the income shock to move some children (in particular, younger girls) to schools of lower quality. An alternative explanation may have to do with schools reducing their fees shortly after the crisis if lower-grade schools reduced fees more than upper-grade schools. While this is plausible, the finding that the gender of the younger child matters cannot be explained away by this alternative explanation.

5.2. JPS

An important consideration for the analysis of household behavior during the crisis is the government response to the crisis. While the government in Indonesia was not able to respond immediately to the rising education costs in the middle of the 1997/1998 academic calendar year, the government budget from July 1998 allocated scholarship money for the new 1998/1999 calendar year under the Indonesian Social Safety Net (JPS) program. The scholarship money was in the form of monthly cash transfers, conditional on school attendance. The goal of the program was to reach about 6% of primary school students, 17% of junior high school students, and 10% of senior high school students. Another goal of the program was to allocate at least half of the scholarships to girls. The scholarships were allocated in a decentralized manner. First, money was sent to the poorest districts. Then, committees were formed to select the poorest schools. Finally, school committees were formed to select the eligible students based on poverty and various socio-economic indicators (Sparrow 2007; Pritchett 2002).

If this government support alleviated some of the effects of the crisis, the results on the size of the difference in education spending between siblings may be underestimated. In my sample of 499 households, 43 households have one child who received JPS funds, and in 6 households both children received the JPS funding. To test if the government subsidy affected parental allocation of resources between siblings, I include an indicator for a child receiving JPS funds in the fixed-effects regressions discussed above. The results remain unchanged. This finding may be due to the small proportion of households with a JPS child. It would also be consistent with the case when parental and government inputs are substitutes (which would not cause a difference in education spending between JPS and non-JPS children). A model with interactions between JPS funding and child order and gender also yields no significant results, suggesting that government support did not necessarily alleviate the problem of the differential parental investment for younger female children.

5.3. Effects of the crisis?

One of the limitations of this analysis is that parental behavior during the crisis is not observed and complete data to estimate the structural model before the crisis is not available. The results on parental elasticity of substitution may therefore be explained by three different scenarios. One possibility is that preferences were different before the crisis, but changed as a result of the crisis and remained so shortly after, in 2000, when observed in this dataset. Second, preferences could have been different before the crisis, changed during the crisis, and then changed again after the crisis as a response to any behavior during the crisis. Third, parental preferences for inequality could have been unaffected by the crisis.

In order to test whether there is any evidence for the first two possibilities, I re-estimate the structural model, interacting child cognitive stocks with a variable describing the shock in real per capita expenditure that the household experienced between 1997 and 2000. Column 4 of Table 2 shows the results for a binary variable indicating a loss in per capita expenditure of more than 20% (defined for about 20% of households). The coefficient on the interaction between differences in math scores and the "shocked" dummy is positive (0.165) and significant at the 10% level.[6] This suggests important differences in the preference parameters between households who experienced a higher income shock and those who did not. Parents who suffered a greater decrease in real per capita expenditure were more likely to have efficiency investment motives and allocate resources to the smarter child, i.e., the child with higher expected returns.

The results are consistent with the analysis by type of investment in Table 3 that show differences in resource allocation patterns between 1997 and 2000. The overall message on the interaction between preferences and income constraints is similar to what Behrman (1988) found for allocation of nutrients in rural India. He showed that parents favored the child with lower health outcomes in surplus seasons. When food was scarce, however, parents favored the male child irrespective of initial health outcomes. In Indonesia, households who were not hit as hard by the crisis would tend not to reinforce initial ability differences. Households who experienced large income shocks, however, would be more sensitive to child ability and invest in the child expected to have higher marginal returns to investment.

These findings may seem to suggest that the third possibility (that parental preferences were unaffected by the crisis) cannot explain the results so that either the first or the second possibility provides a more accurate description of reality. However, the results do not necessarily contradict the third possibility. Parents may always prefer to allocate resources in an efficient manner but this may only matter when they are resource-constrained (i.e., experience an income shock). If parents have high resources before the crisis, they may be able to provide each child with the investment that maximizes their human capital without sacrificing. Therefore, the third possibility cannot be ruled out. Thus, the results cannot clearly identify the reason for the observed patterns in preferences. Nevertheless, regardless of whether the crisis changed preferences, or existing preferences became more important under limited resources, this study shows that not all children were equally well insured from the crisis. In particular, the income shock had a higher negative impact on younger girls than on any other demographic group.

6. Conclusion

The Asian Financial Crisis of late 1990s had a major impact on many aspects of Indonesian life. It interrupted and reversed the progress Indonesia had made over previous decades in economic and social development. One of the potentially long-lasting impacts of the crisis was the shock to children's human capital accumulation, as parents and the government failed to fully insure children against the effects of shocks to household income. Previous studies have documented the effect of the crisis on enrollment rates and years of schooling. This study adds fundamentally to the literature by determining whether some children are potentially better insured than their siblings from income shocks. To do so, I determine whether parents allocate education resources within the household based on efficiency or equity motives. I estimate a structural model which describes the relationship between human capital production and investment allocation decisions implied by a utility-maximization problem for households with two children. The main finding of this analysis is that parental investment in children is not governed by any differences in the human capital already accumulated by children. The results suggest, however, that parents may be more sensitive to the stocks of young female children. A 10% increase in the cognitive stocks of the older child is associated with a 2% higher investment in the older child only when the younger child is a female. The implication of this finding is that young female children are potentially less likely to be fully insured from the negative effects of an income shock compared to their older siblings of either gender.

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[1] School attendance in Indonesia usually requires an annual registration fee, as well as monthly fees. Even in public schools, where annual fees have been abolished, parents pay monthly fees. In public primary schools, Suryadarma et al. (2006) find a positive relationship between fees and school performance, which they attribute to the use of the money for better school inputs. In addition to the household-level surveys, the IFLS data contains community surveys of different types of schools, where school officials are asked to provide information on average spending by students. In addition, school records of up to 25 students are selected and their exit exams scores for mathematics and Indonesian language are recorded. Using this information, I confirm at each level of schooling that higher fees are associated with better student performance.

[2] This relationship holds for any two children in a given household. For this analysis, however, the sample is restricted to households with only two children of school age who attend school in both 1997 and 2000.

[3] Because a significant proportion of households is engaged in agriculture or self-employment, labor income, when available, is measured with error. That is why, instead of income, I control for real per capita expenditure (PCE) as a measure of household welfare. Frankenberg, Smith, and Thomas (2003) show in the Indonesian case that changes in real PCE are a good proxy for changes in the real resources available to households.

[4] The estimation of the structural model suggests little simultaneity between cognitive stocks and investments. Therefore, any bias resulting from potential reverse causality in the estimation problem should not be large. In addition, the sibling fixed-effects procedure accounts for any household-level unobservables in the investment error terms (e.g., the shadow price of income and the household utility levels, which appear in the first-order conditions derived above). The coefficients may still be biased if there is any individual-level heterogeneity in the error term. However, while the empirical approximation of the first-order conditions contains an approximation error term, this term is unlikely to be correlated with child cognitive stocks.

[5] The data does not allow testing this directly as I cannot identify the specific school attended by the child.

[6] Using a continuous variable instead for the size of the shock yields no significance.

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Table 1: Resource allocation between children - Base case analysis

	Estimated Model				
	(1)	(2)	(3)	(4)	(5)
Older child math scores in 2000, $Math_{1,2000}$					
$Math_{1,1997}$	0.3075**	0.3075**	0.3464**	0.2461**	1.0463**
	(0.0455)	(0.0455)	(0.0576)	(0.0917)	(0.2255)
$Expenses_{1,2000}$	0.0618	0.0618	0.0786	-0.059	-0.0056
	(0.0515)	(0.0515)	(0.0608)	(0.1138)	(0.0662)
$Expenses_{1,1997}$	0.0919*	0.0919*	0.066	-0.0045	-0.051
	(0.0503)	(0.0503)	(0.0597)	(0.1040)	(0.0745)
Younger child math scores in 2000, $Math_{2,2000}$					
$Math_{2,1997}$	0.2097**	0.2097**	0.1542**	0.1571*	0.5457**
	(0.0461)	(0.0461)	(0.0584)	(0.0822)	(0.1568)
$Expenses_{2,2000}$	0.0562	0.0562	0.0841	-0.1497*	-0.0174
	(0.0495)	(0.0495)	(0.0631)	(0.0882)	(0.0604)
$Expenses_{2,1997}$	0.0847	0.0847	0.1462**	0.2575**	0.0913*
	(0.0535)	(0.0535)	(0.0554)	(0.0767)	(0.0554)
($Expenses_{1,2000}$-$Expenses_{2,2000}$)					
$Math_{1,2000}$ -$Math_{2,2000}$		0.0372	0.035	-0.0136	0.0412
		(0.0348)	(0.0435)	(0.0558)	(0.0349)
Urban area of residence		-0.0014*	-0.0012	-0.0001	-0.0014
		(0.0009)	(0.0011)	(0.0016)	(0.0009)
Log Pce in 2000		-0.0007	-0.0002	0.0004	-0.0007
		(0.0008)	(0.0009)	(0.0013)	(0.0008)
Households	494	494	304	146	484

Notes:

[1] Model (1) solves simultaneously the production functions of the two children in the sample of households with two children attending school in both 1997 and 2000. Model (2) adds the first-order condition for optimal investment ratios to the system of equations. Model (3) restricts the sample to families with only two children. Model (4) restricts the sample to families where both children are in the same schooling level (primary or junior high or senior high). Model (5) uses the base case sample and controls for potential endogeneity of past math scores.
[2] The production functions also control for age and gender. The equation approximating the first-order condition controls for the age and gender of both children. All regressions include a constant term.

[3] All variables are standardized around mean of 100 with a standard deviation of 1, and then logged. Math scores are standardized by age, investment is standardized by school level (primary, junior high, senior high).

[4] Standard errors in parentheses.
[5] * significant at the 10% level, ** significant at the 5% level

Table 2: Resource allocation between children - Interactions analysis

	Estimated Model			
	(1)	(2)	(3)	(4)
Older child math scores in 2000, $Math_{1,2000}$				
$Math_{1,1997}$	0.3075**	0.3075**	0.3075**	0.3075**
	(0.0455)	(0.0455)	(0.0455)	(0.0455)
$Expenses_{1,2000}$	0.0618	0.0618	0.0618	0.0618
	(0.0515)	(0.0515)	(0.0515)	(0.0515)
$Expenses_{1,1997}$	0.0919*	0.0919*	0.0919*	0.0919*
	(0.0503)	(0.0503)	(0.0503)	(0.0503)
Younger child math scores in 2000, $Math_{2,2000}$				
$Math_{2,1997}$	0.2097**	0.2097**	0.2097**	0.2097**
	(0.0461)	(0.0461)	(0.0461)	(0.0461)
$Expenses_{2,2000}$	0.0562	0.0562	0.0562	0.0562
	(0.0495)	(0.0495)	(0.0495)	(0.0495)
$Expenses_{2,1997}$	0.0847	0.0847	0.0847	0.0847
	(0.0535)	(0.0535)	(0.0535)	(0.0535)
($Expenses_{1,2000}$-$Expenses_{2,2000}$)				
$Math_{1,2000}$ -$Math_{2,2000}$	1.2313	-0.0747	-0.3754	-0.0117
	(0.8274)	(0.0666)	(0.3190)	(0.0366)
Urban area of residence	-0.0015*	-0.0013	-0.0015*	-0.0013
	(0.0009)	(0.0008)	(0.0009)	(0.0008)
Log Pce in 2000	-0.0006	-0.0008	-0.0007	-0.0006
	(0.0008)	(0.0008)	(0.0008)	(0.0009)
Log Pce 2000*($Math_{1,2000}$ -$Math_{2,2000}$)	-0.1032			
	(0.0692)			
Urban*($Math_{1,2000}$ -$Math_{2,2000}$)	0.1326*			
	(0.0750)			
Female 1*($Math_{1,2000}$ -$Math_{2,2000}$)		0.034		
		(0.0690)		
Female 2*($Math_{1,2000}$ -$Math_{2,2000}$)		0.2105**		
		(0.0687)		
Age 1*($Math_{1,2000}$-$Math_{2,2000}$)			0.0365	
			(0.0229)	
Age 2*($Math_{1,2000}$ -$Math_{2,2000}$)			-0.0125	
			(0.0238)	
Shocked*($Math_{1,2000}$ -$Math_{2,2000}$)				0.1651*
				(0.0852)
Shocked				0.0004
				(0.0011)
Households	494	494	494	494

Notes:
[1] The production functions also control for age and gender. The equation approximating the first-order condition controls for the age and gender of both children. All regressions include a constant term.
[2] All variables are standardized around mean of 100 with a standard deviation of 1, and then logged. Math scores are standardized by age, investment is standardized by school level (primary, junior high, senior high).

[3] Standard errors in parentheses.
[4] * significant at the 10% level, ** significant at the 5% level

Table 3: Resource allocation between children in 2000 - by type of investment

	Estimated Model					
	total educational expenses 2000			monthly fees 2000		
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.00016	-0.00019	-0.00019	-0.00038	-0.0004	-0.00039
	(0.00026)	(0.00026)	(0.00026)	(0.00030)	(0.00030)	(0.00030)
Female	0.00041	0.00006	-0.02556	0.00046	-0.00014	0.22913
	(0.00058)	(0.00083)	(0.39029)	(0.00066)	(0.00093)	(0.44171)
Math score in 2000	0.00729	-0.02079	-0.02354	0.00482	-0.00736	0.01741
	(0.04121)	(0.04719)	(0.06319)	(0.04699)	(0.05369)	(0.07186)
Younger child	-0.00005	0.07907	0.06574	-0.00045	0.27169	0.39058
	(0.00091)	(0.31544)	(0.37545)	(0.00103)	(0.35621)	(0.42373)
Younger child* Female		-0.83301**	-0.8074		-0.90098*	-1.12902*
		(0.41145)	(0.56737)		(0.46494)	(0.63995)
Younger child*Math score in 2000		-0.01729	-0.01439		-0.05923	-0.08503
		(0.06847)	(0.08149)		(0.07732)	(0.09197)
Younger child* Female*Math score in 2000		0.18101**	0.17545		0.19587*	0.24536*
		(0.08931)	(0.12314)		(0.10092)	(0.13890)
Female*Math score in 2000			0.00556			-0.04975
			(0.08470)			(0.09586)
N of children	998	998	998	993	993	993
N of households	499	499	499	499	499	499

Notes:
[1] All variables are standardized around mean of 100 with a standard deviation of 1, and then logged. Math scores are standardized by age, investment is standardized by school level (primary, junior high,
[2] Standard errors in parentheses.
[3] * significant at the 10% level, ** significant at the 5% level