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The tempest: Using a natural disaster to evaluate the link between wealth and child development

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Using a natural disaster to evaluate the link between wealth and child development [1]

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Abstract

How does family wealth affect children's development in the short- and long-run? We address this question by exploiting a shock occurred to family's real estate, i.e. housing damages caused by a super typhoon. Our identification strategy is based on a comparison of children, who all lived in the same local area and thus were confronted with the same macro-economic shock, but only some experienced housing damages. We present evidence in favor of housing damages being essentially a severe wealth shock, with no effects on other observable channels which might directly harm children's development. The shock results in a decline of educational investments, but not of health-related investments. We observe a deterioration of children's educational achievements in the short-run and even more pronounced in the long-run. Our findings are mainly driven by children whose families are at the bottom of the wealth distribution or lack the support of a strong family network.

Keywords

Child development, wealth effects, natural disaster.

JEL Classification

I14, I24, Q54.

1. Introduction

The link between socio-economic deprivation and children's development has attracted considerable interest over the previous years (see Currie (2009) for a review). The key question is whether a lack of financial means harms children's development, in terms of their health and education. In light of persistent poverty rates in developing countries, the question whether socio-economic deprivation adversely affects children's human capital and thus results in a situation where children are trapped in poverty is of particular relevance (Ferreira & Schady, 2009).

Measuring the causal effect of poverty on child outcomes is, however, challenging for the following reason. Financial resources are likely to be correlated with other observable and unobservable development stimulating factors and thus establishing causality between families' financial means and children's human capital is not an easy task. A considerable number of studies has exploited different types of negative income shocks to overcome this endogeneity issue. Examples – mainly from developing countries - are shocks induced by economic crises (Schady, 2004; Thomas, Beegle, Frankenberg, Sikokid, Strausse, & Teruel, 2004; Paxson & Schady, 2005; Stillman & Thomas, 2008), price deterioration of household production goods (Cogneau & Jedwab, 2008; Miller & Urdinola, 2010), or unanticipated weather shocks (Jensen, 2000; Maccini & Yang, 2009; Aguilar & Vicarelli, 2011). Other studies have focused on governmental transfers as an exogenous source of permanent income; examples for developing countries are Duflo (2000), Himaz (2008), Paxson and Schady (2010) and Baird, McIntosh and Ozler (forthcoming); examples for developed countries are Akee, Copeland, Keeler, Angold and Costello (2010), Akee, Simeonova, Copeland, Angold and Costello (2010), Løken (2010), Duncan, Morris and Rodrigues (2011) and Dahl and Lochner (forthcoming). While there is basically unanimity regarding the positive effects of income on children's educational outcomes – with some recent evidence pointing towards strong heterogeneity with respect to children's economic background (Paxson & Schady, 2010; Løken, Mogstad, & Wiswall, forthcoming) -, there is rather mixed evidence on the impact of family income on children's health with positive evidence mainly found for children from developing countries.

Our study contributes to the existing literature by focusing on one aspect of financial resources which has been so far mainly neglected: wealth in the form of real estate. To be precise, our focus lies on a real estate shock in form of housing damages caused by a super typhoon in the context of a developing country (super typhoon Mike which hit the Philippines in 1990). Analyzing the consequences of a real estate stock is an interesting example. Not only that real estate usually corresponds to a significant share of family wealth (in our setting 73% of the families own the house they live in), real estate has also some unique characteristics that distinguish it from other types of wealth. In comparison to financial wealth, real estate is rather illiquid. Yet, it serves as collateral and thus can be used for inter-temporal consumption smoothing. In addition, real estate has a consumption character when people reside in their houses. As a result, our particular shock does not only constitute a severe shock to family wealth (57% is on average lost, which corresponds to 38% of the average annual household income), but may shift investments from alternative forms of (human) capital to real estate investments. Moreover, in a situation of binding credit market constraints (a likely situation in the context of a developing country) and with housing being a necessity good, a real estate shock may have even more severe consequences than a pure financial wealth shock.

Super-typhoon Mike represents a very suitable setting to identify the causal effect of a real estate shock on children's development. Conditional on the quality of the building, housing damages are typically the result of random factors, such as the local strength of the typhoon, or the strength of arising mudslides. Additionally, typhoons are rather rare in the Cebu Metropolitan Area. The last super typhoon prior to Mike occurred in 1951, and since typhoon

Mike no further super typhoon has hit the Cebu Metropolitan Area again. Thus, the particular setting under study does not only allow us to identify an unexpected shock to wealth, but it also enables us to follow families and their children over time without them being systematically hit by any further shocks. We can therefore identify the consequences of one specific wealth shock.

One major threat to our identification strategy is that a typhoon may have further direct negative consequences for children's development besides destroying private property. First, extreme weather events have severe macroeconomic consequences (Back & Cameron, 2008; Ferreira & Schady, 2009). To tackle this problem, we compare children who all resided in the disaster area, in particular in the same local district, and were thus, exposed to the same macroeconomic environment.[1] Second, housing damages caused by a typhoon may be furthermore associated with other factors that harm child development. To address this issue, we provide evidence that housing damages led to severe losses in wealth, but did not trigger any other observable channels through which children's development may be affected (e.g. parental labor supply, maternal death, maternal health, mother-child separation, or migration).

The data used in this study is the Cebu Longitudinal Health and Nutrition Survey, which is a particularly suitable dataset to study the outlined objectives. It is a longitudinal study that follows all children born in randomly selected areas of the Cebu Metropolitan Area in 1983/84 from birth to adulthood (age 0 to 21/22). It contains information on children's family background, but most importantly on a wide range of health and educational outcomes measured at all ages. Additionally, it provides information on damages occurred to family homes

[1] In this perspective, our study differs significantly from other studies on 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; Poertner, 2009; Pugatch & Yang, 2009; Yamauchi, Yohannes, & Quisumbing, 2009; Frankenberg, Gillespie, Preston, Sikoki, & Thomas, 2011).

in the aftermath of typhoon Mike. Thus, given the data at hand and the particular setting of typhoon Mike, we can identify the impact of a severe wealth shock occurred during early childhood (at age 6/7) on children’s short- (age 7/8) and long-run (age 21/22) development. This is a further contribution to the existing literature on the link between family income and child development which has mostly focused on a short- or at most medium-term horizon.

Overall, our results do not reveal any detrimental effect on children’s health, but suggest a direct pathway from wealth to children’s educational progress. This is expressed in augmented school drop-outs, a higher prevalence of grade retention as well as worse educational performance in the short- as well as in the long-run. Underlying mechanisms are increased school absences, work for pay (at least for children from poorer families), home production, and reduced time spent on homework. Further analysis reveals that our findings are mainly driven by children whose families are either at the bottom of the wealth distribution or lack the support of a strong family network. Under the latter circumstances, children even experience some negative consequences on their health. Children whose families possess of sufficient financial means seem unaffected by the shock, both in terms of health and education.

The reminder of the paper is structured as follows. The next section introduces the underlying theoretical framework which allows us to make some predictions about the consequences of a wealth shock on children’s human capital. Section 3 describes the data and Section 4 discusses our empirical strategy. Section 5 presents the estimation results and discusses further issues, such as heterogeneity and robustness of the results. Section 6 finally concludes.

2. Theoretical Background

The prime interest of our paper is to empirically model the effect of a major wealth shock on children's human capital formation. This is motivated by a relatively large theoretical literature analyzing the evolution of human capital, where the production technology is determined by inputs and constraints.

The skill production function framework was first formally modeled by Ben Porath (1967) and has since served as the basis for much of the literature on skill acquisition in Economics. Leibowitz (1974) was the first to extend this framework to home investments in children. For the case of biological human capital, Grossman (1972) models individual health as a function of health inputs and health behavior. Dickie (2005) applies this model for the case of children, where the investment decisions are made by their parents.

In recent years, the literature has focused on life-cycle models allowing human capital production to take place at different stages of childhood (Cunha, Heckman, Lochner, & Masterov, 2006; Cunha & Heckman, 2007; Heckman, 2007). In a nutshell, these models are based on the concepts of self-productivity and dynamic complementarity of capacities, in terms of cognitive skills, personality factors or physical health. In other words, capacities produced at one stage during childhood augment capacities attained at later stages and in addition raise the productivity of investments at later stages. In a world with perfect credit markets, the human capital production function is the only determining factor of the optimal investment levels at the different stages during childhood. Parental earnings, wealth or further parameters characterizing parents' utility function do not influence the optimal investment levels. Yet, in a world with imperfect credit markets - i.e. in a world where parents can neither borrow against their own future income nor against their children's future income - income or wealth shocks per se have detrimental effects - either by a reduction of financial investments or a reduction of time investments (due to increased work for pay or home production of the parents or the children themselves). Given moreover the concept of dynamic complementarity, the timing of income or wealth shocks becomes crucial: shocks at early stages of childhood do not only lead to reduced current investments, but also in all later periods and thus result in a reduced future human capital stock.

The described mechanisms also apply to our application. Nevertheless, we deem it important to discuss to which extent a real estate shock may differ from a pure financial shock. In particular, we want to point out to which extent a real estate shock may have even more severe consequences for children's human capital formation than a standard financial wealth or income shock. In contrast to most financial wealth items, real estate has two unique properties:

(1) Real estate does not only serve as an investment good, but also as a consumer good as people often live in their houses. Moreover, accommodation is a necessity good - people need shelter. Thus, assuming that there are no rental markets, people must possess at least a minimum level of real estate in all periods.

(2) The assumption, that parents are not able to borrow against their own income, seems implausible. Even in resource poor settings, households are observed to hold loans. Financial institutions may, however, require collaterals in exchange for a loan. Real estate wealth often serves as collateral, where the maximum loan is a certain fraction of real estate holdings.

In case the above described constraints are binding - i.e. a family only possesses the minimum level of real estate and exhausts the maximum amount of a loan - a shock to real estate experienced during an early stage of childhood leads coercively to a reallocation of financial resources away from consumption and/or investments in children's human capital towards reconstruction of the family home. If reinvestments in real estate can be done by family members, by caregivers and/or the children themselves, a shock to real estate might in addition lead to a reduction in time-intensive investments in children's human capital (e.g. less developmental oriented care, less time devoted to homework, or reduced school attendance).

Additionally, a shock to real estate implies a reduction in the value of a family's collateral, and thus, a loss of opportunities to borrow and to smooth consumption and investments over time. While the loss of opportunity to borrow may hinder parents to maintain investments in their children's human capital during earlier periods, the absence of any accrued debt may allow for compensatory human capital investments in later periods. Given the assumption of dynamic complementarities of human capital investments, parents may, however, face lower incentives to invest further in their children's human capital during later stages.

As a result, we expect that a real estate shock results in a decline in human capital investments in the short-run, as well in the long-run, and thus in a gap in human capital which widens over time.

3. Data

The dataset used in this study is the Cebu Longitudinal Health and Nutrition Survey (CLHNS), which is an ongoing study of a 12-month birth cohort (born May 1983 through April 1984) from 33 randomly selected communities in the Cebu Metropolitan Area (called barangays). 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]

The CLHNS is particularly suited to address the objectives of this study. First, the data provides comprehensive information on children's human capital as well as detailed information on children's family background, in particular on ownership and value of assets. Moreover, it contains information on the housing damages caused by typhoon Mike – information that is crucial for our identification strategy. In addition, the dataset only collects information

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

on children who were living in the Cebu Metropolitan Area and thus all experienced the overall consequences of typhoon Mike – one further essential feature of our identification strategy (see Section 4 for further details). Finally, children are followed for up to 15 years after the typhoon. As a result, we can not only evaluate the short- and medium-run consequences, but also the long-run effects.

We restrict the dataset to children who survived until 1990 (in other words, did not die before typhoon Mike), who were not a twin live birth, whose mothers were the only selected pregnant woman in the household and answered the last interview prior to super typhoon Mike. As a result, our baseline sample consists of 2345 children (prior to treatment). Despite of the longitudinal nature of the data, attrition rates are remarkably low. In 1991, the first survey year where outcome variables are taken from, we still observe 2058 children (88%), in 1994 1993 children (85%), in 1998 1912 children (82%), in 2002 1853 children (79%) and in 2005 1737 children (74%).

In the following subsections we discuss all variables used in our main analysis. An overview of the descriptive statistics is provided in TABLE A.1 in the Appendix. A detailed description of further outcome variables is provided in TABLE I.1 in the Internet Appendix.

Child development outcomes

The variables of interest in this study are indicators of children's human capital, such as health and education, in the short- and long-run after typhoon Mike hit Cebu Island. Thus, outcome variables are taken from the interviews in 1991, 1994, 1998, 2002 and 2005.

The CLNHS provides a series of anthropometric measures including children's body weight, height, arm circumference, skinfold thickness, waist and hip circumference, as well as blood pressure. All anthropometric measures are taken by the interviewer. It additionally contains information on self-reported health, both physical health (questions related to the prevalence of illnesses or hospitalization) and mental health (questions related to emotional and social problems as well as to problems with falling asleep, headaches or digestion). Last, a battery of questions is asked regarding health behavior, health investment, health expenditures and nutrition, which allows us to assess the potential mechanism through which the wealth shocks may affect children's health. Our main analysis focus on weight and height, both standardized with respect to the age- and gender-specific mean (z-scores), as well as on a binary indicator for the prevalence of major illnesses. The reason for this selection is that information on these variables is provided in all surveys and thus can be compared across years.[3]

Intellectual development of children is measured by variables proxying grade progression as well as cognitive performance (measured by standardized tests such as IQ, Cebu, English and Math). Unfortunately, educational 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, not, however, the immediate impact. To assess the underlying mechanism, we consider the following aspects of investments related to children's education. First, we assess time investments such as children's school attendance (enrollment and actual days per month attended school) and children's participation in the labor market and in home production (hours of homework and hours of household chores). Second, we analyze financial investments related to children's education (school expenditures).

Variables to identify the wealth shock

The CLHNS provides two different variables that help us to identify an exogenous shock to family real estate. First, in 1991 households were asked retrospectively whether typhoon Mike caused any major damage to their house. In total, 76% of all households in our sample

[3] The results for the remaining health variables are presented in the Internet Appendix (TABLE I.1 and TABLE I.3)

have experienced some damages. Second, for those who reported damages, the survey asked for estimated reparation costs. Average reported costs amount to 3972 Philippine Pesos (approximately 264$ in constant 1990 international $). This value may however vastly underestimate the socio-economic shock for the following reasons: First, the question relates to reparation costs and does not include the loss if the house was irreparably destroyed. Notice that about 8% of the families who reported housing damages simultaneously reported reparation costs of zero Pesos. Second, monetary costs do not include the full costs if a substantial amount of the reparation was done by a household member. Hence, opportunity costs are not considered. Last, reparation costs do not include losses on other wealth items such as furniture, appliances, etc. For these reasons, our empirical analysis focuses on the binary indicator of reported damages. Reparation costs are only considered when we discuss how consequences on children's human capital vary depending on the severity of the shock (see Section 5.3).

Our prior is that these housing damages essentially correspond to a wealth shock. We therefore investigate if housing damages lead to a decline in wealth (see section 5.1). The CLHNS provides information on ownership and value of different household wealth items for 1991, but only on ownership for all years thereafter. We use information on ownership to construct a wealth index in two different ways. First, following the example of many studies using data from developing countries (Filmer & Pritchett, 2001), we use the information on ownership of different assets and employ a principal components analysis. The disadvantage of this procedure is that the resulting asset index itself has no economic meaning other than a higher index being a sign for more wealth. Therefore, we also employ a regression analysis to construct an alternative wealth index. 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. The so-constructed wealth index can be interpreted as the value of wealth in constant international 1990 $. The obvious disadvantage of this method is that the same price increase is assumed for all considered assets. This may be a strong assumption, if price increases differ across different assets (e.g. due to different quality improvements). Due to the mentioned limitations the wealth indices from year 1994 onwards have to be interpreted with caution.

In addition, we consider the following aspects of a child's environment which might be affected alongside with the housing damages caused by typhoon Mike: disaster relief, family income, parental labor supply, maternal health, maternal mortality, migration, and family separation. This allows us to test if any other channels for children's development is affected by this shock.

Control variables

Our empirical strategy relies on selection on confounding variables (see section 4). All control variables are taken from the baseline (1983/84), birth (1983/84), and the final bimonthly interview (1985/1986) and thus are exclusively measured prior to typhoon Mike. The selection of control variables is further discussed in Section 4.2, but can be summarized as follows: quality indicators of the family home (construction material, soil formation, average soil depth, house ownership, and value of the house), family's SES (presence of the father, parents' employment status, overall income and its single components, overall wealth, and the position in the wealth distribution), parental education (father's and mother's highest degree completed and completion of any vocational training), initial child characteristics (gender, birth weight, birth height, complication at birth and place of delivery), household characteristics (one nuclear or multi-nuclear household, number of rooms, and type of garbage disposal) and a set of barangay fixed effects.

4. Empirical Strategy

4.1. Identification

Measuring the causal effect of wealth on child outcomes is challenging, mainly because financial resources are likely to be correlated with other observable and unobservable child development stimulating factors. Our strategy to overcome this endogeneity problem is to use damages to family homes caused by a super typhoon as an exogenous shock to family wealth in the form of real estate. The particular super typhoon we look at is super typhoon Mike which hit the Cebu Island (Philippines) on 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 (130 knots or greater according to the National Weather Service (2009)) and are thus especially destructive. In contrast to other parts of the Philippines, Cebu Island enjoys a particularly beneficial geographical location. It is surrounded by larger landmasses which serve as a natural barrier against typhoons (see FIGURE A.1). Moreover, Cebu lies only in the southern limit of the typhoon belt (the region between the Pacific Ocean and the South China Sea). As a result, Cebu is rarely hit by typhoons. The Cebu Metropolitan Area, the area under study, has experienced the last super typhoon prior to Mike in 1951 and no other super typhoon after 1990. Thus, typhoon Mike can be seen as an unexpected shock for the residents of the Cebu Metropolitan Area.[4] One further consequence of this scenario is that there are no similar disasters that may prevent us from estimating short- and long-run effects of the damages caused by typhoon Mike.

Besides severe macroeconomic damages - 2 million people were forced into temporary shelters, 37000 houses were destroyed, and the majority of the metropolitan area was left with-

[4] As a result, there should not be any differences in the degree to which families protect themselves against potential natural disaster. In addition, the time after the first warning regarding typhoon Mike should not allow for much more than saving their own lives. Yet, as discussed in Section 5.1., there are no significant differences in the mortality of affected and unaffected families.

out electricity and potable water (Williams, Jung, & Englebretson, 1993) -, there was substantial variation in the damages occurred to family homes. 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% (see FIGURE A.2). Yet, only in one barangay all households report damages.

Our empirical strategy is to exploit this variation and to compare children who all resided in the disaster area and thus experienced the same macroeconomic consequences, but only some suffered from individual damages to their family homes. Doing so allows us to isolate the effect of an individual wealth shock from the general macroeconomic shock. To additionally address the concern that damages occurred to public infrastructure, such as schools or hospitals, differ across local areas, we furthermore restrict our comparison to children living in the same 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), such a comparison should enable us to isolate the shock occurred to private wealth from any further shock occurred to public infrastructure.

The equation underlying all our estimations (estimated using ordinary least squares) looks thus 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 occurred, $D_{i,t}$ is a binary variable and represents whether the family experienced housing damages due to typhoon Mike, $X_{i,t-1}$ 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 barangay where the family resided prior to the shock.

Using damages occurred to family homes during a typhoon to identify a shock to children's development has obviously its pros and cons. Natural questions to ask are, for instance,

(1) Do damages to family homes occur randomly?

(2) Do affected children face further shocks which may directly harm their development?

Arising damages are determined by random factors, such as local wind speed, floods and mudslides (Imamura & Van To, 1997; Nordhaus, 2006). However, individual factors have been proven to be relevant in explaining the severity of damages occurred to private property. As shown by Fronstin and Holtman (1994), the quality of the dwelling plays an important role for the extent of the damages. Consequently, despite random variation in wind speeds, flooding, and mudslides, housing damages may be still plagued from endogeneity. It is therefore necessary to control for indicators of the housing quality as well as further relevant determinants of individually experienced housing damages (see Section 4.2 for details).

Finally, despite being related to a wealth shock, one may argue that home damages may also be associated with other channels that directly harm children. To convince the reader that we mainly deal with a shock to family wealth, we provide evidence that home damages represent essentially a shock to family wealth, but are unrelated to any other channels through which children's development may be directly affected (see Section 5.1. for details).

4.2. Implementation

The previous discussion has highlighted the need to take "selection into housing damages" seriously. For this reason, we employ a "selection-on-observables" strategy and control for a vast set of potential confounders. The choice of these variables is based on the one hand on the underlying theory and empirical evidence for the determinants of children's development and on the other hand on an empirical assessment of the factors related to housing damages.

Grossman (1972) models individual health as a function of health inputs (e.g. medical care, food, etc.), and health behavior (e.g. physical exercising, smoking, or alcohol consumption). As a result, health is endogenous in the sense that individuals choose the optimal amount of inputs to "produce" their desired health status. In the case of children, the investment decisions are made by their parents (Dickie, 2005). In a similar vein, children's cognitive development is determined by the investment made by parents and school (Leibowitz, 1974). Empirical research has put forward the following main determinants of children's development: family's socio-economic status (Duncan, Yeung, Brooks-Gunn, & Smith, 1998; Blau, 1999; Case, Lubotsky, & Paxson, 2002; Currie, 2009; Cameron & Williams, 2009), parental education (Glewwe, 1999; Black, Devereux, & Salvanes, 2005; Glick & Sahn, 2009), and children's initial endowments (Kebede, 2005).

Given that further unobserved indicators for the housing quality are likely to be correlated with the factors discussed above, we control not only for a set of quality indicators of the family home, but also for a set of indicators for the family's socio-economic status, parental education, household characteristics, as well as initial child characteristics. The dataset provides us with information on children's health outcomes prior to the disaster. Controlling for these pre-storm health outcomes may help capturing any unobserved and time constant confounders. Unfortunately we cannot include any pre-disaster educational outcomes as in 1985/1986 (the last year from which control variables are taken): children were simply too young to be already enrolled in the formal education system. Finally, a set of barangay fixed effects helps assuring that we perform our comparison among children who are all living in the same local neighborhood and are thus all exposed to the same macro-economic conditions.

For the empirical assessment of the factors related to housing damages we use the sample of children observed in 1991 and estimate a Probit model where the dependent variable is the binary variable reporting housing damages and the control variables correspond to the set of variables discussed above. TABLE I presents the main results for the probability of experiencing housing damages. TABLE I.2 in the Internet Appendix contains the full set of estimates.

(Please place TABLE I about here)

Despite the fact that we control for more than 50 variables, the fit of our model is relatively low (Pseudo-R2=0.09). Additionally, the estimated coefficients are rather small and in most cases insignificant at any standard significance level. This confirms our prior assumption that housing damages caused by typhoon Mike have a strong random component. With the exception of the housing material and the value of the house, none of the quality indicators for the house significantly predicts damages. A test for joint significance of these variables can, however, not be rejected (chi2=25.58). The coefficients of the variables indicating families' SES are insignificant – the exception being the employment status of the father and the wealth prior to the shock (both decrease the probability to experience housing damages). Joint significance of the different components representing family SES can again not be rejected (chi2 =14.22). Among the parental education variables, only the indicator for mother's highest degree is significant. Joint significance of all educational variables can be rejected (chi2 = 9.69). Similarly, we can exclude joint significance of the pre-existing child characteristics (chi2 = 7.48). The only surprising result among the child characteristics is observed with respect to child's gender: girls are less likely to experience housing damages. Yet, we are not aware of any explanation for this finding – there exists neither a gender-related birth control or an unusual sex-ratio on Cebu Island (yet, our sample displays a slightly higher male to female ratio at birth as normally observed in the Philippines, 1.10 versus 1.05) – and thus, explain this result rather as a statistical artifact. To address any remaining concerns regarding potential endogeneity of housing damages with respect to parental investments into children's human capital or children's pre-treatment educational preposition, we pursue a series of consistency and placebo checks (see Section 5.3).

In our empirical application, we rely on a linear parametric regression model to estimate the effect of property damages caused by typhoon Mike. Linear regressions that control for covariates usually do a good job of eliminating selection bias, particularly if common support is fulfilled, i.e. if estimates are not extrapolated to covariate combinations that have no support (Angrist & Pischke, 2009). The predicted propensity scores resulting from above's Probit model can be used to verify common support among treated and the untreated observations (see FIGURE I.1 in the Internet Appendix). In only 38 cases common support is not fulfilled. Thus, lack of common support does not seem to be a problem.

Given the strong random component of damages caused by a typhoon and the extreme richness of our dataset, we strongly believe that a "selection on observables" strategy, controlling for a rich set of background characteristics as well as for barangay fixed effects, provides us with unbiased estimates for the effect of a wealth shock on children's development.

5. Results

5.1. Channels

Before discussing the estimated effects on a wide range of education and health outcomes (see Section 5.2), we provide evidence that the housing damages represent indeed a severe and long-lasting wealth shock, but do not trigger any other observable channel that might potentially harm children's human capital formation.

Confirming our prior, the results suggest an immediate (in 1991) and significant drop in reported wealth among families whose homes were damaged by typhoon Mike (see TABLE II). On average, the wealth loss amounts to 1401 $ (in constant 1990 international $). This loss corresponds to more than half of the wealth and more than a third of annual household income affected families possessed prior to the disaster. Keeping also in mind that the Philippine GDP per capita in 1991 was 1484 $, the drop in wealth represents indeed a severe shock. For the following years, the magnitude of the effect remained constant (except for year 2002), but due to a high variance in the wealth measure the predicted average treatment effects are not significant (see TABLE A.2 in the Appendix for the long-run effects). The estimated effects on the asset indices derived from the principal component analysis confirm the negative and significant drop in wealth across all years (estimates range from 0.23-0.4 standard deviations). Thus, affected families apparently do not manage to ever catch up in financial terms.

(Please place TABLE II about here)

The most severe losses were experienced in the value of real estate, furniture, appliances, and vehicles, where the value of the latter two is depressed over all years after typhoon Mike occurred. Interestingly, 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 sheds some light on the fact that child labor is positively correlated with the ownership of physical assets that contribute to household production, such as livestock or landholding (see for instance, Bhalotra and Heady (2003), Cockburn and Dostie (2007), Basu, Das and Dutta (2010)).[5]

We furthermore identify a drop in total household income after the storm occurred. The effect is, however, not significant. The income shock only gains magnitude and significance from year 2002 onwards. This income drop is mainly driven by a reduction in income from

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[5] The long-term effects on the different wealth components are presented in the Internet Appendix (TABLE I.3).

market activities and income from other sources, even though the single effects are not significant (see TABLE I.3 in the Internet Appendix). Since parental labor supply is not affected (see below), the income decline in later years points to a decreased earnings capacity among affected children in later periods and thus to a long-lasting effect on children's human capital endowment. This issue is further discussed in Section 5.2.

Affected households are also by far more likely to receive disaster relief from government or other institutions. Unfortunately, the dataset does not provide any information about the type of disaster relief. Outside sources, however, report that relief assistance focuses on the provision of food, clothing, emergency shelter, and medical supplies.[6] Financial assistance to households is likely to be negligible. 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). As a result, 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, maternal health, maternal mortality, migration, or separation of the family, are affected. Yet, despite the richness of our data we cannot exclude the possibility that the observed housing damages relate to other unobserved channels which may be detrimental for children's development. One example for such a channel is 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 outmigration one year after the typhoon. If anything, our results suggest that affected families are more likely to stay in their barangay. Moreover, available evidence about the situation after the dis-

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

aster does not point towards any major evacuation, but state that evacuation camps were only functioning for up to 6 weeks after the disaster. One further unobserved channel may be is a psychological trauma or mental strain children might experience due to the typhoon. Our data provides us only with a depression screener from age 18 onwards (see TABLE I.3 in the Internet Appendix). Yet, based on this information we can at least exclude any long-lasting effects on mental health.

By and large, the results indicate that housing damages due to typhoon Mike can be considered as a severe and long-lasting wealth shock. Thus, when analyzing the effects of housing damages on children's development we interpret them as the effects of a wealth shock.

5.1. Child development

5.1.1. Education

In line with the predictions of the theoretical model, educational investments are severely affected by the wealth shock, in the short-run as well as in the long-run (see TABLE III). In the short run, in particular three years after the disaster, overall school enrollment is still similar among both groups of children. When interpreting this result, it is, however, important to keep in mind that in the Philippines school attendance is compulsory until age 14. As soon as education is not compulsory anymore, there arises a gap between the two groups: in 1998 the gap in school enrollment amounts to 3 percentage points (significant only at the 15% significance level) and at age 18 to 19 this gap increases to 8 percentage points. [7]

(Please place TABLE III about here)

[7] Analogue to the decreased school enrollment, we also observe lower school expenditures from 1998 onwards (see TABLE I.3 in the Internet Appendix for the estimates related to expenditures).

In the context of compulsory schooling laws, one might not expect to observe any immediate impact on the extensive margin, but rather on the intensive margin. And indeed, we already observe a gap in school attendance in the short-run: in 1994 affected children are more often absent in school, on average they miss 0.26 days more per month. In the same vein, they devote less time doing homework (on average 28 minutes less per week, which is only marginally significant), but more time doing household chores (on average 49 minutes per week).[8]

Thus, in addition and in contrast to a pure financial wealth shock, a shock on real estate might not only lead to a reallocation of financial resources away from investments into children's human capital, but also to a reduction of time-intensive investments in children's human capital in order to undertake reparation or reconstruction of the family house. Unfortunately, we lack information about educational investments immediately after the disaster and thus can only speculate about the underlying mechanisms leading to the situation observed three years after the disaster. Yet, using information on children's participation in the labor market available immediately after the disaster might help us to infer more about the underlying mechanisms. While we do not find any significant increase in children's propensity to engage in paid work on average, we do observe that children from the lower part of the wealth distribution are indeed more likely to work for pay even immediately after the disaster in 1991 (see Section 5.2. for details). Moreover, using information from the household raster, we can identify significant consequences on the labor supply of older siblings (age 6-9 years old, 10-13 years old and 14-17 years old when typhoon Mike occurred). Interestingly, the results get stronger the older the siblings are at the time of the disaster - a finding that might be explained by age-increasing opportunity costs of schooling (see TABLE I.4 in the Internet Appendix).

[8] Notice that at ages when school attendance is not mandatory anymore, the picture is again reversed: we do not observe a decrease at the intensive margin anymore, but rather a decrease at the extensive margin.

Reduced school attendance and educational investments seem to translate directly into worse educational performance. First of all, we observe increased grade retention already three years after typhoon Mike occurred: in 1994 children who suffered from a wealth shock 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 0.42 years and in 2005 of even 0.52 years. Analyzing the educational achievements of older siblings we observe the following pattern: the older the siblings are at the time of the disaster, the more likely they are to drop out of school (see TABLE I.4 in the Internet Appendix). Yet both patterns might be due to different explanations: While the first pattern might be explained by skill complementarities, the latter finding might be, as mentioned before, due to the fact that opportunity costs of education increase with age.

Analyzing a battery of scores from cognitive tests corroborates the findings. One year after the natural disaster, specifically in 1991, treated children score on average 0.09 standard deviations lower in a general IQ test. In 1994, we still observe a worse performance among treated 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. Children's cognitive skills are rather malleable during early childhood and are enhanced through investments by parents, social environment and school (Cunha, Heckman, Lochner, & Masterov, 2006). In a similar vein, we observe a worse performance in further tests (Math, English and the native language Cebu) among affected children – the effects are, however, not significant at any conventional level.

The provided evidence confirms the theoretical predictions outlined in Section 2: a reduction in families' wealth occurring during early childhood (to be more precise at school-starting age) leads to a reduction in current and later investments into children's education and thus to a severe and persistent harm to children's educational achievements. This evidence supports the hypothesis that early childhood is a critical period for the development of children's human capital. The aggravation over time suggests furthermore that human capital formation is a cumulative process and accumulated skills enhance the formation of later skills.

5.1.2. Health

In a similar vein to the findings for children's educational development, we would expect detrimental consequences for children's health. TABLE IV displays the estimated average impact of the housing damages on selected indicators of children's health - in the short- and in the long-run (the full set of estimates are shown in TABLE I.3 in the Internet Appendix) .

(Please place TABLE IV about here)

The average effect on children's z-scores for weight and height are small and insignificant. Results for the self-reported health measures also do not point to a deterioration in health: we observe a slight initial increase in children's likelihood to experience major illnesses (significant in 1994 only), but in 1998 actually a slight decrease. Overall, no matter which further health indicators we investigate, being objective, such as skinfold, blood pressure, arm, hip and weight circumference, or subjective, such as overall health status, frequency of hospital visits or psychological measures, we do not find any indication of a deterioration on average.

At first sight our results regarding children's health are surprising, in particular given that some recent studies have found positive effects of family income on the anthropometric measures of children who were both younger (Duflo, 2000), but also older than the children in our study when the income shock occurred (Akee, Simeonova, Copeland, Angold, & Costello, 2010).[9] Yet, explanations for the absence of any detrimental consequences due to our specific shock on family's real estate on children's biological human capital are manifold.

First, affected families are more likely to receive emergency aid (see TABLE II, Section 5.1.). The received aid, which comes in form of food, cloth or shelter, might help to maintain food consumption and basic health investments above the subsistence level and thus, might prevent a significant deterioration of children's health.

Second, one further way to compensate the potential negative health consequences of a wealth shock is to maintain the overall energy intake by switching to a cheaper but not less nutritive diet (Stillman & Thomas, 2008). Analyzing available information on children's diet composition, we indeed find that households who experience a wealth shock reduce their expenditures for food (which is, however, not significant at any conventional level) and change the composition of their diet (to be more precise, they reduce the consumption of meat and substitute it by less expensive fish, see TABLE I.3 in the Internet Appendix).

Third, it is possible that the wealth shock caused by typhoon Mike is on average not severe enough to prevent families from maintaining a level of nutritional intake which is sufficiently high enough to guarantee children's health. Yet, this does not mean that among certain more vulnerable subgroups the shock is dramatic and thus leads to negative health consequences. The following subsection sheds some light on effect heterogeneity.

[9] It is important to keep in mind that our findings refer only to a specific channel (wealth) through which a typhoon can affect child health. Hence, our results do not stand in contrast to the finding of previous papers which evaluate the complete consequences of extreme weather events (Baez & Santos, 2007; Ferreira & Schady, 2009; Poertner, 2009; Pugatch & Yang, 2009; Yamauchi, Yohannes, & Quisumbing, 2009).

5.2. Effect Heterogeneity

The consequences of a wealth shock may differ depending on a family's ability to buffer the shock as well as on the severity of the shock a specific family experienced. To shed 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, we stratify the sample into families who prior to the disaster lived or did not live in their neighborhood of origin (the best available proxy for social ties).

(Please place TABLE V about here)

Stratification with respect to families' initial wealth – where we divide the sample at the median of the wealth distribution prior to the disaster (to be more precise in 1986) – reveals the following findings (see TABLE V). First of all, it is important to notice that despite of the greater loss in absolute terms among richer families (557$ versus 1997$) families from the lower half of the wealth distribution loose more in relative terms: while among poorer families the typhoon eliminates basically all their fortune, among richer families it only destroys 30% of their wealth. Thus, liquidity constraints are likely to be binding among poorer families, while richer families possess of some buffer to maintain human capital investments.

This is exactly what we observe in the data. There are no detrimental effects observed among the children of richer families, neither in terms of health nor education. The absence of any detrimental effect among children of richer families may also provide some supportive evidence for the claim that the housing damages caused by typhoon Mike constitute mainly a wealth shock and not as previously discussed a shock to children's psyche –assuming that any shock to children's psyche occurs independently from the initial level of family wealth.

Quite the opposite is true for children of poorer families: as soon as school attendance is not mandatory anymore - at age 14/15 -, these children start dropping out of school – in 1998 they are 8% less likely to still be enrolled in school, and in 2002 they are even 16% less likely to be enrolled in school. Moreover, they are observed to work for pay already at young ages. As a result, they perform significantly worse in basically all school disciplines: 8 standard deviations in Cebu (not significant at any conventional levels), 12 standard deviations in Math and 18 standard deviations in English. Most worrisome is, however, the increasing gap in educational attainment: at the age of 22, when schooling should be basically completed, the gap between affected and unaffected children among poorer families amounts to almost one year. Thus, the consequences of a natural disaster on individual economic situations seem to aggravate preexisting inequalities within the society.

Yet, on the bright side, it seems that despite being likely to lack financial means, poor families are still able to maintain their children's food consumption at a sustainable level: there are no detrimental effects on health among their children. This might be in part due to a change in the diet composition, but also in part due to formal disaster relief or informal insurance mechanisms – the extended family might for instance provide meals or shelter.

In order to shed some tentative light on the role of informal insurance mechanisms we pursue the following stratification: We distinguish between families who, prior to the disaster, live in the barangay where at least one of the spouses was born and families where, prior to the disaster, both spouses moved away from their barangay of birth (see TABLE V). The results are as follows: Children who are likely to live close to the extended family do not experience any detrimental effect on their health. Yet, children who are likely to lack the help of the extended family experience some initial weight loss (0.17 standard deviations), which, however, vanishes over time. In a similar vein, we observe more severe consequences for the education among the children of the latter group. First of all, they are more likely to drop out of school already early on (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 (0.8 years) than among children who are likely to live rather close to the extended family (0.3 years).

While providing some supportive evidence for the existence of informal insurance mechanisms provided by the extended family, these effects have to be interpreted with caution. Families who prior to the disaster moved away from their original barangay are not only more likely to lack the support of the extended family but experience also a more severe shock on their wealth. As shown in TABLE V, the wealth shock among this group amounts to 2112 $, while the shock among the other group – which is living in the barangay where at least one spouse was born – sums up to only 1237 $. Thus, it is unclear whether the differing consequences for the health and education of the children belonging to these two groups are due to differences in the social network or in the severity to the shock.

In a final step, we want to investigate to which extent the consequences on children's education and health vary with the severity of the shock – in other words we want to provide some measure of the elasticity of children's human capital with respect to the degree of the wealth loss. Unfortunately we only possess of a rather imperfect measure of the severity of the shock, -self-reported repair cost. As discussed in Section 3, repair costs are likely to represent a lower bound of the actual damages and are likely not to be reported in case of a complete destruction. Moreover, repair costs are positively correlated with the initial value of the house and thus using repair costs per se might provide us with biased estimates. For this reason, we use the ratio between the reported repair costs and the overall wealth a family possessed prior to the disaster as a measure for the severity of the shock. We exclude all cases where the reported repair costs are either equal to zero (112 observations) or exceed total family wealth (40 observations). Thus, we restrict our sample only to children whose families experienced some damages to their houses, but are unlikely to have experienced complete house destruction. TABLE VI reports the estimates for the semi-elasticity of children's development with respect to this measure of the severity of the shock.

(Please place TABLE VI about here)

In the short run there does not seem to exist a significant link between wealth and children's anthropometric measures. Interestingly, however, in the long run, we do observe a significant negative impact on children's weight and height: a loss in family' wealth at school starting age by 1% (100%) leads to a reduction in children's weight and height at age 21/22 by around 0.003 (0.3) standard deviations (the estimate for weight is only significant at the 15% significance level). Notice that this translates into a weight reduction of 2.96 kg (in the case of total wealth destruction) and a height reduction of 2.41 cm.

The estimates for the semi-elasticities of children's educational outcomes reflect our previous findings: a wealth loss has detrimental effects on children's education, both in the short and in-the long run. This is visible in both school attendance and educational achievement. A child whose family loses 1% (100%) of its wealth is 0.1% (9%) less likely to still attend school once school attendance is not mandatory anymore. Educational achievement deteriorates already early on: a reduction in wealth by 1% (100%) causes a child to lag behind by 0.006 years (0.6 years) at age 14/15. At age 21/22 – when schooling should be basically completed – this gap amounts to 0.1 (1 year). These findings highlight once again that a small loss in family wealth may a have negligible impact on a child's development, but a severe loss in family wealth may lead to substantial disadvantages for a child's educational success.

5.3. Sensitivity Analysis

Our results suggest that a shock to families' real estate holdings leads to a reduction in families' investments in their children's education (as predicted in the model by Cunha et al. (2006)) but has no effects on health. One may cast doubt whether the estimated effects are causal, i.e., whether the set of control variables is sufficient to claim that housing damages due to typhoon Mike occur at random.

One concern may be that despite our rich set of control variables we fail to take into account any remaining confounders (e.g. parental investments) which could be proxied, for instance, by pre-storm educational outcomes. To address this issue we analyze the impact of housing damages on several placebo outcomes, such as preschool attendance, age at school entry (both retrospectively reported in 1991 and therefore not included as control variables) as well as education of older siblings prior to typhoon Mike (reported in the years prior the typhoon). Notice that these events all occurred prior to typhoon Mike and thus, by default, cannot be affected by the typhoon. Indeed, we cannot detect any significant impact of housing damages caused by typhoon Mike neither on preschool attendance nor on age at school entry nor on educational attainment of older siblings prior to the disaster (see TABLE A.3).

Second, we test robustness of our results leaving blocks of variables out of the estimation procedure (TABLE I.5, Internet Appendix). Our results are robust to omitting the set of children's initial health conditions – which indicates that housing damages are uncorrelated to children's initial preposition-, parental education, socio-economic conditions or housing material. Thus, in line with our empirical findings shown in Section 4.2 housing damages due to typhoon Mike seem to be rather random and not related to observable characteristics of the family. These results also increase the faith in our results, since one can assume that potentially unobserved characteristics are also likely to play a negligible role.

Finally, we test the robustness of our estimation results with respect to assumptions regarding the functional form and the distribution of the error term. For this purpose, we employ an inverse probability weighting (IPW) estimator, a semi-parametric estimation method suggested by Hirano and Imbens (2001). These results are comparable to the OLS results (see TABLE I.6 in the Internet Appendix).

6. Conclusion

The present study analyzes the impact of a severe wealth shock on children's development. Our identification strategy is based on housing damages caused by a super typhoon, which stroke the Cebu Metropolitan Area, Philippines, in 1990. Comparing children who all resided in the disaster area – even in the same neighborhood-, and thus were affected by the same macro-economic consequences, but not necessarily experienced private property damages, allows us to isolate the effect of an individual wealth shock.

Using the Cebu Longitudinal Nutrition and Health Survey, we first establish that the damages to private property caused by typhoon Mike led to severe losses in private wealth (57% on average), but did not trigger any further direct channels through which children's development may be affected (e.g. parental labor supply, maternal death, maternal health, parent-child separation or migration). In a second step, we analyze the impact of the private property damages on children's development.

On average the results do not reveal any detrimental effect of the specific wealth shock on children's health, but strong effects on children's educational progression. This is expressed in increased grade retention, increased school drop-out as well as worse educational performance in the short- and in the long-run. Yet, families at the upper end of the wealth distribution are able maintain their investments into health and education and thus, their children are unaffected, both in terms of health and education. Only children whose families lack sufficient financial resources, fare significantly worse in school. Moreover, children who are likely to live rather far from the extended family and thus, are likely to lack the support of a strong social network, experience, negative consequences, both in terms of health and education.

Our findings are in line with the findings of a very recent but rapidly growing literature on the link between family income and child development. These studies have found consistent evidence for a positive link between income and education. Akee et al. (2010) for instance, find that additional 6000$ per year, which corresponds to an increase in annual household income by 30% for the sample under study, caused the benefited children to attend school for almost one extra year. Dahl and Lochner's (forthcoming) findings reveal that additional 1000$ - which in their sample corresponds to an income increase by around 6% - cause an improvement in children's math and reading scores by 0.06 standard deviations. Løken et al. (forthcoming) provide moreover interesting evidence about large marginal effects in the lower part of the income distribution, but rather small effects in the middle and upper part of the income distribution. Employing a back-of-the-envelope calculation, we find that our wealth shock - on average we talk about a loss of 38% of the average annual income – causes children to leave school 0.52 years earlier and leads to a deterioration in children's school performance in Math and language test scores by 0.07 and 0.06 standard deviation, respectively. Thus, despite using evidence from a developing country, we identify effects which point into the same direction, but are more modest in magnitude.

The existing evidence regarding the link between income and children's health is rather mixed. Exploiting a dramatic income decline induced by the Russian economic crisis, Stillman and Thomas (2008) cannot identify any impact of family income on children's stature. Banerjee et al. (2010), exploiting income shocks experienced by vintners due to phylloxera which destroyed 40% of French vineyards in the 19th century, can only detect a significant impact on children's height, not, however, on any further health measures, such as morbidity or life expectancy. Finally, Akee et al. (2010) find only evidence for a causal link between family income and children's body stature among the children at the bottom of the income distribution. Our findings are in line with these studies: we do not find any general impact of wealth on children's health, but cannot exclude the possibility that either disaster relief or further informal insurance mechanisms may explain the absence of any causal link between wealth and children's health.

The evidence of the present study combined with the general agreement that education is the key to later professional success suggests that the provision of targeted disaster relief - in particular disaster relief which is tied to children's continuous participation in education - may help to alleviate the consequences of unexpected wealth shocks on children's development. Moreover, given the fact that damages caused by natural disasters affect the poorest people disproportionally, aid targeted at children's school attendance may help to prevent a further increase in the inequality of a society.

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Appendix

FIGURE A.1: Philippines and the location of Cebu

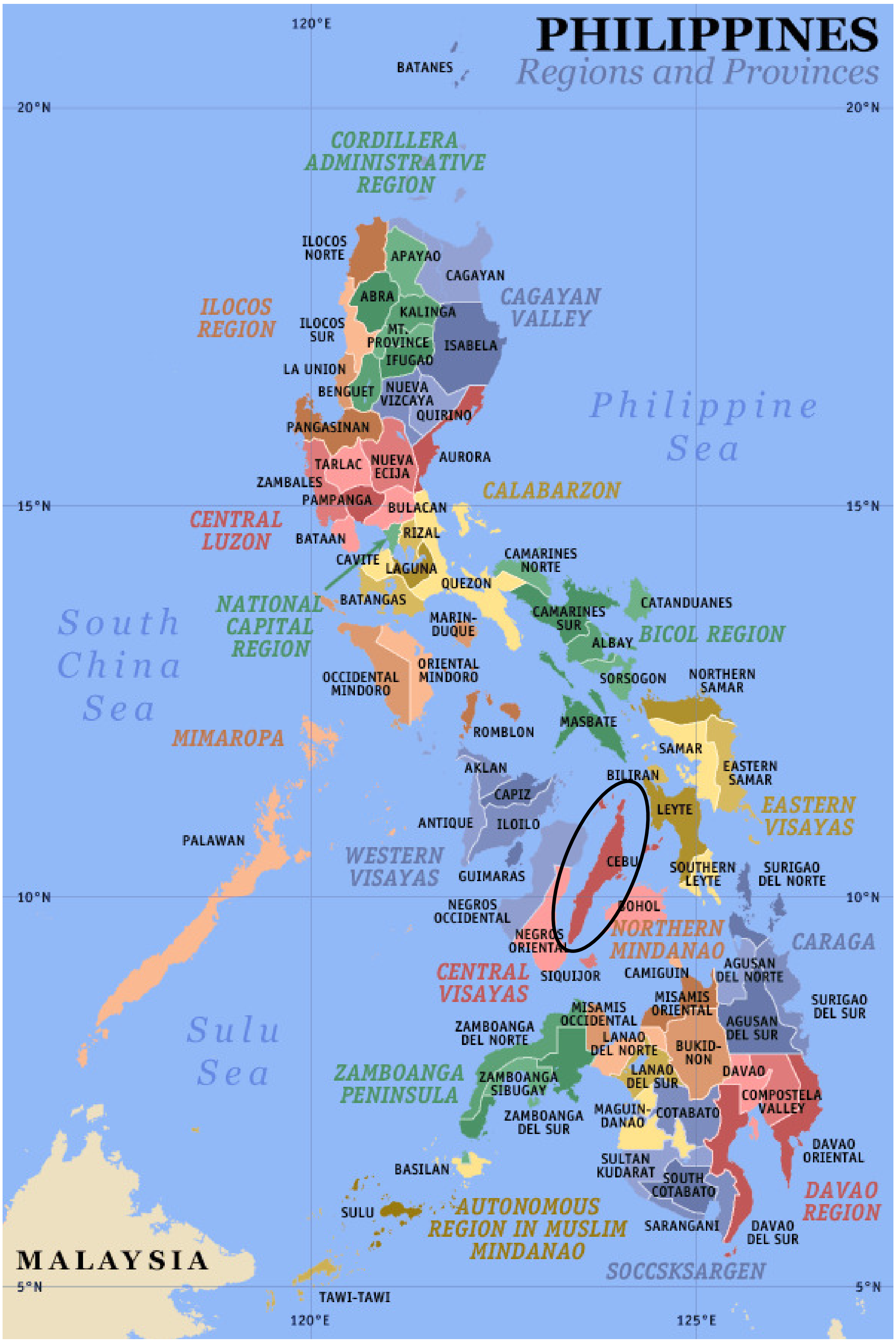

FIGURE A.2: Percentage of housholds reporting damages across barangays in the Cebu Metropolitan Area

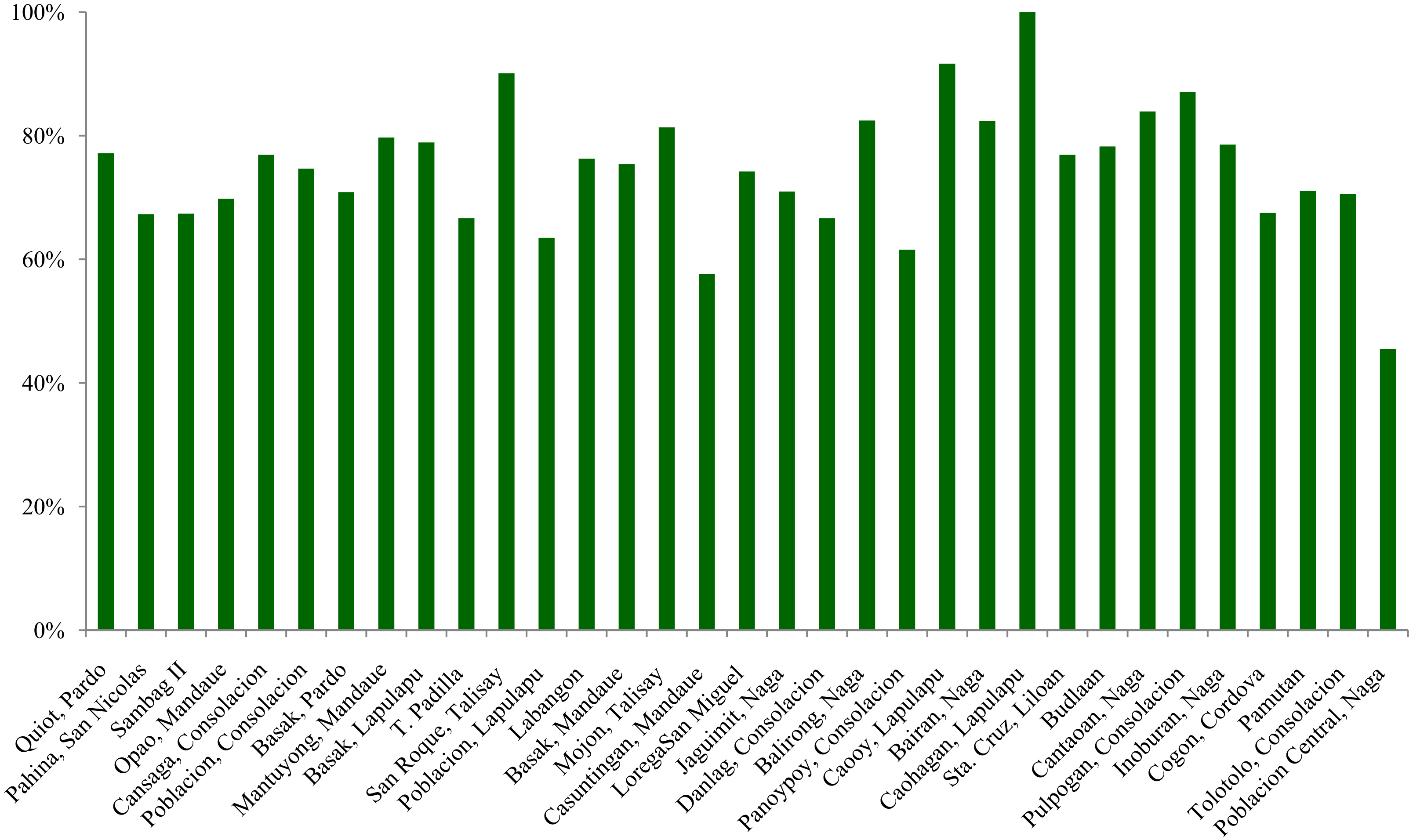

TABLE A.1: Descriptive statistics

Variable (year of measurement)	Obs	Mean	SD	No damages	Damages	
Damages on house						
Any damages on house - binary (1991)	2067	0.755	0.430			
Repair costs in constant 1990$ (1991)	1378	260	888			
Outcome variables						
Health						
Z-score: Weight for age (1991)	1983	-2.170	1.094	-2.005	-2.223	***
Z-score: Weight for age (1994)	1920	-1.851	1.227	-1.697	-1.901	***
Z-score: Weight for age (1998)	1845	-1.788	1.109	-1.706	-1.815	*
Z-score: Weight for age (2002)	1789	-2.023	1.241	-1.960	-2.044	
Z-score: Weight for age (2005)	1679	-2.035	1.398	-1.976	-2.056	
Z-score: Height for age (1991)	1983	-2.264	0.992	-2.144	-2.302	***
Z-score: Height for age (1994)	1917	-1.804	1.030	-1.672	-1.846	***
Z-score: Height for age (1998)	1845	-2.026	0.881	-1.932	-2.056	***
Z-score: Height for age (2002)	1786	-2.111	0.871	-2.067	-2.123	
Z-score: Height for age (2005)	1679	-2.106	0.870	-2.063	-2.118	
Major illness - binary (1991)	1986	0.183	0.387	0.175	0.186	

Variable (year of measurement)	Obs	Mean	SD	No damages	Damages	
Major illness - binary (1994)	1924	0.089	0.285	0.062	0.097	*
Major illness - binary (1998)	1685	0.777	0.416	0.800	0.770	
Major illness - binary (2002)	1788	0.654	0.476	0.635	0.663	
Major illness - binary (2005)	1682	0.347	0.476	0.352	0.346	
Education						
Age of child when entered school – in years	1986	6.379	1.407	6.446	6.357	
Days/month missed school (1994)	1810	1.178	1.877	0.849	1.286	***
Hours/day doing household chores (1994)	1915	0.832	0.754	0.733	0.864	***
Hours/day doing homework (1994)	1818	0.811	0.517	0.888	0.785	***
Currently enrolled in school - binary (1994)	1925	0.778	0.416	0.747	0.789	**
Currently enrolled in school - binary (1998)	1849	0.769	0.422	0.839	0.745	***
Currently enrolled in school - binary (2002)	1805	0.424	0.494	0.543	0.387	***
Currently enrolled in school - binary (2004)	1714	0.172	0.377	0.248	0.148	***
Highest grade completed - in years (1994)	1925	3.532	1.121	3.764	3.459	***
Highest grade completed - in years (1998)	1849	7.600	2.128	8.055	7.457	***
Highest grade completed - in years (2002)	1805	9.794	2.781	10.590	9.539	***
Highest grade completed - in years (2005)	1714	10.747	3.614	11.760	10.432	***

Variable (year of measurement)	Obs	Mean	SD	No damages	Damages	
Standardized IQ score (1991)	1975	-0.006	0.990	0.221	-0.079	***
Standardized IQ score (1994)	1919	0.002	0.980	0.203	-0.061	***
Standardized English score (1994)	1905	-0.013	0.986	0.241	-0.095	***
Standardized Cebu score (1994)	1908	-0.010	0.995	0.200	-0.078	***
Standardized Math score (1994)	1907	-0.009	0.987	0.223	-0.085	***
Channels						
Wealth in constant 1990$ (1991)	2056	3967	9321	6938	3005	***
Asset index (1991)	2067	0.000	2.156	0.840	-0.270	***
Value of the house in constant 1990$ (1991)	2063	2308	6130	3994	1762	***
Value of furniture in constant 1990$ (1991)	2066	205	443	343	160	***
Value of appliances in constant 1990$ (1991)	2067	504	942	780	415	***
Value of livestock in constant 1990$ (1991)	2065	128	368	142	123	
Value of vehicles in constant 1990$ (1991)	2066	441	2867	1016	255	**
Value of business equipment in constant 1990$ (1991)	2065	194	1974	352	143	*
Value of total income in constant 1990$ (1991)	2067	4394	5563	5613	3999	***
Father's employment status - binary (1991)	1820	0.914	0.281	0.898	0.919	
Mother's employment status - binary (1991)	1944	0.691	0.462	0.702	0.687	

Variable (year of measurement)	Obs	Mean	SD	No damages	Damages	
Mother died - binary (1991)	2067	0.008	0.090	0.012	0.007	
Mother has severe illness - binary (1991)	1978	0.111	0.314	0.118	0.107	
Child migration (1991)	1986	0.008	0.089	0.023	0.003	***
Child Family separation (1991)	2067	0.060	0.238	0.057	0.061	
Control variables						
Housing quality						
Material of house: nipa – binary (1984)	2345	0.432	0.495	0.338	0.467	***
Material of house: cement – binary (1984)	2345	0.181	0.385	0.279	0.138	***
Soil formation: unconsolidated – binary (1984)	2345	0.402	0.490	0.403	0.388	
Soil formation: core basalt rocks – binary (1984)	2345	0.097	0.296	0.083	0.102	
Average soil depth: 1-3m – binary (1984)	2345	0.170	0.376	0.192	0.165	
Average soil depth: 0.3-1m – binary (1984)	2345	0.320	0.467	0.281	0.332	**
Average soil depth: < 0.3m – binary (1984)	2345	0.123	0.328	0.13	0.136	
Value of the house in constant 1990$ (1984)	2345	1331	5354	2316	1070	***
Socioeconomic Status						
Wealth in constant 1990$ (1986)	2345	3370	10857	6294	2459	***
Value of total income in constant 1990$ (1986)	2345	4169	8909	5554	3651	***

Variable (year of measurement)	Obs	Mean	SD	No damages	Damages	
Total income (1986): second quintile – binary	2345	0.207	0.405	0.188	0.213	
Total income (1986): third quintile – binary	2345	0.200	0.400	0.152	0.217	***
Total income (1986): forth quintile – binary	2345	0.199	0.399	0.221	0.190	
Total income (1986): fifth quintile – binary	2345	0.197	0.398	0.279	0.164	***
House ownership – binary (1986)	2345	0.730	0.444	0.725	0.764	*
Father's employment status – binary (1986)	2345	0.854	0.353	0.854	0.865	
Mother's employment status – binary (1986)	2345	0.406	0.491	0.401	0.414	
Spouse lives in HH – binary (1986)	2345	0.945	0.229	0.935	0.953	**
Spouse temporary absent – binary (1986)	2345	0.065	0.247	0.079	0.060	
Parental education						
Father's highest grade – years (1986)	2345	6.702	4.354	7.338	6.406	***
Father received vocational training - binary (1986)	2345	0.121	0.326	0.158	0.105	***
Mother's highest grade - years (1986)	2345	7.340	3.766	8.413	6.878	***
Mother received vocational training - binary (1986)	2345	0.165	0.372	0.170	0.157	
Child characteristics						
Female - binary (1984)	2345	0.472	0.499	0.510	0.457	*
Size at birth: smaller than normal - binary (1984)	2345	0.177	0.382	0.164	0.184	

Variable (year of measurement)	Obs	Mean	SD	No damages	Damages	
Size at birth: bigger than normal - binary (1984)	2345	0.270	0.444	0.247	0.281	
Place of delivery: hospital - binary (1984)	2345	0.366	0.482	0.468	0.322	***
Birth complication - binary (1984)	2345	0.137	0.344	0.123	0.140	
Z-Score: Height for age (1986)	2345	-2.323	1.158	-2.152	-2.394	***
Z-Score: Weight for age (1986)	2345	-2.218	1.177	-2.069	-2.27	***
Z-Score: BMI for age (1986)	2345	-0.822	1.024	-0.794	-0.820	
Household characteristics						
Number of rooms (1986)	2345	2.588	1.331	2.951	2.491	***
Garbage disposal : collected - binary(1986)	2345	0.134	0.341	0.186	0.106	***
Garbage disposal : burning - binary (1986)	2345	0.417	0.493	0.377	0.438	**
Garbage disposal : dumping at house - binary (1986)	2345	0.130	0.336	0.125	0.138	
Garbage disposal : dumping away from house - binary (1986)	2345	0.226	0.419	0.221	0.225	
Type HH: One nuclear family household - binary (1986)	2345	0.630	0.483	0.601	0.654	**
Type HH: Multi-nuclear family household - binary (1986)	2345	0.209	0.406	0.249	0.186	***

Note: Descriptive statistics are for the sample observed in the respective year. The last column displays if the difference in variables between families who experienced no damages and those families who experienced damages are significantly different on the 10% (*), 5% (**), or 1% (***) level (derived from a standard t-test).

TABLE A.2: OLS regression results for channels (long-run effects)

	Coefficient	t
Wealth in 1990$ (1994)	-2356.56 *	-1.75
Wealth in 1990$ (1998)	-327.74	-0.28
Wealth in 1990$ (2002)	-3385.87 *	-1.66
Wealth in 1990$ (2005)	-1228.36	-1.36
Asset index (1994)	-0.38 ***	-3.95
Asset index (1998)	-0.23 **	-2.39
Asset index (2002)	-0.37 ***	-3.04
Asset index (2005)	-0.33 ***	-2.67
Value of total income in 1990$ (1994)	-114.48	-0.46
Value of total income in 1990$ (1998)	-210.28	-0.94
Value of total income in 1990$ (2002)	-391.72	-1.30
Value of total income in 1990$ (2005)	-759.23 **	-2.33
Father's employment status (1994)	0.01	0.34
Father's employment status (1998)	0.01	0.42
Father's employment status (2002)	0.03	1.63
Father's employment status (2005)	0.01	0.46
Mother's employment status (1994)	0.01	0.56
Mother's employment status (1998)	0.00	0.14
Mother's employment status (2002)	-0.01	-0.46
Mother's employment status (2005)	0.02	0.66

Note: TABLE A.2 displays the regression coefficients for damages (binary indicator) on the dependent variable described in the table. The coefficients are derived from OLS regressions that additionally control for the set of variables described in TABLE A.1 as well as a set of barangay fixed effects. Results of the full specifications are available upon request. $p < 0.10$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

TABLE A.3: OLS regression results (outcome variables: placebo outcomes)

	Coefficent	**t**
Age of child when entered school	-0.01	-0.07
Child enrolled in school before typhoon	0.02	0.61
Child attended preschool	-0.01	-0.60
Highest grade completed of oldest sibling	0.08	0.32
Highest grade completed of oldest brother	0.42	1.54
Highest grade completed of oldest sister	-0.27	-0.92

Note: TABLE A.3 displays the regression coefficients for damages (binary indicator) on the dependent variable described in the table. The coefficients are derived from OLS regressions that additionally control for the set of variables described in TABLE A.1 as well as a set of barangay fixed effects. Results of the full specifications are available upon request. $p < 0.10$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

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Tables

TABLE I: Probit regression for the propensity to experience housing damages

	Coefficient	z
Housing characteristics		
Material of house: nipa (1984)	-0.014	-0.17
Material of house: cement, wood (1984)	-0.24**	-2.54
Soil formation: unconsolidated (1984)	-0.09	-0.41
Soil formation: core basalt rocks (1984)	-0.05	-0.11
Average soil: 1-3m (1984)	-0.32	-0.93
Average soil: 0.3-1m (1984)	0.12	0.37
Average soil: < 0.3m (1984)	0.24	0.42
Value of the house in 1000 constant 1990$ (1984)	0.03**	2.37
Socio-economic status		
Spouse lives in HH (1986)	0.35	1.58
Spouse temporary absent (1986)	-0.06	-0.39
Father's employment status (1986)	-0.25**	-2.02
Mother's employment status (1986)	0.04	0.62
Value of total income in 1000 constant 1990$ (1986)	0.00	0.40
Wealth in 1000 constant 1990$ (1986)	-0.02***	-2.89
Child characteristics		
Female (1984)	-0.185 9***	-2.74
Size at birth: smaller than normal (1984)	0.12	1.29
Size at birth: bigger than normal (1984)	0.13	1.63
Place of delivery: hospital (1984)	-0.12	-1.41
Birth complication (1984)	0.13	1.40
Height for age (1986)	0.32	0.76
Weight for age (1986)	-0.43	-0.78
BMI for age (1986)	0.33	0.83

	Coefficient	z
Parental education		
Father's highest grade (1986)	0.00	0.33
Father received vocational training (1986)	-0.14	-1.39
Mother's highest grade (1986)	-0.03**	-2.19
Mother received vocational training (1986)	-0.00	-0.05
Pseudo R2	0.09	
N	2058	

Note: We additionally control for quintiles of the value of the house, quintiles for the total HH income, number of rooms, garbage disposal, the type of the household, household size as well as barangay fixed effects. The results for the full specification are shown in TABLE I2 in the Internet Appendix. . p < 0.10 (*), p < 0.05 (**), p < 0.01 (***).

TABLE II: OLS regression results (outcome variables: channels in 1991)

	Coefficient	t
Wealth		
Wealth in constant 1990$	-1401.06***	-3.33
Value of the house in constant 1990$	-1238.74***	-3.70
Value of furniture in constant 1990$	-65.36***	-3.19
Value of household appliances in constant 1990$	-102.01**	-2.36
Value of vehicles in constant 1990$	-293.62**	-2.10
Value of livestock in constant 1990$	1.43	0.08
Value of business equipment in constant 1990$	-4.16	-0.04
Asset index (standardized to mean 0, variance 1)	-0.40***	-4.64
Alternative channels		
Value of total income in constant 1990$	-290.43	-1.09
Disaster relief (binary)	0.26***	10.51
Father is working (binary)	0.01	0.67
Mother is working (binary)	-0.02	-0.82
Mother suffers from major illnesses (binary)	-0.02	-1.3
Mother died (binary)	-0.01	-1.26
Family migrated (binary)	-0.02***	-3.94
Child separated from the family (binary)	0.01	0.68

Note: TABLE II displays the regression coefficients for damages (binary indicator) on the dependent variable described in the table. The coefficients are derived from OLS regressions that additionally control for the set of variables described in TABLE A.1 as well as a set of barangay fixed effects. Results of the full specifications are available upon request. $p < 0.10$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

TABLE III: OLS regression results (outcome variables: educational outcomes)

	Coefficient	t
Attendance		
Currently enrolled in school - binary (1994)	0.02	1.37
Currently enrolled in school - binary (1998)	-0.03	-1.51
Currently enrolled in school - binary (2002)	-0.08 ***	-2.94
Currently enrolled in school - binary (2005)	-0.03	-1.61
Days/month missed in school (1994)	0.26 **	2.50
Days/month missed in school (1998)	0.16	1.13
Days/month missed in school (2002)	0.01	0.04
Days/month missed in school (2005)	0.31	0.69
Hours/day doing household chores (1994)	0.07 *	1.74
Hours/day doing homework (1994)	-0.04	-1.51
Work for pay (1991)	0.01	0.97
Work for pay (1994)	0.01	0.53
Work for pay (1998)	-0.00	-0.12
Work for pay (2002)	-0.00	-0.14
Work for pay (2005)	0.02	0.52
Performance		
Highest grade completed - in years (1994)	-0.12 **	-2.22
Highest grade completed - in years (1998)	-0.20 *	-1.87
Highest grade completed - in years (2002)	-0.42 ***	-3.14
Highest grade completed - in years (2005)	-0.52 ***	-2.79
Standardized IQ score (1991)	-0.09 *	-1.82
Standardized IQ score (1994)	-0.06	-1.21
Standardized English score (1994)	-0.06	-1.43
Standardized Cebu score (1994)	-0.06	-1.31
Standardized Math score (1994)	-0.07	-1.54

Note: TABLE III displays the regression coefficients for damages (binary indicator) on the dependent variable described in the table. The coefficients are derived from OLS regressions that additionally control for the set of variables described in TABLE A.1 as well as a set of barangay fixed effects. Results of the full specifications are available upon request. $p < 0.10$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

TABLE IV: OLS regression results (outcome variables: health outcomes)

	Coefficient	t
Weight (objective)		
Z-score: Weight for age (1991)	-0.06	-1.30
Z-score: Weight for age (1994)	-0.01	-0.12
Z-score: Weight for age (1998)	-0.01	-0.22
Z-score: Weight for age (2002)	-0.01	-0.21
Z-score: Weight for age (2005)	0.01	0.18
Height (objective)		
Z-score: Height for age (1991)	0.04	0.94
Z-score: Height for age (1994)	0.03	0.64
Z-score: Height for age (1998)	0.01	0.24
Z-score: Height for age (2002)	0.04	0.96
Z-score: Height for age (2005)	0.04	1.03
Illness (subjective)		
Major illness (1991)	0.00	0.09
Major illness (1994)	0.03 **	2.20
Major illness (1998)	-0.04	-1.46
Major illness (2002)	0.02	0.73
Major illness (2005)	0.00	0.12

Note: TABLE IV displays the regression coefficients for damages (binary indicator) on the dependent variable described in the table. The coefficients are derived from OLS regressions that additionally control for the set of variables described in TABLE A.1 as well as a set of barangay fixed effects. Results of the full specifications are available upon request. $p < 0.10$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

TABLE V: OLS regression results (stratified samples)

	Poor		Rich		No Network		Network	
	Coefficient	**t**	**Coefficient**	**t**	**Coefficient**	**t**	**Coefficient**	**t**
Wealth in constant 1990$ (1991)	-577 ***	-2.72	-1997 **	-2.57	-2112 ***	-3.53	-1237 **	-2.5
Z-score: Weight (1991)	-0.06	-0.85	-0.05	-0.89	-0.17 **	-2.05	-0.02	-0.33
Z-score: Weight (1994)	0.02	0.30	-0.03	-0.34	-0.08	-0.78	0.04	0.69
Z-score: Weight (1998)	0.04	0.43	-0.05	-0.66	-0.02	-0.20	0.01	0.16
Z-score: Weight (2002)	0.05	0.55	-0.05	-0.59	-0.02	-0.13	-0.01	-0.09
Z-score: Weight (2005)	0.04	0.33	0.00	0.04	0.01	0.09	0.05	0.60
Z-score: Height (1991)	0.03	0.57	0.04	0.82	0.00	0.06	0.03	0.73
Z-score: Height (1994)	0.05	0.75	0.00	0.07	-0.09	-1.05	0.07	1.41
Z-score: Height (1998)	0.02	0.26	0.01	0.26	0.02	0.28	-0.01	-0.28
Z-score: Height (2002)	0.01	0.08	0.08	1.43	0.06	0.76	0.01	0.31
Z-score: Height (2005)	-0.02	-0.27	0.08	1.54	0.06	0.70	0.02	0.37
Enrolled in school (1994)	0.01	0.39	0.03	1.57	0.05	1.57	0.02	0.82
Enrolled in school (1998)	-0.08 **	-2.12	-0.01	-0.41	-0.07 *	-1.66	-0.02	-0.56
Enrolled in school (2002)	-0.16 ***	-3.87	-0.04	-1.02	-0.11 **	-2.14	-0.05	-1.41
Enrolled in school (2004)	-0.07 **	-2.33	-0.02	-0.48	-0.01	-0.34	-0.04 *	-1.70

	Coefficient	t	Coefficient	t	Coefficient	t	Coefficient	t
Work for pay (1991)	0.02 *	1.81	-0.00	-0.55	0.01	0.86	0.01	0.77
Work for pay (1994)	0.02 *	1.79	0.00	0.10	0.02	0.60	0.00	0.20
Work for pay (1998)	0.07	1.58	-0.04	-1.04	0.05	0.91	-0.02	-0.49
Work for pay (2002)	-0.05	-1.16	0.04	1.19	0.01	0.25	-0.01	-0.29
Work for pay (2005)	0.02	1.81	-0.00	-0.55	0.09	1.57	0.00	0.09
Highest grade (1994)	-0.19 **	-2.07	-0.09	-1.46	-0.20 **	-1.95	-0.07	-1.15
Highest grade (1998)	-0.38 **	-2.14	-0.13	-1.03	-0.19	-0.98	-0.15	-1.17
Highest grade (2002)	-0.78 ***	-3.44	-0.26	-1.58	-0.47 *	-1.87	-0.33 **	-1.97
Highest grade (2005)	-0.97 ***	-3.24	-0.35	-1.47	-0.80 **	-2.09	-0.30	-1.39
Std. IQ score (1991)	-0.19 **	-2.52	-0.01	-0.23	-0.13	-1.35	-0.07	-1.22
Std. IQ score (1994)	-0.14 *	-1.83	-0.03	-0.54	0.00	0.03	-0.07	-1.19
Std. English score (1994)	-0.18 ***	-2.72	-0.01	-0.11	-0.11	-1.24	-0.05	-0.87
Std. Cebu score (1994)	-0.08	-1.13	-0.07	-1.09	-0.07	-0.72	-0.06	-1.04
Std. Math score (1994)	-0.12 *	-1.65	-0.06	-0.87	-0.12	-1.33	-0.03	-0.43

Note: TABLE V displays the regression coefficients for damages (binary indicator) on the dependent variable described in the table. The coefficients are derived from OLS regressions that additionally control for the set of variables described in TABLE A.1 as well as a set of barangay fixed effects. Stratification between "Poor" (996 observations) and "Rich" (1062 observations) is based on position in the distribution of wealth in 1986 (below and above the median), the distinction between "No Network" (639 observations) and "Network" (347 observations) is based on whether the family lives in the district where none of the spouses is born or at least one of the spouses is born. Results for the full specification are available upon request. $p < 0.10$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

TABLE VI: OLS regression results (explanatory variable: fraction of damages)

	Coefficient	t
Z-score: Weight for age (1991)	-0.09	-0.83
Z-score: Weight for age (1994)	-0.16	-1.15
Z-score: Weight for age (1998)	-0.09	-0.62
Z-score: Weight for age (2002)	-0.24	-1.41
Z-score: Weight for age (2005)	-0.30	-1.49
Z-score: Height for age (1991)	-0.26	-0.62
Z-score: Height for age (1994)	-0.12	-1.04
Z-score: Height for age (1998)	-0.18 *	-1.67
Z-score: Height for age (2002)	-0.27 **	-2.53
Z-score: Height for age (2005)	-0.32 ***	-2.81
Currently enrolled in school (1994)	0.02	0.39
Currently enrolled in school (1998)	-0.09 **	-2.06
Currently enrolled in school (2002)	-0.10	-1.57
Currently enrolled in school (2004)	-0.04	-0.52
Highest grade completed (1994)	-0.12	-0.80
Highest grade completed (1998)	-0.58 *	-1.90
Highest grade completed (2002)	-0.62 *	-1.92
Highest grade completed (2005)	-1.06 **	-2.10
Standardized IQ score (1991)	-0.10	-0.79
Standardized IQ score (1994)	-0.15	-1.12
Standardized English score (1994)	-0.10	-0.79
Standardized Cebu score (1994)	-0.17	-1.27
Standardized Math score (1994)	-0.06	-0.43

Note: TABLE IV 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. The coefficients are derived from OLS regressions that additionally control for the set of variables described in TABLE A.1 as well as a set of barangay fixed effects. Results of the full specifications are available upon request. $p < 0.10$ (*), $p < 0.05$ (**), $p < 0.01$ (***).