Scarring versus Selective Mortality: The long-term effects of early-life exposure to natural disasters in the Philippines*

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Abstract

This paper analyzes the long-term effects of early-life shocks with varying degrees of severity on mortality and human capital outcomes in the Philippines. We exploit variations in the geographical path and intensity of typhoons, as well as the introduction of disaster relief policies under Ferdinand Marcos to disentangle the effects of culling and scarring. Before Marcos, in-utero exposure to severe typhoons led to higher mortality; the average survivor exhibited similar levels of human capital as the unaffected. Under Marcos, in-utero exposure to severe typhoons had little impact on mortality but significantly reduced survivors' educational attainment and occupational skill level. These adverse effects are intensified within families and among those born to disadvantaged parents.

Keywords: fetal origins hypothesis, selective mortality, Philippines, natural disasters, long-term outcomes

JEL codes: I12, I15, O15

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1 Introduction

Environmental shocks often have lasting consequences on human capital development. Early-life exposure to negative environmental shocks may increase mortality (Doocy et al., 2007; Jayachandran, 2009); these shocks may also have negative effects on human capital that persist into adulthood (Almond and Currie, 2011; Currie and Vogl, 2013). Climate change is expected to further intensify the frequency and unpredictability of environmental shocks, yet much of the existing literature focuses on the effects of rare and severe natural disasters. What about the effects of repeated environmental shocks? Do the effects vary by severity and frequency? Such questions are important for policy makers, but little is known about them. This paper examines the effects of early-life exposure to environmental shocks on mortality and long-term human capital outcomes in a setting where such shocks are relatively frequent. The repetition of the shocks allows us to estimate the dose-response effect of early-life exposure to natural disasters with varying degrees of severity.

We focus on the Philippines, a developing country. Environmental shocks occur more frequently in developing than high income countries (Hsiang and Jina, 2014). Past research suggests that the adverse effects of environmental shocks could be more pronounced in developing countries than in high-income countries (Currie and Vogl, 2013; Hanna and Oliva, 2016; Arceo et al., 2016). Yet studies on developing countries are often plagued by the paradox of mortality selection: if the strong are more likely to survive, higher mortality rates could correspond to better adult outcomes among the survivors (Deaton, 2007). Hence, if an early-life shock leads to higher mortality through culling of the weakest, its long-term effects on human capital, that is, scarring, may be masked (Currie and Vogl, 2013; Meng and Qian, 2009). This paper illustrates the paradox of mortality selection and quantifies the bias in observed long-term effects that arises from selective mortality. We do so by analyzing the introduction of disaster-relief policies that effectively mitigated much of the adverse effects on early mortality but was insufficient to remediate the long-term scarring effects on survivors.

We build on a large body of literature that uses natural experiments as a source of exogenous variation to identify the persistent effects of early-life shocks (Almond and Currie, 2011; Maccini and Yang, 2009; Currie and Rossin-Slater, 2013; Shah and Steinberg, 2017). Our empirical setting exploits variations in the timing, geographic path, and intensity of severe tropical cyclones – typhoons – in the Philippines. The country is prone to typhoons: on average, five to six typhoons make landfall every year, one of which is a severe typhoon (Saffir-Simpson [SS] scale 4 or 5).[1] The high degree of unpredictability in the storm path

[1] Author's calculations based tropical cyclone data from 1945 to 2015 (Table 1).

and intensity provides an ideal natural experiment to study their effects on mortality and survivors' long-term outcomes. At the same time, the high degree of similarity among different typhoon occurrences allows us to estimate the dose-response effects – while it is difficult to compare different types of negative shocks such as severe famines versus severe floods, it is possible to compare the effects of a severe typhoon to that of a less intense one.

We analyze the relative magnitude of selective mortality and survivors' long-term scarring by combining the unpredictability of typhoons with changes in disaster response policies after Ferdinand Marcos came to power in 1965. Before the Marcos regime, disaster relief funds were virtually non-existent in the Philippines. In response to the high frequency of natural disasters and increasing political uncertainty, the Marcos regime introduced various measures to increase funding for disaster relief. These short-term post-disaster relief efforts aimed to protect children from some of the immediate deleterious effects of natural disasters. If these relief efforts reduce typhoon-induced early-life mortality, we may observe changes in the long-term scarring among survivors. We separate early-life typhoon exposure into two periods: before and after Marcos assumed office in December 1965. We then compare the magnitude of the mortality effects and the long-term scarring on cohorts that were exposed to pre- and post-1965 typhoons. In doing this, we also extend the literature on the mitigating effects of early-life interventions (Almond et al., 2017).

We employ a difference-in-differences method to analyze the dose-response effects of early-life exposure to typhoons. We combine individual and municipality level data from the 1990 Philippine Census with historical data on the intensity and paths of all tropical storms passing through the Philippines from 1945 to 1990. The 1990 Philippine Census recorded individuals' year and municipality of birth, which allows us to match each individual with the typhoon activities in his/her municipality of birth while he/she was in utero and in his/her first two years of life. To execute the difference-in-differences method, we use municipality fixed effects as well as four sets of age by island group fixed effects, one for each island group. To study the effects on mortality, we use cohort size and the fraction of males in each cohort as outcome variables. To study the effects on long-term human capital accumulation, we use educational attainment and occupation as outcome variables.

We find that in-utero exposure to severe typhoons (Saffir-Simpson scale 4 or 5) is associated with a 7 percentage point reduction in male cohort size and a lower fraction of males, which suggest an increase in mortality. These results are consistent with the fragile male hypothesis, which argues that males are more vulnerable to negative early-life shocks than females (Kraemer, 2000). The large reduction in male cohort size but small effects on female cohort size also confirms that the reduction in cohort size is driven by an increase in early-life mortality rather than a decline in fertility. Less intense typhoons (Saffir-Simpson scale 1, 2, or 3) had little effects on either cohort size or the fraction of males. We then analyze the effects of early life exposure to typhoons on survivors' educational and labor market outcomes. Again, we find large negative effects among survivors of severe typhoons, but not of less intense typhoons.

The disaster relief policy under Marcos is associated with a change in mortality. Before Marcos assumed office, in-utero exposure to severe typhoons reduced cohort size by almost 10 percentage points, but had little impact on long-term outcomes – the surviving cohorts on average exhibited similar human capital outcomes as unaffected cohorts. In contrast, under the Marcos regime, when disaster relief funds became more available, albeit still limited, in-utero exposure to severe typhoons had little impact on mortality, but significantly reduced survivors' educational attainment and occupational skill level – our estimates suggest 0.3 years reduction in education and a 15 percentage points lower probability of attaining a skilled occupation. These results suggest a strong negative relationship between mortality rates and the long-term scarring effects of adverse early-life shocks. High selective mortality, as observed in the pre-Marcos period, can mask the scarring effects in the long-term. Since the weak are more likely to die shortly after an adverse shock, positively selected survivors exhibit limited long-term adverse outcomes. The positive shock of Marcos' disaster relief funding reduced early-life mortality. Consequently, some individuals who would have died survived and adverse long-term effects on them are observed. In other words, what seem like deteriorating long-term outcomes after the introduction of disaster relief policy actually reflect improved chances of survival.

The adverse long-term effects are intensified when we perform within household sibling comparisons. In other words, the estimates with household fixed effects are even larger in magnitude than the difference-in-differences estimates with municipality fixed effects. This is consistent with the findings in Almond et al. (2009) and suggests that parents may reinforce the adverse effects of negative pre-natal shocks by reducing post-natal investments on the affected child. We also examine heterogeneity in the long-term effects by family socioeconomic status (SES). The adverse effects are more pronounced on low-SES families than on high-SES families, suggesting that family resources affect their ability to cope with the aftermath of a severe typhoon and their ability to engage in compensating behavior for the affected children.

We find that in-utero exposure to *low-intensity* (SS scale 1, 2 and 3) typhoons in the Philippines do not have much effect on either mortality or long-term human capital outcomes. In contrast, studies on low-intensity tropical cyclones in the U.S. and Brazil have found adverse effects on both short-term and long-term outcomes. de Oliveira and Quintana-Domeque (2016) find that, in Brazil, the first-ever reported hurricane in the South Atlantic, a low-intensity hurricane, had significant negative effects on birth weight. In the U.S., where low-intensity hurricanes are more common than in Brazil but less common than in the Philippines, Simeonova (2011) and Currie and Rossin-Slater (2013) find small negative effects on birth outcomes; Karbownik and Wray (2016) find substantial adverse effects on educational attainment and income later in life.[2] One plausible explanation for these different results is that residents in cyclone-prone countries are relatively well adapted to *low-intensity* typhoons. Other evidence from the US also suggests that long-term adaptation mitigates the effects of short-term shocks (Zivin et al., 2015).

We also add to a growing body of research on the effects of typhoons in the Philippines. Ugaz and Zanolini (2011) focus on two severe typhoons that hit Cebu in 1984 and find significant reductions on the height of children who were exposed to these typhoons while in-utero. Deuchert and Felfe (2015) investigate a severe typhoon that hit Cebu in 1990. They find large, persistent damages to the housing and wealth of some households. Consequently, these households reduced their educational expenditures up to 15 years after the typhoon, whichthen lead to significant reductions on the educational attainment of children who were *six years old* at the time of the typhoon. Anttila-Hughes and Hsiang (2013) examine typhoons in the 1980s and find large reductions in durable assets, non-labor income, and expenditures one year after each typhoon. They also find excess infant mortality among those conceived *after* a typhoon, which is consistent with reduced health and human capital investments after a typhoon. Compared to these earlier studies, our use of multiple typhoons in a generalized difference-in-differences framework allows us to compare the effects of in-utero exposure relative to exposure at other ages. That is, we do not exclude the possibility that typhoon exposure adversely affects children of all ages, perhaps through reductions in household wealth and expenditures. Rather, we focus on the incremental effects of in-utero exposure – the difference between the effects on cohorts who were exposed in-utero and cohorts who were exposed at other stages of life. Other than reduced income and expenditures, poor maternal nutrition and sustained maternal stress could also lead to adverse long-term effects (Liu et al., 2016).

The remainder of the paper is organized as follows. Section 2 describes disasters and disaster preparedness in the Philippines. Section 3 describes the data and estimation strategy. Section 4 describes the results. Section 5 discusses the results and the policy implications.

[2]Each paper on the U.S. focuses on a different time period. Simeonova (2011) studies hurricanes between 1968 and 1988; Currie and Rossin-Slater (2013) focuses on hurricanes passing Texas between 1996 and 2008; and Karbownik and Wray (2016) studies historical hurricanes between 1885 and 1899.

2 Background

2.1 Typhoons in the Philippines

The Philippines is the fourth most disaster-prone country in the world.[3] Given its location in the western Pacific Ocean, the Philippines is the largest country to be exposed to tropical cyclones, or typhoons on a regular basis – on average five to six typhoons make landfall in the country every year (Table 1), with an even larger number entering the Philippine waters. The country comprises about 7,000 islands, which we categorize into the following island groups to reflect differences in both geographic location and economic development: Northern Luzon, Southern Luzon, Visayas, and Mindanao. The northeastern parts of the country are especially prone to typhoons: the Cagayan Valley, Ilocos Region, Central Luzon, Bicol Region, and the Eastern Visayas.[4] Typhoons form year round, with the peak months being July to October, and some occurring even in November.

Due to the country's familiarity with typhoons, institutions and infrastructure in the Philippines are more prepared to cope with typhoons than in other developing countries. Despite this familiarity, severe typhoons may still cause extensive damages. For example, Franklin and Labonne (2017) show that local labor markets in the Philippines are unaffected by low-intensity typhoons, but substantially disrupted by severe ones. Following Franklin and Labonne (2017), we categorize typhoons into "small" and "severe" according to the Saffir-Simpson scale and study their effects separately.

We also note that because the majority of municipalities in the Philippines are prone to natural disasters, it is uncommon and almost impossible for citizens to migrate within the Philippines to avoid natural disasters, including typhoons. The southern island group in Mindanao is the only area that is relatively protected from annual typhoon exposures. However, because of the large disparities between the economic and cultural backgrounds of the southern islands and the rest of the country, few people would move from the north to the south to avoid typhoons. In fact, most internal migration flows into big cities with better economic opportunities such as Manila and Cebu, both in typhoon-prone areas.

2.2 Disaster relief before and under the Marcos regime

Ferdinand Marcos rose to power in December 1965, with strong support from his home province, Ilocos Norte (Nothern Luzon), and his wife's home province in the Visayas. Fernando Lopez, the vice presidential candidate from Iloilo (Visayas), brought business backing

[3]Source: UN, The Human Cost of Weather Related Disasters 1995-2015. URL (Last accessed December 27, 2017): http://www.unisdr.org/2015/docs/climatechange/COP21_WeatherDisastersReport_2015_FINAL.pdf

[4]These regions span across the eastern part of Northern Luzon, Southern Luzon, and the Visayas. Source: http://vm.observatory.ph/hazard.html (Last accessed December 27, 2017.)

and support from the southern provinces. The Marcos-Lopez candidacy won the majority vote in the 1965 presidential election. Marcos strengthened the civilian and military bureaucracy and put it at his disposal during his first term (Celoza, 1997).

Disaster preparedness gained prominence during the Marcos years. Before, it had fallen under the National Civil Defense Administration established by the 1954 Civil Defense Act. The body was tasked with protecting the welfare of the civilian population during war and other national emergencies, including typhoons and floods.[5] However, the planning body was poorly funded and lacked interest in disaster preparedness. This apathy changed after the Casiguran earthquake in August 1968, which occurred after Marcos assumed office. The 7.6 magnitude earthquake killed at least 207 people, most of whom died when the Ruby Tower in Manila collapsed. Following this disaster, Administrative Order No. 151 was issued in December 1968 and the National Committee on Disaster Operation was created. This marked the beginning of the coordination of disaster response and disaster relief funding across different agencies. The committee issued a standard operating procedure that prescribed the organizational set-up for disasters from the national level down to the municipal level.

These post-disaster relief efforts were further strengthened in the next decade. The disaster management plan was augmented after typhoon Sening (Joan) in October 1970. This typhoon led to severe flooding, including in Metro Manila for almost three months. A Disaster and Calamities Plan was approved by the president, which led to the creation of a National Disaster Control Center (NDCC). The NDCC includes almost all Department Secretaries as members and still serves as the most important policy-making agency for disasters in the Philippines.

Marcos imposed martial law on September 17, 1972. Under martial law, the Calamity Fund Act of 1972 was amended by a presidential decree in 1972 (a few days after martial law was imposed) as a response to typhoon Gloring (Rita) in July. The National Disaster Control Center was transferred to a new office whose mandate was to ensure the protection of the people during disasters and emergencies. In 1978, Presidential Decree 1566 was issued to further strengthen the Philippine disaster control capability. Some changes were made to further increase the availability of resources for disaster relief efforts.

Post-disaster efforts focused on short-term assistance, such as clothing, food, and medicine immediately after the disasters to mitigate adverse outcomes such as disease outbreaks– one potential cause of child mortality in this context. Key stakeholders, including the military, were mobilized to provide disaster relief and to maintain the stability of prices of prime commodities such as rice, the main staple. Marcos also tapped foreign assistance to provide

[5] Source: NDCC, History of Disaster Management in the Philippines, URL(Last accessed December 27, 2017): http://www2.wpro.who.int/internet/files/eha/tookit_health_cluster/History%20of%20Disaster%20Management%20

relief goods after major typhoons and personally directed the relief effort, involving his wife and son in some cases. There is evidence that these disaster relief efforts were part of the regime's political manipulation as they gave preferential treatment to their supporters (Warren, 2013). Nonetheless, on average, the availability of resources as part of disaster relief efforts may mitigate the short-term deleterious effects of negative shocks, such as early-life mortality.

2.3 The effects of early-life shocks

Research has shown that early-life conditions can have persistent and profound impacts on later life outcomes. Children in-utero are especially vulnerable because their fetal programming may be altered by negative shocks, leaving them susceptible to diseases such as coronary heart disease (Barker, 1995). Such shocks have been shown to adversely affect mortality and children's later life outcomes (Almond and Currie, 2011; Currie and Vogl, 2013). The long-term effects of early-life shocks come from a combination of culling and scarring. To the extent that surviving children are stronger due to culling, we may see limited effects of scarring in the long-term. However, with low selective mortality, scarring among survivors may be more pronounced.

The relative magnitude of culling affects the observed long-term effects among survivors. When the effect of culling dominates, we may observe no scarring because survivors are highly positively selected, such as the case of the severe Finnish famine in 1866 (Kannisto et al., 1997). Similarly, evidence from birth cohort data demonstrates that in high mortality settings, declines in child mortality are associated with decreased height, but in settings with limited selective mortality, declines in child mortality are associated with increased height, and in turn, height correlates with skill (Deaton, 2007; Currie and Vogl, 2013). With the competing effects of selective mortality and scarring, the 1918 flu pandemic in the US was associated with lower human capital outcomes, and in Taiwan, whose mortality rates were higher than the US, the 1918 flu pandemic was also associated with long-term adverse outcomes (Almond, 2006; Lin and Liu, 2014). In a setting with low selective mortality, in-utero exposure to maternal fasting during the 30 days of Ramadan is associated with a lower fraction of male births and lower birth weight, suggesting the effects from competing risks are observed even when the shock is relatively mild (Almond and Mazumder, 2011; Almond et al., 2015). These findings show that the long-term effects of early-life shocks depend on selective mortality, which is the focus of our analysis.

Negative shocks early in life lower children's human capital endowment, and this makes later life investments difficult, leading to poor human capital outcomes in adulthood (Cunha and Heckman, 2007). On the other hand, it is possible that mediation occurs to mitigate the initial effects of negative shocks. Conditional on survival, early interventions may offer protective effects if they occurred in the critical period of development (Currie and Almond, 2011; Almond and Mazumder, 2013). They may allow affected children to catch up when children were exposed to both positive and negative shocks (Aguilar and Vicarelli, 2011; Adhvaryu et al., 2015; Gunnsteinsson et al., 2016). In our setting, we examine whether short-term post-disaster relief could protect exposed children from early-life mortality and, consequently, whether lower early-life mortality changes the observed long-term outcomes of survivors.

3 Data

We draw our outcome variables from the Philippine Census of Population and Housing 1990 (hereafter, CPH 1990). We match each individual in CPH 1990 with historical typhoon exposure information in his or her municipality of birth. To measure typhoon exposure and intensity, we utilize the best-track data from the Japan Meteorological Agency Tropical Cyclone Database (henceforth, JMA) and the typhoon analogs (TD-9635) collected by the National Climatic Data Center. In this section, we explain our use of the CPH1990, the JMA, and TD-9635 best-track data and how we construct the various outcome and exposure variables from our sources.

3.1 Typhoon Data

The JMA provides the most reliable information of all tropical storms passing the Western North Pacific (WP) basin. For each tropical storm between 1951 and 1990, JMA records the longitude and latitude of the storm center and the minimum central pressure every six hours.[6] The typhoon analogs (TD-9635), collected by the National Climatic Data Center, provide the same information for typhoons that passed through the WP basin between 1945 and 1950.

We use the coordinates of the storm center to identify affected municipalities. First, we generate best-fit lines through the six-hourly observations to identify the storm path. Then, we calculate the distance between the centroid of the municipality and the storm path for each municipality-storm pair. If the distance is within 30 kilometers (km), we treat the municipality as affected by the storm. In our robustness checks, we experiment with alternative measures of storm exposure, such as defining municipalities with 60 kilometers of the typhoon path as exposed municipalities. We also use the nearest distance between the

[6] Links to both data sets can be found on the IBTrACS webpage https://www.ncdc.noaa.gov/ibtracs/index.php?name=rsmc-data
Last accessed December 27, 2017.

municipality and the storm track to measure municipality-to-storm distance. The results are qualitatively similar.

To measure storm intensity, we use the minimum central pressure (MCP) instead of the more commonly used maximum sustained wind speed (MSW). This is mainly due to data limitations: MSW was not available in the JMA database until 1972; additionally, the MSW calculation was revised in the 1980s to be consistent across meteorological agencies. Nonetheless, for the years when both MSW and MCP are available in the JMA database, the two measures are highly correlated (-0.833, p-value <0.01). Moreover, recent meteorological studies have found that due to changes in practice over time at meteorological agencies, records of MSWs for historical typhoons (pre-1980s) in the WP basin are likely of low quality (Knapp et al., 2013). Hence, MCP serves as a more accurate measure of storm intensity for tropical cyclones that occurred before the 1980s in the WP basin.

Storm path and severity vary considerably across the island groups. For example, Figure 1 shows the paths and severity of all typhoons that passed the Philippines in 1970. The intensity of a storm fluctuates as the storm moves along, but our databases only provide MCP measures every six hours. To measure the storm intensity for each of the affected municipalities, we utilize the MCP of the nearest observation points. Specifically, we use the weighted average of the MCP readings of the two nearest observation points, using the inverse distance between the observation and the municipality as weights. We then categorize typhoon intensity according to the Saffir-Simpson scale[7], and generate an indicator for "small typhoon" if the storm is of category 3 or lower and "severe typhoon" if the storm is of category 4 or 5 when the storm reached the municipality.

3.2 Philippine Census Data

Outcome variables Our identification strategy requires us to link individuals' later life outcomes to typhoon exposure in-utero and in his or her first two years of life. We use the CPH 1990 10% Household Sample because it is the only census sample that identifies each respondent's mother's usual place of residence at the time of the respondent's birth. This longer census questionnaire was administered to approximately 10 percent of the population.

Our outcomes of interest include cohort size as well as the education and labor market outcomes of individuals. We draw these variables from the census. We estimate municipality-level cohort size at birth based on the number of respondents within each age group who report being born in that municipality. As such, cohort size at birth is proxied by the

[7]Specifically, a category 5 typhoon is one with MCP below 920 millibars; a category 4 typhoon is one with MCP between 920 and 944 millibars; category 3 is between 945 and 964 millibars; category 2 is between 965 and 979 millibars; category 1 is between 980 and 999 millibars. Storms with MCP at or above 1000 millibars are not considered typhoons.

probability of survival to May 1, 1990.[8]

Educational outcomes include literacy, high school completion, and years of education. The census does not include information on respondents' labor market earnings but does provide detailed information on the respondents' occupations. Based on each respondent's reported occupation, we construct three indicators of occupational skill level: whether the respondent has a skilled occupation, an associate professional occupation, or a professional occupation. The data appendix details the construction of years of education and occupational skill level indicators.

Exposure variables To identify whether an individual was affected by typhoons in early-life, we link each respondent in CPH 1990 to the typhoon data according to the respondent's age and municipality of birth. Municipality of birth is given by the respondent's mother's usual place of residence at the time of the respondent's birth.

Our main exposure variables are the expected number of small and severe typhoons that each respondent (or cohort) is exposed to during the in-utero period and in the the first two years of life.[9] We use this expected number of typhoons as our treatment variable because respondents' month of birth is unfortunately not available. However, we do observe each respondent's age as of May 1, 1990 as well as the exact date that the typhoons passed his or her municipality of birth. To construct the expected number of typhoon exposures, we assume that an individual of age y is equally likely to be born any day between May 2, $1990 - y - 1$ and May 1, $1990 - y$ and that gestation starts 40 weeks prior to the potential date of birth. We then use the date that a typhoon passed the municipality of birth to construct the probability that the individual is exposed to the typhoon in-utero. We also construct the probability of exposure in the first two years of life in a similar fashion. We sum the probabilities across typhoons to derive the expected number of typhoons that each respondent (or cohort) is exposed to in each stage of life. The data appendix details the construction of the exposure variables.

This measure allows us to fully exploit the temporal variations of typhoons. For example, because the ages are recorded as of May 1, 1990, a typhoon that took place between August

[8]We remain agnostic about whether the reductions in observed cohort size is due to early-life (under the age of one) or later-life mortality. While the highest mortality is attributed to early-life deaths, the presence of later-life mortality may be a concern. To address this concern, we replicate our cohort size analysis using cohort size in the 1970 Census (CPH 1970). CPH 1970 allows us to restrict the sample to cohorts born before 1965 (aged between 5 and 15 in 1970). However, we are only able to identify the respondent's province of birth (rather than the municipality of birth) in CPH 1970. Hence, we could only define typhoon exposure at the province level. This severely limits the accuracy of results using CPH 1970. Nonetheless, the results using CPH 1970 are similar in magnitude to our main results using CPH 1990.

[9]Migration in the first two years of life is low, therefore we expect measurement error in our exposure variable in the first or second year of life to be low. We explore this further in the Appendix.

and October 1970 could potentially affect the in-utero period of two cohorts – ages 18 and 19 – with a higher probability of affecting the 19-year-old cohort in-utero than the 18-year-old cohort. In contrast, a typhoon that took place in May or June of 1970 could only possibly affect the in-utero period of one age cohort – the 19-year-old cohort. These variations are fully captured by our exposure variable (expected number of typhoons), but would not be captured by a dummy variable indicating whether a typhoon took place one year before birth or the year of birth. The temporal dimension is especially important as most typhoons in the Philippines take place between June and November of each year.

In our robustness section 4.5, we perform all our analysis with two sets of alternative typhoon exposure variables: (1) dummy variables indicating whether *any* small or severe typhoon passed the municipality of birth during the years surrounding birth, and (2) the *number* of small or severe typhoons that passed the municipality of birth during the years surrounding birth. Results using these alternative measures are consistent with our main findings.

Sample restrictions Respondents should finish high school by the age of 16 in the Philippines, so we restrict the sample to respondents over the age of 18 to account for possible grade repetitions or late enrollment in primary school.[10] As we are interested in typhoon exposure in the first 3 years after conception, we further restrict the sample to respondents between the ages of 18 and 43 (those born between 1947 and 1972). to ensure that we have the full history of typhoon exposure for each individual's in-utero period and first two years of life.

3.3 Summary statistics

Table 1 shows the number of typhoons per municipality-year by the four island groups: Northern Luzon, Southern Luzon, Visayas, and Mindanao. We separate the sample into two periods: pre-1965 and post-1965. On average, the number of small typhoons before and after 1965 is similar across island groups. However, the number of severe typhoons is higher post-1965 in Northern Luzon and Southern Luzon.

Table 2 shows the outcomes of interest for those who were likely exposed to typhoons in-utero either before 1965 (Panel A) or after 1965 (Panel B). We divide the sample to those exposed in-utero to small typhoons only (col. 1), those ever exposed to severe typhoons (col. 2), and those never exposed to any typhoons (col. 3). Conditional on survival to adulthood, educational and occupational outcomes for those who were exposed to severe

[10]Since the youngest cohorts might still be in tertiary education in 1990, the sample of the youngest cohorts with any gainful occupation is a selected sample.

typhoons before 1965 are *higher* than those who were exposed to small typhoons or never exposed to typhoons. However, after 1965, those who were exposed to severe typhoons have lower occupational status.

4 Results

4.1 Estimation strategy

We exploit the temporal and geographical variation of the typhoon paths as well as exogenous variations in typhoon intensity. We employ a difference-in-differences method, exploiting variations at the cohort-municipality level. Specifically, we compare individuals who are exposed to typhoons either in-utero or in their first two years of life to those who are either born in the same municipality in a different year or born in a different municipality in the same year and are, therefore, exposed neither in-utero nor in the first two years of their lives. Subsection 4.2 presents results on mortality, using cohort size and the fraction of males in each cohort as outcome variables to infer mortality. Subsection 4.3 presents results on long-term educational and occupational outcomes.

In subsection 4.4, we extend our analysis to comparisons of within-household siblings. That is, we compare individuals who were exposed to typhoons either in-utero or in their first two years of life to a sibling who was born in a different year and, hence, never exposed during the early-life period.

4.2 Cohort size and mortality

We begin by analyzing the effects on mortality. Ideally, there would be detailed data on fetal, infant, child, and adult mortality rates for each cohort born in a given municipality. In practice, such mortality records, especially for fetal mortality, do not exist for the Philippines because pregnancies are not recorded. We adopt the approach of Jayachandran (2009) and infer mortality by measuring the cohort size based on individuals' municipality of birth. The outcome variable we use is the municipality-level cohort size in the 1990 Census. The estimated effects will be the cumulative effects of typhoon exposures on fetal, infant, child, and adult mortality. Specifically, we estimate the following equation for each birth-municipality m and birth-year t,

$$\begin{aligned}\ln(CohortSize_{mt}) = {} & \theta_0 \; small\_inutero_{mt} + \theta_1 \; small\_postnatal_{mt} \\ & + \beta_0 \; severe\_inutero_{mt} + \beta_1 \; severe\_postnatal_{mt} \\ & + \phi_{muni} + \tau_t \times \psi_{island} + \gamma_{region} \times t + \epsilon_{mt} \qquad (1)\end{aligned}$$

where $CohortSize_{mt}$ refers to the number of individuals *born* in municipality m and year t who survived until May 1, 1990. The treatment variable $small\_inutero$ measures exposure to small typhoons in-utero, and $small\_postnatal$ measures exposure to small typhoons in the first and second years of life; $severe\_inutero$ and $severe\_postnatal$ are the corresponding measures for severe typhoons.

In all subsequent analysis, we include municipality fixed effects to take into account non-time varying municipality characteristics. We also include birth-year by island group fixed effects, $\tau_t \times \psi_{island}$. We include four island groups in our analysis: North and Central Luzon, Southern Luzon, Visayas, and Mindanao. These fixed effects allow us to account for differences in education and economic development policies across the four island groups that may affect the outcome of interest. In addition, we include region-specific time trends, $\gamma_{region} \times t$, to allow for differential population growth trends in different regions. We include thirteen different regions.[11] Standard errors are clustered two-ways by both the municipality and the province-by-birth-year levels. Clustering by province-birth year allows us to account for the spatial correlation across municipalities in typhoon exposure.

One potential caveat of using cohort size to study mortality effects is that cohort size can also reflect changes in conception rate. To address this concern, we also present results using the fraction of males in each cohort as the outcome variable. Under the fragile male hypothesis (Kraemer, 2000), adverse early-life shocks would have a larger impact on male mortality rates than female mortality rates, hence reducing the fraction of males in the cohort. If, however, the adverse shock reduces the rate of conception rather than fetal or infant mortality rates, we would expect similar reductions in the male and female cohort size and no change in the fraction of males. Therefore, reductions in the fraction of males would provide suggestive evidence that the changes in cohort size are likely attributable to changes in mortality rather than changes in conception.

Table 4 presents the results of estimating Equation 1. We restrict our sample to cohorts between ages 2 and 43 in columns 1 to 4. We exclude cohorts aged below 2 or above 43 because we do not have full information on typhoon exposure for those cohorts (in-utero to age two). In columns 5 to 8, we further restrict our sample to cohorts aged 18 to 43 to match the sample we use for education and occupational outcomes. We find that severe typhoons are associated with increased mortality, but not small typhoons. On average, in-utero exposure to one severe typhoon reduces cohort size by about 5 percent, but exposure to a small typhoon has no significant effect on it (column 1). The estimated effect is similar,

[11] There are 13 regions in the Philippines in CPH 1990: National Capital Region, Ilocos Region, Cagayan Valley, Central Luzon, Southern Tagalog, Bicol, Western Visayas, Central Visayas, Eastern Visayas, Western Mindanao, Northern Mindanao, Southern Mindanao, and Central Mindanao.

about 7 percent, when we restrict the sample to ages 18 to 43 (column 5). We find no significant effects on cohort size resulting from exposure to small or severe typhoons in one's first or second year of life. Our finding is consistent with the literature on the adverse effects of exposure to severe negative shocks in-utero and suggests a strong dose-response effect to the severity of the shock.

In addition, the mortality effects of exposure to severe typhoons are concentrated among males – the effect on male cohort size is large (8 percent) and statistically significant (column 2), whereas the effect on female cohort size is much smaller (3 percent) and statistically insignificant (column 3). We also estimate the effects on the fraction of male in each municipality of birth for each year of birth (columns 4 and 8). The estimates, albeit imprecise, indicate that exposure to a severe typhoon reduces the fraction of males in each cohort by 1 to 2 percentage points, suggesting that the reduction in male cohort size is driven by increases in early-life mortality rather than reductions in conception. Taken together, these results suggest that the mortality effects of exposure to severe typhoons are more pronounced among males, which is consistent with the fragile male hypothesis (Kraemer, 2000).

We then examine the changes in mortality after the implementation of disaster relief policies. We separate typhoon exposures based on whether it occurred before or after Marcos assumed office in December 1965 and estimate the following equation:

$$\begin{aligned}\ln(CohortSize_{mt}) = {} & \rho_0\ pre\_65\_small\_inutero_{mt} + \rho_1\ pre\_65\_small\_postnatal_{mt} \\ & + \alpha_0\ pre\_65\_severe\_inutero_{mt} + \alpha_1\ pre\_65\_severe\_postnatal_{mt} \\ & + \theta_0\ post\_65\_small\_inutero_{mt} + \theta_1\ post\_65\_small\_postnatal_{mt} \\ & + \beta_0\ post\_65\_severe\_inutero_{mt} + \beta_1\ post\_65\_severe\_postnatal_{mt} \\ & + \phi_{muni} + \tau_t \times \psi_{island} + \gamma_{region} \times t + \epsilon_{mt} \end{aligned} \tag{2}$$

where the treatment variables *small_inutero*, *small_postnatal*, *severe_inutero*, and *severe_postnatal* are interacted with either a *pre*_65 or a *post*_65 dummy variable indicating whether the typhoon exposure took place before or after December 1965. The implicit assumption is that all typhoons that took place after December 1965 are covered by Ferdinand Marcos' disaster relief policies. We present results using December 1968, the month that the National Committee on Disaster Operation was established, as the alternative cut-off for pre- and under-Marcos periods in Subsection 4.5.

Table 5 presents the results of estimating Equation 2. The results show stark contrasts of mortality effects before and after 1965. In-utero exposure to a severe *pre-1965* typhoon is associated with a statistically significant 10 percent decrease in overall cohort size in 1990 (column 1). This effect is also stronger among males (14 percent) compared with females

(6 percent and not statistically significant). In contrast, the effects of in-utero exposure to a severe *post-1965* typhoon are both substantively and statistically insignificant (columns 1-4). The estimates are similar when we restrict the sample size to cohorts between the ages of 18 and 43 (columns 5 to 8).[12] Although the effects on the fraction of males are imprecisely estimated, the difference in magnitude is large between pre- and post- 1965 severe typhoons – in-utero exposure to a severe *pre-1965* typhoon reduces the fraction of males by 2.2 percentage points, whereas a severe *post-1965* typhoon reduces the fraction of males by 0.6 percentage points (columns 4 and 8). Similar to our earlier findings, the effects of in-utero exposure to a small typhoon are insignificant in magnitude both before and after 1965. Interestingly, exposure to small typhoons in one's first two years of life is associated with a small reduction in cohort size post-1965.[13] The effects of exposure to severe typhoons in one's first two years of life before or after 1965 are not significant.

We interpret these as suggestive evidence that the Marcos government's post-disaster relief measures had some contribution to reducing the adverse short-term effects of typhoons. This change in early-life mortality could in turn affect the observed long-term scarring effects on the survivors.

4.3 Educational attainment and occupational skill level

Conditional on survival, we estimate the long-term effects of exposure to small and severe typhoons that occurred before and after Marcos took office. We estimate the following equation:

$$\begin{aligned} y_{imt} = {} & \rho_0 \; pre\_65\_small\_inutero_{mt} + \rho_1 \; pre\_65\_small\_postnatal_{mt} \\ & + \alpha_0 \; pre\_65\_severe\_inutero_{mt} + \alpha_1 \; pre\_65\_severe\_postnatal_{mt} \\ & + \theta_0 \; post\_65\_small\_inutero_{mt} + \theta_1 \; post\_65\_small\_postnatal_{mt} \\ & + \beta_0 \; post\_65\_severe\_inutero_{mt} + \beta_1 \; post\_65\_severe\_postnatal_{mt} \\ & + \delta X_{imt} + \phi_{muni} + \tau_t \times \psi_{island} + \gamma_{region} \times t + \epsilon_{imt} \end{aligned} \tag{3}$$

where y_{imt} is the outcome of interest for individual i, born in municipality m, in year t. We include the same set of typhoon exposure variables as in Equation 2, with the implicit assumption that once a municipality is exposed to a typhoon, everyone residing in the municipality is exposed. Additionally, we include a male indicator as a covariate (X_{imt}). When using occupation as the outcome variable, we also include years of education as a covariate in some specifications.

[12] Table A.1 presents estimates using all municipalities. Results are qualitatively similar.

[13] We explore this further by analyzing the effects of each typhoon category (Table A.15).

As in Equation 2, we include municipality fixed effects, ϕ_{muni}, birth-year-by-island-group fixed effects, $\tau_t \times \psi_{island}$, and region-specific time trends, $\gamma_{region} \times t$. Standard errors are clustered two-way at both the municipality and the province-by-birth-year level. In addition, observations are weighted by the person weights provided in CPH 1990.

Education Table 6 presents the effects on educational attainment. There is a strong dose-response relationship with the intensity of the typhoon as well as a sharp increase in the scarring effects after 1965. Exposure to small typhoons, both pre- and post-1965, had little effects on educational attainment.[14] In contrast, in-utero exposure to severe typhoons is associated with a lower probability of being literate (col. 1), fewer years of education (col. 2), and a lower probability of high school completion (col. 3).These effects are more pronounced for severe typhoons post-1965 than pre-1965. Given that in-utero exposure to severe, pre-1965 typhoons was associated with substantially higher mortality rates, it is not surprising to find that early-life exposure to pre-1965 typhoons had little effects on the educational attainment of survivors. In contrast, in-utero exposure to a severe, post-1965 typhoon reduces the probability of being literate by 0.771 percentage points (a 0.80 percent reduction from the mean), reduces completed years of education by 0.342 years (a 3.53 percent reduction from the mean), and reduces the probability of completing high school by 1.81 percentage points (a 3.49 percent reduction from the mean).[15] We find no significant effects on education among those exposed to typhoons in their first or second year of life. These findings are consistent with the long-term effects of severe in-utero shocks.

Occupation Table 7 presents the effects on occupational skill level. Again, we observe a strong dose-response relationship by the intensity of the typhoon and a sharp increase in the scarring effects after 1965. Exposure to small typhoons, both pre- and post-1965,

[14] We do note that the estimated effects of in-utero exposure to *small,* pre-1965 typhoons are positive for all three outcome variables. Although it seems peculiar that small typhoons might have positive effects on long-term outcomes, the magnitude of the coefficients are negligibly small compared with the effects of severe typhoons. We also note that small, non-destructive typhoons may benefit agriculture and fishing through increased rainfalls and cooler temperatures (Lam et al., 2012), and may increase the abundance and variety of fish in waters near the shore in the ensuing weeks (Yu et al., 2013). If these small, non-destructive typhoons increase agricultural and fishing income without much damage to local infrastructure, they may actually enhance mothers' and children's nutritional intake in the ensuing months and contribute to positive long-term human capital outcomes. Appendix Tables A.16 and A.17 confirm that these positive effects stem from the lowest category (SS scale 1) typhoons, which are relatively common in the Philippines and mild in their power to destroy plantations and infrastructure.

[15] Appendix table A.2 shows the corresponding effects on education pooling all cohorts together. Again, we see that exposure to small typhoons has no significant effect on educational outcomes, but exposure to severe typhoons is associated with adverse later life outcomes. The estimates suggest that, on average, in-utero exposure to one severe typhoon lowers educational attainment by 0.178 years and that exposure to a severe typhoon in the first two years of life reduces educational attainment by 0.059 years (column 2).

is associated with small positive gains on occupational skill level.[16] In contrast, in-utero exposure to severe, *post-1965* typhoons reduces occupational skill level – in-utero exposure to one severe, *post-1965* typhoon reduces the probability of attaining a skilled occupation by 15.9 percentage points, an associate professional occupation by 6.9 percentage points, and a professional occupation by 5.19 percentage points. We find that exposure to severe, *post-1965* typhoons in one's first or second year of life is also associated with lower occupational skill level, although the magnitude is smaller than in-utero exposure. Exposure to severe, *post-1965* typhoons in the first two years of life reduces the probability of attaining a skilled occupation by 5.1 percentage points, an associate professional occupation by 2.5 percentage points, and a professional occupation by 2.1 percentage points.

Similar to the findings of Karbownik and Wray (2016), the effects on labor market outcomes decrease only modestly when we condition on years of completed education. This suggests that the scarring in the labor market operates through channels besides reduced human capital accumulation, probably because educational attainment relies heavily on cognitive ability whereas labor market productivity relies on both cognitive ability and health. Interestingly, in-utero exposure to severe, *pre-1965* typhoons is associated with a small, but statistically significant increase in the probability of attaining an associate professional and professional occupation, suggesting that due to the high mortality in the pre-Marcos era, survivors are extremely positively selected.

Heterogeneity by gender We explore the heterogeneous effects by gender in Tables 8 and 9. The fragile male hypothesis argues that the male fetus is more vulnerable to early-life shocks than the female fetus (Kraemer, 2000). To the extent that the surviving individuals may be positively selected, the fragile male hypothesis predicts that the long-term scarring effects are larger on males when mortality rates are low; however, we may see no differential long-term effects by gender, or even larger long-term effects on females when early-life mortality rates are much higher among males than among females. We have shown earlier that exposure to severe typhoons increases male mortality rates more than it increases female mortality rates in both the pre- and post-1965 periods.

Table 8 presents the heterogeneous effects on educational attainment.[17] Severe typhoons in the *pre-Marcos(pre-1965)* period had no statistically significant effect on literacy or years of education for either gender. Males who were exposed to severe typhoons in-utero were less likely to complete high school. Under Marcos, post-1965, when the effects of mortality were

[16]Please refer to footnote 14 for an explanation of why small typhoons may have small positive effects. Severe typhoons are associated with lower occupational skill when we pool the cohorts (Table A.3).

[17]Tables A.4 and A.5 present the corresponding results without separating pre- and post-1965 typhoons. Severe typhoons are associated with lower education and occupational skill level.

lower, the effects of in-utero exposure to severe typhoons are larger on males than on females for all three educational outcomes (although not statistically significant for the probability of high school completion). These results are consistent with the fragile male hypothesis – when mortality rates are low, long-term scarring is more pronounced among males. Table 9 presents the heterogeneous effects on occupational skill levels. Before Marcos, the effect of in-utero exposure to severe typhoons on occupational skill levels is not statistically significant for males and slightly positive for females. Under Marcos, the adverse effect of in-utero exposure to severe typhoons is similar for males and females, with slightly larger effects on males' probability of obtaining a skilled occupation and modestly larger effects on females' probability of obtaining an associate professional or professional occupation.

4.4 Sibling comparisons

In this section, we compare those who are exposed to typhoons to their siblings by restricting our sample to households with adult co-resident children. We extend the difference-in-differences framework to this sample by using household fixed effects rather than municipality fixed effects.

Within-household analysis adds to our study in three ways. First, this approach controls for any unobserved heterogeneity across households. If the unobserved characteristics of households residing in typhoon-exposed areas deteriorate over time, perhaps due to migration, then our identifying assumption would be violated and we may over-estimate the effects of typhoons, especially the post-1965 typhoons. Sibling comparisons address these concerns by controlling for heterogeneities across households.

Second, by comparing results with household fixed-effects to results with municipality fixed-effects, we can provide some informative evidence of post-natal parental investment behavior (Almond et al., 2009). If within-household sibling comparisons yield smaller effects than cross-household difference-in-differences analyses, parents may have compensated for the negative pre-natal shocks by investing more in the affected child after birth (or there may be changes over time in the unobserved heterogeneity of typhoon-exposed households). If, on the other hand, within-household sibling comparisons yield larger effects than the cross-household analyses, it suggests that parents reinforce negative pre-natal shocks by investing less in the affected child after birth.

Third, we further stratify our household sample by parental socioeconomic status to examine heterogeneities in the effects of typhoons as low-income households may be more vulnerable to typhoons. In the Philippines, low-income households are more likely to have make-shift houses (in squatter areas, along riverbanks, or close to the coast) which may be heavily damaged, if not completely destroyed, by severe typhoons. Wealthy households are more likely to live in concrete buildings on higher grounds, which may be less damaged or may even remain intact after a severe typhoon. Past research provides evidence that typhoons are more damaging to low-income families' household assets than that of high-income families (Huigen and Jens, 2006; Anttila-Hughes and Hsiang, 2013). In addition, wealthy and well-connected families may also have better access to food and clean water after a severe typhoon. There is evidence from recent natural disasters in the Philippines that politically connected communities are better able to obtain post-disaster funds (Atkinson et al., 2014). We, therefore, expect in-utero typhoon exposure to be more damaging to children born to low-income families.

To conduct within family sibling comparisons, we restrict the sample to households with adult co-resident children – individuals between the ages of 18 and 43 who still live in the same household as their parent(s) and whose reported relationship to the household head is either that of "son" or "daughter." We further restrict the sample to individuals who have at least one other sibling living in the same household. These sample restrictions allow us to identify siblings and their parents. However, these restrictions also leave us with a selected sample.[18]

Tables 10 and 11 present the effects on education and occupation, respectively, of the adult co-resident children sample. In both tables, columns 1 to 3 present sibling comparison results using household fixed effects, whereas columns 4 to 6 present results using municipality fixed effects on the same sample. The basic patterns found in the cross section persist when we use household fixed effects. Moreover, comparing columns 1 to 3 to columns 4 to 6 in both tables, the negative effects of in-utero exposure to severe typhoons are larger in magnitude when using household fixed effects than when using municipality fixed effects – this is true for both pre- and post-1965 typhoons. The difference in the estimated effect under household and municipality fixed effects is more pronounced for educational outcomes than for labor market outcomes. These reduced-form estimates offer suggestive evidence that post-natal parental investments may have reinforced the differences between siblings caused by negative pre-natal shocks, but we cannot ascertain the channels through which parents invest differentially on children.

Next, we stratify our sample by household socioeconomic status. Ideally, we would use a measure of family income or wealth around the time of the child's birth as the yardstick to divide households into low and high-SES sub-samples. In the absence of a direct measure of

[18]We note that respondents in this sample are on average more educated than the overall population. Average education in the main analyzed sample is about 9.4 years, while it is 10.5 years in the adult-coresident household sample. In addition, the average education and the fraction of the pre-1965 co-resident sibling sample who were ever exposed are higher than the pre-1965 sample in our main analysis. The post-1965 co-resident sibling sample is more comparable to the main post-1965 sample in our main analysis.

past household income or wealth, we use whether the household head has a skilled occupation to divide the sample into high and low SES.[19]

Tables 12 and 13 present the effects of early-life exposure to typhoons on education and occupational skill level by household SES. Results suggest that the adverse effects are substantially lower among affected children from high-SES households than those from low-SES households – the estimated effects of in-utero exposure to severe typhoons on years of education and the probability of attaining a skilled occupation are large in magnitude and statistically significant for the low-SES sample, but smaller (and statistically insignificant for occupation) for the high-SES sample.

These reduced form estimates are consistent with two potential mechanisms that lie beyond the scope of this paper. One possibility is that high-SES families have more resources to cope with severe typhoons. They may live in more typhoon-resistant houses and are more prepared for potential food shortages in the ensuing weeks.[20] Hence, the wealthier the family, the lower a typhoon's impact on the mother's psychological well-being and nutritional intake. Another possibility is that parents in high-SES families engage in compensating behavior after the child's birth – enhancing educational and health investments on the child who has experienced negative shocks in early-life, whereas parents in low-SES families with limited resources adopt reinforcing behavior post-natally – reducing investments on the child who has experienced negative shocks in early-life.

4.5 Robustness

Effects by timing of exposure We conduct an event study analysis to show the effects of exposure to typhoons that took place before, during, and after the gestation period. To keep the model parsimonious, we include only severe typhoons in our analysis. We estimate the following equation:

[19]We choose this measure because the distribution of the household heads' occupation is quite stable across age groups, whereas other variables such as years of completed education vary more by age group. Given that household heads in the adult co-resident children sample span across a wide age range and tend to be older (with an average of 54 years versus 44 years in the CPH), using household head's occupation allows us to have a time-consistent way of defining household SES.

[20]Deuchert and Felfe (2015) document the large degree of heterogeneity in housing damages in Cebu after a super typhoon in 1990 – wealthier households experienced significantly smaller damages to their housing than low SES households.

$$
\begin{aligned}
\ln(cohort\ size_{mt}) = {} & \alpha_{-1}\ pre\_65\_severe_{m,t-3\ or\ t-2} + \alpha_0\ pre\_65\_severe_{m,t-1\ or\ t} \\
& + \alpha_1\ pre\_65\_severe_{m,t+1\ or\ t+2} + \alpha_2\ pre\_65\_severe_{m,t+3\ or\ t+4} \\
& + \beta_{-1}\ post\_65\_severe_{m,t-3\ or\ t-2} + \beta_0\ post\_65\_severe_{m,t-1\ or\ t} \\
& + \beta_1\ post\_65\_severe_{m,t+1\ or\ t+2} + \beta_2\ post\_65\_severe_{m,t+3\ or\ t+4} \\
& + \phi_{muni} + \tau_t \times \psi_{island} + \gamma_{region} \times t + \epsilon_{mt} \qquad (4)
\end{aligned}
$$

where $pre\_65\_severe_{m,t-3\ or\ t-2}$ is a dummy variable indicating whether the birth-municipality, m, was exposed to any pre-1965 severe typhoons two to three years before the individual's birth-year, t; $pre\_65\_severe_{m,t-1\ or\ t}$ indicates whether the birth-municipality, m, was exposed to any pre-1965 severe typhoons either one year before or during the birth-year, t; and similarly for the other treatment variables. We use two-year windows here to avoid collinearity and to reduce the number of coefficients we have to estimate. By construction, α_0 and β_0 capture the effects of in-utero exposure to severe typhoons, since exposure that took place one year before or during the birth year is possibly in-utero exposure. α_{-1} and β_{-1} measure the effects of severe typhoons that took place before conception. α_1, α_2, β_1 and β_2 reflect the effects of post-natal exposure to severe typhoons.

Figure 2 shows the results of estimating Equation 4. Each panel of Figure 2 shows the results of separate regressions where the outcome variables are the fraction of males for Panel A, $\ln(cohort\ size)$ for Panel B, $\ln(male\ cohort\ size)$ for Panel C, and $\ln(female\ cohort\ size)$ for Panel D. In each panel, we plot the coefficient estimates and 95% confidence intervals of the key coefficients of interest from Equation 4. Coefficients of the pre-1965 typhoons: α_{-1}, α_0, α_1, and α_2, are plotted on the left-hand side of each panel; coefficients of the post-1965 typhoons: β_{-1},β_0, β_1, and β_2, are plotted on the right-hand side of each panel. Estimates for these regressions are also presented in Appendix Table A.6.

The contrast between pre-1965 and post-1965 typhoon exposures is evident in Figure 2. The estimates for α_0 are negative and statistically significant for three outcome variables: fraction of males, cohort size, and male cohort size. In contrast, the estimates for β_0 are almost zero and statistically insignificant for all four outcome variables. These findings are consistent with our previous results that severe, pre-1965 typhoons substantially reduced cohort size, especially male cohort size, while severe, post-1965 typhoons did not.[21]

[21] We note that the estimates for α_0 is - 0.742 when using $\ln(male\ cohort\ size)$ as the outcome variable. This estimate is much smaller than the corresponding coefficient estimate, -0.144, in Table 5 (column 2). This is because the treatment variable in Table 5 measures the expected number of in-utero typhoon exposures for each birth cohort and weights each typhoon that took place one year before or during the birth-year by the probability that the typhoon took place in-utero for a given birth cohort. The treatment variable here

Interestingly, however, α_{-1} and β_{-1}, which measure effects of severe typhoons that took place before conception (two to three years before birth), are significantly different from zero for some outcome variables. Our results suggest that pre-conception exposure to severe, pre-1965 typhoons reduces *male* cohort size by 4 percent and the fraction of males by 0.893 percentage points, but has no detectable effects on *female* cohort size. For severe, post-1965 typhoons, our results suggest that pre-conception exposure reduces *male* cohort size by 2.3 percent and reduces *female* cohort size by 4 percent. The effects on male cohort size or the fraction of males are not statistically significant, whereas the effects on female cohort size is statistically significant.

One channel through which pre-conception typhoon exposure can affect cohort size (and long-term human outcomes) is reduced household wealth. Anttila-Hughes and Hsiang (2013) find that typhoon exposures reduce household assets and consumption up to three years after the initial exposure. It is plausible that those who are severely affected by typhoons need to reduce their food consumption even three years after a typhoon in order to save funds to restore of their physical assets. Anttila-Hughes and Hsiang (2013) also offer suggestive evidence that typhoons reduce female infant mortality rates three years after initial typhoon exposure. Their study focused on typhoons in the 1980s and the 1990s, whereas our results here apply to typhoons between 1945 and 1990. Our results for post-1965 typhoons are largely consistent with their findings. However, we concede that it is not clear why pre-1965 typhoons affect male cohort size but not female cohort size, whereas post-1965 typhoons have the opposite effects.[22]

Next, we perform the same analysis on long-term human capital outcomes. We estimate the equivalent of Equation 4 for education and occupational outcomes at the individual level and include as a control variable a dummy for male. Figure 3 shows the results for four outcome variables: years of completed education, having a skilled occupation, having an associate professional occupation, and having a professional occupation. (Estimates for all educational and occupational outcomes are presented in Appendix Tables A.7 and A.8). Again, the contrasts between pre-1965 and post-1965 typhoon exposure are made salient. Pre-1965 typhoons had little impact on long-term outcomes, whereas post-1965 typhoons

is an indicator of whether any typhoon passed by either one year before or during the year of birth – which may include some typhoons that took place pre-conception. The variable does not place a lower weight on typhoons that took place close to the end of the birth-year. The estimated effects here are the combined effects of in-utero, pre-conception, and post-natal exposures. It is, therefore, not surprising that the estimates here are smaller than the estimates in Table 5. We also used the 1970 Census and find qualitatively similar results on mortality among those exposed to severe typhoons pre- and post-1965. However, in the 1970 census, we can identify the province of birth but not the municipality of birth. The analysis was, thus, done at the province level and the estimates are not precisely measured. These results are available upon request.

[22] We also note that, traditionally, most ethnic groups in the Philippines do not practice son preference.

had large negative effects on both educational attainment and occupational skill level. In-utero exposure has the largest impact; post-natal early childhood exposure has smaller but substantial impacts as well.

Alternative exposure variables Our main analysis used the expected number of typhoons an individual is exposed to as our treatment variable. We assume a linear relationship between the expected number of typhoons in each stage of life and the outcome variables of interest. If some municipalities are exposed to multiple typhoons within a year and if there is a non-linear relationship between the number of exposure and the effects of each exposure, then Equations 1, 2, 3 would lead to biased estimates. As indicated in Table 1, all municipalities are exposed to at most one severe typhoon each year. In less than 1 percent of municipality-year pairs, the municipality was struck by multiple small typhoons within the same year (mostly category 1). To further alleviate the concerns of potential non-linear effects of the number of typhoons one is exposed to, we expand the analysis in Equation 4 to include small typhoons and replace the exposure dummies in Equation 4 with count variables indicating the number of typhoon exposures during each period.

The results show that the non-linearity concerns are minimal. For severe typhoons, we find that the two sets of treatment variables yield nearly identical results. This is consistent with the fact that no municipality was exposed to more than one severe typhoon within the same year. Similar to our earlier findings, the effects of exposure to small typhoons are small and largely insignificant. Moreover, the magnitude of the two sets of estimates are largely consistent with a linear effects model. These results are available upon request.

Alternative distance to the eye of the storm One limitation of our study is that we do not observe the actual size of the typhoon. In our main analysis, we assume that municipalities and individuals within 30 kilometers of the eye of the storm are affected by the typhoon and those outside of the 30-km radius are not as affected. If the size of a typhoon is particularly large such that the wind speed is still as high as a category 4 or 5 typhoon outside of the 30-km radius, municipalities and individuals outside of the 30-km radius may be just as affected as those within the 30-km radius. If this is the case for some typhoons, our estimates may under-estimate the adverse effects of typhoons.[23]

To test whether the effects of typhoons extend beyond the 30-km radius, we add a second layer of treatment variables assigned to municipalities that are between 30 and 60

[23] Brand and Blelloch (1973) documents that intense typhoons passing the Philippines between 1960 to 1970 have an average *eye diameter* of 20 to 30 miles, which translate to an *eye radius* of 16 to 24 kilometers. They also found that the intense typhoons have smaller eye diameters but larger circulation sizes than less-intense typhoons.

kilometers away from the eye of the storm and estimate the effects of typhoon exposure on them. These results are presented in section A.4 of the appendix. We find that pre-1965 typhoons have little effect on municipalities and individuals 30 to 60 kilometers away from the eye of the storm. However, post-1965 typhoons have some negative effects on the cohort size of municipalities 30 to 60 kilometers from the storm path. Moreover, the effects on municipalities 30 to 60 kilometers away are even larger than the effects on municipalities within 30 kilometers. This pattern is unique to cohort size effects – we do not find the same patterns for long-term outcomes. One possible explanation for this would be that the size of some post-1965 typhoons are larger than the size of pre-1965 typhoons. Meanwhile, disaster relief funding may be more available for municipalities close to the typhoon path than for municipalities farther away from the typhoon path.

Alternative storm intensity measures Our main analysis allows for only two storm intensity levels (small and severe). In Appendix Tables A.15, A.16, and A.17, we allow for four levels. We continue to combine SS scale 4 and 5 storms in one category because only a small number of municipalities are ever exposed to scale 5 storms. The results suggest that, one, in most cases, the impact of the storm increases with storm intensity, and, two, there is a discontinuous jump in the impact of the storm once the storm reaches scale 4 or 5 – the magnitudes of the adverse effects are much larger for scale 4 and 5 storms than for scale 1, 2, or 3 storms. These results support our categorization of storm intensity. We discuss further details in Appendix section A.5.

Alternative cutoff year Although Ferdinand Marcos came into office after December 1965, drastic changes in disaster relief policy began only in December 1968 after the Casiguran earthquake. In our main analysis, we used December 1965 as the cut-off time for policy change. For robustness, we also use December 1968 as the alternative cut-off time for policy change (Appendix Tables A.18, A.19, and A.20). While the basic patterns found in the main analysis persist, in most cases, using 1968 as the cut-off time reveals an even larger contrast between the pre- and under-Marcos years. Effects on cohort sizes are larger for the pre-Marcos period when we use 1968 as the cutoff, whereas they become smaller for the under-Marcos period. Effects for most long-term outcomes are still small and insignificant for the pre-Marcos period, whereas long-term effects for the post-Marcos period become even larger, especially on occupation. These results suggest that the change in the availability of disaster relief funding after December 1968 is the main contributor to the muted mortality effects in the under-Marcos period.

5 Conclusion

We find a strong dose-response effect to early-life exposure to natural disasters in a setting where natural disasters occur frequently – severe disasters are associated with adverse outcomes, whereas less intense events are associated with small or not statistically significant effects. These findings stand in stark contrast with findings from the U.S. and Brazil where low-intensity hurricanes can have large negative effects on both short and long-term outcomes (Karbownik and Wray, 2016; Currie and Rossin-Slater, 2013; Simeonova, 2011). One plausible explanation for the differences in findings is the role of adaptation. Due to the high frequency of low-intensity typhoons in the Philippines, residents may be more prepared, both mentally and physically, to cope with lower intensity, somewhat expected natural disasters. However, our findings suggest that, without the help of government assistance, residents and low-SES residents in particular are not prepared to cope with severe typhoons on their own. Therefore, policy makers should take the community's familiarity with the disaster and the severity of natural disasters into account in implementing both short and long-term interventions.

We also find a strong negative relationship between mortality and long-term scarring effects. When the mortality effects of severe disasters are especially high (pre-1965 typhoons in our setting), we do not observe any differences in long-term outcomes between the survivors and those who were not exposed to the shock at all. When the mortality effects of severe disasters are much more muted (post-1965 typhoons), we observe large differences in long-term outcomes between the survivors and the unaffected. The observed adverse outcomes due to scarring in a low mortality setting reflect improved early-life survival. These contrasts suggest that research on early-life shocks in developing countries should pay special attention to selective mortality since observed adverse long-term outcomes may be the result of increased probability of survival (Currie and Vogl, 2013).

The provision of post disaster resources in the aftermath of a natural disaster has long been the focus in policy making in high income and lower income settings. Our findings suggest that short-term assistance like Ferdinand Marcos' disaster response policies in the late 1960s and 1970s have been especially effective in lowering early-life mortality caused by disasters. However, alleviating the scarring effects on long-term outcomes still remains a challenge for future research and for policy making. To that end, our finding that children from high-SES families in the post-1965 sample were somewhat shielded from the negative effects of severe typhoons offers a sense of hope – with strong infrastructure and sufficient post-disaster aid, complete resilience may be within reach even after the most ferocious disasters.

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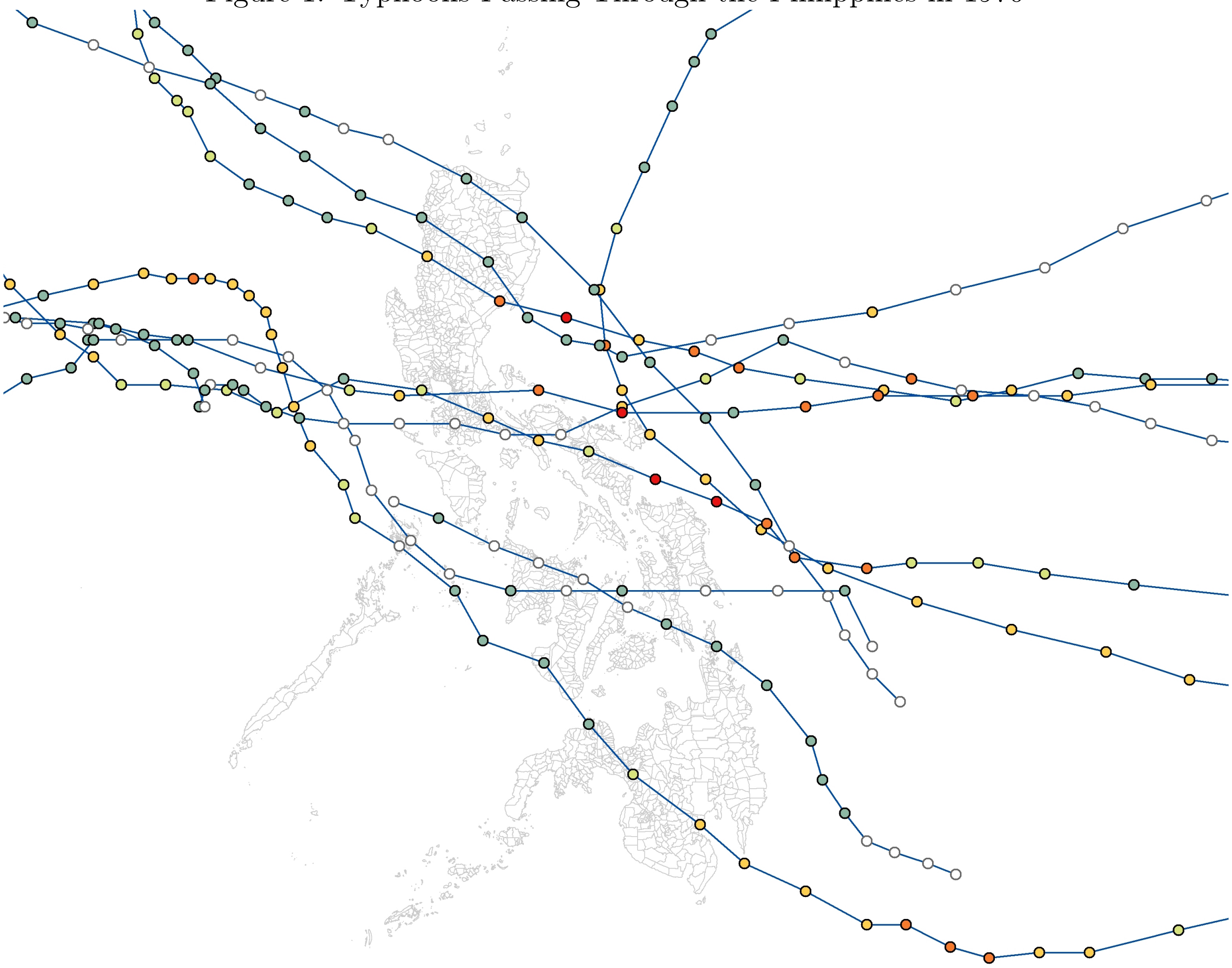
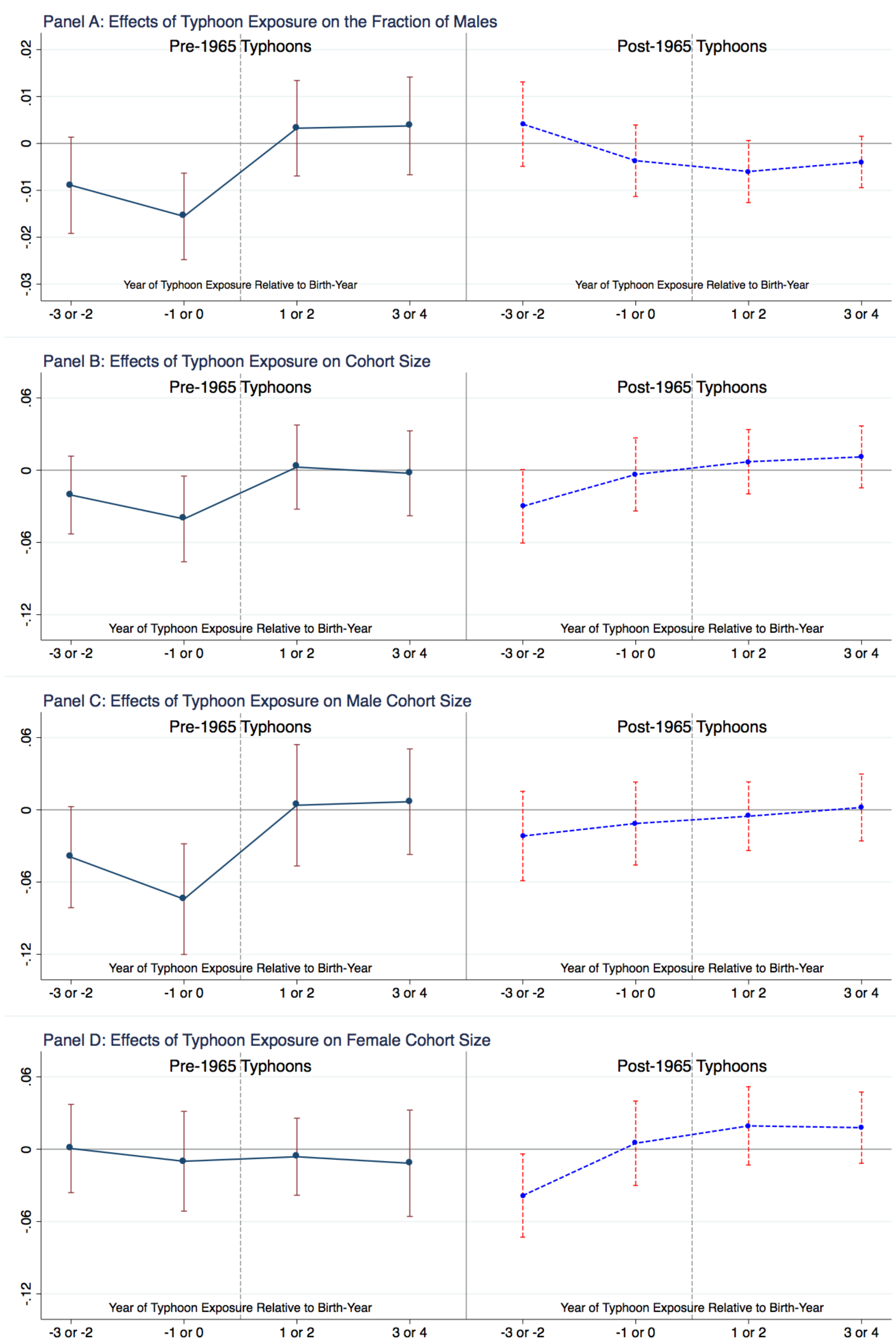
Figures and Tables

Figure 1: Typhoons Passing Through the Philippines in 1970



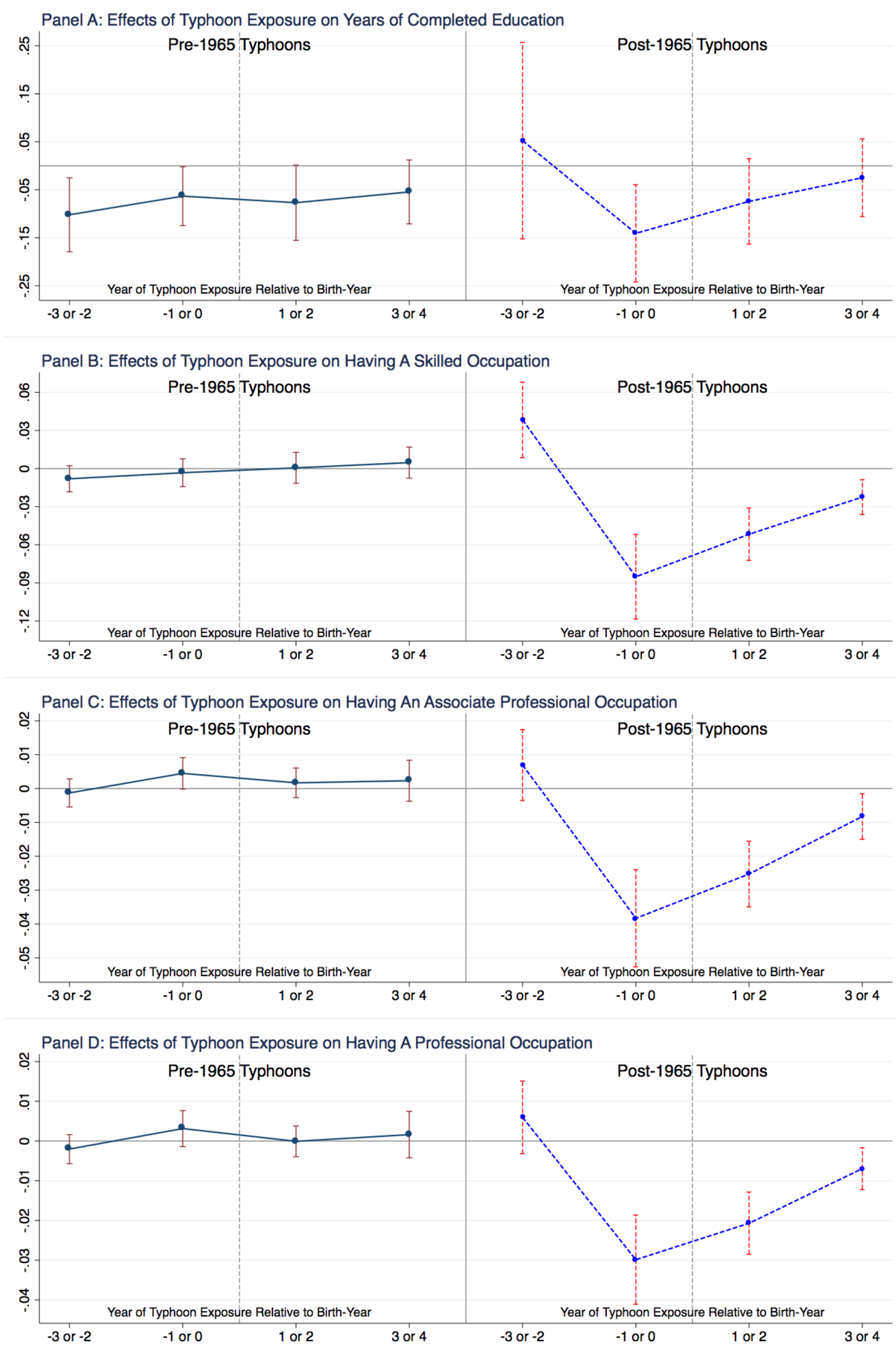
Notes: Authors' calculations of all typhoons that passed by the Philippines region in 1970. Each dot indicates the location and severity of the six-hourly observations of the typhoon. Red dots indicate that the typhoon was category 5 at the time it passed the location, rich orange dots category 4, yellow dots category 3, lime dots category 2, teal dots category 1, and hollow dots tropical cyclones below typhoon severities. In the background is a map of the Philippines with municipality outlines.
Data Source: Japan Meteorological Agency Tropical Cyclone Database.

Figure 2: Effects of Severe Typhoons on Cohort Size by Year of Exposure



Notes: Each panel shows the results of a separate regression where the outcome variable is regressed on eight dummy variables indicating whether there is a severe pre-1965 or post-1965 typhoon passing each municipality-birth-year 2 to 3 years before the birth-year, 0 to 1 year before the birth-year, 1 to 2 years after the birth-year, or 3 to 4 years after the birth-year, as well as municipality fixed effects, age-by-island-group fixed effects, and region-specific time trends. The left side of each panel shows the coefficient estimates and 95% confidence intervals of the four dummy variables associated with pre-1965 typhoons, and the right side post-1965 typhoons. The regressions are run at the municipality-age-cohort level. Sample includes cohorts between the age of 2 and 43 in 1990 and municipalities that has at least one male and one female in each age cohort for all ages under 43 in the 1990 Census 10% Housing Survey. Robust standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Figure 3: Effects of Severe Typhoons on Education and Occupation by Year of Exposure



Notes: Each panel shows the results from a separate regression where the outcome variable is regressed on eight dummy variables indicating whether there is a severe pre-1965 or post-1965 typhoon passing each municipality-birth-year 2 to 3 years before the birth-year, 0 to 1 year before the birth-year, 1 to 2 years after the birth-year, or 3 to 4 years after the birth-year, as well as municipality fixed effects, age-by-island-group fixed effects, and region-specific time trends. The left side of each panel shows the coefficient estimates and 95% confidence intervals of the four dummy variables associated with pre-1965 typhoons, and the right side post-1965 typhoons. Sample includes all individuals between the age of 18 and 43 with non-missing municipality of birth information in the 10% housing sample of CPH1990. Robust standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table 1: Average Typhoon Exposures Across the Philippines, 1945-1972

Panel A: Average number of typhoons affecting **the Philippines** per year

Time Period	All Typhoons	Scale 1	Scale 2	Scale 3	Scale 4	Scale 5	Small	Severe
Period 1: 1945-1965	4.95	2.86	0.62	0.90	0.52	0.05	4.38	0.57
Period 2: 1966-1972	6.43	3.14	1.42	1.00	0.43	0.43	5.57	0.86
Overall: 1945-1972	5.32	2.93	0.82	0.93	0.50	0.14	4.68	0.64

Panel B: Average number of typhoons affecting **each municipality** per year, by island group

		Period 1: 1945-1965			Period 2: 1966-1972		
Island Group	Storm Intensity	Mean	Std. Dev.	Max	Mean	Std. Dev.	Max
Northern Luzon	Small	0.320	(0.561)	3	0.295	(0.556)	2
	Severe	0.010	(0.099)	1	0.019	(0.137)	1
Southern Luzon	Small	0.187	(0.430)	2	0.383	(0.641)	4
	Severe	0.001	(0.033)	1	0.049	(0.216)	1
Visayas	Small	0.155	(0.394)	3	0.259	(0.507)	3
	Severe	0.015	(0.123)	1	0.005	(0.072)	1
Mindanao	Small	0.030	(0.179)	2	0.078	(0.268)	1
	Severe	0.002	(0.044)	1	0	(0)	0
Overall	Small	0.172	(0.426)	3	0.248	(0.517)	4
	Severe	0.007	(0.085)	1	0.017	(0.130)	1

Note: Authors' calculations using JMA and TD-9635 data. Panel A shows the average number of typhoons that cross the Philippine archipelago every year. Panel B shows the average number of typhoons affecting each municipality per year. Geographic divisions and municipality boundaries are consistent with the 1990 Philippine Census. Number of municipalities = 1611. A municipality is affected if the centroid of the municipality lies within 30 km of the typhoon path. Typhoon intensity in Panel A refers to the highest intensity a typhoon ever reached over the Philippine archipelago. Storm intensity in Panel B refers to the intensity when the typhoon passed the corresponding municipality. A small typhoon is one whose highest intensity is SS scale 1, 2, or 3. A severe typhoon is one whose highest intensity is SS scale 4 or 5.

Table 2: Summary statistics

	(1) Exposed Small	(2) Exposed Severe	(3) Never Exposed
Panel A. Age 25-43, Pre-Marcos			
Literacy	0.965	0.964	0.945
	(0.183)	(0.187)	(0.228)
Years of education	9.326	9.448	9.140
	(3.747)	(3.763)	(3.943)
Completed high school	0.450	0.464	0.441
	(0.497)	(0.499)	(0.497)
Skilled occupation	0.315	0.360	0.311
	(0.464)	(0.480)	(0.463)
Associate professional occupation	0.100	0.116	0.101
	(0.300)	(0.320)	(0.302)
Professional occupation	0.083	0.095	0.084
	(0.276)	(0.293)	(0.277)
N	351,245	33,101	1,110,085
Panel B. Age 18-24, under Marcos			
Literacy	0.971	0.982	0.955
	(0.168)	(0.133)	(0.207)
Years of education	9.783	10.398	9.593
	(3.348)	(2.834)	(3.576)
Completed high school	0.526	0.620	0.505
	(0.499)	(0.486)	(0.500)
Skilled occupation	0.169	0.139	0.177
	(0.374)	(0.346)	(0.382)
Associate professional occupation	0.032	0.020	0.038
	(0.176)	(0.138)	(0.192)
Professional occupation	0.024	0.013	0.030
	(0.152)	(0.114)	(0.170)
N	214,533	61,013	551,681

Notes: Source for the outcome variables is the 10% housing sample of the CPH 1990. Outcomes for respondents who were exposed in-utero to small typhoons only (col. 1), ever exposed to severe typhoons (col. 2), or never exposed to typhoons (col. 3). Small typhoon in-utero is the expected number of small typhoons that passed within 30 km of the respondent's municipality of birth when the respondent is in-utero. Similarly, small typhoon in 1st and 2nd year are the expected number of small typhoon during the first and second year after birth. Small typhoons are those with minimum central pressure between 945 and 999 mb, which correspond to a category 1, 2, or 3 typhoon on the Saffir-Simpson scale. Severe typhoons are those with central pressure at or below 944 mb, which correspond to category 4 and 5 typhoons on the Saffir-Simpson scale.

Table 4: Effects on Cohort Size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample: Ages Cohorts 2 to 43				**Sample: Ages Cohorts 18 to 43**			
	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male
Small typhoon in-utero	-0.00841	-0.00612	-0.0138**	0.00162	-0.0110	-0.00749	-0.0174*	0.00181
	(0.00532)	(0.00639)	(0.00676)	(0.00169)	(0.00706)	(0.00888)	(0.00939)	(0.00252)
Small typhoon year 1&2	0.00102	-0.00274	0.00431	-0.00175**	-0.000798	-0.00209	5.23e-07	-0.000491
	(0.00265)	(0.00318)	(0.00308)	(0.000721)	(0.00326)	(0.00427)	(0.00390)	(0.00107)
Severe typhoon in-utero	-0.0502**	-0.0769**	-0.0267	-0.0128*	-0.0735**	-0.111**	-0.0437	-0.0175
	(0.0253)	(0.0329)	(0.0296)	(0.00760)	(0.0304)	(0.0450)	(0.0363)	(0.0109)
Severe typhoon year 1&2	0.00919	0.00121	0.0156	-0.00297	0.00751	0.00375	0.00781	-0.000192
	(0.0115)	(0.0146)	(0.0129)	(0.00337)	(0.0128)	(0.0191)	(0.0147)	(0.00504)
Observations	62,286	62,286	62,286	62,286	38,558	38,558	38,558	38,558
R-squared	0.943	0.910	0.906	0.033	0.939	0.896	0.895	0.045
Mean of Cohort Size	724.68	365.78	358.91	0.5078	576.69	287.98	288.71	0.5056

Notes: Source for the outcome variables is the 10% housing sample of the CPH 1990. Cohort size is the estimated size of each cohort, estimated by summing up the weights of all individuals with non-missing municipality of birth information. Each column is a separate regression. Regressions are run at the birth-municipality by age-cohort level. For columns (1) to (4), the sample includes all cohorts aged 2 to 43 in 1990. For columns (5) to (8), the sample includes all cohorts aged 18 to 43 in 1990. For all columns, municipalities are restricted to those that have at least one male and one female in each age cohort for all ages under 43.

Small typhoon in-utero is the expected number of small typhoons that passed within 30 km of the respondent's municipality of birth when the respondent is in-utero. Similarly, small typhoon in 1st and 2nd year are the expected number of small typhoon during the first and second year after birth. Small typhoons are those with minimum central pressure between 945 and 999 mb, which correspond to a category 1, 2, or 3 typhoon on the Saffir-Simpson scale. Severe typhoons are those with central pressure at or below 944 mb, which correspond to category 4 and 5 typhoons on the Saffir-Simpson scale.

All regressions include municipality fixed effects, birth-year by island group fixed effects, and region-specific time trends. Standard errors are clustered two-way at both the municipality and the province-by-birth-year level.

Table 5: Effects on Cohort Size - Before and After 1965

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample: Ages Cohorts 2 to 43				**Sample: Ages Cohorts 18 to 43**			
	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male
Small typhoon in-utero	-0.00746	-0.00862	-0.00962	-0.000328	-0.0113	-0.0120	-0.0133	-0.000291
pre-1965	(0.00959)	(0.0119)	(0.0119)	(0.00303)	(0.00864)	(0.0113)	(0.0108)	(0.00302)
Small typhoon year 1&2	0.00883*	0.00640	0.0101*	-0.000885	0.00643	0.00440	0.00773	-0.000812
pre-1965	(0.00502)	(0.00609)	(0.00569)	(0.00129)	(0.00432)	(0.00563)	(0.00499)	(0.00133)
Severe typhoon in-utero	-0.0954***	-0.144***	-0.0602	-0.0224	-0.0871**	-0.133**	-0.0517	-0.0217
pre-1965	(0.0354)	(0.0552)	(0.0456)	(0.0144)	(0.0354)	(0.0560)	(0.0470)	(0.0147)
Severe typhoon year 1&2	0.00874	0.00423	0.00722	0.000590	0.00771	0.00816	0.00385	0.00238
pre-1965	(0.0186)	(0.0282)	(0.0181)	(0.00642)	(0.0168)	(0.0269)	(0.0168)	(0.00673)
Small typhoon in-utero	-0.00944	-0.00499	-0.0169**	0.00287	-0.0126	4.32e-05	-0.0281	0.00627
post-1965	(0.00624)	(0.00735)	(0.00803)	(0.00198)	(0.0122)	(0.0149)	(0.0172)	(0.00444)
Small typhoon year 1&2	-0.00361	-0.00807**	0.000881	-0.00224***	-0.0147***	-0.0142**	-0.0151**	0.000283
post-1965	(0.00312)	(0.00356)	(0.00370)	(0.000820)	(0.00499)	(0.00635)	(0.00619)	(0.00169)
Severe typhoon in-utero	-0.0183	-0.0287	-0.00410	-0.00556	-0.0444	-0.0584	-0.0309	-0.00598
post-1965	(0.0359)	(0.0405)	(0.0380)	(0.00766)	(0.0528)	(0.0700)	(0.0545)	(0.0152)
Severe typhoon year 1&2	0.00740	-0.00350	0.0192	-0.00550	-0.00161	-0.0126	0.00582	-0.00470
post-1965	(0.0146)	(0.0150)	(0.0182)	(0.00369)	(0.0185)	(0.0207)	(0.0273)	(0.00693)
Observations	62,286	62,286	62,286	62,286	38,558	38,558	38,558	38,558
R-squared	0.943	0.910	0.906	0.033	0.939	0.896	0.895	0.045
Mean of Y, pre-1965	507.53	254.53	253.01	0.5057	507.53	254.53	253.01	0.5057
Mean of Y, post-1965	904.07	457.68	446.39	0.5096	764.40	378.79	385.62	0.5054

Notes: All details are the same as for Table 4 except that the typhoon exposure variables here are interacted with a dummy variable indicating whether the typhoon occurred before or after December 1965. The mean of cohort size and fraction male are presented in the last two rows. Mean of Y, pre-1965 refers to the averages for cohorts aged 25 to 43. Mean of Y, post-1965 refers to the averages for cohorts aged 2 to 24 for columns (1) to (4) and cohorts aged 18 to 24 for columns (5) to (8).

Table 6: Effects on Educational Attainment

	(1) Literacy	(2) Years of Education	(3) Completed High Sch.
Small typhoon in-utero	0.00129	0.0287*	0.000422
pre-1965	(0.000846)	(0.0173)	(0.00232)
Small typhoon year 1&2	-7.12e-05	0.00735	-0.000707
pre-1965	(0.000437)	(0.00911)	(0.00124)
Severe typhoon in-utero	0.00466	-0.0300	-0.0143
pre-1965	(0.00407)	(0.0666)	(0.00874)
Severe typhoon year 1&2	0.00145	-0.0595	-0.0143***
pre-1965	(0.00209)	(0.0384)	(0.00529)
Small typhoon in-utero	-0.00145	-0.0119	-0.000968
post-1965	(0.00116)	(0.0228)	(0.00286)
Small typhoon year 1&2	-0.000635	-0.00669	-0.00159
post-1965	(0.000603)	(0.0135)	(0.00155)
Severe typhoon in-utero	-0.00771*	-0.342***	-0.0181
post-1965	(0.00394)	(0.109)	(0.0139)
Severe typhoon year 1&2	-0.000442	-0.0614	-0.00966
post-1965	(0.00184)	(0.0465)	(0.00651)
Observations	2,290,886	2,255,017	2,255,017
R-squared	0.143	0.188	0.135
Mean of Y, pre-1965 cohorts	0.950	9.19	0.444
Mean of Y, post-1965 cohorts	0.961	9.70	0.519

Notes: Sample includes all individuals between the age of 18 and 43 with non-missing municipality of birth information in the 10% housing sample of CPH1990. "Literacy" is a dummy variable indicating whether the respondent is literate as of May, 1990. "Years of education" refers to the respondent's completed years of education as of May, 1990. "Completed High School" is a dummy variable indicating whether the correspondent has completed high school as of May, 1990. Each column is a separate regression. Regressions are run at the individual level, whereas the treatment variables are defined at the birth-municipality by age-cohort level. Definitions of treatment variables are the same as in Table 5. All regressions include municipality fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table 7: Effects on Occupational Skill Level

	(1) Skilled Occupation	(2) Associate Professional	(3) Professional	(4) Skilled Occupation	(5) Associate Professional	(6) Professional
Small typhoon in-utero	0.00933***	0.00321**	0.00274**	0.00831***	0.00272*	0.00222*
pre-1965	(0.00299)	(0.00154)	(0.00131)	(0.00280)	(0.00139)	(0.00120)
Small typhoon year 1&2	0.00637***	0.00332***	0.00259***	0.00608***	0.00316***	0.00245***
pre-1965	(0.00172)	(0.00107)	(0.000921)	(0.00158)	(0.000998)	(0.000867)
Severe typhoon in-utero	-0.00302	0.00949**	0.00794*	-0.00397	0.00871*	0.00700
pre-1965	(0.0105)	(0.00470)	(0.00462)	(0.0105)	(0.00454)	(0.00458)
Severe typhoon year 1&2	0.00108	0.00103	-0.000674	0.00290	0.00232	0.000607
pre-1965	(0.00550)	(0.00215)	(0.00215)	(0.00555)	(0.00206)	(0.00172)
Small typhoon in-utero	0.00930	0.00217	0.00206	0.00976	0.00230	0.00224
post-1965	(0.00742)	(0.00274)	(0.00212)	(0.00711)	(0.00247)	(0.00189)
Small typhoon year 1&2	0.00438	0.00150	0.00154	0.00470	0.00180	0.00182
post-1965	(0.00330)	(0.00173)	(0.00147)	(0.00307)	(0.00157)	(0.00134)
Severe typhoon in-utero	-0.159***	-0.0690***	-0.0519***	-0.145***	-0.0601***	-0.0448***
post-1965	(0.0421)	(0.0176)	(0.0131)	(0.0397)	(0.0157)	(0.0115)
Severe typhoon year 1&2	-0.0508***	-0.0252***	-0.0206***	-0.0500***	-0.0244***	-0.0198***
post-1965	(0.0113)	(0.00501)	(0.00392)	(0.0111)	(0.00492)	(0.00389)
Years of education	No	No	No	0.0381***	0.0252***	0.0215***
				(0.000665)	(0.000711)	(0.000615)
Observations	2,093,804	2,093,804	2,093,804	2,069,113	2,069,113	2,069,113
R-squared	0.146	0.045	0.037	0.232	0.146	0.125
Mean of Y, pre-1965 cohorts	0.313	0.101	0.084	0.313	0.101	0.084
Mean of Y, post-1965 cohorts	0.172	0.035	0.027	0.172	0.035	0.027

Notes: Outcome variables are dummy variables indicating whether the individual holds a skilled occupation (columns 1 and 4), an associate professional occupation (columns 2 and 5), or a professional occupation (columns 3 and 6). Other details are the same as in Table 6.

Table 8: Effects on Educational Attainment by Sex

	(1)	(2)	(3)	(4)	(5)	(6)
	Literacy		Years of Education		Completed High Sch.	
	Male	Female	Male	Female	Male	Female
Small typhoon in-utero	0.00102	0.00154	0.00733	0.0516**	-0.000860	0.00193
pre-1965	(0.00107)	(0.00114)	(0.0229)	(0.0219)	(0.00314)	(0.00293)
Small typhoon year 1&2	2.48e-05	-0.000173	0.00691	0.00779	-0.000786	-0.000575
pre-1965	(0.000546)	(0.000557)	(0.0107)	(0.0116)	(0.00145)	(0.00161)
Severe typhoon in-utero	0.00440	0.00480	-0.00734	-0.0540	-0.0215*	-0.00675
pre-1965	(0.00530)	(0.00555)	(0.102)	(0.0856)	(0.0125)	(0.0109)
Severe typhoon year 1&2	0.00191	0.000707	-0.0409	-0.0790	-0.0178**	-0.0107*
pre-1965	(0.00256)	(0.00318)	(0.0562)	(0.0485)	(0.00764)	(0.00568)
Small typhoon in-utero	-0.000860	-0.00209	-0.0272	0.00467	-0.00263	0.00146
post-1965	(0.00141)	(0.00145)	(0.0262)	(0.0301)	(0.00395)	(0.00356)
Small typhoon year 1&2	-0.000608	-0.000738	0.00163	-0.0150	-0.000157	-0.00293
post-1965	(0.000690)	(0.000771)	(0.0132)	(0.0169)	(0.00182)	(0.00200)
Severe typhoon in-utero	-0.00878*	-0.00685	-0.400***	-0.286**	-0.0259	-0.0128
post-1965	(0.00460)	(0.00520)	(0.113)	(0.131)	(0.0175)	(0.0164)
Severe typhoon year 1&2	0.000358	-0.00133	-0.0706	-0.0574	-0.00857	-0.0117
post-1965	(0.00180)	(0.00233)	(0.0435)	(0.0618)	(0.00697)	(0.00810)
Observations	1,144,609	1,146,277	1,127,900	1,127,117	1,127,900	1,127,117
R-squared	0.117	0.177	0.186	0.194	0.137	0.139
Mean of Y, pre-1965 cohorts	0.952	0.949	9.12	9.26	0.447	0.440
Mean of Y, post-1965 cohorts	0.959	0.963	9.41	9.83	0.485	0.552

Notes: Each column is a separate regression using the sub-sample of either male or female respondents in the CPH1990 10% sample. All regressions include municipality fixed effects, birth-year by island group fixed effects, and region-specific time trends. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level. Other details are the same as in Table 6

Table 9: Effects on Occupational Skill Level by Sex

	(1)	(2)	(3)	(4)	(5)	(6)
	Skilled Occupation		Associate Professional		Professional	
	Male	Female	Male	Female	Male	Female
Small typhoon in-utero,	0.0108***	0.00869***	0.00327	0.00326*	0.00247	0.00309*
pre-1965	(0.00414)	(0.00319)	(0.00221)	(0.00177)	(0.00185)	(0.00166)
Small typhoon year 1&2,	0.00494**	0.00791***	0.00308**	0.00361***	0.00269**	0.00253**
pre-1965	(0.00229)	(0.00173)	(0.00136)	(0.00115)	(0.00112)	(0.00106)
Severe typhoon in-utero,	0.00612	-0.00999	-0.00362	0.0223***	-0.00908	0.0242***
pre-1965	(0.0146)	(0.0139)	(0.00826)	(0.00606)	(0.00684)	(0.00597)
Severe typhoon year 1&2,	-0.00227	0.00434	0.00315	-0.000887	0.00256	-0.00370
pre-1965	(0.00834)	(0.00431)	(0.00419)	(0.00318)	(0.00322)	(0.00326)
Small typhoon in-utero,	0.0143	0.00552	0.00118	0.00301	0.00135	0.00254
post-1965	(0.0102)	(0.00609)	(0.00329)	(0.00269)	(0.00246)	(0.00219)
Small typhoon year 1&2,	0.00587	0.00287	0.00187	0.00100	0.00200	0.000974
post-1965	(0.00437)	(0.00325)	(0.00202)	(0.00164)	(0.00171)	(0.00139)
Severe typhoon in-utero,	-0.183***	-0.144***	-0.0684***	-0.0703***	-0.0460***	-0.0579***
post-1965	(0.0553)	(0.0372)	(0.0194)	(0.0170)	(0.0138)	(0.0133)
Severe typhoon year 1&2,	-0.0702***	-0.0360***	-0.0307***	-0.0205***	-0.0242***	-0.0174***
post-1965	(0.0153)	(0.00991)	(0.00663)	(0.00451)	(0.00500)	(0.00389)
Observations	1,043,359	1,050,445	1,043,359	1,050,445	1,043,359	1,050,445
R-squared	0.201	0.066	0.062	0.035	0.048	0.030
Mean of Y, pre-1965 cohorts	0.415	0.221	0.101	0.102	0.078	0.090
Mean of Y, post-1965 cohorts	0.194	0.152	0.029	0.041	0.020	0.034

Notes: Each column is a separate regression using the sub-sample of either male or female respondents in the CPH1990 10% sample. All regressions include municipality fixed effects, birth-year by island group fixed effects, and region-specific time trends. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level. Other details are the same as in Table 7 (Cols. 1-3).

Table 10: Effects on Educational Attainment - Co-residents Sample

	(1)	(2)	(3)	(4)	(5)	(6)
	With Household Fixed Effects			**With Municipality Fixed Effects**		
	Literacy	Years of Education	Completed High Sch.	Literacy	Years of Education	Completed High Sch.
Small typhoon in-utero,	0.00109	0.0428	-0.00617	0.00181	0.0718**	-0.00318
pre-1965	(0.00182)	(0.0353)	(0.00496)	(0.00144)	(0.0332)	(0.00455)
Small typhoon year 1&2,	-0.000502	0.00539	0.000447	-0.000870	-0.0264	-0.00785***
pre-1965	(0.000968)	(0.0196)	(0.00289)	(0.000806)	(0.0176)	(0.00255)
Severe typhoon in-utero,	-0.00371	-0.0775	-0.00331	-0.00137	-0.361***	-0.0444**
pre-1965	(0.00862)	(0.132)	(0.0221)	(0.00721)	(0.126)	(0.0187)
Severe typhoon year 1&2,	-0.00109	-0.0950	-0.00617	0.00113	-0.0308	-0.00616
pre-1965	(0.00410)	(0.0807)	(0.0109)	(0.00364)	(0.0727)	(0.00825)
Small typhoon in-utero,	0.000591	-0.000541	0.00160	-0.000840	-0.0192	0.000472
post-1965	(0.00138)	(0.0290)	(0.00412)	(0.00114)	(0.0252)	(0.00374)
Small typhoon year 1&2,	-0.000156	0.00386	-0.00236	-0.000520	0.0102	-0.000899
post-1965	(0.000640)	(0.0140)	(0.00200)	(0.000572)	(0.0124)	(0.00191)
Severe typhoon in-utero,	-0.00749	-0.472***	-0.0149	-0.00419	-0.222**	0.0166
post-1965	(0.00483)	(0.122)	(0.0154)	(0.00397)	(0.0953)	(0.0168)
Severe typhoon year 1&2,	-6.18e-05	-0.0842**	-0.00722	3.40e-05	-0.00529	0.000257
post-1965	(0.00211)	(0.0382)	(0.00659)	(0.00163)	(0.0414)	(0.00613)
Observations	586,234	575,982	575,982	586,233	577,819	577,819
R-squared	0.665	0.776	0.702	0.101	0.172	0.127
Mean of Y, pre-1965	0.968	10.69	0.629	0.968	10.69	0.629
Mean of Y, post-1965	0.973	10.36	0.605	0.973	10.36	0.605

Notes: Sample restricted to those in the 10% housing sample of CPH 1990 who still live in the same household as his or her parent(s) and whose reported relationship to the household head is that of either "son" or "daughter". Regressions in columns (1) to (3) include household fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Regressions in columns (4) to (6) include municipality fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Other details are the same as in Table 6.

Table 11: Effects on Occupational Skill Level - Sibling Comparison

	(1)	(2)	(3)	(4)	(5)	(6)
	With Household Fixed Effects			**With Municipality Fixed Effects**		
	Skilled Occupation	Associate Professional	Professional	Skilled Occupation	Associate Professional	Professional
Small typhoon in-utero, pre-1965	0.0190**	0.0137***	0.00804*	0.0279***	0.0146***	0.0108***
	(0.00769)	(0.00473)	(0.00467)	(0.00655)	(0.00380)	(0.00344)
Small typhoon year 1&2, pre-1965	0.00607	0.00110	0.000965	0.0138***	0.00601**	0.00461*
	(0.00410)	(0.00300)	(0.00297)	(0.00372)	(0.00283)	(0.00252)
Severe typhoon in-utero, pre-1965	-0.00556	-0.00665	-0.00986	0.00222	0.00478	0.00506
	(0.0324)	(0.0165)	(0.0136)	(0.0311)	(0.0106)	(0.00942)
Severe typhoon year 1&2, pre-1965	-0.0343**	-0.00542	-0.0102	0.000247	0.00950	0.00181
	(0.0157)	(0.00909)	(0.00707)	(0.0155)	(0.00948)	(0.00769)
Small typhoon in-utero, post-1965	0.0112*	0.00106	0.000498	0.0108*	0.00300	0.00243
	(0.00625)	(0.00275)	(0.00220)	(0.00635)	(0.00284)	(0.00236)
Small typhoon year 1&2, post-1965	0.00469	0.00238	0.00243*	0.00565*	0.00358*	0.00333*
	(0.00320)	(0.00190)	(0.00147)	(0.00289)	(0.00206)	(0.00180)
Severe typhoon in-utero, post-1965	-0.126***	-0.0646***	-0.0483***	-0.124***	-0.0620***	-0.0493***
	(0.0379)	(0.0179)	(0.0129)	(0.0328)	(0.0140)	(0.0110)
Severe typhoon year 1&2, post-1965	-0.0460***	-0.0272***	-0.0212***	-0.0461***	-0.0281***	-0.0221***
	(0.0123)	(0.00583)	(0.00497)	(0.0103)	(0.00465)	(0.00394)
Observations	483,553	483,553	483,553	502,380	502,380	502,380
R-squared	0.595	0.525	0.510	0.161	0.084	0.071
Mean of Y, pre-1965	0.407	0.143	0.117	0.407	0.143	0.117
Mean of Y, post-1965	0.187	0.042	0.032	0.187	0.042	0.032

Notes: Sample restricted to those in the 10% housing sample of CPH 1990 who still live in the same household as his or her parent(s) and whose reported relationship to the household head is that of either "son" or "daughter". Regressions in columns (1) to (3) include household fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Regressions in columns (4) to (6) include municipality fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Other details are the same as in Table 7.

Table 12: Effects on Education - Siblings Comparison By Household Head Occupation

	(1)	(2)	(3)	(4)	(5)	(6)
	Sample: Household Head Unskilled Occ			**Sample: Household Head Skilled Occ**		
	Literacy	Years of Education	Completed High Sch.	Literacy	Years of Education	Completed High Sch.
Small typhoon in-utero	0.00260	0.0351	-0.00714	-0.00223	0.0390	-0.00177
pre-1965	(0.00224)	(0.0434)	(0.00606)	(0.00245)	(0.0590)	(0.00771)
Small typhoon year 1&2	-0.000888	-0.00245	0.000769	0.000452	0.0146	0.000977
pre-1965	(0.00119)	(0.0224)	(0.00335)	(0.00150)	(0.0331)	(0.00480)
Severe typhoon in-utero	-0.00692	-0.162	-0.0103	0.00769	0.145	0.0251
pre-1965	(0.0109)	(0.170)	(0.0280)	(0.00975)	(0.195)	(0.0323)
Severe typhoon year 1&2	-0.00219	-0.109	-0.00902	0.000766	-0.0982	0.00442
pre-1965	(0.00558)	(0.0974)	(0.0122)	(0.00616)	(0.120)	(0.0186)
Small typhoon in-utero	0.000858	0.000787	0.00314	-0.000394	-0.0553	-3.64e-05
post-1965	(0.00176)	(0.0313)	(0.00480)	(0.00182)	(0.0452)	(0.00695)
Small typhoon year 1&2	8.97e-05	0.00831	-0.00335	-0.000680	-0.0176	0.000206
post-1965	(0.000855)	(0.0163)	(0.00247)	(0.000811)	(0.0212)	(0.00300)
Severe typhoon in-utero	-0.00884	-0.399***	-0.0159	-0.00569	-0.284*	-0.0179
post-1965	(0.00657)	(0.139)	(0.0199)	(0.00507)	(0.156)	(0.0255)
Severe typhoon year 1&2	0.000210	-0.0707	-0.00324	-0.000701	-0.0701	-0.00618
post-1965	(0.00285)	(0.0504)	(0.00804)	(0.00258)	(0.0670)	(0.00889)
Observations	412,824	405,935	405,935	173,410	170,047	170,047
R-squared	0.679	0.769	0.695	0.510	0.735	0.662
Mean of Y, pre-1965	0.956	10.20	0.577	0.988	12.17	0.787
Mean of Y, post-1965	0.964	9.72	0.526	0.992	11.75	0.776

Notes: Sample restricted to those in the 10% housing sample of CPH 1990 who still live in the same household as his or her parent(s) and whose reported relationship to the household head is that of either "son" or "daughter". For columns (1) to (3), the sample is further restricted to children of households where the household head has an unskilled occupation. For columns (4) to (6), the sample is further restricted to children of households where the household head has a skilled occupation. All regressions include household fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Other details are the same as in Table 6.

Table 13: Effects on Occupation - Siblings Comparison By Household Head Occupation

	(1)	(2)	(3)	(4)	(5)	(6)
	Sample: Household Head Unskilled Occ			**Sample: Household Head Skilled Occ**		
	Skilled Occupation	Associate Professional	Professional	Skilled Occupation	Associate Professional	Professional
Small typhoon in-utero,	0.0110	0.00478	0.00151	0.0190	0.0275**	0.0184*
pre-1965	(0.00856)	(0.00526)	(0.00484)	(0.0148)	(0.0119)	(0.0109)
Small typhoon year 1&2,	0.000901	-0.00341	-0.00262	0.00717	0.00735	0.00609
pre-1965	(0.00399)	(0.00284)	(0.00296)	(0.00855)	(0.00644)	(0.00613)
Severe typhoon in-utero,	-0.0341	-0.0298	-0.0216	0.0623	0.0566	0.0195
pre-1965	(0.0277)	(0.0203)	(0.0177)	(0.0454)	(0.0394)	(0.0295)
Severe typhoon year 1&2,	-0.0300**	0.00232	0.00233	-0.0774***	-0.0466**	-0.0630***
pre-1965	(0.0147)	(0.00884)	(0.00824)	(0.0240)	(0.0194)	(0.0180)
Small typhoon in-utero,	0.00705	-0.000598	-0.000151	0.00993	0.000870	-0.000827
post-1965	(0.00554)	(0.00256)	(0.00206)	(0.00909)	(0.00522)	(0.00436)
Small typhoon year 1&2,	0.00333	0.00220	0.00199	0.00235	0.000274	0.00154
post-1965	(0.00300)	(0.00156)	(0.00127)	(0.00486)	(0.00318)	(0.00269)
Severe typhoon in-utero,	-0.107***	-0.0531***	-0.0391***	-0.0569	-0.0402*	-0.0316*
post-1965	(0.0362)	(0.0161)	(0.0119)	(0.0386)	(0.0226)	(0.0167)
Severe typhoon year 1&2,	-0.0340***	-0.0176***	-0.0149***	-0.0218	-0.0204**	-0.0118
post-1965	(0.0120)	(0.00531)	(0.00457)	(0.0168)	(0.00864)	(0.00731)
Observations	345,476	345,476	345,476	138,077	138,077	138,077
R-squared	0.587	0.512	0.496	0.599	0.539	0.526
Mean of Y, pre-1965	0.345	0.114	0.094	0.602	0.234	0.192
Mean of Y, post-1965	0.151	0.029	0.023	0.266	0.071	0.054

Notes: Sample restricted to those in the 10% housing sample of CPH 1990 who still live in the same household as his or her parent(s) and whose reported relationship to the household head is that of either "son" or "daughter". For columns (1) to (3), the sample is further restricted to children of households where the household head has an unskilled occupation. For columns (4) to (6), the sample is further restricted to children of households where the household head has a skilled occupation. All regressions include household fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Other details are the same as in Table 7.

Appendix

A Supplementary Regression Results

A.1 Effects on Cohort Size Including All Municipalities

Table A.1: Effects on Cohort Size - All Municipalities, Ages 18 to 43

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample: Ages Cohorts 2 to 43				**Sample: Ages Cohorts 18 to 43**			
	ln(Cohort Size+1)	ln(Male Cohort+1)	ln(Female Cohort+1)	Fraction Male	ln(Cohort Size+1)	ln(Male Cohort+1)	ln(Female Cohort+1)	Fraction Male
Small typhoon in-utero	-0.00728	-0.000462	-0.00984	0.00216	-0.00791	7.18e-05	-0.0113	0.00259
pre-1965	(0.0107)	(0.0134)	(0.0123)	(0.00307)	(0.00924)	(0.0123)	(0.0107)	(0.00304)
Small typhoon year 1&2	0.00650	0.00539	0.00524	-0.000136	0.00556	0.00527	0.00366	0.000156
pre-1965	(0.00570)	(0.00697)	(0.00650)	(0.00137)	(0.00490)	(0.00635)	(0.00569)	(0.00142)
Severe typhoon in-utero	-0.0926**	-0.149**	-0.0492	-0.0247*	-0.0791*	-0.135**	-0.0344	-0.0248
pre-1965	(0.0464)	(0.0685)	(0.0480)	(0.0147)	(0.0419)	(0.0595)	(0.0511)	(0.0151)
Severe typhoon year 1&2	-0.00112	0.00563	-0.00441	0.00266	0.00346	0.0145	-0.00254	0.00437
pre-1965	(0.0248)	(0.0321)	(0.0251)	(0.00639)	(0.0181)	(0.0279)	(0.0180)	(0.00662)
Small typhoon in-utero	-0.00817	-0.00714	-0.0142*	0.00203	-0.00771	0.000564	-0.0223	0.00594
post-1965	(0.00642)	(0.00732)	(0.00830)	(0.00200)	(0.0130)	(0.0149)	(0.0176)	(0.00437)
Small typhoon year 1&2	-0.00597*	-0.00994***	-0.00251	-0.00181**	-0.0137**	-0.0106	-0.0176***	0.00164
post-1965	(0.00322)	(0.00383)	(0.00371)	(0.000828)	(0.00572)	(0.00701)	(0.00652)	(0.00171)
Severe typhoon in-utero	-0.00154	0.00169	-0.00473	0.00220	-0.0158	0.000698	-0.0392	0.00965
post-1965	(0.0377)	(0.0449)	(0.0380)	(0.00859)	(0.0581)	(0.0752)	(0.0619)	(0.0165)
Severe typhoon year 1&2	0.00589	-0.00519	0.0189	-0.00586	0.00389	-0.00981	0.0225	-0.00868
post-1965	(0.0153)	(0.0159)	(0.0190)	(0.00387)	(0.0230)	(0.0267)	(0.0299)	(0.00703)
Observations	67,578	67,578	67,578	67,554	41,834	41,834	41,834	41,810
R-squared	0.939	0.897	0.896	0.031	0.935	0.880	0.883	0.043
Mean of Y, pre-1965	475.44	238.50	236.95	0.5057	475.44	238.50	236.95	0.5057
Mean of Y, post-1965	851.09	430.97	420.12	0.5097	717.30	355.56	361.74	0.5054

Notes: Sample includes all birth-municipalities in CPH 1990. If a municipality has zero birth in a given year in the 10% sample of CPH1990, it results in a missing value for "faction male" for the corresponding birth-municipality-birth-year. As a result, column (4) shows results from an unbalanced panel. Other details are the same as in Table 5.

A.2 Results *Not* Separating Pre- and Post-1965 Era

Table A.2: Effects on Educational Attainment

	(1) Literacy	(2) Years of Education	(3) Completed High Sch.
Small typhoon in-utero	0.000294	0.0149	-4.65e-05
	(0.000653)	(0.0134)	(0.00177)
Small typhoon year 1&2	-0.000196	0.00370	-0.00108
	(0.000326)	(0.00735)	(0.000895)
Severe typhoon in-utero	-0.00102	-0.178***	-0.0160*
	(0.00297)	(0.0658)	(0.00824)
Severe typhoon year 1&2	0.000447	-0.0593*	-0.0117***
	(0.00139)	(0.0308)	(0.00426)
Observations	2,290,886	2,255,017	2,255,017
R-squared	0.143	0.188	0.135
Mean of Y	0.954	9.36	0.468

Notes: Details are the same as in Table 6 except for that typhoon exposure variables are not interacted with pre- or post-1965 dummies.

Table A.3: Effects on Occupational Skill Level

	(1) Skilled Occ.	(2) Associate Prof.	(3) Professional	(4) Skilled Occ.	(5) Associate Prof.	(6) Professional
Small typhoon in-utero	0.00989***	0.00314**	0.00271**	0.00934***	0.00282**	0.00240**
	(0.00368)	(0.00154)	(0.00121)	(0.00350)	(0.00139)	(0.00108)
Small typhoon year 1&2	0.00689***	0.00326***	0.00268***	0.00675***	0.00323***	0.00266***
	(0.00190)	(0.00120)	(0.00103)	(0.00177)	(0.00112)	(0.000976)
Severe typhoon in-utero	-0.0793***	-0.0287***	-0.0212***	-0.0735***	-0.0249***	-0.0184***
	(0.0233)	(0.0101)	(0.00772)	(0.0220)	(0.00900)	(0.00684)
Severe typhoon year 1&2	-0.0259***	-0.0125***	-0.0110***	-0.0246***	-0.0115***	-0.0100***
	(0.00770)	(0.00335)	(0.00251)	(0.00765)	(0.00331)	(0.00243)
Years of education	No	No	No	0.0381***	0.0252***	0.0215***
				(0.000665)	(0.000712)	(0.000615)
Observations	2,093,804	2,093,804	2,093,804	2,069,113	2,069,113	2,069,113
R-squared	0.146	0.045	0.037	0.231	0.146	0.125
Mean of Y	0.265	0.078	0.064	0.265	0.078	0.064

Notes: Details are the same as in Table 7 except for that typhoon exposure variables are not interacted with pre- or post-1965 dummies.

Table A.4: Effects on Educational Attainment by Sex

	(1)	(2)	(3)	(4)	(5)	(6)
	Literacy		Years of Education		Completed High Sch.	
	Male	Female	Male	Female	Male	Female
Small typhoon in-utero	0.000369	0.000199	-0.00436	0.0356**	-0.00155	0.00189
	(0.000839)	(0.000818)	(0.0175)	(0.0168)	(0.00251)	(0.00220)
Small typhoon year 1&2	-0.000131	-0.000296	0.00750	-9.95e-05	-0.000582	-0.00149
	(0.000404)	(0.000425)	(0.00821)	(0.00923)	(0.00108)	(0.00116)
Severe typhoon in-utero	-0.00185	-0.000350	-0.199**	-0.160**	-0.0237**	-0.00938
	(0.00382)	(0.00381)	(0.0809)	(0.0783)	(0.0107)	(0.00988)
Severe typhoon year 1&2	0.00113	-0.000411	-0.0563	-0.0655	-0.0130**	-0.0109**
	(0.00154)	(0.00193)	(0.0348)	(0.0404)	(0.00513)	(0.00505)
Observations	1,144,609	1,146,277	1,127,900	1,127,117	1,127,900	1,127,117
R-squared	0.117	0.177	0.186	0.194	0.137	0.139
Mean of Y	0.955	0.954	9.20	9.51	0.458	0.479

Notes: Details are the same as in Table 8 except for that typhoon exposure variables are not interacted with pre- or post-1965 dummies.

Table A.5: Effects on Occupational Skill Level by Sex

	(1)	(2)	(3)	(4)	(5)	(6)
	Skilled Occupation		Associate Professional		Professional	
	Male	Female	Male	Female	Male	Female
Small typhoon in-utero	0.0126**	0.00817**	0.00267	0.00363**	0.00213	0.00326**
	(0.00492)	(0.00333)	(0.00191)	(0.00165)	(0.00149)	(0.00143)
Small typhoon year 1&2	0.00687***	0.00705***	0.00325**	0.00328***	0.00285**	0.00250**
	(0.00233)	(0.00194)	(0.00141)	(0.00115)	(0.00119)	(0.00102)
Severe typhoon in-utero	-0.0878***	-0.0745***	-0.0351***	-0.0227**	-0.0270***	-0.0157*
	(0.0297)	(0.0216)	(0.0112)	(0.0103)	(0.00787)	(0.00877)
Severe typhoon year 1&2	-0.0377***	-0.0164**	-0.0144***	-0.0109***	-0.0114***	-0.0107***
	(0.0105)	(0.00642)	(0.00463)	(0.00307)	(0.00344)	(0.00255)
Years of education	No	No	No	No	No	No
Observations	1,043,359	1,050,445	1,043,359	1,050,445	1,043,359	1,050,445
R-squared	0.201	0.066	0.061	0.035	0.048	0.030
Mean of Y	0.339	0.191	0.076	0.080	0.058	0.070

Notes: Details are the same as in Table 9 except for that typhoon exposure variables are not interacted with pre- or post-1965 dummies.

A.3 Effects by Year of Exposure (Regression Results for Event-Study Graphs)

Table A.6: Event Study - Effects of Severe Typhoons on Cohort Size by Year of Exposure

	(1)	(2)	(3)	(4)
	ln(Cohort Size)	ln(Male)	ln(Female)	Fraction Male
Severe typhoon pre-1965				
2 or 3 years *before* birth-year	-0.0206	-0.0393*	0.000570	-0.00893*
	(0.0165)	(0.0214)	(0.0187)	(0.00523)
0 or 1 year *before* birth-year	-0.0405**	-0.0742***	-0.0100	-0.0156***
	(0.0181)	(0.0234)	(0.0211)	(0.00471)
1 or 2 years *after* birth-year	0.00256	0.00380	-0.00626	0.00324
	(0.0178)	(0.0257)	(0.0163)	(0.00519)
3 or 4 years *after* birth-year	-0.00258	0.00675	-0.0117	0.00374
	(0.0180)	(0.0223)	(0.0225)	(0.00531)
Severe typhoon post-1965				
2 or 3 years *before* birth-year	-0.0309**	-0.0228	-0.0392**	0.00406
	(0.0155)	(0.0189)	(0.0176)	(0.00460)
0 or 1 year *before* birth-year	-0.00340	-0.0109	0.00483	-0.00354
	(0.0155)	(0.0176)	(0.0178)	(0.00388)
1 or 2 years *after* birth-year	0.00740	-0.00478	0.0195	-0.00590*
	(0.0136)	(0.0146)	(0.0165)	(0.00338)
3 or 4 years *after* birth-year	0.0112	0.00176	0.0184	-0.00413
	(0.0131)	(0.0142)	(0.0151)	(0.00280)
Observations	62,286	62,286	62,286	62,286
R-squared	0.943	0.910	0.906	0.034

Notes: Each column shows the results from a separate regression where the outcome variable is regressed on eight dummy variables indicating whether there is a severe pre-1965 or post-1965 typhoon passing each municipality-birth-year 2 to 3 years before the birth-year, 0 to 1 year before the birth-year, 1 to 2 years after the birth-year, or 3 to 4 years after the birth-year, as well as municipality fixed effects, age-by-island-group fixed effects, and region-specific time trends. The regressions are run at the municipality-age-cohort level. Data source is the 1990 Census of the Philippines 10% Housing Survey. Sample includes cohorts between the age of 2 and 43 in 1990 and municipalities with at least one male and one female in each age cohort for all ages under 43 in the 1990 Census 10% Housing Survey. Robust standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table A.7: Effects of Severe Typhoons on Education by Year of Exposure

	(1)	(2)	(3)
	Literacy	Years of Education	Completed High Sch.
Severe typhoon pre-1965			
2 or 3 years *before* birth-year	0.00257	-0.102***	-0.0167***
	(0.00183)	(0.0393)	(0.00543)
0 or 1 year *before* birth-year	0.00376**	-0.0632**	-0.0164***
	(0.00177)	(0.0312)	(0.00467)
1 or 2 years *after* birth-year	0.00190	-0.0769*	-0.0167***
	(0.00195)	(0.0400)	(0.00517)
3 or 4 years *after* birth-year	0.00278	-0.0545	-0.0124**
	(0.00192)	(0.0339)	(0.00597)
Severe typhoon post-1965			
2 or 3 years *before* birth-year	-0.0129*	0.0524	0.0225
	(0.00763)	(0.104)	(0.0138)
0 or 1 year *before* birth-year	-0.00210	-0.141***	-0.0105
	(0.00170)	(0.0517)	(0.00661)
1 or 2 years *after* birth-year	-0.000980	-0.0742	-0.00970
	(0.00165)	(0.0454)	(0.00625)
3 or 4 years *after* birth-year	-0.00137	-0.0249	-0.00788
	(0.00167)	(0.0413)	(0.00540)
Observations	2,290,886	2,255,017	2,255,017
R-squared	0.143	0.188	0.135

Notes: Each column shows the results from a separate regression where the outcome variable is regressed on eight dummy variables indicating whether there is a severe pre-1965 or post-1965 typhoon passing each municipality-birth-year 2 to 3 years before the birth-year, 0 to 1 year before the birth-year, 1 to 2 years after the birth-year, or 3 to 4 years after the birth-year, as well as municipality fixed effects, age-by-island-group fixed effects, region-specific time trends, and a dummy for being male. The regressions are run at the individual level. Data source is the 1990 Census of the Philippines 10% Housing Survey. Sample includes all individuals between the age of 18 and 43 with non-missing municipality of birth information in the 10% housing sample of CPH1990. Robust standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table A.8: Effects of Severe Typhoons on Occupation by Year of Exposure

	(1) Skilled Occupation	(2) Associate Professional	(3) Professional
Severe typhoon pre-1965			
2 or 3 years *before* birth-year	-0.00801	-0.00129	-0.00203
	(0.00522)	(0.00211)	(0.00186)
0 or 1 year *before* birth-year	-0.00326	0.00448*	0.00313
	(0.00560)	(0.00237)	(0.00231)
1 or 2 years *after* birth-year	0.000574	0.00168	-8.22e-05
	(0.00620)	(0.00223)	(0.00196)
3 or 4 years *after* birth-year	0.00469	0.00231	0.00161
	(0.00623)	(0.00309)	(0.00298)
Severe typhoon post-1965			
2 or 3 years *before* birth-year	0.0384**	0.00693	0.00595
	(0.0151)	(0.00534)	(0.00466)
0 or 1 year *before* birth-year	-0.0852***	-0.0383***	-0.0299***
	(0.0170)	(0.00732)	(0.00572)
1 or 2 years *after* birth-year	-0.0517***	-0.0252***	-0.0207***
	(0.0105)	(0.00494)	(0.00400)
3 or 4 years *after* birth-year	-0.0224***	-0.00826**	-0.00694***
	(0.00698)	(0.00343)	(0.00268)
Observations	2,093,804	2,093,804	2,093,804
R-squared	0.146	0.045	0.037

Notes: Each column shows the results from a separate regression where the outcome variable is regressed on eight dummy variables indicating whether there is a severe pre-1965 or post-1965 typhoon passing each municipality-birth-year 2 to 3 years before the birth-year, 0 to 1 year before the birth-year, 1 to 2 years after the birth-year, or 3 to 4 years after the birth-year, as well as municipality fixed effects, age-by-island-group fixed effects, region-specific time trends, and a dummy for being male. The regressions are run at the individual level. Data source is the 1990 Census of the Philippines 10% Housing Survey. Sample includes all individuals between the age of 18 and 43 with non-missing municipality of birth information in the 10% housing sample of CPH1990. Robust standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

A.4 Alternative Distance to the Eye of the Storm

This subsection presents results with additional treatment variables assigned to municipalities between 30 and 60 kilometers from the eye of the storm. Other than the eight treatment variables in the main analysis, which are assigned to municipalities and individuals within 30 kilometers of the storm path, we add eight more treatment variables, constructed in the same fashion as in the main analysis but assigned to municipalities and individuals that are between 30 and 60 kilometers from the eye of the storm. Specifically, a municipality is exposed to a typhoon 30 to 60 kilometers away if the distance between the centroid of the municipality and the typhoon path is larger than 30 km but no larger than 60 km.

As such, we estimate the effects of typhoon exposure on municipalities and individuals within 30 kilometers of the typhoon path as well as municipalities and individuals between 30 and 60 kilometers away from the typhoon path. The "control group" here is, thus, municipalities and individuals outside of the 60-kilometer radius of the storm path.

Tables A.9 and A.10 present results for cohort size and the fraction of males. Tables A.11 and A.12 present results for educational attainment and occupational skill levels, respectively. Tables A.13 and A.14 separately estimate the long-term outcomes by sex.

Table A.9: Effects on Cohort Size - Varying Distance to Storm - Never-Zero Municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample: Ages Cohorts 2 to 43				**Sample: Ages Cohorts 18 to 43**			
	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male
Small typhoon in-utero	-0.00966	-0.0101	-0.0126	1.02e-05	-0.0138	-0.0137	-0.0167	0.000115
within 30km, pre-1965	(0.0103)	(0.0125)	(0.0128)	(0.00310)	(0.00924)	(0.0118)	(0.0116)	(0.00309)
Small typhoon year 1&2	0.00989*	0.00720	0.0110*	-0.000895	0.00718	0.00497	0.00824	-0.000786
within 30km, pre-1965	(0.00535)	(0.00646)	(0.00599)	(0.00132)	(0.00459)	(0.00596)	(0.00520)	(0.00136)
Severe typhoon in-utero	-0.103***	-0.151***	-0.0665	-0.0227	-0.0928***	-0.137**	-0.0563	-0.0219
within 30km, pre-1965	(0.0360)	(0.0565)	(0.0461)	(0.0147)	(0.0359)	(0.0572)	(0.0474)	(0.0150)
Severe typhoon year 1&2	0.0105	0.00487	0.00985	0.000155	0.00869	0.00832	0.00554	0.00205
within 30km, pre-1965	(0.0186)	(0.0283)	(0.0184)	(0.00658)	(0.0168)	(0.0272)	(0.0170)	(0.00688)
Small typhoon in-utero	-0.0101	-0.00567	-0.0178**	0.00291	-0.0133	-0.000194	-0.0291*	0.00645
within 30km, post-1965	(0.00641)	(0.00748)	(0.00822)	(0.00198)	(0.0122)	(0.0146)	(0.0173)	(0.00440)
Small typhoon year 1&2	-0.00359	-0.00776**	0.000621	-0.00210**	-0.0155***	-0.0154**	-0.0157**	0.000156
within 30km, post-1965	(0.00322)	(0.00367)	(0.00383)	(0.000854)	(0.00507)	(0.00643)	(0.00623)	(0.00169)
Severe typhoon in-utero	-0.0241	-0.0371	-0.00810	-0.00658	-0.0545	-0.0913	-0.0182	-0.0167
within 30km, post-1965	(0.0370)	(0.0414)	(0.0391)	(0.00757)	(0.0555)	(0.0681)	(0.0620)	(0.0150)
Severe typhoon year 1&2	0.00424	-0.00724	0.0166	-0.00577	-0.00509	-0.0193	0.00527	-0.00613
within 30km, post-1965	(0.0150)	(0.0155)	(0.0187)	(0.00373)	(0.0212)	(0.0221)	(0.0310)	(0.00720)
Small typhoon in-utero	-0.0122	-0.00820	-0.0169	0.00212	-0.0130	-0.00806	-0.0184	0.00247
30 to 60km, pre-1965	(0.00914)	(0.0107)	(0.0125)	(0.00297)	(0.00841)	(0.0101)	(0.0118)	(0.00300)
Small typhoon year 1&2	0.00543	0.00409	0.00516	-0.000250	0.00418	0.00335	0.00328	-8.18e-06
30 to 60km, pre-1965	(0.00495)	(0.00586)	(0.00587)	(0.00130)	(0.00437)	(0.00544)	(0.00529)	(0.00131)
Severe typhoon in-utero	-0.0366	-0.0268	-0.0288	-0.00205	-0.0395	-0.0262	-0.0322	-0.00103
30 to 60km, pre-1965	(0.0323)	(0.0425)	(0.0509)	(0.0152)	(0.0328)	(0.0419)	(0.0515)	(0.0151)
Severe typhoon year 1&2	0.0280	0.0182	0.0349	-0.00343	0.0196	0.0135	0.0249	-0.00212
30 to 60km, pre-1965	(0.0175)	(0.0243)	(0.0235)	(0.00730)	(0.0161)	(0.0245)	(0.0217)	(0.00749)
Small typhoon in-utero	-0.00599	-0.00575	-0.00797	0.000446	0.00509	0.0118	-0.00412	0.00362
30 to 60km, post-1965	(0.00560)	(0.00662)	(0.00721)	(0.00188)	(0.0102)	(0.0116)	(0.0145)	(0.00377)
Small typhoon year 1&2	-0.000661	0.000923	-0.00174	0.000629	-0.0109**	-0.0113**	-0.0112*	-8.56e-05
30 to 60km, post-1965	(0.00305)	(0.00340)	(0.00374)	(0.000832)	(0.00456)	(0.00571)	(0.00592)	(0.00159)
Severe typhoon in-utero	-0.0378*	-0.0538**	-0.0259	-0.00646	-0.0213	-0.0997**	0.0596	-0.0373***
30 to 60km, pre-1965	(0.0204)	(0.0242)	(0.0281)	(0.00747)	(0.0311)	(0.0419)	(0.0457)	(0.0137)
Severe typhoon year 1&2	-0.0188	-0.0236*	-0.0143	-0.00219	-0.00335	-0.00806	-1.49e-05	-0.00183
30 to 60km, post-1965	(0.0122)	(0.0136)	(0.0139)	(0.00276)	(0.0180)	(0.0218)	(0.0239)	(0.00601)
Observations	62,286	62,286	62,286	62,286	38,558	38,558	38,558	38,558
R-squared	0.943	0.910	0.906	0.033	0.939	0.896	0.895	0.045

Notes: Sample restricted to municipalities that has at least one male and one female in each age cohort under the age of 43. Definitions of treatment variables are the same as in the main analysis, with an additional set of treatment variables indicating exposure to typhoons "30 to 60 km" away. A municipality is exposed to a typhoon "30 to 60 km" away if the distance between the centroid of the municipality and the typhoon path is larger than 30km but no larger than 60km. All regressions include municipality fixed effects, birth-year by island group fixed effects, and region-specific time trends. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table A.10: Effects on Cohort Size - Varying Distance to Storm - All Municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample: Ages Cohorts 2 to 43				**Sample: Ages Cohorts 18 to 43**			
	ln(Cohort Size+1)	ln(Male Cohort+1)	ln(Female Cohort+1)	Fraction Male	ln(Cohort Size+1)	ln(Male Cohort+1)	ln(Female Cohort+1)	Fraction Male
Small typhoon in-utero	-0.00935	-0.000692	-0.0120	0.00247	-0.00992	0.000131	-0.0135	0.00299
within 30km, pre-1965	(0.0114)	(0.0141)	(0.0131)	(0.00313)	(0.00989)	(0.0129)	(0.0115)	(0.00310)
Small typhoon year 1&2	0.00722	0.00596	0.00537	-3.97e-05	0.00617	0.00590	0.00350	0.000320
within 30km, pre-1965	(0.00610)	(0.00738)	(0.00692)	(0.00140)	(0.00524)	(0.00673)	(0.00601)	(0.00145)
Severe typhoon in-utero	-0.0992**	-0.155**	-0.0509	-0.0258*	-0.0840*	-0.140**	-0.0338	-0.0260*
within 30km, pre-1965	(0.0475)	(0.0707)	(0.0493)	(0.0153)	(0.0429)	(0.0618)	(0.0522)	(0.0157)
Severe typhoon year 1&2	0.000851	0.00649	-0.00243	0.00233	0.00525	0.0154	-0.000814	0.00415
within 30km, pre-1965	(0.0249)	(0.0323)	(0.0253)	(0.00656)	(0.0184)	(0.0283)	(0.0183)	(0.00679)
Small typhoon in-utero	-0.00901	-0.00759	-0.0156*	0.00223	-0.00842	0.000414	-0.0233	0.00611
within 30km, post-1965	(0.00662)	(0.00746)	(0.00854)	(0.00202)	(0.0130)	(0.0147)	(0.0178)	(0.00434)
Small typhoon year 1&2	-0.00604*	-0.00973**	-0.00264	-0.00173**	-0.0143**	-0.0114	-0.0180***	0.00154
within 30km, post-1965	(0.00330)	(0.00396)	(0.00382)	(0.000855)	(0.00582)	(0.00712)	(0.00650)	(0.00172)
Severe typhoon in-utero	-0.00667	-0.00579	-0.00773	0.00114	-0.0249	-0.0275	-0.0260	0.000170
within 30km, post-1965	(0.0390)	(0.0464)	(0.0389)	(0.00863)	(0.0610)	(0.0755)	(0.0668)	(0.0166)
Severe typhoon year 1&2	0.00266	-0.00922	0.0167	-0.00621	0.00516	-0.0149	0.0279	-0.0108
within 30km, post-1965	(0.0159)	(0.0164)	(0.0195)	(0.00390)	(0.0254)	(0.0282)	(0.0330)	(0.00722)
Small typhoon in-utero	-0.0119	-0.000375	-0.0138	0.00229	-0.0105	0.00252	-0.0135	0.00284
30 to 60km, pre-1965	(0.0100)	(0.0120)	(0.0128)	(0.00303)	(0.00927)	(0.0113)	(0.0121)	(0.00303)
Small typhoon year 1&2	0.00371	0.00214	0.00159	0.000118	0.00357	0.00293	0.000599	0.000467
30 to 60km, pre-1965	(0.00552)	(0.00652)	(0.00661)	(0.00140)	(0.00484)	(0.00603)	(0.00589)	(0.00140)
Severe typhoon in-utero	-0.0374	-0.0381	0.00275	-0.00953	-0.0386	-0.0409	0.00455	-0.0101
30 to 60km, pre-1965	(0.0301)	(0.0534)	(0.0467)	(0.0175)	(0.0302)	(0.0506)	(0.0485)	(0.0173)
Severe typhoon year 1&2	0.0309*	0.0210	0.0281	-0.00239	0.0253	0.0168	0.0225	-0.00166
30 to 60km, pre-1965	(0.0183)	(0.0269)	(0.0252)	(0.00755)	(0.0176)	(0.0269)	(0.0243)	(0.00764)
Small typhoon in-utero	-0.00753	-0.00436	-0.0115	0.00175	-0.00299	0.00395	-0.0125	0.00401
30 to 60km, post-1965	(0.00610)	(0.00713)	(0.00735)	(0.00184)	(0.0115)	(0.0132)	(0.0144)	(0.00355)
Small typhoon year 1&2	-0.00122	-0.000284	-0.000335	0.000120	-0.0103**	-0.00949*	-0.00955	0.000198
30 to 60km, post-1965	(0.00311)	(0.00350)	(0.00376)	(0.000853)	(0.00464)	(0.00563)	(0.00590)	(0.00159)
Severe typhoon in-utero	-0.0353	-0.0528*	-0.0182	-0.00813	-0.0170	-0.0860*	0.0626	-0.0346**
30 to 60km, pre-1965	(0.0225)	(0.0269)	(0.0286)	(0.00748)	(0.0377)	(0.0469)	(0.0509)	(0.0145)
Severe typhoon year 1&2	-0.0197	-0.0263*	-0.0138	-0.00252	0.00800	-0.00682	0.0146	-0.00399
30 to 60km, post-1965	(0.0137)	(0.0147)	(0.0150)	(0.00282)	(0.0201)	(0.0249)	(0.0250)	(0.00642)
Observations	67,578	67,578	67,578	67,554	41,834	41,834	41,834	41,810
R-squared	0.939	0.897	0.896	0.032	0.935	0.880	0.883	0.044

Notes: Sample includes all birth-municipalities in CPH 1990. If a municipality has zero birth in a given year in the 10% sample of CPH1990, it results in a missing value for "faction male" for the corresponding birth-municipality-birth-year. As a result, column (4) shows results from an unbalanced panel. All other details are the same as in Table A.9

Table A.11: Effects on Education - Varying Distance to Eye of Storm

	(1)	(2)	(3)
	Literacy	Years of Education	Completed High Sch.
Small typhoon in-utero	0.00150	0.0326*	0.000631
within 30km, pre-1965	(0.000938)	(0.0181)	(0.00244)
Small typhoon year 1&2	0.000176	0.0116	-0.000206
within 30km, pre-1965	(0.000484)	(0.00913)	(0.00125)
Severe typhoon in-utero	0.00399	-0.0363	-0.0155*
within 30km, pre-1965	(0.00413)	(0.0683)	(0.00899)
Severe typhoon year 1&2	0.000994	-0.0623	-0.0144***
within 30km, pre-1965	(0.00208)	(0.0389)	(0.00543)
Small typhoon in-utero	-0.00156	-0.00949	-0.000548
within 30km, post-1965	(0.00118)	(0.0227)	(0.00289)
Small typhoon year 1&2	-0.000825	-0.00546	-0.00111
within 30km, post-1965	(0.000626)	(0.0132)	(0.00155)
Severe typhoon in-utero	-0.0104**	-0.345***	-0.0125
within 30km, post-1965	(0.00449)	(0.107)	(0.0138)
Severe typhoon year 1&2	-0.00148	-0.0820*	-0.00978
within 30km, post-1965	(0.00229)	(0.0469)	(0.00680)
Small typhoon in-utero	0.00116	0.0182	0.00113
30 to 60km, pre-1965	(0.000932)	(0.0187)	(0.00237)
Small typhoon year 1&2	0.000845*	0.0162*	0.00185*
30 to 60km, pre-1965	(0.000492)	(0.00847)	(0.00109)
Severe typhoon in-utero	-0.00384	0.0155	-0.00162
30 to 60km, pre-1965	(0.00411)	(0.0810)	(0.0104)
Severe typhoon year 1&2	-0.00305	-0.0556	-0.00629
30 to 60km, pre-1965	(0.00260)	(0.0367)	(0.00525)
Small typhoon in-utero	-0.00105	0.00577	4.89e-05
30 to 60km, post-1965	(0.00112)	(0.0257)	(0.00301)
Small typhoon year 1&2	-0.000888*	0.00889	0.00275
30 to 60km, post-1965	(0.000533)	(0.0127)	(0.00176)
Severe typhoon in-utero	-0.00412	-0.0165	0.0120
30 to 60km, pre-1965	(0.00450)	(0.0792)	(0.0101)
Severe typhoon year 1&2	-0.00156	-0.0540	-0.00317
30 to 60km, post-1965	(0.00174)	(0.0408)	(0.00623)
Observations	2,290,886	2,255,017	2,255,017
R-squared	0.143	0.188	0.135

Notes: Sample includes all individuals between the age of 18 and 43 with non-missing municipality of birth information in the 10% housing sample of CPH1990. Definitions of treatment variables are the same as in the main analysis, with an additional set of treatment variables indicating exposure to typhoons "30 to 60 km" away. A municipality is exposed to a typhoon "30 to 60 km" away if the distance between the centroid of the municipality and the typhoon path is larger than 30km but no larger than 60km. All regressions include municipality fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table A.12: Effects on Occupation - Varying Distance to the Eye of the Storm

	(1) Skilled Occ.	(2) Associate Prof.	(3) Professional	(4) Skilled Occ.	(5) Associate Prof.	(6) Professional
Small typhoon in-utero	0.00853***	0.00307**	0.00261*	0.00745**	0.00252*	0.00204*
within 30km, pre-1965	(0.00310)	(0.00154)	(0.00134)	(0.00290)	(0.00141)	(0.00123)
Small typhoon year 1&2	0.00617***	0.00350***	0.00290***	0.00567***	0.00319***	0.00263***
within 30km, pre-1965	(0.00176)	(0.00103)	(0.000887)	(0.00163)	(0.000966)	(0.000839)
Severe typhoon in-utero	-0.00398	0.00892*	0.00733	-0.00449	0.00844*	0.00663
within 30km, pre-1965	(0.0105)	(0.00459)	(0.00447)	(0.0105)	(0.00446)	(0.00446)
Severe typhoon year 1&2	0.000115	0.000891	-0.000914	0.00203	0.00225	0.000426
within 30km, pre-1965	(0.00539)	(0.00209)	(0.00215)	(0.00546)	(0.00202)	(0.00172)
Small typhoon in-utero	0.00938	0.00232	0.00215	0.00976	0.00240	0.00228
within 30km, post-1965	(0.00735)	(0.00269)	(0.00207)	(0.00706)	(0.00243)	(0.00184)
Small typhoon year 1&2	0.00426	0.00146	0.00139	0.00453	0.00174	0.00164
within 30km, post-1965	(0.00322)	(0.00165)	(0.00139)	(0.00301)	(0.00151)	(0.00127)
Severe typhoon in-utero	-0.165***	-0.0702***	-0.0544***	-0.150***	-0.0611***	-0.0469***
within 30km, post-1965	(0.0426)	(0.0174)	(0.0133)	(0.0404)	(0.0156)	(0.0118)
Severe typhoon year 1&2	-0.0539***	-0.0281***	-0.0239***	-0.0523***	-0.0267***	-0.0227***
within 30km, post-1965	(0.0114)	(0.00492)	(0.00397)	(0.0113)	(0.00493)	(0.00401)
Small typhoon in-utero	-0.00294	-0.000407	-0.000329	-0.00335	-0.000748	-0.000601
30 to 60km, pre-1965	(0.00243)	(0.00153)	(0.00132)	(0.00222)	(0.00139)	(0.00121)
Small typhoon year 1&2	-0.000594	0.000694	0.00121*	-0.00138	0.000129	0.000739
30 to 60km, pre-1965	(0.00119)	(0.000754)	(0.000692)	(0.00109)	(0.000688)	(0.000637)
Severe typhoon in-utero	-0.00471	-0.000669	0.00184	-0.00413	-0.000256	0.00196
30 to 60km, pre-1965	(0.00962)	(0.00534)	(0.00487)	(0.00880)	(0.00519)	(0.00482)
Severe typhoon year 1&2	-0.00746	-0.00158	-0.00204	-0.00541	-0.000155	-0.000774
30 to 60km, pre-1965	(0.00476)	(0.00241)	(0.00218)	(0.00457)	(0.00247)	(0.00220)
Small typhoon in-utero	-0.00195	0.000532	-0.000226	-0.00249	1.93e-05	-0.000510
30 to 60km, post-1965	(0.00733)	(0.00306)	(0.00245)	(0.00684)	(0.00269)	(0.00213)
Small typhoon year 1&2	0.000605	0.000133	-0.000444	0.000270	-1.74e-05	-0.000638
30 to 60km, post-1965	(0.00280)	(0.00125)	(0.00108)	(0.00262)	(0.00114)	(0.000977)
Severe typhoon in-utero	-0.0152	-0.00347	-0.00494	-0.0122	-0.00236	-0.00387
30 to 60km, pre-1965	(0.0240)	(0.00780)	(0.00682)	(0.0231)	(0.00725)	(0.00641)
Severe typhoon year 1&2	-0.00861	-0.00708**	-0.00760***	-0.00698	-0.00575*	-0.00653**
30 to 60km, post-1965	(0.00791)	(0.00332)	(0.00291)	(0.00737)	(0.00299)	(0.00271)
Years of education	No	No	No	0.0381***	0.0252***	0.0215***
				(0.000665)	(0.000712)	(0.000615)
Observations	2,093,804	2,093,804	2,093,804	2,069,113	2,069,113	2,069,113
R-squared	0.146	0.045	0.037	0.232	0.146	0.125

Notes: All details are the same as in Table A.11

Table A.13: Effects on Education by Sex - Varying Distance to Storm

	(1)	(2)	(3)	(4)	(5)	(6)
	Literacy		Years of Education		Completed High Sch.	
	Male	Female	Male	Female	Male	Female
Small typhoon in-utero	0.00115	0.00181	0.0146	0.0526**	0.000102	0.00145
within 30km, pre-1965	(0.00113)	(0.00127)	(0.0240)	(0.0230)	(0.00328)	(0.00308)
Small typhoon year 1&2	0.000126	0.000214	0.00957	0.0135	-0.000245	-0.000164
within 30km, pre-1965	(0.000577)	(0.000636)	(0.0108)	(0.0119)	(0.00152)	(0.00160)
Severe typhoon in-utero	0.00355	0.00425	-0.0136	-0.0611	-0.0226*	-0.00805
within 30km, pre-1965	(0.00527)	(0.00567)	(0.103)	(0.0866)	(0.0126)	(0.0107)
Severe typhoon year 1&2	0.00131	0.000373	-0.0442	-0.0818*	-0.0179**	-0.0107*
within 30km, pre-1965	(0.00253)	(0.00320)	(0.0575)	(0.0483)	(0.00782)	(0.00576)
Small typhoon in-utero	-0.000977	-0.00222	-0.0251	0.00734	-0.00225	0.00195
within 30km, post-1965	(0.00142)	(0.00148)	(0.0256)	(0.0302)	(0.00390)	(0.00364)
Small typhoon year 1&2	-0.000701	-0.00105	0.00516	-0.0163	0.000537	-0.00268
within 30km, post-1965	(0.000698)	(0.000807)	(0.0133)	(0.0163)	(0.00185)	(0.00198)
Severe typhoon in-utero	-0.0114**	-0.00997*	-0.390***	-0.308**	-0.0140	-0.0145
within 30km, post-1965	(0.00518)	(0.00581)	(0.111)	(0.131)	(0.0178)	(0.0166)
Severe typhoon year 1&2	0.000132	-0.00320	-0.0675	-0.104*	-0.00684	-0.0141
within 30km, post-1965	(0.00233)	(0.00284)	(0.0500)	(0.0624)	(0.00773)	(0.00865)
Small typhoon in-utero	0.000905	0.00134	0.0328	0.00551	0.00446	-0.00200
30 to 60km, pre-1965	(0.00117)	(0.00123)	(0.0234)	(0.0241)	(0.00303)	(0.00305)
Small typhoon year 1&2	0.000276	0.00138**	0.00908	0.0224**	0.00183	0.00167
30 to 60km, pre-1965	(0.000577)	(0.000640)	(0.0108)	(0.0110)	(0.00140)	(0.00140)
Severe typhoon in-utero	-0.00866	0.000158	-0.0664	0.0839	-0.0115	0.00685
30 to 60km, pre-1965	(0.00793)	(0.00505)	(0.122)	(0.0919)	(0.0152)	(0.0140)
Severe typhoon year 1&2	-0.00494	-0.00107	-0.0823	-0.0310	-0.0102	-0.00265
30 to 60km, pre-1965	(0.00364)	(0.00392)	(0.0569)	(0.0451)	(0.00784)	(0.00596)
Small typhoon in-utero	-0.000161	-0.00205	0.0465	-0.0326	0.00769*	-0.00698*
30 to 60km, post-1965	(0.00124)	(0.00150)	(0.0283)	(0.0323)	(0.00405)	(0.00376)
Small typhoon year 1&2	-0.000428	-0.00144**	0.0151	0.00206	0.00251	0.00300
30 to 60km, post-1965	(0.000628)	(0.000693)	(0.0136)	(0.0151)	(0.00202)	(0.00205)
Severe typhoon in-utero	-0.00600	-0.00281	-0.0418	-0.00842	0.0215	-0.000294
30 to 60km, pre-1965	(0.00449)	(0.00598)	(0.0859)	(0.0958)	(0.0133)	(0.0129)
Severe typhoon year 1&2	0.000178	-0.00327	0.0115	-0.123***	0.00397	-0.0111
30 to 60km, post-1965	(0.00233)	(0.00216)	(0.0560)	(0.0420)	(0.00844)	(0.00710)
Observations	1,144,609	1,146,277	1,127,900	1,127,117	1,127,900	1,127,117
R-squared	0.117	0.177	0.186	0.194	0.137	0.139

Notes: Each column is a separate regression using the sub-sample of either male or female correspondents in the CPH1990 10% sample. All regressions include municipality fixed effects, birth-year-by-island-group fixed effects, and region-specific time trends. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table A.14: Effects on Occupation By Sex - Varying Distance to Storm

	(1)	(2)	(3)	(4)	(5)	(6)
	Skilled Occupation		Associate Professional		Professional	
	Male	Female	Male	Female	Male	Female
Small typhoon in-utero	0.00951**	0.00836**	0.00306	0.00319*	0.00234	0.00298*
within 30km, pre-1965	(0.00434)	(0.00327)	(0.00219)	(0.00181)	(0.00188)	(0.00171)
Small typhoon year 1&2	0.00424*	0.00807***	0.00296**	0.00407***	0.00279**	0.00301***
within 30km, pre-1965	(0.00236)	(0.00175)	(0.00134)	(0.00115)	(0.00112)	(0.00106)
Severe typhoon in-utero	0.00520	-0.0110	-0.00445	0.0220***	-0.0100	0.0239***
within 30km, pre-1965	(0.0147)	(0.0137)	(0.00822)	(0.00603)	(0.00661)	(0.00592)
Severe typhoon year 1&2	-0.00422	0.00436	0.00256	-0.000527	0.00180	-0.00339
within 30km, pre-1965	(0.00822)	(0.00430)	(0.00408)	(0.00307)	(0.00316)	(0.00321)
Small typhoon in-utero	0.0140	0.00599	0.00119	0.00332	0.00124	0.00284
within 30km, post-1965	(0.0101)	(0.00600)	(0.00320)	(0.00267)	(0.00240)	(0.00217)
Small typhoon year 1&2	0.00530	0.00333	0.00169	0.00115	0.00164	0.00106
within 30km, post-1965	(0.00426)	(0.00321)	(0.00192)	(0.00160)	(0.00160)	(0.00134)
Severe typhoon in-utero	-0.194***	-0.145***	-0.0710***	-0.0700***	-0.0500***	-0.0585***
within 30km, post-1965	(0.0580)	(0.0355)	(0.0192)	(0.0169)	(0.0142)	(0.0133)
Severe typhoon year 1&2	-0.0751***	-0.0375***	-0.0346***	-0.0224***	-0.0284***	-0.0197***
within 30km, post-1965	(0.0161)	(0.00982)	(0.00647)	(0.00470)	(0.00515)	(0.00402)
Small typhoon in-utero	-0.00464	-0.00112	-0.000434	-0.000336	-3.18e-05	-0.000570
30 to 60km, pre-1965	(0.00371)	(0.00247)	(0.00213)	(0.00178)	(0.00173)	(0.00173)
Small typhoon year 1&2	-0.00243	0.000674	-0.000544	0.00185**	0.000354	0.00200**
30 to 60km, pre-1965	(0.00181)	(0.00127)	(0.00107)	(0.000941)	(0.000933)	(0.000920)
Severe typhoon in-utero	-0.00971	-0.00361	-0.0107*	0.00880	-0.00766	0.0110
30 to 60km, pre-1965	(0.0143)	(0.0127)	(0.00645)	(0.00945)	(0.00553)	(0.00880)
Severe typhoon year 1&2	-0.0113*	-0.00477	-0.00355	0.000319	-0.00432*	0.000229
30 to 60km, pre-1965	(0.00664)	(0.00566)	(0.00277)	(0.00398)	(0.00250)	(0.00376)
Small typhoon in-utero	-0.00460	0.00302	0.00152	5.61e-05	0.000324	-0.000437
30 to 60km, post-1965	(0.0100)	(0.00594)	(0.00371)	(0.00282)	(0.00289)	(0.00232)
Small typhoon year 1&2	-0.00119	0.00294	-0.000701	0.00111	-0.00171	0.000897
30 to 60km, post-1965	(0.00395)	(0.00245)	(0.00152)	(0.00129)	(0.00124)	(0.00112)
Severe typhoon in-utero	-0.0261	-0.00964	-0.00747	0.000174	-0.00827	-0.00146
30 to 60km, pre-1965	(0.0313)	(0.0225)	(0.00737)	(0.00955)	(0.00646)	(0.00809)
Severe typhoon year 1&2	-0.0125	-0.00541	-0.00859*	-0.00540*	-0.00862**	-0.00647**
30 to 60km, post-1965	(0.0119)	(0.00668)	(0.00438)	(0.00324)	(0.00361)	(0.00294)
Years of education	No	No	No	No	No	No
Observations	1,043,359	1,050,445	1,043,359	1,050,445	1,043,359	1,050,445
R-squared	0.201	0.066	0.062	0.035	0.048	0.030

Notes: Each column is a separate regression using the sub-sample of either male or female correspondents in the CPH1990 10% sample. All regressions include municipality fixed effects, birth-year by island group fixed effects, and region-specific time trends. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

A.5 Alternative Storm Intensity Measures

In this subsection, we separately estimate the effects of exposure to each category of typhoons on the Saffir-Simpson scale. Instead of using two storm intensity categories (small and severe), we now allow four different storm intensity categories. We continue to combine SS scale 4 and scale 5 storms in one category because only a small number of municipalities were ever exposed to scale 5 storms.

We find evidence for a strong dose-response effect (Table A.15). Before 1965, scale 1 and 2 storms have no significant effect on overall cohort size, while scale 3 and higher storms are associated with smaller cohort size. In general, the magnitude of the adverse effects increases with storm intensity. Moreover, compared to the severe (scale 4 and 5) storms, the effects scale 3 storms, albeit statistically significant, are much smaller in magnitude. For post-1965 typhoons, we do not find any significant effect on cohort size when we pool all age cohorts 2 to 43-year-olds together. When we use the restricted sample of 18 to 43-year-olds, we find that category 3 storms are associated with a 7 percent decrease in cohort size. This may be a result of the storms not being 'severe enough' for disaster relief funds.

Tables A.16 and A.17 present results on education and occupation respectively. Again, in most cases, the magnitude of the adverse effects increases with storm intensity. For pre-1965 typhoons, we do not find any significant reduction in either educational attainment or occupational skill levels among those exposed in their early-life. For post-1965 typhoons, although we do find statistically significant effects for scale 2 and 3 storms for some outcome variables, the magnitudes of the effects are much smaller compared to the effects of scale 4 and 5 storms.

Table A.15: Effects on Cohort Size with Alternative Storm Measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample: Ages Cohorts 2 to 43				**Sample: Ages Cohorts 18 to 43**			
	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male
SS Scale 1 in-utero	-0.00196	-0.00525	0.00179	-0.00232	-0.00626	-0.00810	-0.00331	-0.00180
pre-1965	(0.0110)	(0.0138)	(0.0134)	(0.00339)	(0.00968)	(0.0128)	(0.0122)	(0.00338)
SS Scale 1 year 1&2	0.00886	0.00142	0.0143**	-0.00302*	0.00649	-0.000291	0.0118*	-0.00283*
pre-1965	(0.00601)	(0.00711)	(0.00706)	(0.00156)	(0.00524)	(0.00660)	(0.00633)	(0.00160)
SS Scale 2 in-utero	0.0134	0.0451	-0.0254	0.0159*	0.0117	0.0428	-0.0273	0.0158**
pre-1965	(0.0220)	(0.0288)	(0.0295)	(0.00814)	(0.0208)	(0.0287)	(0.0273)	(0.00802)
SS Scale 2 year 1&2	0.0264**	0.0350**	0.0146	0.00480	0.0253**	0.0335**	0.0133	0.00472
pre-1965	(0.0131)	(0.0159)	(0.0154)	(0.00358)	(0.0109)	(0.0142)	(0.0134)	(0.00358)
SS Scale 3 in-utero	-0.0481**	-0.0702**	-0.0445	-0.00608	-0.0527**	-0.0767**	-0.0458	-0.00733
pre-1965	(0.0221)	(0.0294)	(0.0300)	(0.00853)	(0.0216)	(0.0301)	(0.0288)	(0.00865)
SS Scale 3 year 1&2	-0.00941	-0.000155	-0.0134	0.00298	-0.0134	-0.00402	-0.0162	0.00270
pre-1965	(0.0104)	(0.0128)	(0.0134)	(0.00364)	(0.00967)	(0.0125)	(0.0126)	(0.00372)
SS Scale 4 or 5 in-utero	-0.0987***	-0.147***	-0.0642	-0.0222	-0.0929***	-0.139**	-0.0573	-0.0219
pre-1965	(0.0352)	(0.0543)	(0.0455)	(0.0142)	(0.0353)	(0.0550)	(0.0468)	(0.0143)
SS Scale 4 or 5 year 1&2	0.0108	0.00712	0.00914	0.000790	0.00895	0.0103	0.00499	0.00257
pre-1965	(0.0186)	(0.0282)	(0.0182)	(0.00643)	(0.0167)	(0.0269)	(0.0167)	(0.00673)
SS Scale 1 in-utero	-0.0100	0.00431	-0.0272***	0.00743***	-0.00449	0.0213	-0.0328	0.0123**
post-1965	(0.00738)	(0.00881)	(0.00966)	(0.00251)	(0.0142)	(0.0169)	(0.0209)	(0.00537)
SS Scale 1 year 1&2	-0.00717**	-0.0104**	-0.00390	-0.00158	-0.0137**	-0.0161**	-0.0105	-0.00117
post-1965	(0.00363)	(0.00423)	(0.00429)	(0.000998)	(0.00605)	(0.00777)	(0.00709)	(0.00196)
SS Scale 2 in-utero	-0.00359	-0.0231	0.0117	-0.00785**	-0.0244	-0.0499*	-0.00341	-0.0112
post-1965	(0.0152)	(0.0164)	(0.0191)	(0.00387)	(0.0263)	(0.0298)	(0.0352)	(0.00792)
SS Scale 2 year 1&2	0.00739	0.00121	0.0129	-0.00310*	-0.00958	0.00706	-0.0288**	0.00834**
post-1965	(0.00663)	(0.00730)	(0.00792)	(0.00165)	(0.0113)	(0.0137)	(0.0134)	(0.00326)
SS Scale 3 in-utero	-0.0223	-0.0386**	-0.00670	-0.00752	-0.0687**	-0.0816*	-0.0542	-0.00604
post-1965	(0.0137)	(0.0175)	(0.0196)	(0.00545)	(0.0313)	(0.0420)	(0.0384)	(0.0112)
SS Scale 3 year 1&2	-0.00208	-0.0126	0.0101	-0.00549**	-0.0309*	-0.0425**	-0.0174	-0.00642
post-1965	(0.00751)	(0.00909)	(0.00904)	(0.00230)	(0.0162)	(0.0214)	(0.0199)	(0.00551)
SS Scale 4 or 5 in-utero	-0.0182	-0.0289	-0.00368	-0.00572	-0.0398	-0.0453	-0.0356	-0.00173
post-1965	(0.0360)	(0.0405)	(0.0380)	(0.00755)	(0.0510)	(0.0663)	(0.0544)	(0.0146)
SS Scale 4 or 5 year 1&2	0.00764	-0.00316	0.0194	-0.00545	-0.000385	-0.0117	0.00740	-0.00483
post-1965	(0.0145)	(0.0149)	(0.0182)	(0.00368)	(0.0180)	(0.0203)	(0.0270)	(0.00695)
Observations	62,286	62,286	62,286	62,286	38,558	38,558	38,558	38,558
R-squared	0.943	0.910	0.906	0.034	0.939	0.896	0.895	0.046

Notes: Sample restricted to municipalities that has at least one male and one female in each age cohort under the age of 43. Definitions of treatment variables are the same as in the main analysis except that we now separate storms into four categories – Saffir-Simpson Scale 1, Scale 2, Scale 3, and Scale 4 or 5. All regressions include municipality fixed effects, birth-year by island group fixed effects, and region-specific time trends. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table A.16: Effects on Education with Alternative Storm Measures

	(1) Literacy	(2) Years of Education	(3) Completed High Sch.
SS Scale 1 in-utero	0.00186*	0.0486**	0.00205
pre-1965	(0.000989)	(0.0201)	(0.00263)
SS Scale 1 year 1&2	0.000139	0.0149	-0.000665
pre-1965	(0.000541)	(0.0110)	(0.00148)
SS Scale 2 in-utero	-4.40e-05	-0.0491	-0.00716
pre-1965	(0.00189)	(0.0496)	(0.00689)
SS Scale 2 year 1&2	-0.000328	-0.0314	-0.00268
pre-1965	(0.00118)	(0.0282)	(0.00378)
SS Scale 3 in-utero	-0.000696	-0.00484	-0.00194
pre-1965	(0.00205)	(0.0383)	(0.00511)
SS Scale 3 year 1&2	-0.000919	0.0123	0.00143
pre-1965	(0.00106)	(0.0216)	(0.00288)
SS Scale 4 or 5 in-utero	0.00397	-0.0401	-0.0140
pre-1965	(0.00397)	(0.0663)	(0.00873)
SS Scale 4 or 5 year 1&2	0.00134	-0.0580	-0.0139***
pre-1965	(0.00209)	(0.0387)	(0.00529)
SS Scale 1 in-utero	9.18e-05	0.00373	-0.00265
post-1965	(0.00162)	(0.0278)	(0.00329)
SS Scale 1 year 1&2	0.000314	-0.00270	-0.00249
post-1965	(0.000701)	(0.0152)	(0.00187)
SS Scale 2 in-utero	-0.00481**	-0.0592	0.00291
post-1965	(0.00200)	(0.0491)	(0.00652)
SS Scale 2 year 1&2	-0.00229**	0.0106	0.000131
post-1965	(0.00111)	(0.0228)	(0.00285)
SS Scale 3 in-utero	-0.00542*	-0.00468	0.00350
post-1965	(0.00300)	(0.0718)	(0.00816)
SS Scale 3 year 1&2	-0.00281*	-0.0672*	0.000612
post-1965	(0.00144)	(0.0374)	(0.00521)
SS Scale 4 or 5 in-utero	-0.00737*	-0.308***	-0.0184
post-1965	(0.00398)	(0.106)	(0.0143)
SS Scale 4 or 5 year 1&2	-0.000218	-0.0688	-0.00989
post-1965	(0.00186)	(0.0443)	(0.00651)
Observations	2,290,886	2,255,017	2,255,017
R-squared	0.143	0.188	0.135

Notes: Sample includes all individuals between the age of 18 and 43 with non-missing municipality of birth information in the 10% housing sample of CPH1990. Definitions of treatment variables are the same as in the main analysis except that we now separate storms into four categories – Saffir-Simpson Scale 1, Scale 2, Scale 3, and Scale 4 or 5. All regressions include municipality fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

Table A.17: Effects on Occupation with Alternative Storm Measures

	(1) Skilled Occ.	(2) Associate Prof.	(3) Professional	(4) Skilled Occ.	(5) Associate Prof.	(6) Professional
SS Scale 1 in-utero	0.0105***	0.00401**	0.00317**	0.00866***	0.00306**	0.00226*
pre-1965	(0.00335)	(0.00168)	(0.00145)	(0.00309)	(0.00151)	(0.00130)
SS Scale 1 year 1&2	0.00724***	0.00338***	0.00236**	0.00663***	0.00303***	0.00205**
pre-1965	(0.00195)	(0.00120)	(0.00103)	(0.00183)	(0.00113)	(0.000973)
SS Scale 2 in-utero	-0.00246	0.00223	0.00424	-0.000536	0.00320	0.00524
pre-1965	(0.00664)	(0.00445)	(0.00387)	(0.00615)	(0.00412)	(0.00367)
SS Scale 2 year 1&2	-0.00110	0.00210	0.00196	0.000113	0.00305*	0.00279*
pre-1965	(0.00316)	(0.00191)	(0.00170)	(0.00284)	(0.00171)	(0.00154)
SS Scale 3 in-utero	0.0109	-0.00154	-0.00223	0.0112*	-0.000992	-0.00205
pre-1965	(0.00668)	(0.00311)	(0.00255)	(0.00653)	(0.00286)	(0.00234)
SS Scale 3 year 1&2	0.00809**	0.00344	0.00368*	0.00770**	0.00310*	0.00338**
pre-1965	(0.00379)	(0.00209)	(0.00191)	(0.00340)	(0.00184)	(0.00172)
SS Scale 4 or 5 in-utero	-0.00402	0.00824*	0.00691	-0.00458	0.00773*	0.00618
pre-1965	(0.0100)	(0.00456)	(0.00450)	(0.0101)	(0.00437)	(0.00443)
SS Scale 4 or 5 year 1&2	0.000488	0.000868	-0.000733	0.00223	0.00209	0.000505
pre-1965	(0.00534)	(0.00216)	(0.00224)	(0.00534)	(0.00203)	(0.00177)
SS Scale 1 in-utero	0.0259***	0.00873***	0.00703***	0.0259***	0.00867***	0.00706***
post-1965	(0.00877)	(0.00312)	(0.00234)	(0.00823)	(0.00272)	(0.00200)
SS Scale 1 year 1&2	0.00680*	0.00333*	0.00331**	0.00704**	0.00356**	0.00349***
post-1965	(0.00374)	(0.00176)	(0.00147)	(0.00345)	(0.00157)	(0.00132)
SS Scale 2 in-utero	-0.0391***	-0.0180***	-0.0130***	-0.0370***	-0.0171***	-0.0121***
post-1965	(0.0116)	(0.00530)	(0.00422)	(0.0111)	(0.00476)	(0.00376)
SS Scale 2 year 1&2	-1.59e-05	-0.00210	-0.00219	-0.000645	-0.00225	-0.00217
post-1965	(0.00549)	(0.00284)	(0.00232)	(0.00536)	(0.00273)	(0.00224)
SS Scale 3 in-utero	0.000437	0.000288	-0.000180	-2.19e-05	-0.000311	-0.000737
post-1965	(0.0208)	(0.00698)	(0.00535)	(0.0191)	(0.00586)	(0.00448)
SS Scale 3 year 1&2	0.00603	-0.000626	-0.000681	0.00877	0.00107	0.000849
post-1965	(0.00819)	(0.00378)	(0.00314)	(0.00767)	(0.00343)	(0.00283)
SS Scale 4 or 5 in-utero	-0.152***	-0.0659***	-0.0499***	-0.140***	-0.0578***	-0.0434***
post-1965	(0.0395)	(0.0166)	(0.0126)	(0.0373)	(0.0148)	(0.0110)
SS Scale 4 or 5 year 1&2	-0.0491***	-0.0243***	-0.0197***	-0.0479***	-0.0233***	-0.0188***
post-1965	(0.0111)	(0.00495)	(0.00391)	(0.0108)	(0.00484)	(0.00388)
Years of education	No	No	No	0.0381***	0.0252***	0.0215***
				(0.000665)	(0.000711)	(0.000615)
Observations	2,093,804	2,093,804	2,093,804	2,069,113	2,069,113	2,069,113
R-squared	0.147	0.045	0.037	0.232	0.146	0.125

Notes: Sample includes all individuals between the age of 18 and 43 with non-missing municipality of birth information in the 10% housing sample of CPH1990. Definitions of treatment variables are the same as in the main analysis except that we now separate storms into four categories – Saffir-Simpson Scale 1, Scale 2, Scale 3, and Scale 4 or 5. All regressions include municipality fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

A.6 Results Using 1968 as the Alternative Cut-Off Year

Table A.18: Effects on Cohort Size - Before and After 1968

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Sample: Ages Cohorts 2 to 43				**Sample: Ages Cohorts 18 to 43**			
	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male	ln(Cohort Size)	ln(Male Cohort)	ln(Female Cohort)	Fraction Male
Small typhoon in-utero	-0.00829	-0.0102	-0.00899	-0.000757	-0.0109	-0.0122	-0.0116	-0.000641
pre-1968	(0.00849)	(0.0105)	(0.0110)	(0.00286)	(0.00780)	(0.00996)	(0.0103)	(0.00285)
Small typhoon year 1&2	0.00596	0.00462	0.00572	-0.000249	0.00416	0.00332	0.00374	-0.000107
pre-1968	(0.00435)	(0.00527)	(0.00503)	(0.00116)	(0.00375)	(0.00489)	(0.00445)	(0.00120)
Severe typhoon in-utero	-0.108***	-0.148***	-0.0791*	-0.0188	-0.0987***	-0.134**	-0.0719	-0.0172
pre-1968	(0.0348)	(0.0517)	(0.0450)	(0.0134)	(0.0349)	(0.0527)	(0.0461)	(0.0136)
Severe typhoon year 1&2	0.000267	-0.00536	-0.00110	4.82e-05	0.00341	0.00199	-9.72e-05	0.00157
pre-1968	(0.0177)	(0.0265)	(0.0179)	(0.00621)	(0.0160)	(0.0251)	(0.0170)	(0.00648)
Small typhoon in-utero	-0.00902	-0.00308	-0.0185**	0.00372*	-0.0147	0.00714	-0.0414*	0.0109**
post-1968	(0.00675)	(0.00783)	(0.00839)	(0.00196)	(0.0170)	(0.0195)	(0.0225)	(0.00510)
Small typhoon year 1&2	-0.00287	-0.00862**	0.00343	-0.00300***	-0.0184***	-0.0210**	-0.0134	-0.00173
post-1968	(0.00347)	(0.00382)	(0.00408)	(0.000830)	(0.00689)	(0.00850)	(0.00826)	(0.00212)
Severe typhoon in-utero	-0.00759	-0.0245	0.0125	-0.00852	-0.0275	-0.0614	0.00570	-0.0154
post-1968	(0.0368)	(0.0422)	(0.0378)	(0.00779)	(0.0538)	(0.0786)	(0.0479)	(0.0171)
Severe typhoon year 1&2	0.0131	0.00296	0.0251	-0.00527	0.00778	-0.00278	0.0193	-0.00523
post-1968	(0.0149)	(0.0153)	(0.0185)	(0.00366)	(0.0184)	(0.0218)	(0.0270)	(0.00726)
Observations	62,286	62,286	62,286	62,286	38,558	38,558	38,558	38,558
R-squared	0.943	0.910	0.906	0.033	0.939	0.896	0.895	0.045

Notes: All details are the same as for Table 5 except for that the typhoon treatment variables here are interacted with a dummy variable indicating whether the typhoon passed through before or after December 1968.

Table A.19: Effects on Education - Before and After 1968

	(1) Literacy	(2) Years of Education	(3) Completed High Sch.
Small typhoon in-utero	0.00105	0.0142	-0.000530
pre-1968	(0.000732)	(0.0152)	(0.00205)
Small typhoon year 1&2	-0.000273	-0.00310	-0.00180
pre-1968	(0.000376)	(0.00840)	(0.00110)
Severe typhoon in-utero	0.00353	-0.0165	-0.00906
pre-1968	(0.00388)	(0.0656)	(0.00909)
Severe typhoon year 1&2	0.000772	-0.0649*	-0.0152***
pre-1968	(0.00194)	(0.0380)	(0.00517)
Small typhoon in-utero	-0.00198	0.0114	0.00118
post-1968	(0.00143)	(0.0275)	(0.00348)
Small typhoon year 1&2	-0.000317	0.0141	0.000798
post-1968	(0.000749)	(0.0162)	(0.00187)
Severe typhoon in-utero	-0.00759*	-0.360***	-0.0215
post-1968	(0.00440)	(0.114)	(0.0144)
Severe typhoon year 1&2	0.000368	-0.0507	-0.00780
post-1968	(0.00200)	(0.0486)	(0.00687)
Observations	2,290,886	2,255,017	2,255,017
R-squared	0.143	0.188	0.135

Notes: All details are the same as for Table 6 except for that the typhoon treatment variables here are interacted with a dummy variable indicating whether the typhoon passed through before or after December 1968.

Table A.20: Effects on Occupation - Before and After 1968

	(1) Skilled Occupation	(2) Associate Professional	(3) Professional	(4) Skilled Occupation	(5) Associate Professional	(6) Professional
Small typhoon in-utero	0.00565**	0.00165	0.00161	0.00516**	0.00143	0.00131
pre-1965	(0.00270)	(0.00139)	(0.00118)	(0.00254)	(0.00127)	(0.00108)
Small typhoon year 1&2	0.00463***	0.00232***	0.00182**	0.00473***	0.00247***	0.00195***
pre-1965	(0.00148)	(0.000883)	(0.000759)	(0.00137)	(0.000821)	(0.000713)
Severe typhoon in-utero	0.00322	0.0103**	0.00891*	0.00209	0.00935**	0.00782*
pre-1965	(0.00981)	(0.00461)	(0.00455)	(0.00985)	(0.00441)	(0.00444)
Severe typhoon year 1&2	0.00246	0.00156	0.000101	0.00448	0.00311*	0.00158
pre-1965	(0.00515)	(0.00199)	(0.00213)	(0.00506)	(0.00186)	(0.00173)
Small typhoon in-utero	0.0193**	0.00613*	0.00494*	0.0189**	0.00569*	0.00474*
post-1965	(0.00951)	(0.00349)	(0.00274)	(0.00916)	(0.00313)	(0.00243)
Small typhoon year 1&2	0.00736	0.00304	0.00284	0.00687	0.00268	0.00258
post-1965	(0.00454)	(0.00240)	(0.00203)	(0.00428)	(0.00222)	(0.00189)
Severe typhoon in-utero	-0.176***	-0.0755***	-0.0571***	-0.162***	-0.0662***	-0.0496***
post-1965	(0.0451)	(0.0184)	(0.0134)	(0.0428)	(0.0165)	(0.0118)
Severe typhoon year 1&2	-0.0572***	-0.0280***	-0.0230***	-0.0568***	-0.0277***	-0.0227***
post-1965	(0.0118)	(0.00527)	(0.00403)	(0.0116)	(0.00513)	(0.00398)
Years of education	No	No	No	0.0381***	0.0252***	0.0215***
				(0.000665)	(0.000711)	(0.000615)
Observations	2,093,804	2,093,804	2,093,804	2,069,113	2,069,113	2,069,113
R-squared	0.147	0.045	0.037	0.232	0.146	0.125

Notes: Other details are the same as in Table A.19.

B Data Appendix

B.1 Typhoon Exposure

Exposure variable at the storm-municipality-birth year level

We determine the set of affected municipalities for each storm based on the distance between the centroid of the municipality and the typhoon path. To do this, we first generate best-fit lines through the six-hourly typhoon observations to identify the storm path. We then use ArcGIS to calculate the distance between the centroid of the municipality and the storm path for each municipality-storm pair. If the distance is within 30 kilometers, we treat the municipality as affected by the storm on the day that the typhoon was recorded by the nearest observation point.

Second, we determine storm intensity for each affected municipality. We categorize storm intensity based on its minimum central pressure (MCP). Storm intensity varies as the storm moves, and we capture this using the six-hourly readings. We use the distance-weighted average of the MCP readings at the two nearest observation point as the MCP measure for the municipality. We categorize storm intensity by MCP as follows:

Saffir-Simpson Scale	Exposure	Minimum central pressure
1	Small	980-1000
2	Small	965-980
3	Small	945-965
4	Severe	920-945
5	Severe	$<$920

Third, for each storm-municipality-birthyear triple, we determine the probability that individuals born in the municipality during the birth-year would be affected by the storm either in-utero or during the first two years after birth. We resort to this measure because month of birth was not recorded in CPH 1990. CPH 1990 records each repondent's age as his or her age as of May 1, 1990. Most typhoons take place between July and November of each year. The probability of exposure measure allows us to fully exploit variation in the timing of the typhoon.

To compute the probability of exposure, we assume no seasonality of conception in the Philippines. In other words, we assume that an individual born in a given birth-year is equally likely to be born on any day during the year, if there were no exogenous shocks to fetal mortality. We formally test this assumption below and find that this is indeed the case in the Philippines for individuals born between 1947 and 1972. The expected number of typhoons a respondent is exposed to depends on his or her municipality of birth and age as of May 1, 1990. We assume 40 weeks of gestation (280 days).[24]

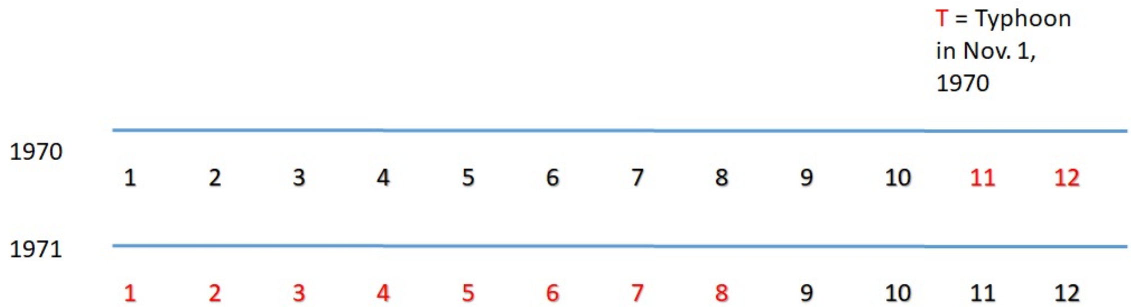
For any given recorded *age*, the respondent could be born either between May 2 to December 31 of the year given by: $1990 - age - 1$ or between January 1 to May 1 of the year given by: $1990 - age$. For example, an individual who is 19 years old on May 1, 1990 may be born between May 2, 1970 and May 1, 1971.

If there was a typhoon on month-date T, year Y, this typhoon would affect the in-utero period of all individuals born up to 280 days after month-date T, year Y. For example, consider figure B.1 below. Consider a typhoon that takes place on November 1, 1970 ($T =$

[24] For robustness, we use 36 weeks (252 days). The results are qualitatively similar.

November 1, Y =1970).

Figure B.1: Probability of exposure



This typhoon would affect the in-utero period of all individuals born between November 1, 1970 and August 8, 1971. The probability of in-utero exposure to this typhoon is the fraction of the cohort's potential birth dates that lie between November 1, 1970 and August 8, 1971. This typhoon may have affected the in-utero period of both the 18-year-old cohort and the 19-year-old cohort. However, because the November 1, 1970 to August 8, 1971 window has a larger overlap with the potential birth dates of the 19-year-old cohort, the typhoon has a larger probability of affected the in-utero period of the 19-year-old cohort than the 18-year-old cohort .

Similarly, this typhoon could affect the post-utero period, which we define as the first two years after birth, of all individuals born in the two years prior to November 1, 1970. It may have affected the post-utero period of the 19-year-old, 20-year-old, and 21-year-old cohorts. For the 20-year-old cohort, the probability of post-utero exposure to this typhoon is 1 because all their potential birth dates lie within the two-year window before November 1, 1970. For the 19-year-old and 21-year-old cohort, the probability of post-utero exposure is then the fraction of the cohort's potential birth dates that lie in the two years before November 1, 1970.

Based on each person's age, their probability of exposure to a typhoon that occurs on this date is calculated as the following (for a typhoon on November 1, 1970):

$$\mathrm{P(Affected\,postutero|Age\,21\,on\,May\,1{,}1990)} = \frac{\mathrm{No.\,of\,days\,between\,Nov\,1{,}1968\,and\,May\,1{,}1969}}{365}$$

$$\mathrm{P(Affected\,postutero|Age\,20\,on\,May\,1{,}1990)}=1$$

$$\text{P(Affected postutero|Age 19 on May 1,1990)} = \frac{No.\,of\ days\,between\,May\,2,1969\,and\,November\,1,1970}{365}$$

$$\text{P(Affected inutero|Age 19 on May 1,1990)} = \frac{No.\,of\ days\,between\,Novermber\,1,1970\,and\,May\,1,1971}{365}$$

$$\text{P(Affected inutero|Age 18 on May 1,1990)} = \frac{No.\,of\ days\,between\,May\,2,\ 1971\,and\,August\,8,1971}{365}$$

We also note that not all typhoons could affect the in-utero period of the two cohorts. All typhoons in May and June, for example, would only affect one cohort – the cohort born in the same year, as the 280 days window would not expand beyond the May 1, of the next year. For example for a typhoon on June 1, 1970:

$$\text{P(Affected postutero|Age 21 on May 1,1990)} = \frac{No.\,of\ days\,between\,June\,1,1968\,and\,May\,1,1969}{365}$$

$$\text{P(Affected postutero|Age 20 on May 1,1990)} = 1$$

$$\text{P(Affected postutero|Age 19 on May 1,1990)} = \frac{No.\,of\ days\,between\,May\,2,1969\,and\,June\,1,1970}{365}$$

$$\text{P(Affected inutero|Age 19 on May 1,1990)} = \frac{280}{365}$$

$$\text{P(Affected inutero|Age 18 on May 1,1990)} = 0$$

We generate exposure probabilities in a similar manner for all storm-municipality-birthyear triples. We then calculate the expected number of typhoons (by intensity) that each municipality-birthyear pair is exposed to by adding up the probabilities the municipality-birthyear is exposed to each typhoon in the database.

Seasonality of birth

We formally test the seasonality assumption following He and Earn (2007) and Dorelien (2016) using the 1993 Demographic and Health Survey (1993 DHS). Using the 1993 DHS, we recover the distribution of month of birth for women aged 18 to 43 in 1990 (i.e. born between 1947 and 1972). As presented in Table B.1, the distribution is indeed close to uniform. To formally test the assumption, we begin by aggregating the number of births in each month of the year, using the 1993 DHS sample weight as inflation factor. We then convert the month and year of birth data to monthly amplitude, which is defined as the percent deviation from the annual monthly mean as follows:

$$A_{my} = \frac{C_{my}X_{my} - \bar{X}_y}{\bar{X}_y}$$

where

$$\bar{X}_y = \frac{1}{12}\sum X_{my}$$

is the average number of births in a month in year y and $C_{my} = \frac{days\,in\,y/12}{days\,in\,m\,of\,year\,y}$ is the scaling factor to correct for the number of days in each month of the year. We then regress monthly amplitude on birth month indicators to formally test the assumption of equal proportion of births across 12 months of the year. The regressions (columns 2, 4, and 6) confirm that seasonality is low in the sample: the R-squared from each regression is low and we fail to reject the null hypothesis of equal deviations across the 12 months of the year (with p-values ranging from 0.292 to 0.762).

Table B.1: Seasonality of birth for Women Aged 18 to 43 in 1990

	(1)	(2)	(3)	(4)	(5)	(6)
	Birth year 1947-1972		Birth year 1947-1965		Birth year 1966-1972	
	%	Difference	%	Difference	%	Difference
January	8.71		8.64		8.86	
February	7.55	0.0121*	7.50	0.0141	7.65	0.00669
		(0.00727)		(0.00891)		(0.00851)
March	8.56	0.00491	8.34	0.00724	9.03	-0.00143
		(0.00698)		(0.00868)		(0.00594)
April	8.11	0.00189	8.25	0.00162	7.82	0.00262
		(0.00575)		(0.00712)		(0.00639)
May	8.68	0.000879	8.47	0.00167	9.13	-0.00127
		(0.00683)		(0.00853)		(0.00747)
June	7.82	0.0100	7.50	0.0118	8.50	0.00531
		(0.00702)		(0.00882)		(0.00605)
July	7.71	0.00708	7.82	0.00885	7.46	0.00229
		(0.00879)		(0.0114)		(0.00706)
August	8.33	0.00134	8.46	0.00277	8.05	-0.00255
		(0.00705)		(0.00889)		(0.00628)
September	8.52	-0.00192	8.63	-0.00333	8.28	0.00191
		(0.00548)		(0.00658)		(0.00813)
October	8.62	0.00300	8.72	0.00324	8.42	0.00235
		(0.00823)		(0.0107)		(0.00752)
November	8.68	0.00150	8.88	-4.25e-05	8.28	0.00568
		(0.00564)		(0.00683)		(0.00825)
December	8.71	-0.000878	8.79	-0.00145	8.54	0.000677
		(0.00542)		(0.00663)		(0.00646)
R-squared		0.020		0.030		0.059
F-statistic		0.86		0.68		1.22
p-value		0.762		0.753		0.292

Notes: Authors' calculations using the Philippines Demographic and Health Survey 1993. Regressions are run at the month of birth by birth year level. Difference (cols. 2, 4, 6) captures monthly amplitude, defined as the percent deviation from the annual monthly mean, relative to January. Regressions at the birth month-birth year level. Sample restricted to women born between 1947 and 1972 (aged 18 to 43 in 1990). Sample weight included, robust standard error

Outcomes and covariates

Cohort size

We measure cohort size at the birth-municipality birth-year level. The variable is defined as number of individuals born in municipality m in year t that survived until May 1, 1990.

To order to capture cohort size at the municipality of birth (rather than the municipality of residence in 1990), we keep using the 10% sample of CPH 1990 for which we observe each individual's municipality of birth. The cohort size of municipality m in year t is calculated by adding up the person weights of all individuals who were born in municipality m in year t.[25] We similarly define male cohort and female cohort by restricting the sample to males and females respectively. We restrict the sample to municipalities with at least one male and one female in each age cohort for all ages under 43.

Education

The 1990 Census categorizes education into, pre-school, elementary 1 to 6, high school 1 to 4, and post-secondary education. We count pre-school completion as having 1 year of education. Elementary school completion is equivalent to having 7 years of education and high school completion 11 years of education. The majority of students in the Philippines begin formal elementary school at age 6, assuming no grade repetition, respondents should be aged 16 when they complete high school. We use the Census categories for post-secondary education to convert post-secondary achievement to years of education.

Occupational skill level

We categorize occupations into professional, associate professional, and skilled occupations based on the the 1990 Census categories. CPH1990 records occupations using the 4-digit Philippine Standard Occupational Classification (PSOC) system, which is patterned after the International Standard Classification of Occupations (ISCO) released by the International Labour Organization. The PSOC categorizes occupations by both the set of tasks carried out and the skills involved in the job. Each major group in the PSOC can be mapped to a ISCO skill level, which we use to categorize occupations into professional, associate professional, and skilled.

The Census questionaire asks one's occupation in the past year as well as the past week. Whenever occupation from the past year is available, we use it as one's occupation; when occupation from the past year is not reported, we use occupation from the past week.

We then map one's occupation into professional, associate professional, and skilled occupations according to the first digit of one's 4-digit occupation code. Professional occupations include two major groups: officials of the government and special interest organizations, corporate executives, managers, managing proprietors and supervisors (PSOC group 1) and

[25]As a robustness check, we also perform all our analysis using a simple count of individuals as cohort size, rather than adding up the weights of all individuals. All results are very similar.

professionals (PSOC group 2). Associate professionals include, besides the two groups included in professionals, another major group which requires skills at the third ISCO skill level: technicians and associate professionals (PSOC group 3). Skilled occupations add five other major groups that require skills at the second ISCO skill level: clerks (PSOC group 4); service workers and shop and market sales workers (PSOC group 5); farmers, forestry workers, and fishermen (PSOC group 6); trades and related workers (PSOC group 7); plant and machine operators and assemblers (PSOC group 8). Excluded from the skilled occupations are laborers and unskilled workers (PSOC group 6) which requires skills at the first ISCO skill level. Also excluded from skilled occupations are non-gainful occupations, which includes volunteers, housekeepers, students, pensioners and other retirees, disabled, and other non-gainful or no reported activity.

Using the first digit of PSOC code allows us to capture categorization allows us to capture the required level of skill for one's usual job. For example, in agriculture, the PSOC separates "skilled rice farm worker" from "farm laborer" and we code the two occupations under different skill levels.

C Sample Selection

C.1 Age cohorts

One concern with the age range in our sample is that the youngest cohorts (respondents aged 18 to 21) may still be in school. We explore whether our estimated effects among the younger cohorts are driven by the negative selection of respondents who did not attend tertiary education. Unfortunately, the fraction of respondents who identified as students is low in CPH 1990, we suspect item non-response. We restrict our sample to individuals between 22 and 43 years old and re-estimate the effects of early life exposure to small and severe typhoons. Our estimates using the restricted sample (columns 1-3) are qualitatively similar to our main estimates (columns 4-6).

Table C.1: Effects on Occupational Skill Level, Age 22-43

	(1) Skilled Occupation	(2) Associate Professional	(3) Professional	(4) Skilled Occupation	(5) Associate Professional	(6) Professional
Small typhoon in-utero	0.0114**	0.00550	0.00340	0.00933***	0.00321**	0.00274**
pre-1965	(0.00544)	(0.00362)	(0.00355)	(0.00299)	(0.00154)	(0.00131)
Small typhoon year 1&2	0.00384	0.000814	0.000344	0.00637***	0.00332***	0.00259***
pre-1965	(0.00321)	(0.00256)	(0.00235)	(0.00172)	(0.00107)	(0.000921)
Severe typhoon in-utero	-0.0164	-0.00820	-0.00378	-0.00302	0.00949**	0.00794*
pre-1965	(0.0228)	(0.0118)	(0.00984)	(0.0105)	(0.00470)	(0.00462)
Severe typhoon year 1&2	-0.0105	0.000827	-0.00463	0.00108	0.00103	-0.000674
pre-1965	(0.0128)	(0.00769)	(0.00642)	(0.00550)	(0.00215)	(0.00215)
Small typhoon in-utero	-0.000773	-0.00866	-0.00452	0.00930	0.00217	0.00206
post-1965	(0.0103)	(0.00560)	(0.00463)	(0.00742)	(0.00274)	(0.00212)
Small typhoon year 1&2	0.000703	-0.00114	-0.000446	0.00438	0.00150	0.00154
post-1965	(0.00432)	(0.00246)	(0.00212)	(0.00330)	(0.00173)	(0.00147)
Severe typhoon in-utero	0.182**	-0.00110	-0.0598**	-0.159***	-0.0690***	-0.0519***
post-1965	(0.0908)	(0.0484)	(0.0296)	(0.0421)	(0.0176)	(0.0131)
Severe typhoon year 1&2	0.00842	-0.0115	0.00872	-0.0508***	-0.0252***	-0.0206***
post-1965	(0.0304)	(0.0138)	(0.0147)	(0.0113)	(0.00501)	(0.00392)
Observations	282,377	282,377	282,377	2,069,113	2,069,113	2,069,113
R-squared	0.123	0.064	0.055	0.232	0.146	0.125
Mean of Y, pre-1965 cohorts	0.313	0.101	0.083	0.313	0.101	0.083
Mean of Y, post-1965 cohorts	0.173	0.035	0.027	0.173	0.035	0.027

Notes: Outcome variables are dummy variables indicating whether the individual holds a skilled occupation (columns 1 and 4), an associate professional occupation (columns 2 and 5), or a professional occupation (columns 3 and 6). Regressions are run at the individual level, whereas the treatment variables are defined at the birth-municipality by age-cohort level. All regressions include municipality fixed effects, birth-year by island group fixed effects, region-specific time trends, and a dummy for being male. Standard errors are clustered two-way at both the municipality level and the province-by-birth-year level.

C.2 Migration before age 2

One concern with our treatment variable is measurement error in the post-utero exposure variables due to migration within the first two years of life. Migration introduces measurement error in our post-utero exposure variables since we assign the probability of exposure in the first two years of life based on individuals' municipality of birth but we are unable to determine individuals' municipality of residence in their first or second year of life. We first note that given the high probability of typhoon exposure in the Philippines, it is unlikely that individuals move to avoid typhoon exposure. Hence, neither the probability nor the direction of migration should be correlated with post-utero typhoon exposure and the measurement error introduced by migration could only bias our estimates downwards. We further note that despite the high rates of migration in the Philippines, the probability of moving in the first two years of life is low. We do not have the complete migration history of the adults between 18 and 43. We find that less than 3% reported migrating to their place of residence in 1985 before the age of 2 and when we interact household SES and typhoon exposure, we find no evidence of selective migration by household SES. Using CPH 1990, we restrict the sample to households with children under 5 and find that about 5% of households migrated in the past five years. We also use the 1993 Philippines Demographic and Health Survey (1993 DHS) to explore early life migration for women aged 18 to 43 in 1990 (i.e. born between 1947 and 1972). More than 60 percent of women born between 1947 and 1972 in the sample ever moved. The 1993 DHS does not include a complete migration history, but we restrict the sample to women who moved to their place of residence in 1993 before the age of 15, and find that 6% of the sample moved to their current place of residence before aged 2. We repeat the exercise using children under 5 in the 1993 DHS and also find that 5% of children under-5 in the survey moved before age 2.

D A Conceptual Framework for Culling and Scarring

We present a modified version of the "fetal origins" model in Almond (2006) to illustrate how in-utero exposure to typhoons and changes in post-disaster relief policies could interact to create the culling and scarring effects we have documented in this paper.

Following Almond (2006), we allow a severe typhoon to have two potential effects on fetal health: (1) a negative shift in the unobserved distribution of fetal health (scarring) and (2) a reduction in the survival odds conditional on health. Both effects contribute to culling. The latter may happen as a result of deteriorating medical care and a shortage of clean water and food in the ensuing weeks after a severe typhoon. The fetal origins hypothesis asserts that the first effects, the deterioration in the distribution of fetal health, would persist into adulthood and result in poorer educational and labor market outcomes.

We modify the model to incorporate changes in post-disaster relief policies. We assume that Marcos' post-disaster relief policies alleviate the second effect of typhoons but do not have much impact on the first effect. That is, by providing food, water, and medical services *after* each typhoon incident, Marcos' post-disaster relief policies would reduce the negative effects of typhoons on survival odds conditional on health.

This is illustrated graphically in the figure below. Let h denote the underlying fetal health. In the absence of any natural disasters, $F_0(\cdot)$ is the cumulative distribution function of fetal health. There is a natural fetal mortality rate associated with health threshold, d_o, such that those whose $h < d_o$ would not survive to adulthood. A severe typhoon shifts the distribution of fetal health to left, to $F_1(\cdot)$. In the absence of any disaster relief measures, a severe typhoon also reduces the survival odds conditional on health such that all those with $h < d_{pre}$ would not survive to adulthood (where $d_o < d_{pre}$). As a result of selective mortality, we do not observe long-term scarring. The effect of Marcos' post-disaster policy is to shift the survival threshold to the left, to d_{post} (where $d_0 \leq d_{post} < d_{pre}$). In other words, some of those who would have died survived as a result of the policy. The change in the composition of respondents who survived pre and post-1965 results in changes in the observed long-term scarring effects.

Figure D.1: Conceptual framework for culling and scarring