Universität St.Gallen

The Tempest: Natural disasters, early shocks and children's short- and long-run development^{*}

Eva Deuchert, Christina Felfe^{**}

This draft: July, 2014

Abstract: Economic theory predicts that adverse shocks during early childhood have detrimental 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. In line with the theory, the effects on children's education aggravate over time. We find no similar effects for health, neither in the short nor in the long run.

Keywords: child development, natural disaster, wealth shock

JEL classification: I14, I24, Q54

^{*} A previous version of the paper was presented at the Norges Handelshøyskole (Norway), University of St. Gallen (Switzerland), the Tinbergen Institute (Netherlands), Uppsala University (Sweden), Universitat Pompeu Fabra (Spain), the conference on "Health, Happiness, Inequality" (Germany), the congress of the European Economic Association (Scotland), the 16th Annual Meetings of SOLE (Canada), the Health and Human Capital Workshop at the ZEW (Germany), the CESifo Area Conference of Economics of Education (Germany), and the Simposio de Analisis Economico (Spain). We thank all participants, in particular David Figlio, Rita Ginja, Albrecht Glitz, Bas van der Klaauw, Marten Lindeboom, Lance Lochner, Karthik Mulidharan, Björn Öckert, Hessel Oosterbeek, Erik Plug, Kjell Salvanes, Andreas Steinmayr, Steven Stillman and Yanos Zylberberg, and two anonymous reviewers for their helpful comments and suggestions. The usual disclaimer applies.

^{**} Corresponding author: Christina Felfe, Swiss Institute for Empirical Economic Research (SEW), Varnbühlstrasse 14, 9000 St. Gallen, Switzerland, christina.felfe@unisg.ch, phone +41 71 224 2329, fax +41 71 224 2302

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 earlier stages enhance the productivity of later investments and thus the attainment of capacities at later stages.¹ As a result, investments or adverse shocks during early childhood do not only have an immediate impact on children's development, but arising inequalities are likely to widen over time.

Empirical corroboration of the features underlying the cumulative nature of this production process, however, is hampered by two facts. First, one needs to identify a suitable shock in early childhood or even before birth. Candidates so far examined are economic crises (Ferreira & Schady, 2009; Paxson & Schady, 2005; Schady, 2004; Thomas, et al., 2004; Stillman & Thomas, 2008), unanticipated weather shocks (Aguilar & Vicarelli, 2011; Jensen, 2000; Maccini & Yang, 2009), natural disasters (Baez & Santos, 2007; Currie & Rossin-Slater, 2013; Frankenberg, et al., 2011; Fuller, 2013; Poertner, 2009; Sacerdote, 2012; Sotomayor, 2013; Yamauchi, et al., 2009), or destructions caused by wars (Akbulut-Yuksel, 2014; Akresh, et al., 2009; Akresh, et al., 2012). Second, one needs a dataset 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 natural disaster.² The particular natural disaster under study is super typhoon

¹ A related strand of research investigates horizontal complementarities of different forms of human capital, such as health and education (Miguel & Kremer, 2004; Grossman, 2006).

² Our study differs from the above cited literature evaluating the total effect of exposure to a natural disaster. The total effect subsumes the effects of common threats, such as destruction of public infrastructure, epidemics or food shortages, and the effects of idiosyncratic threats, such as the destruction of individual property, family

Mike, which hit Cebu Island (Philippines) in 1990. 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 -, enables us to analyze both the short- and the long-term consequences of the housing damages caused by typhoon Mike on children's education and health development. As a result, we can shed some light on the hypothesis that an adverse shock during early childhood drives a wedge between the development of affected and unaffected children that aggravates over time.

While identification of the causal effects of a typhoon is straight forward - the incidence of a typhoon is basically random -, identification of the causal effects of housing damages caused by a typhoon is more challenging. Housing damages are likely to be correlated with housing location and housing quality. We address this key identification problem as follows. First, we rely on within “barangay” variation in housing damages. A barangay is the smallest administrative division in the Philippines and is the native Filipino term for a village or district. In the case of the Cebu Metropolitan Area, a barangay has a diameter of 2 kilometers on average. A barangay fixed effect approach enables us to control for housing location and to abstract from common macroeconomic consequences of a natural disaster. Second, super typhoons are relatively rare in the area under study – Cebu Island lies in the center of an archipelago and is thus surrounded by larger landmasses that serve as a natural barrier against typhoons. As a consequence, families hardly consider natural disasters when building their family home. Nevertheless, we control for proxies of housing quality, such as construction material, soil formation and family background. Given the richness of our data set and the size of a barangay, the remaining differences in housing damages should be the result of random factors such as the strength of arising gusts or mudslides at the exact location of residence.

member death, or displacements. Our paper abstracts from the effects of common threats and aims at isolating the effects of one idiosyncratic shock, namely damages to families' real estate. In other words, our results are not directly comparable to the total effect of a tropical storm evaluated by the above cited papers.

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,³ an increasing prevalence of grade retentions and a reduction in overall schooling in the long-run. Results are robust to a variety of sensitivity checks including the analysis of several placebo outcomes.

We analyze a broad set of observed potential channels, such as family wealth, family income, parental employment, parental health, parental death, temporary absence of a family member, migration and family separation. The only observable mechanism which is significantly and persistently affected is wealth. We thus interpret our results as the effect of a shock to families' financial well-being. As such, our study relates to the recently rising literature on the role of financial assets on children's development. This literature is based on income shocks induced by unconditional cash transfers (Akee, et al., 2013; Manley, et al., 2013; Paxson & Schady, 2010), variation in the earned income tax credit (Dahl & Lochner, 2012), loss of agricultural income (Banerjee, et al., 2010), revenues from a casino opening (Akee, et al., 2010), or short-term income fluctuation due to unexpected changes in relative commodity prices (Grimm, 2011) or economic crisis (Stillman & Thomas, 2008). Consistent with our results, this research typically suggests sizeable effects on children's education, but rather small or even no effects on children's health.

The remainder 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, evidence for effect heterogeneity and underlying channels are presented in section 5. Section 7 finally concludes.

³ Unfortunately, test scores are only provided in the short-run (one and three years after the disaster).

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 during early childhood on children's short- and long-run 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.

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 in the southern limit of the typhoon belt. As a result, Cebu is rarely hit by typhoons. This is particularly true for the Cebu Metropolitan Area – the area where our study takes place. Cebu Island is a long narrow island stretching from north to south. The north is more likely to be exposed to typhoons (for example to super typhoon Haiyan, which passed north of Cebu Island in 2013), while the Cebu Metropolitan Area lies in the southern part of the island and is typically unaffected. Prior to typhoon Mike, the Cebu Metropolitan Area has experienced its last super typhoon in 1951 and no other super typhoon has occurred since then. Typhoon Mike and related housing damages can thus be seen as an unexpected shock to the population under study, to both families who experienced housing damages (the treatment group) and families who did not experience housing damages (the control group). In other words, we do not expect prevention measures to systematically vary between the treatment and the control group.⁴

⁴ There may be concerns that there exist other types of natural disasters that bias our results. One example is an earthquake that happened in 2013 on the seismically active neighboring island Bohol. Yet, to the best of our knowledge, no further disaster occurred during our study period that would have been strong enough to have severe consequences for the citizens of the Cebu Metropolitan Area. Obviously, the area under study is exposed to heavy rains and smaller tropical storms. Yet, such climate is typical for the area, and thus should not confound our results.

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. Arising damages are not uniform, but most severe right next to the eye of the typhoon and at places where particularly strong gusts (i.e. wind peaks of a few seconds) or mudslides arise. As a consequence, damages are likely to vary within the disaster area (which in our case corresponds to the Cebu Metropolitan area and extends over 40 miles) as well as within barangays. The overall damages due to super typhoon Mike were severe: 748 people were killed, 3.2 million people were forced into temporary shelters in schoolhouses and evacuation centers, more than 100'000 houses were destroyed and almost 300'000 houses were damaged, 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). Real estate, however, is characterized by two important features, which distinguishes it from being a pure financial asset. First, real estate serves as collateral. A shock on real estate wealth may therefore lead to binding credit market constraints (Chaney, et al., 2012). Second, people live in their house. In other words, real estate does not only serve as investment good, but also as consumption good. In a situation of an underdeveloped rental housing market, which was the case for the Philippines in the early 1990s (Ballesteros, 2001) people are thus forced to invest in reconstruction of their house.

The focus of this paper lies on a shift of investment into reconstruction of the house away from investments into children's human capital. In the Philippines in the early 1990s, attendance to primary school was compulsory for six years, but attendance was not perfectly enforced. Besides attending school, many children engaged in market or home production

activities and thus were likely to contribute to household income (DeGraff & Bilsborrow, 2003). Given the costs of schooling – either direct (tuition fees or material) or indirect (opportunity costs of time) – investments in education, such as school attendance, time devoted to studying, and education expenditures, were likely to decline following the occurrence of housing damages. This is particularly likely if children were helping to rebuild the family house. The consequences on health investments are a priori unclear: on the one hand, we may expect them to go down, in particular given the rather low health insurance penetration in the Philippines in the early 1990s (in our sample 33%); on the other hand, children under study may already live at the subsistence level, and thus parents may try to avoid a reduction in health investments. Hence, it is an empirical question to answer the impact on health investments.

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 - April 1984) from 33 randomly selected barangays in the Cebu Metropolitan Area. Initial interviews were held 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 1991, 1994, 1998, 2002 and 2005.⁵

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. 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 2'367 children in 31 barangays.

⁵ For more information on the CLHNS please refer to <http://www.cpc.unc.edu/projects/cebu/>

Like any other longitudinal survey, our sample is plagued by attrition. 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%) and total attrition from the baseline to 2005 amounts to 21% (see table A1 in the appendix). In comparison to common attrition rates of 10% after one year and 50% after 20 years (Lee, 2003), attrition in our sample is thus remarkably low.

The major reason for attrition in our sample is outmigration (Adair, et al., 2011). One threat to our analysis is that outmigration might be systematically related to housing damages. Unfortunately, we cannot test for such attrition bias as damages are retrospectively reported (and thus not available for households dropping out of the sample). Nevertheless, cumulative attrition rates from 1991 onwards are not significantly higher among families who experience housing damages. If anything, their attrition rates are slightly lower once children grow older (see table A1 in the appendix).⁶ We furthermore compare the attrition sample (those dropping out of the sample before 1991) to the remaining sample to investigate whether attrition systematically correlates with factors associated with damages (see table I1 in the internet appendix). There is no empirical evidence that attrition rates are higher among those experiencing housing damages. In fact, those dropping out of the sample enjoy at baseline a house of better quality and a higher socio-economic status suggesting that attrition is more likely to be driven by economic factors (such as work opportunities of the household members) than by damages due to the typhoon.⁷

The data provides two different variables describing housing damages. In 1991, households were asked retrospectively whether typhoon Mike caused any major damage to

⁶ One reason for lower attrition among treated children in the long-run might be lower mobility given lower human capital and thus fewer work opportunities outside Cebu Island. Such differential attrition between treatment and control group may, if anything, bias our results towards zero (only the children with the best work opportunities outside Cebu Island are likely to migrate and thus to drop out of the sample).

⁷ And again, even if more advantaged families are more likely to attrite and at the same time are less likely to experience housing damages, such differential attrition may, if anything, bias our estimates towards zero (only children from the most advantaged families are likely to attrite).

their house (76% of all households experienced some damages). For those who reported damages, the survey additionally asked about estimated reparation costs. Average reported costs amounted to 3'972 Philippine Pesos (approximately 260 constant 1990 international \$). This value may, however, vastly underestimate the shock: it neither includes the loss if the house was irreparably destroyed nor any losses on other items such as furniture, or household appliances. 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. Nevertheless, further analysis providing a measure for the elasticity of children's development with respect to real estate wealth considers the reparation costs.

The CLHNS provides comprehensive information on children's development in terms of health and education (see table A2 in the appendix). To keep this paper within reasonable limits, we restrict our main analysis to a subset of outcome variables.⁸ 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). Regarding education, we concentrate on two measures for children's cognitive development - grade progression and standard IQ tests – and two measures for educational investments – school enrollment and school attendance. Unfortunately, information on grade progression, school enrollment and school attendance is only reported from year 1994 onwards, and IQ tests are only executed in 1991 and 1994.⁹

Descriptive statistics reveal that children whose families suffered from housing damages perform worse in terms of their health and education, both in the short- and the long-run (table A2 in the appendix). Yet, at the same time we observe pre-existing differences in health and

⁸ See our Internet appendix for extended analysis.

⁹ Importantly, tests for cognitive performance are part of the interview and are thus not restricted to children attending schools. Nevertheless, test results are not available for all children. In 1991, test results are missing for about 5% of all children who lived in a house which was damaged by typhoon Mike and about 4% of children who lived in a house which was not damaged. In 1994, attrition is negligible (0.5%).

education outcomes – particularly preschool enrollment (table A3 in the appendix) - and pre-treatment background variables - all measured at baseline or birth (table A5 in the appendix). 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.

4 Empirical Strategy

4.1 Identification

Our data documents substantial variation in housing damages. Overall, 76% of the households in our sample have experienced some damages to their property. On average damages amount to 19% of the pre-disaster value of the house. The share of affected households ranges between 45% and 90% across barangays. One natural question to ask is whether housing damages happened at random. Random factors, particularly local wind speed and the prevalence of severe gusts are important determinants of arising damages (Imamura & Van To, 1997; Nordhaus, 2006). Yet, individual factors, such as the location of residence and the quality of the house, are also key in explaining the severity of damages to private property and may confound our results (Fronstin & Holtmann, 1994).

We address this key identification problem as follows. First, we rely on within barangay variation in housing damages. A barangay fixed effect approach does not only allow us to tackle endogenous choice of location of residence, but also to address between barangay variation in damages to public infrastructure, such as schools or hospitals. Given the rather small area of a barangay (an average diameter of 2 km) and the 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. Second, as pointed out before the area under study enjoys a particularly beneficial location where super typhoons are rather rare. As a consequence, families hardly consider natural disasters when building their family home. Nevertheless, we control for proxies of the housing quality as well as further relevant determinants of housing damages (see section 4.2. for details). The underlying assumption is thus that the remaining within barangay variation (net of the set of control variables) in housing damages occurs due to random within barangay variation in the local strength of the typhoon, and is not confounded with any further factors that influence investments in children's human capital. In section 4.3 we provide empirical evidence supporting this assumption.

The equation underlying all our estimations (estimated by ordinary least squares and clustered at the barangay level) is thus:

$$Y_{i,t+s} = \alpha + \beta D_{i,t} + \gamma X_{i,0} + \delta B_{i,0} + e_{i,t+s}$$

where $Y_{i,t+s}$ represents a child outcome measured in period s after typhoon Mike, $D_{i,t}$ represents housing damages due to the typhoon (either the binary indicator or the share of the damages of the total value of the house prior to the typhoon), $X_{i,0}$ stands for the set of control variables measured prior to the shock (including pre-existing health outcomes),¹⁰ and $B_{i,0}$ contains a set of barangay dummies, indicating the location of residence prior to the shock.

4.2 Selection of control variables

We employ a barangay fixed effect method and control additionally for potential confounders that jointly affect housing damages and child development. The literature on child development has stressed initial child characteristics and the socio-economic background of the family as the main determinants of children's human capital production.

¹⁰ The health related regressions correspond to a value-added model – which contains the lagged dependent variable as a control variable and thus is comparable to a fixed effect model. Given the lack of pre-treatment educational outcomes, we cannot use a similar strategy in the regressions related to education outcomes. We therefore opt for controlling for lagged health outcomes – as one measure of pre-treatment human capital – in all our regressions, independently whether we use health or educational variables as outcome.

These characteristics are likely to be correlated with observed and unobserved quality indicators of family homes as well as any last-minute actions undertaken by the family to protect themselves and their belongings against the storm damages. 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): indicators of the house (construction material, ownership, value, size, soil formation and soil depth, hygienic conditions), characteristics of the child (gender, weight and height at birth and at month two after birth, complications at birth, place of delivery), and characteristics of the family (household type, number of siblings, absenteeism of family members, parents' education and employment status, income, wealth).

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. Marginal effects are presented in table 1. The internet appendix contains the results of the same exercise for the continuous measure of damages (table I2 in the internet appendix).

First, quality indicators of the house matter the most for the likelihood of reported damages. The selected quality indicators are jointly significant ($\chi^2=468.20$). Most important determinants of housing damages are the material of the house - houses built of cement and wood are least likely to be damaged -, the size of the house - the more rooms, the less likely are housing damages -, and the depth of the underlying soil - the deeper the underlying soil, the less likely are housing damages.

Second, household characteristics matter jointly ($\chi^2 = 63.70$) even if each single estimated marginal effect is relatively small. Overall, housing damages are negatively associated with the socio-economic status – measured by father's formal employment status, mother's education and family wealth. In addition, multi-nuclear families are more likely to experience housing damages than one-nuclear families.

Table 1: Probit specification (dependent variable: binary indicator for damages)

<i>Independent variables</i>	<i>dy/dx</i>	<i>Std. Err.</i>	<i>Independent variables</i>	<i>dy/dx</i>	<i>Std. Err.</i>
<u>Characteristics of the house: chi2 = 468.20***</u>			Place of delivery: hospital	-0.038	0.027
Material of house (omitted category: mixed materials)			Birth complication	0.04	0.029
___: nipa	-0.002	0.019	Height for age	-0.002	0.008
___: cement, wood	-0.075***	0.025	Weight for age	0.012	0.007
Soil formation (omitted category: weathered limestone)			<u>Characteristics of the household: chi2 = 63.70***</u>		
___: unconsolidated	-0.02	0.031	Type of family (omitted category: one nuclear)		
___: core basalt rocks	0.02	0.055	___: multi-nuclear	0.056***	0.021
Average soil depth (omitted category: > 3m)			___: other	0.027	0.027
___: 1-3m	-0.071	0.054	Nr of siblings	0.009	0.006
___: 0.3-1m	0.052	0.032	Spouse lives in HH	0.091	0.071
___: < 0.3m	0.081***	0.026	Spouse temp. absent	0.079	0.059
Own house	0.027	0.036	Father's highest grade	0.002	0.004
Log of house value	0.004	0.005	Father voc. training	-0.041	0.032
Nr of rooms	-0.024***	0.008	Mother's highest grade	-0.01***	0.003
Garbage disposal (omitted category: other)			Mother voc. training	0.002	0.027
___: collected	-0.05	0.044	Father employment	-0.053**	0.023
___: burning	0.035	0.038	Mother employment	0.008	0.021
___: dumping at house	-0.012	0.048	Log of total income	-0.013	0.011
___: dumping away	-0.007	0.037	Log wealth	-0.016*	0.010
<u>Characteristics of the child: chi2 = 17.17**</u>					
Female	-0.05***	0.018			
Size at birth (omitted category: normal)					
___: smaller than normal	0.034	0.030			
___: bigger than normal	0.018	0.023			

Note: The regression controls additionally for barangay fixed effects. The results for the full specification are available upon request. Standard errors are clustered by barangay. *, **, and *** denote statistical significance at 10, 5 and 1% level of significance.

Finally, initial child characteristics tend to matter the least ($\chi^2 = 17.17$). The only surprising result among child characteristics is related to gender (girls are less likely to experience damages). Yet, it is unlikely that gender picks-up any unobserved housing quality. Gender preferences are uncommon and abortions are illegal in the Philippines (Almond, et al., 2013). Moreover, gender is not significantly correlated with features of the socio-economic status at baseline (such as income or wealth). Thus, it is likely that the significant coefficient of gender is a statistical artifact driven by the relatively low number of barangays and the initial sampling procedure relying on local barangay reporters.¹¹

4.3 *Assessment of the validity of the underlying assumptions*

One key concern of our identification strategy is that relevant confounding variables are unobserved. To address the issue of omitted confounders, we proceed as follows. First, we test whether a vast array of potentially omitted variables (such as further characteristics of the house, the distance to the next vehicular road, short term health conditions of the child, or baseline health outcomes of the mother) are significant predictors of housing damages when conditioning on the set of core control variables. None of these variables reveals to be significant in omitted variable tests following the probit estimations of housing damages shown in section 4.2.¹²

Second, we test the robustness of our results when excluding the main blocks of the core control variables. Detailed results for education and health outcomes are provided in Table I3 and I4 in the internet appendix, respectively. Results generally maintain their sign and significance. We additionally test whether the results are significantly different from the

¹¹ In contrast to the sex ratio at birth of 1.06 males per females for the Philippines in the 1980s reported by the UN Population division, our sample displays an unusual high sex ratio at birth of 1.13. Hence, in our sample male births are more likely to be reported than female births. If underreporting of female births happens more often in areas that were hit harder by the storm (in fact we observe a negative correlation between the sex ratio at birth on the barangay level and average storm damages), gender might pick up local storm severity.

¹² The p-values of the omitted variable tests are as follows: further characteristics of the house (p-value 0.87), the distance to the next vehicular road (p-value 0.21), short term health conditions of the child (0.56), or baseline health outcomes of the mother (p-value 0.38).

baseline specification. While excluding the characteristics of the house does not change the results significantly, excluding child characteristics significantly increases the effects of the shock on educational outcomes, not, however, the effects of the shock on health outcomes. Excluding family background matters the most. For instance, excluding family background characteristics leads to an increase of the effect of the typhoon on IQ test scores by almost 50%. This is not surprising since family background does not only matter the most for children's development, but also for the likelihood to have experienced housing damages.

The fact that the magnitude of our estimates is sensitive to excluding blocks of variables raises concerns that unobserved confounders still exist and bias our results. We therefore perform several placebo tests using children's health status prior to the typhoon, children's preschool attendance, children's age at school entry as well as educational achievements of elderly siblings prior to the typhoon as placebo outcomes. As discussed in section 3 (see also Table A3 in the appendix), there are substantial raw differences between affected and unaffected children. If the assumption underlying our identification strategy is valid, considering the full set of control variables should eliminate these differences. As we can see in Table A6 in the appendix this is the case for our main dependent variable (binary damage indicator). The only exception is the positive correlation between the continuous damage indicator and weight for age. The effect is, however, significant at the 10% level only and, rather negligible in size and meaningful only if the household lost all wealth (in this case, the effect amounts to -0.288 standard deviation (henceforth, sd)). The results of our placebo analysis make us thus confident that the assumption underlying our identification strategy is valid.

5 Empirical results

5.1 *Average effect of damages on child development outcomes*

This section provides empirical evidence for the effect of housing damages on child development outcomes. Table 2 presents the effect of the binary damage indicator on different outcome variables. Standard errors are clustered on the barangay level. Given the relatively small number of clusters (31 barangays), one may be concerned about the correlation of errors within geographical units. We therefore provide also p-values from Wild clustered bootstraps (Cameron, et al., 2008) in square brackets.

In line with the theoretical considerations, an adverse shock during early childhood translates into worse educational performance – summarized by children’s probability to progress in school – not only in the short-, but also in the long-run. We observe increased grade retention already four years after typhoon Mike occurred: in 1994 children who suffered from housing damages lag on average 0.11 years behind in school. This gap remains significant and widens when children grow older: in 1998 we observe a gap in completed grades of 0.26 years, in 2002 of 0.50 years and in 2005 of even 0.65 years. Importantly, the estimated gaps between the impact of the shock occurred in 1990 on the progression in school up to 1994 and up to each subsequent year are statistically significant. Thus, our results are in line with the idea of the cumulative nature of the human capital production process.

One would also expect a gap in IQ test scores, since cognitive skills are malleable during early childhood and are enhanced through investments by parents and the social environment (Cunha, et al., 2006).¹³ Indeed, one year after the natural disaster (1991) children affected by housing damages score on average 0.10 sd lower in a general IQ test. In 1994, the effect of damages on IQ is still negative, yet loses significance. Thus, our results do not indicate that

¹³ We analyze the effect of damages on further test results (provided for the year 1994 only, see table I5 in the internet appendix). The results are very similar in sign and magnitude to the results of the IQ tests.

the gap is increasing over the initial years.¹⁴ Since the IQ tests are missing for later years, we can unfortunately not test whether the gap widens in the long-run.

We also investigate if the gap in education outcomes is driven by reduced investments at the extensive (i.e. school dropouts) or the intensive margin (i.e. school attendance). There is no significant effect of damages on enrollment rates in the medium-run (1994 and 1998), but only in the long-run when education is not mandatory anymore (from age 14 onwards). The initial decline in educational performance is thus unlikely to be driven by permanent dropouts. Affected children, however, are more often absent in school. In 1994, they miss on average 0.29 days more per month. Given the average absence in our sample of 1.17 days per month, this corresponds to a non-negligible increase.¹⁵

In a similar vein to the findings for children's educational development, we may expect detrimental consequences on children's health. We may expect a direct negative effect due to reduced investments in health as well as an indirect negative effect on health investments due to the complementary nature of health and education (Grossman, 2006) – the latter effect may gain relevance with increasing age as children with lower education might behave differently in terms of health investments (e.g. eating habits, smoking, drinking). Our results, however, do not indicate any effect of the specific shock under study on children's health, neither in the short- nor in the long-run (see Table 2). The average effects on children's z-scores for weight and height are small and insignificant. These results are consistent using a large battery of further physical and mental health outcomes, which are both objectively measured as well as self-reported (Table I5 in the internet appendix). Hence, it seems that parents successfully avoid a reduction in health investments.

¹⁴ The gap is measured in standard deviations which may say very little about absolute ability, but more about the relative position in the distribution. This is particularly relevant since children are tested at different ages.

¹⁵ For the year 1994, we have additional information on time use. Affected children devote less time on homework, but more time on household chores (see Table I5 in the internet appendix).

Table 2: Effects of damages (binary indicator) on child development outcomes

<i>Dependent variables</i>	<i>Survey year</i>				
	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
<u>Education outcomes</u>					
Highest grade completed	-	-0.113**	-0.264**	-0.501***	-0.646***
	-	(0.05)	(0.102)	(0.112)	(0.178)
	-	[0.05]	[0.022]	[0.002]	[0.002]
Standardized IQ score	-0.095**	-0.084	-	-	-
	(0.039)	(0.054)	-	-	-
	[0.024]	[0.15]	-	-	-
School enrollment	-	0.022	-0.03	-0.079***	-0.058**
	-	(0.019)	(0.021)	(0.028)	(0.027)
	-	[0.266]	[0.136]	[0.012]	[0.048]
Days missed in school	-	0.293**	0.156	-0.071	0.280
	-	(0.111)	(0.136)	(0.24)	(0.58)
	-	[0.024]	[0.27]	[0.799]	[0.627]
<u>Health outcomes</u>					
Weight for age	-0.052	-0.016	-0.017	0.005	0.007
	(0.073)	(0.083)	(0.073)	(0.078)	(0.095)
	[0.496]	[0.897]	[0.845]	[0.933]	[0.905]
Height for age	0.024	-0.006	-0.029	0.026	0.031
	(0.056)	(0.055)	(0.05)	(0.059)	(0.061)
	[0.617]	[0.901]	[0.539]	[0.675]	[0.625]

Note: Each cell corresponds to the regression coefficient of the binary damage indicator resulting from a separate estimation using equation (1) for each outcome variable. Control variables are the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistical significance at 10, 5 and 1% level of significance. P-values from wild clustered bootstraps are provided in square brackets.

We can only speculate on the reasons underlying the differential results for children's health and education. One reason may be that parents are unwilling to sacrifice the help of their children to rebuild the house and thus reduce rather education-related investments and not health-related investment. One further reason may be that children are already living at the subsistence level and thus any further reduction in health-related investments is life-

threatening which parents try to avoid at any cost. Finally, it is likely that the provided disaster relief - which usually includes food, clothing, emergency shelter, and medical supplies - is sufficient to avoid any major damages to children's health. The fact that children, which experienced housing damages, are more likely to receive disaster relief (see section 5.4. for details) supports this final explanation.

5.2 *Intensity of the shock*

We also investigate to which extent consequences on children's development vary with the severity of the shock. As described in section 2, we possess only of an imperfect measure for the severity of the shock – self-reported repair costs. We use the ratio between reported repair costs and housing value prior to the disaster as a measure for the severity of the shock, which acknowledges that repair costs and housing value (and thus wealth) are positively correlated. In addition, we exclude all cases where affected families report repair costs of either zero or costs that exceed the initial value of the house (162 observations).

The estimates are presented in Table 3 and reflect our previous findings: housing damages have detrimental effects on children's education, both in the short- and in the long-run: at age 14/15 children who experienced housing damages that corresponded to a reduction in wealth by 10%, lag already behind by 0.04 years; at age 21/22 – when schooling should be completed – this gap amounts to 0.18 years. In the case of full wealth destruction (housing damages amount to 100%), the final gap corresponds to a loss in schooling of almost two years. Full wealth destruction has also non-negligible negative effects on children's performance in cognitive tests (IQ scores decline by about 0.30 sd in case of full wealth loss). Nevertheless, analogue to our previous findings, health outcomes are not significantly affected by housing damages.

Table 3: Effects of damages (continuous indicator) on child development outcomes

<i>Dependent variables</i>	<i>Survey year</i>				
	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
<u>Education outcomes</u>					
Highest grade completed	-	-0.421**	- 1.030***	-1.487***	-1.784***
	-	(0.161)	(0.341)	(0.424)	(0.484)
	-	[0.014]	[0.002]	[0.002]	[0.002]
Standardized IQ score	-0.294***	-0.276**	-	-	-
	(0.086)	(0.128)	-	-	-
	[0.004]	[0.064]	-	-	-
School enrollment	-	-0.063	-0.149**	-0.182***	-0.061
	-	(0.051)	(0.058)	(0.056)	(0.046)
	-	[0.266]	[0.136]	[0.012]	[0.048]
Days missed in school	-	0.204	0.491	0.210	1.035
	-	(0.262)	(0.356)	(0.667)	(1.175)
	-	[0.024]	[0.270]	[0.790]	[0.627]
<u>Health outcomes</u>					
Weight for age	0.113	0.018	0.158	-0.034	-0.055
	(0.117)	(0.157)	(0.136)	(0.173)	(0.181)
	[0.338]	[0.927]	[0.260]	[0.849]	[0.767]
Height for age	0.053	0.004	0.028	0.075	0.043
	(0.125)	(0.111)	(0.112)	(0.12)	(0.122)
	[0.635]	[0.995]	[0.825]	[0.559]	[0.771]

Note: We estimated equation (1) for each outcome variable. Each cell corresponds to the regression coefficient for the continuous damage indicator. Control variables are the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistically different from zero at 10, 5 and 1% level of significance. P-values from Wild clustered bootstraps are provided in square brackets.

5.3 Effect heterogeneities

We test whether the impact of our shock differs across child and family background. To shed some light on possible effect heterogeneities, we stratify our sample according to different background characteristics (individual characteristics such as gender and number of elderly siblings as well as family characteristics such as wealth, home ownership, type of

household, and origin of the family, all taken from pre-disaster surveys) and test if estimated effects are different between these strata. For the purpose of illustration, we present results for the main education outcome only - highest grade completed (Table 4).¹⁶

It is important to mention that differences are mostly insignificant at any conventional significance level and thus, are only of suggestive nature. On the individual level, the results indicate that the short- and medium-run effects are more pronounced for girls. In the long-run, however, initial gender differences vanish and are partially even higher for boys. Interestingly, those with no or only one elderly sibling experience the highest consequences. This suggests that older siblings are more likely to leave school in order to support the family.

To provide some evidence on the relevance of credit constraints, we stratify our sample with respect to families' initial wealth. Negative effects on education outcomes tend to be stronger for children living in poorer households (with initial wealth below the median of 862 \$): at the age of 22 the gap in educational attainment amounts to almost one year, an effect which is almost double as high as the effect we observe for children in richer families. Not surprisingly, the effect is also stronger for children whose families own their home. In the case of families who rent their home, the majority of damages does not occur to their own property (except their furniture or household appliances). Hence, the liability to reconstruct the building does not lie in their responsibility.

Finally, we look at the importance of informal insurance devices due to social networks (Foster & Rosenzweig, 2001; Rosenzweig, 1989; Zylberberg, 2012). For this purpose we distinguish first 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 lives in their barangay of origin and second between one-nuclear households and multi-nuclear households. These variables are likely to proxy the strength of social (family) ties in the local neighborhood.

¹⁶ Results for a selected health outcome – weight for age - are provided in the Internet appendix (Table I6). Overall, we find no significant effect heterogeneities.

Table 4: Effect heterogeneities (dependent variable: highest grade completed)

<i>Strata</i>	<i>Survey year</i>			
	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
Panel A: Gender				
Male	-0.046 (0.077)	-0.177 (0.158)	-0.466** (0.198)	-0.735** (0.318)
Female	-0.187** (0.085) [0.225]	-0.347** (0.148) [0.420]	-0.542*** (0.140) [0.772]	-0.522** (0.197) [0.547]
Panel B: Nr. of elderly siblings				
No or one sibling	-0.176** (0.079)	-0.359** (0.146)	-0.597*** (0.158)	-0.814** (0.325)
More than one sibling	-0.076 (0.089) [0.442]	-0.174 (0.157) [0.395]	-0.312 (0.196) [0.303]	-0.395 (0.272) [0.301]
Panel C: Family wealth				
Poor (total wealth < 862 \$)	-0.164 (0.101)	-0.447** (0.207)	-0.834*** (0.249)	-0.945*** (0.308)
Rich (total wealth > 862 \$)	-0.104* (0.058) [0.627]	-0.200 (0.123) [0.322]	-0.349** (0.161) [0.141]	-0.551 (0.326) [0.429]
Panel D: Home ownership				
No homeowner	-0.082 (0.094)	0.029 (0.205)	-0.244 (0.228)	-0.639 (0.403)
Homeowner	-0.119 (0.071) [0.38]	-0.347** (0.144) [0.291]	-0.522*** (0.147) [0.388]	-0.457* (0.226) [0.811]
Panel E: Household type				
One-nuclear HH	-0.119 (0.071)	-0.347** (0.144)	-0.522*** (0.147)	-0.457* (0.226)
Multi-nuclear HH	-0.082 (0.094) [0.708]	0.029 (0.205) [0.119]	-0.244 (0.228) [0.275]	-0.639 (0.403) [0.681]
Panel F: Origin of the family				
Parents born in barangay	-0.059 (0.063)	-0.209** (0.100)	-0.434*** (0.103)	-0.462*** (0.155)
No parent born in barang.	-0.237** (0.104) [0.100]	-0.245 (0.211) [0.851]	-0.518* (0.274) [0.743]	-0.865* (0.455) [0.339]

Note: The table reports effects of the binary damage indicator on highest grade completed for each group separately. Control variables are the variables shown in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistical significance at 10, 5 and 1% level. P-values for the test of equality of coefficients across different strata are provided in square brackets.

Highlighting the importance of social ties, effects on educational achievement tend to be most severe among children who live in one-nuclear households as well as among children who live in a neighborhood where none of their parents was born.

5.4 Potential channels

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

First, we provide estimates for the effect on families' wealth. Unfortunately, the data only provides information on the value of different wealth items for the year 1991. For the remaining years, only ownership of different wealth items is reported. Nevertheless, we use this information to construct two different wealth indices. First, following the example of many studies using data from developing countries, we create an asset index. In other words, we use the information on ownership of different assets and employ a principal components analysis (Filmer & Pritchett, 2001). The disadvantage of this procedure is that the resulting asset index has no economic meaning other than a higher index being a sign for more wealth. In a second step, we predict wealth for the years 1994 to 2005 based on a regression analysis of 1991 wealth items.¹⁷

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 2'034 constant 1990 international \$. This loss corresponds to more than half of overall wealth and more than a third of annual household income affected families possessed prior to the disaster. Keeping in mind that the Philippine GDP per capita in 1991 amounted to

¹⁷ We use available information in 1991 to regress the total value (measured in constant international 1990 \$) of different asset groups (houses, furniture, appliances, vehicles, business equipment and livestock) on a set of indicators for ownership of the mentioned asset groups. The estimated regression coefficients are then used to construct a linear wealth index using indicators for asset ownership from later surveys.

1'484 \$, the drop in wealth represents indeed a severe shock. In the following years we still find a negative, but imprecisely estimated effect on wealth. Results based on the asset index - a more stable measure because index weights are chosen to minimize projection residuals – indicate that housing damages have a non-negligible and persistent effect on wealth.¹⁸

Table 5: Effects of damages (binary indicator) on channels

<i>Dependent variables</i>	<i>Survey year</i>				
	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
Asset index	-0.494*** -0.066 [0.002]	-0.492*** -0.104 [0.002]	-0.327*** -0.110 [0.004]	-0.490*** -0.132 [0.004]	-0.446*** -0.162 [0.018]
Wealth (index)	-2034*** (549) [0.002]	-3424*** (1140) [0.006]	-842 (1425) [0.603]	-4003 (3325) [0.318]	-1706* (995) [0.108]
HH income	-547*** (174) [0.016]	-1464 (1223) [0.232]	-325 (211) [0.120]	-567 (562) [0.346]	-832** (328) [0.034]
Disaster relief	0.270*** -0.025 [0.000]	- - -	- - -	- - -	- - -

Note: We estimated equation (1) for each outcome variable. Each cell corresponds to the regression coefficient for the binary damage indicator. Control variables are the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistical significance zero at 10, 5 and 1% level of significance. P-values from Wild clustered bootstraps are provided in square brackets.

We also identify a drop in household income (significant for the year 1991 and 2005). The initial drop is mainly driven by a reduction in income from market activities.¹⁹ In addition, we observe a decline in income in later years which is likely to be due to decreased earnings

¹⁸ The internet appendix provides estimates for different wealth components (see Table I7). The most severe losses are experienced in the value of real estate (this value is reported for all years). This effect is rather strong in the first two survey year and loses significance in the years after.

¹⁹ There is no reduction of parents' employment at the extensive margin, see Table I7 in the Internet appendix.

among affected children.²⁰ This is likely to be the result of the decreased educational attainment and thus a further indication of the long-term impact of a negative shock on educational investments during early childhood.

Affected households are more likely (by 27 percentage points) to receive disaster relief from the government or other institutions. 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. Governmental funds usually provide funding for emergency relief operations, 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 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 (see Table I7, internet appendix). 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 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 which are mostly located in schoolhouses or evacuation centers. 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).

²⁰ The estimates using children's labor income are negative and almost the same size as the overall decrease observed in income in 2002 and 2005.

6 Conclusion

This paper studies the effect of an idiosyncratic shock to families' real estate wealth caused by a super typhoon that occurred in the Philippines in the early 1990s. Our results reveal negative and persistent effects on children's education, but not on children's health.

Common theories on the human capital formation process are based on the concept of dynamic and horizontal complementarities. According to these theories an adverse shock during early life translates into lower investments in human capital which in turn cause a gap in human capital that widens over time. In addition, arising inequalities in one type of human capital are likely to translate into inequalities also in other types of human capital. Considering our results for children's educational development, our study confirms the theory underlying children's human capital production: an adverse shock occurred during early childhood causes a gap in children's educational achievement which widens over time. Considering our results for children's health, however, we cannot confirm the hypothesis based on the theory of children's human capital formation. Yet, it may well be the case that the provided disaster relief – which contained food, clothing, emergency shelter, and medical supplies – was sufficient to avoid the most severe consequences on children's health.

Our results have also important policy implications for natural disaster management, in particular for developing countries where formal insurance coverage for natural catastrophes does not exist and credit constraints prevent access to capital markets. In such settings, it is crucial to go beyond the common public health interventions, such as disease control, food or water security, and provide financial disaster relief – potentially tied to children's continuous participation in education – as it helps preventing negative consequences on children's intellectual development and an aggravation of existing inequalities over time.

References

- Adair, L. et al., 2011. Cohort profile: the Cebu longitudinal health and nutrition survey. *International Journal of Epidemiology*, 40(3): 619-625.
- Aguilar, A. & Vicarelli, M., 2011. El Nino and Mexican Children: Medium-term Effects of Early-life Weather Shocks on Cognitive and Health Outcomes. *mimeo*.
- Akbulut-Yuksel, M., 2014. Children of War: The Long-Run Effects of Large-Scale Physical Destruction and Warfare on Children. *Journal of Human Resources*, 49 (3): 634-662.
- Akee, R. et al., 2010. Parent's Incomes and Children's Outcomes: A Quasi-Experiment. *American Economic Journal: Applied Economics*, 2(1): 86-115.
- Akee, R. et al., 2013. Young Adult Obesity and Household Income: Effects of Unconditional Cash Transfers. *American Economic Journal: Applied Economics*, 5(2): 1-28.
- Akresh, R., Lucchetti, L. & Thirumurthy, H., 2012. Wars and Child Health: Evidence from the Eritrean-Ethiopian Conflict. *Journal of Development Economics*, 99(2): 330-340.
- Akresh, R., Verwimp, P. & Bundervoet, T., 2009. Health and Civil War in Rural Burund. *Journal of Human Resources*, 44(2) : 536-563.
- Almond, D., Edlund, L. & Milligan, K., 2013. Son Preference and the Persistence of Culture: Evidence from South and East Asian Immigrants to Canada. *Population and Development Review*, 39(1) : 75-95.
- Baez, J. & Santos, I. V., 2007. Children's Vulnerability to Weather Shocks: A Natural Disaster as a Natural Experiment. *mimeo*.
- Baird, S., McIntosh, C. & Ozler, B., 2011. Cash or Condition? Evidence from a Randomized Cash Transfer Program. *Quarterly Journal of Economics*, 126(4): 1709-1753.
- Ballesteros, M., 2001. *The Dynamics of Housing Demand in the Philippines: Income and Lifecycle Effects*, Makati City, Philippines: Philippine Institute for Development Studies.
- Banerjee, A., Duflo, E., Postel-Vinay, G. & Watts, T., 2010. Long-Run Health Impacts of Income Shocks: Wine and Phylloxera in Nineteenth-Century France. *Review of Economics and Statistics*, 92(4): 714-728.
- Cameron, A., Gelbach, J. & Miller, J., 2008. Bootstrap-Based Improvements for Inference with Clustered Errors. *Review of Economics and Statistics*, 90(3): 414-427.
- Chaney, T., Sraer, D. & Thesmar, D., 2012. The Collateral Channel: How Real Estate Shocks Affect Corporate Investment. *American Economic Review*, 102(6): 2381-2409.
- Cunha, F., Heckman, J., Lochner, L. & Masterov, D., 2006. Interpreting the Evidence on Life Cycle Skill Formation. In: E. A. Hanushek & F. Welch, eds. *Handbook of the Economics of Education*. s.l.:Elsevier B.V.: 698-812.
- Currie, J. & Rossin-Slater, M., 2013. Weathering the storm: Hurricanes and birth outcomes. *Journal of Health Economics*, 32(3): 487-503.
- Dahl, G. & Lochner, L., 2012. The impact of family income on child achievement: Evidence from the Earned Income Tax Credit. *American Economic Review*, 102(5): 1927-1956.
- Davies, J. B., Sandström, S., Shorrocks, A. B. & Wolff, E. N., 2009. *The Level and Distribution of Global Household Wealth*. s.l.:National Bureau of Economic Research.
- DeGraff, D. & Bilsborrow, R., 2003. Children's School Enrollment and Time at Work in the Philippines. *The Journal of Developing Areas*, 37(1): 127-158.

- Duflo, E., 2000. Child Health And Household Resources In South Africa: Evidence From The Old Age Pension Program. *American Economic Review*, 90(2): 393-398.
- Duncan, G., Morris, P. & Rodrigues, C., 2011. Does money really matter? Estimating impacts of family income on young children's achievement with data from random-assignment experiments. *Developmental Psychology*, 47(5): 1263-79.
- Ferreira, F. H. G. & Schady, N., 2009. Aggregate Economic Shocks, Child Schooling, and Child Health. *World Bank Research Observer*, 24(2): 147-81.
- Filmer, D. & Pritchett, L., 2001. Estimating wealth effects without expenditure data—or tears: An application of educational enrollment in states of India. *Demography*, 38(1): 115-132.
- Foster, A. & Rosenzweig, M., 2001. Imperfect Commitment, Altruism, and the Family: Evidence from Transfer Behavior in Low-Income Rural Areas. *Review of Economics and Statistics*, 83(3): 389–407.
- Frankenberg, E. et al., 2011. Mortality, the Family, and the Indian Ocean Tsunami. *Economic Journal*, 121(554): F162-182.
- Fronstin, P. & Holtmann, A. G., 1994. The determinants of residential property damage caused by Hurricane Andrew. *Southern Economic Journal*, 61(2): 387-397.
- Fuller, S., 2013. *The Effects of Natural Disasters on Birth and School Outcomes of Children in North Carolina*. Dissertation: Duke University.
- Grimm, M., 2011. Does household income matter for children's schooling? Evidence for rural Sub-Saharan Africa. *Economics of Education Review*, 30(4): 740-754.
- Grossman, M., 1972. On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy*, 80(2): 223-255.
- Grossman, M., 2006. Education and Nonmarket Outcomes. In: E. Hanushek & F. Welch, eds. *Handbook of the Economics of Education*. Amsterdam: North Holland: 577-633.
- Heckman, J., 2007. The technology and neuroscience of capacity formation. *Proceedings of the National Academy of Sciences*, 104(3): 13250-13255.
- Himaz, R., 2008. Welfare Grants and Their Impact on Child Health: The Case of Sri Lanka. *World Development*, 36(10): 1843-57.
- Imamura, F. & Van To, D., 1997. Flood and Typhoon Disasters in Viet Nam in the Half Century Since 1950. *Natural Hazards*, 15(1): 71-87.
- Jensen, R., 2000. Agricultural Volatility and Investments in Children. *American Economic Review*, 90(2): 399-404.
- Lee, U., 2003. *Panel attrition in survey data: A literature review*, University of Cape Town: CSSR Working Paper No. 41.
- Maccini, S. & Yang, D., 2009. Under the Weather: Health, Schooling, and Economic Consequences of Early-Life Rainfall. *American Economic Review*, 93(3): 1006-26.
- Manley, J., Gitter, S. & Slavchevska, V., 2013. How Effective Are Cash Transfers at Improving Nutritional Status?. *World Development*, 48: 133-155.
- Miguel, E. & Kremer, M., 2004. Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities. *Econometrica*, 72(1): 159-217.
- Nordhaus, W. D., 2006. *The Economics of Hurricanes in the United States*, s.l.: National Bureau of Economic Research.

- Paxson, C. & Schady, N., 2005. Child Health and Economic Crisis in Peru. *World Bank Economic Review*, 19(2): 203-223.
- Paxson, C. & Schady, N., 2010. Does Money Matter? The Effects of Cash Transfers on Child Health and Development in Rural Ecuador. *Economic Development and Cultural Change*, 59(1): 187-229.
- Poertner, C., 2009. Natural Hazards and Child Health. *mimeo*.
- Rosenzweig, M., 1989. Risk, Implicit Contracts and the Family in Rural Areas of Low-Income Countries. *Economic Journal*, 98(393): 1148–1170.
- Sacerdote, B., 2012. When the Saints Go Marching Out: Long-Term Outcomes for Student Evacuees from Hurricanes Katrina and Rita. *American Economic Journal: Applied Economics*, 4(1): 109-135.
- Schady, N., 2004. Do Macroeconomic Crises Always Slow Human Capital Accumulation?. *World Bank Economic Review*, 18(2): 131-154.
- Sotomayor, O., 2013. Fetal and Infant Origins of Diabetes and Ill Health: Evidence from Puerto Rico's 1928 and 1932 Hurricanes. *Economics and Human Biology*, 11(3): 281-293.
- Stillman, S. & Thomas, D., 2008. Nutritional Status during an Economic Crisis: Evidence from Russia. *Economic Journal*, 118(531): 1385–1417.
- Stillman, S. & Thomas, D., 2008. Nutritional Status during an Economic Crisis: Evidence from Russia. *The Economic Journal*., 118(531): 1385–1417.
- Thomas, D. et al., 2004. Education in a Crisis. *Journal of Development Economics*, 74(1): 53-85.
- Williams, F., Jung, G. & Englebreton, R., 1993. *Forecasters Handbook for the Philippine Islands and Surrounding Waters*,. Monterey, CA: Naval Research Laboratory.
- World Bank, 2005. *Natural Disaster Risk Management in the Philippines : Enhancing Poverty Alleviation Through Disaster Reduction*, Washington, DC: World Bank.
- Yamauchi, F., Yohannes, Y. & Quisumbing, A., 2009. Natural disasters, self-insurance and human capital investment: evidence from Bangladesh, Ethiopia and Malawi. *Policy Research Working Paper Series: 4910*.
- Zylberberg, Y., 2012. Do tropical typhoons smash community ties? Theory and Evidence from Vietnam. *mimeo*.

Appendix

Table A1: Sample Attrition

<i>Year</i>	<i>Sample # Obs.</i>	<i>Cum. Attrition since baseline</i>	<i>No damages # Obs.</i>	<i>Cum. Attrition since 1991</i>	<i>Damages # Obs.</i>	<i>Cum. Attrition since 1991</i>	<i>Significance p-value</i>
Baseline	2'367	-	-	-	-	-	-
1991	2'073	0.124	520	-	1553	-	-
1994	1'930	0.185	484	0.069	1443	0.071	0.902
1998	1'883	0.204	471	0.094	1404	0.096	0.908
2002	1'914	0.191	470	0.096	1438	0.074	0.107
2005	1'871	0.210	452	0.131	1411	0.091	0.010

Note: Damages are only retrospectively reported in 1991. We therefore cannot calculate the attrition rate from baseline to 1991 separately for treated and control children, but only attrition with respect to 1991.

Table A2: Child development outcomes: mean, standard deviation in parentheses

<i>Variables</i>	<i>Survey year</i>				
	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
<u>Highest grade completed</u>					
Total	-	3.54 (1.13)	7.62 (2.12)	9.80 (2.78)	10.78 (3.63)
No damages	-	3.76 (1.00)	8.08 (1.77)	10.61 (2.33)	11.83 (3.48)
Damages	-	3.47 (1.16)***	7.46 (2.21)***	9.54 (2.86)***	10.43 (3.61)***
<u>Standardized IQ score</u>					
Total	0.01 (0.99)	0.02 (0.98)	-	-	-
No damages	0.23 (0.98)	0.22 (0.95)	-	-	-
Damages	-0.07 (0.98)***	-0.05 (0.98)***	-	-	-
<u>School enrollment</u>					
Total	-	0.78 (0.41)	0.77 (0.42)	0.43 (0.50)	0.18 (0.38)
No damages	-	0.74 (0.44)	0.84 (0.37)	0.55 (0.50)	0.26 (0.44)
Damages	-	0.79 (0.41)**	0.75 (0.43)***	0.39 (0.49)***	0.15 (0.36)***
<u>Days missed in school</u>					
Total	-	1.17 (1.89)	1.52 (2.26)	1.40 (2.56)	2.00 (3.49)
No damages	-	0.84 (1.60)	1.33 (2.04)	1.42 (2.42)	1.79 (3.02)
Damages	-	1.29 (1.97)***	1.60 (2.34)**	1.39 (2.62)	2.14 (3.75)
<u>Weight for age</u>					
Total	-2.17 (1.1)	-1.85 (1.23)	-1.79 (1.11)	-2.02 (1.25)	-2.04 (1.4)
No damages	-2.00 (1.2)	-1.69 (1.31)	-1.71 (1.17)	-1.95 (1.32)	-1.96 (1.46)
Damages	-2.22 (1.06)***	-1.90 (1.2)***	-1.81 (1.1)*	-2.04 (1.22)	-2.06 (1.38)
<u>Height for age</u>					
Total	-2.26 (0.99)	-1.80 (1.03)	-2.03 (0.88)	-2.11 (0.87)	-2.11 (0.87)
No damages	-2.13 (1.05)	-1.66 (1.04)	-1.93 (0.89)	-2.06 (0.91)	-2.06 (0.91)
Damages	-2.3 (0.97)***	-1.85 (1.03)***	-2.06 (0.88)***	-2.13 (0.86)	-2.12 (0.86)

Note: We perform a test for statistical difference of the respective mean between the children with and without damages. *, **, and *** denote statistically significant differences at 10, 5 and 1% level of significance, respectively.

Table A3: Placebo outcomes: Mean, standard deviation in parentheses

<i>Variables</i>	<i>Total</i>	<i>No damages</i>	<i>Damages</i>
<u>Highest grade completed</u>			
Oldest sibling (1984/85)	3.18 (3.24)	3.39 (3.50)	3.11 (3.16)
<u>Education prior Mike (retrospectively reported in 1991/94)</u>			
Enrolled in Preschool	0.42 (0.49)	0.52 (0.50)	0.38 (0.49)***
School starting age	6.37 (1.42)	6.45 (1.00)	6.34 (1.53)
School enrollment	0.53 (0.50)	0.56 (0.50)	0.52 (0.50)
<u>Health</u>			
Weight for age (1984/85)	-2.22 (1.16)	-2.07 (1.13)	-2.27 (1.17)***
Height for age (1984/85)	-2.34 (1.16)	-2.15 (1.18)	-2.40 (1.15)***

Note: We perform a test for statistical difference of the respective mean between the children with and without damages. *, **, and *** denote statistically significant differences at 10, 5 and 1% level of significance, respectively.

Table A4: Channels: Mean, standard deviation in parentheses

<i>Variables</i>	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
<u>Asset index</u>					
Total	0.04 (2.18)	0.09 (2.36)	0.00 (2.25)	0.04 (2.89)	0.01 (2.75)
No damages	0.89 (2.47)	1.01 (2.68)	0.69 (2.43)	1.00 (3.56)	0.87 (2.98)
Damages	-0.24 (2)***	-0.22 (2.16)***	-0.24 (2.14)***	-0.28 (2.55)***	-0.27 (2.61)***
<u>Wealth (index)</u>					
Total	4090 (9472)	8187 (26019)	9454 (22885)	8916 (37731)	7310 (17317)
No damages	7216 (14898)	13308 (28523)	13443 (27038)	14941 (65122)	10870 (19560)
Damages	3044 (6421)***	6468 (24898)***	8115 (21153)***	6935 (21989)***	6166 (16376)***
<u>Total income</u>					
Total	4476 (5671)	5074 (18924)	6683 (4390)	4074 (5791)	3751 (6032)
No damages	5698 (7344)	7237 (37017)	7618 (4884)	5167 (8097)	4940 (8432)
Damages	4067 (4922)***	4349 (4155)***	6369 (4166)***	3717 (4753)***	3370 (4972)***
<u>Disaster relief</u>					
Total	0.56 (0.50)	-	-	-	-
No damages	0.31 (0.46)	-	-	-	-
Damages	0.64 (0.48)***	-	-	-	-

Note: We perform a test for statistical difference of the respective mean between the children with and without damages. *, **, and *** denote statistically significant differences at 10, 5 and 1% level of significance, respectively.

Table A5: Control variables (pre-treatment): Mean, standard deviation in parentheses

<i>Variables</i>	<i>Total</i>	<i>No damages</i>	<i>Damages</i>
<u>Characteristics of the house</u>			
Material of house (omitted category: mixed materials)			
___: nipa	0.43 (0.50)	0.33 (0.47)	0.46 (0.50)***
___: cement, wood	0.17 (0.38)	0.28 (0.45)	0.14 (0.34)***
Soil formation (omitted category: weathered limestone)			
___: unconsolidated	0.40 (0.49)	0.40 (0.49)	0.40 (0.49)
___: core basalt rocks	0.10 (0.30)	0.08 (0.28)	0.10 (0.31)
Average soil (omitted category: > 3m)			
___: 1-3m	0.18 (0.38)	0.19 (0.40)	0.17 (0.37)
___: 0.3-1m	0.32 (0.47)	0.28 (0.45)	0.34 (0.47)**
___: < 0.3m	0.13 (0.33)	0.13 (0.34)	0.12 (0.33)
House ownership	0.13 (0.32)	0.13 (0.34)	0.73 (0.45)**
Log of house value	5.00 (2.65)	5.12 (3.00)	4.96 (2.52)
Nr of rooms	2.61 (1.34)	2.95 (1.61)	2.49 (1.22)***
Garbage disposal (omitted category: other)			
___: collected	0.13 (0.33)	0.19 (0.39)	0.11 (0.31)***
___: burning	0.42 (0.49)	0.37 (0.48)	0.43 (0.50)**
___: dumping at house	0.14 (0.34)	0.13 (0.34)	0.14 (0.35)
___: dumping away	0.22 (0.42)	0.22 (0.41)	0.23 (0.42)
<u>Characteristics of the child</u>			
Female	0.47 (0.50)	0.51 (0.50)	0.46 (0.50)**
Size at birth (omitted category: normal)			
___: smaller than normal	0.18 (0.39)	0.17 (0.38)	0.19 (0.39)
___: bigger than normal	0.27 (0.44)	0.25 (0.43)	0.28 (0.45)
Place of delivery: hospital	0.36 (0.48)	0.47 (0.50)	0.32 (0.47)***
Birth complication	0.14 (0.34)	0.13 (0.34)	0.14 (0.35)
Height for age (first interview after birth)	-0.71 (1.10)	-0.64 (1.04)	-0.73 (1.11)
Weight for age (first interview after birth)	-1.18 (1.15)	-1.19 (1.11)	-1.18 (1.16)
<u>Characteristics of the household</u>			
Type of family (omitted category: one nuclear)			
___: multi-nuclear	0.21 (0.40)	0.25 (0.43)	0.19 (0.39)***
___: other	0.16 (0.36)	0.15 (0.36)	0.16 (0.36)
Nr of siblings	2.22 (2.02)	1.94 (1.90)	2.32 (2.05)***
Spouse lives in HH	0.95 (0.23)	0.93 (0.26)	0.95 (0.21)**
Spouse temporary absent	0.04 (0.19)	0.03 (0.18)	0.04 (0.19)
Father's highest grade	6.68 (4.30)	7.32 (4.67)	6.47 (4.15)***
Father voc. training	0.12 (0.32)	0.15 (0.36)	0.11 (0.31)***
Mother's highest grade	7.38 (3.71)	8.55 (4.05)	6.99 (3.50)***
Mother voc. training	0.16 (0.37)	0.17 (0.37)	0.16 (0.36)
Father employment	0.41 (0.49)	0.41 (0.49)	0.41 (0.49)
Mother employment	0.86 (0.35)	0.84 (0.37)	0.86 (0.34)***
Log of total income	8.37 (1.28)	8.6 (1.24)	8.29 (1.28)***
Log wealth	7.31 (1.68)	7.75 (1.88)	7.17 (1.58)***

Note: We perform a test for statistical difference of the respective mean between the children with and without damages. *, **, and *** denote statistically significant differences at 10, 5 and 1% level of significance, respectively.

Table A6: Placebo analysis

<i>Dependent variables</i>	<i>dy/dx for binary damage indicator</i>	<i>dy/dx for continous damage indicator</i>
Enrolled in Preschool	-0.026 (0.021)	-0.089 (0.075)
School starting age	-0.016 (0.064)	-0.168 (0.146)
School enrollment (before 1990)	0.010 (0.024)	-0.045 (0.073)
Highest grade (1984/85): eldest sibling	-0.100 (0.233)	-0.801 (0.514)
Height for age (1984/85)	-0.031 (0.045)	0.112 (0.126)
Weight for age (1984/85)	-0.009 (0.054)	0.228* (0.119)

Note: We estimated equation (1) for each outcome variable. Each cell of the first column corresponds to the regression coefficient for the binary damage indicator; regression coefficients for the continuous damage indicator can be found in the second column. Control variables are the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. * denote statistical significance from 10% level of significance.

Internet appendix

Table I1: Comparing HH with/without interviews in 1991 by baseline characteristics

<i>Variables</i>	<i>No interview in 1991</i>	<i>Interview in 1991</i>	<i>Significance Differences (t-Statistic)</i>
Material of house: nipa	0.401	0.429	-0.892
Material of house: cement, wood	0.245	0.173	2.986*
Soil formation: unconsolidated	0.473	0.397	2.462*
Soil formation: core basalt rocks	0.092	0.100	-0.431
Average soil: 1-3m	0.167	0.175	-0.357
Average soil: 0.3-1m	0.320	0.323	-0.103
Average soil:< 0.3m	0.031	0.126	-4.832*
House owner	0.524	0.713	-6.637***
Log of house value	3.998	4.997	-5.9*
Number of rooms	2.483	2.607	-1.497
Garbage disposal: collected	0.197	0.128	3.252*
Garbage disposal: burning	0.388	0.418	-0.993
Garbage disposal: dumping at house	0.092	0.136	-2.106*
Garbage disposal: dumping away	0.231	0.224	0.268
Female	0.500	0.471	0.922
Size at birth: smaller than normal	0.163	0.183	-0.816
Size at birth: bigger than normal	0.255	0.270	-0.544
Place of delivery: hospital	0.432	0.360	2.383*
Birth complication	0.153	0.137	0.768
Height for age	-0.739	-0.709	-0.448
Weight for age	-1.174	-1.182	0.112
Multi-nuclear family	0.259	0.205	2.082*
Other type of family	0.201	0.156	1.958*
Nr of siblings	1.884	2.222	-2.71*
Spouse lives in HH	0.915	0.945	-2.051*
Father's highest grade	6.891	6.684	0.76
Father voc. training	0.143	0.119	1.162
Mother's highest grade	8.088	7.382	3.063*
Mother voc. training	0.204	0.159	1.943*
Father employment	0.793	0.857	-2.88*
Mother employment	0.378	0.408	-0.999
Log of total income	8.535	8.367	2.109*
Log wealth	7.229	7.314	-0.801

Note: *, **, and *** denote statistically significant differences between mean values for individuals who participated in the interview 1991 and those who did at 10, 5 and 1% level of significance.

Table I2: OLS regression (dependent variable: share of damages on total wealth)

<i>Independent variables</i>	<i>dy/dx</i>	<i>Std. Err.</i>		<i>dy/dx</i>	<i>Std. Err.</i>
<u>Characteristics of the house:</u> F-statistics: 81.8***			Place of delivery: hospital	-0.009	0.018
Material of house (omitted category: mixed materials)			Birth complication	0.005	0.015
___: nipa	-0.003	0.015	Height for age	0.004	0.006
___: cement, wood	-0.054***	0.015	Weight for age	0.007	0.006
Soil formation (omitted category: weathered limestone)			<u>Characteristics of the household</u> F-statistics: 3.87*		
___: unconsolidated	-0.004	0.009	Type of family (omitted category: one nuclear)		
___: core basalt rocks	0.22***	0.018	___: multi-nuclear	0.004	0.018
Average soil depth (omitted category: > 3m)			___: other	-0.018	0.022
___: 1-3m	0.038	0.026	Nr of siblings	0.007*	0.003
___: 0.3-1m	0.033	0.025	Spouse lives in HH	0.032	0.034
___: < 0.3m	0.024	0.024	Spouse temp. absent	0.058	0.041
Own house	0.06***	0.021	Father's highest grade	0.00	0.002
Log of house value	0.009***	0.003	Father voc training	0.007	0.016
Nr of rooms	-0.009**	0.004	Mother's highest grade	-0.002	0.002
Garbage disposal (omitted category: other)			Mother voc training	-0.024*	0.014
___: collected	-0.033	0.031	Father employment	-0.024	0.019
___: burning	0.019	0.019	Mother employment	0.008	0.010
___: dumping at house	-0.014	0.025	Log of total income	0.003	0.005
___: dumping away	-0.013	0.022	Log wealth	-0.023***	0.006
<u>Characteristics of the child:</u> F-statistics: 2.58**					
Female	-0.025**	0.010			
Size at birth (omitted category: normal)					
___: smaller than normal	0.046***	0.015			
___: bigger than normal	0.026	0.016			

Note: The regression controls additionally for barangay fixed effects. The results for the full specification are available upon request. Standard errors are clustered by barangay. *, **, and *** denote statistical significance from zero at 10, 5 and 1% level of significance.

Table I3: Sensitivity analysis (outcome variables: education outcomes)

<i>Dependent variables</i>	<i>baseline</i>	<i>w/o house</i>	<i>w/o child</i>	<i>w/o family</i>
<u>Highest grade completed</u>				
1994	-0.113** (0.05) -	-0.105* (0.052) [0.594]	-0.135** (0.052) [0.057]	-0.168*** (0.044) [0.007]
1998	-0.264** (0.102) -	-0.254** (0.106) [0.74]	-0.274** (0.102) [0.482]	-0.388*** (0.1) [0.004]
2002	-0.501*** (0.112) -	-0.524*** (0.115) [0.475]	-0.591*** (0.105) [0.043]	-0.654*** (0.114) [0.009]
2005	-0.646*** (0.178) -	-0.700*** (0.171) [0.038]	-0.742*** (0.171) [0.050]	-0.86*** (0.213) [0.002]
<u>Standardized IQ score</u>				
1991	-0.095** (0.039) -	-0.103** (0.039) [0.405]	-0.102** (0.040) [0.365]	-0.150*** (0.040) [0.002]
1994	-0.084 (0.054) -	-0.088 (0.055) [0.735]	-0.093* (0.054) [0.186]	-0.139** (0.051) [0.001]

Note: Each cell corresponds to the regression coefficient of the binary damage indicator resulting from a separate estimation using equation (1) for each outcome variable, but leaving blocks of control variables out of the estimation (blocks are defined as in Table 1. The full set of control variables corresponds to the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistical significance at 10, 5 and 1% level of significance. P-values of the test that the regression coefficients for damages are equal between the baseline model and the restricted model are provided in square brackets.

Table I4: Sensitivity analysis (dependent variables: health outcomes)

<i>Dependent variable</i>	<i>baseline</i>	<i>w/o house</i>	<i>w/o child</i>	<i>w/o family</i>
<u>Weight for age</u>				
1991	-0.052 (0.073)	-0.059 (0.075)	-0.050 (0.074)	-0.101 (0.075)
	-	[0.491]	[0.907]	[0.007]
1994	-0.016 (0.083)	-0.025 (0.086)	-0.044 (0.083)	-0.061 (0.086)
	-	[0.449]	[0.159]	[0.015]
1998	-0.017 (0.073)	-0.019 (0.074)	-0.017 (0.072)	-0.039 (0.075)
	-	[0.707]	[0.978]	[0.105]
2002	0.005 (0.078)	0.007 (0.077)	-0.010 (0.073)	-0.023 (0.083)
	-	[0.864]	[0.44]	[0.052]
2005	0.007 (0.095)	0.006 (0.096)	-0.010 (0.086)	-0.025 (0.096)
	-	[0.922]	[0.439]	[0.047]
<u>Height for age</u>				
1991	0.024 (0.056)	0.004 (0.059)	0.025 (0.058)	-0.028 (0.061)
	-	[0.066]	[0.981]	[0.003]
1994	-0.006 (0.055)	-0.017 (0.058)	-0.026 (0.06)	-0.052 (0.056)
	-	[0.223]	[0.135]	[0.010]
1998	-0.029 (0.050)	-0.045 (0.051)	-0.019 (0.054)	-0.059 (0.049)
	-	[0.011]	[0.377]	[0.017]
2002	0.026 (0.059)	0.014 (0.062)	0.027 (0.064)	0.001 (0.060)
	-	[0.187]	[0.934]	[0.027]
2005	0.031 (0.061)	0.013 (0.064)	0.031 (0.063)	0.009 (0.062)
	-	[0.018]	[0.965]	[0.057]

Note: Each cell corresponds to the regression coefficient of the binary damage indicator resulting from a separate estimation using equation (1) for each outcome variable, but leaving blocks of control variables out of the estimation. Control variables are the set of variables displayed in Table 1 (excluding one block of variables) and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. P-values for the test that the regression coefficients for damages are equal in the full model and the restricted model are provided in square brackets.

Table I5: Effects of damages (binary indicator) on alternative outcomes

<i>Dependent variables</i>	<i>Survey year</i>				
	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
<u>Educational Outcomes</u>					
Cebu test scores	-	-0.066	-	-	-
	-	(0.043)	-	-	-
English test scores	-	-0.074*	-	-	-
	-	(0.036)	-	-	-
Math test scores	-	-0.091	-	-	-
	-	(0.046)	-	-	-
Time for homework	-	-0.059	-	-	-
	-	(0.031)	-	-	-
Time for household chores	-	0.074**	-	-	-
	-	(0.035)	-	-	-
<u>Health outcomes</u>					
Arm circumference	-0.105	-0.052	-	-	-
	(0.094)	(0.141)	-	-	-
Skinfold (triceps)	-0.131	-0.185	-	-	-
	(0.117)	(0.176)	-	-	-
Skinfold (subscapular)	-0.121	-0.151	-	-	-
	(0.121)	(0.223)	-	-	-
Waist circumference	-	-	-	-0.053	-0.146
	-	-	-	(0.469)	(0.523)
Hip circumference	-	-	-	-0.070	-0.330
	-	-	-	(0.525)	(0.484)
Blood pressure	-	-	-	-0.105	-0.052
	-	-	-	(0.094)	(0.141)
Psychological problems	-	-	-	0.061	0.010
	-	-	-	(0.053)	(0.065)

Note: Each cell corresponds to the regression coefficient of the binary damage indicator resulting from a separate estimation using equation (1) for each outcome variable. Control variables are the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistical significance at 10, 5 and 1% level of significance

Table I6: Effect heterogeneities (dependent variable: weight for age)

<i>Strata</i>	<i>Survey year</i>				
	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
Panel A: Gender					
Male	-0.085 (0.100)	-0.111 (0.103)	-0.141 (0.086)	-0.129 (0.078)	-0.128 (0.111)
Female	-0.013 (0.075) [0.395]	0.084 (0.091) [0.032]	0.097 (0.082) [0.008]	0.120 (0.087) [0.001]	0.111 (0.112) [0.060]
Panel B: Nr. of elderly sibling					
No or one sibling	-0.089 (0.115)	-0.014 (0.132)	-0.060 (0.113)	0.037 (0.137)	0.031 (0.178)
More than one sibling	0.021 (0.071) [0.271]	0.000 (0.094) [0.918]	0.038 (0.070) [0.328]	0.015 (0.068) [0.862]	0.033 (0.091) [0.992]
Panel C: Family wealth					
Poor (total wealth < 862 \$)	-0.017 (0.097)	0.053 (0.091)	0.067 (0.083)	0.100 (0.088)	0.067 (0.143)
Rich (total wealth > 862 \$)	-0.077 (0.089) [0.604]	-0.068 (0.106) [0.321]	-0.077 (0.106) [0.243]	-0.072 (0.106) [0.111]	-0.052 (0.108) [0.433]
Panel D: Home ownership					
No homeowner	-0.233 (0.141)	-0.033 (0.198)	-0.153 (0.145)	-0.054 (0.151)	-0.184 (0.189)
Homeowner	0.072 (0.089) [0.238]	0.055 (0.101) [0.365]	0.105 (0.103) [0.473]	0.057 (0.103) [0.379]	0.048 (0.124) [0.841]
Panel E: Household type					
One nuclear HH	0.072 (0.089)	0.055 (0.101)	0.105 (0.103)	0.057 (0.103)	0.048 (0.124)
Multi-nuclear HH	-0.233 (0.141) [0.048]	-0.033 (0.198) [0.693]	-0.153 (0.145) [0.146]	-0.054 (0.151) [0.556]	-0.184 (0.189) [0.253]
Panel F: Origin of the family					
Parents born in barangay	-0.037 (0.084)	0.028 (0.094)	0.018 (0.091)	0.018 (0.097)	0.052 (0.117)
No parent born in barang.	-0.082 (0.105) [0.695]	-0.056 (0.127) [0.519]	-0.036 (0.121) [0.700]	0.024 (0.139) [0.967]	0.021 (0.145) [0.857]

Note: The table report effects for the binary damages indicator on weight for age for each subgroup. We estimated equation (1) for each group separately. Control variables are the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistically different from zero at 10, 5 and 1% level of significance. P-values for the test of equality of coefficients in different strata are provided in square brackets.

Table I7: Effects of damages (binary indicator) on detailed channels

<i>Dependent variable</i>	<i>Survey year</i>				
	<i>1991</i>	<i>1994</i>	<i>1998</i>	<i>2002</i>	<i>2005</i>
Relocation	-0.019** (0.008)	-0.019 (0.018)	0.012 (0.014)	-0.022 (0.024)	0.000 (0.021)
Family sperated	0.006 (0.011)	0.003 (0.013)	-0.008 (0.012)	0.018 (0.016)	0.009 (0.020)
HH member absent	0.016 (0.014)	0.034*** (0.012)	0.010 (0.016)	0.016 (0.017)	-0.026 (0.018)
Employment: father	0.013 (0.016)	0.009 (0.016)	0.006 (0.012)	0.037* (0.022)	0.014 (0.030)
Employment: mother	-0.019 (0.020)	0.019 (0.033)	0.008 (0.023)	-0.005 (0.027)	0.034 (0.024)
Employment: child	0.002 (0.005)	0.007 (0.017)	0.004 (0.034)	0.004 (0.029)	0.020 (0.031)
Mother died	-0.006 (0.006)	-0.013* (0.007)	-0.020** (0.008)	-0.020* (0.01)	-0.015 (0.011)
Mother sick	-0.023 (0.017)	0.009 (0.022)	0.001 (0.018)	-0.023 (0.025)	- -
Value of house	-1779*** (434)	-2856** (1373)	-636 (1603)	-3628 (3486)	-1572* (803)
^a Value of furniture	-30*** (10)	-20** (9)	7 (10)	-10 (18)	-141*** (49)
^a Value of appliances	-141*** (49)	-190*** (52)	-146** (66)	-139*** (33)	-117** (51)
^a Value of vehicles	-447** (189)	-666*** (222)	-494** (208)	-403* (197)	-411 (338)
^a Value of equippment	-7 (21)	23 (52)	31 (47)	7 (10)	9 (8)
Any remittances	-0.022 (0.017)	-0.019 (0.015)	-0.034** (0.016)	-0.008 (0.017)	-0.004 (0.015)
Income from work	-268* (143)	-1350 (1236)	-131 (174)	-318 (514)	-790** (315)
Income from livestock	-10 (16)	7 (10)	4 (8)	-10 (6)	-2 (9)
Income from farming	-5 (5)	-5 (8)	-5 (6)	4 (3)	3 (2)
Other income	-266** (103)	-141 (86)	-167* (84)	-189* (110)	-117 (85)

Note: We estimated equation (1) for each outcome variable. Each cell corresponds to the regression coefficient for the binary damage indicator. Control variables are the set of variables displayed in Table 1 and a set of barangay fixed effects. The results for the full specification are available upon request. Standard errors (in parentheses) are clustered by barangay. *, **, and *** denote statistical significance at 10, 5 and 1% level of significance. ^a Predicted value (based on regression analysis, see main text).