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Eva Deuchert
Christina Felfe

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Abstract

Economic theory predicts that adverse shocks during early childhood have detrimental short- and long-run consequences for children's development. We examine this hypothesis by analyzing the short-and long-run effects on children's health and education of a specific shock: housing damages caused by a super typhoon. Our results reveal negative effects on children's education - not, however, on health. The effects on children's education aggravate over time. Empirical evidence indicates that the main underlying channel is a shock on families' wealth.

JEL-Code: I140, I240, Q540.

Keywords: child development, natural disaster, wealth shock.

Eva Deuchert
Center for Disability and Integration
University of St. Gallen / CDI-HSG
Rosenbergstrasse 51
Switzerland - 9000 St. Gallen
eva.deuchert@unisg.ch

Christina Felfe
Swiss Institute for Empirical Economic Research (SEW) / University of St. Gallen
Varnbüelstrasse 14
Switzerland – 9000 St. Gallen
christina.felfe@unisg.ch

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1 Introduction

Human capital is commonly modeled as the outcome of a cumulative production process (Cunha, et al., 2006; Heckman, 2007). Dynamic complementarities and self-productivity are the key features of this production process, i.e. capacities produced at an earlier stage enhance the productivity of later investments and thus the attainment of capacities at later stages. As a result, investments or adverse shocks during early childhood may not only have immediate consequences for children's human capital development, but arising inequalities are also likely to widen over time.

Empirical corroboration of the features underlying the cumulative production process, however, is hampered by two facts. First, one needs to identify a suitable and exogenous shock in early childhood. Candidates so far examined are economic crises (Ferreira & Schady, 2009; Paxson & Schady, 2005; Schady, 2004; Stillman & Thomas, 2008; Thomas, et al., 2004), unanticipated weather shocks (Aguilar & Vicarelli, 2011; Jensen, 2000; Maccini & Yang, 2009), natural disasters (Baez & Santos, 2007; Frankenberg, et al., 2011; Poertner, 2009; Sacerdote, 2012; Yamauchi, et al., 2009), or destructions caused by wars (Akbulut-Yuksel, 2009; Akresh, et al., 2009; Akresh, et al., 2012). Second, a dataset is needed that follows children from early childhood to adulthood. Given the rareness of such data, in particular in developing countries where children are more likely to experience severe shocks early in life, existing studies concentrate on arising effects of such shocks at one point in time, but do not investigate their evolution over time.

Our study analyzes the impact of one, so far unstudied, adverse shock: housing damages caused by a typhoon; to be precise, super typhoon Mike, which hit Cebu Island (Philippines) in 1990. More importantly, we possess of a dataset - the Cebu Longitudinal Health and Nutrition Survey – that follows children born in the Cebu Metropolitan area between May, 1983 and April, 1984 from birth until adulthood. As a consequence, we can shed some light on the hypothesis that an adverse shock during early childhood – here occurred at age 6/7 - drives a wedge between the health and human capital development of affected and unaffected children that aggravates over time.

The longitudinal nature of our data combined with the specific geographic location of the area under study, where super typhoons are a rare and unexpected event, enables us to identify the short and long-term effects of the shock of interest. To abstract from common macroeconomic consequences of a natural disaster and thus to isolate the effect of housing damages, we compare children who all resided in the same neighborhood, but only some experienced housing damages.[1] In addition, housing damages are - to a large extent- the result of random factors, such as the local strength of the typhoon or arising mudslides. Yet, to ensure causal identification of the resulting effects on children's development, we control for remaining differences in determinants of housing damages, such as the location, the quality of the building or the underlying soil formation.

Our results indicate a direct pathway from housing damages to children's education, not, however, to health. In addition to short-term effects, we observe widening educational gaps as children grow older. This is expressed in initially lower test scores, an increasing prevalence of grade retentions and a reduction in overall schooling in the long-run. These results are robust to a variety of sensitivity checks including the analysis of several placebo outcomes. Further analysis reveals that our findings are driven by children whose families are either at the bottom of the wealth distribution or who lack the support of a strong family network.

Analyzing the nature of the shock, we find that among a broad set of observed potential channels – death or temporary absence of a family member, migration or family separation,

[1] In this perspective, our study differs significantly from other studies on the consequences of natural hazards. Existing studies do not distinguish between the effects of idiosyncratic shocks and macroeconomic shocks, but evaluate the overall effect of a natural disaster (Baez & Santos, 2007; Ferreira & Schady, 2009; Frankenberg, et al., 2011; Poertner, 2009; Sacerdote, 2012; Yamauchi, et al., 2009).

parental health, parental employment, household income and wealth – the only mechanism which is significantly and persistently affected, is real estate wealth. We thus interpret the results as the effect of a shock to families' real estate wealth.

We contribute to the existing literature of shocks in early childhood in two important ways. First, we analyze both short- and long-term consequences. We are thus able to provide empirical evidence for the concepts of dynamic complementarities and self-productivity present in human capital production. Second, the shock under study constitutes mainly a shock on families' real estate wealth. Real estate corresponds to a significant share of total wealth (Davies, et al., 2009). As such, we contribute to the recently rising literature on the role of permanent income on children's development (Akee, et al., 2010; Baird, et al., 2011; Banerjee, et al., 2010; Dahl & Lochner, 2012; Duflo, 2000; Duncan, et al., 2011; Himaz, 2008). Yet, a real estate shock may have consequences that go beyond the ones of a pure financial shock: it deprives families of a consumption good (people usually live in their houses) and may enforce credit market constraints (in case real estate serves as collateral).

The reminder of the paper is structured as follows. The next section discusses the nature of our shock. Section 3 describes our data. Section 4 discusses the empirical strategy. Estimation results regarding child development and evidence for effect heterogeneity and robustness of our results are presented in section 5. Section 6 analyses the effects on underlying channels. Section 7 finally concludes.

2 The nature of the shock under study

This paper seeks to empirically corroborate the cumulative nature of the human capital production process by analyzing the effects of an adverse shock on children's health and human capital development. The shock under consideration is housing damages caused by super typhoon Mike, which hit Cebu Island (Philippines) in the morning of November 12, 1990.

Typhoons come along with numerous thunderstorms that produce strong winds and heavy rain. Super typhoons are characterized by an exceptionally high wind speed (150 mph or greater) and are thus especially destructive. The overall damages caused by super typhoon Mike were severe: 2 million people were forced into temporary shelters, 37,000 houses were destroyed, and the majority of the metropolitan area was left without electricity and potable water (Williams, et al., 1993).

Our study focuses on the arising damages to families' real estate. Real estate represents an important component of families' wealth, in particular in a developing country such as the Philippines (in our sample real estate wealth corresponds to 40% of total wealth). The shock under study is thus comparable to a shock on families' wealth or permanent income (Akee, et al., 2010; Baird, et al., 2011; Banerjee, et al., 2010; Dahl & Lochner, 2012; Duflo, 2000; Duncan, et al., 2011; Himaz, 2008). Wealth or income shocks have immediate consequences on human capital investments if credit constraints become binding. If human capital accumulated during childhood raises the productivity of human capital investments at older ages, detrimental effects may moreover aggravate over time (Cunha, et al., 2006; Heckman, 2007).

Two further characteristics of the shock under study are likely to intensify the mechanisms described above. First, real estate often serves as collateral. A shock on real estate wealth may therefore lead to binding credit market constraints and thus reduce subsequent investments (Chaney, et al., 2012). Second, people often live in their house. In other words, real estate does not only serve as an investment good, but also as a consumer good. In the case of an underdeveloped rental housing market, which is the case for the Philippines (Ballesteros, 2001) people are thus forced to invest in reconstruction of the house (real estate is basically a necessity good). Investments are both of financial nature, but also time investments of household members (including the child). Such investments may crowd out investments in children's human capital.

3 Data

The dataset used in this study is the Cebu Longitudinal Health and Nutrition Survey (CLHNS), which is a 12-month birth cohort study (May 1983 through April 1984) from 33 randomly selected neighborhoods (barangays) in the Cebu Metropolitan Area. Initial interviews were hold with all pregnant women in the sample area. Follow-up interviews took place immediately after birth, at bimonthly intervals for 24 months after birth, and in the years 1991, 1994, 1998, 2002 and 2005.[2]

We restrict the dataset to children who survived until 1990 (i.e. did not die before typhoon Mike), whose mothers answered the last interview prior to super typhoon Mike and for whom we have complete and consistent background information (see Table A.1. in the Appendix for details). In addition, we exclude all children who lived in a barangay with no treatment variation (i.e. where all interviewed families reported housing damages). As a result, our baseline sample consists of 2'322 children.

Initial attrition – from our baseline sample in 1985/86 to the first post-disaster survey in 1991 - amounts to 12%, which corresponds to an annual attrition rate of roughly 2%. Attrition rates in the following waves are rather low (2-7%) and do not vary between children experiencing and not experiencing housing damages. The major reason for attrition is outmigration (Adair, et al., 2011). If outmigration is mainly sought by people who experienced housing damages, we potentially face attrition bias. Unfortunately, we cannot test whether this is the case as damages are retrospectively reported. Yet, our baseline sample and the post-disaster sample do not differ in terms of observables (see Table I.1. in the Internet Appendix). Moreover, the implicit annual attrition rate from 1985/1986 to 1991 is comparable to attrition between 1984/1985 and 1985/1986 (Adair, et al., 2011). Thus, housing damages do not seem to boost attrition. We therefore believe that attrition does not constitute a major source of bias.

[2] For more information on the CLHNS please refer to http://www.cpc.unc.edu/projects/cebu/

The data provides two different variables describing housing damages. In 1991, households were asked retrospectively whether typhoon Mike caused any major damage to their house (76% of all households experienced some damages). For those who reported damages, the survey asked for estimated reparation costs. Average reported costs amount to 3'972 Philippine Pesos (approximately 260 constant 1990 international $). This value may, however, vastly underestimate the shock: it does neither include the loss if the house was irreparably destroyed[3] nor losses on other wealth items such as furniture, appliances, etc. Moreover, it does not consider opportunity costs if the reparation was done by a household member. For these reasons, our main analysis focuses on the binary indicator of reported damages. Yet, further analysis providing a measure for the elasticity of children's development with respect to real estate wealth considers the reparation costs (see Section 4.3).

The CLHNS provides moreover comprehensive information on children's development in terms of health and education. Health outcomes, that are provided in all surveys and thus can be compared across years, include anthropometric measures, such as body weight and height (which we standardize with respect to the age- and gender-specific mean, so-called z-scores), as well as a binary indicator for the prevalence of major illnesses. In addition, we analyze an indicator for long-run psychological problems based on information on emotional and social problems as well as on problems with falling asleep, headaches or digestion. Intellectual development is measured by variables that proxy grade progression and cognitive performance (such as standardized tests in overall intelligence (IQ), Cebu, English and Math). Unfortunately, education outcomes are only available from 1994 onwards and thus, we can assess the medium- and long-run impact of the shock on children's education, but not the immediate impact. Information on children's school attendance and time use (time devoted to work for pay,

[3] Notice that 7.4% of the families who reported housing damages simultaneously reported zero reparation costs.

household production and homework) allows us to shed some light on reductions of investments in children's development.

The descriptive statistics (Table A.2 in the Appendix) show that children who live in families that experience housing damages have lower health and education outcomes in the short- and the long-run. Yet, at the same time we observe pre-existing differences in relevant background variables. It is thus left for the empirical analysis to show to which degree housing damages cause deterioration of children's development and to shed some light on the underlying mechanisms leading to potential deterioration of children's development.

4 Empirical Strategy

4.1 *Identification*

The particular setting of this study offers suitable conditions to analyze short- and long-term effects of housing damages caused by a natural disaster. In contrast to other parts of the Philippines, which are frequently exposed to typhoons, Cebu Island enjoys a particularly beneficial geographical location. It lies in the center of an archipelago and is thus surrounded by larger landmasses that serve as a natural barrier against typhoons. Moreover, Cebu lies only in the southern limit of the typhoon belt. As a result, Cebu is rarely hit by typhoons. Prior to typhoon Mike, the Cebu Metropolitan Area has experienced its last super typhoon in 1951 and no other super typhoon has occurred thereafter. Typhoon Mike and related housing damages can thus be seen as an unexpected shock with no similar event confounding our results.

Our data documents a substantial variation in housing damages. In total, 76% of the households in our sample have experienced some damages to their property. Damages are fairly even distributed across the area under study. The rate of affected households within barangays ranges from 43 to 100%, but only in two barangays all households report damages. Our empirical strategy exploits this variation and compares children who all reside in the disaster area and thus experience the same macroeconomic consequences, but only some suffer from damages to their homes. This strategy helps isolating the effect of housing damages from the general macroeconomic shock. To address the concern that damages to public infrastructure, such as schools or hospitals, differ across local areas, we restrict our comparison to children living in the same neighborhood (barangay). Given the rather small area of a barangay (an average diameter of 2 km) and the rather limited offer of public infrastructure (most barangays have either none (19%) or only one elementary school (44%), while only few barangays have two elementary schools (17%); similar numbers apply for hospitals, drugstores and grocery stores), the comparison of neighbors should enable us to disentangle the shock occurred to family real estate from any other shock occurred to public infrastructure.

One natural question to ask is whether damages occurred to family homes indeed occur randomly. Random factors, such as local wind speed, floods and mudslides are important determinants of storm damages (Imamura & Van To, 1997; Nordhaus, 2006). Yet, individual factors, such as the quality of a dwelling, are key in explaining the severity of damages to private property (Fronstin & Holtmann, 1994). Consequently, despite random variation in wind speed, flooding, and mudslides, housing damages may be still plagued from endogeneity. It is therefore necessary to control for proxies of the housing quality as well as other relevant determinants of housing damages (see Section 4.2. for details). To additionally ensure that unobserved confounders do not constitute a source of bias, we provide various placebo and sensitivity checks (see Section 5.2 for details).

The equation underlying all our estimations (estimated using ordinary least squares) is as follows:

$$Y_{i,t+s} = \alpha + \beta D_{i,t} + \gamma X_{i,t-1} + \delta B_{i,t-1} + e_{i,t+s}$$

where $Y_{i,t+s}$ represents a child outcome measured in period s after typhoon Mike, $D_{i,t}$ is a binary variable and represents whether the family experienced housing damages due to the typhoon, $X_{i,t-1}$ stands for the set of control variables measured prior to the shock, and $B_{i,t-1}$ contains a set of barangay fixed effects, indicating the location of residence prior to the shock.

4.2. Selection of Control Variables

We employ a “selection-on-observables” strategy to control for potential confounders that jointly affect housing quality and child development. The literature on children’s development has stressed the socio-economic background of the family and initial child characteristics as the main determinants of children’s human capital production. These characteristics are likely to be correlated with observed and unobserved quality indicators of family homes and thus with housing damages due to typhoon Mike. To address this endogeneity issue, we select the following control variables (which stem from surveys before the typhoon and are thus not plagued by reverse causality): quality indicators of the house (construction material, ownership, value, size, location, soil formation and depth), socio-economic status (household type, single parenthood, parents' employment status, income, wealth), parental education (father’s and mother’s highest degree and completion of vocational training), as well as initial child characteristics (gender, weight, height, birth size, complication at birth, place of delivery).

We empirically assess whether these factors are associated with housing damages by estimating a Probit model with the binary indicator for damages as the dependent variable. As Table 1 shows, estimated coefficients are rather small and in most cases insignificant. The strongest influence on damages can be found for housing material, ownership and size of the house (number of rooms). Most variables indicating families' SES are insignificant, with the exception of father’s employment status and mother's education (both leading to a reduction of the probability of housing damages). Joint significance of pre-existing child characteristics can be rejected. The only surprising result among the child characteristics is observed with respect to gender (girls are less likely to experience damages). In addition, we test this model for a vast array of potentially omitted variables. Yet, none of these variables is significant.

Table 1: Probit model for household damages

Independent variable	Marginal effect	z	Independent variable	Marginal effect	z
Material: nipa	-0.005	-0.21	Father temporary absent	-0.017	-0.35
Material: cement, wood	-0.077**	-2.37	Father's employment status	-0.071**	-2.26
House ownership	0.257**	2.10	Mother's employment status	0.015	0.76
Log of house value	-0.033	-1.54	Log total income in constant 1990$	-0.008	-0.46
Value of the house : third quintile	0.004	0.09	Total income : second quintile	-0.008	-0.20
Value of the house : forth quintile	-0.004	-0.07	Total income : third quintile	0.057	1.45
Value of the house : fifth quintile	0.037	0.46	Total income : forth quintile	-0.012	-0.24
Number of rooms	-0.019**	-2.15	Total income : fifth quintile	-0.014	-0.23
Elevation barangay	0.000	-0.05	Log wealth in constant 1990$	-0.004	-0.38
Soil: unconsolidated	-0.030	-0.43	Father's highest grade	0.001	0.38
Soil: core basalt rocks	-0.012	-0.08	Father received vocational training	-0.042	-1.30
Soil depth: 1-3m	-0.080	-0.70	Mother's highest grade	-0.008**	-2.27
Soil depth: 0.3-1m	0.051	0.57	Mother received vocational training	-0.003	-0.11
Soil depth: < 0.3m	0.079	0.57	Female	-0.054***	-2.66
Garbage disposal : collected	-0.048	-0.98	Birth size: smaller than avg.	0.034	1.33
Garbage disposal : burning	0.030	0.84	Birth size: bigger than avg.	0.034	1.53
Garbage disposal: dumping at house	-0.012	-0.26	Place of delivery: hospital	-0.033	-1.32
Garbage disposal: dumping away	-0.015	-0.38	Birth complication	0.042	1.56
HH type: Multi-nuclear family	-0.005	-0.18	Height for age	0.071	0.56
HH type: Other family type	0.060	2.37	Weight for age	-0.095	-0.59
Father lives at home	0.120	1.59	BMI for age	0.074	0.62
Pseudo R2			0.09		
N			2046		

Note: Results are from a probit regression with additionally a set of barangay fixed effects (not reported but available upon request). *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

5 Consequences for Children's Development

5.1 *Average Effects of Housing Damages*

This section provides empirical evidence for the effect of housing damages on child development outcomes using a binary indicator for housing damages as our prime variable of interest. In line with the theoretical considerations, an adverse shock during early childhood translates into worse educational performance (see Table 2). We observe increased grade retention already four years after typhoon Mike occurred: in 1994 children who suffered from housing damages lag on average 0.12 years behind in school. This gap remains significant and even widens when children grow older: in 1998 we observe a gap in completed grades of 0.20 years, in 2002 of 0.43 years and in 2005 of even 0.52 years.

Analyzing a battery of tests scores corroborates these findings. One year after the natural disaster (1991), affected children score on average 0.09 standard deviation (henceforth, sd) lower in a general IQ test. In 1994, we still observe a worse performance among affected children - this difference is, however, not significant anymore. Notice that against conventional wisdom, children's IQ-scores do not measure their innate intelligence, but their cognitive ability. Cognitive skills are rather malleable during early childhood and are enhanced through investments by parents, social environment and school (Cunha, et al., 2006). In a similar vein, we observe a worse performance in further cognitive tests (Math, English and the native language Cebu) among affected children.

Table 2: Impact of housing damages on child development

	Coef.	t
Education		
Highest grade completed		
1994	-0.12**	-2.22
1998	-0.20*	-1.91
2002	-0.43***	-3.18
2005	-0.52***	-2.82
Standardized IQ score		
1991	-0.09*	-1.81
1994	-0.06	-1.18
Standardized Test scores (1994)		
English	-0.06	-1.43
Cebu	-0.06	-1.27
Math	-0.07	-1.54
Health		
Z-score: Weight for age		
1991	-0.05	-1.29
1994	-0.01	-0.1
1998	-0.01	-0.21
2002	-0.01	-0.22
2005	0.01	0.17
Z-score: Height for age		
1991	0.04	0.95
1994	0.03	0.65
1998	0.01	0.24
2002	0.04	0.94
2005	0.04	1.01
Major illness, disability		
1991	0.00	0.09
1994	0.03**	2.19
1998	-0.04	-1.47
2002	0.02	0.71
2005	0.00	0.11
Index of psychological problems		
2002	0.04	0.74
2005	-0.03	-0.45

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

What are underlying mechanisms for the arising gap in educational achievements? Table A.3 provides an overview of the effects of housing damages on time investments into children's human capital.[4] In the short run, affected children are more often absent in school, on average they miss 0.26 days more per month. Given the average absence of children in our sample of 1.17 days per month, this corresponds to a non-negligible increase (0.14 sd). Affected children also devote less time doing homework (on average 28 minutes less per week – which corresponds to a decrease of 0.08 sd), but more time doing household chores (an increase of 49 minutes per week on average or 0.09 sd). As soon as education is not obligatory anymore (from age 14 onwards), there also arises a gap with respect to school enrollment: at age 14/15 the gap in school enrolment amounts to 3 percentage points (significant at the 15% significance level) and at age 18/19 this gap increases to 8 percentage points.[5] Overall, reduced school attendance is not associated with an increase in work for pay among targeted children. Yet, older siblings work significantly more if the family home was damaged by typhoon Mike - a finding that might be explained by age-increasing opportunity costs of schooling.

In a similar vein to the findings for children's educational development, we would expect detrimental consequences for children's health. Table 2 displays the estimated average impact of housing damages on selected health indicators - in the short- and in the long-run. The average effect on children's z-scores for weight and height are small and insignificant. Results for the self-reported prevalence of illnesses or disabilities also do not point to a deterioration in

[4] Unfortunately, we do not possess of any time use measures right after the disaster and thus cannot test, whether an initial substitution between time devoted to education and time devoted to (reconstruction) work might trigger a later reduction in educational investments. Yet, a substitution between alternative activities in the medium-run might indicate an initial substitution.

[5] Analogue to the decreased school enrollment, we also observe lower school expenditures from 1998 onwards (see Table I.2 in the online Appendix for the estimates related to expenditures).

health.[6] One may furthermore suspect that housing damages cause a psychological trauma or mental strain and thus explain the observed consequences for children's intellectual development. Unfortunately, we do not possess any information on short-term mental health. Yet, our data provides us with a depression screener from age 18 onwards. Based on this information we can exclude any long-lasting effects on mental health.

At first sight our results regarding health may seem surprising. Yet, one potential explanation could be that affected families are more likely to receive emergency aid (see Table 5). Emergency aid comes in form of food, cloth or shelter, which helps to maintain initial food consumption and basic health investments so that no short-term and due to dynamic complementarities no long-run damages arise. Moreover, despite arising budget constraints families might be able to maintain health investments, such as food or medical expenditures. And indeed, consistent with the absence of any long-run deterioration of children's health capital, we do not observe any immediate or long-run effect on food and medical spending (see Table I.2 in the Internet Appendix). Finally, our findings are in line with the existing evidence on the rather negligible link between shocks to families' financial resources and children's health. Stillman and Thomas (2008), for instance, exploit a dramatic income decline induced by the Russian economic crisis and cannot identify any impact on children's body stature. Banerjee et al. (2010), using income shocks experienced by vintners due to phylloxera, can only detect a significant impact on children's height, not, however, on any other health measures. Akee et al. (2010) find only evidence for a causal link between income and children's body stature among the poor. Our results point into the same direction: Families can maintain a desired level of health investments by shifting spending from other goods or investments.

[6] We investigate a series of further health indicators, both, objective, such as skinfold, blood pressure, arm, hip and weight circumference, and subjective, such as general health or frequency of hospital visits. We do not find any indication for a deterioration on average. These results are shown in Table I.3 in the Internet Appendix.

5.2 *Sensitivity Analysis*

The provided evidence supports the hypothesis that an adverse shock during early childhood leads to a reduction in families' human capital investments in their children and thus to a severe and persistent deterioration of children's educational achievements, but not of health outcomes. Yet, one may cast into doubt whether our identification strategy is valid.

One key concern is that relevant confounding variables may be unobserved. This may be a particular concern in our study because we cannot control for pre-existing differences in children's intellectual abilities. To address this issue we analyze the impact of housing damages on several placebo outcomes, such as children's preschool attendance and age at school entry (both retrospectively reported in 1991 and thus not included as control variables) as well as educational achievements of elderly siblings. All these events occur prior to typhoon Mike and thus, by default, cannot be affected by the disaster. If unobserved confounding factors bias our results, we would observe similar results for these placebo outcomes. Yet, there is no significant effect on these pre-treatment outcomes (see Table A.4).

We additionally test the robustness of our results leaving blocks of variables out of the estimation procedure. Table A.5 shows that our estimates are fairly robust to omitting different blocks of control variables. In particular, leaving out the block of initial child characteristics – which contains among others children's pre-disaster weight and height – does not change the results on children's health. This suggests that bias due to unobserved characteristics may not be important. Indeed, if one is confident in assuming that bias due to observables is an upper bound on bias due to unobservables – the key assumption in Altonji et al. (2005) –, one can safely claim that bias due to unobserved characteristics is negligible.

5.3 *Intensity of the shock*

To which extent do the consequences on children's education and health vary with the severity of the shock? In this section, we provide some tentative measure of the elasticity of children's development with respect to the degree of housing damages.

As described in Section 2, we possess only of a rather imperfect measure of the severity of the shock – self-reported repair costs. First, repair costs are likely to represent a lower bound of actual damages. Second, repair costs are positively correlated with the initial value of the house. Consequently, using repair costs per se might provide us with biased estimates. Instead, we use the ratio between reported repair costs and overall wealth a family possessed prior to the disaster as a measure for the severity of the shock. In addition, we exclude all cases where families report housing damages, but simultaneously repair costs of either zero or costs that exceed the initial value of the house (162 observations).

The estimates shown in Table 3 reflect our previous findings: housing damages have detrimental effects on children's education, both in the short and long run: at age 14/15 housing damages that correspond to a reduction in wealth by 10% cause a child to lag behind by 0.01 years, at age 21/22 – when schooling should be basically completed – this gap amounts to 0.10 years. In the case of full wealth destruction (housing damages amount to 100%), this gap corresponds to a loss in schooling of around one year. Full wealth destruction has also non-negligible negative effects on children's performance in the set of cognitive tests. These effects are, however, not significant at any conventional level.

In the short run, housing damages during early childhood do not seem to provoke any significant harm to children's anthropometric development. Yet, in the long run (at age 21/22), we observe a significant negative impact on children's weight and height: housing damages that correspond to a 10% reduction in family wealth lead to a reduction in children's weight and height of around 0.03 sd (the weight estimate is only significant at the 15% significance level). This translates into a weight reduction of 0.30 kg and a height reduction of 0.25 cm.

Table 3: Impact of effect intensity on child development

	Coef.	t
Education		
Highest grade completed		
1994	-0.12	-0.80
1998	-0.58*	-1.90
2002	-0.62*	-1.92
2005	-1.06**	-2.10
Standardized IQ score		
1991	-0.10	-0.79
1994	-0.15	-1.12
Standardized Test scores (1994)		
English	-0.10	-0.79
Cebu	-0.17	-1.27
Math	-0.06	-0.43
Health		
Weight for age (z-score):		
1991	-0.09	-0.83
1994	-0.16	-1.15
1998	-0.09	-0.62
2002	-0.24	-1.41
2005	-0.30	-1.49
Height for age (z-score)		
1991	-0.26	-0.62
1994	-0.12	-1.04
1998	-0.18*	-1.67
2002	-0.27**	-2.53
2005	-0.32***	-2.81

Note: This table displays the regression coefficients for damages (fraction of wealth) on the dependent variable described in the table. The sample contains 1096 children whose houses are damaged by typhoon Mike and for whom we possess of an estimate of the repair costs. Each coefficient stems from a separate OLS regression based on equation (1). Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

5.4 *Effect heterogeneity*

The consequences of a shock may differ depending on a family's ability to buffer the shock. Besides family's financial resources, the network of relatives constitutes the main insurance device in developing countries to overcome arising credit constraints and the lack of private insurance (Foster & Rosenzweig, 2001; Rosenzweig, 1989; Zylberberg, 2012). To shed some light on such possible effect heterogeneities, we stratify our sample according to the following criteria: first, we stratify with respect to the level of family wealth prior to the shock, and second, with respect to the strength of social ties in the local neighborhood prior to the disaster. For the latter stratification we use the information whether a child lived in the parents' neighborhood of origin – the best available proxy for social ties based on the evidence that geographical and social proximity are the major determinants of mutual insurance in rural areas (Marcel & Lund, 2001).[7] Results for education and health outcomes are shown in Table 4, for the underlying mechanism in Table A.6.

Stratification with respect to families' initial wealth – where we divide the sample at the median of the wealth distribution prior to the disaster – reveals the following: while the share of damaged houses is non-negligible among both poor and rich families (81% and 70%, respectively), results are mainly driven by children from poorer families. Among poorer families, affected children perform significantly worse in basically all school disciplines: 0.08 sd in Cebu (which is not significant at any conventional levels), 0.12 sd in Math and 0.18 sd in English. Most worrisome is the increasing gap in educational attainment: at the age of 22, when schooling should be basically completed, the gap amounts to almost one year. Further analysis reveals that children from poorer families are also likely to drop out of school as soon as schooling is not mandatory anymore – in 1998 they are 8% less likely to be enrolled in

[7] Given the rare nature of typhoons in Cebu Island, it is unlikely that people systematically prepare themselves against typhoons, e.g. by choosing a more protected location of residence, settling down strategically at different locations of the island, etc..

school, and in 2002 they are even 16% less likely to be enrolled in school. Moreover, they are observed to work more for pay, by 2 percentage points in 1994 and 1998, and 7 percentage points in 2002. Yet, on the bright side, poor families seem to be able to maintain their children's nutritional intake and medical care at a sustainable level. As a result, there are no detrimental effects on health among their children.

Distinguishing between families who prior to the disaster live in the barangay where at least one of the parents was born and families where none of the parents lived in their barangay of origin, reveals further interesting results. Among children of the first group, we do not observe any detrimental effect on their health. Yet, among children of the latter group we observe some initial weight loss (0.17 sd) that disappears over time. In addition, we observe more severe consequences for the education of these children. First, they are more likely to drop out of school (7% in 1998 and 11% in 2002), which is not the case for children who live in the same neighborhood as the extended family. Second, the gap in educational achievement is more pronounced among these children (in 2005 it amounts to 0.8 versus 0.3 years). These results might provide some supportive evidence for the existence of informal insurance mechanisms provided by a family network.[8]

[8] Notice, however that families who do not reside in their barangay of origin also experience a more severe shock on real estate wealth. Thus, the more severe consequences for children belonging to this subgroup may also be due to a more severe shock. Regression results for the impact of housing damages on wealth and alternative underlying channels for the different strata are available upon request.

Table 4: Heterogeneity analysis

	Poor Family		Rich Family		No Network		Network	
	Coef.	**t**	**Coef.**	**t**	**Coef.**	**t**	**Coef.**	**t**
Education								
Highest Grade 1994	-0.19**	-2.14	-0.09	-1.41	-0.20*	-1.95	-0.08	-1.16
1998	-0.40**	-2.23	-0.12	-0.98	-0.19	-0.98	-0.16	-1.22
2002	-0.80***	-3.57	-0.25	-1.50	-0.47*	-1.87	-0.33**	-2.00
2005	-1.01***	-3.38	-0.33	-1.39	-0.80*	-2.09	-0.31	-1.41
IQ Score 1991	-0.21***	-2.7	-0.01	-0.11	-0.13	-1.35	-0.07	-1.21
1994	-0.14*	-1.86	-0.03	-0.48	0.00	0.03	-0.07	-1.15
English Score 1994	-0.19***	-2.82	0.00	-0.02	-0.11	-1.24	-0.05	-0.86
Cebu Score 1994	-0.1	-1.34	-0.06	-0.89	-0.07	-0.72	-0.06	-0.99
Math Score 1994	-0.13**	-1.75	-0.05	-0.82	-0.12	-1.33	-0.02	-0.43
Health								
Weight (z-score) 1991	-0.05	-0.75	-0.05	-0.94	-0.17**	-2.05	-0.02	-0.34
1994	0.03	0.36	-0.03	-0.37	-0.08	-0.78	0.04	0.68
1998	0.04	0.53	-0.05	-0.71	-0.02	-0.20	0.01	0.15
2002	0.05	0.55	-0.05	-0.60	-0.02	-0.13	-0.01	-0.12
2005	0.04	0.32	0.00	-0.03	0.01	0.09	0.05	0.56
Height (z-score) 1991	0.05	0.79	0.04	0.72	0.00	0.06	0.03	0.73
1994	0.06	0.91	0.00	0.01	-0.09	-1.05	0.07	1.41
1998	0.02	0.35	0.01	0.19	0.02	0.28	-0.01	-0.30
2002	0.01	0.09	0.08	1.41	0.06	0.76	0.01	0.27
2005	-0.02	-0.24	0.08	1.50	0.06	0.70	0.02	0.32
Share damaged	80.74%		69.79%		75.64%		75.57%	
Obs. (1991)	1023		1023		657		1929	

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

6 Potential channels

One obvious question to ask is what kind of shock do housing damages due to a super typhoon represent. Do housing damages only represent the visible consequences on families' real estate wealth, or do they trigger any further channels that may directly or indirectly harm children's development?

As we can see in Table 5, there is an immediate and significant drop in reported wealth among families whose homes were damaged by typhoon Mike. On average, the wealth loss amounts to 1'394 constant 1990 international $. This loss corresponds to more than half of overall wealth and more than a third of annual household income of affected families prior to the disaster. Keeping in mind that the Philippine GDP per capita in 1991 amounted 1'484 $, the drop in wealth represents indeed a severe shock. For the following years, the magnitude of the effect is persistent, even if not always significant. The analysis of the asset index corroborates the findings that the housing damages due to typhoon Mike caused a non-negligible and persistent destruction of families' overall belongings (0.23-0.39 sd).

Regarding the single wealth components, the most severe losses are experienced in the value of real estate, furniture, household appliances, and vehicles, where the latter two are also depressed in the long-run.[9] There are no significant losses in business related equipment or livestock. In other words, the effective loss is related to assets which contribute to family wealth, but does not extend to any physical assets which contribute to household production. This is important in light of the recent literature on the "wealth paradox", which investigates the stylized fact that child labor is positively correlated with the ownership of productive physical assets (Balothra & Heady, 2003; Basu, et al., 2010; Cockburn & Dostie, 2007).

[9] Table I.4 displays results for long-run effects on single wealth components, single income components as well as alternative channels.

Table 5: Effect on channels

	Coef.	t
Wealth (in 1990 international $)		
1991	-1394***	-3.30
1994	-2344*	-1.73
1998	-318	-0.27
2002	-3374*	-1.65
2005	-1216	-1.34
Asset index		
1991	-0.39***	-4.60
1994	-0.38***	-3.91
1998	-0.23**	-2.38
2002	-0.37***	-3.02
2005	-0.33***	-2.64
Wealth Components in 1991		
Real estate	-1229***	-3.66
Furniture	-65***	3.19
Household appliances	-101**	-2.33
Vehicles	-294**	-2.09
Business equipment	-3	0.03
Livestock	1	0.07
Household income		
1991	-290	-1.08
1994	-109	-0.44
1998	-223	-1.00
2002	-392	-1.30
2005	-756**	-2.31
Alternative channels		
Disaster relief	0.26***	10.51
Father is working	0.01	0.68
Father‘s work hours/week	0.86	0.65
Mother is working	-0.02	-0.81
Mother‘s work hours/week	-1.36	-0.83
Mom has major illness (binary)	-0.02	-1.29
Mother died (binary)	-0.01	-1.32
Family migrated	-0.02***	-3.92
Family separated	0.01	0.69
Family member temporary absent	0.02	1.54

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

We also identify a drop in income. The immediate effect, however, is relatively small and insignificant. The income shock only gains magnitude and significance from year 2002 onwards. This drop is mainly driven by a reduction in income from market activities (see Table I.4 in the Internet Appendix). Analyzing income earned by single household members indicates that the income decline in later years is due to decreased earnings among affected children and thus points to a long-lasting effect on children's human capital endowment.[10]

Affected households are more likely to receive disaster relief from the government or other institutions (yet not in form of remittances). Unfortunately, the dataset does not provide any information about the type of disaster relief. Outside sources report that relief assistance focuses on the provision of food, clothing, emergency shelter, and medical supplies.[11] Governmental funds usually provide funding for emergency relief operations, emergency repair and rebuilding of public infrastructures, but do not cover private property damages. Moreover, non-life insurance penetration in the Philippines is very low, and residential property policies rarely cover natural perils (World Bank, 2005). Financial assistance is thus likely to be negligible and costs related to damages of private goods are largely borne by the families.

Finally, our results provide little evidence that other channels, such as parental labor supply (both at the extensive and the intensive margin), maternal health, maternal mortality, migration, separation of the family or temporary absence of a family member, play a major role in explaining our results on children's education. With the exception of some increase in fathers' work hours and slightly increased temporary absence of a family member in the medium-run, further channels are largely unrelated to housing damages due to typhoon Mike.

Yet, despite the richness of our data we cannot exclude the possibility that housing damages relate to other unobserved channels which may be detrimental for children. Our prime

[10] The estimates using children's labor income are negative and of almost the same size as the overall decrease observed in income in 2002 and 2005. Results are available from the authors.

[11] http://wwww.reliefweb.int/rw/rwb.nsf/db900SID/ACOS-64CS8J?OpenDocument&rc=3&emid=ACOS-635PDE

concern is related to temporary evacuation. Unfortunately, our dataset does not contain any detailed information about the duration of people's stay in emergency bearings. Yet, the available data allow us to reject increased relocation one year after the typhoon. If anything, our results suggest that affected families are more likely to stay in their barangay. Moreover, available outside evidence about the situation after the disaster does not point towards any long-term evacuation (camps were functioning for up to 6 weeks).

By and large, the results indicate that housing damages due to typhoon Mike can be interpreted as a severe and long-lasting wealth shock, in particular as a shock on real estate wealth. As such, our study contributes to the very recent but rapidly growing literature on the causal relation between families' permanent income and children's development. Our results are in line with the existing evidence on the link between families' permanent income and children's education outcomes. Akee et al. (2010), for instance, find that additional 6'000$ per year – an increase in annual household income by 30% - causes benefited children to attend school for almost one extra year. Dahl and Lochner (2012) reveal that additional 1'000$ - which in their sample corresponds to an income increase of 6% - leads to an improvement in children's math and reading scores by 0.06 sd. Our wealth shock corresponds to about 38% of the average annual income which translates into a reduction in school by 0.40 years and a deterioration in test scores by 0.02-0.06 sd. Thus, our effects on educational outcomes are comparable in direction and magnitude.

7 Conclusion

The present study analyzes the impact of a major adverse shock during early childhood on children's health and education in the short- and long run. Our results reveal negative and persistent effects on children's education, not however on children's health. To be more precise, we observe initially worse educational outcomes that even increase over time. As such, our results speak to the theoretical concepts of self-productivity and dynamic complementarities present in the skill production: early arising educational gaps widen steadily over time.

Our results have furthermore important policy implications for situations where a major shock occurs during early childhood – one of the most frequently occurring being natural disasters. Provision of targeted disaster relief – in particular disaster relief tied to children's continuous participation in education – may help to alleviate the consequences for children's intellectual development. Moreover, given the heterogeneity observed in our estimates, with the most disadvantaged children being the ones suffering the most, emergency aid targeted to children's school attendance may help to prevent a further aggravation of existing inequalities in a society.

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Appendix

Table A.1: Sample size and attrition

	Observations	Treated	Control	Attrition
Last survey prior to typhoon (1985/86)	2631	-	-	-
Died before 1991	-116	-	-	-
Data inconsistencies	-32	-	-	-
Missing background information	-138	-	-	-
No treatment variation within barangay	-23	-	-	-
Baseline sample (1985/86)	2322	-	-	-
Sample 1991	2046	1540	506	12%
Sample 1994	1901	1431	470	7%
Sample 1998	1850	1393	457	3%
Sample 2002	1812	1370	442	2%
Sample 2005	1773	1346	427	2%

Note: Initially the CLNHS screened 3080 pregnant women in 33 baranagays in the Cebu Metropolitan Area. Yet, conditional on information in the last survey prior to typhoon Mike (which corresponds to the last bimonthly interview after childbirth), the child having survived until right before the typhoon, no data inconsistencies, full background information and variation in the treatment (housing damages) within the barangay, our baseline sample consists of 2‘322 observations.

Table A.2: Descriptive statistics

		Pooled Sample			Control	Treated	Difference
	Year	Obs.	Mean	S.D.	Mean	Mean	
Outcome variables							
Z-score: Weight for age	1991	1962	-2.17	1.10	-2.01	-2.22	-0.22***
	1994	1896	-1.85	1.23	-1.70	-1.90	-0.2***
	1998	1818	-1.79	1.11	-1.71	-1.82	-0.11*
	2002	1764	-2.03	1.24	-1.96	-2.05	-0.09
	2005	1654	-2.04	1.40	-1.98	-2.06	-0.09
Z-score: Height for age	1991	1962	-2.26	0.99	-2.14	-2.30	-0.16***
	1994	1893	-1.80	1.03	-1.67	-1.85	-0.17***
	1998	1818	-2.03	0.88	-1.93	-2.06	-0.12***
	2002	1761	-2.11	0.87	-2.07	-2.12	-0.06
	2005	1654	-2.11	0.87	-2.06	-2.12	-0.06
Major illness, disability	1991	1965	0.18	0.39	0.18	0.19	0.01
	1994	1900	0.09	0.28	0.06	0.10	0.04**
	1998	1661	0.78	0.42	0.80	0.77	-0.03
	2002	1763	0.66	0.48	0.64	0.66	0.03
	2005	1657	0.35	0.48	0.35	0.35	-0.01
Psychological problems	2002	1763	0.72	1.06	0.71	0.72	0.01
	2005	1657	0.67	1.09	0.68	0.67	-0.01
Highest grade complete	1994	1901	3.54	1.12	3.76	3.46	-0.3***
	1998	1824	7.62	2.12	8.06	7.47	-0.59***
	2002	1780	9.81	2.78	10.59	9.56	-1.03***
	2005	1689	10.77	3.60	11.76	10.45	-1.31***
IQ score	1991	1954	0.01	0.99	0.22	-0.07	-0.29***
	1994	1895	0.01	0.98	0.20	-0.05	-0.25***
English score	1994	1881	0.00	0.99	0.24	-0.08	-0.32***
Cebu score	1994	1884	0.00	0.99	0.20	-0.06	-0.26***
Math score	1994	1883	0.00	0.99	0.22	-0.07	-0.3***
School enrollment	1994	1901	0.78	0.41	0.75	0.79	-0.05**
	1998	1824	0.77	0.42	0.84	0.75	0.091***
	2002	1780	0.43	0.50	0.54	0.39	0.155***
	2005	1689	0.17	0.38	0.25	0.15	0.097***
Days/month missed school	1994	1789	1.17	1.88	0.85	1.29	-0.43***
	1998	1423	1.53	2.26	1.34	1.60	-0.26*
	2002	690	1.39	2.54	1.39	1.38	0.013
	2005	317	1.90	3.25	1.64	2.04	-0.4
Work for pay	1991	1965	0.01	0.11	0.01	0.02	-0.009
	1994	1901	0.11	0.32	0.10	0.12	-0.019
	1998	1819	0.38	0.49	0.35	0.39	-0.037
	2002	1780	0.47	0.50	0.42	0.49	-0.065**
	2005	1689	0.53	0.50	0.48	0.55	-0.064**

Table A.2: Descriptive statistics (continued)

		Pooled Sample			Control	Treated	Difference
	Year	Obs.	Mean	S.D.	Mean	Mean	
Hours/day homework	1994	1891	0.83	0.76	0.73	0.87	-0.14***
Hours/day chores	1994	1797	0.81	0.52	0.89	0.79	0.103***
Treatment variables							
Housing damages	1991	2046	0.75	0.43	0.00	1.00	-
Reparation costs	1991	1358	260.00	893.00	-	-	-
Potential channels							
Wealth	1991	2035	3991	9364	6938	3024	-3914***
	1994	1900	8001	25834	12706	6454	-6252***
	1998	1850	9342	22708	13099	8106	-4993***
	2002	1875	8768	37713	14711	6848	-7864***
	2005	1835	7308	17262	10685	6240	-4446***
Asset index	1991	2046	0.02	2.16	0.84	-0.25	-1.09***
	1994	1901	0.06	2.34	0.94	-0.23	-1.17***
	1998	1852	-0.01	2.24	0.65	-0.22	-0.87***
	2002	1886	0.01	2.82	0.92	-0.28	-1.2***
	2005	1847	0.01	2.73	0.84	-0.25	-1.08***
Total income	1991	2046	4419	5584	5613	4026	-1587***
	1994	1901	4621	4889	5518	4326	-1191***
	1998	1852	6659	4321	7548	6366	-1182***
	2002	1888	4041	5767	5059	3714	-1345***
	2005	1847	3758	6044	4944	3384	-1561***
Disaster relief	1991	2046	0.57	0.50	0.32	0.65	0.33***
Father employment status	1991	1800	0.91	0.28	0.90	0.92	0.02
	1994	1640	0.93	0.26	0.92	0.93	0.01
	1998	1536	0.93	0.26	0.93	0.93	0.00
	2002	1325	0.88	0.32	0.86	0.89	0.03
	2005	1106	0.81	0.39	0.80	0.81	0.01
Mother employment status	1991	1925	0.69	0.46	0.70	0.69	-0.02
	1994	1761	0.73	0.44	0.73	0.74	0.01
	1998	1678	0.78	0.41	0.78	0.78	0.00
	2002	1749	0.76	0.43	0.76	0.75	-0.01
	2005	1671	0.73	0.44	0.72	0.73	0.02
Work hours dad	1991	1686	41.51	22.56	41.11	41.63	0.52
	1994	1537	43.43	23.97	41.70	43.97	2.27
	1998	1448	40.55	21.33	38.90	41.08	2.18*
	2002	1235	37.93	24.50	36.52	38.39	1.86
	2005	1046	36.44	25.51	37.37	36.13	-1.24

Table A.2: Descriptive statistics (continued)

		Pooled Sample			Control	Treated	Difference
	Year	Obs.	Mean	S.D.	Mean	Mean	
Work hours mom	1991	1838	27.49	29.43	28.99	26.99	-2.00
	1994	1677	28.66	27.77	29.98	28.22	-1.76
	1998	1596	32.01	27.21	31.92	32.04	0.12
	2002	1657	30.90	29.67	32.58	30.36	-2.23
	2005	1614	30.72	29.66	30.44	30.81	0.37
Mom has major illness	1991	2046	0.01	0.09	0.01	0.01	-0.01
	1994	1901	0.01	0.10	0.02	0.01	-0.01
	1998	1852	0.02	0.14	0.03	0.02	-0.02
	2002	1844	0.03	0.18	0.04	0.03	-0.01
Mother died	1991	1861	0.03	0.18	0.04	0.03	-0.01
	1994	1959	0.11	0.32	0.12	0.11	-0.01
	1998	1752	0.21	0.41	0.21	0.21	0
	2002	1852	0.13	0.34	0.14	0.13	-0.01
	2005	1752	0.48	0.50	0.48	0.48	-0.01
Migration	1991	1965	0.01	0.09	0.02	0.00	-0.02***
	1994	1901	0.07	0.26	0.09	0.07	-0.02
	1998	1823	0.09	0.28	0.08	0.09	0.00
	2002	1849	0.22	0.41	0.24	0.22	-0.02
	2005	1877	0.35	0.48	0.35	0.35	0.00
Family separated	1991	2046	0.06	0.24	0.06	0.06	0.00
	1994	1901	0.08	0.27	0.07	0.08	0.01
	1998	1852	0.09	0.28	0.08	0.09	0.00
	2002	1888	0.13	0.34	0.11	0.14	0.03*
	2005	1847	0.22	0.41	0.20	0.22	0.02
HH member absent	1991	2046	0.06	0.24	0.05	0.06	0.01
	1994	1901	0.06	0.23	0.03	0.06	0.03***
	1998	1852	0.11	0.31	0.09	0.12	0.03*
	2002	1888	0.14	0.35	0.13	0.15	0.02
	2005	1847	0.12	0.32	0.13	0.11	-0.02
Control variables							
House material: nipa	Base	2046	0.44	0.50	0.34	0.47	0.13***
House material: cement	Base	2046	0.17	0.38	0.28	0.14	-0.14***
Soil: unconsolidated	Base	2046	0.40	0.49	0.40	0.39	-0.01
Soil: core basalt	Base	2046	0.10	0.30	0.08	0.10	0.02
Average soil:1-3m	Base	2046	0.17	0.38	0.19	0.17	-0.02
Average soil:0,3-1m	Base	2046	0.32	0.47	0.28	0.34	0.06**
Average soil:< 0,3m	Base	2046	0.13	0.33	0.13	0.12	-0.01
House ownership	Base	2046	0.75	0.43	0.73	0.76	0.04
Log of house value	Base	2046	4.73	3.00	4.95	4.66	-0.29*
Elevation brgy	Base	2046	22.78	49.49	22.92	22.73	-0.19

Table A.2: Descriptive statistics (continued)

		Pooled Sample			Control	Treated	Difference
	Year	Obs.	Mean	S.D.	Mean	Mean	
Spouse lives in HH	Base	2046	0.95	0.22	0.94	0.95	0.02
Spouse temporary absent	Base	2046	0.06	0.24	0.08	0.06	-0.02*
Father employment status	Base	2046	0.86	0.35	0.85	0.86	0.01
Mother employment status	Base	2046	0.41	0.49	0.40	0.41	0.01
Log of total income	Base	2046	7.80	1.10	8.02	7.72	-0.3***
Log wealth	Base	2046	6.75	1.62	7.20	6.60	-0.6***
Female birth	Base	2046	0.47	0.50	0.51	0.46	-0.05*
Birth size: smaller than avg.	Base	2046	0.18	0.38	0.16	0.18	0.02
Birth size: bigger than avg.	Base	2046	0.27	0.45	0.25	0.28	0.03
Place of delivery: hospital	Base	2046	0.36	0.48	0.47	0.33	-0.14***
Birth complication	Base	2046	0.14	0.34	0.12	0.14	0.02
Height for age	Base	2046	-2.33	1.16	-2.15	-2.39	-0.24***
Weight for age	Base	2046	-2.22	1.15	-2.07	-2.27	-0.2***
Father’s highest grade	Base	2046	6.67	4.31	7.34	6.45	-0.89***
Father vocational training	Base	2046	0.12	0.32	0.16	0.11	-0.05***
Mother’s highest grade	Base	2046	7.28	3.76	8.41	6.91	-1.51***
Mother vocational training	Base	2046	0.16	0.37	0.17	0.16	-0.01
Number of rooms	Base	2046	2.61	1.35	2.95	2.49	-0.46***
Garbage: collected	Base	2046	0.13	0.33	0.19	0.11	-0.08***
Garbage: burning	Base	2046	0.42	0.49	0.38	0.44	0.06**
Garbage: dumping at house	Base	2046	0.14	0.34	0.13	0.14	0.01
Garbage: dumping away	Base	2046	0.22	0.42	0.22	0.22	0.00
One nuclear family	Base	2046	0.16	0.37	0.15	0.16	0.01
Multi-nuclear family	Base	2046	0.20	0.40	0.25	0.19	-0.06***
Log hh in brgy	Base	2046	8.54	0.86	8.54	8.54	0.00

Table A.3: Mechanisms underlying the effects on children's educational outcomes

	Coef.	t
Missed school (days/month)		
1994	0.26*	2.5
1998	0.15	1.1
2002	0.01	0.04
2005	0.31	0.69
Activtities 1994 (hours/day)		
Household chores	0.07*	1.73
Homework	-0.04*	-1.69
Enrolled in school (binary)		
1994	0.02	1.35
1998	-0.03	-1.56
2002	-0.08***	-2.95
2005	-0.03	-1.59
Work for pay (binary)		
1991	0.01	0.93
1994	0.01	0.56
1998	0	-0.08
2002	0	-0.15
2005	0.03	1.25
Sibling age 8-10: 1991	0.03**	2.25
Sibling age 11-14: 1991	0.06*	1.91
Sibling age 15-18: 1991	0.06	1.24

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

Table A.4: Robustness check – Placebo outcomes

	Coef.	t
Pre-treatment outcomes of index child		
Preschool attendance	0.02	0.64
School starting age	-0.01	-0.07
Enrolled in school before typhoon	-0.01	-0.58
Pre-treatment outcomes of elderly siblings		
Highest grade completed of oldest sibling	0.08	0.31
Highest grade completed of oldest brother	0.42	1.55
Highest grade completed of oldest sister	-0.28	-0.93

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request.

Table A.5: Robustness check – Ommitting pretreatment control variables

Excluding	**child information**		**house information**		**SES information**		**parents' education**		**additional information**	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Highest Grade: 1994	-0.15***	-2.74	-0.12**	-2.28	-0.12**	-2.21	-0.14***	-2.63	-0.12**	-2.21
1998	-0.24**	-2.2	-0.2*	-1.92	-0.19*	-1.82	-0.25**	-2.32	-0.23**	-2.15
2002	-0.53***	-3.76	-0.43***	-3.22	-0.41***	-3.07	-0.5***	-3.64	-0.47***	-3.49
2005	-0.64***	-3.41	-0.53***	-2.87	-0.5***	-2.73	-0.64***	-3.37	-0.59***	-3.2
IQ Score: 1991	-0.1**	-2.09	-0.08*	-1.73	-0.09*	-1.87	-0.11**	-2.24	-0.1**	-1.98
1994	-0.07	-1.48	-0.06	-1.23	-0.06	-1.24	-0.08*	-1.7	-0.07	-1.35
English Score: 1994	-0.11**	-2.28	-0.06	-1.36	-0.06	-1.41	-0.1**	-2.04	-0.07	-1.55
Cebu Score: 1994	-0.11**	-2.15	-0.06	-1.36	-0.06	-1.3	-0.08*	-1.72	-0.06	-1.31
Math Score: 1994	-0.11**	-2.24	-0.07	-1.53	-0.07	-1.58	-0.1**	-2.04	-0.08	-1.61
Weight (z-Score): 1991	-0.06	-1.01	-0.06	-1.4	-0.06	-1.41	-0.05	-1.27	-0.04	-0.98
1994	-0.03	-0.46	-0.01	-0.25	-0.01	-0.17	-0.01	-0.16	0	0.07
1998	-0.03	-0.36	-0.01	-0.17	-0.01	-0.24	-0.01	-0.08	0	0.02
2002	-0.02	-0.19	0.01	0.15	0.01	0.19	0.02	0.24	0.03	0.39
2005	-0.06	-1.01	-0.06	-1.4	-0.06	-1.41	-0.05	-1.27	-0.04	-0.98
Height (z-Score): 1991	0.02	0.34	0.03	0.79	0.03	0.93	0.03	0.87	0.05	1.22
1994	-0.01	-0.25	0.02	0.52	0.03	0.66	0.03	0.61	0.03	0.8
1998	-0.01	-0.27	0.01	0.17	0.01	0.35	0.01	0.25	0.01	0.35
2002	0.03	0.56	0.04	0.97	0.04	1.02	0.04	0.96	0.04	1.1
2005	0.02	0.42	0.04	1	0.05	1.13	0.04	1.09	0.05	1.2

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

Table A.6: Heterogeneity analysis for underlying mechanisms

	Poor Family		Rich Family		No Family Network		Family network	
	Coef.	**t**	**Coef.**	**t**	**Coef.**	**t**	**Coef.**	**t**
Currently enrolled								
1994	0.01	0.34	0.03	1.59	0.05	1.57	0.02	0.77
1998	-0.08**	-2.19	-0.01	-0.37	-0.07*	-1.66	-0.02	-0.61
2002	-0.16***	-3.96	-0.03	-0.91	-0.11**	-2.14	-0.04	-1.41
2005	-0.06**	-2.17	-0.02	-0.49	-0.01	-0.34	-0.04	-1.48
Work for pay								
1991	0.02*	1.81	0	-0.62	0.01	0.86	0.01	0.71
1994	0.02	0.83	0	0.12	0.02	0.60	0.01	0.25
1998	0.07*	1.69	-0.04	-1.09	0.05	0.91	-0.01	-0.44
2002	-0.05	-1.07	0.04	1.10	0.01	0.25	-0.01	-0.34
2005	0	0.09	0.07*	1.88	0.05	0.93	0.04	1.04
Activities in hours/day								
Homework	0.09*	1.66	0.03	0.64	0.12	1.56	0.06	1.23
HH chores	-0.07*	-1.74	-0.01	-0.16	-0.1	-1.63	-0.01	-0.21
Food expenditures								
1994	0.55	0.56	-1.24	-0.93	-4.06**	-2.30	0.35	0.37
1998	-0.47	-0.63	-0.33	-0.37	-0.68	-0.60	-0.68	-0.97
2002	0.57	0.78	-1.36	-1.47	-0.36	-0.32	-0.82	-1.19
2005	0.32	0.44	-0.73	-1.34	-1.69	-1.52	-1.42	-1.33
Medical expenditures								
1994	0.23	0.65	0.35	0.62	0.35	0.45	0.18	0.50
1998	0.02	0.08	-0.54	-1.25	-0.51	-0.87	-0.02	-0.08
2002	-0.11	-0.47	0.1	0.18	-0.89	-1.39	0.19	0.53
2005	-0.28	-0.39	0.46	1.12	-0.19	-0.31	0.27	0.55
Share damaged	**0.8074**		**0.6979**		**0.7564**		**0.7557**	
Obs. (1991)	1023		1023		657		1929	

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

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Table I.1: Descriptive statistics – Baseline sample vs. post-disaster sample (1991)

	Baseline	Study	Diff.
Material of house: nipa	0.435	0.432	-0.003
Material of house: cement, wood	0.172	0.181	0.009
Soil formation: unconsolidated	0.396	0.406	0.010
Soil formation: core basalt rocks	0.099	0.098	-0.001
Average soil: 1-3m	0.174	0.172	-0.002
Average soil: 0.3-1m	0.323	0.323	0.000
Average soil: < 0.3m	0.126	0.114	-0.011
House ownership	0.752	0.728	-0.024*
Log of house value	4.729	4.57	-0.159*
Elevation brgy	22.778	23.736	0.958
Spouse lives in HH	0.949	0.944	-0.004
Spouse temporary absent	0.063	0.064	0.001
Father's employment status	0.861	0.853	-0.008
Mother's employment status	0.408	0.403	-0.005
Log of total income in constant 1990$	7.797	7.811	0.013
Log wealth in constant 1990$	6.751	6.729	-0.022
Female (birth)	0.469	0.472	0.003
Size at birth: smaller than normal (birth)	0.179	0.177	-0.002
Size at birth: bigger than normal (birth)	0.272	0.27	-0.002
Place of delivery: hospital (birth)	0.361	0.37	0.009
Birth complication (birth)	0.135	0.137	0.002
Height for age	-2.334	-2.323	0.011
Weight for age	-2.219	-2.217	0.002
BMI for age	-0.812	-0.821	-0.008
Father's highest grade	6.67	6.736	0.066
Father got vocational training	0.119	0.122	0.003
Mother's highest grade	7.281	7.366	0.085
Mother got vocational training	0.161	0.166	0.005
Value of the house : third quintile	0.201	0.196	-0.005
Value of the house : forth quintile	0.208	0.2	-0.007
Value of the house : fifth quintile	0.201	0.193	-0.008
Total income : second quintile	0.207	0.207	0.000
Total income : third quintile	0.201	0.199	-0.001
Total income : forth quintile	0.199	0.201	0.002
Total income : fifth quintile	0.193	0.197	0.005
Number of rooms	2.605	2.589	-0.016
Garbage disposal: collected	0.127	0.136	0.009
Garbage disposal: burning	0.423	0.417	-0.006
Garbage disposal: dumping at house	0.135	0.13	-0.005

Table I.1: Descriptive statistics (continued)

	Baseline	**Study**	**Diff.**
Garbage disposal: dumping away	0.223	0.226	0.002
Type HH: One nuclear family	0.158	0.161	0.004
Type HH: Multi-nuclear family	0.202	0.209	0.007
Log # hh in brgy	8.54	8.562	0.022

Table I.2: OLS regression results for expenditures (in 1990 $, measured in 1994)

	Coef.	t
Total expenses/week		
1994	-2.53	-0.88
1998	-5.55**	-2.17
2002	-7.95***	-3.00
2005	-4.89**	-2.13
School expenses/week		
1994	-0.13	-0.52
1998	-0.75***	-2.69
2002	-0.97***	-3.35
2005	-0.74***	-2.93
Food expenses/week		
1994	-0.93	-1.11
1998	-0.74	-1.27
2002	-0.73	-1.26
2005	-1.44***	-2.69
Medical expenses/week		
1994	0.18	0.54
1998	-0.24	-0.90
2002	-0.09	-0.28
2005	0.22	0.56

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

Table I.3: OLS regression results for further health outcomes

	Coef.	t
Waist circumference in cm		
1998	-0.25	-0.87
2002	-0.213	-0.58
2005	-0.032	-0.08
Hip circumference in cm		
1998	-0.163	-0.50
2002	-0.044	-0.11
2005	-0.303	-0.74
Arm circumference in cm		
2002	-0.029	-0.20
2005	-0.068	-0.40
Triceps skinfold thickness		
1998	-0.204	-1.07
2002	-0.177	-0.67
2005	-0.322	-0.96
Subscapular skinfold thickness		
1998	0.122	0.74
2002	-0.029	-0.12
2005	0.034	0.10
Blood pressure systolic 1 mm Hg		
1998	-1.028*	-1.85
2002	0.577	0.99
2005	0.001	0.00
Blood pressure diastolic 1 mm Hg		
1998	-0.984**	-2.14
2002	0.147	0.28
2005	0.038	0.07
Any cavities or decayed teeth		
2002	-0.005	-0.17
2005	0.034	1.26
Headache past 12 month		
2002	-0.048***	-2.58
2005	-0.003	-0.42

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.

Table I.4: OLS regression results for detailed long-run effects

	Coef.	t
Value of the house in 1990$		
1994	-1618	-1.08
1998	-235	-0.19
2002	-2562	-1.16
2005	-833	-0.91
Value of furniture in 1990$		
1994	-22**	-2.13
1998	-15	-1.63
2002	7	0.84
2005	-6	-0.36
Value of appliances in 1990$		
1994	-139***	-2.72
1998	-82	-1.51
2002	-104**	-2.24
2005	-68	-1.56
Value of vehicles in 1990$		
1994	-521***	-3.88
1998	-426***	-2.68
2002	-309*	-1.9
2005	-371*	-1.88
Value of business equipment in		
1994	1	0.08
1998	30	0.59
2002	46	0.95
2005	5	0.51
Value of livestock in 1990$		
1994	30	0.58
1998	46	0.94
2002	5	0.5
2005	12	1.33
Income from market work (in 1990		
1991	-112	-0.45
1994	-73	-0.31
1998	-67	-0.36
2002	-218	-0.75
2005	-745**	-2.19
Income other sources (in 1990 $)		
1991	-164*	-1.75
1994	-85	-0.98
1998	-148	-1.4
2002	-102	-1.03
2005	-98	-1.1

Table I.4: Detailed long-run effects (continued)

	Coef.	t
Remittances (binary)		
1991	-0.02	-1.2
1994	-0.02	-1.24
1998	-0.03**	-2.21
2002	0	-0.03
2005	-0.01	-0.45
Father's employment status (binary)		
1994	0.01	0.34
1998	0.01	0.41
2002	0.03	1.61
2005	0.01	0.46
Mother's employment status (binary)		
1994	0.01	0.54
1998	0	-0.17
2002	-0.01	-0.47
Father's work hours/week		
1994	2.66*	1.79
1998	3.62***	2.67
2002	2.85*	1.68
2005	-0.19	-0.1
Mother's work hours/week		
1994	-1.82	-1.13
1998	0.5	0.31
2002	-1.55	-0.89
2005	0.82	0.46
Mother has major illness (binary)		
1994	0.01	0.57
1998	0.01	0.45
2002	-0.02	-0.61
2005		
Mother died (binary)		
1994	-0.01*	-1.74
1998	-0.02**	-2.05
2002	-0.02	-1.5
2005	-0.01	-0.91
Family migrated (binary)		
1994	-0.02	-1.4
1998	0.01	0.33
2002	-0.02	-0.69
2005	0	-0.13

Table I.4: Detailed long-run effects (continued)

	Coef.	t
Family separation (binary)		
1994	0.01	0.61
1998	0	-0.18
2002	0.03*	1.72
2005	0.02	0.85
Family member permanent absent		
1994	0.04***	2.74
1998	0.01	0.4
2002	0.01	0.63
2005	-0.01	-0.76

Note: Each coefficient stems from a separate OLS regression based on equation (1) using a binary indicator for damages as treatment variable. Control variables are the set of variables displayed in Table 1 as well as a set of barangay fixed effects. The results for the full specification are available upon request. *, **, and *** means statistically different from zero at 10, 5 and 1% level of significance.