Complementarities and Intergenerational Educational Mobility: Theory and Evidence from Indonesia

Ahsan, Nazmul and Emran, M. Shahe and Shilpi, Forhad

16 December 2021

Complementarities and Intergenerational Educational Mobility: Theory and Evidence from Indonesia

Md Nazmul Ahsan[1]
Saint Louis University

M. Shahe Emran
IPD, Columbia University

Forhad Shilpi
World Bank

First Draft: August 3, 2020
This Version: December 16, 2021

ABSTRACT

We provide a theory based empirical analysis of the role of two types of complementarities in intergenerational educational mobility. We develop a model where parental financial investment in children's schooling can be complementary to or a substitute of school quality and parent's education level. Such complementarities can make the mobility equation convex with starkly different mobility patterns compared to the workhorse linear model. Mobility and investment equations derived from the model are estimated for Indonesia, using exceptional data that allow us to tackle two major sources of bias: coresidency and cognitive ability heterogeneity. We find that the mobility equation is convex in rural but linear in urban areas. The children of low educated fathers enjoy higher relative mobility in rural areas, while the urban children fare better in highly educated households. The standard linear model in rural areas incorrectly suggests no rural-urban gap in relative mobility. Theoretical insights help interpret the evidence, suggesting complementarity between financial investment and parental education in both rural and urban areas even though the mobility curve is linear in urban areas. We develop an approach to recover the parameters determining the interaction between school quality and parental investment. School quality is complementary to financial investment in rural areas, with stronger effect in more educated households. In urban areas, school quality is a substitute in low educated households, but complementary in the highly educated households. These results imply that public investment in school quality would lower relative mobility in Indonesia.

Keywords: Intergenerational Educational Mobility, Complementarity, Convex Mobility Curve, School Quality, Rural-Urban Divide, Returns to Education, Coresidency, Sample Truncation, Ability Heterogeneity, Developing Countries, Indonesia

JEL Codes: J62, O12, I 24

[1]We are grateful to Hanchen Jiang for extensive and insightful comments on an earlier draft. We would like to thank Halsey Rogers, Deon Filmer, Arya Gaduh, Margaret Triyana and participants at a seminar at the World Bank for helpful discussions and/or comments. Our sincere thanks to Sailesh Tiwari and Imam Setiawan for help with data. An earlier substantially different version of the paper was circulated under the title "The Rural-Urban Divide and Intergenerational Educational Mobility in a Developing Country : Theory and Evidence from Indonesia". This version supersedes the earlier version. Emails for correspondence: ahsanm@slu.edu, shahe.emran.econ@gmail.com, fshilpi@worldbank.org. Standard disclaimers apply.

(1) Introduction

We study intergenerational educational mobility in a developing country with a focus on two types of complementarities in education production function, and taking into consideration the rural-urban differences in school quality and returns to education.[1] In an influential contribution, Becker et al. (2015, 2018) present a model of intergenerational mobility where a parent's education is complementary to financial investment in children's schooling because higher educated parents are more efficient in their investment choices.[2] Such complementarity, when strong enough, can make the intergenerational mobility equation convex. Compared to the workhorse linear model, a convex mobility equation implies starkly different mobility patterns because intergenerational persistence is the strongest at the top of the distribution and "successive generations of the same family may cease to regress toward the population mean" (Becker et al. (2015)).[3] The second type of complementarity we analyze refers to the effects of school quality on the marginal returns to parental financial investment in children's education. While public investment in education is widely seen as a key policy lever to address inequality and immobility, the equity and efficiency implications depend critically on the nature of the interactions (complementarity vs. substitutability) between public investment and parental investments (Becker (1991), Becker et al. (2018), Solon (1999)). Public investment in school quality may in fact lower relative mobility and increase educational inequality by strengthening the advantages of the children born to highly educated parents if private investments are complementary to school quality. The extant empirical literature on intergenerational educational mobility in developing countries, however, relies on a linear model, and ignores the existence and implications of such complementarities/substitutabilities for

[1]The focus on education is motivated primarily by the role played by skill premium in rising inequality, and an emphasis on educational mobility as the key to tackling economic inequality (Goldin and Katz (2008), Stiglitz (2012), Autor (2014)).

[2]Although they emphasize the efficiency of investment choices in a complex education market such as college decisions in USA, Becker et al. (2015, 2018) note that such complementarity can also arise from other sources such as peer and role model effects. In the context of underdeveloped education market in a developing country, education investment decisions are unlikely to be complex, and the other factors may be more important.

[3]A convex mobility curve thus implies strong cumulative advantages at the top, providing part of the explanation for the recent evidence on widening top income inequality in many countries (Atkinson et al. (2011)). The mobility equation can be concave when diminishing returns dominate the complementarity, implying lower persistence at the top of the distribution. However, a concave mobility curve also implies that persistence is the strongest at the lower end of the distribution.

understanding intergenerational educational mobility.[4] To the best of our knowledge, this is the first paper to provide a theoretically grounded empirical analysis of the role of these two types of complementarities in intergenerational educational mobility in a developing country.

We develop an extension of Becker et al. (2015) model to incorporate self-finance constraint on parental investment in children's schooling because of an underdeveloped credit market, and the differences in school quality and returns to education across rural and urban areas.[5] The model allows for complementarity/substitutability between school quality and parental investment in the education production function, in addition to the complementarity between parent's education and financial investments emphasized by Becker et al. (2015, 2018). We derive the estimating equations for intergenerational educational mobility and parental financial investments from the theoretical model. The close link between the theory and estimating equations enables us to explore the economic mechanisms and sets apart this paper from the existing literature on intergenerational educational mobility.[6]

We estimate the mobility and investment equations from the model using household panel data from the Indonesia Family Life Survey (IFLS). The IFLS is exceptional among the existing household surveys as it allows us to tackle two major empirical issues highlighted in the literature: (i) truncation bias in a coresident sample, and (ii) omitted variables bias due to cognitive ability heterogeneity.[7] Recent evidence suggests that the estimates of intergenerational mobility suffer severe downward bias from sample truncation caused by coresidency, and, more importantly, inter group ranking of mobility can be reversed in a coresident sample compared to the correct ranking in the full sample (see Emran et al. (2018)). The IFLS

[4]There is a large and growing literature on dynamic complementarities in investments in human capital at various ages of a child, following the work of Heckman. Most of this literature is devoted to developed countries and emphasizes the importance of early life investments. For recent surveys, please see Heckman and Mosso (2014) and Heckman and Corbin (2016).

[5]Our model is different from that of Becker et al. (2015) in terms of the nature of the credit market imperfections. Please see section 3 below for details.

[6]None of the published studies on intergenerational educational mobility in developing countries we are aware of derive the estimating equations from theory. We are aware of only two unpublished working papers that derive the intergenerational educational mobility equation from theory: Card et al. (2018) on USA and Emran et al. (2021) on India. As emphasized recently by Mogstad (2017), the absence of a theoretical foundation makes it difficult to interpret the estimates.

[7]Such panel data remain rare in developing countries. The only other comparable data set we know of is MxFLS which is a companion survey of IFLS. There are some surveys that can deal reasonably well with the coresidency issue such as IHDS in India and CFPS in China, but they do not have reliable data on children's cognitive ability. Some data sets have good information on cognitive ability of children of specific age groups, see, for example, The Young Lives Surveys, but they often focus on the coresident samples.

data do not suffer from any significant truncation as the survey collected information on non-resident parents of any household member older than 15 using multiple modules.[8] A second advantage of the IFLS 2014 data, used in this paper, is the availability of multiple measures of cognitive ability of adult children in our sample.[9] This enables us to test whether the observed intergenerational educational persistence is primarily due to genetic correlations in cognitive ability across generations. Our analysis of intergenerational mobility is based on the 18-40 years old children in the 2014 wave of IFLS who went to school in the 1990s and 2000s.[10]

The main conclusions from the empirical analysis are as follows. First, the mobility conditional expectation function (henceforth CEF) is convex in rural Indonesia, but linear in urban Indonesia.[11] The combination of a convex and a linear CEFs gives rise to interesting rural-urban differences in relative and absolute mobility. If we follow the existing literature and rely on a linear model in both rural and urban areas, the evidence leads to incorrect conclusions, suggesting no significant rural-urban gap in relative mobility. In contrast, the estimates from the correct convex-linear combination of CEFs show a complex pattern with substantial rural-urban differences. While the children from low educated households (less than primary educated fathers) enjoy higher relative mobility in the rural areas, the advantage flips in favor of the urban children when the father has more than primary schooling. The evidence also suggests that rural children face lower absolute mobility for most of the distribution; they catch up with the urban children only when the father has college or more education. Again, the standard linear model leads us astray, implying that rural children face lower absolute mobility even when fathers have college or more education. It is important to appreciate that these conclusions are unlikely to be driven by ability bias, as we control for nonlinear effects of children's cognitive ability heterogeneity. That the observed intergenerational persistence in economic outcomes might be driven primarily by genetic inheritance of ability is a central empirical challenge in this literature. Please see the discussion by Black and Devereux (2011) and Solon (1999).

[8]We use household roster, nonresident parents module, and mother's marriage module. For an excellent discussion on the advantages of the IFLS data for studying intergenerational mobility in Indonesia, see Mazumder et al. (2019). For a detailed discussion, please see the online appendix.

[9]The measures include Raven test scores and two memory tests.

[10]According to the estimates of Friedman (2005), inequality in Indonesia increased dramatically over this period: the consumption Gini rose from 29.2 in the 1990s to 38.9 in the 2000s.

[11]For the mobility estimation, we consider urban if the individual was born in a big city or town and rural if the individual was born in a village.

Theoretical insights help uncover the economic mechanisms. Complementarity between parental education and financial investment is important not only in the rural areas where mobility CEF is convex, but also in the urban areas even though the mobility CEF is linear. We develop a test of the null hypothesis that a linear mobility CEF in fact reflects no complementarity between a parent's education and financial investments.[12] We report suggestive evidence that the complementarity between parental education and financial investment cannot be accounted for by assortative marriage matching (as captured by mother's education) or neighborhood role model and peer effects, and this holds in both rural and urban areas.[13] The evidence is consistent with an important role for the nonfinancial direct impacts of a more educated father such as own role model effect and home tutoring in an environment of poor school quality.

We develop an approach to understand the nature of interaction (substitutability vs. complementarity) between school quality and parental financial investment. To uncover the parameters of this interaction, we need estimates of school quality in rural vs. urban areas along with estimates of two parameters of the education production function that determine the effects of parent's financial investment on children's schooling. Our approach to recovering the two production parameters is simple and exploits the observation that the most educated (and thus high income) households have better access to the credit market, and, for them, an appropriate market interest rate can be used as a reliable measure of the shadow price of credit.[14] We construct an index of school quality based on pupil/teacher ratio adjusted for teacher qualifications and teacher absenteeism rates in rural vs. urban schools.[15] The estimate of the rural-urban gap in school quality when combined with the estimates of the two parameters of production function help us determine whether school quality is complementary to or substitutes of parental investments. In rural areas, we find complementarity across the distri-

[12]The test exploits a sharp theoretical restriction implied by the constant returns education production function. Please see section 6 below.

[13]We do not use mother's education for our main analysis because a substantial proportion of children is missing information on mother's education in the data set.

[14]This helps us to solve for the parameters of consumption sub utility function. We get an estimate of parental altruism from the literature. With estimates of the 3 preference parameters, we have 5 reduced form parameters from the investment and mobility equations exactly identifying the parameters of the production function.

[15]It is widely appreciated that school quality is a multidimensional concept and not easy to measure (see the discussion by Rouse (2005)). Our measure should be viewed as an imperfect proxy. We check the sensitivity of our main conclusions with regards to the estimated rural-urban gap in school quality. The details are available from the authors.

bution, and the strength of complementarity increases with a father's education. This implies that public investment in school quality would crowd in parental investment irrespective of a child's family background in rural areas, but the children born to educated fathers will reap much higher benefits. In urban areas, there is substitutability in the households with low educated fathers, but complementarity in the highly educated households. This implies that public investment in school quality crowds out parental investment in disadvantaged urban households, and crowds in parental investment in a highly educated household. This pattern of crowding in and crowding out effects is expected to lower relative mobility and increase educational inequality as a result of public investment in school quality, both in urban and rural areas.

The rest of the paper is organized as follows. Section (2) provides a brief discussion on the country background and related literature with a focus on work on developing countries, and on Indonesia in particular. Section (3) develops the extension of the Becker et al. (2015) model incorporating self-finance constraint on financing children's education and derives the estimating equations for intergenerational persistence and optimal parental investment. Section (4) defines the measures of relative and absolute mobility in a quadratic model, and discusses the data and empirical issues. The next section presents the estimates for the mobility and investment equations. Section (6) is devoted to understanding the economic forces at work behind the observed pattern of educational mobility. The paper concludes with a summary of the results and highlights the portability of the model and methods developed here to understand intergenerational educational mobility in other developing country.

(2) Country Background and Related Literature

(2.1) Country Background: Inequality and Education in Indonesia

Inequality in Indonesia

After relative stability during the Suharto era, inequality in Indonesia began to rise in the late 1980s to the early 1990s. The Asian financial crisis arrested this increasing trend temporarily, but inequality increased dramatically after 2000. According to the estimates reported by the World Bank (2016), consumption Gini rose from 30 in 2000 to 37 in 2008/2009, and to 41 in 2014 (based on BPS and Susenas data). The rise in inequality from the 1990s to 2000s has been more pronounced in urban areas, and the level of inequality was also higher in urban areas in the 1990s compared to the rural areas (Kanbur and Jhuang (2014)).[16] The rural-urban gap in living standards has been widening over time: per capita consumption in urban areas was 37 percent higher in 1964/65, which grew to 79 percent in 1981, and to 92 percent in 1993 (Booth (1998)).

An important feature of the rising inequality in Indonesia is that skill-based wage inequality has played an increasingly prominent role (World Bank (2016)). Returns to education and skill at the right tail have increased substantially in the recent decades, leaving a large majority of unskilled people trapped in low-wage jobs and low return informal self-employment. This skill-based dualism in the labor market underscores the importance of understanding the educational opportunities of the children across different family backgrounds.

Education in Indonesia

The school enrollment rates in Indonesia were very low prior to its independence in 1945 (Frankema, 2017). Under the Dutch colonial rule, the Indonesian educational sector received a meager amount of funding. Consequently, most of the population had little or no education. According to the estimates of Furnivall (1943), only 4% of the population were enrolled in schools in the 1930s.[17] However, after Indonesia gained independence, enrollment rates in primary levels started to rise (Frankema, 2017). A big push in primary enrollment came when government constructed nearly 61,000 primary schools during 1973 to 1978 in an effort to provide access to primary school in every village (Duflo, 2001). Subsequently, the Indonesian government made primary education, six years of schooling, compulsory in 1984 (Suryadarma and Jones, 2013). The compulsory education was then raised to 9 years in 1994 (Suryadarma and Jones, 2013). In 2013, the compulsory education has been raised to 12 years (Setiyono, 2019).

According to the compulsory schooling law in Indonesia, schooling must be provided by government free of costs to every citizen. However, the compulsory education law allowed "voluntary contributions" by the parents which, in practice, resulted in public schools ef-

[16]A link between higher inequality and lower intergenerational mobility has been the focus of a growing literature on the Great Gatsby Curve (Corak (2013), Fan et al. (2020), Neidhofer et al. (2018)). Does the *higher* level of inequality in the urban areas imply that there is a "rural bias" where urban children face *lower* educational (and economic) mobility compared to the rural children, as the logic of the Great Gatsby Curve seems to suggest?

[17]The school enrollment rate in Philippines was almost 3 times higher at 11.5% in the 1930s.

fectively charging some fees.[18] Even with such fees, the costs in public schools are much less compared to the private schools. Since the villages are usually served by public schools, with the high cost private schools concentrated in the urban areas, we would expect parental financial investment to play a larger role in the urban areas.

Recent evidence on Indonesia shows that the rural schools remain at a substantial disadvantage in terms of teacher quality, teacher absenteeism, and school infrastructure during our study period (see World Bank (2016), Echazarra and Readinger (2019)). According to the estimates reported by Chaudhury et al. (2006), teacher absentteism rate in urban Indonesia was 13 percent in urban schools, while it was almost twice as high in rural schools at 25 percent. In Indonesia, the roots of urban bias in school quality go back to the Dutch colonial policies that allocated most of the educational budget to a few selected urban schools catering to the children of elite Dutch and Chinese households, and the rural schools (desa schools) were neglected (Frankema (2014)).

(2.2) Related Literature

The literature on intergenerational economic mobility in developed countries is vast, with many fundamental theoretical and empirical contributions: Becker-Tomes (1979, 1986), Solon (1992), and Chetty et al. (2014) are some of the seminal studies. Most of the studies focus on intergenerational persistence in permanent income between father and son. An important finding from this literature is that rich panel data on income for many years from appropriate phases of the life-cycle are required to get credible estimates of intergenerational persistence in permanent income (Solon (1992), Mazumder (2005)). For excellent surveys of this literature, see Solon (1999) and Black and Devereux (2011).

The literature on developing countries is limited, with an increasing interest in the last few years (see Iversen et al. (2019) and Emran and Shilpi (2019) for recent surveys). The required panel data on income are not available in most of the developing countries, and as a result, the focus of the literature has been on educational linkages across generations (see, among others, Neidhofer et al. (2018), Azam and Bhatt (2015), Emran and Shilpi (2015), Hertz et al. (2008), Thomas (1996)). Among the few contributions on income mobility, see Fan et al. (2020) on China. The recent analysis of intergenerational occupational linkages in developing countries

[18] The observation that "free schooling" may not be really free is of wider relevance in developing countries. Emran et al. (2020a) show that, in Bangladesh, the poor parents end up paying bribes for admission into "free" public schools while the rich do not pay because of their higher bargaining power.

includes Bossuroy and Cogneau (2013), Emran and Sun (2015) and Emran and Shilpi (2011).

The literature on intergenerational mobility in Indonesia is small, with only a handful of studies available. We are aware of three studies on Indonesia that can be broadly classified as dealing with intergenerational issues in education, and all of them study the effects of the same policy experiment: a large scale school construction program in the 1970s, originally studied by Duflo (2001).[19] Hertz and Jayasundera (2007) analyze the effects on IGRC in schooling for the children, and find that the exposure to new schools weakened the intergenerational persistence for men, but not for women. In a recent paper, Mazumder et al. (2019) focus on the long-term effects of the program on the second generation children, i.e., children of those who benefited from the school construction when they were children themselves. Since most of these second generation children have not completed their schooling, it is difficult to estimate Intergenerational Regression Coefficient (henceforth IGRC) in schooling attainment. They focus on the academic performance of the children which would be correlated with the final educational attainment of a child. They show that the children of the mothers exposed to the large scale school construction in the 1970s had significant gains in school examination scores. But they do not find any effects of the fathers. In a related paper, Akresh et al. (2018) study the effects of school construction on the socioeconomic well-being of the first generation directly exposed to the program and the intergenerational effects on school attainment using the SUSENAS 2016 cross section data.

We contribute to the literature in two ways: (i) ours is the first study to provide a theoretically grounded empirical analysis of intergenerational educational mobility in Indonesia. Our analysis highlights the pitfalls in relying on the linear mobility model currently standard in the literature; (ii) unlike many existing studies, the theoretical foundation enables us to identify the economic mechanisms, and provide credible evidence on the role of complementarity/substitutability between financial investment in children's schooling and school quality and parental education.

(3) Rural vs. Urban: A Model of Intergenerational Educational Mobility

We consider an economy consisting of two-person households with the parent and a child. The parent of child i has education level E_i^p (years of schooling). Following Solon (2004) and

[19] The main impact of the program was on the cohorts who went to school in the early 1970s.

Becker et al. (2015, 2018), parent's income is determined as follows:

$$Y_i^p = Y_0^{pj} + R^{pj} E_i^p + \upsilon_i \tag{1}$$

where υ_i captures idiosyncratic income shocks unrelated to education with $E(\upsilon_i) = 0$. Returns to education are R^{pj} in the parental generation in location $j = r, u$, with r for rural and u for urban. We assume that the parents with no schooling earns $Y_0^{pj} > 0$. The focus here is on how a household's permanent income changes with the education of the parent E_i^p. The "returns to education" thus refer to a household's permanent income, not an individual's labor market income in the survey year which has been the focus in an extensive Mincerian literature on returns to education.

The parent allocates income Y_i^p between own consumption C_i^p and investment in the child's education I_i. The budget constraint is:

$$Y_i^p \geqq C_i^p + I_i \tag{2}$$

This specification of the budget constraint assumes that there is no credit market where the parent can borrow to finance children's education.[20] While the assumption of no credit market seems appropriate for most of the households, the highly educated households are likely to have better access to credit markets. One way to think about such highly educated households in our model is that the shadow price of credit equals the relevant market interest rate, and they are indifferent between using own funds and loans from the banks (urban areas) or moneylenders (rural areas) when choosing the investment in children's education. As we will see in section (6.2), this interpretation is valuable in solving for the preference parameters of the consumption sub utility, which in turn allows us to recover the structural parameters of education production function from the reduced form estimates of the investment and mobility equations.[21]

Following Becker et al. (2015), we assume that the education production function ex-

[20]This is a plausible assumption in the context of developing countries where the student loan market (public or private) is underdeveloped or nonexistent (see Chapman and Suryadarma (2013) in the context of Indonesia).

[21]It is possible to allow the highest educated households to lend/borrow at the relevant market interest rate. This extension, however, does not change any of the major conclusions of our analysis. Details are available from the authors upon request.

hibits the following features: (i) diminishing returns to financial investment, (ii) potential complementarity between the financial investment and parental education, (iii) direct effect of parent's education capturing the non-financial aspects such as role model effects and home tutoring, and (iv) higher ability of a child is complementary to financial investment in addition to an additively separable impact on children's education. We augment the specification to allow for possible effects of a child's ability on the curvature of the production function with respect to the financial investment.

$$E_i^c = \delta_0^j + \alpha_1 \phi_i - \alpha_2 (\phi_i)^2 + (1 + \omega_1 \phi_i)\, \delta_1^j I_i - (1 - \omega_2 \phi_i)\, \delta_2^j I_i^2 + \delta_3^j I_i E_i^p + \delta_4^j E_i^p + \varsigma_i \tag{3}$$

where ϕ_i is the cognitive ability of the child, and ς_i is a mean zero term capturing the idiosyncratic shocks to educational attainment unrelated to parental education and financial investment by the parents. We assume that $\delta_0^j, \delta_1^j > 0$ and $\delta_2^j \geq 0$. The last inequality is weak to allow for the possibility that over the relevant range the education production function is approximately linear in financial investment. Note that we do not impose any a priori sign restrictions on δ_3^j. $\delta_3^j > 0$ implies complementarity (emphasized by Becker et al. (2015, 2018)), $\delta_3^j < 0$ implies substitutability, and $\delta_3^j = 0$ implies separability. Becker et al. (2015,2018) focus on more efficient educational investments by educated parents as the main source of such complementarity, but also suggest peer and role model effects as other possible sources. The quality of peer and role models depends on the geographic location choices. Spatial sorting based on education implies that educated parents locate in neighborhoods with better schools and highly educated population. The children of highly educated parents are thus likely to have better quality peers in schools and better adult role models in the neighborhood. Complementarity can also arise from "own role model effect" where the educated parents themselves are children's role models, and from home tutoring by educated parents. For example, when more educated parents can help the children to learn better from educational materials such as books financed by investment, home tutoring becomes complementary to financial investments.

Note that home tutoring, peers, and role model effects (own and neighborhood) can also have direct (nonfinancial) influences which are captured by the parameter δ_4^j. On a priori grounds, δ_4^j can be either positive or negative. For example, if a more educated parent provides effective homework help, then we expect $\delta_4^j > 0$. However, when more educated parents work outside the home and the shadow price of time becomes too high, a more educated parent may cut back on the time inputs to children's education such as home tutoring and spend money on private tutors, making $\delta_4^j < 0$. The specification in equation (3) allows for a flexible effect of a child's ability on the educational outcome; when $\omega_1, \omega_2 > 0$, we have complementarity, higher ability increasing the linear coefficient by a multiplier $(1 + \omega_1 \phi_i)$ and also lowering the quadratic coefficient by $(1 - \omega_2 \phi_i)$.[22] The specification of ability adopted by Becker et al. (2015) is nested in this formulation: they assume that $\alpha_2 = \omega_2 = 0$.

There are two major sources of differences between rural vs. urban areas. First, the returns to education (R^{pj} in equation (1) above) may be different because of differences in occupational and economic structure. The rural areas engage predominantly in agricultural activities, although the share of non-farm activities has increased substantially in many countries in the last few decades. The existing evidence suggests that returns to education in agriculture is low, especially beyond secondary schooling (Phillips (1994), Kurosaki and Khan (2006))).[23] While returns to education in nonfarm occupations in villages are usually higher than that in agriculture, they are likely to be lower than the returns to education in urban areas specializing in modern manufacturing and skill-intensive services activities.

Second, the quality of schooling is likely to be different across rural vs. urban locations. The rural areas are primarily served by government schools and (some) low-quality private schools (see Febriana et al. (2018) for a discussion on Indonesia). To capture these differences in the supply side of the education provision, we allow for the effects of financial investment to vary with the quality of schools, denoted as q, with a higher value implying a better quality. In particular we assume the following:

$$\delta_1^j = \pi_1 \left(q_j\right)^{\mu_1}; \quad \delta_2^j = \pi_2 \left(q_j\right)^{-\mu_2}.$$

It is important to note that no a priori restrictions are imposed on the signs of the parameters μ_1 and μ_2. Parental investment can be complementary to or substitute of school quality under a variety of combinations of the parameters μ_1 and μ_2. Complementarity (substitutability) implies that $\frac{\partial}{\partial q}(\frac{\partial E^c}{\partial I}) > 0 (< 0)$. It is easy to check that the sign of $\frac{\partial}{\partial q}(\frac{\partial E^c}{\partial I})$ is the same as the

[22] In this formulation, $\omega_1, \omega_2 < 0$ imply substitutability.

[23] Based on a meta analysis, Phillips (1994) reports a yearly rate of return of 1.60 percent. Kurosaki and Khan (2006) find that returns fall sharply after primary schooling in rural Pakistan.

sign of $\mu_1\delta_1 + 2I\mu_2\delta_2$. This implies that the nature of the interaction effect may be different at different levels of investment.

The income function for the children is:

$$Y_i^c = Y_0^{cj} + R^{cj}E_i^c + \vartheta_i \tag{4}$$

where ϑ_i captures the idiosyncratic shocks to children's income (for example, market luck a la Becker and Tomes (1979)) and $E(\vartheta_i) = 0$. Again, the returns to education are location specific; when returns to education are lower in rural areas, we have $R^{cr} < R^{cu}$.

Following Becker et al. (2015), the consumption sub-utility function of the parent is given by:[24]

$$U\left(C^p\right) = \beta_1 C^p - \beta_2\left(C^p\right)^2 \tag{5}$$

(3.1) Optimal Educational Investment

The parent's optimization problem is (denoting the Lagrange multiplier on the budget constraint by λ):

$$Max_{C_i^p, I_i} E(W^p = U\left(C_i^p\right) + \sigma E\left(Y_i^c\right) + \lambda\left[E\left(Y_i^p\right) - C_i^p - I_i\right] \tag{6}$$

where σ is the degree of parental altruism, and parents use production function (4) to estimate the expected income of children $E\left(Y_i^c\right)$.

The first order conditions are:

$$\begin{gathered} \beta_1 - 2\beta_2 C_i^p - \lambda = 0 \\ \sigma R^{cj}\left[\left(1+\omega_1\phi_i\right)\delta_1^j - 2\left(1-\omega_2\phi_i\right)\delta_2^j I_i + \delta_3^j E_i^p\right] - \lambda = 0 \end{gathered} \tag{7}$$

Using the first order conditions and equations (1) and (2) above, we solve for the optimal

[24]Models of intergenerational income mobility assume constant elasticity utility function to generate a log-linear equation for intergenerational income persistence, see for example, Becker et al. (2018), and Solon (2004). However, the estimating equation for educational mobility is linear in levels (years of schooling) because fathers of many children have zero schooling. A constant elasticity utility function is not appropriate for our analysis because it is difficult to generate an estimating equation in terms of years of schooling. As noted by Emran et al. (2021), a linear in levels intergenerational educational mobility equation can be derived in Solon (2004) model if one assumes that government investment in public education is zero. But, even in this case, it is not possible to allow for complementarity (or substitutability) between father's education and financial investment in children's schooling if the goal is to derive an estimating equation in years of schooling.

investment in a child's education as a function of parental education:

$$I_i^* = \theta_0^j + \theta_1^j E_i^P + \varepsilon_i \tag{8}$$

where

$$\theta_0^j = \frac{2\beta_2 Y_0^{pj} + (1 + \omega_1 \phi_i)\,\delta_1^j \sigma R^{cj} - \beta_1}{2\left\{\beta_2 + (1 - \omega_2 \phi_i)\,\delta_2^j \sigma R^{cj}\right\}} \tag{9}$$

$$\theta_1^j = \frac{2\beta_2 R^{pj} + \delta_3^j \sigma R^{cj}}{2\left\{\beta_2 + (1 - \omega_2 \phi_i)\,\delta_2^j \sigma R^{cj}\right\}} \tag{10}$$

$$\varepsilon_i = \frac{\beta_2}{\left\{\beta_2 + (1 - \omega_2 \phi_i)\,\delta_2^j \sigma R^{cj}\right\}} \upsilon_i$$

(3.2) Intergenerational Persistence in Education

The optimal education of a child can be written as follows:

$$E_i^{c*} = \delta_0^j + \alpha_1 \phi_i - \alpha_2 (\phi_i)^2 + (1 + \omega_1 \phi_i)\,\delta_1^j I_i^* - (1 - \omega_2 \phi_i)\,\delta_2^j (I_i^*)^2 + \delta_3^j I_i^* E_i^p + \delta_4^j E_i^p + \varsigma_i \tag{11}$$

where I_i^* is given by equation (8) above.

Since optimal investment I_i^* is a linear function of parental education E_i^p, E_i^{c*} is a quadratic function of parental education E_i^p even when $\delta_2^j = 0$ if $\delta_3^j \neq 0$. The estimating equation for intergenerational persistence implied by equations (8) and (11) above is as follows:

$$E_i^{c*} = \psi_0^j + \psi_1^j E_i^p + \psi_2^j (E_i^p)^2 + \varsigma_i \tag{12}$$

where

$$\psi_0^j = \delta_0^j + \alpha_1 \phi_i - \alpha_2 (\phi_i)^2 + \theta_0^j \left[(1 + \omega_1 \phi_i)\,\delta_1^j - (1 - \omega_2 \phi_i)\,\delta_2^j \theta_0^j\right]$$
$$\psi_1^j = \theta_1^j \left[(1 + \omega_1 \phi_i)\,\delta_1^j - 2(1 - \omega_2 \phi_i)\,\delta_2^j \theta_0^j\right] + \delta_4^j + \delta_3^j \theta_0^j; \qquad \psi_2^j = \theta_1^j \left(\delta_3^j - (1 - \omega_2 \phi_i)\,\delta_2^j \theta_1^j\right) \tag{13}$$

(4) Measures of Mobility, Empirical Issues, and Data

(4.1) Measures of Relative and Absolute Mobility

The most widely used measure of relative mobility in the current literature is the intergenerational regression coefficient (IGRC) which is estimated as the slope parameter of a linear

CEF (see, for example, Hertz et al. (2008), Torche (2019)). When the CEF is not linear, relative mobility is no longer constant across the distribution, as it depends on the level of parental education. A natural extension of the concept of IGRC in the case of a quadratic mobility CEF is the marginal effect of father's education on children's schooling. Emran et al. (2021) call it Intergenerational marginal effect (IGME, for short). Denoting the OLS estimate of a parameter with a hat, the IGME is defined as follows:

$$IGME_k = \hat{\psi}_1^j + 2\hat{\psi}_2^j E_k^p \tag{14}$$

where $IGME_k$ is the intergenerational marginal effect when the father has k years of schooling. Thus, relative mobility is lower (higher) at higher levels of parental education when the CEF is convex (concave).

As a measure of absolute mobility, we use expected years of schooling conditional of father's schooling, denoted as ES_k when the father has k years of schooling:

$$ES_k = \hat{\psi}_0^j + \hat{\psi}_1^j E_k^p + \hat{\psi}_2^j \left(E_k^p\right)^2 \tag{15}$$

Absolute mobility thus depends on both the slope and the intercept estimates of the intergenerational persistence equation (12) above. This definition of absolute mobility is similar to the one adopted by Chetty et al. (2014).

There is a different measure of absolute mobility adopted by some studies where the focus is on whether the children achieve more schooling than their parents. While this definition is widely used for income mobility, it may not be appropriate for understanding intergenerational educational mobility. The difficulties arise from the fact that unlike income, education as a measure is bounded from both below and above. The fact that the children of fathers with zero schools cannot experience downward mobility is particularly problematic in the context of developing countries where a significant proportion of parents have zero schooling.[25] Because, in this case, even a year of more schooling would imply upward mobility for a substantial proportion of children even though they are still stuck at the bottom of the education distribution in their own generation (for more details on this point, please see Emran and

[25] For example, according to 2000 census data, 23.84 percent fathers have zero schooling in Indonesia. In IHDS 2012 data on rural India, 47 percent parents of children of age 16-35 have zero schooling.

Shilpi (2019)). Parental generation as a benchmark for absolute mobility also faces difficulties at the right tail of the distribution. While the children of the richest parents can have higher income than their parents, it is almost impossible to have higher education for the children of parents with PhD.[26]

(4.2) Empirical Issues

The analysis developed above is based on years of schooling as an indicator of educational (and economic) status. Some recent studies use percentile rank in the schooling distribution in respective generations as the relevant indicator of educational status, following the rank-rank intergenerational income mobility model of Chetty et al. (2014) and Dahl and DeLeire (2008). The rank-rank empirical model is, however, not suitable for our analysis on both theoretical and empirical grounds. First, as noted by Heckman (2016), the Becker-Tomes model implies that the rank of a child in his/her own generation replicates exactly the rank of his/her parent in parental generation irrespective of the magnitude of intergenerational persistence.[27] The rank correlation is 1 in this case, and the available estimates from the rank-rank model (usually a slope of less than 1) cannot be interpreted by Becker-Tomes type models, including the model developed in this paper. The rank-rank model also faces additional empirical challenges when applied to education because, unlike income which is effectively a continuous measure, years of schooling is a discrete variable with limited support. As discussed by Neslehova (2007), in the case of discrete variables rank correlation cannot, in general, be interpreted as a copula. Moreover, there are many ties at each rank, and it is not clear which tie breaking rule to use for calculating the schooling ranks.[28]

When estimating the mobility and investment equations (equations (8) and (12) above), a question often arises whether one should control for other family and location characteristics. For example, one might argue that we should include province fixed effects to control for inter province differences in schooling infrastructure in Indonesia, among other things. However, it is important to appreciate that parent's (father in our data) education is a summary measure of

[26]We say "almost' impossible as a child can have higher number of Ph.Ds than her parents, but such cases are likely to be empirically irrelevant. It is easy for a reader to check whether a child is expected to attain higher schooling than his/her father from the estimates of absolute mobility we report.

[27]Heckman (2016) made this observation in the context of intergenerational income mobility in a Becker-Tomes model. But the same argument applies to intergenerational educational mobility.

[28]The default in Stata, the most widely used statistical software by economists, is mid rank method, and all the papers we are aware of use this tie breaking rule. However, a substantial literature in statistics proposed many alternatives such as Woodbury method, Maxmin method.

socioeconomic status of a household in an analysis of intergenerational mobility, and represents the impacts of *all family characteristics that are correlated with parental education*, including geographic location. Note also that province fixed effects allow for the intercept to vary across provinces, but the slope of the mobility equation is assumed to be the same. This is appropriate only when absolute mobility varies across provinces, but relative mobility does not which seems highly implausible. Although such geographic fixed effects are often used in the existing studies on developing countries, the implications for relative and absolute mobility estimates have not always been adequately appreciated (for a more extended discussion on this point, see Emran and Shilpi (2021)).

(4.3) Data and Variables

We use panel data from the Indonesia Family Life Survey (IFLS) for our analysis of educational persistence across generations in rural and urban areas in Indonesia. The first wave of the IFLS was fielded in 1993, and the second, third, fourth and fifth waves were fielded in 1997, 2000, 2007 and 2014, respectively. At the time of the first wave, 7,224 households were interviewed and it represented 83 % of the national population of Indonesia covering 13 of the 27 provinces (Frankenberg et al., 1995). In the subsequent waves, the sample size grew because others joined the sampled households either through marriage or births.

Our focus is on the children of 18-40 years age cohorts in the IFLS 2014 wave. This is motivated by three factors. First, we are interested in intergenerational educational persistence in rural vs. urban Indonesia during the 1990s and 2000s, and most of the children in the 18-40 age cohorts went to school during this period. Second, we can use the earlier rounds of the IFLS to estimate the investment equation (8) above for most of these age cohorts. Third, only the 2014 wave contains data on cognitive ability necessary for our analysis of the biases from omitted ability heterogeneity.

An important data issue for estimating intergenerational mobility is sample truncation that arises from the fact that many existing household surveys such as LSMS and DHS include information on only those household members who are coresident at the time of the survey. The criteria used for determining coresidency may vary, but when nonresident parents or children are not included in a survey, it can cause substantial biases in the estimates of intergenerational persistence in education.[29] We utilize the household roster, nonresident

[29] Emran et al. (2018) report that the standard measures of relative mobility can be 20-50 percent downward

parents module, and mother's marriage module to gather the education information on fathers. For details, please see the online appendix OA.2.

We use the data on Raven test scores and two memory tests to construct an index of cognitive ability of a child.[30] We construct a measure of cognitive ability as follows. First, we calculate the first principal component of three measures of cognitive ability available in the IFLS. In the second step, we take out the differences in ability due to age differences (i.e., the Flynn effect) by regressing the first principal component on age and age squared and retrieve the residual from this regression. Third, we calculate the percentile rank of an individual in the distribution of the residual as the measure of ability. We include this percentile ability measure as our indicator of ability heterogeneity across children.

The existing literature on returns to education provides estimates of labor market returns that capture only part of household permanent income we are interested in. To address this issue, we take advantage of the panel data on consumption expenditure in the first 3 rounds to calculate a measure of household permanent income in the parental generation, and estimate returns to education equation (1) above using this measure of permanent income. For returns to education in children's generation, we use the household expenditure data from the last two waves (2007 and 2014).

Table 1 provides the summary statistics for our various estimation samples, separately for rural and urban areas. In our "mobility sample" (18-40 years old children in 2014 wave), the average education of rural fathers is 5.96 years, and 8.24 years for urban fathers. The rural children attain 10 years of schooling, while the urban children acquire more than a year more schooling at 11.40 years on average. The household income and education expenditure are deflated by the SUSENAS province level CPI, separately for rural and urban areas. In the education expenses sample (pooled 1993, 1997, 2000, 2007), the average monthly educational expenditure (deflated by CPI) by rural households is 107.02 rupiah, and it is much higher in the urban households at 184.74 rupiah. The real average annual household expenditure in the parental generation (using 1993, 1997, and 2000 waves) are 24010.04 rupiah for rural areas, and 28914.93 rupiah in the urban areas. The summary statistics thus suggest a substantial rural-urban divide in Indonesia.

biased in coresident samples, giving a false impression of high intergenerational mobility.

[30]An advantage of these measures is that they do not require any knowledge of numeracy or literacy to do well in the tests.

(5) Empirical Evidence

(5.1) Estimates of the Intergenerational Persistence Equation

We begin with the estimates of the intergenerational educational mobility equation; Table 2 reports the estimates with and without ability controls. The estimation sample consists of the cohorts 18-40 years age children in 2014. Following the guidance of Abadie et al. (2017), all estimated standard errors reported in this paper are clustered at the primary sampling unit.

The upper panel contains the estimates without ability controls and the lower panel with ability controls. The first two columns in each panel report the estimates from a linear CEF which are useful as a benchmark comparable to other estimates available in the literature.[31] With linearity a maintained assumption, the estimates suggest that there is no significant rural-urban difference in relative mobility, and this conclusion does not depend on whether we control for children's ability heterogeneity. For example, with ability controls, the IGRC estimate is 0.359 in rural areas, while it is 0.351 in urban areas. The rural-urban difference is thus numerically small, and statistically not significant at the 10 percent level. In contrast, the intercept term is significantly smaller in the rural areas and the rural-urban difference is significant at the 1 percent level. If we rely exclusively on the linear model as is the practice in the current literature, we reach two major conclusions: (i) the rural children do not face any disadvantage in relative educational mobility, but (ii) they face lower absolute mobility across the entire distribution of father's schooling. Both of these conclusions, however, turn out to be incorrect as we will see below.

The estimates of the parameters of the quadratic CEF in equation (12) are reported in columns (4) and (5) of Table 2 for rural and urban areas respectively. The evidence shows that the null hypothesis of a linear CEF (i.e., $H_0 : \psi_2 = 0$) is rejected at the 1 percent level for the rural households, but linearity is not rejected in the urban sample. The coefficient on squared father's schooling in rural sample is *positive*, implying that the CEF is convex.[32] The differences in the functional forms in rural vs. urban areas suggest that the forces of complementarity (magnitude of δ_3) is likely to be stronger in the rural areas (see section (6.2)

[31] Almost all of the estimates on developing countries rely on the linear CEF and do not control for ability heterogeneity.

[32] This is in contrast to the recent evidence on India presented by Emran et al. (2020b) which shows that the CEF is concave in both rural and urban areas.

below).

Given the contrasting evidence on the functional form of the mobility CEFs, our main estimates of relative and absolute mobility in Table 3 are based on the convex CEF for rural and the linear CEF for urban Indonesia (with quadratic ability controls).[33] Relative mobility in rural areas varies with father's education, while it remains constant in the urban areas. The estimated IGMEs for the rural households (based on equation (14)) for a number of focal points of father's schooling distribution are reported in the lower panel of Table 3. The estimates show that the children born to fathers with low education (less than primary) have higher relative mobility in rural areas, but the pattern flips in favor of urban children for the households with higher educated fathers. In contrast, expected years of schooling, a measure of absolute mobility, is higher in urban areas for most of the distribution of father's schooling, but the rural-urban differences become small and statistically insignificant when the father is college educated (16 years of schooling).[34]

The estimates of relative and absolute mobility in Table 3 highlight the limitations of the standard linear model (Table 2). The linear model misses important heterogeneity, specially at the tails of the distribution because it ignores the convexity of the mobility CEF in the rural areas. The evidence in Table 3 suggests that the children from the rural households with low father's education have higher relative mobility, but suffer lower absolute mobility, and the children from highly educated rural households suffer from low relative mobility but do not face any disadvantage in terms of absolute mobility. This is in sharp contrast to the (incorrect) conclusions from the work-horse linear model where rural children enjoy the same relative mobility as the urban children across the distribution, but face consistently lower absolute mobility.

The Role of Cognitive Ability Heterogeneity

A long standing concern in the literature is whether the observed persistence across generations in economic status is primarily a result of mechanical transmission of ability from parents to children, with little influence of the economic forces such as school quality discussed in the theoretical model in section (2). The IFLS 2014 is well suited to make some progress

[33] We do not include multiplicative effects of ability as the evidence suggests no significant interaction effects. Please see the discussion on the role of cognitive ability heterogeneity below.

[34] When father's generation is used as a benchmark for absolute mobility, the estimates suggest that at low level of father's education, the expected years of schooling for children is higher, but it is lower when father's education is higher than a threshold.

on this question in the context of a developing country because it collected high quality data on cognitive ability of adult children. Such data on cognitive ability are rare in developing countries and we are not aware of any other analysis of intergenerational mobility in developing countries that exploits such measures of cognitive ability to understand the implications of ability bias.

Recall that the theory allows for both additive separable and interaction effects of ability in the education production function. We thus employ a flexible specification of the intergenerational mobility equation where ability and its squared are interacted with both father's education and father's education squared. The estimates from this exercise are reported in appendix Table A1: none of the interaction terms are significant at the 5 percent level, and this is true in both rural and urban areas.[35] In contrast, the direct effects of ability and its squared are statistically significant at the 1 percent level in both rural and urban areas. The coefficient of ability squared is negative, suggesting that high ability children face diminishing returns. The magnitudes of both the linear and quadratic coefficients are larger in rural areas, indicating a stronger role for cognitive ability of children in villages where the quality of schools is poor.

The standard linear CEF estimates in the first two columns of Table 3 show that the inclusion of the ability controls reduces the magnitudes of both the estimated slope and intercept which confirms that ability bias is positive, as widely argued in the literature. The evidence suggests that the upward bias is much larger in the estimated intercept in the linear model. The effects of ability controls on the quadratic CEF estimates are as follows: (i) the intercept and linear coefficients are lower, and (ii) the estimated quadratic coefficient remains virtually unaffected.[36] The pattern of rural-urban differences in the estimated coefficients we found earlier in Table 2 without any ability controls remain intact: (i) there is no significant differences in the intercepts, (ii) the linear coefficient is larger in the urban areas, and (iii) the quadratic coefficient is positive in rural areas and zero in urban areas.

(5.2) Estimates of the Investment Equation

To understand possible differences in the financial investment by parents in rural vs. urban

[35] Only 1 interaction term is significant at the 10 percent level.

[36] The coefficients of ability and ability squared remain virtually the same in the linear vs. quadratic models.

areas, we estimate the following regression specification:

$$I_i^* = \rho_0 + \rho_1 E_i^p + \rho_2 D^r + \rho_3 \left(E_i^p \times D^r\right) + \varepsilon_i \tag{16}$$

where D^r is the rural dummy taking on the value 1 for a household located in villages, and zero otherwise, and ε_i is the error term. The estimated parameters of equation (16) are related to the parameters in the investment equation (8) as follows: $\theta_0^u = \rho_0$, $\theta_1^u = \rho_1$, and $\theta_0^r = \rho_0 + \rho_2$, $\theta_1^r = \rho_1 + \rho_3$.

We use the pooled sample from four earlier rounds of the IFLS panel data to estimate equation (16) above.[37] The average education expenditure of the top 1 percent households in our data is 15 times higher than that of the bottom 99 percent households. To ensure that the conclusions are not distorted by a few large outliers, we trim the estimation sample at the top 1 percent, and the estimates are reported in Table 4, and the corresponding estimates from the winsorized sample are in the online appendix (see Table A.2).

We report estimates from three specifications: the first column contains the estimates of equation (16) without any controls, the second column controls for the number of children in a household, and the third column in addition controls for the ability index and its squared. The evidence is robust regarding the interaction of rural dummy with father's education: it is consistently negative across the three specifications and is statistically significant at the 1 percent level. The marginal effect of father's education on educational expenditure on a child is thus lower in the rural areas. The evidence on the intercept is also similar: the sign of the rural dummy is negative, and it is significant at the 1 percent level in all three specifications. The intercept term refers to the educational expenditure for the children of fathers with no schooling, and thus of special interest in our context as these households are likely to be the most disadvantaged. The evidence suggests that the education expenditure by parents is lower in the rural areas across the whole distribution of father's schooling.

(5.3) Estimates of Household level Returns to Education

As noted earlier in section (2), the concept of returns to education relevant for our analysis is different from most of the available estimates in the literature, as we are interested in how household economic status varies with the education level of the father. To reduce

[37] IFLS 2007 (wave 4), IFLS 2000 (wave 3), IFLS 1997 (wave 2) and IFLS 1993 (wave 1).

measurement error, we focus on household consumption expenditure as a measure of permanent income. It is widely noted that, compared to income data, expenditure suffers much less measurement error from transitory shocks because of consumption smoothing (see, for example, Deaton (1997)).

For parents, we use the average of the 1993, 1997, and 2000 rounds of household expenditure (deflated by province level rural and urban CPIs) data as a measure of household permanent income and estimate the income equation (equation (1) in the theoretical model in section (2)). The estimating equation for the fathers is given as follows:

$$Y_i^p = \tau_0 + \tau_1 E_i^p + \tau_2 D^r + \tau_3 \left(E_i^p \times D^r\right) + \upsilon_i \tag{17}$$

For the children, we use an analogous estimating equation and take the average of the household expenditure in 2007 and 2014.

The estimates for both parents and children are reported in Table 5.[38] For children, we are able to correct for ability bias using the ability index and its squared as controls. However, for parents, we cannot directly deal with the ability bias as the cognitive ability data are missing for a substantial proportion of fathers. To correct for ability bias in parental generation, we implement the following procedure based on the KLS (Kinky Least Squared) estimator of Kiviet (2013, 2020b,a) that can correct for arbitrary correlation between an endogenous variable and the error term in an OLS regression.[39] For implementation of KLS, we run the regressions separately for rural and urban samples. We pin down a plausible value for the correlation $Corr\left(E_{ij}^p, \upsilon_{ij}\right)$ based on the evidence from the cognitive ability data in children's generation. To do this, we estimate the income equation for children's generation using KLS for alternative values of the $Corr\left(E_{ij}^c, \upsilon_{ij}^c\right)$ and search for the value that replicates closely the estimates when we control for quadratic effect of children's ability in a standard OLS regression (see online appendix Table A.4). This procedure suggests a value of 0.02 for $Corr\left(E_{ij}^p, \upsilon_{ij}\right)$ in

[38] Our main estimates are based on a sample trimmed at the 99 percentile to ensure that the estimates are not affected by a few outliers. The corresponding winsorized sample estimates are in online appendix Table A.3. Our main estimates do not control for age and age squared as they capture across cohort variations in educational mobility. However, the main conclusions about returns to education are robust to the inclusion of age and age squared in the regressions. Please see online appendix Table A.8.

[39] Note that we cannot use the AET (2005) and Oster (2019) approach here because of a parsimonious set of controls in the regressions. If we include a rich set of conditioning variables, then they would capture some of the effects of family background correlated with father's education. KLS is suitable in this case as it does not require any conditioning variables in the regression.

both rural ($j = r$) and urban ($j = u$) areas. The KLS estimates corresponding to this value of the correlation are reported in the online appendix Table A.5. To ensure that the conclusions below are robust to allowing for a stronger ability correlation in the KLS estimation, we report additional estimates (see Tables A.4 and A.5 in online appendix).

The evidence on parent's generation suggests strongly that the intercept is higher in rural areas. The higher income in the rural households with father having no schooling seems unexpected, but reflects the fact that these rural households own more assets, especially land: 80 percent of the households in this group own farming land in rural areas, and only 27 percent own land in the urban areas. The interaction of the rural dummy with the father's education is negative and statistically significant at the 1 percent level. The evidence thus strongly suggests that returns to education at the household level was substantially lower in the rural areas. In terms of the parameters of the income equation (1) we have the following binary relations implied by the estimates in Table 5: $\hat{Y}_0^{pr} > \hat{Y}_0^{pu}$ and $\hat{R}^{pr} < \hat{R}^{pu}$. The evidence on children's generation also shows that the returns to education at the household level are substantially lower in the rural areas.

(6) Understanding the Mechanisms

The estimates of the investment equation and intergenerational persistence equations discussed above can be summarized in the following binary relations (using a hat to denote the OLS estimate of a parameter):

$$INVESTMENT \qquad \hat{\theta}_1^r < \hat{\theta}_1^u \quad \hat{\theta}_0^r < \hat{\theta}_0^u \tag{18}$$

$$MOBILITY \qquad \begin{matrix} \hat{\psi}_0^r < \hat{\psi}_0^u; & \hat{\psi}_1^r < \hat{\psi}_1^u \\ \hat{\psi}_2^r > 0; & \hat{\psi}_2^u = 0 \end{matrix} \tag{19}$$

In the discussion below, we assume that $\omega_1 = \omega_2 = 0$ in all the relevant equations (equations (9), (10) and (13) above), reflecting the evidence discussed earlier that the interactions of ability are not statistically significant.

Our focus here is on two issues: (i) is parental education complementary to or a substitute of financial investment in children's schooling by parents?; (ii) is school quality complementary to or a substitute of parental financial investment? As we discuss below, the estimated reduced form relations in (18) and (19) can answer the first question when combined with the estimates of returns to education in section (5.3) above. For the second question, the reduced form parameter estimates are not enough, we need estimates of two parameters of the education production function that determine the effects of parental financial investment: δ_1 and δ_2.

(6.1) Is Financial Investment Complementary to Parental Education?

Becker et al. (2015, 2018) emphasize that parental financial investment in children's education may be complementary to the education level of the parents, implying $\delta_3 > 0$. A convex mobility CEF in rural Indonesia provides strong evidence of such complementarity, as $\psi_2^r = \theta_1^r\left(\delta_3^r - \delta_2^r\theta_1^r\right) > 0$ implies $\delta_3^r > 0$. The evidence that the mobility CEF is linear (i.e., $\psi_2^u = 0$) in urban Indonesia is consistent with two cases: (i) $\delta_3^u > 0$, and (ii) $\delta_3^u = 0$. However, $\delta_3^u = 0$ is consistent with $\psi_2^u = \theta_1^u\left(\delta_3^u - \delta_2^u\theta_1^u\right) = 0$ only if the education production function in the urban areas has constant returns, i.e., $\delta_2^u = 0$. From equation (10) above, $\delta_2^u = 0$ implies that $\theta_1^u = R^{pu}$ which is rejected by the evidence in Tables 4 and 5 that (estimates denoted by a hat) $\hat{\theta}_1^u < \hat{R}^{pu}$. The evidence thus rejects the null hypothesis that $\delta_2^u = 0$ in favor of $\delta_3^u > 0$ even though the mobility CEF is linear in urban Indonesia.

The analysis and evidence above are important for two reasons. First, although Becker et al. (2015, 2018) highlight the role of complementarity between financial investment and a parent's human capital in mobility analysis, to the best of our knowledge, ours is the first rigorous evidence that $\delta_3 > 0$ in both urban and rural areas in a developing country. Second, our analysis suggests that even when the data fail to reject the linear mobility CEF, the underlying model is likely to be quadratic. The test of the null hypothesis that the true model is linear without any interaction effects developed here can be implemented readily in other developed and developing countries.

Given that the mobility CEF is convex in rural areas, and linear in urban areas, it seems plausible to expect that $\delta_3^r > \delta_3^u > 0$. The estimates of structural parameters of the education production function in section (6.2) below supports this conclusion.

Sources of Complementarity

We next explore the sources of complementarity (i.e., $\delta_3 > 0$) in rural and urban areas. The focus of our analysis is whether the complementarity between father's education and financial investment is generated primarily by the fact that father's education is a proxy for other correlated factors such as mother's education (assortative marriage matching), and neighborhood peers and role models (higher educated fathers locate in more educated neighborhoods with better schools). The empirical approach for this exercise is developed in detail in online appendix section OA.1. The basic idea is as follows: if the complementarity is driven by, for example, mother's education, then an estimated positive effect of father's education squared will become small (and may turn negative) once we include mother's education, its squared, and its interaction with father's education in the mobility equation. The estimates are reported in online appendix Table A.6.[40]

The evidence suggests that the observed complementarity cannot be explained by peer, role model, and mother's education as correlated factors, and this holds in both rural and urban areas. The positive coefficient on father's education squared remain unchanged or even increases in magnitude in rural areas when we control for other possible sources of complementarity in the regression. In urban areas, where the mobility CEF is linear, the inclusion of the competing factors fail to make it concave, rather makes it convex in some cases. See online appendix OA.1 for details. This evidence suggests that a father's own nonfinancial impacts such as role model effect and home teaching are the likely mechanisms underlying the complementarity between father's education and financial investment.

(6.2) School Quality and Parental Financial Investment: Are they Complementary or Substitutes?

As discussed before, the parameters that determine the nature of interactions between school quality and parental financial investment are μ_1 and μ_2. We need estimates of two production parameters δ_1 and δ_2 along with estimates of school quality in rural and urban areas to recover estimates of μ_1 and μ_2. This can be seen from the following:

$$\hat{\mu}_1 = \frac{\ln(\delta_1^r) - \ln(\delta_1^u)}{\ln(q^r) - \ln(q^u)} \tag{20}$$

$$\hat{\mu}_2 = \frac{\ln(\delta_2^r) - \ln(\delta_2^u)}{\ln(q^u) - \ln(q^r)} \tag{21}$$

We first provide an estimate of school quality in rural and urban areas, and then develop an approach to recover estimates of δ_1 and δ_2.

[40]We emphasize that our analysis does not deal with the effects of peer and role models in transmitting education across generation. The analysis here is focused only on the question whether these factors might be responsible for the complementarity between father's education and financial investment suggested by the evidence.

Estimates of School Quality in Rural and Urban Areas

A simple but widely used indicator of school quality is pupil-teacher ratio. However, teacher quality is in general substantially higher in the urban areas (Booth (1998), World Bank (??)). Moreover, the problem of teacher absenteeism in rural areas is specially acute. Based on the 1990 census data in Indonesia, we use a teacher's years of schooling as a measure of teacher quality. Denote the number of teachers in an area by T^j with $j = r, u$. We define weights ω_i by normalizing a teacher's years of schooling by the maximum years of schooling (17 years) and calculate quality adjusted number of teachers as $ET^j = \sum_i \omega_i^j T_i^j$, and construct an index of school quality as follows:

$$q^j = \left(\frac{P^j}{ET^j \left(1 - A^j\right)} \right)$$

where P^j is the number of pupils in area J and A^j is the rate of teacher absenteeism. The estimates of rural and urban teacher absenteeism rates reported by Chaudhury et al. (2006) are $A^r = 25\%$ and $A^u = 13\%$. The estimates of the index suggest that quality is 67 percent higher in the urban areas.[41]

Estimates of δ_1 and δ_2

We develop a simple approach to recover estimates of δ_1 and δ_2 from the reduced from parameters of investment and mobility equations. The estimates of the investment and mobility equations provide 5 reduced form parameters, but there are 8 structural parameters in the model: 5 parameters of education production function and 2 parameters of consumption sub utility function and the parameter of degree of parental altruism. We can recover the 5 production function parameters once we have estimates of the 3 preference parameters. We get an estimate of the degree of parental altruism σ from the literature: Sen (2013) reports an estimate of 0.488 for India, and Nishiyama (2000) reports an estimate of 0.70 in the context of USA. We use $\sigma = 0.60$ as our central case but the conclusions are not sensitive to alternative assumptions.[42] To get estimates of the parameters of the consumption sub utility function, we rely on the observation that the educated (high income) households are likely to be less

[41] The main conclusions below do not depend on this exact value of rural-urban gap in school quality. We check sensitivity assuming a range of 50 percent to 75 percent rural-urban gap. Details are available from the authors.

[42] The results for $\sigma = 0.50$ and $\sigma = 0.70$ are available from the authors.

credit constrained. As discussed in section (3) above, the shadow price of credit for the most educated households are likely to be close to the relevant market interest rate. For the most educated urban households, we use the bank interest rate, and for the corresponding rural households, we use the moneylender interest rate.

Denote the shadow price of credit for the most educated households in rural and urban areas by λ_h^{r*} and λ_h^{u*} respectively, and the rural (moneylender) and urban (bank) interest rates by ρ^r and ρ^u respectively.[43] Since the educational investment data are at the monthly frequency, the relevant interest rate for us is the monthly interest rate.

From the first order conditions (see equation (7) above), we have the following two equations to solve for the preference parameters β_1 and β_2:

$$\beta_1 - 2\beta_2 C_h^{pr} = \lambda_h^{r*} = 1 + \rho^r \tag{22}$$

$$\beta_1 - 2\beta_2 C_h^{pu} = \lambda_h^{u*} = 1 + \rho^u \tag{23}$$

Equations (22) and (23) imply that the most educated households are indifferent between using own funds and loans for financing investment in children's education.[44] Based on the data on interest rates from the second and third waves of IFLS, we use monthly moneylender interest rate of 6.4% and monthly bank interest rate is 2%.[45] Some estimates of moneylender interest rate in Indonesia in the 1990s report higher rates (Schrader (1997)), and we use a 8.33 percent rate (100% annual rate) as a sensitivity check to see if the main conclusions hold up.[46] For estimates of consumption of these households, i.e., C_h^{pr} and C_h^{pu}, we utilize the first three rounds of IFLS data. Given the estimates of consumption and interest rates, we solve equations (22) and (23) simultaneously for the preference parameters which yields: $\hat{\beta}_1 = 1.6225$ and $\hat{\beta}_2 = 0.00013$.

We can now solve for the parameters of education production function: plugging in the values of the 3 preference parameters, we have 5 reduced form parameters as a function of 5 structural parameters of education production function. The recovered structural parameters

[43]Subscript h refers to the highly educated fathers.

[44]Note that for recovering the preference parameters what is required is that , on average, the shadow price of credit equals the relevant interest rate.

[45]The annual moneylender interest rate is 77% and the bank interest rate is 24%, based on data from IFLS.

[46]10 percent monthly interest rates are not uncommon among professional moneylenders in Indonesia (Schrader (1997)).

are reported in Table 6. Figures 1R (rural) and 1U (urban) show the model generated and data based estimates of expected years of schooling, and the model does an excellent job of capturing the actual variation in the data.

The important findings from Table 6 for our purpose are that $\left(\hat{\delta}_1^u > \hat{\delta}_2^r\right)$ and $\left(\hat{\delta}_2^u < \hat{\delta}_2^r\right)$. From the estimates of school quality, we know $q^u > q^r$. These three inequalities when applied to equations (20) and (21) imply that $\hat{\mu}_1 < 0$ and $\hat{\mu}_2 > 0$.

Understanding the Interaction Between School Quality and Parental Investment

The result that $\hat{\mu}_1 < 0$ and $\hat{\mu}_2 > 0$ means that we have local complementarity or substitutability: it is possible to have complementarity in some range of the distribution and substitutability in another part of the distribution. Thus, we need to use the cross-partial derivative to determine whether parental investment is substitute or complement to school quality at a given level of parental schooling:

$$\begin{aligned} \frac{\partial}{\partial q}\left(\frac{\partial E^c}{\partial I^*}\right) &= \frac{1}{q}\left[\hat{\mu}_1\hat{\delta}_1 + 2\hat{\mu}_2\hat{\delta}_2 I^*\right] \\ &= \frac{1}{q}\left[\left(\hat{\mu}_1\hat{\delta}_1 + 2\hat{\mu}_2\hat{\delta}_2\hat{\theta}_0\right) + 2\hat{\mu}_2\hat{\delta}_2\hat{\theta}_1 E^p\right] \end{aligned} \tag{24}$$

As noted earlier the sign of the cross partial is determined by the sign of the expression in brackets in the right hand side of equation (24). Plugging in values for $\hat{\mu}_1$, $\hat{\mu}_2$, $\hat{\delta}_1$, $\hat{\delta}_2$ $\hat{\theta}_0$ and $\hat{\theta}_1$ in equation (24) above, we plot the term in the brackets as a function of father's education E^p for rural and urban areas; please see Figures 2U (urban) and 2R (rural). The results show that the cross-partial curve in the rural area is fully contained in the positive quadrant implying that parental investment is complementary to school quality irrespective of the level of education of a father. In the urban area, the curve is in the negative quadrant for low levels of father's education, but crosses into the positive quadrant for the higher educated fathers. Thus, there is substitutability in the low educated (less than primary) urban households, but for the educated parents, there is complementarity. The estimates also suggest that the strength of complementarity is stronger in the rural areas at each level of parental education.

The findings above have important implications. The evidence suggests that government investment in rural schools to improve quality would crowd in parental investment for all children irrespective of family background, but more so for the children from the more educated and higher income households. In the urban areas, public investment in school quality is expected to crowd out parental financial investment in low educated households, but crowd in financial investment in the educated households. In Figures 3U (urban) and 3R (rural), we plot the simulation results for a 10 percent improvement in school quality (the estimates are reported in online appendix Table A.7). The school quality improvement shifts and rotates the absolute mobility curves upward. There is an increase in educational attainment of all children as a result but the extent of improvement is much larger for children of households with higher parental education. In particular, the children of fathers with no schooling experience virtually no change in their absolute or relative mobility. To reduce the inequalizing effect of such school quality improvements, some offsetting policies targeting the low educated households are required.

(8) Conclusions

We develop an extension of the Becker-Tomes model to study the role of complementarities in intergenerational educational mobility in Indonesia. Following Becker et al. (2018), the model includes an interaction effect between parent's education and financial investment in children's schooling production function which can give rise to a convex mobility curve. In addition, school quality can be complementary to or substitutes of parental education. Using household data free of the truncation bias due to coresidency restrictions in surveys, we find that the mobility curve is convex in rural areas, but linear in urban areas.

If we follow the existing literature and consider only the linear model for both rural and urban samples, the evidence (incorrectly) suggests that there is no rural-urban gap in relative mobility. The rural-urban relative mobility curves from the correct models cross, with the children of low educated fathers enjoying higher relative mobility in rural areas, while the urban children fare better at the upper tail of the distribution. The rural children face lower absolute mobility for most of the distribution, catching up with the urban children only when the father has college or more education.

Theoretical insights help uncover the economic mechanisms. Parental education is complementary to financial investment in both rural and urban areas even though the urban mobility equation is linear. We develop a test for the null hypothesis that a liner mobility equation is driven by a constant returns education production function which relies only on the reduced form estimates and can be fruitfully used in other studies. As emphasize recently by Becker et al. (2018), such complementarity has dramatically different implications for the pattern of mobility; for example, we may not observe regression toward the population mean for the households at the top of the distribution.

We also develop an approach to understand the nature of the interaction between school quality and parental financial investment. The evidence shows that school quality in rural areas is complementary to parental financial investment across the distribution with stronger complementarity in the higher educated households. In urban areas, school quality is a substitute of parental investment in low educated households, while it is complementary in high educated households. These patterns of interaction effects suggest that public investment in school quality would lower relative mobility and increase educational inequality.

References

Abadie, A., Athey, S., Imbens, G., and Wooldridge, J. (2017). When Should You Adjust Standard Errors for Clustering? NBER Working Papers 24003, National Bureau of Economic Research, Inc.

Akresh, R., Halim, D., and Kleemans, M. (2018). Long-term and Intergenerational Effects of Education: Evidence from School Construction in Indonesia. NBER Working Papers 25265, National Bureau of Economic Research, Inc.

Atkinson, A. B., Piketty, T., and Saez, E. (2011). Top incomes in the long run of history. *Journal of Economic Literature*, 49(1):3–71.

Autor, D. H. (2014). Skills, education, and the rise of earnings inequality among the "other 99 percent". *Science*, 344(6186):843–851.

Azam, M. and Bhatt, V. (2015). Like Father, Like Son? Intergenerational Educational Mobility in India. *Demography*, 52(6):1929–1959.

Becker, G., Kominers, S. D., Murphy, K. M., and Spenkuch, J. L. (2015). A Theory of Intergenerational Mobility. MPRA Paper 66334, University Library of Munich, Germany.

Black, S. E. and Devereux, P. J. (2011). Recent Developments in Intergenerational Mobility. In *Handbook of Labor Economics*, volume 4, chapter 16, pages 1487–1541. Elsevier.

Booth, A. (1998). *The Indonesian Economy in the Nineteenth and Twentieth Centuries: A History of Missed Opportunities.* Macmillan Press Limited.

Bossuroy, T. and Cogneau, D. (2013). Social Mobility in Five African Countries. *Review of Income and Wealth*, 59:84–110.

Card, D., Domnisoru, C., and Taylor, L. (2018). The Intergenerational Transmission of Human Capital: Evidence from the Golden Age of Upward Mobility. NBER Working Papers 25000, National Bureau of Economic Research, Inc.

Chapman, B. and Suryadarma, D. (2013). Financing higher education: The viability of a commercial student loan scheme in Indonesia. *Education in Indonesia*, pages 203–215.

Chetty, R., Hendren, N., Kline, P., and Saez, E. (2014). Where is the land of Opportunity? The Geography of Intergenerational Mobility in the United States. *The Quarterly Journal of Economics*, 129(4):1553–1623.

Corak, M. (2013). Income Inequality, Equality of Opportunity, and Intergenerational Mobility. *Journal of Economic Perspectives*, 27(3):79–102.

Dahl, M. W. and DeLeire, T. (2008). The Association between Childrens Earnings and Fathers Lifetime Earnings: Estimates Using Administrative Data. Working paper, institute for research on poverty, University of WisconsinMadison.

Echazarra, A. and Readinger, T. (2019). Learning in Rural Schools: Insignts from PISA, TALIS, and the Literature. OECD Education Working Paper Series 196, OECD.

Emran, M. S., Greene, W., and Shilpi, F. (2018). When Measure Matters: Coresidency, Truncation Bias, and Intergenerational Mobility in Developing Countries. *Journal of Human Resources*, 53(3):589–607.

Emran, M. S., Islam, A., and Shilpi, F. (2020a). Distributional Effects of Corruption When Enforcement is Biased: Theory and Evidence from Bribery in Schools in Bangladesh. *Economica*, 87(348):985–1015.

Emran, M. S., Jiang, H., and Shilpi, F. (2021). Is Gender Destiny? Gender Bias and Intergenerational Educational Mobility in India. GLO Discussion Paper Series 807, Global Labor Organization (GLO).

Emran, M. S., Jiang, H., and Shilpi, F. J. (2020b). Gender Bias and Intergenerational Educational Mobility : Theory and Evidence from China and India. Policy Research Working Paper Series 9250, The World Bank.

Emran, M. S. and Shilpi, F. (2011). Intergenerational Occupational Mobility in Rural Economy: Evidence from Nepal and Vietnam. *Journal of Human Resources*, 46(2):427–458.

Emran, M. S. and Shilpi, F. (2015). Gender, Geography, and Generations: Intergenerational Educational Mobility in Post-Reform India. *World Development*, 72:362–380.

Emran, M. S. and Shilpi, F. (2021). Economic approach to intergenerational mobility: Measures, methods, and challenges in developing countries. In Iversen, V., Krishna, A., and Sen, K., editors, *Social mobility in developing countries: Concepts, methods, and determinants*.

Emran, M. S. and Shilpi, F. J. (2019). Economic approach to intergenerational mobility: Measures, Methods, and Challenges in Developing Countries. Working Paper Series 98, UNU-WIDER.

Emran, M. S. and Sun, Y. (2015). Magical transition? intergenerational educational and occupational mobility in rural China : 1988-2002. Policy Research Working Paper Series 7316, The World Bank.

Fan, Y., Yi, J., and Zhang, J. (2020). Rising Intergenerational Income Persistence in China. *American Economic Journal: Economic Policy*.

Febriana, M., Nurkamto, J., Rochsantiningsih, D., and Muhtia, A. (2018). Teaching in Rural Indonesian Schools: Teachers Challenges. *International Journal of Multicultural and Multireligious Understanding*, 5:11–20.

Frankema, E. (2014). Why was the Dutch legacy so poor? Educational development in the Netherlands Indies, 1871-1942. CGEH Working Paper Series 54, Universiteit Utrecht.

Frankenberg, E., Karoly, L. A., Gertler, P., Achmad, S., Agung, I., Hatmadji, S. H., and Sudharto, P. (1995). The 1993 indonesian family life survey: Overview and field report.

Friedman, J. (2005). How Responsive is Poverty to Growth? A Regional Analysis of Poverty, Inequality, and Growth in Indonesia, 1984-1999. In Kanbur, R. and Venables, A., editors, *Spatial Inequality and Development*. Oxford University Press.

Furnivall, J, S. (1943). Educational Progress in Southeast Asia. Working paper series, New York: Institute of Pacific Relations.

Goldin, C. and Katz, L. (2008). *The Race Between Education and Technology*. Belknap Press.

Heckman, J. and Corbin, C. (2016). Capabilities and Skills. *Journal of Human Development and Capabilities*, 17(3):342–359.

Heckman, J. and Mosso, S. (2014). The Economics of Human Development and Social Mobility. *Annual Review of Economics*, 6(1):689–733.

Hertz, T. and Jayasundera, T. (2007). School Construction and Intergenerational Mobility in

Indonesia. Working Papers 2007-18, American University, Department of Economics.

Hertz, T., Jayasundera, T., Piraino, P., Selcuk, S., Smith, N., and Verashchagina, A. (2008). The Inheritance of Educational Inequality: International Comparisons and Fifty-Year Trends. *The B.E. Journal of Economic Analysis & Policy*, 7(2):1–48.

Iversen, V., Krishna, A., and Sen, K. (2019). Beyond poverty escapes − social mobility in developing countries: A review article. *World Bank Research Observer*, 34(2):239–273.

Kanbur, R. and Jhuang, J. (2014). Urbaization and Inequality in Asia. In Kanbur, R., Rhee, C., and Jhuang, J., editors, *Inequality in the Asia and Pacific*, pages 288–302. Rutledge and ADB.

Kiviet, J. F. (2013). Identification and inference in a simultaneous equation under alternative information sets and sampling schemes. *Econometrics Journal*, 16(1):24–59.

Kiviet, J. F. (2020a). Instrument-free inference under confined regressor endogeneity; derivations and applications. Working Papers 09/2020, Stellenbosch University, Department of Economics.

Kiviet, J. F. (2020b). Testing the impossible: Identifying exclusion restrictions. *Journal of Econometrics*, 218(2):294–316.

Kurosaki, T. and Khan, H. (2006). Human Capital, Productivity, and Stratification in Rural Pakistan. *Review of Development Economics*, 10:116–134.

Mazumder, B. (2005). Fortunate Sons: New Estimates of Intergenerational Mobility in the United States Using Social Security Earnings Data. *The Review of Economics and Statistics*, 87(2):235–255.

Mazumder, B., Rosales-Rueda, M., and Triyana, M. (2019). Intergenerational Human Capital Spillovers: Indonesia's School Construction and Its Effects on the Next Generation. *AEA Papers and Proceedings*, 109:243–249.

Neidhofer, G., Serrano, J., and Gasparini, L. (2018). Educational inequality and intergenerational mobility in Latin America: A new database. *Journal of Development Economics*, 134(C):329–349.

Nishiyama, S. (2000). Measuring Time Preference and Parental Altruism. Working Papers 13333, Congressional Budget Office.

Phillips, J. M. (1994). Farmer education and farmer efficiency: A meta-analysis. *Economic Development and Cultural Change*, 43(1):149–65.

Schrader, H. (1997). *Changing Financial Landscapes in India and Indonesia: Sociological Aspects of Monetization and Market Integration*. LIT Verlag Münster.

Sen, S. (2013). Model of Child Bearing with 2-sided Altruism in Developing Countries: A Calibration Exercise. Working paper, Pennsylvania State University.

Solon, G. (1992). Intergenerational Income Mobility in the United States. *American Economic Review*, 82(3):393–408.

Solon, G. (1999). Intergenerational mobility in the labor market. In Ashenfelter, O. and Card, D., editors, *Handbook of Labor Economics*, volume 3 of *Handbook of Labor Economics*, pages 1761–1800. Elsevier.

Stiglitz, J. (2012). *The Price of Inequality*. W. W. Norton Company.

Thomas, D. (1996). Education across Generations in South Africa. *American Economic Review*, 86(2):330–334.

Torche, F. (2019). Educational mobility in developing countries. WIDER Working Paper Series 2019-88.

Table 1: Summary Statistics

Panel A: Mobility Sample				
	Rural (NOB:10236)		Urban (NOB: 5230)	
	Mean	SD	Mean	SD
Father's Years of Education	5.96	3.88	8.24	4.21
Child Years of Education	10.00	3.50	11.40	3.27
Child Age	29.47	6.25	28.88	6.37
Child Raven Test Score	67.14	24.20	71.53	23.24
Child Memory Test 1	55.74	16.00	57.65	15.83
Child Memory Test 2	46.40	17.40	48.30	17.21
Panel B: Educational Expense Sample				
	Rural (NOB: 9763)		Urban (NOB: 8379)	
	Mean	SD	Mean	SD
Average Monthly Expenses	97.71	146.11	153.02	204.40
Father's Years of Education	5.59	4.06	8.10	4.37
Child Years of Education	10.51	3.28	12.05	2.92
Child Raven Test Score	69.72	23.28	76.02	21.38
Child Memory Test 1	56.36	15.52	59.44	15.27
Child Memory Test 2	47.17	17.03	50.31	16.51
Number of School Age Children	2.21	1.16	2.32	1.16
Panel C: Permanent Income (Father)				
	Rural (NOB: 2241)		Urban (NOB: 1712)	
	Mean	SD	Mean	SD
Permanent Income	23306.45	14154.66	27076.52	16980.00
Father's Years of Education	5.49	3.97	8.07	4.21
Panel D: Permanent Income (Children)				
	Rural (NOB: 2494)		Urban (NOB: 1016)	
	Mean	SD	Mean	SD
Permanent Income	30542.00	18224.56	36897.82	36039.63
Child Years of Education	9.24	3.88	11.22	3.61

Notes: Author's calculation based on the Indonesian Family Life Survey. In Panel A, Rural and Urban are defined based on location of birth. If the respondent was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. The sample in Panel A is based on the 18 to 40 years old in the fifth wave of the IFLS. In panel B, Rural and Urban are defined based on the location of the household in the survey. The summary statistics of Panel B are based on the merged sample of first four waves of the IFLS. The average monthly educational expenses are adjusted for inflation. In Panel C, Rural and Urban are defined based on household location in the first wave (1993). Father's permanent income (adjusted for inflation) is calculated taking an average of household consumption expenditure in first three waves (1993, 1997, and 2000). In panel D, Rural and Urban are defined based on location of birth (same as in Panel A). Children's permanent income (adjusted for inflation) is calculated taking an average of household consumption expenditure in last two waves (2007, 2014). The average monthly educational expenses, father's permanent income, and children's permanent income were adjusted for inflation using the Susenas provincial CPI estimates separately for rural and urban areas. The samples in panel B, C, and D excludes top 1 percent of household educational expenses, income in father's generation, and children's generation, respectively.

Table 2: Intergenerational Persistence in Schooling in Indonesia

Panel A: Without Cognitive Ability Controls						
	LINEAR CEF			**QUADRATIC CEF**		
	Rural(R)	**Urban(U)**	**R-U**	**Rural(R)**	**Urban(U)**	**R-U**
Father Edu	0.394***	0.385***	0.009	0.298***	0.361***	-0.062
	(0.012)	(0.015)	(0.016)	(0.030)	(0.046)	(0.051)
Father Edu Sq				0.007***	0.001	0.005**
				(0.002)	(0.002)	(0.003)
Constant	7.652***	8.227***	-0.5749***	7.878***	8.303***	-0.424*
	(0.129)	(0.172)	(0.169)	(0.146)	(0.237)	(0.232)
Observations	10236	5230	15466	10236	5230	15466

Panel B: With Cognitive Ability Controls						
	LINEAR CEF			**QUADRATIC CEF**		
	Rural(R)	**Urban(U)**	**R-U**	**Rural(R)**	**Urban(U)**	**R-U**
Father Edu	0.359***	0.351***	0.009	0.259***	0.319***	-0.060
	(0.011)	(0.014)	(0.016)	(0.027)	(0.044)	(0.048)
Father Edu Sq				0.007***	0.002	0.005**
				(0.002)	(0.002)	(0.003)
Constant	5.745***	6.711***	-0.966***	5.975***	6.802***	-0.826***
	(0.204)	(0.225)	(0.240)	(0.216)	(0.270)	(0.275)
Ability Index	0.682***	0.464***		0.685***	0.467***	
	(0.057)	(0.066)		(0.057)	(0.066)	
Ability Index Sq	-0.038***	-0.018***		-0.038***	-0.019***	
	(0.005)	(0.006)		(0.005)	(0.006)	
Observations	10236	5230	15466	10236	5230	15466

Notes: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). Rural and Urban are defined based on location of birth. If the respondent was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. Cognitive ability index is expressed in percentile; it is constructed taking the first principal component of Raven Test and two memory memory tests net of age and age square.

Table 3: Intergenerational Persistence in Schooling Indonesia with Mobility Estimates (Including Cognition Ability Controls)

	Rural	**Urban**	**R-U**
Father Edu	0.259***	0.351***	-0.092***
	(0.027)	(0.014)	(0.030)
Father Edu Sq	0.007***		0.007***
	(0.002)		(0.002)
Constant	5.975***	6.711***	-0.7358***
	(0.216)	(0.225)	(0.249)
Ability Index	0.685***	0.464***	
	(0.057)	(0.066)	
Ability Index Sq	-0.038***	-0.018***	
	(0.005)	(0.006)	
Observations	10236	5230	15466

	Relative Mobility				**Absolute Mobility**		
	Rural (R)	**Urban (U)**	**R-U**		**Rural (R)**	**Urban (U)**	**R-U**
IGME0	0.259***	0.351***	-0.092***	**ES0**	5.975***	6.711***	-0.736**
	(0.027)	(0.014)	(0.031)		(0.216)	(0.225)	(0.312)
IGME6	0.345***	0.351***	-0.006	**ES6**	7.786***	8.815***	-1.029***
	(0.012)	(0.014)	(0.018)		(0.179)	(0.182)	(0.255)
IGME9	0.388***	0.351***	0.037**	**ES9**	8.885***	9.867***	-0.982***
	(0.011)	(0.014)	(0.018)		(0.173)	(0.172)	(0.244)
IGME12	0.431***	0.351***	0.080***	**ES12**	10.112***	10.919***	-0.807***
	(0.017)	(0.014)	(0.022)		(0.171)	(0.172)	(0.242)
IGME16	0.488***	0.351***	0.137***	**ES16**	11.949***	12.322***	-0.372
	(0.028)	(0.014)	(0.031)		(0.195)	(0.186)	(0.269)
Weighted IGME	0.344	0.351	-.007	**Weighted ES**	7.881	9.594	-1.713

Notes: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). Rural and Urban are defined based on location of birth. If the respondent was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. Here, $IGME_k = \hat{\psi}_1^{\,j} + 2\hat{\psi}_2^{\,j} E_k^p$ and $ES_k = \hat{\psi}_0^{\,j} + \hat{\psi}_1^{\,j} E_k^p + \hat{\psi}_2^{\,j} (E_k^p)^2$. E_k^p is when father has k years of schooling. Cognitive ability index is expressed in percentile; it is constructed taking the first principal component of Raven Test and two memory memory tests net of age and age square.

Table 4: Estimates of the Investment Equation

Father's Years of Education	8.23***	8.26***	7.82***
	(0.65)	(0.65)	(0.65)
HH Rural (=1)	-17.27***	-17.50***	-15.26**
	(6.49)	(6.51)	(6.40)
Father's Years of Education × Rural	-3.15***	-3.14***	-3.13***
	(0.80)	(0.80)	(0.78)
Number of School Age Children		-3.19**	-3.15**
		(1.33)	(1.30)
Ability Index			3.98**
			(1.99)
Ability Index Sq			0.07
			(0.20)
Constant	60.72***	65.74***	45.61***
	(5.93)	(6.38)	(7.09)
Observations	18142	18142	18142

Notes: Standard errors are clustered at the community level (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). The sample excludes top 1 percent of educational expenses. The sample mean of monthly average educational expenditure 143.18 rupiah (adjusted for inflation), whereas the top 1 percent mean of monthly average educational expenditure is 2,118.92 rupiah (adjusted for inflation). The dependent variable is average monthly educational expenditure which is adjusted for inflation using the Susenas provincial CPI estimates separately for rural and urban areas. All regressions include wave fixed effects. Rural and urban are defined based on location of household at the time of survey. Cognitive ability index is expressed in percentile; it is constructed taking the first principal component of Raven Test and two memory memory tests net of age and age square.

Table 5: Household-level Returns to Education for Father and Children

	Father's Generation		**Children's Generation**		
Years of education	1489.82***	1468.96***	1623.79***	1657.34***	1672.53***
	(115.95)	(113.70)	(188.94)	(187.38)	(202.93)
HH Rural(=1)	1922.37*	2711.83**	3465.51	3714.52	4418.07*
	(1148.65)	(1134.04)	(2337.97)	(2307.31)	(2417.99)
Years of Education × HH Rural	-336.76**	-321.38**	-399.26*	-414.52*	-466.42**
	(147.50)	(144.11)	(212.95)	(211.29)	(226.82)
Number of Working Age Adults		2703.15***		899.66***	932.75***
		(233.06)		(212.82)	(224.38)
Constant	15055.14***	7680.83***	15763.14***	13140.29***	12834.44***
	(936.73)	(1139.02)	(2171.01)	(2183.73)	(2439.04)
Ability Index					-492.08
					(422.47)
Ability Index Sq					70.29*
					(40.68)
Observations	3953	3953	3510	3510	3362

Notes: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). Unit of observation is household in both father's generation and children's generation. If reported father year's education varied within a household, an average of father's years of education is taken. In column (1) and (2), the dependent variable is father's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in first three waves (1993, 1997, and 2000). In column (3),(4) and (5), the dependent variable is children's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in last two waves (2007, 2014). Household incomes in both generations were adjusted for inflation using the Susenas provincial CPI estimates separately for rural and urban areas. For father's generation, rural and urban are defined based on the location of household in 1993. The father's household income sample is restricted to fathers who are between 25 and 56 in 1993. In father's sample, the number of working age adults is the total number of individuals who are between age 18 to 60 within the household in 1993. For children, rural and urban defined based on the location of birth. If the child was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. The children sample is restricted to individuals who are 18 to 40 in 2007 and also a household head. In children's sample, the number of working age adults is the total number of individuals who are between 18 to 60 within the household in 2007. The sample excludes top 1 percent of household income in both father's and children's generation.

Table 6: Recovering the Structural Parameters

	Rural		Urban	
	Estimate	S.E.	Estimate	S.E.
δ_0	4.526	0.410	5.721	0.297
δ_1	0.0482	0.0071	0.0218	0.0026
δ_2	0.0004	0.0001	0.0000	0.0000
δ_3	0.0035	0.0006	0.0004	0.0001
δ_4	0.0451	0.0570	0.1971	0.0278
β_1	1.6225		1.6225	
β_2	0.0001		0.0001	
σ	0.6000		0.6000	

Notes: The estimates are based on annual interest rates of 24 percent (urban) and 77 percent (rural). The parental altruism parameter is set at 0.60.

Figure 1R: Goodness of fit for rural sample

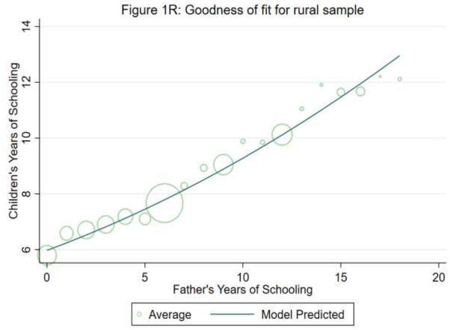
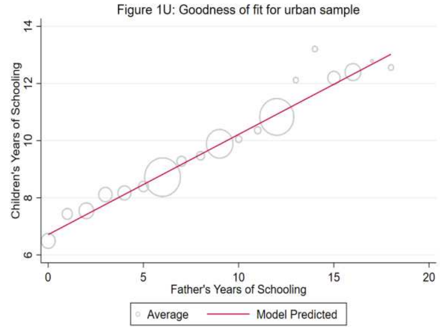


Figure 1U: Goodness of fit for urban sample



Note: The size of bubble is proportionate to number of observations

Figure 2R: School Quality and Parental Inputs: Rural Areas

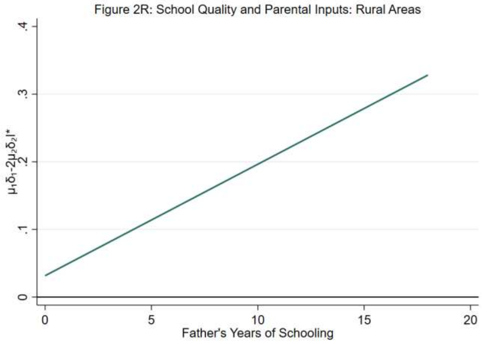


Figure 2U: School Quality and Parental Inputs: Urban Areas

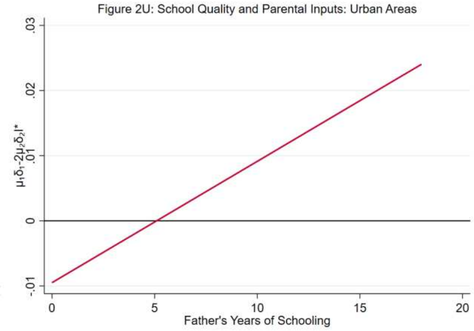


Figure 3R: Expected Children's Years of Education in Rural Areas

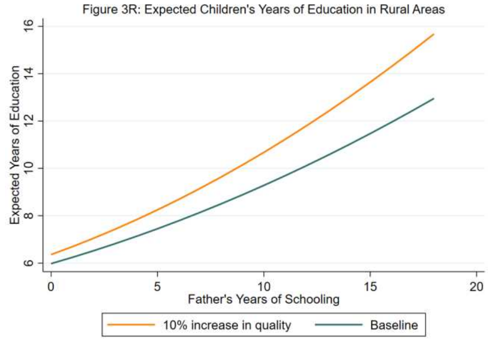
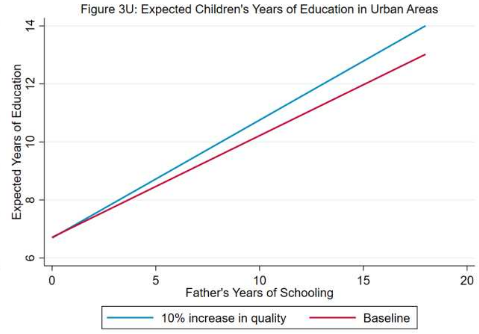


Figure 3U: Expected Children's Years of Education in Urban Areas



Online Appendix: Not for Publication

OA1. Sources of Complementarity: An Extended Discussion

Becker et al. (2015, 2018) note neighborhood peer and role model effects as possible sources of complementarity, but emphasize the role of more efficient investment choices of the educated parents in a complex education market such as college choices in USA. In the context of a developing country such as Indonesia where education investment choices are not complex, we expect peer and role model effects to be more important. In addition to an educated father being a natural role model for his children, there are two other plausible sources of role model effects. An educated mother is likely to be important as a role model, and educated adults in the neighborhood may also act as role models for children. The focus of the analysis in this subsection is whether the observed complementarity between father's education and financial investment is generated primarily by the fact that father's education is a proxy for other correlated factors such as mother's education (assortative marriage matching), and neighborhood peers and role models (higher educated fathers locate in better neighborhoods).

Denote the candidate mechanism for complementarity as E^z, for example, E^z is the average education of the peers when the focus is on peer effects as a possible explanation for the complementarity.[1] To check if the complementarity in the mobility equation is driven by factors correlated with father's education, we estimate the following mobility equation: $\mathrm{E}_i^{c^*} = \psi_0 + \psi_{1p} E_i^p + \psi_{1z} E_i^z + \psi_{2p} \left(E_i^p\right)^2 + \psi_{2z} \left(E_i^z\right)^2 + \psi_{3z} \left(E_i^p \times E_i^z\right) + \alpha_1 \phi_i - \alpha_2 \left(\phi_i\right)^2$ Note that the above specification allows for direct quadratic effect of a mechanism, for example, for $z = m$ (mother's education), we include E_i^m and $(E_i^m)^2)$ in addition to the interaction effect with father's education $(E_i^p \times E_i^m)$.[2] We check whether the addition of these alternative mechanisms makes the estimated ψ_{2p} zero or negative.

The evidence reported in Table A.6 in this appendix suggests that the convex effect of father's education in rural Indonesia cannot be explained by peer, role model, and mother's education as mediating factors. The positive coefficient on father's education squared remains

[1] We emphasize that our analysis does not deal with the effects of peer and role models in transmitting education across generation. The analysis below is focused only on the question whether these factors might be responsible for the complementarity between father's education and financial investment suggested by the evidence.

[2] E_i^m is mother's education.

unchanged or even increases in magnitude when we control for other possible sources of convexity in the regression. This suggests that father's own nonfinancial impacts such as role model effect and home teaching are the likely mechanisms underlying the convex mobility CEF in rural Indonesia.

The evidence on urban areas is also similar: the inclusion of the alternative mechanisms of complementarity does not make the effect of father's education concave which would be the case if the complementarity is driven by these alternative factors. The estimates for urban areas with the inclusion of neighborhood peer and role model effects are particularly interesting: the coefficient on father's education squared ψ_{2p} in fact becomes positive and significant at the 5 percent level in these cases.

OA.2 Data Appendix

The Indonesian Family Life Survey (IFLS) is an ongoing longitudinal survey. So far five waves have been fielded. The first wave was fielded in 1993, and the second, third, fourth and fifth waves were fielded in 1997, 2000, 2007 and 2014, respectively. At the time of the first wave, 7224 households were interviewed and it represented 83 % of the national population of Indonesia covering 13 out of the 27 provinces (**?**). In the subsequent waves, the sample size grew because others joined the sampled households either through marriage and births. An appealing feature of the IFLS is its low-attrition rate (**?**).

Below we provide detailed discussion and rationale on how we have obtained different variables from the IFLS data:

Children Sample:

As noted in data section, our primary mobility sample is based on children who are 18 to 40 years old in 2014 (wave 5). We restrict the sample to 18 to 40 years old of the fifth wave for two reasons. First, these individuals were in school at some point during 1990s and 2000s. Therefore, we can use the previous waves to estimate the effects on schooling investment. Secondly, only in the fifth wave, the IFLS started to collect Raven Test scores a measure of "fluid intelligence" for all adults. Since we include cognitive ability in much of our analysis, we have chosen to use the fifth wave for our children sample.

Child Years of Education:

In order to obtain the child years of education, we use two sources of data in the fifth wave of the IFLS: book 3A and roster. Book 3A has education information for anyone who is 15 years and older. If the 18 to 40-year-old household member do not have education reported in book 3A, we use the education reported in roster.

Father's Years of Education:

We use three sources to calculate father's years of education. Below we discuss each source:

Household roster: As noted above, the IFLS household roster reports education information of the household member. Moreover, the roster data also provides household member ID of father and mother of each child listed in the roster. Starting with the latest (fifth) wave, we check if the father has co-resided with children at any wave. If the father has co-resided with the children during the any wave, we obtain the education information from the latest wave in which the father has co-resided with the children.

Non-resident parents module: For any household member who is 15 years and older, the IFLS asks about parental education if the parents are not residing in the same household. If the child did not co-reside with the father in any of the survey waves, we use this module to obtain father's years of education. Using the panel ID, we identify the latest wave in which the children have reported parental education of non-resident parents and extract that education information.

Mothers marriage module: Ideally, we should be able to find education information all fathers using the above two sources. But in some cases, the fathers' education is missing because of non-response or the reported value exceed any meaningful years of schooling value. The IFLS asks all married women about their husband's years of education if the husband is not residing in the household. If we unable to find father's years of education using above two sources, we identify if the mother has co-resided with the child in any of the waves. If the mother co-resided with the child, we then use mother's marriage module to obtain fathers' schooling information.

Using all three sources, we are able to collect fathers' education information for almost 90 percent of the sample.

Children's Birth Location:

For any household member who are 15 or older, the IFLS has information about the location types of birth: village, small town, or a big city. If the respondents were born in a village, we define the birth location as rural and otherwise, urban. The IFLS collects this information in all waves. For any respondent, we use the birth location in the latest wave in which the respondent reported his/her birth location type.

Child Cognitive Ability:

We use the Raven test scores and two memory tests to construct the cognitive ability index. An advantage of these measures is that they do not require any knowledge of numeracy or literacy to do well in the tests. To arrive at the index, we first take the first principal component of the raven test scores and two memory tests. Then we regress that on age and age square. A critical issue is that cognition outcomes are positively correlated with age because of the Flynn effect. We, therefore, use residual of the regression as the cognitive ability index.

Education Expenses:

The IFLS has separate education modules for children (age below 15) and adult (age equal to or above 15). The expense data includes all types of school-related expenses. We aggregate the expenses Using the Panel ID, we match individuals of our children sample (18 to 40 years old in wave 5) with their education expense data in the previous waves. The expenses are then adjusted for inflation taking 1993 as the base year; we obtain the yearly inflation of Indonesia from the World Bank web site.

In the investment sample, we also control for number of school age of children. To calculate the number of school children in wave, we first obtain the fathers' ID from the roster. We then calculate how many other individuals in the education sample also listed as the same ID as the father. That number provides us with the number of school age children. Finally, in the investment sample, we also include whether the household is located in urban area or rural area. In each wave, the household location information is available in book K. We match the household ID with the location information.

Permanent income:

We use the household expenditures as a proxy for income, since income data often suffer from more measurement error than household expenditure. For the fathers' generation, we use the average of household consumption expenditure of the first three waves, and the children's generation, we the average of household consumption expenditure of the last two waves. Below we discuss in more details how we calculate the permanent income:

Fathers' generation permanent income:

For each of the first three waves, we first separately calculate the household expenditure. For each household member, the IFLS provides his/her relationship to household head. We identify the households in which the individuals of our children sample (18 to 40 years old in 2014) were listed as children or grandchildren in the any of the first three waves. We consider both children and grandchildren because these children may grow up in an extended family where the grandfather is household head. Using the household tracking id, we then merge the identified households with their total expenditures. We adjust for inflation by using yearly inflation data from the World bank web site taking 1993 as the base year. After this we merge the sample with fathers' age information. We restrict the sample to fathers who are age 25 to 56 in 1993.

Children's Generation Permanent Income:

For each of the last two waves, we first calculate the household expenditure. Since we want to focus on children who are 25 to 56 years old in 2007, we extend the original children sample to this age group. We then identify children who are household heads in 2007. We wanted to make sure the children are household heads because if the children are living with parents, we may falsely attribute the permanent income of children to parents. Then we merge the household expenditure of the fourth wave (2007) with the household expenditure of the fifth wave (2014) using the household tracking ID. We adjust inflation taking 1993 as the base year.

Role model data:

The role model in our study are individuals who were born in the same district as the child and belong to the top 50 percent of education distribution of fathers' reference age group. To calculate the role model education, we first needed to obtain fathers' age. We check if the father has co-resided with children in any of waves. If we can find the father, we obtain the age from the household roster and convert that value to what his age would be in 2014. For the non-resident father, we obtain the age from the non-resident module. The IFLS asks age at death and year of death, if the father is not alive. Using this information, we calculate what would have been fathers' age in 2014. We then obtain the birth district information of the children. Separately, next we use the roster data of each wave to obtain years of education and age of all individuals who are older than 22 at the time of the survey. We choose older than 22 because by age 22 the individuals would have completed their education. Then we convert the age of these individuals to the value it would be in 2014. Using the birth district information, we obtain the birth district of all the individuals in the roster. For any given age, we calculate the average of years of education of the top 50 percent achievers within the ± 3 (± 5 for robustness check) age group of a district. We then merge the district ID information and age information with the birth district ID and father age information of the data above.

Peer Data:

We select individuals who are within ± 3 (± 5 for robustness check) of the age group of our children sample and born in the same district as the children. First, we create a data where we include individuals who are 15 to 43 years old. We then obtain years of education and birth district information for these individuals. After that, we take the average years of education for ± 3 (± 5 for robustness check) of the age group for each district. We then restrict that sample to 18 to 40 years old and merge the sample to the original

References

Frankenberg, Elizabeth, Lynn A Karoly, Paul Gertler, Sulistinah Achmad, IGN Agung, Sri Harijati Hatmadji, and Paramita Sudharto, "The 1993 Indonesian family life survey: Overview and field report," 1995.

Strauss, John, Firman Witoelar, and Bondan Sikoki, *The fifth wave of the Indonesia family life survey: overview and field report*, Vol. 1, RAND Santa Monica, CA, 2016.

Appendix

Table A.1: Intergenerational Persistence in Schooling (Ability Interacted with Father Education)

	LINEAR CEF			QUADRATIC CEF		
	Rural(R)	**Urban(U)**	**R-U**	**Rural(R)**	**Urban(U)**	**R-U**
Father Edu	0.4097***	0.4429***	-0.0332	0.2504***	0.3332**	-0.0828
	(0.0284)	(0.0355)	(0.0435)	(0.0755)	(0.1408)	(0.1492)
Father Edu Sq				0.0136**	0.0070	0.0066
				(0.0054)	(0.0081)	(0.0093)
Father Edu × Ability Index	-0.0179	-0.0253*	0.0074	-0.0136	0.0101	-0.0237
	(0.0112)	(0.0137)	(0.0171)	(0.0313)	(0.0611)	(0.0662)
Father Edu × Ability Index Sq	0.0012	0.0012	0.0000	0.0019	-0.0026	0.0045
	(0.0010)	(0.0012)	(0.0016)	(0.0029)	(0.0056)	(0.0062)
Father Edu Sq × Ability Index				-0.0010	-0.0022	0.0011
				(0.0021)	(0.0034)	(0.0039)
Father Edu Sq × Ability Index Sq				-0.0000	0.0002	-0.0002
				(0.0002)	(0.0003)	(0.0004)
Constant	5.4906***	6.0809***	-0.5902	5.7730***	6.3833***	-0.6103
	(0.2660)	(0.3527)	(0.3932)	(0.3075)	(0.5631)	(0.5489)
Ability Index	0.7720***	0.6230***		0.7913***	0.5183**	
	(0.0937)	(0.1426)		(0.1188)	(0.2490)	
Ability Index Sq	-0.0438***	-0.0233*		-0.0472***	-0.0113	
	(0.0082)	(0.0133)		(0.0110)	(0.0237)	
Observations	10236	5230	15466	10236	5230	15466

Notes: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). Rural and Urban are defined based on location of birth. If the respondent was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. Cognitive ability index is expressed in percentile; it is constructed taking the first principal component of Raven Test and two memory memory tests net of age and age square.

Table A.2: Estimates of the Investment Equation (Winsorized Sample)

Father's Years of Education	11.16***	11.20***	10.72***
	(0.79)	(0.80)	(0.79)
HH Rural (=1)	-12.66*	-13.02*	-10.72
	(7.08)	(7.12)	(7.00)
Father's Years of Education × Rural	-5.19***	-5.17***	-5.15***
	(0.93)	(0.93)	(0.91)
Number of School Age Children		-5.09***	-5.07***
		(1.53)	(1.49)
Ability Index			3.43
			(2.39)
Ability Index Sq			0.15
			(0.24)
Constant	52.88***	60.90***	40.89***
	(6.87)	(7.20)	(7.98)
Observations	18325	18325	18325

Notes: Standard errors are clustered at the community level (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). The top 1 percent educational expenses is winsorized. The sample mean of monthly average educational expenditure 143.18 rupiah (adjusted for inflation), whereas the top 1 percent mean of monthly average educational expenditure is 2,118.92 rupiah (adjusted for inflation). The dependent variable is average monthly educational expenditure which is adjusted for inflation using the Susenas provincial CPI estimates separately for rural and urban areas. All regressions include wave fixed effects. Rural and urban are defined based on location of household at the time of survey. Cognitive ability index is expressed in percentile; it is constructed taking the first principal component of Raven Test and two memory memory tests net of age and age square.

Table A.3: Household-level Returns to Education for Father and Children (Winsorized Sample)

	Father's Generation		Children's Generation		
Years of education	1686.33***	1655.56***	2004.78***	2057.06***	2053.84***
	(118.92)	(115.34)	(225.28)	(225.19)	(238.29)
HH Rural (=1)	2608.65**	3541.84***	5246.41*	5651.44**	6199.82**
	(1218.72)	(1195.26)	(2708.89)	(2680.85)	(2823.11)
Years of Education × HH Rural	-481.60***	-459.86***	-593.68**	-620.24**	-657.66**
	(157.23)	(152.64)	(256.00)	(254.86)	(269.34)
Number of Working Age Adults		3151.50***		1373.30***	1467.71***
		(267.16)		(291.66)	(310.67)
Constant	14465.51***	5859.24***	13042.91***	9017.87***	9486.97***
	(972.66)	(1183.52)	(2479.29)	(2566.25)	(2786.42)
Ability Index					-989.94**
					(486.12)
Ability Index Sq					123.17**
					(48.08)
Observations	3992	3992	3545	3545	3395

Notes: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). Unit of observation is household in both father's generation and children's generation. If reported father year's education varied within a household, an average of father's years of education is taken. In column (1) and (2), the dependent variable is father's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in first three waves (1993, 1997, and 2000). In column (3),(4) and (5), the dependent variable is children's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in last two waves (2007, 2014). Household incomes in both generations were adjusted for inflation using the Susenas provincial CPI estimates separately for rural and urban areas. For father's generation, rural and urban are defined based on the location of household in 1993. The father's household income sample is restricted to fathers who are aged between 25 and 56 in 1993. In father's sample, the number of working age adults is the total number of individuals who are between age 18 to 60 within the household in 1993. For children, rural and urban defined based on the location of birth. If the child was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. The children sample is restricted to individuals who are 18 to 40 in 2007 and also a household head. In children's sample, the number of working age adults is the total number of individuals who are between 18 to 60 within the household in 2007. The top 1 percent sample is winsorized at 99 percent level.

Table A.4: Children's Generation Returns to Education (Trimming Right Tail 1 Percent)

	Urban					
	Include Ability Controls	**KLS Estimates–Without Ability Controls)**				
		$\rho = 0$	$\rho = 0.01$	$\rho = 0.02$	$\rho = 0.03$	$\rho = 0.04$
	(1)	(2)	(3)	(4)	(5)	(6)
Child Years of Education	1612.90***	1720.20***	1666.03***	1611.84***	1557.62***	1503.35***
	(198.07)	(174.01)	(174.04)	(174.14)	(174.30)	(174.52)
Number of Working Age Adults	668.92*	702.35*	691.43*	680.51*	669.58*	658.64*
	(397.90)	(385.53)	(385.55)	(385.62)	(385.72)	(385.86)
Constant	11400.50***	12859.50***	13492.89***	14126.48***	14760.45***	15395.00***
	(3053.49)	(2334.39)	(2334.75)	(2335.83)	(2337.64)	(2340.18)
Observations	961	961	961	961	961	961

	Rural					
	Include Ability Controls	**KLS Estimates–Without Ability Controls)**				
	(1)	(2)	(3)	(4)	(5)	(6)
Child Years of Education	1233.21***	1247.01***	1202.09***	1157.17***	1112.21***	1067.22***
	(117.73)	(91.50)	(91.53)	(91.60)	(91.73)	(91.90)
Number of Working Age Adults	1056.90***	1052.62***	1045.42***	1038.22***	1031.02***	1023.81***
	(274.62)	(253.08)	(253.09)	(253.13)	(253.20)	(253.29)
Constant	17542.96***	16431.53***	16864.15***	17296.91***	17729.93***	18163.33***
	(1376.82)	(1132.79)	(1133.00)	(1133.63)	(1134.70)	(1136.19)
Observations	2401	2401	2401	2401	2401	2401

Notes: Standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Column (1) reports OLS estimates controlling for ability and ability square. In columns (2) to (6), ρ represents assumed correlation between education and omitted cognitive ability. Unit of observation is household. The dependent variable is children's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in last two waves (2007, 2014). For children rural and urban defined based on the location of birth. If the child was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. The children sample is restricted to individuals who are 18 to 40 in 2007 and also a household head. In children's sample, the number of working age adults is the total number of individuals who are between 18 to 60 within the household in 2007. The sample excludes top 1 percent of household income.

Table A.5: Father's Generation Returns to Education (Trimming Right Tail 1 Percent)

	Urban KLS				
	$\rho = 0$	$\rho = 0.01$	$\rho = 0.02$	$\rho = 0.03$	$\rho = 0.04$
	(1)	(2)	(3)	(4)	(5)
Father's Years of Education	1469.46***	1432.84***	1396.21***	1359.55***	1322.87***
	(88.47)	(88.49)	(88.52)	(88.58)	(88.66)
Number of Working Age Adults	2638.50***	2641.37***	2644.24***	2647.12***	2649.99***
	(281.99)	(282.00)	(282.05)	(282.12)	(282.22)
Constant	7857.20***	8144.69***	8432.25***	8719.99***	9007.99***
	(1113.31)	(1113.40)	(1113.67)	(1114.12)	(1114.76)
Observations	1712	1712	1712	1712	1712
	$\rho = 0$	$\rho = 0.01$	$\rho = 0.02$	$\rho = 0.03$	$\rho = 0.04$
			Rural KLS		
	(1)	(2)	(3)	(4)	(5)
Father's Years of Education	1147.40***	1114.41***	1081.41***	1048.39***	1015.34***
	(69.68)	(69.70)	(69.73)	(69.80)	(69.89)
Number of Working Age Adults	2792.87***	2793.98***	2795.08***	2796.18***	2797.29***
	(282.95)	(282.97)	(283.01)	(283.08)	(283.18)
Constant	10174.10***	10352.48***	10530.91***	10709.44***	10888.14***
	(835.49)	(835.55)	(835.74)	(836.07)	(836.52)
Observations	2241	2241	2241	2241	2241

Notes: Standard errors in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). In columns (1) to (5), ρ represents assumed correlation between education and omitted cognitive ability. Unit of observation is household. If reported father year's education varied within a household, an average of father's years of education is taken. The dependent variable is father's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in first three waves (1993, 1997, and 2000). Inflation rates were adjusted using the Susenas provincial inflation estimates separately for rural and urban areas. For father rural and urban are defined based on the location of household in 1993. The fathers income sample is restricted to fathers who are between 25 and 56 in 1993. In father's sample, the number of working age adults is the total number of individuals who are between age 18 to 60 within the household in 1993. The sample excludes top 1 percent of household income.

Table A.6: Sources of Complementarity Between Financial Investment and Father's Education

	Mother Education					
	Urban			**Rural**		
	(1)	(2)	(3)	(4)	(5)	(6)
Father's Years of Education	0.374***	0.257***	0.227***	0.304***	0.184***	0.163***
	(0.047)	(0.047)	(0.046)	(0.030)	(0.029)	(0.027)
Father's Years of Education Square	0.000	0.003	0.004	0.007***	0.015***	0.015***
	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)	(0.002)
Mother's Years of Education × Father's Years of Education		-0.012**	-0.011**		-0.024***	-0.023***
		(0.005)	(0.004)		(0.004)	(0.004)
Mother's Years of Education		0.224***	0.210***		0.255***	0.222***
		(0.049)	(0.047)		(0.032)	(0.031)
Mother's Years of Education Square		0.007**	0.006**		0.012***	0.013***
		(0.003)	(0.003)		(0.003)	(0.003)
Cognitive Ability Index Residual in Percentiles			0.413***			0.638***
			(0.063)			(0.055)
Cognitive Ability Index Residual in Percentiles Sq			-0.016***			-0.035***
			(0.006)			(0.005)
Constant	8.345***	7.847***	6.522***	7.908***	7.391***	5.669***
	(0.237)	(0.262)	(0.285)	(0.148)	(0.157)	(0.229)
R2	0.251	0.295	0.345	0.200	0.239	0.298
Observations	5064	5064	5064	9733	9733	9733
	Peer Education (± 3 Years)					
	Urban			**Rural**		
	(1)	(2)	(3)	(4)	(5)	(6)
Father's Years of Education	0.357***	0.757***	0.698***	0.301***	0.584***	0.551***
	(0.047)	(0.080)	(0.079)	(0.030)	(0.062)	(0.060)
Father's Years of Education Square	0.002	0.010***	0.010***	0.007***	0.010***	0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Father's Years of Edu × Average Years of Peer Edu		-0.056***	-0.052***		-0.041***	-0.041***
		(0.008)	(0.008)		(0.006)	(0.006)
Average Years of Education of Peer		0.857***	0.796***		0.875***	0.654***
		(0.240)	(0.222)		(0.163)	(0.139)
Average Years of Education of Peer Sq		0.014	0.012		0.008	0.017**
		(0.012)	(0.011)		(0.009)	(0.008)
Cognitive Ability Index Residual in Percentiles			0.354***			0.580***
			(0.059)			(0.046)
Cognitive Ability Index Residual in Percentiles Sq			-0.013**			-0.031***
			(0.005)			(0.004)
Constant	8.329***	-1.739	-2.125*	7.892***	-1.111	-1.467**
	(0.240)	(1.283)	(1.198)	(0.149)	(0.757)	(0.622)
R2	0.244	0.354	0.391	0.192	0.321	0.372
Observations	5079	5079	5079	9904	9904	9904
	Role Model Education (± 3 Years)					
	Urban			**Rural**		
	(1)	(2)	(3)	(4)	(5)	(6)
Father's Years of Education	0.114***	0.217***	0.189***	0.152***	0.167***	0.131***
	(0.043)	(0.054)	(0.052)	(0.029)	(0.037)	(0.035)
Father's Years of Education Square	0.017***	0.020***	0.020***	0.014***	0.018***	0.018***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Father's Years of Education × Average Years of Education of Role Model		-0.016***	-0.015***		-0.010**	-0.009**
		(0.004)	(0.004)		(0.004)	(0.004)
Average Years of Education of Role Model		0.182	0.176		0.191***	0.157**
		(0.116)	(0.111)		(0.066)	(0.061)
Average Years of Education of Role Model Sq		-0.001	-0.002		-0.002	-0.001
		(0.005)	(0.005)		(0.004)	(0.004)
Cognitive Ability Index Residual in Percentiles			0.245***			0.503***
			(0.071)			(0.052)
Cognitive Ability Index Residual in Percentiles Sq			-0.002			-0.026***
			(0.007)			(0.005)
Constant	7.829***	6.359***	5.433***	7.472***	6.214***	4.940***
	(0.202)	(0.687)	(0.687)	(0.127)	(0.288)	(0.272)
R2	0.254	0.258	0.293	0.191	0.200	0.251
Observations	4112	4112	4112	8311	8311	8311

Notes: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). A peer is someone who was born in the respondents district within ± 3 years of respondents birth. Rural and Urban are defined based on location of birth. A role model is someone who was born in the respondents district but is within ± 3 of respondents father age and belongs to top 50 percent education level within that age group of that district. If the respondent was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. Ability controls include ability index and ability index square. Cognitive ability index is expressed in percentile; it is constructed taking the first principal component of Raven Test and two memory memory tests net of age and age square.

Table A.7: Simulation Results for 10% Improvement in School Quality

	Baseline		ML interest rate=77%		ML interest rate=100%	
	Rural	Urban	Rural	Urban	Rural	Urban
δ_0	4.526	5.721	4.979	6.294	4.814	6.087
δ_1	0.048	0.022	0.042	0.019	0.046	0.023
δ_2	0.000	0.000	0.000	0.000	0.000	0.000
θ_0	30.342	45.605	33.422	21.133	32.653	30.877
θ_1	4.687	7.820	7.028	11.563	6.674	11.012
ψ_0	5.975	6.711	6.357	6.689	6.321	6.784
ψ_1	0.259	0.351	0.324	0.406	0.319	0.406
ψ_2	0.007	0.000	0.011	0.000	0.010	0.000

Note: ML stands for Money-lender. The annual bank (urban) interest rate is 24%. The parental altruism Parameter is 0.60.

Table A.8: Household-level Returns to Education for Father and Children Including Age and Age Square (Trimmed Sample)

	Father's Generation		Children's Generation		
Years of education	1560.64***	1522.86***	1686.84***	1701.38***	1733.22***
	(114.51)	(112.55)	(184.47)	(183.67)	(200.04)
HH Rural(=1)	2060.82*	2819.45**	3386.65	3531.18	4334.28*
	(1127.26)	(1119.32)	(2308.20)	(2289.60)	(2409.58)
Years of Education × HH Rural	-312.37**	-298.97**	-369.13*	-379.18*	-443.80**
	(145.00)	(142.07)	(209.24)	(208.32)	(224.88)
Age	2025.99***	2862.70***	542.83	355.86	257.59
	(385.73)	(371.01)	(614.74)	(617.34)	(631.15)
Age Square	-14.18***	-21.60***	-0.30	1.83	2.91
	(3.19)	(3.07)	(8.32)	(8.35)	(8.54)
Number of Working Age Adults		2631.29***		538.85***	574.64***
		(235.80)		(204.61)	(218.19)
Constant	-54887.73***	-84956.56***	-5114.78	-2679.27	-1017.64
	(11424.78)	(11064.00)	(11290.07)	(11329.95)	(11640.53)
Ability Index					-415.02
					(407.41)
Ability Index Sq					59.39
					(39.58)
Observations	3953	3953	3510	3510	3362

Notes: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). Unit of observation is household in both father's generation and children's generation. If reported father year's education varied within a household, an average of father's years of education is taken. In column (1) and (2), the dependent variable is father's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in first three waves (1993, 1997, and 2000). In column (3),(4) and (5), the dependent variable is children's permanent income (inflation adjusted), which is calculated taking an average of household consumption expenditure in last two waves (2007, 2014). Household incomes in both generations were adjusted for inflation using the Susenas provincial CPI estimates separately for rural and urban areas. For father's generation, rural and urban are defined based on the location of household in 1993. The father's household income sample is restricted to fathers who are aged between 25 and 56 in 1993. In father's sample, the number of working age adults is the total number of individuals who are between age 18 to 60 within the household in 1993. For children, rural and urban defined based on the location of birth. If the child was born in a big city or town, it was considered as Urban, and if the respondent was born in a village, it was considered Rural. The children sample is restricted to individuals who are 18 to 40 in 2007 and also a household head. In children's sample, the number of working age adults is the total number of individuals who are between 18 to 60 within the household in 2007. The sample excludes top 1 percent of household income. All regressions include age and age square.