Essays in Health, Education and Development

by

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Public Policy Studies
Duke University

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor of Philosophy in Public Policy Studies
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ABSTRACT

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Abstract

This dissertation encompasses three essays that examine the extent to which parental loss and social programs affect the health, education and time allocation of children in developing countries.

The first chapter asks the question of whether early life public health interventions have lasting or long term impact on children's human capital development. In order to answer this question, this chapter investigates the long term impact of the safe motherhood program in Indonesia on later cognition and schooling outcomes of children when they are age 11 to 17 years. The paper further investigates this question by examining the impact of the program based on exposure that began during a particular year. The findings suggest that the safe motherhood program had an impact on adolescent cognition and schooling. In particular, the program impact is relatively large and significant for those children who began exposure to the program at age 2 or younger, or not yet conceived. These estimates are robust to a series of robustness and specification checks. The results are also in general consistent with the findings in biological literature that suggest the importance of the first two years of life in shaping outcomes later in life.

The second chapter examines the question of how parental loss or absence affects child well-being. While the strategy of many papers in the literature is to use parental death due to HIV/Aids to examine this question, this chapter uses the 2004 Indian Ocean tsunami as a plausibly exogenous source of variation in parental death. In addition, the

paper uses a unique longitudinal dataset that has baseline information on the same sample of individuals interviewed after the tsunami. Also, given rich data, the paper is able to look at various dimensions of child well-being which include school attendance, post-secondary aspirations, time allocation as well as educational attainment and marriage decisions for older children. The paper provides an in-depth analysis by examining the impact of parental death by age and gender of the child as well as looking at the impact in the short term and longer term. The results suggest that death of both parents, which has been little explored in the literature, has a large, negative impact on the human capital accumulation of both males and females. The loss of father alone led older males (aged 15 to 17 at the time of tsunami) to acquire less education compared to same age males whose both parents survived, while no effect is found on younger males aged 9 to 14. Furthermore, the results suggest that maternal death has little impact on schooling outcomes but does affect time allocation of children.

Finally, the third chapter examines the impact of a unique bilateral grant-aid program which provided typhoon-resistant schools and instructional equipment to the Philippines. The results suggest that the presence of both the typhoon-resistant schools and instructional equipment programs had a positive impact on the educational attainment of both men and women. The availability of instructional equipment program alone also increased the educational attainment of men but it does not seem to

have had substantive effect on women. On the other hand, the availability of typhoon-resistant schools without the instructional equipment package did not have any impact on schooling outcomes of either the males or females. Except for the falsification exercise which suggests that there could be other underlying trends which may not be fully captured by the specifications, the estimates are in general robust to the inclusion of individual level characteristics, accounting of other concurrent national government's programs, restricting to municipalities in the *typhoon belt* region and accounting for municipality-specific trends. The findings suggest the importance of not only expanding access to schooling through increased availability of schools or classrooms (particularly, those that are resistant to natural disasters) but also the importance of improving the quality of learning through the availability of school resources that aide in students' learning in developing countries.

Dedication

I dedicate this dissertation to my family, relatives and friends who have tirelessly supported and encouraged me throughout my PhD studies. This is especially dedicated to my parents.

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Acknowledgements

First and foremost, I am very grateful to my adviser, Elizabeth Frankenberg, for all her support and guidance. I thank her for believing in me and for allowing me to do things on my own at times and make mistakes along the way. Without those mistakes, I would not have learned a thing about myself and I would not have discovered the topic and strategy for my job market paper. I also thank Duncan Thomas, Alessandro Tarozzi and Amar Hamoudi for their guidance and suggestions to improve my papers. Furthermore, I am very grateful to the generosity of International Institute for Education/Hewlett Foundation Dissertation Fellowship Program and the Population Reference Bureau Fellows Program for not only providing me the funding support for my work but also for giving me the opportunity to get access to a growing network of wonderful scholars. Finally, I am very thankful to my family, relatives and friends for all their love and support.

1. Early Life Public Health Intervention and Adolescent Cognition: Evidence from the Safe Motherhood Program in Indonesia

1.1 Introduction

The past decades have seen a growing interest in public health investments in children at early stages of development. This is primarily due to the growing knowledge and awareness of the importance of environmental influences during the earliest childhood years on human capital achievement and success later in life. Striking evidence from a number of disciplines including behavioral development, neurobiology, medical epidemiology, population and economics converge on the key finding that environmental influences early in life have important implications for subsequent development. Despite this, few papers establish a direct link between early life public health interventions in developing countries and long run human capital outcomes (Cutler et. al., 2010; Joshi and Schultz, 2007; Field et. al., 2009; Maluccio, 2009; Ozier, 2011; Politt et. al., 1993). Likewise, important policy questions such as when and until when to intervene remain unresolved. Most studies show the importance of either the fetal period in isolation (Barker, 1994; Berhman and Rosenzweig, 2004; Almond, 2006; Almond et. al., 2009) or the early child-hood years (Alderman, 2006; Maccini and Yang, 2009) and thus little is still known about the relative importance of each period of development.

This paper exploits the ambitious safe motherhood intervention implemented in Indonesia during the early 1990s to evaluate the effects of a public health intervention on later human capital. Between 1990 and 1996, over 54,000 nursing

school graduates with one year of midwifery training were introduced in most of Indonesia's nonmetropolitan villages. Beyond providing skilled and safe delivery services to mothers, the village midwives implemented safe motherhood protocols that include providing prenatal, obstetric, postnatal and general primary health care to mothers and their children, as well as educating families on proper nutrition and other health promoting behaviors. Earlier studies provide evidence of the impact of the program on health outcomes in the short run: improved antenatal care and postnatal care (including longer exclusive breastfeeding); higher birth weight; better height-for-age of young children (aged 1 to 4) as well as improved body mass index of the reproductive age women in the communities (Frankenberg and Thomas, 2001; Frankenberg et. al., 2005; 2009).

The paper adds to the earlier studies on expanding access to midwives by examining the impact of the program expansion on cognitive outcomes measured during adolescence. I focus on cognition because there is a strong biological basis for the linkage between health and environment during early life and later cognitive ability. Influential researchers in the field of developmental psychobiology hypothesized that the nature of early experiences leads to 'permanent changes in neural cells in the cerebrum cortex' (Hunt, 1961; Politt et. al., 1993). Studies conducted in both animals and humans show that poor nutrition, micronutrient deficiencies, environmental toxins and poor stimulation particularly during the fetal period and the first two years of life result in later cognitive deficit (Politt et. al., 1993; Grantham-McGregor and Ani, 1999; Liu et. al., 2000; Meaney, 2001). More recently, a growing avenue of research based primarily in animal studies postulates that even

maternal health and nutrition status (diet, vitamin intake and glucose levels) prior to ovulation and conception, can have long term effects on fetal health as well as adolescent and adult outcomes (Aagaard-Tillery et. al., 2008; Kanakkaparambil, 2009; Wang et. al., 2009; Watkins and Fleming, 2009).

Since cognitive ability is likely to influence schooling outcomes, I also examine various measures of education including years of education completed. Attained education is a widely recognized measure of human capital and countless studies have examined the linkage between years of education and other outcomes including income, productivity and bargaining power (see Strauss and Thomas (1995) for survey of literature).

Beyond safe motherhood, my findings contribute to the small but growing literature that examines the long run impact of early life health interventions on later human capital. For instance, studies show that the maternal-and-child health and family planning program in Bangladesh had long run effects on test scores, health and schooling of children (Barham, 2010; Chauduri, 2005; Joshi and Schultz, 2007). Field, Robles and Torero (2009) show that Tanzanian children who benefited from iodine supplementation while in *utero* attained more schooling 10 to 14 years later than their counterparts who did not benefit from the supplementation. Cutler et. al. (2010) illustrate that exposure to malaria eradication program early in life led to modest increase in household per capita consumption of prime aged men. A recent paper by Ozier (2011) finds large cognitive effects for children who were less than one year old when their community received mass deworming intervention in Kenya. The well-known INCAP experimental study in Guatemala shows the

importance of nutritional intervention in the earliest childhood years (age 0 to 3) for later cognition, schooling and income (i.e., Hoddinott, 2008; Maluccio et. al., 2009; Politt et. al., 1993). The INCAP has been an influential treatment-control study linking child health to cognitive development. Despite this, the experimental study has some weaknesses which include large attrition and a small sample size with only four villages and no pure control group (see Strauss and Thomas (2008) for more detailed discussion).

In this study I use the Indonesian Family Life Survey (IFLS) which is a high quality, long-running longitudinal socio-economic survey of individuals, households and communities. I combine the panel dimension of IFLS with the variation in the availability and timing of the arrival of village midwives as well as the biology of cognition in order to carefully examine the impact of the program on outcomes of children over the longer run, at ages 11 to 17, when human capital outcomes are still in formation. Results show that exposure to program midwives had sizable and significant impacts on later measures of human capital. In particular, I find that children who were born during the rapid program expansion increased their test scores on average by 5.12% to 5.49%. This is equivalent to about 0.23 to 0.25 standard deviations increase if cognitive test scores are standardized, which is comparable to the effect size of receiving nutritional intervention from birth to age 3 (as that found in the INCAP experimental study in Guatemala). As a complementary analysis, I exploit the variation in the year of the arrival of the pro-gram midwives with respect to the timing of the child's birth to examine the effect of the program for each exposure period. Using this more flexible specification, the resulting estimates reveal

patterns of dose response. That is, the impact of the program is larger for those who are exposed at earlier stages of development. In particular, I find relatively large effects on cognition and schooling of children who were born in communities that received a midwife prior to their conception, while they were in *utero* and during their first two years of life (ranging from 0.13 to 0.33 standard deviations increase in standardized cognitive test scores and 0.23 to 0.52 more years of schooling). For children whose exposure began at age three or later, estimates become really small and non-significant. These results are consistent with the findings in the biological literature that the fetal period and the first two years of life are critical periods in brain development during which environmental influences could have persistent effects on one's cognitive processes.

The rest of the paper is organized as follows. Section 2 provides the background on the Safe Motherhood Program. Section 3 discusses the data and outcomes. Section 4 provides some background on the biology of cognition. Section 5 presents the econometric strategy. Section 6 discusses the results. Section 7 concludes.

1.2 Indonesia's Safe Motherhood Program

In this section I briefly review the history and the features of the first comprehensive Safe Motherhood Intervention in Indonesia drawing broadly from Frankenberg et. al. (2005), Frankenberg and Thomas (2001), Sweet et. al. (1995) and World Bank (1991). In 1987, the global Safe Motherhood Initiative was launched by the United Nations in cooperation with international maternal and child health

organizations. The initiative issued a call to action for national governments, funding agencies, and non-governmental organizations (NGOs) to make maternal health an urgent health priority. Thus in 1989, sparked by this global event, the Indonesia Ministry of Health (MOH) launched its first comprehensive safe motherhood intervention that aimed to train and deploy a large number of community midwives locally known as *bidan desa* throughout the nonmetropolitan villages in Indonesia. Between 1990 and 1996, over 54,000 nursing school graduates with one year of midwifery training were gradually deployed in most of Indonesia's non-metropolitan villages with the objective of exponentially increasing women's access to health care and safe delivery services.

This safe motherhood strategy is based on the principle that the village midwife will act as a 'linchpin' of safe motherhood activities at the community level. Beyond providing access to safe and medically oriented delivery services, the village midwife serves as a health resource person in the community providing antenatal, postnatal and general health care, working with traditional birth attendants and referring complicated obstetric cases to health centers and hospitals. Her duties include promoting community participation in health as well as educating families on family planning, on proper nutrition and other health-promoting behaviors. The village midwife particularly offers a number of services that could affect children's health. This includes provision of curative care and medicines such as antibiotics and cough syrup as well as children's immunizations and vitamins and mineral supplements.

Once assigned to a community, the village midwife is given a salary by the Government of Indonesia for three to six years in the expectation that this will lead to a permanent private practice in the community. She maintains a public practice during normal working hours and is allowed to practice privately after that.

1.2.1 Safe Motherhood studies in Indonesia

Since the safe motherhood program is primarily motivated by the long standing problem with maternal mortality in Indonesia, many studies examine the effect of the above intervention on maternal health. For instance, studies find that women in communities that received village midwives by the time of their conception were more likely to receive antenatal care, take iron tablets during their pregnancy and obtain medically oriented delivery (Frankenberg et. al., 2009; Hatt et. al, 2007). In general, the availability of village midwives in the communities also improved the nutritional status (body mass index) of women of reproductive age (Frankenberg and Thomas, 2001; Setyowati, 2003). Other studies examine the effects of the program on the outcomes of the children in their early life. For example, Shresthra (2010) finds that the introduction of the program led to lower infant mortality while Frankenberg, Suriastini and Thomas (2005) show that program improved the nutritional status of children aged 1 to 4 (as measured by height-for-age). A recent study by Giles and Satriawan (2011) show that the effect of nutritional

status on school enrollment of children aged 7-9 is higher if the child had access to the midwife during early childhood.[1]

These earlier studies suggest that the Safe Motherhood program had an immediate impact on the health of reproductive age women as well as children in the recipient communities. My study will examine whether these short term benefits actually persist and translate in better cognition and schooling outcomes of children later in adolescence.

1.3 The Indonesia Family Life Survey (IFLS)

The data come from the four waves of the Indonesia Family Life Survey (IFLS) conducted in 1993, 1997, 2000 and 2007 (known as IFLS1, IFLS2, IFLS3 and IFLS4, respectively). The IFLS is a large-scale ongoing longitudinal survey that collects information at the individual, household and community level. The IFLS began in 1993 with a sample of 7,224 households and 22,000 individuals in 13 provinces, representing 83% of the Indonesian population. One of the exceptional features of the data set is the high re-contact rate, including among those who relocate. The re-contact rates were high, with 94.4% of IFLS1 households re-contacted in IFLS2, and 95.3% of the original IFLS1 households re-contacted in IFLS3. In IFLS4 (nearly 15 years since IFLS1), 90.6% of the IFLS1, IFLS2 and IFLS3 households were

[1] Studies conducted by Frankenberg and colleagues take into account of the non-random placement of the program. Satriawan and Giles (2011) also try to address the endogeneity of the program using community fixed effects.

re-contacted. These rates are high compared to other long-running longitudinal surveys in developing countries.[2]

In the analysis I focus on children born between 1983 and 1996 in the original IFLS communities. In addition, I also examine the cohorts born between 1976 and 1982 as part of a falsification exercise. I match these children to their community of birth based on their mothers' location at the time of their birth.[3] I supplement that information with the individual responses of children who are aged 15 and above by 1997, 2000 or 2007 regarding their place of birth. Out of 10,245 children born between 1983 and 1996 and living in baseline IFLS communities in IFLS1 and IFLS2, 8762 were re-surveyed as young adults (age 11 to 17) in IFLS3 or IFLS4. Of the re-surveyed children, 8295 can be matched to their community of birth while 467 cannot be matched either because these children were born outside the original 321 IFLS enumeration areas or they have missing information on their place of birth.[4] The analysis for this paper will focus on children who were born in one of the original 321 IFLS enumeration areas (matched children). However as part of the robustness

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[2] See Frankenberg and Karoly (1995), Frankenberg and Thomas (2000), Strauss et. al. (2004) and Strauss et. al. (2009) for a full description of IFLS1, IFLS2 and IFLS3 and IFLS4, respectively.

[3] About 51% of the mothers in the sample have been living in the same village since age 12 or have never stayed outside the village for more than six months. For the rest of the mothers, I use mainly the location information based on their last move or the date of migration from the community where they were previously living to the IFLS baseline community. Thus the reporting bias on migration history could be less of an issue here given that individuals may be most accurate about their recent moves. As mentioned above, this information is also cross-checked with the individual responses of children interviewed in 1997, 2000 and 2007 as young adults.

[4] For the cohorts used in falsification analysis, of the 11,510 children born in1976 to 1989, about 7751were re-surveyed at ages 18 to 24. Of the re-surveyed children, 7068 can be matched to their community of birth while 683 cannot be matched either because they were born outside the IFLS original communities or they have missing information on place of birth. As expected, the individuals who were no longer interviewed are different from the ones interviewed in 2000/2007. This is particularly true for the falsification cohorts (see Appendix Table).

checks later, I add the unmatched children back to the sample to check whether estimates are sensitive to their inclusion.[5]

1.3.1 Identifying the Presence of Village Midwife

In each IFLS wave, the village head and the head of the PKK (Village Women's Group) were asked about the presence of a village midwife in each community.[6] In IFLS2, IFLS3 and IFLS4, more detailed questions were asked including the timing of the first village midwife's arrival in the community, number of village midwives in the community, the length of their stay and year when they left. The information in these modules is cross-checked against information from the volunteers at the village health post about where women obtain prenatal care and delivery assistance in order to evaluate the consistency of reporting on the village midwife's presence in the community. An index of the presence of midwives in the community and when they arrived is then constructed by combining information from these multiple sources. The Indonesian Family Life Survey (IFLS) data reflects the remarkable expansion of this program. As Figure 1 shows, while only about 5 percent of the IFLS communities had received program midwives in 1992, this fraction had risen to about 47 percent by 1996 indicating the rapid expansion of the program between 1993 and 1996. On average there are about 1.25 village midwives in the communities that received the program by 1997. Earlier studies (Frankenberg and Thomas, 2001; Frankenberg et. al., 2005) also show that the communities that received a village midwife were more likely to have poorer infrastructure and poorer

[5] The unmatched children are likely to be born to mothers who are more mobile. As expected, they are quite different from the matched children (see columns 1-3 of Appendix Table).
[6] In general the village leaders in Indonesia are known to be knowledgeable of the activities and programs, particularly government-sponsored ones, in their communities.

economic and health status. This non-random placement of the program therefore makes the evaluation less straightforward.

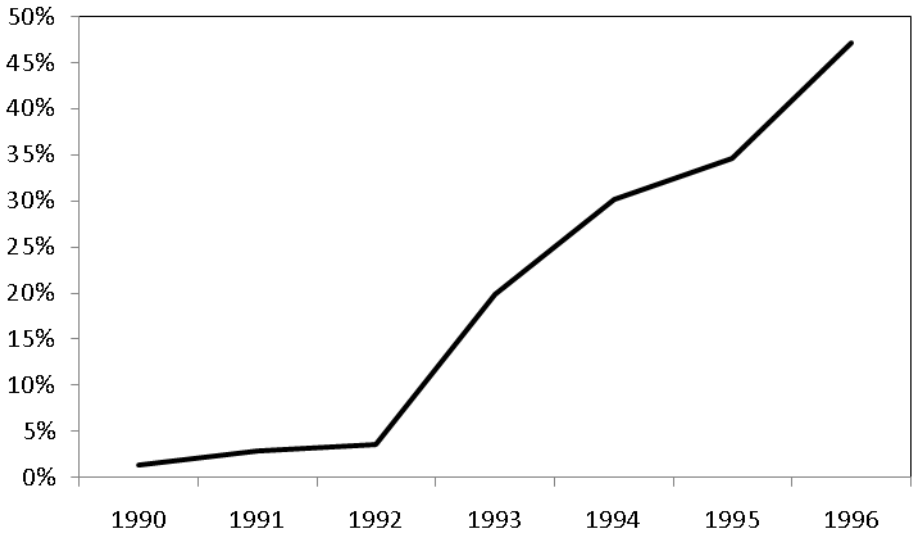

Figure 1: Expansion of the Safe Motherhood Program over the period 1990 to 1996

1.3.2 Outcomes

I examine cognition and also measures of education (completed years of education, age of entry in school, and school enrolment) when children are aged 11 to 17. The IFLS3 and IFLS4 survey waves administered the same cognitive test to individuals aged 7-24. The purpose of the cognitive test is to assess general cognitive level using Raven's Colored Progressive Matrices (CPM) test questions as well as a set of mathematics test questions. There are two levels of tests, one for those aged 7 to 14 and another for those aged 15 to 24. The Raven's CPM assessment is commonly used as a measure of general intelligence, and is considered as the single best measure of Spearman's general "intelligence factor" *g* (Kaplan and Saccuzzo, 1997).

This test consists of pattern-matching exercises wherein the respondent is asked to identify the `missing piece' that best matches the shown patterns (see an example in Figure 2). I considered standardizing the cognitive test scores within the sample but instead chose to use raw scores (percent correct) as dependent variable. The results are not sensitive to using standardized test scores.

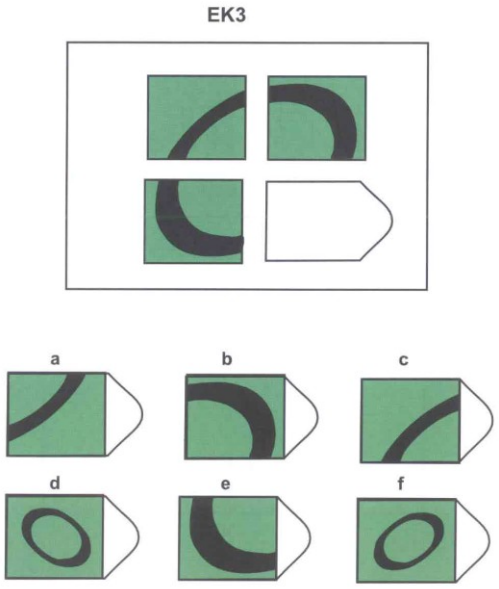

Figure 2: Raven's CPM Sample Exercise

1.4 The Biology of Cognition

Influential researchers in the field of developmental psychobiology hypothesized that the nature of early experiences leads to `permanent changes in neural cells in the cerebrum cortex' which could influence subsequent development (Hunt, 1961; Politt et. al., 1993). Negative effects of environment on the development of cerebral cortex have been documented extensively in both animal and human

studies. Experimental studies in animals show that early under-nutrition, micro-nutrient deficiencies, environmental toxins and poor stimulation can lead to permanent changes in brain structure and function and thus have long-lasting cognitive and behavioral effects (see for instance Liu et. al., 2000; Meaney, 2001; Rodier, 2004; Webb et. al., 2001). These animal studies were supported by large number of observational studies and a few randomized experiments conducted in humans providing evidence that poor nutrition and micronutrient deficiencies particularly during the fetal period and first two years of life results in later cognitive deficit (see a review of studies in Grantham-McGregor and Ani, 1999; Politt et. al., 1993). In economics, economists have investigated a wide range of environmental shocks during the fetal period and find impacts on a variety of later life outcomes along with health such as test scores, schooling and labor market outcomes (see Almond and Currie (2011) for a review of this rapidly growing literature). Other studies examine the effects of postnatal exposure to environmental shocks (particularly during the first 2 or 3 years of life) for later schooling and health outcomes (Alderman et. al., 2006; Maccini and Yang, 2009). The well-known INCAP experimental study in Guatemala finds that child exposure to nutritional supplementation from birth up to age 3 has long run positive effects on cognition and schooling (Maluccio, 2009).

More recently, a growing avenue of research (although still based primarily from animal studies) postulates that maternal health and nutrition status (diet, vitamin intake and glucose levels) prior to ovulation and conception, can have long term effects on later life outcomes (Aagaard-Tillery et. al., 2008; Kanakkaparambil,

2009; Wang et. al., 2009; Winder et. al., 2011). Studies suggest that the intrinsic developmental program during the pre-implantation period (or the period between fertilization of the egg and the implantation of the embryo in the uterus) appears to be responsive to external signals from the maternal environment to fine tune the course of development (Eckert and Fleming, 2008; Watkins and Fleming, 2009). In other words, during the first few days or weeks of pregnancy, the embryo undergoes rapid and significant developmental changes that depend largely on the prior health and nutritional status of the mother. From a range of animal studies and from different laboratories, it has been demonstrated that changes in the environment prior to the implantation of embryo either through nutrition or in vitro culture treatments can affect adult cardiovascular and metabolic health (Sinclair et. al., 2007; Thompson et. al., 2007, Watkins et. al., 2008).[7] Thus these studies also suggest the important role played by pre-conception health and nutritional status of mothers in determining the development of embryo and subsequent outcomes later in life. In humans, research shows that folic acid supplementation, started prior to conception, has markedly decreased the incidence of neural tube defects (Czeizel and Dudas, 1992; Berry et. al., 1999) although its long run effects on cognition are not yet well understood.

[7] For instance, Watkins and Fleming (2009) investigate the effects of low protein diet prior to conception in a mouse model. Although the treatment mice were fed with normal diet subsequently after conception, their o springs experienced higher probability of hypertension, arterial disease and even-metabolic disorders later in life. In this paper, I expand on the hypothesis of biological studies to examine the importance of preconception health for later economic outcomes.

Table 1: Summary Statistics by Presence of Village Midwife

	Panel A. Experiment of Interest		Panel B. Falsification Experiment	
	Cohorts Born 1983 – 1996		Cohorts Born 1976 - 1989	
Variables	Has Village Midwife by 1997	No Village Midwife by 1997	Has Village Midwife by 1997	No Village Midwife by 1997
Panel A. Control Variables				
Mother's education	5.01	6.49	4.09	5.63
	(4.02)	(4.30)	(3.68)	(4.12)
Father's education	5.94	7.52	5.37	7.09
	(4.13)	(4.39)	(3.93)	(4.24)
Mother's height	150.08	150.68	149.49	150.07
	(5.24)	(5.56)	(5.26)	(5.35)
Male	0.51	0.52	0.50	0.49
	(0.50)	(0.50)	(0.50)	(0.50)
Panel B. Outcomes				
Cognitive Test Score (% correct)	65.68	70.34	58.21	63.85
	(22.44)	(21.34)	(23.79)	(23.17)
Math Questions Score (% correct)	53.63	59.11	39.79	46.38
	(29.46)	(29.33)	(31.16)	(32.17)
Raven's CPM Questions Score (% correct)	72.13	76.40	69.72	74.76
	(24.67)	(22.92)	(26.81)	(24.89)
Entered school by age 6 (%)	50.82	60.96	42.82	50.64
	(50.00)	(48.79)	(49.49)	(50.00)
Still attending school (%)	76.68	85.53	15.15	23.48
	(42.29)	(35.19)	(35.86)	(42.40)
Completed education level (in years)	6.89	7.36	9.17	10.64
	(2.24)	(2.21)	(3.30)	(3.20)
Observations	8295		6991	

Note: For all variables (except gender), the difference between children in communities that received midwives and did not receive midwives are statistically significant at 1%. In Panel A, outcomes for cohorts born 1983-1989 are measured in 2000 (when they are aged 11 to 17) while outcomes for cohorts born 1990-1996 are measured in 2007 (when they are aged 11 to 17) and these data are pooled together. In Panel B, outcomes for cohorts born 1976-1982 are measured in 2000 (when they are aged 18 to 24) while outcomes for cohorts born 1983-1989 are measured in 2007 (when they are aged 18 to 24) and these data are pooled together. Variable means displayed to the right of variable names. Standard deviations displayed below the mean in parentheses.

1.5 Econometric Strategy

The summary statistics in Table 1 illustrate the non-random placement of the program. In general, children in communities that received a midwife tend to have lower socioeconomic status and poorer health endowment (as indicated by mother's height). On average, they also tend to have lower test scores and poorer schooling outcomes.

Thus the paper's identification strategy combines the variation in the availability and timing of the arrival of the program across communities with the idea that environmental influences in utero and early childhood are particularly central to examining the causal impact of the program on cognitive outcomes and schooling. In particular, I draw from the biology of cognition and the results of the earlier studies that environmental factors which influence maternal health prior to conception and during the fetal period as well as the first two to three years of life mark the critical or sensitive periods during which environmental influences could have lasting impact on cognition and other measures of human capital. This thus suggests that children who are exposed to the program at age 4 and beyond are less likely to benefit from the program than children exposed earlier.

I estimate two basic specifications of two-way fixed effect models: first using a crude measure of being exposed to the program, focusing on the major expansion that occurred between 1990 and 1996, and another using a finer exposure measure that allows for empirically examining the onset of exposure at different ages. Given the biological linkage between environmental influences in early life and later cognition, I particularly focus my analysis on cognition, but also examine the

measures of schooling later on.

I begin with the simple difference-in-difference framework wherein I ask whether children born during the rapid program expansion (1993 to 1996) have better outcomes compared to their counterparts who were born prior to the start of the program (1986 to 1989) in the communities that received the program, and relative to those born in the same year in other communities that did not receive the program.[8] Note that the pre-program cohorts (born 1986 to 1989) were already at least age 4 in 1993 when the rapid program expansion began. Thus the program is unlikely to have long run benefits on these children.[9] This suggests estimating the following reduced-form equation:

$$Y_{ijt} = c + \beta(VM_{ij}*EXP1_{it}) + \theta X_{ijt} + \mu Z_{jt} + \delta_t + \gamma_j + \epsilon_{ijt} \quad (1)$$

where Y_{ijt} is the outcome of interest of individual *i* born in community *j* in year *t*, VM_{ij} is a dummy indicating whether the individual's community of birth received a program midwife between 1990 and 1996, $EXP1_{it}$ denotes whether the individual was born during the rapid program expansion period 1993-1996, δ_t is the cohort of birth fixed effect while γ_j is the community of birth fixed effect. X_{ijt} is a vector of individual and parental characteristics including gender, age at the time of measurement,

[8] I can also just compare cohorts who were born during the program expansion (1990-1996) with the same span of cohorts born prior to program expansion (1983-1989). But for this specification I restrict the analysis to those born during the rapid program (1993-1996) to ensure that the treatment cohorts are exposed only within the first three years of life depending on when the village midwife arrived between 1993 and 1996. Children who were born in 1990 would be exposed at age 3 if the program arrived in 1993 but would already be age 4 and above if the program arrived in 1994 to 1996. To avoid this inefficiency, I will just exclude them for this specification but include them back to the sample when I estimate the effect of the program for each birth year cohort and also in the second specification where I use a finer measure of exposure to the program.

[9] Although they are aged 1 to 3 in 1990 to 1992, only about 3.6 percent of the children in the sample received the program between 1990 and 1992, thus, on average, the effect of the program should be close to zero for these children.

mother's and father's education and mother's height. Z_{jt} is a vector of time-varying community characteristics that includes an indicator of changes in local amenities (such as new schools, new health facilities, or new road constructed) and the availability of child development services over time across communities. I also include the number of schools (junior and senior level) in the community at the time of measurement.[10]

As a second empirical strategy I take advantage of the phased-in deployment of the safe motherhood program in the communities and combine it with the timing of birth of the child to come up with relatively finer exposure measures. In this specification, I now examine cohorts born 1983 to 1996, thus including cohorts 1990 to 1992 who are likely to be exposed to the program in the post-birth period. In particular I ask whether children who were born in the communities that received a village midwife and exposed to the village midwife before birth or during the first 2 to 3 years of life, have better outcomes than their counterparts who already passed those critical years, and relative to those born in other communities in the same year. Instead of creating a simple indicator of whether an individual belongs to such treatment status, I create dummies for each particular year of child's development.

[10] A section in the community surveys of IFLS1 and IFLS2 ask the village heads to indicate the important events that occurred in the communities in the last 5 years (for IFLS2, IFLS3 and IFLS4) and since 1980 for IFLS1, including information of when the event occurred and how it impacted the welfare of the local population. The questionnaire provides a list of commonly occurring positive events (such as construction of new school, new health facility or new roads, etc.) in the communities. Any other event that is not mentioned is provided by the village head. Also the questionnaire administered to posyandu (community health center) asks question on the availability and timing of provision of child development services in the community. For the availability of schools at the time of measurement (using IFLS3 and IFLS4), I exclude primary level schools since the large scale primary school construction program launched in Indonesia in 1970s and enrollment in primary level has been very high since then (see Du o (2001) for the impact of this program).

This suggests running the following regression:

$$Y_{ijt} = c + \Sigma_{\ell} \beta_{\ell} EXP2_{ijt\ell} + \theta X_{ijt} + \mu Z_{jt} + \delta_t + \gamma_j + \epsilon_{ijt} \quad (2)$$

where $EXP2_{ijt\ell}$ is a set of indicator variables that reflect the timing of the arrival of the midwife relative to child's birth date. The indicator is set to zero if the community did not receive a village midwife. Exposure to village midwife ranges from 6 years prior to birth until 13 years after birth in the sample.[11] Given the pattern of arrival of the program in these communities, there are fewer cases where individuals are exposed 4 to 6 years prior to birth and so I lump them together under 3 to 6 years prior to birth. Each β_{ℓ} can be interpreted as the effect of the program on exposure that began during a particular year.

The biology of cognition and the results of earlier studies suggest that children exposed at age 4 years and above are unlikely to benefit from the program. Thus, β_{ℓ} should be 0 for $\ell >= 4$. On the other hand, children born in communities that received a midwife 2 or more years prior to their birth are fully exposed to the potential benefits of prenatal care, postnatal care and general health care services provided by the midwife. They may also have the additional benefit of having mothers whose preconception health and nutritional status were positively affected by the presence of midwife.[12] Meanwhile, children who were exposed to the midwife while in utero may only be partially exposed to the prenatal care services but fully

[11] Given the period of program expansion occurred in 1990 to 1996 and the birth year cohorts spans 1983 to 1996, the timing of midwife's arrival with respect to child's birth can be determined by the following difference: year of village midwife's arrival in community - birth year, where -6 is the difference between the earliest year the program arrived (1990) and the youngest birth cohort (1996) while 13 is the difference between the latest year the program arrived (1996) and the oldest birth cohort.

[12] Frankenberg et. al. (2001) carefully showed earlier that the presence of midwife in the communities led to better nutritional status of women of reproductive age.

exposed to the postnatal and general health care services provided by the midwife.[13] Likewise, those who were exposed to the village midwife during their first year or second year of life may only be partially exposed to the postnatal services provided by the midwife. In general, effects should be increasing with earlier exposure for $\ell < 4$.

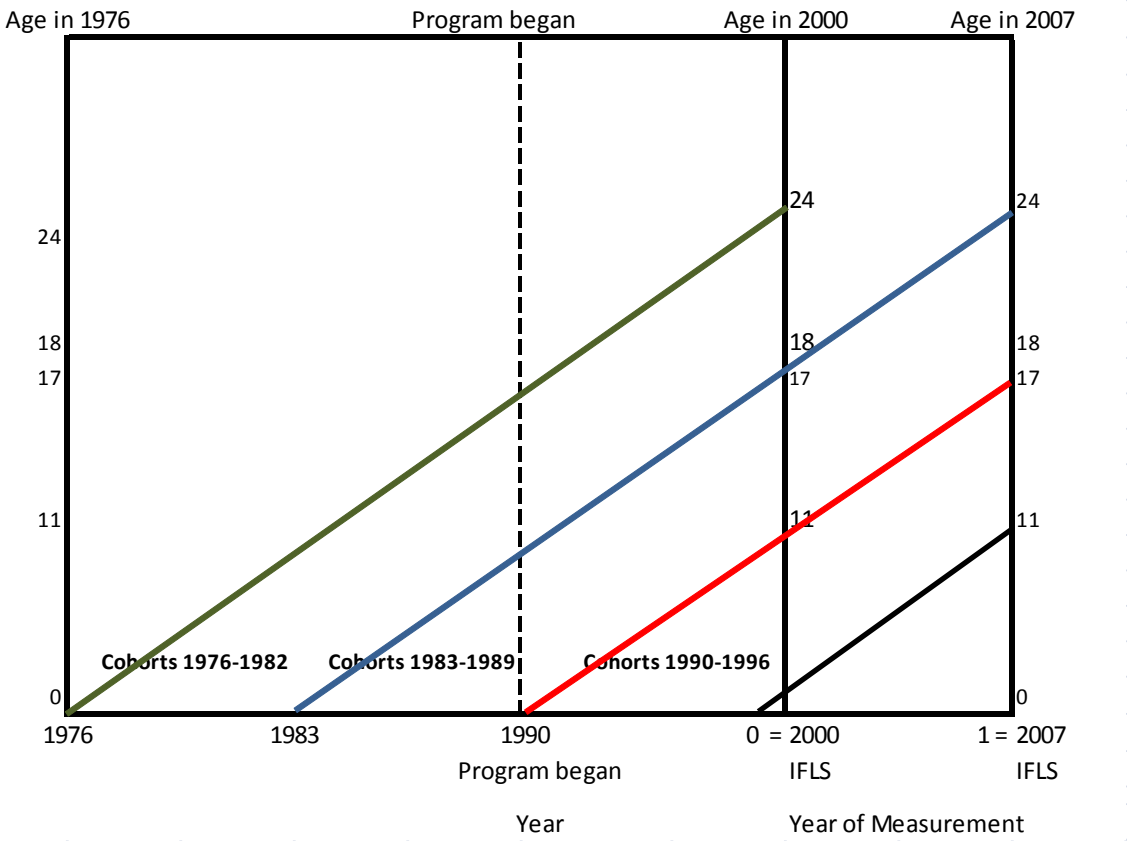

Figure 3: Lexis Diagram: Comparing Cohorts of Same Age

Since I am examining the outcomes of individuals during the period (age 11 to 17) when their cognitive skills are still being formed as well as still attending

[13] A limitation of this study is that only information on the year of the arrival of village midwife is available. Thus receiving a midwife while in utero or 1 year before birth means that the midwife arrived anytime in the previous year before the child's year of birth. Thus these children may only be partially exposed to prenatal services of the midwife.

school, it is crucial to compare treatment and control cohorts whose outcomes were measured at the same age. Thus I exploit the panel dimension of IFLS and in particular the seven years gap between IFLS3 (2000) and IFLS4 (2007) to take into account age-dependent variation in cognition.[14] To examine the effect of the program, I compare the outcomes of the treatment cohorts born in 1990 to 1996 and measured in 2007 at age 11 to 17 with the outcomes of control cohorts born in the prior years 1983 to 1989 and measured in 2000 when they are of same age. This can be further illustrated using a lexis diagram in Figure 3. Time in years is represented in x-axis. The vertical lines in 2000 and 2007 correspond to the years IFLS measures the outcomes of interest and the diagonal lines identify different cohorts: the red diagonal line refers to the cohorts born during the program expansion (1990-1996), the blue diagonal line refers to cohorts born prior to program expansion (1983-1989) and the green line refers to the cohorts born in 1976-1982. In the main experiment of interest, I compare the red diagonal (treatment) cohorts with blue diagonal (control) cohorts. To ensure that I am comparing children of same age (taking into account of age effects), I measure the outcomes of red diagonal cohorts in 2007 at age 11 to 17 while I measure the outcomes of blue diagonal cohorts in 2000 when they are of similar age. In the falsification experiment, I compare the outcomes of blue diagonal (pseudo-treatment) cohorts with the outcomes of green diagonal cohorts (pseudo-control) cohorts. This time I measure the blue diagonal cohorts in 2007 at age 18 to 24

[14] Frankenberg et. al. (2005) also exploited the panel dimension of IFLS1 and IFLS2 such that they compare the height-for-age of children aged 1-4 in 1997 with the height-for-age of children aged 1-4 in 1993.

while I measure the outcomes of the green diagonal cohorts in 2000 when they are of similar age.

1.6 Results

Table 2 reports the results of estimating the impact of the program on cognition based on the difference -in-differences specification (specification 1). In Panel A, I compare the outcomes of cohorts born during the rapid program expansion (1993 to 1996) with the outcomes of cohorts born earlier (1986 to 1989).[15] In column 1, the specification controls only for birth year and community of birth fixed effects while in column 2 individual and parental controls are added. Controlling for parental characteristics is particularly important as this helps to address the issue that there could be positive selection into fertility during the program expansion period and that could be driving the improved outcomes of children. The estimates are statistically significant at 1% level and suggest that exposure to safe motherhood program increases test scores by 5.12% for the whole sample (column 2, row A) and 5.49% for the sample restricted to those who did not move out of the village before age 5 (column 2, row B).[16] If test scores are standardized within the sample, these estimates are equivalent to about 0.23 to 0.25 standard deviations increase.

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[15] I examine these children when they are aged 11 to 14. Following the lexis diagram, the cohorts born 1993 to 1996 are measured in 2007 at ages 11 to 14 while cohorts born 1986 to 1989 are measured in 2000 when they are of same age.

[16] The movement of children before age 5 is tied to the migration of mothers. IFLS has a very intensive tracking system that allows for tracking of the movement of households from their original location in 1993 to their new locations in 1997, 2000 and 2007. In general, based on IFLS data, mobility of mothers tends to be limited when their children are still young (before teenage years). For instance, of the cohorts belonging to experiment of interest, 94% of the children have not moved out of the village before their age 5.

Table 2: Impact of Safe Motherhood Program on Long-run Cognition: Coefficients based on the Interaction between Cohort Dummies and the Availability of Village Midwife by 1997 (Diff-in-diff Specification)

		Cognitive Test Score (% Correct)			
	Obs	(1)	(2)	(3)	(4)
Panel A. Experiment of Interest: For cohorts born 1993 to 1996 or cohorts born 1986 to 1989 (Treatment Cohorts: Born during rapid program expansion: 1993 to 1996)					
(A) Full Sample	4575	5.37***	5.12***	5.12***	5.21***
		[1.19]	[1.17]	[1.17]	[1.17]
(B) Sample of non-movers (before age 5)	4281	5.76***	5.49***	5.48***	5.54***
		[1.25]	[1.22]	[1.22]	[1.23]
(C) Full sample plus those either not born in the same community or have missing information on community of birth	4847	4.22***	4.14***	4.17***	4.20***
		[1.16]	[1.14]	[1.14]	[1.15]
Panel B. Falsification Experiment: For cohorts born 1986 to 1989 or cohorts born 1979 to 1982 (Pseudo-treatment cohorts: Born prior to program expansion: 1986 to 1989)					
(A) Full Sample	4221	0.70	0.63	0.64	0.65
		[1.40]	[1.39]	[1.39]	[1.39]
(C) Full sample plus those either not born in the same community or have missing information on community of birth	4520	0.78	0.96	0.95	0.95
		[1.36]	[1.34]	[1.34]	[1.34]
Controls:					
Birth year and community of birth FE		Yes	Yes	Yes	Yes
Individual and parental char		No	Yes	Yes	Yes
Time-varying changes in local amenities and availability of child devt services		No	No	Yes	Yes
Availability of schools at the time of measurement		No	No	No	Yes

Note: In the experiment of interest, children born 1993 to 1996 are measured in 2007 (when they are aged 11 to 14) while children born in 1986 to 1989 are measured in 2000 (when they are aged 11 to 14) and these data are pooled together. In the falsification experiment, children born in 1986 to 1989 are measured in 2007 (when they are aged 18 to 21) while children born 1979 to 1982 are measured in 2000 (when they are aged 18 to 21) and these data are pooled together. Individual and parental characteristics include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. Time-varying community characteristics include an indicator of changes in local amenities (i.e., a new health facility, a new road, etc.) and the timing of the availability of child development services in the communities over the period covered. Availability of schools are measured in 2000 for cohorts born 1986 to 1989 (1976 to 1982) and in 2007 for cohorts born 1993 to 1996 (1986 to 1989). In column 3 for panel B, I only include the availability of child development services in the communities over time since I do not have complete information for history of community events between 1979 to 1982. Standard errors adjusted for clustering at the community level in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

Interestingly, these standardized estimates are about the same as the Raven's test z-score estimate based on the well-known INCAP based on these estimates are equivalent to about 0.23 to 0.25 standard deviations experimental study that examined the impact of child's exposure to nutritional supplementation during the first three years of life (see details of study in Maluccio et. al., 2009).

The above estimates could be interpreted as a causal impact of the program based on the assumption that the allocation of the program expansion is uncorrelated with the other contemporaneous events in the communities. Although there is no known program that is correlated with the allocation of the safe motherhood program, in column 3 I also control for any other time-varying changes in local amenities as well as the availability of child development services over time across communities. Column 4 adds the availability of the schools (at the junior and senior level) at the time of measurement. This helps to address the concern that the program may have been targeted to those villages that are likely to develop faster or are likely to be targeted by future programs that improve cognition and schooling. Estimates in columns 3 and 4 are significant at 1% level and suggest that the program increased the test scores by 5.21% to 5.54% (column 4, row A and row B).

To ensure that the resulting estimates are not driven by general effect of improvement in cognitive outcomes over time, panel B of Table 2 presents the results of the falsification experiment that compares the test scores of older cohorts (those born in 1986 to 1989 vis-a-vis those born in 1979 to 1982) who also took the cognitive tests in 2000 and 2007. The pseudo-treatment cohorts or children born in 1986 to 1989 are measured in 2007 (at age 18 to 24) while the pseudo-control cohorts or children

born in 1979 to 1982 are measured in 2000 at the same age. As shown in row A of panel B, estimates are very small and not significant.[17] Thus, estimates are not likely to be explained by a secular time trend. Further, this exercise also shows that estimates are not likely to be an artifact of mean reversion. There is a concern that individuals in the communities that received the program may have poor cognition or poor human capital when measured in 2000 due to temporary shock and as conditions just get better in these communities in the following period (2007), the individuals also improve their cognition or human capital. However, if that is really what is driving the results in panel A, then we should also see systematic improvement in cognitive test scores among cohorts born 1986 to 1989 who are measured in 2007 relative to cohorts born 1979 to 1982 who are measured in 2000. However the results in Panel B of table 2 suggest that is not the case here.

Now, although the previous exercise is reassuring that the identification strategy is reasonable and that the safe motherhood program had an impact on cognition, it may over-simplify the impact of the program. In general, the program may have had differential impact depending on the timing of the arrival of the village midwife with respect to the child's stage in development.

As an alternative identification strategy, I use the information on the year (timing) of the arrival of village midwives in these communities with respect to child's year of birth to create an individual level measure of exposure to the program. To be as flexible as possible, I relax the earlier hypothesis that the program must have had an impact only on children who are less than age 4 when the village

[17] Note that I do not present falsification estimates for the sample restricted to non-movers before age 5 since in the sample these children are likely to have been living in the same communities since birth.

Figure 4: Coefficients of the Intensity of Exposure to Safe Motherhood Program in the Cognitive Test Score Equation (Cohorts born 1983 to 1996)[18]

midwife arrived. I estimate the coefficients of the intensity of exposure for each of the exposure period ranging from 3 to 6 years prior to birth up to age 11 and omit exposures at ages 12 to 13 to serve as part of the reference group. Figure 4 plots the coefficients for each of these exposure measures while the dashed lines show the confidence interval. As shown in the graph, coefficients are close to zero and about same level until age 3 and then increases markedly after that, for children two and younger, or not yet conceived, when the midwife arrived. In fact coefficients for

[18] The y-axis plots the coefficients for the intensity of exposure to the program, plus the 95% confidence intervals (dashed lines). The x-axis corresponds to age of the child when the village midwife arrived to the program. Negative numbers refer to the years when the village midwife arrived prior to child's birth (for instance, -3 to -6 means the village midwife arrived 3 to 6 years prior to child's birth). The sample consists of cohorts born 1983 to 1996 measured at age 11 to 17.

children 2 and younger when the midwife arrived are statistically different from zero. These results suggest that children who were exposed to the program while in *utero* or during their earliest childhood years seem to have benefited from the program age 3 or older did not seem to benefit. In general, these results provide evidence that the program had an impact, consistent with the findings in the biological literature that suggest the importance of the first two years of life in shaping outcomes later in life. The results are also consistent with the idea that maternal health prior to conception matters for outcomes in later life, although more work needs to be done to isolate the impact of the program itself from other issues such as selective fertility.

Following the hypothesis based on findings in biology and the results of earlier studies, I test whether β_ℓ is equal to 0 for $\ell >= 4$. But instead of directly testing each β_ℓ for $\ell >= 4$, I now impose that restriction. In Table 3, I examine the impact of cumulative exposure to the program for exposures before age 4. The omitted group is now comprised of individuals with exposures of age 4 and above. As shown in the first four columns of Table 3, results change little even if I enter the control variables separately. In general, the estimates tend to show patterns of dose response (except for ages 1 and 2 which tend to switch in magnitude).Although cohorts born in 1990 to 1996 have varying exposures ranging from 3 to 6 years prior to birth to about 6 years after birth depending on the timing of the arrival of the village midwife, estimates are only relatively large and significant for those children exposed 3 to 6 years prior to birth until age 2; beyond that estimates become really small and non-significant (by age 3).

This pattern is similar to the results based on a more flexible specification plotted in Figure 4. As shown in column 4 of Table 3, exposure to the benefits of safe

Table 3: Impact of Safe Motherhood Program on Long-run Cognition: Coefficients based on Intensity of Exposure to the Program

Timing of Midwife's Arrival	*Main Results*			
	(1)	(2)	(3)	(4)
Experiment of Interest: For Cohorts born 1983 to 1996				
3 or more years before birth [-3 to -6]	7.59***	7.21***	7.22***	7.27***
	[2.03]	[2.00]	[2.00]	[2.00]
2 years before birth [-2]	6.50***	6.50***	6.49***	6.56***
	[1.72]	[1.69]	[1.69]	[1.69]
1 year before birth [-1]	4.39***	4.44***	4.44***	4.54***
	[1.56]	[1.53]	[1.53]	[1.53]
At year of birth [0]	4.57***	4.44***	4.34***	4.39***
	[1.42]	[1.40]	[1.40]	[1.40]
1 year after birth [1]	3.32**	2.81**	2.83**	2.88**
	[1.34]	[1.32]	[1.32]	[1.32]
2 years after birth [2]	2.84**	2.95**	2.97**	3.06**
	[1.34]	[1.32]	[1.32]	[1.32]
3 years after birth [3]	0.65	0.59	0.66	0.67
	[1.32]	[1.30]	[1.30]	[1.30]
Controls:				
Birth year and community of birth fixed effect	Yes	Yes	Yes	Yes
Individual and parental characteristics	No	Yes	Yes	Yes
Time-varying changes in local amenities and availability of child development services	No	No	Yes	Yes
Availability of schools at the time of measurement	No	No	No	Yes
Observations	8295			

Note: The sample includes cohorts born 1983 to 1996 for the experiment of interest. Cohorts born 1990 to 1996 are measured in 2007 (when they are aged 11 to 17) while children born in 1983 to 1989 are measured in 2000 (when they are aged 11 to 17) and these data are pooled together. Individual and parental characteristics include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. Time-varying community characteristics include an indicator of changes in local amenities (i.e., a new health facility, a new road, etc.) and the timing of the availability of child development services in the communities over the period 1983 to 1996. Availability of schools is measured in 2000 and 2007. Standard errors adjusted for clustering at the community level in brackets* significant at 10%; ** significant at 5%; *** significant at 1%

motherhood program that begins prior to conception, while in utero and during the first two years of life increase test scores by about 2.88% to 7.27% (equivalent to 0.13 to 0.33 standard deviations increase if test scores are standardized).

Table 4 presents a number of robustness checks. Since the above specifications rely on the timing of the arrival of village midwives, a major concern is that the timing of the arrival of village midwives might be correlated with the time-varying development in these communities. Thus in column 1 I add province-specific trends (province x birth year fixed effects) to account for differential evolution of provinces.

This particularly addresses the worry that communities in certain provinces that received midwives earlier may have evolved differently or have grown faster than communities in other provinces that received midwives later or have not received midwives.[19] As shown in column 1 although standard errors slightly increase as a result of imposing this additional restriction, results remain robust which suggest that this is not likely to be an important issue.

On top of this restrictive specification, in columns 2 and 3 I examine whether results might be driven by selective migration. This is done by restricting the sample to those children who did not move out of their village before age 5 (column 6) and to those children whose mothers have been living in the same community even three years prior to birth (column 7).[20] Estimates only become bigger when I correct for the issue of selective migration, suggesting that estimates are not likely to be upwardly biased by possible differential migration of high ability mothers into the communities that received the midwives.

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[19] In other words, this helps identify the causal impact of the program so long as the unobserved factors determining that a village midwife is allocated to community *i* versus community *j* in the same province are uncorrelated with the relative economic development in these communities over time.

[20] In very small number of cases wherein information on community of birth is determined solely based on own response of the individual as young adult (15 and above) due to lack of information on mother's location at the time of birth, I do not have information on mother's community 3 years prior to birth. In this case I just use the community of birth.

Table 4: Robustness Checks

Timing of Midwife's Arrival	*Robustness Checks*				
	(1)	(2)	(3)	(4)	(5)
Experiment of Interest: For Cohorts born 1983 to 1996					
3 or more years before birth	7.11***	7.25***	7.72***	-0.67	7.87***
[-3 to -6]	[2.08]	[2.20]	[2.09]	[2.41]	[2.39]
2 years before birth [-2]	5.89***	6.91***	6.20***	2.16	6.37***
	[1.78]	[1.90]	[1.80]	[2.18]	[2.03]
1 year before birth [-1]	3.88**	4.65***	4.45***	2.35	3.74**
	[1.61]	[1.71]	[1.62]	[1.88]	[1.83]
At year of birth [0]	4.06***	4.51***	4.27***	-0.15	4.28***
	[1.46]	[1.55]	[1.48]	[1.77]	[1.66]
1 year after birth [1]	2.33*	2.76*	2.58*	1.02	2.5
	[1.39]	[1.43]	[1.40]	[1.68]	[1.54]
2 years after birth [2]	2.54*	2.47*	2.89**	-1.55	2.81*
	[1.38]	[1.42]	[1.41]	[1.55]	[1.51]
3 years after birth [3]	0.76	0.71	1.06	2.17	0.94
	[1.36]	[1.38]	[1.38]	[1.58]	[1.45]
Sample Compositions (columns):					
(A) Province x Birth Year fixed effects	Yes				
(B) Sample of non-movers before age 5	No	Yes			
(C) Full Sample using community of mother 3 years before child's birth	No	No	Yes		
(D) Falsification (full) sample: cohorts born 1976 to 1989	No	No	No	Yes	
(E) Restricted to communities that ever received midwives as of 2007	No	No	No	No	Yes
Observations	8295	8073	7981	6146	6991

Note: The sample includes cohorts born 1983 to 1996 for the experiment of interest (except column 4). Cohorts born 1990 to 1996 are measured in 2007 (when they are aged 11 to 17) while children born in 1983 to 1989 are measured in 2000 (when they are aged 11 to 17) and these data are pooled together. All regressions include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. They also include time-varying community characteristics and availability of schools. Standard errors adjusted for clustering at the community level in brackets. In column 4, cohorts born 1983 to 1989 are measured in 2007 (when they are aged 18 to 24) while children born in 1976 to 1982 are measured in 2000 (when they are aged 18 to 24). * significant at 10%; ** significant at 5%; *** significant at 1%

Another concern is that estimates might be only driven by time effect. To address this concern, I ran the same specification using the cohorts born prior to the

program as a falsification exercise. Although there could be several ways of doing this, I implement the simplest one which is to assume that the program expansion occurred exactly 7 years earlier and then replicate the analysis for cohorts born 1976 to 1989.[21] As shown in column 4, estimates do not yield the same pattern observed above and are not significant.

In column 5, I restrict the sample to communities that ever received a midwife as of 2007.[22] By restricting the sample to all communities that received the program at some point, I remove the communities that never received a midwife as of 2007 which may be very different. In general, results are invariant to this sample restriction although the coefficient for exposure period 1 year after birth is less precisely estimated.

1.6.1 Additional Robustness Checks

In Table 5, I add some more robustness checks. First, I include back in the sample children who were not matched to their IFLS community of birth because they were identified as either not born in one of the 321 original IFLS communities or have missing information on the place where they were born. I use the community where these children are found in the 1993 baseline survey as proxy for their community of birth. As shown in column 1 (and in rows (C) in panels A and B of Table 2), the estimates are just slightly smaller but remain highly statistically

[21] This means that if the program midwife arrived in 1990, it would be coded as arrived in1983 or if the program midwife arrived in 1995, it would be coded as arrived in 1988.
[22] Between 1997 and 2007 (after the rapid program expansion) the fraction of communities that received midwives rose from 47% to 57%.

Table 5: More Robustness Checks

Timing of Midwife's Arrival	(1)	(2)
Experiment of Interest: For Cohorts born 1983 to 1996		
3 or more years before birth [-3 to -6]	6.78***	7.69***
	[2.06]	[2.12]
2 years before birth [-2]	5.56***	6.99***
	[1.76]	[1.81]
1 year before birth [-1]	3.23**	4.78***
	[1.59]	[1.66]
At year of birth [0]	3.51**	5.29***
	[1.44]	[1.53]
1 year after birth [1]	2.26*	3.11*
	[1.37]	[1.78]
2 years after birth [2]	2.45*	5.78***
	[1.37]	[2.24]
3 years after birth [3]	0.52	2.57
	[1.34]	[2.55]
Sample Compositions (columns):		
(A) Full sample plus those either not born in the same community or have missing information on comm of birth	Yes	No
(B) Sample in Table 2: cohorts born 1993 to 1996 vs born 1986 to 1989	No	Yes
Observations	8729	4575

Note: The sample includes cohorts born 1983 to 1996 for the experiment of interest (except column 4). Cohorts born 1990 to 1996 are measured in 2007 (when they are aged 11 to 17) while children born in 1983 to 1989 are measured in 2000 (when they are aged 11 to 17) and these data are pooled together. All regressions include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. They also include time-varying community characteristics and availability of schools. Standard errors adjusted for clustering at the community level in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

significant.

Also, to ensure that estimates in Tables 3 and 4 were not influenced by the inclusion of birth cohorts 1990 to 1992 in the sample, I ran the intensity of exposure specification using the sample used in Table 2.[23] As shown in column 2, even if I restrict the analysis to cohorts born 1993 to 1996 vis-a-vis cohorts born 1986 to 1989, I

[23] Note the sample used in Table 2 comprise of cohorts born during the rapid program expansion, 1993 to 1996.

still get the same pattern of estimates observed in general in Table 2. Thus the results cannot be attributed to the inclusion of these cohorts in the sample.

1.6.2 Subcomponents of Cognitive Test and Measures of Schooling Outcomes

In Table 6, I examine the subcomponents of cognitive test and measures of schooling. All specifications include all control variables and the three columns under each variable presents the results for full sample, sample restricted to non-movers before age 5 and finally, sample that includes the children who were not matched to IFLS communities.[24] In columns 1 to 2, I examine the impact of the program separately for the subcomponents of cognitive test: Raven's CPM test (which comprise 80% of the test questions) and Mathematics questions. In general results remain robust regardless of change in sample specification. The patterns of estimates under the Raven's CPM test questions score are similar to the results shown in Tables 2 and 3 for pooled cognitive test score although the coefficients under 1 year after birth are not significant. Interestingly, for the Mathematics test questions score, estimates are relatively large and statistically significant only until about age 1.

For the remaining columns of Table 6, I examine the impact of the program on measures of schooling. Studies conducted in developed and developing countries

[24] Note that results are in general robust to other sample specifications used in Table 3 although not shown here.

Table 6: Sub-components of Cognition and Measures of Schooling

Timing of Midwife's Arrival	Sub-components of Cognitive Test		Measures of Schooling		
	Raven's Score (% correct)	Math Score (% correct)	Entered school by Age 6 (%)	Whether Still Attending School (%)	Education (years)
	(1)	(4)	(7)	(10)	(13)
Experiment of Interest: For Cohorts born 1983 to 1996					
3 or more years before birth [-3 to-6]	7.26***	6.67**	-1.72	14.13***	0.52***
	[2.26]	[2.68]	[4.72]	[3.49]	[0.16]
2 years before birth [-2]	6.07***	7.43***	3.33	10.76***	0.48***
	[1.91]	[2.27]	[3.99]	[2.95]	[0.13]
1 year before birth [-1]	3.58**	6.40***	1.54	8.09***	0.48***
	[1.73]	[2.05]	[3.64]	[2.67]	[0.12]
At year of birth [0]	3.97**	5.13***	2.79	4.04*	0.23**
	[1.59]	[1.88]	[3.31]	[2.44]	[0.11]
1 year after birth [1]	2.36	4.01**	3.09	4.47*	0.29***
	[1.49]	[1.76]	[3.12]	[2.30]	[0.10]
2 years after birth [2]	3.78**	1.88	-1.64	0.61	0.11
	[1.49]	[1.76]	[3.10]	[2.29]	[0.10]
3 years after birth [3]	0.56	0.8	0.58	0.59	-0.04
	[1.47]	[1.74]	[3.07]	[2.26]	[0.10]
Observations	8295	8295	8145	8295	8295

Note: The sample includes cohorts born 1983 to 1996 for the experiment of interest (except column 4). Cohorts born 1990 to 1996 are measured in 2007 (when they are aged 11 to 17) while children born in 1983 to 1989 are measured in 2000 (when they are aged 11 to 17) and these data are pooled together. All regressions include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. They also include time-varying community characteristics and availability of schools. Standard errors adjusted for clustering at the community level in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

show that early cognitive and socio-emotional development is strongly associated with school progress (Currie and Thomas, 1999; Feinstein, 2003; Gorman and Politt, 1996; Maluccio, 2009; Daniels and Adair, 2004). In column 3, I first investigate whether the program had an impact on early school entry of the child. I find that the program had no impact on whether or not the child enters elementary school by age

6.[25] Looking at other measures of schooling in columns 4 and 5, I find that the children exposed to the program are more likely to still be attending school at the time of measurement and they also tend to complete more years of education. Estimates suggest that the program led to an increase of about 0.23 to 0.52 years of education (column 5) depending on the exposure of the child to the program. Interestingly, the patterns observed for measures of schooling are similar to the pattern observed in Mathematics test scores. That is, coefficients are relatively large and significant until the first year of life, but beyond that estimates become really small and not statistically significant. One possible explanation for this is that mathematics ability could be influencing the child's progress in schooling. However, the question of why the pattern of relatively large and significant coefficients for Mathematics test scores ceases by age 2 needs further research.

1.7 Conclusion

Although many papers have documented the importance of early life health for later human capital outcomes, few papers have attempted to rigorously evaluate the long run impacts of early life public health interventions. This paper aims to address this unresolved issue using an identification strategy that combines the variation in the availability and timing of the arrival of a public health intervention with the biology of cognition.

The first comprehensive Safe Motherhood intervention in Indonesia that allocated over 54,000 midwives in most of nonmetropolitan villages in Indonesia led

[25] In Indonesia, children typically enter elementary school by age 6 or 7.

to an increase in both cognition and education of individuals at age 11 to 17. On average, estimates indicate that the program led to an increase of about 5.12% to 5.49% in cognitive test scores (equivalent to 0.23 to 0.25 standardized deviations increase in standardized test scores). These findings are robust to using alternative specification based on intensity of exposures which indicate that the program led to an increase of about 2.88% to 7.27% in cognitive test scores (about 0.13 to 0.33 standard deviations increase in standardized test scores). The program also led to an increase of 0.23 to 0.52 years of education depending on the timing of child's exposure to the program. These results are robust to a number of specification checks and robustness checks.

This study is one of the very few studies that examine the long run impact of early life public health intervention on later human capital (during adolescence). Examining whether these benefits actually persist into adulthood and translate into higher productivity will be the subject of future work.

2. The Impact of Parental Death on Child Well-Being

2.1 Introduction

Demographers, sociologists, economists, and psychologists share a long-standing interest in understanding how parental absence affects children's well-being. This interest has intensified as divorce, domestic and international migration, and the HIV/AIDS epidemic have increased the numbers of children experiencing the absence or loss of a parent. Moreover, in recent years a number of high-mortality natural disasters have created sharp surges in the numbers of children without parents, bringing media attention and humanitarian concern to their plight.

Establishing the impact of parental death on children is not straightforward. A family in which a parent dies may differ from other families in ways that would have affected a child's outcomes had the parent survived.

We provide new evidence on this issue using longitudinal data from the Study of the Tsunami Aftermath and Recovery (STAR), which was conducted in the provinces in Indonesia that were affected by the December 2004 Indian Ocean earthquake and tsunami. The baseline survey took place ten months before the tsunami and is representative of the population living in districts with coastlines that were vulnerable to inundation. Re-interviews took place annually between 2005 and 2010. The first post-tsunami interview took place about a year after the event, providing evidence regarding the short-term impact. The most recent interview, which took place about 5 years after the tsunami, provides evidence regarding the longer-term impact.

Although Indonesia regularly experiences earthquakes, tsunamis are rare and the event in 2004 was largely unanticipated. Moreover the intensity of the tsunami varied within small areas as a function of the topography and orientation of the land relative to the direction and force of the waves. Survival was to large extent attributable to idiosyncratic factors revolving around the combination of where the waves hit and people's precise locations at that moment. For these reasons parental death is more likely to be independent of prior behaviors and less likely to be anticipated than when death results from an illness. However, we show that parental survival is related to several characteristics of children measured in the pre-tsunami baseline. Therefore, to identify the causal impact of parental death we compare outcomes measured before and after the tsunami for children whose parents died in tsunami with the change in those outcomes for children whose parents survived. The combination of the longitudinal data on children who were living along the coast of Aceh and the unanticipated nature of the tsunami yield a unique window on how children's well-being is affected by parental death.

Our measures of well-being relate to human capital and time allocation and are available from the surveys collected both before and after the tsunami. Parental death potentially affects other indicators of well-being, such as psycho-social health, but because measures are not available in the baseline data we do not examine them in this research.

We find that the impact of parental death varies with the age and gender of the child and that shorter-term impacts do not reliably portend what the longer-term impacts will be. Few papers examine the impact of losing both parents. We find that

the death of both parents has a large, negative impact on the human capital accumulation of 15-17 year olds of both sexes, and likely of 9-14 year old females. In addition, loss of only a father has negative implications for older males, who acquire less education than males whose parents survived the tsunami. We find little evidence that parental death affects the human capital of 9-14 year old males. Maternal death has little impact on schooling outcomes of children but does affect their time allocation.

2.2 Background

A parent's death typically ends a child's relationship with someone of central emotional importance, with the attendant potential for straining his or her relationship with the remaining parent or caregiver, worsening the family's economic status and living situation, creating pressure to take on responsibilities of the dead parent, and isolating the child from friends (Worden 1996; Tremblay and Israel 1998, Stokes, Reid, and Cook 2009).

Not surprisingly, parental absence is often accompanied by symptoms of poor psycho-social well-being. Sometimes changes in behavior and school performance occur as well. Nevertheless, the results of studies on how children fare after a parental death are not uniform, leading to efforts to identify factors that mediate the impact of parental loss (Leuken, 2008; Sandler, 2003).

A key challenge in this literature is that parental loss is potentially correlated with other, unobserved factors that affect children's welfare. Some authors have contrasted the impacts of parental absence brought on by a death with absence because of divorce, arguing that the death of a parent is plausibly exogenous with

respect to other factors that affect child welfare, whereas absence because of divorce is not. Using data from a British cohort study, Fronstin (2001) shows that parental absence when a child is 11-15 years old is associated with reduced educational attainment for males and females. For males the magnitude of the association is larger if the absence results from death rather than divorce. Drawing on Norwegian registry data, Steele et al (2009) , report that a paternal death lowers transition rates from lower to upper secondary school, but that the effects are similar in magnitude to those estimated for divorce. The models include mother-specific random effects to control for selection, but it is not clear that random effects absorb all unobserved differences between children whose parents divorce and those whose parent dies. More generally, although some parental deaths are likely to be random, it is hard to argue that all are..

In developing countries much of the literature focuses on parental deaths from HIV-AIDS. The earliest studies relied on cross-sectional surveys to examine school enrollment at the time of the interview as a function of a parental death at an earlier point. For example, Lloyd and Blanc (1996) analyze living arrangements and enrollment rates of children aged 10-14 as a function of orphan status in seven African countries using Demographic and Health Surveys (DHS). They find no statistically significant associations between enrollment and maternal or paternal death. Bicego et al. (2003) examine orphanhood in five sub-Saharan Africa countries and show that losing one or both parents is associated with a reduced probability of being in the age-appropriate grade level. Case et al (2004) find that in 10 sub-Saharan African countries, orphanhood is associated with reduced school attendance, largely

because of orphans who live with distantly or unrelated caregivers. As the authors note, these associations may be driven by unobserved heterogeneity: children whose parents died may be less likely than others to attend school even if the parent had lived.

To address concerns with unobserved heterogeneity and investigate the dynamic impact of AIDS-induced parental death on child outcomes, several studies have used longitudinal data collected in Africa. Yamano and Jayne (2004) examine the impact of working-age adult mortality in Kenyan households on school enrollment using two waves of a panel survey. Their difference-in-difference estimates indicate a significant negative impact of death of an adult, but only among children living in poorer households. Using panel data from Tanzania, Ainsworth, Beegle and Koda (2005) find that for children age 7-14 years, death of an adult delays entry into school but has no effect on subsequent enrollment among those who have already started school,

Case and Ardington (2006) analyze the relationship between maternal death, paternal death and investments in child education using longitudinal data from rural Kwa-Zulu Natal, South Africa. Maternal death has strong negative effects on subsequent enrollment, school attainment and education spending. Because future maternal death does not predict baseline school outcomes, their results are not likely to be driven by unobserved heterogeneity. The authors' careful attention to identifying the causal effect of maternal death on school outcomes is an important contribution of the work. In contrast with the result for maternal death, Case and Ardington find that paternal death has no effect on school outcomes. They suggest

that the effects of parental death, if they exist at all, may operate through socio-economic status since paternal death is a powerful predictor of subsequent socio-economic status. An alternative interpretation is that paternal death matters less than maternal death for children in rural Kwa-Zulu Natal because many of the fathers are absent, working on the mines or urban centers. In their sample, less than 30% of children co-reside with the father while around two-thirds co-reside with the mother (Case and Ardington, 2006, Table 1.)

Evans and Miguel (2007) use panel data from Kenya to compare changes in primary school participation of children whose parents died between 1999 and 2002 with changes for children whose parents did not die. They find a child is about 5% less likely to be in school after the mother dies. This effect emerges about two years prior to the mother's death, which the authors attribute to the influence of parental illness due to HIV/AIDS and persists for several years after the death. As in Case and Ardington, effects of paternal death are smaller and not statistically significant.

In a study of longer-term impacts of orphanhood in Tanzania, Beegle, DeWeerdt, and Dercon (2010) follow up children originally interviewed when they were between 7 and 15 years old and both parents were alive. Ten years later, children who had lost a parent during the hiatus had completed one year less of schooling and were 2 cms shorter than those whose parents survived. Because height is largely determined by the time a child is age 4 or 5 (Martorell and Habicht, 1986), the differences in height at follow-up may reflect pre-existing differences between children who lose a parent and those who do not. This possibility underscores a recurring theme in the literature on the impact of death from HIV/AIDS. Because the

parent is often ill for several years prior to death, behavioral responses associated with investments in children may precede the baseline measurement, biasing estimates of how parental death changes childrens' trajectories.

This concern has been directly addressed in the literature. When a parent dies after a prolonged illness, the child may be better prepared for the eventual loss (Worden 1996). In a study of adolescents who lost a parent to HIV/AIDS, Rotheram-Borus et al (2005) found that emotional distress and contact with the juvenile justice system peaked in the year before the death, then steadily declined. Similar results were reported in children who lost a parent to cancer (Siegel et al 1992, Siegel, Karus, Raveis 1996).

Some studies are predicated on the argument that the causal effect of orphanhood can be more clearly identified from cases where parental death resulted from an accident rather than from a chronic illness. Using this approach for Indonesia, Gertler et al (2004) find that recent parental death is associated with reduced school enrollment among children. Their results suggest that older daughters with younger siblings, are at higher risk of dropping out when a parent dies. IN another study, administrative records from Taiwan are used to examine the relationship between parental deaths due to accidents and college enrollment (Chen, Chen, and Liu 2009). Comparing children at least 18 years of age when a parent died to younger siblings, the unexpected death of a mother results in a 4% lower probability of enrolling in college. Death of a father does not affect college

enrollment.[1] The authors interpret these patterns as evidence that maternal provision of non-financial support is more important in driving college-going behavior than the paternal provision of financial support, which can potentially be replaced with resources provided to families in the event of the father's death.

Our research makes at least three contributions to the literature. First, we identify the effect of orphanhood based on unexpected parental deaths that occurred because of the tsunami. Second, we use longitudinal data collected before and after the tsunami to estimate empirical models that purge estimates of contamination from unobserved heterogeneity that is fixed at the child and family level. Third, we examine both shorter- and longer-term impacts of parental death on child outcomes. Finally, we distinguish male from female children, older from younger children, and the loss of a mother from the loss of a father from the loss of both parents. We turn next to a description of the tsunami and our study context.

2.3 The 2004 Indian Ocean Tsunami

The Sumatra-Andaman earthquake of 2004 resulted in a 2,000 km rupture along the floor of the Indian Ocean. The displaced water generated an immense tsunami surge, which slammed into the island of Sumatra shortly after the earthquake (Kerr 2005; Lay et al. 2005; Marris 2005; Sinadinovski 2006). The tsunami affected 26 countries bordering the Indian Ocean, but Indonesia was hit hardest:

[1] The authors report that paternal death is associated with lower college enrollment in the cross section but this can be attributed to the role of unobserved heterogeneity.

130,000 individuals perished and another 30,000 remain classified as missing (Rofi et al. 2006; Doocy et al. 2007).

Two features of the tsunami are important for our empirical approach. First, the tsunami was not expected. No early warning systems were in place. Moreover, geological evidence documents that mainland Sumatra had not been touched by a tsunami for more than 600 years (and the last tsunami to occur in the region was in 1907, affecting Simeulue Island off the coast of Sumatra) (Monecke et al 2008). Second, the severity of the impact varied in ways that could not be anticipated even within small areas. Areas where the water hit full force experienced the greatest damage, but sites nearby were protected from the water's full force by topographical features of the coastline (Frankenberg, et al, 2011). Because idiosyncratic features of the landscape played an important role in determining risk, parental deaths from the tsunami are driven less by genetic risk factors, prior behavioral choices, and socioeconomic status than is the case for parental absence caused by death from illness, for example.

2.4 Data

We draw our data are drawn from the Study of the Tsunami Aftermath and Recovery (STAR), a longitudinal survey of individuals who were living, prior to the tsunami, along the coast of Aceh and the neighboring province of North Sumatra. The baseline survey was conducted in February 2004, as part of the population-representative cross-sectional socioeconomic survey, SUSENAS, conducted annually by Statistics Indonesia.

With Statistics Indonesia assistance, we fielded the first follow up wave, STAR1, between May 2005 and July 2006. We targeted all SUSENAS respondents from the 2004 survey who were living in any of 11 *kabupaten* (districts) in Aceh and 8 *kabupaten* in North Sumatra. The baseline sample survey includes 585 enumeration areas in 525 villages. The *kabupaten* were selected because their coastlines were, in principle, vulnerable to inundation from the tsunami waves. The tsunami did not affect all areas in these kabupaten because the force and reach of the water varied considerably as a function of topography.

In the baseline survey, informants reported on the socioeconomic and demographic characteristics of themselves and other household members. In STAR1 we collected individual and household-level data, drawing on and augmenting the baseline questionnaire. In addition village leaders and informants at local schools and health facilities provided information as part of a large community-level survey.

STAR1 was the first of five annual post-tsunami surveys. In our analysis we draw also on data from the fifth follow-up, STAR5, which took place between September, 2009 and December 2010.

We focus on children and young adults who were between 9 and 17 years old at the time of the baseline survey and were living in 91 communities along the coast that sustained heavy damage from the tsunami, as measured by a combination of satellite imagery, direct observations of survey supervisors, and interviews with village leaders. In our sample the vast majority of deaths due to the tsunami occurred in these areas. In STAR1 and subsequently we put considerable effort into identifying which baseline respondents who had died and locating the survivors. When

respondents could not be found in the baseline location interviewers obtained proxy information about their whereabouts and tracked them to their new location. In about half the cases, survivors had moved to temporary camps; the others had moved to the homes of family or friends. Family members provided information survival status or, if family could not be found, we drew on neighbors, village leaders and local death registers compiled after the tsunami. Of 1,173 age-eligible children in the baseline, 345 (30%) are known to have died. Of the remaining 828 children, we interviewed 709 (86%) in the first follow-up. Persistent attempts to track all survivors in subsequent waves paid off: we found more of them and 737 (89%) were assessed in the final interview.[2]

About one in six of the children interviewed in the first follow-up lost at least one parent, as shown in panel A of Table 7. The literature suggests that the loss of a mother has a larger impact on child human capital outcomes than the loss of a father. In our empirical models we will distinguish the loss a mother from the loss of a father, as well as the loss of both parents to the tsunami. In our study sample of children, 7.9% lost a mother, 4.5% lost a father and about the same fraction, 4.4%, lost both parents to the tsunami.

We examine five shorter-term child outcomes and five longer-term outcomes, all of which are related to human capital and time allocation. The shorter-term outcomes are measured at the first follow-up interview, about a year after the tsunami, when the children were age 10 through 18 years. At that time 83% were

[2] 1% of the children refused to participate in each wave, 2 children died between the first and final re-survey and the remaining children were lost to follow-up.

Table 7: Parental Death, Shorter Term and Longer Term Outcomes

A. Parental death as a result of the tsunami	16.8
% of children who lost one or both parents	
% of children whose	
mother died	7.9
father died	4.5
mother and father both died	4.4
B. Child outcomes	
B.1 Shorter-term outcomes (at first follow-up interview)	
% of children	
enrolled in school at time of follow-up interview	83.2
received scholarship[a]	19.2
working in market sector in week before interview	9.2
housekeeping in week before interview	35.7
aspire to post-secondary school[b]	78.4
Sample size	709
B.2 Longer-term outcomes (at final follow-up interview)	
Completed years of education	10.2
% of children	
enrolled in school at time of interview	62.1
working in market sector in week before interview	28.2
housekeeping in week before interview	38.5
ever married by time of interview	11.1
Sample size	696

Notes: Sample consists of tsunami survivors who were, at baseline interview age 9 through 17 years and living in a community that was subsequently heavily damaged by the tsunami. Shorter-term outcomes measured during first post-tsunami interview, about a year after tsunami. Longer-term outcomes measured in final interview, about 5 years after the tsunami.

[a] Between time of tsunami and first follow-up interview

[b] Subsample of 606 respondents who are enrolled in school or plan to return to school at first follow-up.

enrolled in school at the time, 9% had worked in the previous week and 36% had helped with housekeeping in the previous week (Panel B of Table 7). About 19% of the children had received a scholarship after the tsunami to encourage them to stay at school. In the first follow-up interview, we asked each child who was enrolled in

school or wanted to return to school, whether he/she planned to continue beyond a post-secondary education. Slightly over three-quarters of them aspired to some form of tertiary education.

By the time of the final interview, about five years later, fewer than two-thirds of the children were enrolled in school and the average child had completed 10.3 years of schooling. About 28% were working and 39% did housework in the week prior to the survey and 10% had married.

2.5 Empirical Strategy

Our goal is to identify the extent to which variation in these human-capital related outcomes can be attributed to the death of a parent in the tsunami. A natural starting place is to estimate the relationship between each of the shorter-term and longer-term outcomes for child i at time t (where t spans the period before and after the tsunami), Y_{it}, and parental death, D_{it}, controlling time varying and time invariant child and family characteristics, X_{it}, and X_i, respectively:

$$Y_{it} = \alpha + \beta D_{it} + \gamma X_{it} + \delta X_i + \varepsilon_{it} \qquad [1]$$

Parental death, D, is vector-valued distinguishing children who lost their mother, those who lost their father and those who lost both parents in the tsunami. An important advantage of our research design is that, in contrast with much of the literature that examines the impact of AIDS mortality, parental death in this study does not reflect prior health-related behaviors but rather is the consequence of a large and unexpected natural disaster. If parental death in the tsunami can be treated as random, then estimates from [1] can be given a causal interpretation. Formally, it is necessary to assume that unobserved heterogeneity ε_{it} is not correlated with

covariates in the model including parental death, D_{it}. This assumption may not hold. It is possible that parents who survived the tsunami are stronger or better able to swim than other parents, or they may live in more robust houses that were better able to withstand the force of the water. If these surviving parents were also more inclined to invest in the human capital of their children prior to the tsunami, then the assumption that ε_{it} is unrelated to parental death is unlikely to be true.

To the extent that such differences exist and are traits that do not change during the study period, they can be taken into account in [1] by include a child-specific fixed effect. Specifically, separating unobserved heterogeneity into two components, a fixed effect that is time invariant for each child, ω_i, and a component that varies over time for each child, ω_{it}, re-write [1] as

$$Y_{it} = \alpha + \beta D_{it} + \gamma X_{it} + \omega_i + \omega_{it} \qquad [2]$$

The fixed effect absorbs all characteristics of the parent and child that do not change over time and affect the outcome, Y_{it}, in a linear and additive way. These include, for example, parents' tastes for investments in their children, characteristics of the child such as ability and ambition as well as characteristics of the family and community in which they were living at the time of the tsunami.

Estimates of [2] require repeat observations on the same child before and after the tsunami. Therein lies a second key advantage of our research design which includes a baseline pre-tsunami survey and follow-up interviews conducted with the same children after the tsunami. We examine indicators of schooling and time allocation in this framework that were measured in the baseline and in the surveys conducted after the tsunami.

Two indicators that we consider were only collected after the tsunami. In the first re-survey we asked about participation in programs implemented after the tsunami to assist families, including whether the child received a scholarship from such a program. The question was not relevant at baseline and we set all children as not receiving a scholarship at that time.

The second question that we added in the first resurvey asked children about their aspirations regarding post-secondary schooling. The question was motivated by three lines of research. First, theory suggests that loss of a parent has the potential to affect beliefs about the future and future-looking decisions. Second, loss of a parent potentially affects resources available for schooling which may have affected aspirations. Third, psycho-social well-being may have been affected which would also potentially affect future aspirations. Because we have no information about aspirations at baseline, it is not possible to estimate models with child fixed effects. We adopt an alternative approach and draw comparisons between children who were living in the same enumeration area, some of whom lost a parent and others did not. These estimates exploit the local nature of the tsunami's impact and assure that differences in education aspirations across communities do not contaminate the estimates. In addition to parental death, the models include child, parent and household characteristics, Z, measured at baseline, along with the community fixed effect, ω_c:

$$Y_{it} = \alpha + \beta D_{it} + \gamma Z_{it} + \omega_c + \omega_{it} \qquad [3]$$

Before presenting empirical results, it is useful to assess whether parental death can legitimately be treated as exogenous and, thereby, provide insights into the

Table 8: Child and Family Characteristics at Pre-tsunami Baseline (Stratified by Survival of Parents)

		One of both	Difference (relative to both parents survived)			
	Both parents survived tsunami	parents died during tsunami	Any parent died	Mother died	Father died	Both parents died
	[1]	[2]	[3]	[4]	[5]	[6]
Age (years)	12.9	13.5	0.6	0.6	0.2	0.8
	[0.1]	[0.2]	[0.3]	[0.4]	[0.5]	[0.4]
Male (%)	54.2	65.5	11.3	8.2	8.2	19.9
	[2.1]	[4.7]	[5.1]	[8.3]	[9.1]	[8.8]
Education (years)	6	7.2	1.15	1.1	0.9	1.6
	[0.2]	[0.2]	[0.29]	[0.4]	[0.6]	[0.5]
Enrolled in school (%)	91.4	96.6	5.25	5	5.5	5.4
	[1.5]	[1.5]	[2.17]	[2.8]	[3.5]	[3.6]
Working for a wage (%)	4.6	2.8	-1.82	-2.7	3.1	-4.6
	[1.6]	[1.5]	[2.19]	[2.5]	[5.5]	[1.6]
Engaged in housekeeping (%)	8.2	3.8	-4.4	-4.3	-8.2	-1.3
	[1.8]	[2.9]	[3.39]	[4.2]	[1.8]	[5.1]
Mother's education (years)	8.5	8.6	0.1	0.5	-0.8	0.3
	[0.4]	[0.4]	[0.52]	[0.8]	[0.8]	[0.6]
Father's education (years)	9.4	9	-0.39	-0.5	-0.9	0.3
	[0.4]	[0.4]	[0.52]	[0.7]	[0.8]	[0.7]
Mother alive at baseline (%)	98.1	99.2	1.02	1.9	-1.3	1.9
	[0.7]	[0.9]	[1.08]	[0.7]	[3.2]	[0.7]
Father alive at baseline (%)	95.4	90.8	-4.68	-0.8	-4.8	-11.6
	[1.0]	[4.0]	[4.03]	[5.3]	[9.0]	[7.3]
Per capita expenditure (Rp10,000 per month)	40	41.8	1.84	7.9	-10.1	3.1
	[2.7]	[5.7]	[5.94]	[11.0]	[3.7]	[5.6]
Household size	5.9	5.8	-0.13	0	-0.1	-0.5
	[0.2]	[0.2]	[0.22]	[0.3]	[0.4]	[0.3]

Notes: [Standard errors] adjusted for clustering at community level. Col3=Col2-Col1. Rp10000 is approximately equal to US$1.

value-added of exploiting the longitudinal dimension of our research design. We compare indicators measured prior to the tsunami at baseline for children whose parents subsequently survived the tsunami with those who lost one or both parent in the tsunami.

As shown in the first row of Table 8, children whose parents survived the tsunami were, on average, age 12.9 at the baseline survey (column 1). Those who lost a parent were, on average, age 13.5 (column 2) and the difference of 0.6 years is significant (column 3). The differences for children who lost their mother, their father or both parents, relative to those whose parents survived are displayed in columns 4, 5 and 6, respectively. None of the differences is significant.

The second row of the table indicates that males constitute a higher fraction of survivors within the group of children that lost parents than within the group of children whose parents survived, and this difference is significant. The difference is largest for children who lost both parents – in this group there are 19.9% more surviving young males relative to females, and this difference is also significant. Children whose parents died in the tsunami were also significantly better educated and significantly more likely to be enrolled in school prior to the tsunami. They were about half as likely to be working and half as likely to be engaged in housekeeping during the week prior to the pre-tsunami survey relative to those whose parents survived (these differences are not significant.) The rest of Table 8 compares parental education, whether the parents were alive at baseline, household per capita expenditure, an indicator of resource availability, and household composition, all

measured at baseline. In these dimensions there are no significant differences between children whose parents survived and those who did not.

Overall, children who lost one or both parents appear to have higher levels of human capital investments before the tsunami than those whose parents survived the tsunami and these pre-existing differences underscore the critical importance of having a pre-tsunami baseline in order to identify the causal effect of parental death on the outcomes.[3]

We established above that males are more likely to have survived the tsunami than females. The male survival advantage characterizes our sample of adolescents and young adults, and also holds for all adults. It has been attributed to the fact that males are stronger and, in Islamic Aceh, much more likely to know how to swim than females (Frankenberg et al, 2011). We will estimate models separately for males and females.

We also explore whether other attributes are associated with children's survival status (Appendix Table 1). As documented above, male children were significantly more likely to survive. Examining the other indicators in Appendix Table 1, it is also the case that children who helped with housekeeping were more likely to survive. This difference is not significant when comparisons are drawn within communities suggesting that it reflects variation in the intensity of the tsunami across study sites. The evidence points to children's deaths in the tsunami being

[3] In models that include a community fixed effect, which compares children *within* each community, we find no significant differences in any of the indicators in the table between children who lost one or more parents and those who did not. Thus, some of the differences between orphans and non-orphans can be attributed to differences in death of parents across our study sites.

largely random and not related to own human capital, parental human capital or household resources.

The final three columns of Appendix Table 1 compare the same indicators for respondents who were interviewed in the first follow-up with those who were not. None of the differences is significant and, taken together, the indicators explain only 1.2% of the variation in the probability an individual is not interviewed in the follow-up survey (F statistic for the significance of all the covariates in the appendix table is 1.2, p value is 0.31.) In short, we find no evidence that attrition is selected on observed characteristics measured at baseline.

2.6 Results

The empirical models, [2] and [3], are estimated by ordinary least squares. All estimates of variance-covariance matrices take into account clustering at the community level and are robust to arbitrary forms of heteroskedasticity. Results for short-term outcomes, measured a year after the tsunami, are reported in Table 9. Results for longer-term outcomes are reported in Table 10. All models are stratified by gender of the child and we also distinguish younger children (age 9 through 14 at baseline) from older children (age 15 through 17 at baseline) who are more likely to make the transition from school to work during the study period. Each panel of the table reports the impact on the outcome listed in the first column of the table of death of the mother, death of the father and death of both parents relative to both parents surviving the tsunami. All models include child fixed effects, [2], except estimates of the impact of aspirations to go to college (or any tertiary education institution).

Table 9: Effects of death of a parent on shorter-term outcomes (Comparing first post-tsunami interview with pre-tsunami interview)

		Males		Females	
	Indicator of Parental Death	Short-term [1]	Long-term [2]	Short-term [3]	Long-term [4]
% of enrolled in school	Mother	-11.6	7	-22.2	-0.5
		[18.0]	[15.2]	[17.4]	[21.1]
	Father	-37.7	-24.7	14.5	11.4
		[18.6]	[16.5]	[4.9]	[29..4]
	Both	-9.2	-40.2	-15.9	-55.7
		[14.7]	[10.6]	[28.7]	[4.5]
Years of education (completed)	Mother		-0.9		0.7
			[0.6]		[1.0]
	Father		-1.3		-0.5
			[0.7]		[0.5]
	Both		-1.7		-0.1
			[0.4]		[0.5]
% working (previous week)	Mother	12.8	-10.1	8.1	7.7
		[13.5]	[13.6]	[11.3]	[21.0]
	Father	2	3.7	-37.5	-26.1
		[11.7]	[17.8]	[28.0]	[48.1]
	Both	27.1	34.2	-5	-25.8
		[16.2]	[14.3]	[3.0]	[4.9]
% doing housework (previous week)	Mother	15	0.8	34	15.2
		[21.9]	[7.6]	[12.8]	[3.7]
	Father	18.9	7.8	-39	15.4
		[13.6]	[2.8]	[8.5]	[3.9]
	Both	-5.5	7.7	53.2	15.9
		[10.8]	[2.8]	[6.5]	[3.8]
% received scholarship	Mother	-13.3		10.2	
		[7.3]		[9.2]	
	Father	0.6		19.3	
		[15.4]		[26.8]	
	Both	-21.8		-16.9	
		[4.3]		[4.3]	
% aspire to go to college	Mother	-1.7		18.4	
		[13.3]		[19.4]	
	Father	0.7		23.9	
		[13.4]		[18.0]	
	Both	-51.1		12.8	
		[29.9]		[11.8]	

Table 9 (continued)

		Males		Females	
	Indicator of Parental Death	Short-term [1]	Long-term [2]	Short-term [3]	Long-term [4]
% ever married	Mother		-0.1		7.1
			[7.7]		[20.5]
	Father		-7.3		-4.7
			[2.9]		[27.3]
	Both		-7.2		62.3
			[2.8]		[5.6]

Notes: Older children age 15-17 at baseline; younger children age 9-14 at baseline. Linear probability estimates and [standard errors]. All models (except aspiration to college) include child fixed effects and age. Aspirations to college models include community fixed effects and also control presence and education of mother and father, log(per capita expenditure) and household size, all measured pre-tsunami. [Standard errors] take into account clustering at community level and are robust to arbitrary forms of heteroskedasticity.

Beginning with shorter-term impacts of parental death, in the first column of Table 9, older males-- those orphaned at 15-17 years of age-- are less likely to be enrolled in school if a parent died – an impact that is large and significant if the father died. If both parents died, these young men are more likely to be working, less likely to receive a scholarship and much less likely to aspire to college.[4] Apparently, for this group, scholarship receipt was not well-targeted to those who lost parents and had little impact on school enrollment.

These deleterious impacts of death of parents in the short-term are reflected in the longer-term outcomes, some five years after the tsunami, which are displayed in the first column of Table 10. At the time of the final interview, relative to males whose

[4] The effect on scholarship receipt is significant at a 5% size of test; the effects on working and aspirations are significant at the 10% level.

parents survived the tsunami, those who lost both parents at ages 15 to 17 are 40% less likely to be enrolled in school, have completed 1.7 fewer years of education, are 34% more likely to be working and 8% more likely to be doing housework. They are also 7% less likely to be married. All of these effects are significant at a 5% level. Loss of a father had essentially the same impact, although perhaps it is smaller (albeit not significantly). Loss of the father, or both parents, has clearly taken a toll on the human capital accumulation of these young men that they will likely carry through adulthood.

Results for older females are reported in the second column of each table. In the shorter-term, death of a father results in higher rates of school enrollment and lower rates of doing housework. However, death of the mother or both parents results in lower school enrollment (albeit not significantly) and substantially higher arrest of doing housework (34% and 53% respectively). It appears that when the father dies, the mother protects older females whereas the death of the mother results in the older female stepping into the mother's role, at least in terms of housekeeping. Again, the scholarship program does not appear to have been well-targeted, as older females who lost both parents are the least likely to receive a scholarship. Parental death does not appear to affect aspirations for education.

However, in the longer term, death of both parents results in 56% lower school enrollment, lower rates of participation in the work force, higher rates of keeping house and very much higher rates of marriage (62%). These young women are transitioning to the adult role of marriage earlier than women who lost one parent or whose parents survived the tsunami. Indeed, the only significant impact of death

Table 10: Effects of death of a parent on longer-term outcomes

		Males		Females	
	Indicator of Parental	Short-term	Long-term	Short-term	Long-term
	Death	[1]	[2]	[3]	[4]
% of enrolled in school	Mother	2.5	-13	7.5	9
		[2.2]	[13.5]	[3.4]	[8.3]
	Father	2.8	-2.1	-4.1	-26.9
		[2.5]	[22.9]	[11.1]	[21.8]
	Both	2.8	-13.6	6.3	-50.8
		[2.5]	[12.4]	[2.8]	[16.7]
Years of education (completed)	Mother		-0.3		0.4
			[0.3]		[0.5]
	Father		-1.4		1
			[1.0]		[1.0]
	Both		-0.2		-0.2
			[0.8]		[0.4]
% working (previous week)	Mother	0	2.6	-2.4	-9.9
		[5.4]	[12.3]	[1.6]	[4.8]
	Father	7.1	26.7	8.9	-9.8
		[12.2]	[25.9]	[9.6]	[4.8]
	Both	-5.4	22.3	-2	23.6
		[2.2]	[16.1]	[1.4]	[21.6]
% doing housework (previous week)	Mother	12.6	2.6	-1.1	0.5
		[10.5]	[1.2]	[17.0]	[7.5]
	Father	-12.7	2.3	15	7.8
		[3.6]	[1.3]	[21.2]	[2.6]
	Both	-21	-6.3	-26.5	-8.8
		[9.0]	[9.0]	[30.3]	[16.2]
% received scholarship	Mother	3.2		6.7	
		[8.3]		[14.7]	
	Father	32		22.2	
		[19.7]		[13.2]	
	Both	32		40	
		[11.9]		[24.9]	
% aspire to go to college	Mother	4.4		6.9	
		[15.9]		[10.4]	
	Father	-10		-30.7	
		[24.6]		[16.5]	
	Both	-28.2		-65.9	
		[41.6]		[25.2]	

Notes: Linear probability models include child fixed effects and age of child. [Standard errors] take into account clustering at community level. Older are age 14-17 at baseline; younger are age 9-13 at baseline.

of one parent on older females is elevated rates of doing housework – presumably as substitutes for mothers who have died or to assist those mothers who are widows and are working in the labor market to replace income lost with the death of the father.

Although mothers who survived may have attempted to protect their older daughters' schooling investments in the short-term, there is little evidence that this effort was sustainable over the longer-term, at least relative to those whose father survived. However, death of both parents appears to have an enduring impact on girls orphaned at ages between 15 and 17.

We turn now to results for those orphaned between the ages of 9 and 14. Although younger males are no more or less likely to be enrolled in school if one or both parents died in the tsunami than are younger males whose parents survived, they are 30% more likely to have received a scholarship if the father died or both parents died. If both parents died, they are less likely to be working or doing housework, and if the father died, they are also less likely to be doing housework. It is possible that these effects on time allocation are driven by the scholarship program. Very little evidence suggests longer-term impacts of orphanhood on these younger males apart from a slightly higher probability of doing housework if the mother or father died.

Younger females who lost their mother or both parents are significantly more likely to be enrolled in school. Targeting of scholarships to young girls who lost both parents may explain one piece of these results. But young females who lost their father are also more likely to receive a scholarship and their enrollment rates are not

higher, whereas enrollment rates of the young girls who lost a mother are higher, yet these girls were not more likely to receive a scholarship. No significant differences emerge in working and housework among those who lost one or both parents and those who did not.

Aspirations of young girls, however, are affected: girls who lost both parents are 66% less likely to aspire to college, relative to those whose parents survived. Five years later, these girls are 50% less likely to be enrolled in school. Loss of a father has effects in the same direction (but half the magnitude and significant only at the 10% level for aspirations). Although there are no detectable differences in completed schooling for these young women, relative to those whose parents survived, the low enrollment rates suggest the gaps will emerge in the coming years. Whereas loss of a mother or a father results in significantly lower rates of working in the market, loss of both parents results in a 24% increase in that probability – these girls have left school and entered the labor force earlier than similar girls whose parents did not die in the tsunami. Death of a father does result in higher rates of housekeeping as these young girls, like older females, may substitute for the mother.

2.7 Discussion and Conclusions

The potential repercussions for children of the death of a parent are likely to be multi-faceted and to evolve over time. The role in the family played by the parent goes unfilled for at least some period of time. The surviving parent may assume some of the deceased parent's responsibilities and, depending on the child's age and gender, the child may also take on some of those responsibilities. The child's relationship with the surviving parent (and/or other relatives and care-givers) likely

changes and the child may strike out on his or her own earlier than if the parent had not died. Parental death is often accompanied by changes in the socioeconomic status of the family. All of these processes likely change over time. We have, therefore, investigated both the short and longer-term impacts of parental death on boys and girls focusing on human capital related indicators.

A considerable body of evidence indicates that children who lose a parent have less human capital than those who do not. While it may be intuitively appealing to interpret this as a causal relationship, in fact, establishing a causal link has proved to be a significant challenge.

Using data collected before and after the Indian Ocean tsunami, we examine the impact of death of one or both parents on child outcomes soon after the tsunami and over the longer-term. Although the tsunami was unexpected and survival depended largely on where people were located when the water came ashore, identifying the causal impact of parental death is facilitated by the availability of measures of human capital and time allocation before and after the tsunami.

We find that the impact of parental death varies with the age and gender of the child and that shorter term impacts are not reliable indicators of the effects that emerge in the longer-term. An older male child who lost his father or lost both his parents in the tsunami has substantially lower levels of education and is more likely to be working than a son whose parents survived the tsunami. It is likely that older females who lost both parents will also have less human capital than those that did not; these females are less likely to be in school or working and much more likely to be married five years after the tsunami. An older female is more likely to be doing

housework if her mother, father of both parents died suggesting that she substitutes for the parent who died in a complex way. These girls will likely carry the costs of parental death through their entire lives.

The impact of parental death on younger children is more muted. Younger males are largely protected from the deleterious impact of the death of any parent. Whereas this may be true for a younger female who lost either her mother or father, those who lost both parents appear to be on trajectory of lower human capital investments that have not yet fully played out. It is possible that a scholarship program that targeted younger children who lost their fathers or both parents offset negative impacts on enrolment among these children immediately after the tsunami. More generally, it is possible that the impact of parental death on the outcomes we consider has been offset by the influx of assistance after the tsunami, which included opening temporary schools in camps and subsequent reconstruction of infrastructure. We note, however, that children whose parents did not die were also able to take advantage of these services. Indeed, it is precisely those children who serve as the control group in our empirical models.

The literature on HIV/AIDS mortality in Africa indicates that death of a mother typically has significant negative consequences for child education whereas death of a father has negligible and insignificant effects. It has been suggested that this may, in part, reflect the fact at many children do not co-reside with their fathers, particularly in South Africa. In contrast, we find that death of a father in the tsunami has significant negative consequences for the educational attainment of older sons whereas the impact of maternal death is more muted. The evidence suggests that

children and the surviving parent substitute for the parent that died. However, the death of both parents in the tsunami has large and substantively important impacts on older males, older females and possibly younger females. No studies have examined the impact of the loss of both parents in a longitudinal design that compares children before and after the death of the parents. This is important since clearly its impact is not the sum of the impacts of maternal and paternal death.

Appendix Table

Attrition – Comparisons of Characteristics at the Baseline

	All Age Eligible Children [1]	Died in tsunami [2]	Survived tsunami [3]	Diff (Surv-Died) [4]	Ivwed in first survey [5]	Not ivwed in first resurvey [6]	Diff (Ivw - Not Ivw) [7]
Age (years)	13	13	13	0.03	13	12.9	0.12
				[0.14]			[0.24]
Male	52.34	46.09	46.09	8.86	56.14	47.9	-8.24
				[4.3]			[5.2]
Education (years)	6.3	6.5	6.2	-0.25	6.2	6.3	-0.03
				[0.27]			[0.44]
Enrolled in school (%)	92	93	91.7	-1.36	92.5	86.3	6.2
				[1.82]			[4.76]
Working for a wage (%)	4.1	3.1	4.5	1.37	4.3	5.7	-1.39
				[1.72]			[3.44]
Engaged in housekeeping (%)	6.5	3.7	7.7	3.97	7.4	9.5	-2.12
				[1.84]			[3.31]
Per capita expenditure (Rp10,000 month)	39.7	38.3	40.2	1.93	40.3	39.6	0.78
				[3.84]			[5.15]
Household size	5.9	5.7	5.9	0.21	5.9	6.1	-0.16
				[0.22]			[0.71]
Sample size	1,173	345	828		709	119	

Note: Means, differences and [standard errors] of survivors (relative to those who died) and among survivors, those who were interviewed (relative to those not interviewed)

3. The Impact of Typhoon-Resistant Schools and Instructional Equipment on Education in the Philippines

3.1 Introduction

The question of whether improvement in the access to and quality of school resources enhances education outcomes is of interest to many economists. Besides examining the benefits of expanding the number of schools or classrooms in developing countries (Duflo, 2001; Osili and Long, 2008), a growing number of studies also investigate the impact of allocating school resources that assist in the students' learning. For instance, studies (Angrist and Lavy, 2002; Barrow et. al., 2009) investigate whether providing computers for pedagogical use in the classrooms (*computer-aided instruction* (CAI)) improved reading, mathematics and algebra test scores of students in Israel and US. A more recent study examines the *One Laptop per Child* (OLPC) program which aims to improve learning in the poorest regions of the world through provision of laptops to children at schools and at home (Cristia et. al., 2012). Although there is no evidence of effects of this program on enrollment and test scores improvement in Mathematics and Language subjects, some positive effects are found in general cognitive skills, as measured by Raven's Progressive Matrices.

In this paper, I evaluate a bilateral grant aid that aimed to provide typhoon-resistant secondary schools and instructional equipment for major high school subjects such as Science, Mathematics, Biology, Chemistry, Physics, Technology and Home Economics in the Philippines. The importance of the technology of typhoon-resistant schools cannot be understated in a country such as the Philippines. Lying on

the so-called "typhoon belt" in the Pacific Ocean, the Philippines is the most typhoon visited country in the world with an average of 20 typhoons each year, of which an average of 6 are classified as extreme or destructive typhoons with maximum sustained winds of 150 KPH and above.[1] Localities that tend to be hit directly by the passing typhoons tend to sustain severe damage in infrastructures. Thus the loss in school infrastructure can disrupt schooling for an extended period of time especially if the building is permanently damaged. On the other hand, the instructional equipment component of the grant aid is also equally important as the adequacy and availability of instructional equipment for major subjects in secondary level would help improve the quality of students' learning.

I examine the impact of the typhoon resistant schools and instructional equipment program 10 years after it began, on schooling attainment in the Philippines. The results of my analysis suggest that, for men, presence of typhoon-resistant schools equipped with instructional equipment in the municipalities led to an average increase of about 0.26 to 0.30 years of education while the presence of instructional equipment alone led to an average increase of 0.23 to 0.26 years of education. For women, the availability of both components led to an average increase of 0.23 to 0.32 years of education but the availability of either component without the other does not seem to have an effect. Except for the falsification exercise which suggests that there

[1] Tropical cyclones in the West Pacific Ocean are called "typhoons" while tropical cyclones in the Atlantic and East Pacific Ocean are called "hurricanes". Typhoons are generally very strong because of the Pacific's warm water, and are also more frequent than hurricanes.

are other underlying trends not fully captured by the specifications, the estimates are in general robust to the inclusion of individual level characteristics, accounting of other concurrent national government's programs, restricting to municipalities in the *typhoon belt* region and accounting for municipality-specific trends.

The paper contributes to the literature in two ways. First, it adds to the growing literature that independently evaluates the longer run impact of a grant-aid or loan using micro-level data. Except perhaps for the well-known conditional cash transfers program that has been launched in various countries and has been evaluated by development economists, many of the development aid projects (particularly the older ones) were evaluated at the project level by the same aid agencies or institutions that provided the funding. Moreover, few of these projects were followed up in the longer run. One of them is a World Bank financed rural development program that was also evaluated 10 years after it began (Chen et. al., 2009). In their evaluation, the authors find that although sizeable income gains were found in the short term during the project's disbursement period, these gains did not persist in the longer term.

Second, this paper evaluates an innovative policy solution for mitigating the risks of natural disasters. The 2012 Global Climate Risk Index lists Philippines as one of the top 10 countries most affected by extreme weather events between 1991 and 2010. As global warming continues, countries such as the Philippines will continue to experience extreme weather conditions that can human capital accumulation. Thus in such circumstance, it is important to seek and evaluate more innovative solutions to improving schooling outcomes.

The rest of the paper is organized as follows. Section 2 provides a background on the 1988 secondary education policy and Japanese grant-aid which comprised of typhoon-resistant school building program and instructional equipment program. Section 3 describes the theoretical framework. Section 4 presents the data and presents the results for the determinants of the program placement. Section 5 provides the identification strategy. Section 6 presents the main results while section 7 concludes.

3.2 The 1988 Secondary Education Reform and the Typhoon-Resistant School Building and Instructional Equipment Project

In 1988, the Philippines implemented a free public secondary education policy to complement its historically free and compulsory public elementary education policy.[2] Under this policy, the tuition and matriculation fees, laboratory and library fees, medical and dental fees and athletic fees were made free. Thus the policy led to rapid increase in secondary school enrollment and shortfall in classrooms and school buildings. Part of the reasons for the shortage in classrooms and the school buildings is that some of the provinces' school infrastructures were greatly damaged by the two super typhoons in 1987. Given these capacity constraints, as a general implementation rule, the Department of Education officials prioritized the enrollment for first year high school of the graduates of public elementary schools in the same municipality as well as students in the second, third and fourth years of the same school.[3]

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[2] The Philippines has a long history of free and compulsory elementary education which dates back in 1898, when a new constitution was established after the Spanish regime.
[3] The Philippines has a 6-4-4 education system, with six years of elementary education, 4 years of secondary education and another 4 years of tertiary education.

In that same year, the government explored the possibility of tapping Japanese bilateral assistance in the form of grants in order to supplement the initiatives to address the shortage of classrooms and school facilities. This resulted into a school building project (which became known as Typhoon-Resistant School Building Program (TRSBP)) which uses the Japanese technology for constructing typhoon-resistant pre-fabrication structures. The idea behind this program is not just to build schools or classrooms but to build better schools by making them typhoon-resistant so that access to school is not interrupted by school infrastructure loss due to typhoons that regularly visit the country. This is an unusual assistance program as the Government of Japan provided an "in-kind" grant. Thus, the Japanese handled the school building construction, using pre-fabricated construction materials transported to the Philippines from Japan. At the end of this program, a total of 252 public secondary schools with 902 classrooms and 153 science rooms and workshops were constructed mainly in the regions which are most frequently visited by the typhoons.[4] On average, each school had an investment worth 7.4 to 11.1 million Philippine pesos.[5]

The major consideration for the selection of recipient provinces (or states) under this program is that a province should have been heavily affected by the past typhoons, particularly those that were directly hit by the two super typhoons in 1987. The specific guidelines used in selecting the recipient municipalities (or counties)

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[4] The program also constructed schools at the elementary level, although the secondary level was prioritized. Overall, a total of 360 elementary and secondary schools were constructed with 1289 classrooms and 219 science rooms.

[5] In 1990, 1 USD is equivalent to 47.08 Philippine pesos. This is thus roughly equivalent to about US$ 157,000 to 236,000. About 5.4% of the total project cost was appropriated to consultancy fees.

were as follows: (a) the schools should have sufficient space to build on; (b) the schools should be located near areas of large population; (c) the municipality should not be a prospective recipient of financial aid from any foreign assistance agency or of the government's regular school building program or calamity fund project; and (d) the schools should not have received more than P300,000 in addition to their regular budget. The basic design criteria for building schools include emphasis on typhoon-resistance capability, flood resistance, flexibility for multiple uses, adaptation to tropical climatic conditions, requirements of handicapped students, ease of maintenance and systematized construction method to complete each project phase in one year with uniform quality. The mission team also considered the availability of water, power and sewerage facilities in the areas. However if the basic facilities such as power/electrical lines, water and sewerage systems were insufficient, new basic facilities were installed to ensure that the schools would function properly.

In addition to the typhoon-resistant school building project, the Philippine government also requested the Japanese government for a grant-aid for the provision of instructional materials and equipment (also known as the Secondary Instructional Equipment Program (SEIEP)).[6] In view of increasing access to quality education and developing students' curiosity in natural science and technology, the Department of Education aimed to address the shortage of experimental and training equipment in the fields of Science and Technology as well as Home Management. The basic criteria

[6] To ensure the proper use and maintenance of the equipment, a three to five days teacher training was conducted by the project team (comprised of representatives from the Philippine government and Japanese government) for the recipient schools.

used in the selection of school recipients was that the school should be a TRSBP recipient, although not all TRSBP recipient schools received this program and the project also ended up providing instructional equipment to non-TRSBP recipient schools that also needed these packages.[7] The other criteria used are that the school should not be receiving any assistance in facilities or equipment from any local or foreign source and that it should have an enrollment of more than 200 students.

In general, the Japanese bilateral grant-aid led to three types of program packages: (i) only the typhoon-resistant schools (TRSBP); (ii) only the instructional equipment (SEIEP); and (iii) both components.

3.2.1 Concurrent Programs

Besides tapping into the Japanese assistance, the Philippine government also obtained loans from Asian Development Bank and assistance from USAID to construct more than 675 school packages (more than 2,145 classrooms) in other parts of the country. Like the TRSBP schools, these schools also received the instructional equipment packages to meet the Philippine government's goal of raising the quality of education and developing students' interest in natural science and technology. However, unlike the TRSBP schools, these schools were constructed using the traditional lighter materials and not typhoon-resistant, similar to the ones used by the government under its regular school building program. The rest of the municipalities in the country that did not receive either the TRSBP program or the ADB or USAID

[7] Similar to TRSBP program, the mission team also considered the availability of electrical and water supply utilities. But in case these basic facilities were insufficient, the Government of the Philippines provided the required electrical system and water supply packages.

funded programs were covered under the regular school building program of the government.[8]

Another program called the National Secondary Education Curriculum (NSEC) program was implemented around 1993 and was also phased-in various localities. Since this is also part of the government's secondary education policy reform, it may potentially be correlated with either the allocation of typhoon-resistant schools or instructional equipment packages. Unfortunately, I do not have data on the placement of this curriculum program. Thus to estimate the pure impact of the Japanese grant-aid programs, I will restrict my analysis to program packages allocated by 1992, before the NSEC program began.

At around the same time, the government launched a water supply, sanitation and sewerage master plan for the years 1988-2000. The goal of the project was to provide basic water supply facilities (such as wells) in 37 provinces and sanitation facilities (such as providing household latrines, public toilets, sullage removal units and well disinfections) in 75 provinces of the 83 provinces in the country. Since the allocation of these concurrent programs may be correlated with the allocation of TRSBP and SEIEP programs, the specifications will also account for the presence of these programs.

[8]Since these schools could be easily destroyed by strong or destructive typhoons, part of the funding under the regular school building program is being used to repair severely damaged buildings or classrooms by typhoons.

3.3 Theoretical Framework

How can typhoon-resistant schools help improve schooling outcomes in the Philippines? Lying on the so-called "typhoon belt" in the Pacific Ocean, the Philippines is the most typhoon visited country in the world with an average of 20 typhoons each year.[9] Of these 20 typhoons, on average about 6 are classified as extreme or destructive typhoons with maximum sustained winds of 150 KPH and above. Besides the loss of lives and assets, the other possible direct consequence of these typhoons is the loss of infrastructures such as schools and instructional equipments that translate into higher marginal cost of production of human capital. The destruction of schooling-related infrastructures can lead to a direct loss of human capital, especially if permanently damage and is not repaired (Baez et. al., 2010). Thus, a major portion of the government budget under its regular school building program is allocated into reconstruction of damaged schools in areas hit by destructive typhoons.

However, if the children whose schooling were disrupted for several weeks (during the reconstruction of schools) fail to return to school, the loss of human capital could be inevitable. Also, when instruction time is lost, the quality of learning may also drop and students may find it difficult to catch up and eventually drop out of school. Furthermore, schools damaged beyond repair require a level of

[9] Tropical cyclones in the West Pacific Ocean are called "typhoons" while tropical cyclones in the Atlantic and East Pacific Ocean are called "hurricanes". Typhoons are generally very strong because of the Pacific's warm water, and are also more frequent than hurricanes.

reinvestment several times higher than the incremental cost of building typhoon-resistant schools.

3.4 Data and Determinants of Programs' Placement

The main data source in this paper is the 10% Integrated Public Use Microdata Series (IPUMS) of the Philippines decennial censuses. The 2000 IPUMS is the main data used in regression estimates while the 1990 IPUMS is used to construct variables predicting the determinants of program availability. Data on program availability for both the TRSBP and SEIEP projects were obtained from the project completion reports of the said programs made available by the Educational Development Projects Implementing Task Force of the Philippines' Department of Education. These reports provide a complete list of schools under these programs and their corresponding municipality locations. The Manual on Secondary Education Development Program, published by Department of Education, also provides a list of recipient schools and municipalities under the Asian Development Bank (ADB) and USAID-funded school building projects. The data on the concurrent water and sanitation programs are all at the province-level and were obtained from the project completion reports under the Rural Water and Sanitation Services Program funded by ADB and the International Bank for Reconstruction and Development (IBRD). I also obtained data on the tracking of all typhoons or tropical cyclones that passed the Philippine Area of Responsibility in each of the years 1980-2000 from the Philippine Atmospheric, Geophysical and Astronomical Services Administration of the country. The data includes the areas affected as well as the corresponding strength of the typhoons or storms.

As shown in Table 11, during the project's implementation between 1989 and 1992, out of 1,104 municipalities at that time, about 5% received typhoon resistant secondary school packages (TRSBP) alone, about 4.3% of the municipalities received instructional equipment packages (SEIEP) alone while about 4.5% received both programs. The second row of the table restricts the sample within the *typhoon belt* region. Figure 5 shows the tracks of tropical cyclones that formed in the Western North Pacific (WNP) during the period 1948-2010. In general, except for the southern part of the country (which includes 25 of the 83 provinces), the rest of the country is within the *typhoon belt*. Restricting the sample to typhoon belt region leads to only slightly higher percentages. Finally, among the municipalities that were heavily affected by the two super typhoons in 1987, about 11% received TRSBP, 13% received SEIEP and 12% received both programs. This is consistent with the goal of the bilateral grant-aid project to target those areas that were heavily hit by the 1987 super typhoons, although other areas within the *typhoon belt* region were also targeted.

Table 11: Percentage of Municipalities that Received the Program Packages

	Number of Municipalities	TRSBP only	SEIEP only	Both	None
Overall	1104	5.43%	4.26%	4.53%	90.31%
Within the "Typhoon Belt" Region	817	6.98%	5.75%	6.12%	87.27%
Heavily Affected by 1987 Super Typhoons	278	11.15%	12.95%	12.23%	63.67%

Table 12 shows the cross-municipality relationship between the availability of the Japanese grant-aid programs (TRSBP, SEIEP or both) and a variety of potential determinants. Except for the typhoon indicator which was obtained from the Philippines weather agency, the rest of the correlates are all calculated from the census. I measure the share of the population living in each municipality with various demographic backgrounds such as Christians, Tagalog ethnic group, Cebuano and Ilonggo ethnic group, Ilocano ethnic group (the omitted category includes the other smaller ethnic groups) and the share of children aged 13-16 in 1988 (or aged 15-18 in 1990). In addition to these demographic characteristics I calculated municipality-level share of various economic determinants such as access to electricity and piped water, land ownership, ownership of dwellings, access to appliances such as TV and radio, toilet, metal roof and whether wall is made of wood. In addition, I also compute the average years of schooling of those aged 25-40 (adults) as well as share of these adults working in agriculture sector. As an indicator of prior schooling status of secondary school aged children, I included the municipality-level non-enrollment rate or the share of those aged 13-16 in 1988 who did not attend school in the academic year 1989 to1990.

I ran an OLS model so that I compare each category (TRSBP, SEIEP and Both) with the reference category which includes the municipalities that did not receive any of the typhoon-resistant schools or instructional equipment packages under the TRSBP or SEIEP program. The first three columns (columns 1-3) in Table 1 show the correlation between the typhoon indicator plus the indicators for major ethnic groups and the availability of these programs. The typhoon indicator (which varies at the

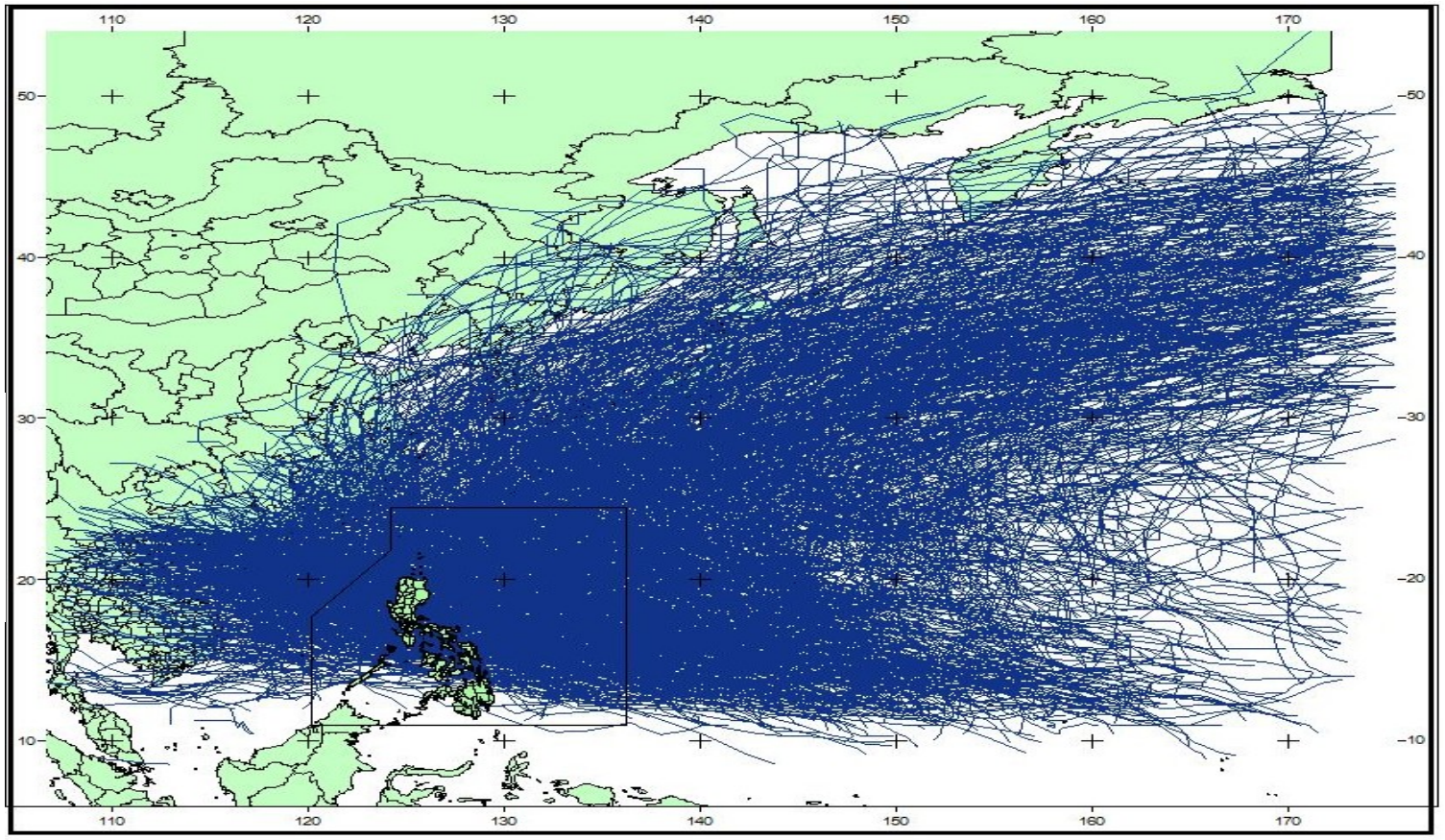

Figure 5: Tracks of tropical cyclones that formed in the Western North Pacific (WNP) for the period 1948-2010

Table 12: 1990 Municipality-Level Determinants of Programs

		TRSBP	SEIEP	Both	TRSBP	SEIEP	Both
	Mean	(1)	(2)	(3)	(4)	(5)	(6)
Areas heavily hit by two super typhoons in 1987	0.25	0.08***	0.25***	0.23***	0.10***	0.19***	0.17***
	(0.43)	[0.03]	[0.04]	[0.03]	[0.03]	[0.04]	[0.03]
Demographic characteristic:							
Share Tagalog	0.23	0.01	-0.23***	-0.23***	0.04	-0.24***	-0.21***
	(0.38)	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]	[0.04]
Share Cebuano and Ilonggo	0.35	-0.04**	-0.04***	-0.07***	-0.06**	-0.07***	-0.12***
	(0.44)	[0.02]	[0.01]	[0.02]	[0.03]	[0.02]	[0.02]
Schooling Status							
1989 Non-enrollment rate (aged 13-16 in 1988)	0.40				0.01	0.26***	0.27***
	(0.11)				[0.11]	[0.09]	[0.09]
Economic characteristics:							
Share electricity	0.46				0.13*	-0.02	0.22***
	(0.27)				[0.08]	[0.06]	[0.06]
Share piped water	0.30				-0.05	0.19***	0.15***
	(0.22)				[0.05]	[0.05]	[0.05]
Share land ownership	0.53				-0.06	-0.11**	-0.18***
	(0.16)				[0.07]	[0.05]	[0.05]
Share own dwelling	0.88				0.12	0.13*	0.12
	(0.09)				[0.09]	[0.07]	[0.07]
Share TV	0.24				-0.19*	-0.04	-0.26***
	(0.23)				[0.10]	[0.08]	[0.09]

Table 12 (continued)

		TRSBP	PASEIEP	Both	TRSBP	PASEIEP	Both
		(1)	(2)	(3)	(4)	(5)	(6)
Share radio	0.67				0.1	-0.13	0.08
	(0.10)				[0.12]	[0.10]	[0.08]
Share toilet	0.51				0.08*	-0.03	0.03
	(0.25)				[0.05]	[0.03]	[0.04]
Share metal roof	0.44				0.12	-0.09**	-0.20***
	(0.25)				[0.07]	[0.04]	[0.05]
Share wood wall	0.70				0.18**	-0.14*	-0.13*
	(0.21)				[0.08]	[0.08]	[0.08]
Average years of schooling	7.6				-0.01	0.02**	0.01
(aged 25-40)	(1.5)				[0.01]	[0.01]	[0.01]
Share agriculture industry	0.29				-0.04	0.09	0.10*
(aged 25-40)	(0.14)				[0.06]	[0.06]	[0.06]
Constant		0.06***	0.06***	0.08***	-0.38**	0.1	-0.01
		[0.01]	[0.01]	[0.01]	[0.18]	[0.13]	[0.13]
Region fixed effects	No	No	No	No	No	No	No
Observations		976	962	966	976	962	966

province level) indicates whether a particular locality was heavily hit by two super typhoons in 1987 based on whether the province experienced a typhoon with sustained winds of 100 KPH to 185 KPH. Note that this is slightly different from the indicator of whether the locality was "heavily damaged" by the super typhoons which would be potentially more correlated with the pre-existing characteristics of the localities. The results suggest that the municipalities that were heavily hit by the 1987 super typhoon were highly likely to receive instructional equipment packages only (25%) and both the instructional equipment and the typhoon-resistant schools (23%). They are also likely to receive typhoon-resistant schools only although the coefficient is much smaller (8%).

The next three columns (columns 4-6) add the economic variables and the 1989 non-enrollment rate in the equation. In general, these variables show mixed signs. For instance, while there is some evidence that the municipalities that received both programs (column 6) tend to have lower share of households owning dwellings or with TV and metal roof, these municipalities also tend to have more access to electricity, piped water and are less likely to have walls made of wood. Likewise, the same pattern is observed for the case of instructional equipment program. It is possible that these may reflect some of the efforts of the government to improve access to basic services in some of the provinces.

3.5 Identification Strategy

To investigate the impact of this unique grant-aid on education, I compare the evolution of schooling outcomes by age cohorts, those that were fully exposed to these program packages (or aged 9-12 in 1989) versus those that may had little or no

exposure to the program (aged 17-20 in 1989), in municipalities with and without access to the three types of program packages: only TRSBP, only SEIEP and both programs. This suggests estimating equations of the following general form,

$$Y_{imt} = \alpha_1 TRSBP_m T_t + \alpha_2 SEIEP_m T_t + \alpha_3 Both_m T_t + \alpha_4 X_{impt} + \alpha_4 Z_m T_t + \delta_m + \gamma_t + \epsilon_{imt} \quad (1)$$

where Y_{impt} is the years of schooling of person *i* residing in municipality *m* of province p in 1990 and born in year *t*; T_t refers to dummy indicating whether the individual belongs to age group 9 to 12 in 1989; X_{impt} refers to the individual-level characteristics such as religion and ethnicity; Z_m is the vector of variables such as the availability of ADB/USAID school packages and the water and sanitation; δ_m refers to the 1990 municipality of residence fixed effect and γ_t refers to the age-cohort fixed effect. In this specification, the parameters of interest are α_1, α_2, and α_3, which correspond to the interaction between the age-group dummy T_t and each program package under the Japanese bilateral grant-aid.

3.5.1 Potential Threats to Validity

In the Philippines, children typically enter secondary school at age 13 and finish by age 16. Based on administrative data from the Department of Education, less than 5 percent of the population of young adults aged 17 to 24 were enrolled in secondary school in the school year 1988-1989. Hence the effect of the program should be relatively close to zero for these children. On the other hand, children who are aged 12 or younger are only about to enter the secondary school and are therefore fully exposed to the program.

Could it be that higher ability and more determined children simply attend the secondary schools in nearby municipalities that have access to these program

packages? Or, could it be that parents with higher ability or better schooling might have migrated with their children to other municipalities with access to typhoon-resistant school and instructional equipment? As mentioned in section 2, the government mandated that secondary schools prioritize the enrollment for first year high school of the graduates of public elementary schools in the same municipality as well as students in the second, third and fourth years of the same school. Thus, it would be quite difficult at that time to be enrolled in a secondary school of another municipality, particularly for the first few years of the program which I am analyzing. To deal with migration issue, I use the municipality of residence of the individual in 1990 (at the time when the TRSBP program just started) which is available in 2000 IPUMS. To further examine the migration patterns of the individuals in my sample (those aged 9-12 and aged 17-20 in 1989) prior to 1990, I use the question in the 1990 IPUMS that asks about the number of years a person is residing in the current (or 1990) municipality. In general, less than 3 percent of the sampled individuals were living in their 1990 municipality for at most one year (migrated in 1989) while less than 5 percent has been living in their 1990 municipality for three years or less (migrated in 1987). Further analysis would help clarify whether the migration of these individuals prior to 1990 was selective or not. But in general it does not seem that migration is likely to drive the results.

3.6 Main Results

Table 13 presents the average educational attainment (in years) by program package, by age group and by gender. On average, individuals from municipalities that received typhoon-resistant schools tend to have higher education than those in the

municipalities that received no program package from the Japanese grant-aid. The ones from municipalities that received both programs have slightly lower education than those from municipalities without any program package. On the other hand,

Table 13: Average Educational Attainment (years), By Program and By Age Group (Sample: Individuals aged 9-12 and 17-20 in 1989)

Girls					Difference		
Age in 1989	TRSBP	SEIEP	Both	None	TRSBP – None	SEIEP - None	Both - None
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
9-12	10.15	9.34	9.69	9.95	0.20	-0.61	-0.26
	[0.03]	[0.04]	[0.04]	[0.01]	[0.03]	[0.04]	[0.04]
17-20	9.46	8.62	8.66	9.28	0.18	-0.66	-0.61
	[0.03]	[0.05]	[0.04]	[0.01]	[0.04]	[0.03]	[0.05]
Difference	0.69	0.73	1.03	0.67	**0.02**	**0.05**	**0.36**
	[0.04]	[0.07]	[0.06]	[0.01]	**[0.05]**	**[0.07]**	**[0.06]**
N	21875	10733	13256	324453			
BOYS					Difference		
Age in 1989	TRSBP	SEIEP	Both	None	TRSBP - None	SEIEP - None	Both - None
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
9-12	9.37	8.62	8.70	9.23	0.15	-0.61	-0.53
	[0.03]	[0.04]	[0.04]	[0.01]	[0.03]	[0.04]	[0.04]
17-20	9.06	7.97	7.99	8.89	0.17	-0.92	-0.90
	[0.03]	[0.05]	[0.04]	[0.01]	[0.04]	[0.05]	[0.05]
Diff	0.31	0.65	0.70	0.34	**-0.02**	**0.31**	**0.37**
	[0.04]	[0.07]	[0.06]	[0.01]	**[0.05]**	**[0.07]**	**[0.06]**
N	23028	11843	14693	340687			

Note: Standard errors in parenthesis.

those living in municipalities that received the instructional equipment package have the lowest average education compared to other categories. In all types of municipalities, average education increased over time (younger cohorts aged 9-12 have higher mean schooling). However, it has increased more in municipalities that received both programs, for the case of girls. For the case of boys, it increased more in

municipalities that received either the SEIEP program or both programs. The figures in bold text show the basic difference- in-differences estimate (without fixed effects).

Table 14 formally reports the estimates of the effect of access to typhoon-resistant schools, instructional equipment or both components on the years of schooling of males and females (columns 1-3). Column (1) shows the most parsimonious specification, including only age-cohort fixed effects and municipality fixed effects. The results indicate that the availability of instructional equipment program package in a municipality leads to an average increase of 0.23 years of schooling for males and no effect on females. On the other hand, the presence of both programs leads to an average increase of 0.29 years of education for males and 0.30 years of education for females. Relative to the average education of men and women in the Philippines which are relatively high compared to other Asian countries, these effects are equivalent to about 3.33% and 3% increase in years of education, respectively.

The succeeding column (column 2) suggests that these estimates are also generally robust to inclusion of individual level characteristics such as ethnicity and religion, increasing the estimates slightly for both males and females. Column (3) accounts for the presence of other concurrent programs implemented at that time that could be potentially correlated with the Japanese grant-aid program packages. For males, these leads to an average increase of about 0.25-0.26 years of education for those exposed to SEIEP program and both programs (the SEIEP and TRSBP), respectively. For females, the availability of the both programs, leads to an average of

0.23 more years of education while the availability of either program alone does not seem to have an effect.

Table 14: Impact of the Typhoon- Resistant School Building (TRSBP) and Secondary Instructional Equipment (SEIEP) Grant Programs on Education (Sample: Individuals Aged 9-12 and 17-20 in 1989)

	Males		
	(1)	(2)	(3)
TRSBP x Age (9-12) in 1989	-0.02	-0.02	-0.03
	[0.04]	[0.04]	[0.04]
SEIEP x Age (9-12) in 1989	0.23***	0.26***	0.25***
	[0.06]	[0.06]	[0.06]
Both x Age 9-12 in 1989	0.29***	0.31***	0.26***
	[0.05]	[0.05]	[0.05]
Water and Sanitation x Age (9-12) in 1989			0.04**
			[0.02]
ADB/USAID x Age (9-12) in 1989			-0.18***
			[0.02]
Individual level characteristics	No	Yes	Yes
Constant	8.80***	7.36***	7.36***
	Females		
TRSBP x Age (9-12) in 1989	0.01	0.00	-0.02
	[0.04]	[0.04]	[0.04]
SEIEP x Age (9-12) in 1989	0.02	0.03	0.00
	[0.06]	[0.06]	[0.06]
Both x Age 9-12 in 1989	0.30***	0.32***	0.23***
	[0.06]	[0.06]	[0.06]
Water and Sanitation x Age (9-12) in 1989			0.14***
			[0.02]
ADB/USAID x Age (9-12) in 1989			-0.21***
			[0.02]
Individual level characteristics	No	Yes	Yes
Constant	9.20***	7.51***	7.51***

Note: Standard errors (in brackets) account for clustering on the municipality of residence in 1990. The base sample consists of all children who are either aged 9 to 12 or aged 17 to 20 in 1989. These children are in measured in 2000 when they are aged 20 to 23 or 28 to 31. The dependent variable (education) is measured in years. Each column report estimates of the interaction of the Typhoon-Resistant School Building Program (TRSBP) availability and the age (9-12) dummy, the interaction of the Secondary Instructional Equipment Program (SEIEP) availability and the age (9-12) dummy, and the interaction of the indicator of both programs' availability and the age (9-12) dummy. All specifications include single age dummies and 1990 municipality of residence. Individual level characteristics include religion and ethnicity indicators. Single asterisk (*) denotes statistical significance at the 90% level; double (**) 95%; triple (***); 99%. *Source:* 2000 IPUMS.

Table 15 runs a number of robustness checks. The first two columns restrict the analysis to regions within the *typhoon belt*. By restricting the analysis to the *typhoon belt* regions, municipalities have more or less similar probability of receiving a destructive typhoon. As shown columns (1) and (2), this leads to slightly higher coefficients. For males, the availability of SEIEP program leads to an average increase of 0.29 years of education while the availability of both programs leads to an average increase of 0.30 years of education. For females, the latter program package leads to an average increase of 0.28 more years of education. Columns (3) and (4) adds a municipality-specific linear time trends to capture gradually evolving, unobserved municipality characteristics that may have changed the level of schooling

Table 15: Robustness Checks

	Restrict to typhoon belt		With municipality-specific linear trend	
	Male	Female	Male	Female
	(1)	(2)	(3)	(4)
TRSBP x Age (9-12) in 1989	0.00	0.01	-0.05	-0.05
	[0.04]	[0.04]	[0.04]	[0.04]
SEIEP x Age (9-12) in 1989	0.29***	0.04	0.23***	-0.03
	[0.06]	[0.06]	[0.06]	[0.06]
Both x Age 9-12 in 1989	0.30***	0.28***	0.24***	0.20***
	[0.05]	[0.05]	[0.05]	[0.06]
Constant	4.88***	5.02***	3.61***	3.44***
	[0.30]	[0.30]	[0.26]	[0.27]

Note: Standard errors (in brackets) account for clustering on the municipality of residence in 1990. The dependent variable (education) is measured in years. Each column report estimates of the interaction of the Typhoon-Resistant School Building Program (TRSBP) availability and the age (9-12) dummy, the interaction of the Secondary Instructional Equipment Program (SEIEP) availability and the age (9-12) dummy, and the interaction of the indicator of both programs' availability and the age (9-12) dummy. All specifications include single age dummies, 1990 municipality of residence, religion and ethnicity indicators, water and sanitation availability X Age (9-12), ADB/IUSAID X Age (9-12), and enrollment rate X Age. Single asterisk (*) denotes statistical significance at the 90% level; double (**) 95%; triple (***) 99%.
Source: 2000 IPUMS.

independent of the programs. In general, adding this only slightly decreases the coefficients but patterns remain the same. The results suggest that, for men, the availability of SEIEP program alone leads to an average increase of 0.23 years of education while the availability of both programs increases education, on average, by 0.24 years. For women, the presence of both program components increases their education, on average, by about 0.20 years.

In Table 16, I run the same specifications used in Table 3 using a sample of all post-secondary school aged individuals who should have little or no exposure to the program packages. In general this table serves as specification check, since I am examining the prior trend in outcomes in the same municipalities that later received the Japanese grant-aid. If education had already increased faster in municipalities that later received these program packages even among young adults who should not have been exposed to these programs, then the estimates may be capturing the effects of some other municipality trends that are correlated with the program. In general, for both males and females, the coefficients under the TRSBP and both program packages are relatively small and not significant. On the other hand, the coefficients under the SEIEP program package are relatively large and are particularly significant for females. Even the basic difference-in-differences estimates in the summary statistics in Table 2B reflect the same patterns.

The results shown in Table 16 seem to suggest that the SEIEP X Age (9-12) may be capturing some other trends correlated with education. Since the effect of SEIEP package for women is small and not statistically significant when using the

Table 16: Impact of the Typhoon- Resistant School Building (TRSBP) and Secondary Instructional Equipment (SEIEP) Grant Programs on Education (Control Sample: :Individuals Aged 17-20 and 21-24 in 1989)

	Males		
	(1)	(2)	(3)
TRSBP x Age (9-12) in 1989	-0.03	-0.03	-0.04
	[0.05]	[0.05]	[0.05]
SEIEP x Age (9-12) in 1989	0.11*	0.1	0.09
	[0.07]	[0.07]	[0.07]
Both x Age 9-12 in 1989	-0.03	-0.03	-0.05
	[0.06]	[0.06]	[0.06]
Water and Sanitation x Age (9-12) in 1989			0.04*
			[0.02]
ADB/USAID x Age (9-12) in 1989			-0.03
			[0.02]
1989 school attendance rate x Age in 1989			
Individual level characteristics	No	Yes	Yes
Constant	8.66***	7.17***	7.18***
	[0.02]	[0.04]	[0.04]
	Females		
TRSBP x Age (9-12) in 1989	0.01	0	-0.01
	[0.05]	[0.05]	[0.05]
SEIEP x Age (9-12) in 1989	0.18***	0.19***	0.18***
	[0.07]	[0.07]	[0.07]
Both x Age 9-12 in 1989	-0.03	-0.03	-0.05
	[0.06]	[0.06]	[0.06]
Water and Sanitation x Age (9-12) in 1989			0.06**
			[0.02]
ADB/USAID x Age (9-12) in 1989			-0.04
			[0.02]
1989 school attendance rate x Age in 1989			
Individual level characteristics	No	Yes	Yes
Constant	8.93***	7.15***	7.15***
	[0.02]	[0.04]	[0.04]

Note: Standard errors (in brackets) account for clustering on the municipality of residence in 1990. The base sample consists of all children who are either aged 17 to 20 or 21 to 24 in 1989. These children are in measured in 2000 when they are aged 28 to 31 or 32 to 35. The dependent variable (education) is measured in years. Each column report estimates of the interaction of the Typhoon-Resistant School Building Program (TRSBP) availability and the age (17-20) dummy, the interaction of the Secondary Instructional Equipment Program (SEIEP) availability and the age (17-20) dummy, and the interaction of the indicator of both programs' availability and the age (17-20) dummy. All specifications include single age dummies and 1990 municipality of residence dummies. Single asterisk (*) denotes statistical significance at the 90% level; double (**) 95%; triple (***) 99%. *Source:* 2000 IPUMS.

original sample, but becomes large and statistically significant when using the control sample, it could be that there is also a time issue. For instance, children in relatively poorer localities may be more likely to be "behind schedule" in schooling relative to their peers in better off localities. It is possible that these children may have entered school at a later age.

To further examine this potential explanation, in table 17, I interact the availability of each program package with age dummies ranging from age 9 to 18. In this case, those who were aged 19 to 20 in 1989 are included in the control group. In general, the interactions of the availability of typhoon-resistant schools (TRSBP) with age yield relatively small and insignificant coefficients, although some coefficients are larger than the others. The coefficients of the interaction of both programs component with each age dummy support to the results found earlier. For both males and females, coefficients are relatively large and statistically significant (ranging from 0.16 to 0.42) until about age 13 or 14 and then fluctuates around zero. Meanwhile the interaction of SEIEP with age seems to confirm the pattern of effects found in Table 3. For men, coefficients are relatively large and statistically significant until about age 12 and then become smaller and not significant. For women, in general the coefficients are relatively small and not significant except for some large and statistically significant effects at ages 14 and 17. The large coefficient (0.34) for the interaction between the availability of instructional equipment program and age 17 may suggest three things. It is possible that even children of this age (aged 17) may be benefiting from the program. This is either because, in general, children of this age may still be

Table 17: Coefficients of the Interaction of Each Program Package with Age in 1989 (Sample: Individuals Aged 9 to 20)

	Male	Female		Male	Female		Male	Female
TRSBP_9	-0.02	0.03	seiep_9	0.26***	0.15	both_9	0.22**	0.42***
	[0.07]	[0.07]		[0.10]	[0.10]		[0.09]	[0.09]
TRSBP_10	-0.11	-0.03	seiep_10	0.27***	0.03	both_10	0.35***	0.28***
	[0.08]	[0.07]		[0.10]	[0.10]		[0.09]	[0.09]
TRSBP_11	0.01	0.08	seiep_11	0.30***	-0.07	both_11	0.19**	0.28***
	[0.08]	[0.08]		[0.10]	[0.11]		[0.09]	[0.10]
TRSBP_12	-0.01	-0.05	seiep_12	0.27**	0	both_12	0.18*	0.16*
	[0.08]	[0.08]		[0.11]	[0.11]		[0.10]	[0.10]
TRSBP_13	-0.09	-0.09	seiep_13	0.1	0.01	both_13	0.27***	0.21**
	[0.08]	[0.08]		[0.10]	[0.11]		[0.10]	[0.10]
TRSBP_14	-0.12	0.02	seiep_14	-0.03	0.26**	both_14	0.18*	0
	[0.08]	[0.08]		[0.11]	[0.11]		[0.10]	[0.10]
TRSBP_15	-0.02	0.09	seiep_15	0.03	0.02	both_15	-0.03	0.07
	[0.08]	[0.08]		[0.11]	[0.11]		[0.10]	[0.10]
TRSBP_16	-0.01	0.01	seiep_16	-0.03	0.03	both_16	0.18*	0
	[0.08]	[0.08]		[0.11]	[0.11]		[0.10]	[0.10]
TRSBP_17	0.01	0.01	seiep_17	0	0.34***	both_17	0.04	0.13
	[0.08]	[0.08]		[0.11]	[0.11]		[0.10]	[0.10]
TRSBP_18	-0.01	0.09	seiep_18	0.11	-0.17	both_18	-0.17*	0.08
	[0.08]	[0.08]		[0.11]	[0.11]		[0.10]	[0.10]
Constant	7.30***	7.47***						
	[0.03]	[0.03]						

in secondary school level in poorer municipalities due to possible delay in school entrance. Second, the school officials in these municipalities may have also prioritized the enrollment of these students who are considered to be in the "borderline". Unfortunately, I do not have any data to prove either of these potential reasons. A third possible explanation is, as mentioned earlier, that there could be other trends that may be correlated with the SEIEP program and are not captured by the specification. Future analysis should thus take into account of this underlying trend.

3.6 Conclusion

This study evaluates the schooling consequences of a unique bilateral grant-aid program which provided typhoon-resistant schools and instructional equipment to the Philippines. The results of my analysis suggest that in general, for men, the presence of typhoon-resistant schools equipped with instructional equipment in the municipalities led to an average increase of about 0.26 to 0.30 years of education while the presence of instructional equipment alone led to an average increase of 0.23 to 0.26 years of education. On the other hand, for women, the availability of both components led to an average increase of 0.23 to 0.32 years of education but the availability of either component alone does not seem to have an effect. Except for the falsification exercise which suggests that there could be other underlying trends which may not be fully captured by the specifications, the estimates are in general robust to the inclusion of individual level characteristics, accounting of other concurrent national government's programs, restricting to municipalities in the typhoon-belt region and accounting for municipality-specific trends.

The findings reported here suggest the importance of not only expanding access to schooling through increased availability of schools or classrooms (particularly, those that are resistant to natural disasters) but also the importance of improving the quality of learning through the availability of school resources that aide in students' learning in developing countries. It is important to emphasize that the policy solution of building typhoon resistant schools may only be applicable to countries that are regularly visited by extreme typhoons every year.

Future analysis will examine how the effects on education translate into labor market outcomes and international migration of men and women exposed to these programs.

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Biography

I was born in the town of Los Banos, Laguna in the Philippines in 1981. As the eldest in the family, I lived mostly in my grandparents' house. At age 5, I started my schooling and my parents and I moved to the town of San Pedro, the first district of Laguna. While I was not a star student at first, starting my second grade, I have always been an honor student. In high school, I graduated as Valedictorian of my class and went to finish the Bachelor of Science in Statistics from the University of the Philippines with *Cum Laude* honors.

After college, I worked at the National Statistical Coordination Board of the Philippines for two years. Knowing that I would want to become an economist someday, I then studied master's degree in international development in Japan over the next two years. After graduating from my master's degree in 2006, I applied for PhD in US. I decided to go to Duke's Public Policy program in 2007 and successfully finished the degree in the summer of 2012.