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## Can Education Survive A Crisis?

*A Case Study on the Effects of Typhoon Haiyan in the Philippines*

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**Abstract:** This paper investigates the medium-run effects of the 2013 Typhoon Haiyan on educational attainment, as a measure of human capital, in the Philippines, using a difference-in-difference approach. We use reported damages to identify affected and unaffected regions, and a 2019 nation-wide survey to measure the educational attainment of those aged 6 to 31 at the time of the disaster. The results from our core regression suggest that Typhoon Haiyan had no significant impact on educational attainment in the medium run for any level of education or any cohort. We then investigate heterogeneous impacts of the Typhoon on different demographic groups, using gender, urbanity and household size as proxies of inherent socioeconomic inequalities. We find suggestive evidence that: women in affected regions were on average 4.3 percentage points less likely to complete higher education, while men were 2.3 percentage points more likely; children aged 6 to 11 in affected regions from rural regions completed 0.54 less years of schooling; and students between the ages of 12 to 17 from larger households were all less likely to complete senior education than those from medium and small households in affected regions.

**Keywords:** Natural Disaster, Typhoon Haiyan, Human Capital, Educational Attainment

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# 1 Introduction

*“We are rushing to get critical supplies to children who are bearing the brunt of this crisis.”* - UNICEF Philippines Representative Tomoo Hozumi, 2013

The 2023 World Risk Report named the Philippines, Indonesia, and India as being at the “highest risk worldwide of - falling victim to a humanitarian disaster caused by extreme natural events and the negative impacts of climate change.” This apparent risk, inspires questions as to the economic impact of natural disasters as well as what can be done to prevent them, drawing our attention to a variety of research. Most notably, studies on the medium-run impact of natural disasters on human capital accumulation (such as childhood health and early-childhood education) have demonstrated that there can be significant, long-run impacts on local, and even national, economies - as seen in the cases of Nepal (2018; Paudel, Ryu) and Pakistan (2021, Andrabi et. al).

Typhoon Haiyan, which struck the Philippines on November 8, 2013, was one of the most prominent storms ever recorded. It devastated many areas of the country, causing major economic and human losses. Even so, 10 years later, no study has yet been conducted to examine this unparalleled disaster’s impact on human capital. This then prompts the question which we seek to investigate:

*What are the direct medium-run effects of Typhoon Haiyan on the educational attainment of individuals in highly impacted regions?*

Motivated by Paudel and Ryu (2018), we employ a difference-in-difference (DID) model as an empirical strategy to examine the potential medium-run effects of the disaster on educational outcomes of those who were of student age (6 to 21 years old) when the Typhoon struck; using older cohorts as relevant control groups as we assume they would have completed their education at the time of the disaster - Duflo (2001) had a similar approach. We use the National Disaster Risk Reduction and Management Council’s (NDRRMC) ”Final Report on the Effects of Typhoon ”Yolanda” (Haiyan) to compile data on the number of affected persons and damages (to infrastructure and the social sector) which we use in conjunction with the Typhoon’s trajectory to determine which regions in the Philippines were most affected. We determine that **Regions IV-B, V, VI, VII and VIII** were most affected and use them as our treatment groups. We used the 2019 Functional Literacy, Education, and Mass Media (FLEMMS) Survey by the Philippines Statistic Authority (PSA) for data on individuals’ educational attainment. From this, we gathered over 62,000 observations documenting individuals’ highest level of educational attainment, gender, urbanity, and household size. From this, we sorted their educational attainment into relevant categories and assigned them to their respective cohorts based on the ages they would have been in 2013. Belonging to an

affected region and a given cohort jointly determines an individual's exposure to the disaster. In our core regression, we control for gender, urbanity, and household size and include province and birth year fixed effects. Then, we investigate any potentially heterogeneous impact of the disaster using the aforementioned controls as proxies of inherent socioeconomic inequalities in the Philippines.

From our core regression, we fail to reject the null hypothesis that Typhoon Haiyan did not have a negative effect on educational attainment in the Philippines in the medium-run. This is because we find no evidence of a statistically significant difference in any cohort's average educational attainment outcomes, for any level of education. We find these outcomes indicative of effective and successful disaster response measures in the immediate aftermath of the disaster. Within affected regions, however, we find suggestive evidence that women between the ages of 18 to 21 were 4.3 percentage points less likely to complete their higher education, while men were 2.3 percentage points more likely; children aged 6 to 11 in affected rural regions completed 0.54 less years of schooling; and students between the ages of 12 to 17 from larger households were less likely to complete senior education than those from medium and small households in affected regions. We argue that these latter findings could have long-term implications, whereby - without improved infrastructure to tackle these disparities -, rural areas and larger households will remain economically disadvantaged, with children of primary and senior highschool age 'bearing the brunt' of these challenges.

While the importance of human capital in the progress of developing nations is nearly undisputed, existing literature on how a single shock affects educational attainment in the medium-run is sparse. Most literature considers the long-run impacts of natural disasters, and measures of human capital - an ambiguous term - are of great variety - from women empowerment and technology to early childhood development, nutrition, and education. We focus on education. Our aforementioned results confirm the findings of the studies similar to ours, for example; Agamile and Lawson (2021) investigate how rainfall shocks affected children's school attendance in Uganda and find these shocks to have a negative impact, especially on children of primary school age and children in rural areas; and Andrabi's (2021) study on the 2005 Kashmir earthquake found no significant difference in grade enrollment rates between more and less affected areas.

Broadly speaking, our findings strongly suggest that education can indeed survive a crisis with the right mitigation, preparedness, response, and recovery. That is why we hope our study can serve to encourage not only further research on the impact of single-event shocks - whether that be natural disasters or otherwise - on education, but also as a motivation for national and international policy to continue to prioritize immediate and effective, sustainable responses to natural disasters; especially as the threat of climate change grows stronger, and already vulnerable nations become more at risk.

## 2 Background

To examine natural disasters’ effects on human capital, we study Typhoon Haiyan (2013) and human capital, using a case-study approach. First, we present the details of the disaster itself. Then we elaborate on the status of human capital, specifically educational attainment, in the Philippines.

### 2.1 Super Typhoon Haiyan

The Philippines is located in both the “Pacific Ring of Fire” and the “Typhoon Belt” where over a third of the world’s tropical cyclones form<sup>1</sup>. This renders around 60% of land and 74% of the population (which was roughly 99.7 million in 2013<sup>2</sup>) vulnerable to numerous hazards according to the International Monetary Funds (IMF). The country ranks among the top three most disaster-prone nations worldwide in the latest World Risk Index (World Risk Report, 2022). With that, it is plagued by around 20 cyclones yearly, with as many as 8 making landfall<sup>3</sup>.

Typhoon Haiyan (locally named Yolanda) made landfall early morning, local time, on November 8, 2013. It is cited as the strongest tropical storm to have made landfall at the time, as a category 5 storm<sup>4</sup> in other words classified as a “super typhoon”. It is also ranked among the most powerful storms in recorded history, globally. Sustained wind speeds reported from ground stations reached 300 km per hour (according to the UN Food and Agricultural Organisation), making landfall five times as it skirted through the island chains. Some islands were hit by a 3 to 5-meter storm surge<sup>5</sup>. The disaster prompted the then-Philippine President to declare a “state of calamity”<sup>6</sup>.

The Philippines is divided into 17 administrative regions, of which 9 were reported as affected, and 82 provinces, 63 of which were reported as affected<sup>7</sup>. In some regions over 90 per cent of the housing was destroyed. In total, it affected over 16 million people, with 4 million displaced, and over 6000 casualties. The Typhoon Haiyan also caused losses of

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<sup>1</sup>Typhoons are a type of tropical cyclone formed in the mapthwest Pacific Ocean and vary from Hurricanes only in that they occur in the mapth Atlantic, central North Pacific or eastern North Pacific Ocean. Both are the same type of tropical storm. According to the National Hurricane Center and Central Pacific Hurricane Center, for a tropical cyclone to be classified as a storm, it must reach sustained wind speeds of at least 119 kilometers per hour. If wind speeds reach 178.6 kilometers per hour, they are classified as an intense hurricane or typhoon and if they reach 240 kilometers per hour, they are considered to be “super typhoons”.

<sup>2</sup>According to the World Bank.

<sup>3</sup>According to the Asian Disaster Reduction Center (ADRC).

<sup>4</sup>The standard measure is the Saffir-Simpson Hurricane Wind Scale, a 1 to 5 rating based only on a hurricane’s maximum sustained wind speed. Category 1 (119-153 kmh) produces some damage, Category 2 (154-177 kmh) produce extensive damages, Category 3 (178-208 kmh) produce devastating damages, Category 4 (209-251 kmh) and Category 5 ( $\geq 252$  kmh) cause catastrophic damages according to the National Hurricane Center and Central Pacific Hurricane Center.

<sup>5</sup>See Appendix A for the path of Typhoon Haiyan.

<sup>6</sup>According to the Philippines Disaster Risk Reduction and Management (DRRM) Act of 2010 a “state of calamity” is defined as; “a condition involving mass casualty and/or major damages to property, disruption of means of livelihoods, roads and normal way of life of people in the affected areas as a result of the occurrence of natural or human-induced hazard”.

<sup>7</sup>Data on the effects of Typhoon Haiyan according to the Philippines National Disaster Risk Reduction and Management Center “Final Report re effects of Typhoon “Yolanda” (Haiyan)”.

4.6% of the Philippines annual GDP at the time, according to the International Disasters Database (EM-DAT). Considerable losses were within infrastructure<sup>8</sup> and social damages<sup>9</sup>. It is worth noting that a universal measure of the effect of natural disasters, is yet to have been formally established<sup>10</sup>. Therefore, as demonstrated later on, we use a composite measure to determine that of these 9 reportedly affected regions namely five; Region IV-B (Mimaropa), Region V (Bicol), Region VI (Western Visayas), Region VII (Central Visayas), and Region VIII (Eastern Visayas), were hit the hardest in terms of affected persons and infrastructure damage. By all measures - meteorological<sup>11</sup> and economic, and in terms of the human cost - Typhoon Haiyan was undoubtedly catastrophic. Unsurprisingly, it generated massive emergency response efforts on the national, international, and bilateral levels. Initial response included aid worth; €180m from the EU Commission and its member states; \$90m from U.S Agency for International Development (USAID) Office of Foreign Assistance in aid; and the World Health Organisation (WHO) coordinated health response involving over 200 partner organizations. In the immediate aftermath of the disaster, responses prioritized life-saving assistance, such as shelter, food, water, sanitation, and healthcare. Three months after the disaster, the focus swiftly shifted to recovery. For example, USAID rebuilt more than 250 classrooms on the island of Leyte, , Save the Children repaired classrooms for 500,000 children, and UNICEF provided several thousands of teaching kits, learning materials, and blackboards to schools.

## 2.2 Overview of Human Capital in the Philippines

To effectively understand the impact of Typhoon Haiyan on human capital, we must look into the status in the Philippines preceding 2013. Specifically, we use educational attainment as a measure of human capital. The following is meant to set the scene and introduce the forces that Typhoon Haiyan interacted with <sup>12</sup>.

Overall, by 2013, improvements were made in the sphere of educational attainment. In 2008, the rate of out-of-school children to the total number of children between the ages of 5 and 15 was 11.7%, this was reduced to less than half by 2012, to 5.21%. Reasons for the improving rates can be attributed to government policy and intervention in the years preceding Typhoon Haiyan. The “K-12 law”, or “Republic Act 10533” of 2013, that brought curricular

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<sup>8</sup>Infrastructure damages pertain to damages to transport that include national and provincial/local roads and bridges, seaports, airports, flood control and utilities like water supply, power supply, drainage and telecommunications. Specified infrastructure that was destroyed include schools, health facilities, and government buildings, as defined by the NDRRMC.

<sup>9</sup>Social damages pertain to damages within the sectors of a) Education b) Health c) Housing. Damages to school buildings and materials, health structures, medical supplies, medical equipment and dwelling units., as defined by the NDRRMC.

<sup>10</sup>Since Typhoon Haiyan, the Sendai Framework for Disaster Risk Reduction 2015-2030 has been developed in an attempt to improve the understanding of disaster risk, exposure, vulnerability and hazard characteristics in helping recovery too. It also aims to improve international coherence in measuring disasters that look at incidents as a whole, without accounting for national borders that can be limiting. The framework was developed after the disaster, and has not yet been adopted globally.

<sup>11</sup>Including the sustained wind speed of the storm, rainfall and storm surges.

<sup>12</sup>All data on drop-out rates and reason for not attending school are according to the Philippine Institute for Development Studies report on “Recent Trends in Out-of-School Children in the Philippines”.

reforms strengthening basic education by making kindergarten mandatory. It also became mandatory for families receiving government assistance through certain schemes to send their children to school, and with a minimum attendance rate of 85%. This was the chief reason for the sharp decline in dropout rates. It was also reflected in net attendance rates, which for primary school increased from 90.8% in 2008 to 96.5% in 2013. The Third Elementary Education Project (TEEP) implemented by the Philippine Department of Education from 2000 to 2006 was also ratified as part of a reform of the public primary and elementary school system. Measures included investing in physical buildings, and textbooks, training teachers and principals, and decentralizing school management to the school and community levels. With just a two-year exposure to the TEEP, there was a positive performance by students at higher grades. The Department of Education also made changes in its hiring policy making license exams, experience, interviews and communication skills mandatory criteria in teachers application process. Curricular changes included implementing mother tongue-based multi-lingual education and expanding the range of languages and dialects offered, widening the inclusivity of the system and appealing to the entire country.

One of the remaining concerns is centered around the gender gap in education. Males, on average, underachieve in academic performance and showed higher dropout rates. The main reasons for not attending school varies for their respective gender. For females, the main reasons include marriage and housekeeping duties while for males the main reasons revolves around lack of interest. For both genders, lack of family income is a high-ranked reason for not attending school.

High school can be identified as a particularly problematic cohort age. Student-teacher ratios are high and boys are much more likely to drop out at higher rates. The rate of increase in dropouts is the same between males and females; meaning that enrollment rates remain 10% higher among women. A reason for the worsened state of high school attendance is that governmental schemes thus far has solely addressed kindergarten and primary education schooling. While this has spill-over effects in secondary education it did not reach high school education, as the reason for children dropping out of high school is most often centered around the economic factor. This is explained by the fact that high school-aged children face a significantly higher opportunity cost of studying, as they could instead enter the workforce immediately.

### **3 Literature Review**

Natural disasters of great magnitude, like the one of Typhoon Haiyan, gravely shake impacted regions and existing studies focus on a wide scope of such effects. In the following section, we refer to similar forms of research pertaining to how single large-scale disasters in disaster-

prone countries affect human capital. We highlight the research gap in the medium-run human capital effects of Typhoon Haiyan.

### **3.1 Human Capital**

The focus of our study is to understand the degree to which natural disasters impact people in the medium run by threatening human capital. With that, it is important to define human capital, especially as precedence varies. It is also pivotal to clarify the grave private and social returns of human capital.

#### **3.1.1 Defining Human Capital**

Human Capital is ambiguous in its exact definition. For instance, Goldin’s paper on Human Capital broadly breaks down Human Capital as an umbrella term considering “education and training” and “health” while Becker’s parallel definition separates the term under “schooling, learning on the job and health”. The broadness of the expression is heavily recognised in academia and thus, research within it is heterogenous in the indicators used. The World Bank’s “Human Capital Project” is an example of how domains can range further from women empowerment, technology, innovation, early childhood development, nutrition and finally, what we choose to focus on in our study, education. When honing in on education as a signal for human capital, studies use varying measures for it. Relevant ones include literacy rates, educational attainment or dropout rates, Agamile and Lawson (2021), test scores Morrilla and Westall (2023), cognitive ability and emotional ability Schady et.al (2023) and the rate of overaged pupils. We want to emphasize that our study focuses on educational attainment by measuring the level of education reached, something we will hereafter refer to, as educational attainment.

#### **3.1.2 Human Capital Externalities**

Since our study focuses on the effect of a disaster on human capital using educational attainment, it is important to emphasize the implications that human capital has on an individual and national economic level; also known as the private and social returns of human capital. We start with the individual implications that are broadly centered around the role human capital plays in personal health, welfare and household economy. Empirically, Rauch (1993) finds that a one-year increase in the average education in a metropolitan area in the US is associated with a 3 per cent increase in wages even in regressions that control for observed characteristics. Card (1999) reports a figure as high as 6 to 10 per cent. The World Bank also produce evidence of reduced schooling having a negative effect on productivity with an estimate that 60% of children born today are, at best, only half as productive to what

they could be if they had complete education and were full health. In times of shock, less educated workers and younger workers are disproportionately more vulnerable to unemployment, Blanchard and Wolfers (2000) looked at this in the European context. This question become especially relevant in the context of the shock in the form of a natural disaster. Other studies show how reductions in educational investment in response to positive early life shocks reduce overall child welfare Bau, Rotemberg, Shah, Steinberg (2020). Studies also show the link between higher education leading to improved health Grossman (2000), which is another aspect of human capital that could accumulate to stronger effects for human capital. On a macroeconomic level, the positive effects of high human capital is undisputed and has for long been the argument for government policy investment in, for instance, compulsory public education. Romer (1990) suggests that societies with more skilled workers generate more ideas and grow faster, linking human capital with economic growth. It is also important to note that increasing rates of human capital in developing countries cause the tendency of such high-skilled workers to emigrate to areas with higher skill premiums. This phenomenon known as brain drain is a large barrier to the development of many countries, according to the IMF. Moreover, Polat (2017) even proves positive social externalities with higher education levels in substantially decreasing gender inequality and declining regional gender disparities. Adding importance to our study is the predicted rise in frequency of many such shocks, highlighting the importance of also understanding their effects. Rising global temperatures increase the occurrence of major extreme weather events predicted by the IMF, World Economic Forum, and USGS. As events resembling Typhoon Haiyan will grow ever so frequent and more intense, it is paramount to also understand the individual and economy through channels, such as human capital. Especially so in disaster-prone areas, which unfortunately in many cases coincide with developing or underdeveloped economies.

### **3.2 How Shocks Affect Educational Attainment and Human Capital**

There are generally two streams of studies that look into the effect of different types of shocks on human capital. We will present and differentiate between the type of shock, measure of human capital, and their varying scopes.

One stream is derived from climate-related and biological shocks. Studies most similar to ours, follow the case-study approach investigating how a single climate-related or biological shock affects human capital attainment in a country, depending on the degree of exposure. As demonstrated by Andrabi et. al (2021) who look at how the 2005 earthquake in Kashmir affected human capital accumulation in the medium-run. They conducted a household survey in the regions most affected with children that were in utero or up to the age of 11 at the time of the earthquake. They use distance to activated fault lines to determine how exposed households were. They conclude at there is no difference in enrollment rate

nor any differential gender effects on enrollment, grade attainment, adult weight, household consumption or wealth compared to less-affected areas. Much of this can be attributed to the extensive compensation schemes preceding said disasters. However, they do state significant physical and cognitive shortcomings in the children that were in the 1000 first days of development at the time of the earthquake, using height and test scores as indicators. In a similar study, Reyes and Randell (2023) consider how exposure to household shocks across early life affects educational levels and well-being among Peruvian children. Using a longitudinal survey that follows cohorts of children over 15 years, they link exposure to shocks defined as economic/agricultural shocks, environmental shocks, and family shocks. Shocks were self-reported in the survey. Using urbanity and access to a paved road (signal of socioeconomic status and means of transportation) as control. Results of the multivariable OLS model show that a higher exposure to shocks in childhood significantly lowers reading and vocabulary scores, as well as lower likelihood of always having enough to eat (food security). Thus, lowering the likelihood of human capital attainment. Another paper by Agamile and Lawson (2021) looks at how Rainfall shocks children’s school attendance in Uganda. They use geo-referenced spatial rainfall data to track rainfall, panel data survey for attendance rates, and consider child and household characteristics as relevant variables including; household size, poverty status, and incidence of food shortage. Their results reflect how exposure to negative rainfall shocks significantly by reducing children’s school attendance. This trend is significantly pronounced for children in rural areas and in primary schools. Such methods consider how shocks as a phenomenon affect completion rates on average, while we decide on the narrower scope of a single shock to consider national context and medium-run effect. Contrarily, studies of a broader nature often conclude that there are negative effects on human capital, specifically in the realm of education, in cases where children and adolescents experience numerous shocks while studies with a single disaster as a focus show little effect and where they do, it is centered around health. Both scopes usually point out that being female, from a rural area, or of a larger household, as factors leading to individuals being more exposed.

The second stream of studies analyzes the in-utero effect of shocks. One study by Almond, Edlund and Palme (2009) looks into how radiation fallout exposure from the Chornobyl accident affected human capital for children in utero. The results show significant negative effects on cognitive ability that correspond to regional differences in fallout. The fall 1986 birth cohort performed substantially worse in the final year of compulsory education (then, middle school) with mathematics grades particularly suffering and were much less likely to graduate high school. The pattern was most prominent for children with parents with low education. There were no detected health damages. A resembling study by Tan Ce. et al (2009) investigate fetal exposure to an earthquake in China on long-term human capital

accumulation using educational attainment. They use a difference-in-differences model and present how individuals who experienced either high-intensity or low-intensity earthquake shaking in-utero have lower educational attainment in adulthood. Maternal psychological stress prominent in high-intensity shook areas may have been a reason for this. Females were found to be more affected than males, however, with no adverse effects on labour market outcomes. For studies focusing on the in-utero effects of a disaster, there is an important component recognizing the health effects of a disaster on maternal or fetal health as a mechanism determining educational attainment, something that we do not investigate in our study. Within these streams of research, there is variety. There is a differentiation in the type of shock analyzed, from climate-related, biological, economic, political, or even policy shocks. There is also variety in the measure of human capital from using educational attainment, test scores to measure cognitive ability, and height as a health indicator, and looking at in-utero, childhood or young adults. The scope also varies from looking at several disasters in many countries, several disasters in a single country or a single disaster in a single country. Our thesis, however, distinctly measures the effect of a single climate-related shock on human capital using education attainment alone as an indicator.

### **3.3 Case Studies on Typhoon Haiyan**

Currently, there does not seem to be a study on how Typhoon Haiyan impacted medium-run educational attainment in the Philippines. Nevertheless, there are some tangential studies, that is the one strand of literature and it focuses on the recovery of Typhoon Haiyan. One small-scale study looks into the experiences and needs of students and teachers at several Philippine universities, who were either directly affected by Typhoon Haiyan or served as responders to the Typhoon survivors shed light on the psychological effects of the disaster that could be relevant to human capital. The study specifically studies the experiences of displacement in an academic setting. The results showed that for academic recovery, students expressed a need to return to normalcy, quickly resuming academic activities, responsibilities, and emotional support. A similar study by Iuchi (2021) investigates how multiple levels of disaster allocation actors, prompted by the Typhoon response, interacted and evolved in their changed environment. In terms of changes pertaining to education, residents relocated by the Typhoon continued to revisit their pre-typhoon school or work area as their new neighborhoods had not been rebuilt year. Note that durable housing, access to schools and a health care center, and access to water were the three major reasons for increased satisfaction among evacuated residents, highlighting the importance of schooling in Filipino society.

## 4 Research Design

In this section, we provide a more detailed explanation of how we fill gaps in existing literature exploring the impact of disasters on human capital and, specifically, educational attainment. Then, we present our research question and hypothesis.

### 4.1 Medium-term Impact

We mention that several studies examine the short- and long-run impacts of natural disasters on different components of human capital. However, at the time of publishing this report (2024) it has been just over 10 years since Typhoon Haiyan struck the Philippines, and the most recent data available on educational attainment in the Philippines was only published in 2019 with the Philippines Statistic Authority’s 2019 Functional Literacy, Education, and Mass Media Survey (FLEMMS). As such, the scope of our investigation is limited to the medium-run effects of the disaster by the availability of reliable data at the individual and regional level. That said, any potential findings in the medium-term will be both illustrative of the sustainability of any disasters response initiatives introduced in the immediate aftermath of the disaster, and indicative of long-term consequences of the disaster for individuals - as well as the nation at large. This will be an addition to the literature considering, as previously mentioned, we found no previous study that has investigated the case of Typhoon Haiyan, despite it having been among the strongest typhoons to have made landfall in recorded history.

### 4.2 Regional-level Analysis

The Philippines is divided into several types of geographical categories. The 17 regions of the Philippines are the second-highest geographic and administrative category<sup>13</sup>. Our main motivations for opting to have the level of treatment at the regional level were (i) the availability of data<sup>14</sup>, and that (ii) the operational directives of disaster responses and schools are dispersed at the regional level<sup>15</sup>. For these reasons, we consider the use of regional data to be the most accurate and reflective of how any eventual responses to the disaster (i.e. disaster management centers and school emergency policies) may or may not have mitigated the potential impacts of the disaster individuals.

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<sup>13</sup>The categories are (in descending order): island groups, regions, provinces, cities, municipalities, and barangays (a local term for ‘village’).

<sup>14</sup>While the FLEMMS survey notes which region and province each individual belongs to, disaster data at the provincial level is limited in terms of total damages (discussed in section 4.3) and the Typhoon’s exact trajectory.

<sup>15</sup>In response to the disaster, donation desks and the Philippines Disaster Response and Operations Monitory and Information Center (DROMIC) were run at the regional level, and reported mostly as such. Regarding school administration, according to the Philippines Republic Act no. 9155, the responsibilities of establishing schools (primary-highschool, public or private), managing fiscal resources and collecting data on all schools falls upon the regional office. Meanwhile there’s no clear distinction between the roles of cities and provinces, rather they are both assigned the responsibility of school supervision and further resource management.

### 4.3 Contribution and Research Question

Our study contributes to the gap in existing literature by investigating the medium-run impact of natural disasters on human capital attainment. We add to the literature by focusing on different levels of educational attainment, a less explored component of human capital attainment. Moreover, we look at the medium-run effects of the disaster, whereas many other studies focus on the long-run. More generally, by investigating Typhoon Haiyan, the strongest and most disastrous tropical cyclones the Philippines has ever experienced, we hope to emphasize the importance of studying cases of natural disasters in developing nations.

Considering previous literature, especially the findings of Duflo (2001) and Paudel (2018), we hypothesize that Typhoon Haiyan will have had a significant and negative medium-run effect on the educational attainment of individuals in highly impacted regions who were of student-age when the Typhoon struck.

Our research question is:

*What are the direct medium-run effects of Typhoon Haiyan on the educational attainment of individuals in highly impacted regions?*

As such, we test the following null hypothesis:

*H0: Typhoon Haiyan did not have an effect on educational attainment in the Philippines.*

## 5 Data

In this section, first we present how our data was collected. Then, we further present the method and reasoning behind our constructed dependent and independent variables.

### 5.1 Data Collection

We use a nationwide household survey, the 2019 FLEMMS survey, to evaluate the short-term repercussions of Typhoon Haiyan, on educational outcomes in the Philippines. The survey includes individual-level data on age, sex, and highest level of educational attainments. The individuals surveyed were between the ages of 10 and 64 at the time of the survey; as such they would have been between the ages of 4 and 58 at the time of the Typhoon Haiyan in 2013 (six years prior). For our investigation, we limit the data to individuals between the ages of 6 to 31<sup>16</sup>, and after ‘cleaning’ the data (i.e. removing incomplete and erroneous observations), our analysis included 62,738 observations. The levels of education included in

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<sup>16</sup>As we are only investigating the effects on primary to undergraduate education, and Filipinos start their compulsory primary education at age 6, we explain the use of older cohorts as a control group in section 6.2

the data set range from primary to post-graduate degrees, with educational codes for each<sup>17</sup>. The survey also includes household data on urbanity (i.e. urban or rural) and the number of household members. For data on the direct impact of the typhoon, we used the ‘Final report [regarding the] effects of Typhoon “Yolanda” (Haiyan)’ from the Philippines’ National Disaster Risk Reduction and Management Council (NDRRMC<sup>18</sup>). The “effects” covered by the report include figures regarding affected persons<sup>19</sup>, casualties, damaged households, and costs of damages across 9 regions<sup>20</sup>.

### 5.1.1 Constructed Variables

**Educational Attainment:** We recode the data for educational attainment, i.e. we use educational codes to derive a *edu\_years* variable to capture how many years of education an individual has undergone, as well as a cumulative binary variable for primary, junior high, senior secondary/diploma<sup>21</sup> studies, and undergraduate studies<sup>22</sup>. As such, for an individual whose highest level of education is, for example, upper secondary; the binary variables for primary, lower and upper secondary would all be equal to 1, while those for diploma and undergraduate studies would be equal to 0. We opted to include these binary variables, in addition to *edu\_years*, as the continuous variable can be difficult to interpret (especially since we assume that diploma and undergraduate studies are attained during similar ages, 18-22), and in order to better analyze whether or not the potential impact of exposure to the typhoon has varying effects at different stages in one’s education.

**Cohorts:** We create the variable *age\_2013*, based on the original data set Age variable, to reflect how old the surveyed individuals would have been in 2013. This was done simply by subtracting 6 years from their age in 2019<sup>23</sup>. Following guidelines from the Southeast Ministers of Education Organization on the Philippines’ K-12 system<sup>24</sup>, we then proceeded to create four binary cohort variables for each category of educational attainment; as well as two older cohorts, Cohort A being those aged 22-26 years and Cohort B being those between the ages 27-31. As explained in Section 6.2, these two older cohorts are used as relevant

<sup>17</sup>In the dictionary for the 2019 FLEMMS dataset there were 3,102 codes (1-5 digits in length) that represent grade levels (from Grade 1 to Grade 12, meaning primary to upper secondary school) and specific degrees (e.g. a Bachelor of Arts in Biology has the code 60511)

<sup>18</sup>The NDRRMC had published updates as early as April of 2014, but the final report that we use was published in December 2015. The authors of the final report mention the difficulty of collecting accurate post-disaster data, but emphasize their use of several sources (including the National Statistics Authority) and field visits, as well as expert opinions in cases of missing data; as such, we consider them a highly reliable source.

<sup>19</sup>The term ‘affected persons’ is not explicitly defined but we have taken it to be a holistic term for those who were for instance, injured, had their homes damaged and were forced to temporarily evacuate.

<sup>20</sup>While the degree of impact clearly varies between these 9 regions, we take the exclusion of the Philippines’ 8 other regions to suggest that those excluded were not considered impacted enough to necessitate reporting. See Section 5.1.2 for why we later only consider 5 regions highly impacted in our empirical methodology.

<sup>21</sup>These studies include specialized tracks, certificates, diplomas and associate degrees. See Appendix E

<sup>22</sup>Given that less than one hundred doctorates are awarded annually in the Philippines and that only 0.5% of our observations had attained a doctorate - we opted to limit the investigation to people that have obtained up to a Bachelor degree.

<sup>23</sup>The dataset does not provide individuals’ exact birth dates, so we cannot not derive how old exactly each person would have been at the time of the typhoon in November, 2013.

<sup>24</sup>See Appendix E

control groups.

***Affected Regions:*** As mentioned in Section 2.1, the intensity of a typhoon is generally measured by looking at sustained windspeed per minute. That said, while there are several maps plotting the trajectory of the Typhoon and ranges for sustained windspeed as it passed over the Philippines between November 6th and 11th, we find none to be wholly indicative of the *impact* Typhoon Haiyan had on each region<sup>25</sup>. As such, using data on damages (in combination with these aforementioned mappings) provides a more nuanced overview of how Typhoon Haiyan affected the different regions, and allows us to derive which regions were ‘highly’ (i.e. significantly) impacted by it.

### 5.1.2 Determining the affected regions

The aforementioned NDRRMC final report reports disaster data for 9 regions, namely Regions IV-A, IV-B, V, VI, VII, VIII, X, XI and CARAGA. By looking at these reported damages in proportion to each region’s population in 2013 and GDP, we determine that of these 9 regions, 5 were more significantly affected than the others, namely Regions IV-B, V, VI, VII, VIII, and thus we only consider them as *Affected* regions in our analysis (*Affected* = 1). Our reasoning behind this is as follows:

***Affected persons as a percentage of regional 2013 populations:*** Population censuses in the Philippines are only conducted every 5 years. We use data from the 2015 census by the Philippines Statistics Authority (PSA), using the average growth rate of the population from 2010 to 2015 (estimated by the PSA) and the regional populations in 2010 to estimate the 2013 population (see Appendix F). We calculate the number of ‘affected persons’ reported by the NDRRMC as a percentage of our regional 2013 population estimates. Only 5 of the 9 regions have more than 10% of its population affected, the next highest proportion being 2.8%. We consider having one in ten persons directly affected by a disaster both significant and consequential for a region.

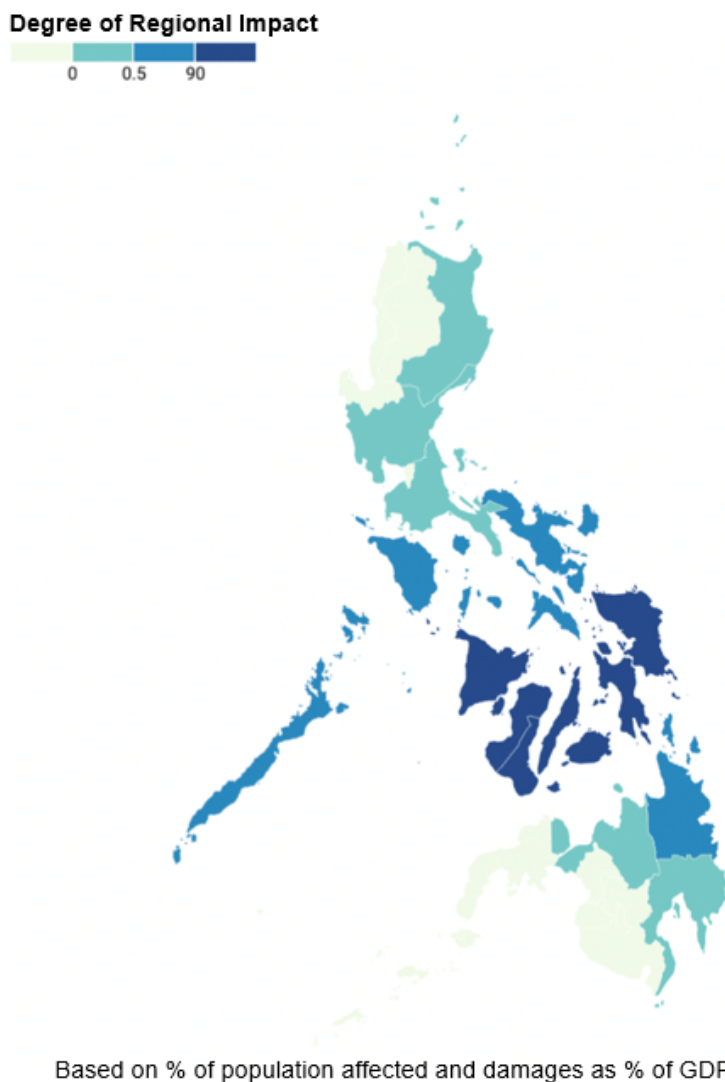
***Infrastructure damage as a percentage of GDP:*** The NDRRMC report includes various accounts on the costs of damages. These include the costs of damages of different types (i.e. to infrastructure, the social sector, or agricultural sector), as well as to regions within and beyond the so-called Post Disaster Needs Assessment (PDNA)<sup>26</sup>. We opt to focus

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<sup>25</sup>Additionally, we had attempted to source weather data from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and use it in combination with the latitude and longitude as coordinates of regional centers to get a more accurate measure of how exposed each region had been to the typhoon. However, this proved to be difficult as nearest weather stations to certain regional centers had evidently been entirely destroyed, and the measure for wind speed was only a 3-hour average. Furthermore, as explained in our literature review, an international standard for measuring the impact of a disaster is yet to have been agreed upon.

<sup>26</sup>The PDNA is a World Bank Methodology for assessing post-disaster damages. In this case the scope of the PDNA is limited to being within a 50-km radius of the typhoon as identified by the Department of Science and Technology (DOST) at the time of the disaster, and thus those outside said radius were not response priorities. We decide to also include reported damages to infrastructure in provinces outside the PDNA, as we do not want to overlook impacts to a region based on purely a geographical boundary established in a state of urgency - before the extent of the disaster was fully known (recall that the final report was finalized in 2015).

Figure 1: Map of Affected Regions



on infrastructure damages as it includes damages to transport (i.e. roads and bridges), water supply systems, school buildings, health facilities, government buildings, etc. - all of which would have had a *direct* impact on the regions' functionality. Meanwhile, it is unclear in the report whether the described damages to 'schools' in the social sector damages overlapped with the infrastructure damages; and we do not consider agricultural sector damages (i.e. mining and trade, agriculture, etc) as having a direct impact on education. Then, considering how regions vary in their economic development, we calculate these damages to infrastructure as a percentage of regional GDP<sup>27</sup>. The range of Total Infrastructure Damage as a percentage of Regional GDP rose from 0.01 to 2.19 percent.

<sup>27</sup>We sourced 2012 GDP figures from a PSA 2014 Regional GDP report. We did this considering that 2013 GDP figures would have included these damages and losses and it was a practice of comparing the degree of damage across regions, not only measuring it. Infrastructure damage as a percentage of (regional) GDP is a common practice in World Bank reports on disasters.

Ultimately, considering the trajectory of the Typhoon, the affected population as a percentage of regional populations, and total damages as a percentage of GDP, we decided to only recognize **Regions IV-B, V, VI, VII and VIII as Affected regions** (i.e. *Affected* = 1) in our analysis. By restricting our treatment group to only significantly impacted regions we emphasize the exceptionally disastrous nature of Typhoon Haiyan, and can attribute any potential effects on education in these regions to them being struck by the typhoon.

## 5.2 Summary Statistics

Table 1: Summary Statistics

| Cohort:          | PRIMARY |       | JUNIOR |       | SENIOR |       | COLLEGE |       | CONTROL <sub>A</sub> |       | CONTROL <sub>B</sub> |       |
|------------------|---------|-------|--------|-------|--------|-------|---------|-------|----------------------|-------|----------------------|-------|
| Affected:        | (✓)     | (X)   | (✓)    | (X)   | (✓)    | (X)   | (✓)     | (X)   | (✓)                  | (X)   | (✓)                  | (X)   |
| <i>Variables</i> |         |       |        |       |        |       |         |       |                      |       |                      |       |
| Female:          | 0.484   | 0.492 | 0.473  | 0.486 | 0.497  | 0.492 | 0.515   | 0.508 | 0.501                | 0.497 | 0.510                | 0.501 |
| Urban:           | 0.290   | 0.506 | 0.338  | 0.558 | 0.416  | 0.596 | 0.396   | 0.576 | 0.382                | 0.578 | 0.346                | 0.556 |
| Age:             | 8.49    | 8.47  | 13.40  | 13.42 | 16.48  | 16.47 | 19.48   | 19.48 | 23.95                | 23.98 | 29.00                | 29.00 |
| Household size:  | -       | -     | -      | -     | -      | -     | -       | -     | -                    | -     | -                    | -     |
| edu_years:       | 7.65    | 7.48  | 10.91  | 10.80 | 11.60  | 11.79 | 11.09   | 11.17 | 10.56                | 10.55 | 10.34                | 10.32 |
| Primary:         | 0.997   | 0.994 | 0.995  | 0.991 | 0.989  | 0.989 | 0.993   | 0.986 | 0.991                | 0.983 | 0.987                | 0.977 |
| Junior:          | -       | -     | 0.919  | 0.901 | 0.878  | 0.890 | 0.858   | 0.855 | 0.813                | 0.824 | 0.784                | 0.799 |
| Senior/Diploma:  | -       | -     | 0.612  | 0.580 | 0.518  | 0.546 | 0.424   | 0.449 | 0.373                | 0.374 | 0.348                | 0.357 |
| Bachelor:        | -       | -     | -      | -     | 0.443  | 0.453 | 0.363   | 0.382 | 0.300                | 0.299 | 0.291                | 0.296 |

*Source: PSA 2019 FLEMMS Survey*

Table 1 exhibits the means of the outcome and control variables in affected and unaffected regions, for each cohort. These variables include regional demographic characteristics, including the proportion of females, proportion of urban dwellers, average age, and average household size, as well as average years of education (*edu\_years*), and the proportion of the cohorts that have completed different levels of education <sup>28</sup>.

Firstly, we see some common trends across affected and unaffected regions. Both exhibit balanced proportions in gender across all the cohorts, both of student-age (i.e. primary to college) and older (Control\_A and Control\_B). Unsurprisingly<sup>29</sup>, we also see near 100% rates of primary school completion across all cohorts<sup>30</sup>. Next, we observe that a notably larger share of the population live in urban areas in unaffected regions compared to affected regions.

Considering that the average years of education is wholly independent of the Typhoon for the older cohorts, namely cohorts Control\_A and Control\_B, we do not see a notable

<sup>28</sup>We do not include the proportion of primary-aged children in 2013 who had completed junior education by 2019, as the majority of the cohort would not have been of age to have finished junior highschool. The same reasoning applied to college education for the junior cohort.

<sup>29</sup>Recall that primary school education is mandatory in the Philippines.

<sup>30</sup>The slightly lower completion rates in the older cohorts are to be expected as educational attainment tends to improve over generations.

difference in average years of education between individuals in affected and unaffected regions. We then observe a near 1% higher rate of primary school completion in affected regions for both older cohorts. Next, we see that unaffected regions have 1% and 1.4% higher rate of junior highschool completion for both older cohorts. Rates of senior/diploma and college-level studies are similar in both.

For those of student-age at the time of the Typhoon, the average years of education attained is also very similar in affected and unaffected regions. We only see slight differences in that for the senior and college cohorts, unaffected regions have slightly higher years of education - a 0.19 and 0.08 difference, respectively-, whereas the opposite is true those in the primary and junior cohorts - 0.17 and 0.11 more years in affected regions in the primary and junior cohorts, respectively. These differences are extremely small, however. More notably, nearly 2% more of the junior-aged students in affected regions have a junior highschool education. Meanwhile, 3% more of senior-aged and 2% more of college-aged students in unaffected regions have a senior highschool/diploma. Similarly, 1% more of senior students appear to have go on to complete a college-level (or equivalent) education in unaffected regions compared to affected regions. Also, 2% more of college-aged students completed their college-level education in unaffected regions compared to affected regions. We test the significance of these differences later on and see if it could be the case that higher, non-compulsory education was impacted more by the Typhoon than compulsory education (which may not have been impacted at all).

Finally, we also note that with regards to years of education, the additional year exhibited by the senior highschool and college cohorts (i.e. those between the ages of 16 to 21 years), compared to older cohorts, is likely to be reflective of the K-12 system's mandatory senior education requirement (see Appendix D). The sizeable increases in the number of students who complete a college-level or equivalent education is also interesting, but we suspect that this is most likely due to the expansion of the Philippines' education system to encourage more students to pursue higher degrees, and that the K-12 system's requirement of senior highschool subsequently encourages (and enables) more students to pursue higher education.

### 5.3 Limitations of Data

The data we use are subject to certain limitations. Firstly, to examine educational outcomes we use data demonstrating an individual's highest-level of educational attainment. This does not reflect how the effectiveness of schooling is impacted after the disaster; for example through impact on test scores (like Andrabi et al. did in their investigation of post-earthquake outcomes in Pakistan). With that, the FLEMMS survey that we use is only conducted every 5 or so years. In combination with a measure of the effectiveness of schools, one might have wanted to study the recovery time of educational institutions and students' performance

post-disaster over more time intervals.

This introduces a second limitation. Even if the FLEMMS survey were conducted more frequently, the data would still most likely be annualized as it is a nationwide survey. Meanwhile, the response to disasters, especially one as destructive as Typhoon Haiyan, is immediate with both domestic and international operations rallying to get essential infrastructure ‘up and running’ as quickly as possible after a disaster strikes. We consider these positive short-run interventions and their implications of our study in the discussion of our results later on. We see our study as a useful benchmark for recognizing whether or not students impacted by a single major disaster are more or less likely to complete and progress in their education in the medium-run.

Third, the individual-level data provided by the FLEMMS survey is quite limited in scope, and the data is randomized and anonymized with no unique identifiers that match to other surveys taken by the PSA in 2019 or otherwise. As such, we cannot include other variables regarding personal health and family background, which could potentially influence an individual’s educational attainment. That said, we are confident that the controls we include in our specification account for any potential omitted variable biases.

## 6 Empirical Methodology

### 6.1 Difference-in-Differences

Motivated by Paudel and Ryu (2018), we employ a difference-in-difference (DID) model as an empirical strategy to examine the medium-run effects on educational outcomes of students who were between the ages of 6 and 21 when Typhoon Haiyan struck the Philippines in 2013. We opted for a DID specification, as it allows for the effect of the shock to vary depending on how old an individual was at the time of the disaster. We compare the educational outcomes of students in regions highly impacted by the Typhoon (hereafter ‘affected’ regions) to those of students in less impacted regions (hereafter, ‘unaffected’ regions), and treat those between the ages of 22 and 31 years, who we implicitly assume would have already completed their education at the time of the Typhoon - from either affected or unaffected regions -, as a relevant control group.

To estimate the impact of Typhoon Haiyan on education, we use the following specification:

$$Y_{ijt} = \beta_1 Affected_j * Cohort_{it} + \beta_2 Affected_j + \beta_3 Cohort_{it} + \delta_t + \gamma_p + X_{ijt} + \epsilon_{ijt}$$

$Y_{ijt}$ , our dependent variable, denotes the educational attainment of an individual  $i$  living in region  $j$  belonging to cohort  $t$ , it is binary and includes all four educational outcomes (i.e.

Primary, Junior High, Senior/Diploma and College level studies);  $Affected_j$  is an indicator variable that takes a value of 1 for an individual belonging to an affected region and 0 otherwise;  $Cohort_{it}$  is an indicator variable that takes a value of 1 for the cohort belonging to a given level of education (e.g.  $prim\_CH = 1$  for those born between the ages of 6 and 11), and 0 otherwise, and it includes all four cohorts relevant to educational outcomes as well as the two older cohorts;  $\delta_t$  captures birth year fixed effects;  $\gamma_j$  captures region fixed effects;  $X$  is a vector of control variables that include controls for urbanity, gender, and the number of household members; and  $\epsilon_{ijt}$  is a random, idiosyncratic error term.

## 6.2 Identification Strategy

In our study, an individual’s age and the region to which they belong jointly determine an individual’s exposure to the disaster. Thus, a key assumption for our study is that observed differences in educational outcomes across different cohorts should be similar across the two types of regions in our analysis<sup>31</sup>, those highly affected and those unaffected. One testable implication of this assumption is that trends do not differ for cohorts that were too old to have been directly affected in their human capital accumulation at the time of the disaster. This strategy is similar to Duflo (2001) where an interaction term analysis in the investigation of the effects of school construction in Indonesia on educational outcomes. As we shall see in Section 8 Table 2, the coefficient on the interaction terms the control cohort (Affected\*Cohort\_A) it is in fact near-zero in absolute magnitude and statistically insignificant for all specifications.

## 6.3 Treatment and Control groups

Just as Paudel and Ryu (2018) and Caruso and Miller (2015), we take advantage of two control groups across space and time. The first being a cohort of students in either affected or unaffected regions who were between the ages of 6 to 21 in 2013; the second being a cohort of individuals aged between 22 to 31 in either affected or unaffected regions. The second older group would have been old enough to have completed schooling at the time of the typhoon, and thus their educational attainment would be unaffected.

## 6.4 Controls

Using the data available in our dataset, we attempt to enhance the internal validity of our model by including controls for an individual’s gender, urbanity and number of members in their household, as well as province and birth year fixed effects.

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<sup>31</sup>See Appendix H; We also plotted the average rates of completion for every level of education, by birth year, and generally observe parallel trends. However, clear shocks to certain birth years weaken the appearance of parallel trends somewhat, and thus we are more confident in the proven and applicable logic of Duflo’s approach.

**Gender:** As discussed in the literature review, educational outcomes tend to differ between men and women. Societal and economic factors create disparities between men and women in their willingness and ability to complete different levels of education. Gender roles like patriarchal expectations for men to be bread-winners and for women to be primary caretakers within families, lead to men choosing to work after high school instead of pursuing higher education (recall the opportunity cost discussion) and women dropping out of school for marriage<sup>32</sup>. By controlling for gender, we aim to isolate the impact of the Typhoon on educational attainment.

**Urbanity:** Urban areas tend to be more socioeconomically developed, with more resources, higher quality of education, and better infrastructure in general. These tend to present more favorable conditions for students in urban areas to attend school (e.g. better public transport), and arguably even more incentive to do so<sup>33</sup>. Notably, in relation to the previous point on gender, the 2013 Philippines Demographic and Health Survey found that women in urban areas married a year and a half later than their rural counterparts, and also had children two years later.

**Size of Household:** The size of a household is a useful indicator of a household's socioeconomic status. It is less likely to have been impacted by the Typhoon than other measures of socioeconomic status such as household income, occupational status or housing quality/material. It also avoids the issue of endogeneity had we not included this control, given that wealthier individuals and families are likely better equipped to mitigate the impact of a typhoon on their children's education.

**Province and Birth Year Fixed Effects:** Time-invariant provincial characteristics such as geography (i.e. coastal or landlocked) and culture<sup>34</sup> could influence how individuals' education had been impacted by previous disasters and generally. Different resource allocations across provinces could also have influenced education. Therefore, we include province fixed effects to account for these unobserved differences. Similarly, including birth year fixed effects allows us to control for unobserved differences across cohorts from external factors like economic downturns and educational policy changes.

Controlling for these confounding variables we mitigate the risk of omitted variable bias, and are confident that our results more accurately reflect the impact of Typhoon Haiyan on student's educational attainment outcomes.

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<sup>32</sup>According to a 2013 Philippines Demographic and Health Survey report, 1 in 3 women in the Philippines were married by age 20, and half of women had their first child by 24. These findings would suggest that when they're of age to pursue higher education (i.e. an undergraduate degree), they're also at the age of starting families. Presenting a choice between the two.

<sup>33</sup>High-skilled work opportunities in urban areas may require certain degrees and/or accreditation. Meanwhile, rural areas dependent on more physical labor, such as in the agricultural or manufacturing industries, often do not.

<sup>34</sup>There are over 10 ethnic groups in the Philippines.

## 7 Results

In this section, we display the results of our core regression. Then, we investigate the potentially heterogeneous impact of the typhoon on various socioeconomic groups, running the regression separately by gender, urbanity, and household size. We discuss the implications of all these results extensively in Section 8.

### 7.1 Effects on Educational Attainment

Table 2 summarizes the results for the post-disaster medium-run. Our main coefficient of interest,  $\beta_1 \text{Affected}^*(\text{Cohort}^{35})$  is statistically insignificant (at the 1- and 5-percent levels) for years of education and each cohort's relevant level of education (i.e. the level of education they would have been partaking in at the time of the Typhoon). As such, we cannot reject our null hypothesis that Typhoon Haiyan (2013) did not have an effect on educational attainment in the Philippines in the medium-run. This aligns with findings of Andrabi *et. al* (2021) who also found no decline in school enrollment in earthquake affected areas four years after the 2005 Kashmir earthquake. We also see that in the Philippines as a whole, being in an urban area and female, are associated with higher rates of educational attainment for each level of education, while the opposite is true for household size - we explore this further in the next section.

We note here that the  $R^2$  value for 'PRIMARY' education specification of our model is exceptionally low compared to those for years of education, junior, senior and college level education, suggesting the explanatory power of our model is weak when examining any differences in educational attainment outcomes for those who were of primary school age in 2013 between affected and unaffected regions (this holds true for our general specification, as well as all of our results when we look at heterogeneous impacts of the typhoon). We take this to suggest that other factors influencing primary education, such as parental influences<sup>36</sup> and health (i.e. in-utero and the first 1000 days of life, as explored in other studies), which we do not account for, are likely more important than being exposed to the disaster in determining primary education outcomes.

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<sup>35</sup>Note: prim.CH = primary cohort (ages 6-11), jun.CH = junior cohort (ages 12-15), sen.CH = senior (ages 16-17), coll.CH = college (ages 18-21); and recall that the 'Diploma' level of education includes senior highschool, short-tertiary and vocational diploma degrees.

<sup>36</sup>We note here that while our dataset did have household data, a sizeable chunk of these households did not have complete observations for every member of the house, making it difficult to discern parental education as a variable.

Table 2: Impact of Typhoon Haiyan on Educational Attainment

| Dependent Variables:<br>Model: | edu_years<br>(1)       | PRIMARY<br>(2)        | JUNIOR<br>(3)          | DIPLOMA<br>(4)         | COLLEGE<br>(5)        |
|--------------------------------|------------------------|-----------------------|------------------------|------------------------|-----------------------|
| <i>Variables</i>               |                        |                       |                        |                        |                       |
| urban                          | 0.8497***<br>(0.0872)  | 0.0093**<br>(0.0037)  | 0.0630***<br>(0.0077)  | 0.0867***<br>(0.0085)  | 0.0759***<br>(0.0073) |
| female                         | 0.8452***<br>(0.0378)  | 0.0048***<br>(0.0010) | 0.0755***<br>(0.0042)  | 0.0713***<br>(0.0042)  | 0.0639***<br>(0.0037) |
| h_members                      | -0.0501***<br>(0.0106) | 0.0002<br>(0.0003)    | -0.0053***<br>(0.0008) | -0.0043***<br>(0.0013) | -0.0035**<br>(0.0013) |
| Affected $\times$ prim.CH      | 0.0836<br>(0.2357)     | -0.0055<br>(0.0070)   | 0.0464*<br>(0.0244)    | -0.0018<br>(0.0204)    | 0.0017<br>(0.0174)    |
| Affected $\times$ jun.CH       | 0.1200<br>(0.1927)     | -0.0059<br>(0.0058)   | 0.0351<br>(0.0219)     | 0.0396*<br>(0.0223)    | -0.0006<br>(0.0173)   |
| Affected $\times$ sen.CH       | -0.1820<br>(0.1810)    | -0.0100<br>(0.0065)   | 0.0072<br>(0.0170)     | -0.0162<br>(0.0229)    | -0.0036<br>(0.0235)   |
| Affected $\times$ coll.CH      | -0.0786<br>(0.1448)    | -0.0025<br>(0.0056)   | 0.0219<br>(0.0168)     | -0.0146<br>(0.0152)    | -0.0138<br>(0.0141)   |
| Affected $\times$ control_A    | -0.0023<br>(0.1103)    | -0.0013<br>(0.0046)   | 0.0053<br>(0.0130)     | 0.0072<br>(0.0135)     | 0.0055<br>(0.0121)    |
| <i>Fixed-effects</i>           |                        |                       |                        |                        |                       |
| province                       | Yes                    | Yes                   | Yes                    | Yes                    | Yes                   |
| birthy                         | Yes                    | Yes                   | Yes                    | Yes                    | Yes                   |
| <i>Fit statistics</i>          |                        |                       |                        |                        |                       |
| Observations                   | 62,738                 | 62,738                | 62,738                 | 62,738                 | 62,738                |
| R <sup>2</sup>                 | 0.30229                | 0.06471               | 0.29726                | 0.23754                | 0.20194               |
| Within R <sup>2</sup>          | 0.02904                | 0.00189               | 0.01870                | 0.01415                | 0.01345               |

*Clustered (province) standard-errors in parentheses*

*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*

*Source: PSA 2019 FLEMMS Survey*

## 7.2 Heterogeneous Impact of the Typhoon

While we find no evidence that the Typhoon has significant impact on educational attainment for different cohorts overall, it is plausible that different socioeconomic groups were impacted differently- as similar studies on natural disasters and education (e.g. Paudel *et. al* 2018) have found - and that our core regression might overshadow these differences. Hence, motivated by previous literature, we investigate any potential differential impacts of the Typhoon, using gender, urbanity and household size as proxies of inherent socioeconomic inequalities in the Philippines. This presents three other hypotheses that we test:

*H1:* Within regions affected by Typhoon Haiyan, female students were more impacted than male students.

*H2:* Within regions affected by Typhoon Haiyan, students in rural areas were more impacted than students in urban areas.

*H3:* Within regions affected by Typhoon Haiyan, students in larger households were more impacted than students belonging to medium and small households.

### 7.2.1 Results by Gender

On the following page, Table 3 presents the results of our core regression when it is run separately for men and women. We find suggestive evidence that women in affected areas between the ages of 18 to 21 (coll.CH) were, on average, 4.3 percentage points less likely to complete college-level education, noting that the average rate of women belonging to this cohort in the Philippines with a college-level degree is 42%<sup>37</sup>. For men of this age group, the average rate of college-level attainment was 31.1%, and our results suggest that the men in affected regions were 2.4 percentage points more likely to complete college-level education. We take notice of the negative and significant impact on the diploma-level attainment of women in the same cohort, and this is not completely unsurprising considering, as previously explained, that this category of education also includes short-cycle non-tertiary education of various lengths that many between the ages of 18 to 21 might also pursue<sup>38</sup>. Still, we cannot be certain of the scale of the impact. That said, we also observe a negative impact on the average years of education of women in affected regions belonging to the same cohort. The results suggest that women of this cohort in affected areas have completed, on average, 0.38 years less years of education.

When we run the three-way interaction of *Affected\*coll.CH\*Female*, we confirm that the difference in educational attainment at these levels for women and men (between the ages of 18 to 21) in affected areas is negative and significant, for both college-level education and

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<sup>37</sup>Based on our calculations using our dataset.

<sup>38</sup>We apply similar logic to the junior highschool educational attainment for men and women who were of primary age at the time, such that we note the significant result - where male students appear more likely than women to have completed junior high, but hesitant from considering it conclusive as not all of primary age in 2013 would have completed junior high in 2019.

years of education.

Hence, our results strongly suggest that, within affected regions, women in higher education were more adversely affected by the Typhoon than men. As such, we cannot reject *H1* with regards to diploma- and college-levels of educational attainment. This aligns with findings by Paudel and Ryu's (2018) study, which found that the negative effect of the 1988 earthquake in Nepal was more pronounced among females than among males (albeit for elementary and highschool education).

Table 3: Impact of Typhoon Haiyan on Educational Attainment, by Gender

| Dependent Variables:<br>Model: | edu_years              |                        | PRIMARY               |                      | JUNIOR                 |                        | DIPLOMA               |                        | COLLEGE               |                        |
|--------------------------------|------------------------|------------------------|-----------------------|----------------------|------------------------|------------------------|-----------------------|------------------------|-----------------------|------------------------|
|                                | Female                 | Male                   | Female                | Male                 | Female                 | Male                   | Female                | Male                   | Female                | Male                   |
| <i>Variables</i>               |                        |                        |                       |                      |                        |                        |                       |                        |                       |                        |
| urban                          | 0.7549***<br>(0.0855)  | 0.9375***<br>(0.0997)  | 0.0076**<br>(0.0032)  | 0.0109**<br>(0.0046) | 0.0458***<br>(0.0067)  | 0.0802***<br>(0.0098)  | 0.0843***<br>(0.0099) | 0.0881***<br>(0.0088)  | 0.0774***<br>(0.0081) | 0.0734***<br>(0.0080)  |
| h_members                      | -0.0355***<br>(0.0119) | -0.0640***<br>(0.0124) | 0.0002<br>(0.0004)    | 0.0001<br>(0.0003)   | -0.0032***<br>(0.0009) | -0.0072***<br>(0.0012) | -0.0026<br>(0.0016)   | -0.0059***<br>(0.0015) | -0.0016<br>(0.0017)   | -0.0052***<br>(0.0016) |
| Affected × prim.CH             | -0.1423<br>(0.2391)    | 0.3300<br>(0.2702)     | -0.0138*<br>(0.0075)  | 0.0031<br>(0.0078)   | 0.0318<br>(0.0244)     | 0.0623**<br>(0.0283)   | -0.0177<br>(0.0264)   | 0.0152<br>(0.0213)     | -0.0101<br>(0.0215)   | 0.0157<br>(0.0202)     |
| Affected × jun.CH              | -0.0216<br>(0.2090)    | 0.2901<br>(0.2363)     | -0.0128**<br>(0.0059) | 0.0012<br>(0.0073)   | 0.0250<br>(0.0207)     | 0.0455*<br>(0.0269)    | 0.0474<br>(0.0305)    | 0.0368<br>(0.0231)     | -0.0093<br>(0.0243)   | 0.0116<br>(0.0204)     |
| Affected × sen.CH              | -0.0825<br>(0.2250)    | -0.2497<br>(0.2253)    | -0.0128<br>(0.0077)   | -0.0067<br>(0.0094)  | 0.0105<br>(0.0203)     | 0.0057<br>(0.0265)     | 0.0105<br>(0.0310)    | -0.0198<br>(0.0308)    | 0.0044<br>(0.0314)    | -0.0085<br>(0.0301)    |
| Affected × coll.CH             | -0.3782**<br>(0.1743)  | 0.2337<br>(0.1812)     | -0.0090<br>(0.0059)   | 0.0041<br>(0.0069)   | 0.0078<br>(0.0189)     | 0.0368*<br>(0.0218)    | -0.0502**<br>(0.0245) | 0.0236<br>(0.0173)     | -0.0429**<br>(0.0209) | 0.0168<br>(0.0184)     |
| Affected × control_A           | -0.0860<br>(0.1799)    | 0.0952<br>(0.1319)     | -0.0132**<br>(0.0054) | 0.0106*<br>(0.0056)  | -0.0037<br>(0.0169)    | 0.0139<br>(0.0181)     | 0.0079<br>(0.0245)    | 0.0088<br>(0.0148)     | 0.0108<br>(0.0202)    | 0.0022<br>(0.0151)     |
| <i>Fixed-effects</i>           |                        |                        |                       |                      |                        |                        |                       |                        |                       |                        |
| province                       | Yes                    | Yes                    | Yes                   | Yes                  | Yes                    | Yes                    | Yes                   | Yes                    | Yes                   | Yes                    |
| birthy                         | Yes                    | Yes                    | Yes                   | Yes                  | Yes                    | Yes                    | Yes                   | Yes                    | Yes                   | Yes                    |
| <i>Fit statistics</i>          |                        |                        |                       |                      |                        |                        |                       |                        |                       |                        |
| Observations                   | 31,023                 | 31,715                 | 31,023                | 31,715               | 31,023                 | 31,715                 | 31,023                | 31,715                 | 31,023                | 31,715                 |
| R <sup>2</sup>                 | 0.33253                | 0.26544                | 0.07438               | 0.06232              | 0.33441                | 0.26509                | 0.26464               | 0.20996                | 0.22626               | 0.17511                |
| Within R <sup>2</sup>          | 0.00943                | 0.01357                | 0.00160               | 0.00163              | 0.00405                | 0.00883                | 0.00668               | 0.00741                | 0.00589               | 0.00676                |

Clustered (province) standard-errors in parentheses

Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1

Source: PSA 2019 FLEMMS Survey

### 7.2.2 Results by Urbanity

On the following page, Table 4 presents the results of our core regression when it is run separately for urban and rural areas.

Nationwide, children between the ages of 6 to 11 in urban areas complete an average of 7.63 years of education, and same-aged children in rural areas complete an average of 7.46 years of education. We find suggestive evidence that in affected rural areas children between the ages of 6 to 11 in affected regions residing in rural areas completed, on average, approximately 0.54 less years of education. Meanwhile, children in affected regions residing in urban areas showed no sizeable change in their years of education, on average. We verify this finding with a three-way interaction of *Affected\*prim\_CH\*urban* (see Appendix G) that shows a significant negative difference in affected regions between children of primary age residing in urban areas and those in rural areas. With that, we recall from our summary statistics that children in affected regions who between the ages of 6 to 11 in 2013 generally completed more years of education than those in unaffected. Our findings thus suggest that within affected areas, the typhoon impacted rural children's education more than that of children in urban areas. This closely echoes the findings of Agamile and Lawson's (2021) study in Uganda; as discussed, they found that the negative impact of rainfall shocks was significantly more pronounced for children in urban areas and in primary schools. Thus, we fail to reject  $H2$  for children between the ages of 6-11.

Again, we note the significant result on junior highschool education for the primary cohort in affected regions, but are hesitant to consider it conclusive as not all those of primary age would have completed junior highschool by 2019. Similarly, when we ran a three-way interaction between *Affected\*sen\_CH\*urban*, we did not find the coefficient on said term to be statistically significant (see Appendix G), and thus cannot confirm that there was indeed a statistically significant difference between 16 to 17-year-old students in urban and rural areas and the years of education they have attained<sup>39</sup>.

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<sup>39</sup>Running the three same three-way interaction, with PRIMARY(=1) as the dependent variable, the result was also insignificant.

Table 4: Impact of Typhoon Haiyan on Educational Attainment, by Urbanity

| Dependent Variables:<br>Model: | edu_years              |                       | PRIMARY                              |                       | JUNIOR                 |                       | DIPLOMA                |                       | COLLEGE                |                       |
|--------------------------------|------------------------|-----------------------|--------------------------------------|-----------------------|------------------------|-----------------------|------------------------|-----------------------|------------------------|-----------------------|
|                                | Urban                  | Rural                 | Urban                                | Rural                 | Urban                  | Rural                 | Urban                  | Rural                 | Urban                  | Rural                 |
| <i>Variables</i>               |                        |                       |                                      |                       |                        |                       |                        |                       |                        |                       |
| female                         | 0.6441***<br>(0.0447)  | 1.040***<br>(0.0437)  | 0.0023**<br>(0.0009)                 | 0.0074***<br>(0.0018) | 0.0517***<br>(0.0039)  | 0.0986***<br>(0.0052) | 0.0575***<br>(0.0060)  | 0.0846***<br>(0.0050) | 0.0565***<br>(0.0050)  | 0.0706***<br>(0.0048) |
| h_members                      | -0.0910***<br>(0.0131) | -0.0011<br>(0.0137)   | -1.58 × 10 <sup>-5</sup><br>(0.0002) | 0.0004<br>(0.0005)    | -0.0072***<br>(0.0010) | -0.0029**<br>(0.0013) | -0.0086***<br>(0.0017) | 0.0007<br>(0.0017)    | -0.0081***<br>(0.0020) | 0.0020<br>(0.0014)    |
| Affected × prim.CH             | 0.0192<br>(0.1452)     | -0.5405**<br>(0.2674) | 0.0011<br>(0.0035)                   | -0.0186<br>(0.0124)   | 0.0441**<br>(0.0182)   | -0.0072<br>(0.0247)   | -0.0122<br>(0.0213)    | -0.0487**<br>(0.0239) | -0.0152<br>(0.0189)    | -0.0369*<br>(0.0202)  |
| Affected × jun.CH              | -0.1203<br>(0.1225)    | -0.2043<br>(0.2075)   | -0.0009<br>(0.0030)                  | -0.0163<br>(0.0098)   | 0.0121<br>(0.0150)     | 0.0053<br>(0.0237)    | -0.0191<br>(0.0216)    | 0.0454*<br>(0.0260)   | -0.0268<br>(0.0196)    | -0.0144<br>(0.0212)   |
| Affected × sen.CH              | -0.2035<br>(0.1570)    | -0.5176**<br>(0.2557) | -0.0033<br>(0.0074)                  | -0.0212**<br>(0.0103) | 0.0044<br>(0.0131)     | -0.0210<br>(0.0214)   | -0.0340<br>(0.0244)    | -0.0345<br>(0.0306)   | -0.0042<br>(0.0272)    | -0.0282<br>(0.0309)   |
| Affected × coll.CH             | -0.1681<br>(0.1418)    | -0.2259<br>(0.2140)   | 0.0037<br>(0.0030)                   | -0.0126<br>(0.0108)   | 0.0112<br>(0.0162)     | 0.0069<br>(0.0213)    | -0.0257<br>(0.0218)    | -0.0199<br>(0.0214)   | -0.0272<br>(0.0174)    | -0.0146<br>(0.0213)   |
| Affected × control_A           | 0.1510<br>(0.1065)     | -0.1888<br>(0.1936)   | 0.0043<br>(0.0031)                   | -0.0076<br>(0.0083)   | 0.0152<br>(0.0126)     | -0.0097<br>(0.0194)   | 0.0155<br>(0.0147)     | -0.0036<br>(0.0202)   | 0.0070<br>(0.0148)     | 0.0007<br>(0.0186)    |
| <i>Fixed-effects</i>           |                        |                       |                                      |                       |                        |                       |                        |                       |                        |                       |
| province                       | Yes                    | Yes                   | Yes                                  | Yes                   | Yes                    | Yes                   | Yes                    | Yes                   | Yes                    | Yes                   |
| birthy                         | Yes                    | Yes                   | Yes                                  | Yes                   | Yes                    | Yes                   | Yes                    | Yes                   | Yes                    | Yes                   |
| <i>Fit statistics</i>          |                        |                       |                                      |                       |                        |                       |                        |                       |                        |                       |
| Observations                   | 30,795                 | 31,943                | 30,795                               | 31,943                | 30,795                 | 31,943                | 30,795                 | 31,943                | 30,795                 | 31,943                |
| R <sup>2</sup>                 | 0.33492                | 0.26122               | 0.03193                              | 0.08425               | 0.31895                | 0.28071               | 0.23279                | 0.23435               | 0.21267                | 0.17927               |
| Within R <sup>2</sup>          | 0.01574                | 0.02695               | 0.00054                              | 0.00161               | 0.01062                | 0.01790               | 0.00621                | 0.01337               | 0.00691                | 0.01147               |

Clustered (province) standard-errors in parentheses

Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1

Source: PSA 2019 FLEMMS Survey

### 7.2.3 Results by Household Size

On the following pages, Table 5 and 6 present the results of our core regression when it is run separately for urban and rural areas.

Those between the ages of 12 to 15 in 2013 were 18 to 21 in 2019 so, following our logic, the majority of them would have been old enough to have completed at least 2 years of senior/diploma education in 2019. Our results in Table 5 suggest that those in small households were approximately 10.5% more likely to complete this level of education at the 1% significance level. The three-way interaction term *Affected\*jun\_CH\*small\_house* is statistically significant and positive at the 5-percent level, while the coefficients of three-way interactions *Affected\*jun\_CH\*medium\_house* and *Affected\*jun\_CH\*large\_house* are not significant but are indeed negative. We take these results to mean that within affected regions, children between the ages of 12 to 15 that belonged to smaller households were notably more likely to progress to senior education, compared to medium and large households.

For those between the ages of 16 and 17 in affected areas and belonging to large households, we observe that they were approximately 7.8% less likely to complete diploma-level education. When we run three-way interactions on *Affected\*sen\_CH\*large\_house* the coefficient of this interaction is negative and significant at the 5% level, while the coefficient on the term *Affected\*sen\_CH\*medium\_house* is positive and significant at the 5% level and the coefficient of *Affected\*jun\_CH\*large\_house* is not significant, but also positive. Considering this, we find students between the ages of 16 and 17 in affected regions were significantly less likely to complete their senior/diploma-level education if they were part of larger households. Hence, we fail to reject  $H3$  for children between the ages of 12 to 17.

Before moving on to an in-depth discussion of our findings, it is important to consider a caveat to our study. Considering that our specification involves several different interaction variables, the testing of multiple hypotheses simultaneously could inflate the risk of Type I errors, suggesting that our significant finding could be due to ‘chance’. However, we would also highlight the large number of observations in our sample (over 62,000), which should increase the statistical power of our investigation.

Table 5: Impact of Typhoon Haiyan on Educational Attainment, by Household Size - Years of Education and Compulsory Education

| Dependent Variables:        |  | edu_years             |                       |                       | PRIMARY               |                       |                       | JUNIOR                |                       |                       |
|-----------------------------|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Model:                      |  | Small                 | Medium                | Large                 | Small                 | Medium                | Large                 | Small                 | Medium                | Large                 |
| <i>Variables</i>            |  |                       |                       |                       |                       |                       |                       |                       |                       |                       |
| female                      |  | 0.8954***<br>(0.0807) | 0.8078***<br>(0.0448) | 0.8713***<br>(0.0409) | 0.0035**<br>(0.0018)  | 0.0045***<br>(0.0012) | 0.0054***<br>(0.0017) | 0.0664***<br>(0.0073) | 0.0755***<br>(0.0051) | 0.0798***<br>(0.0051) |
| urban                       |  | 1.229***<br>(0.1226)  | 0.8738***<br>(0.1077) | 0.6631***<br>(0.0959) | 0.0095***<br>(0.0046) | 0.0082**<br>(0.0036)  | 0.0105**<br>(0.0042)  | 0.0830***<br>(0.0128) | 0.0668***<br>(0.0087) | 0.0508***<br>(0.0089) |
| Affected $\times$ prim_CH   |  | 0.1726<br>(0.2519)    | 0.0828<br>(0.2487)    | 0.0514<br>(0.3559)    | 0.0082<br>(0.0077)    | -0.0038<br>(0.0053)   | -0.0126<br>(0.0114)   | 0.0229<br>(0.0259)    | 0.0500*<br>(0.0275)   | 0.0563<br>(0.0342)    |
| Affected $\times$ jun_CH    |  | 0.5078*<br>(0.2559)   | -0.1079<br>(0.2414)   | 0.1609<br>(0.3248)    | 0.0066<br>(0.0079)    | -0.0095*<br>(0.0053)  | -0.0086<br>(0.0100)   | 0.0486*<br>(0.0260)   | 0.0326<br>(0.0256)    | 0.0355<br>(0.0311)    |
| Affected $\times$ sen_CH    |  | -0.0717<br>(0.3499)   | 0.4176*<br>(0.2464)   | -0.7273*<br>(0.3825)  | 0.0014<br>(0.0086)    | -0.0104<br>(0.0080)   | -0.0163<br>(0.0120)   | 0.0038<br>(0.0229)    | 0.0424*<br>(0.0231)   | -0.0213<br>(0.0322)   |
| Affected $\times$ coll_CH   |  | -0.0793<br>(0.3463)   | -0.3626<br>(0.2442)   | 0.1283<br>(0.3647)    | 0.0110<br>(0.0067)    | -0.0059<br>(0.0059)   | -0.0068<br>(0.0109)   | 0.0180<br>(0.0298)    | 0.0109<br>(0.0229)    | 0.0310<br>(0.0328)    |
| Affected $\times$ control_A |  | -0.0449<br>(0.2486)   | -0.2311<br>(0.1956)   | 0.3315<br>(0.2650)    | 0.0071<br>(0.0081)    | -0.0002<br>(0.0047)   | -0.0064<br>(0.0090)   | -0.0110<br>(0.0220)   | -0.0026<br>(0.0207)   | 0.0278<br>(0.0251)    |
| <i>Fixed-effects</i>        |  |                       |                       |                       |                       |                       |                       |                       |                       |                       |
| province                    |  | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   |
| birthy                      |  | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   |
| <i>Fit statistics</i>       |  |                       |                       |                       |                       |                       |                       |                       |                       |                       |
| Observations                |  | 11,069                | 25,685                | 25,984                | 11,069                | 25,685                | 25,984                | 11,069                | 25,685                | 25,984                |
| R <sup>2</sup>              |  | 0.25503               | 0.30068               | 0.33091               | 0.08776               | 0.07502               | 0.05883               | 0.22465               | 0.30720               | 0.32106               |
| Within R <sup>2</sup>       |  | 0.03610               | 0.02841               | 0.02827               | 0.00168               | 0.00172               | 0.00256               | 0.01976               | 0.01925               | 0.01724               |

Clustered (province) standard-errors in parentheses

Signif. Codes: \*\*\*, 0.01, \*\*, 0.05, \*, 0.1

Source: PSA 2019 FLEMMS Survey

Table 6: Impact of Typhoon Haiyan on Educational Attainment, by Household Size - Senior/Diploma and College Education

| Dependent Variables:<br>Household Size: | DIPLOMA               |                       |                       | COLLEGE               |                       |                       |
|-----------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|                                         | Small                 | Medium                | Large                 | Small                 | Medium                | Large                 |
| <i>Variables</i>                        |                       |                       |                       |                       |                       |                       |
| female                                  | 0.0805***<br>(0.0104) | 0.0633***<br>(0.0052) | 0.0766***<br>(0.0048) | 0.0696***<br>(0.0096) | 0.0599***<br>(0.0052) | 0.0667***<br>(0.0039) |
| urban                                   | 0.1403***<br>(0.0142) | 0.0826***<br>(0.0124) | 0.0687***<br>(0.0092) | 0.1099***<br>(0.0120) | 0.0747***<br>(0.0110) | 0.0626***<br>(0.0079) |
| Affected $\times$ prim_CH               | 0.0073<br>(0.0251)    | -0.0030<br>(0.0243)   | -0.0072<br>(0.0309)   | 0.0047<br>(0.0239)    | 0.0031<br>(0.0210)    | 0.0003<br>(0.0272)    |
| Affected $\times$ jun_CH                | 0.1045***<br>(0.0338) | 0.0134<br>(0.0316)    | 0.0350<br>(0.0316)    | 0.0091<br>(0.0285)    | -0.0100<br>(0.0251)   | 0.0033<br>(0.0265)    |
| Affected $\times$ sen_CH                | -0.0002<br>(0.0431)   | 0.0498*<br>(0.0295)   | -0.0776**<br>(0.0390) | -0.0150<br>(0.0419)   | 0.0574*<br>(0.0338)   | -0.0452<br>(0.0400)   |
| Affected $\times$ coll_CH               | -0.0237<br>(0.0350)   | -0.0476<br>(0.0291)   | 0.0127<br>(0.0362)    | -0.0487<br>(0.0308)   | -0.0296<br>(0.0278)   | 0.0146<br>(0.0340)    |
| Affected $\times$ control_A             | 0.0182<br>(0.0266)    | -0.0274<br>(0.0196)   | 0.0410<br>(0.0283)    | -0.0180<br>(0.0277)   | -0.0185<br>(0.0199)   | 0.0517*<br>(0.0298)   |
| <i>Fixed-effects</i>                    |                       |                       |                       |                       |                       |                       |
| province                                | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   |
| birthy                                  | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   | Yes                   |
| <i>Fit statistics</i>                   |                       |                       |                       |                       |                       |                       |
| Observations                            | 11,069                | 25,685                | 25,984                | 11,069                | 25,685                | 25,984                |
| R <sup>2</sup>                          | 0.19479               | 0.24723               | 0.25977               | 0.18240               | 0.20345               | 0.22028               |
| Within R <sup>2</sup>                   | 0.02282               | 0.01219               | 0.01439               | 0.01691               | 0.01274               | 0.01422               |

*Clustered (province) standard-errors in parentheses*

*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*

*Source: PSA 2019 FLEMMS Survey*

## 8 Discussion

In this section we discuss the results from our study. First, we consider the interpretations and implications of investigating the medium-run effect of the Typhoon. Then, we discuss the observed differences between the educational attainment outcomes of men and women and urbanity in affected regions. Finally, we present more general implications of our study.

### 8.1 Results Discussion

Generally, our study does not find any significant medium-run effects on educational attainment in affected regions of Typhoon Haiyan, for any cohort overall. For certain age groups, however, we see a difference in impact depending on demographic characteristics.

### 8.1.1 Medium-run Effects

The absence of any apparent impact of the Typhoon, negative nor positive, in the medium-run is suggestive of effective and successful disaster response measures in the Philippines that we briefly introduce in Section 2. Many of these disaster response initiatives are executed under the premise of 'building back better' (i.e. with sturdier, more disaster resilient infrastructure for schools, hospitals, etc.). More importantly, they are also executed in the *immediate* aftermath of the disaster. Recall that many primary and junior schools were rebuilt within the span of 3 to 6 months following the disaster, and temporary schooling solutions were established in the meantime. As such, we find it likely that many of the obstacles to education that we suspected were mostly resolved within a year of the Typhoon, highlighting the limitation discussed in Section 4.3; where the infrequency of FLEMMS survey (roughly every 5 years) restricting our ability to consider of these short-term interventions, and how even they varied between affected regions<sup>40</sup> in our medium-turn study. This is a limitation of our methodology and this is why we present a suggestion for smaller scale studies of regions over more periods of time as a recommendation for future studies in our conclusion.

### 8.1.2 Differences by Gender, Urbanity and Household Size

Generally, women in the Philippines tend to be more educated than men. That said, our findings suggest that women aged 18 to 21 at the time of Typhoon Haiyan were, on average, 4.3 percentage points less likely to complete higher education than their counterparts in unaffected regions; meanwhile, same-aged men were 2.4 percentage points more likely to attend higher education than their counterparts in unaffected regions. Recall what we presented in Section 2; in 'normal' times, one primary reason for drop-outs amongst young men was typically the pursuit of work; while for women it was marriage and household duties. According to the International Labour Organization, over 1.5 million workers were affected after the Typhoon, with over 520,000 considered 'vulnerably employed'; as such, we suspect that the unavailability of work post-Typhoon Haiyan may have encouraged more young men to complete their higher education. Simultaneously, when we calculate the percentage of married women in each cohort, 60.9% of women in affected regions who were 18 to 21 at the time are married, while 56.4% of women in unaffected regions are married. This is the biggest difference between the proportion of married women in unaffected and affected regions for any cohort (e.g. in cohort Control\_A, the difference is less than 1%), and the biggest jump in proportion of married women (and men) between cohorts takes place between the senior and college cohorts. These figures are suggestive of more women in this cohort perhaps being burdened with the social expectation to care for the home, and therefore drop out of school.

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<sup>40</sup>We suggest that disaster responses likely varied even between regions with different priorities - for example, injured persons in one region, damaged medical/school infrastructure within a another - and different degrees of effectiveness. If we could account for this, we would better understand how the impact of disasters on educational attainment is mitigated.

Hence, we understand why our results suggest women between the ages of 18 to 21 in affected areas achieved 0.38 less years of schooling on average.

Urban areas tend to be more densely populated relative to rural areas; schools, hospitals and other key infrastructure (e.g. roads) are often more spread out in rural areas. Knowing this, it could be that the reconstruction of schools yielded higher returns in urban areas compared to rural, and that this is one potential cause as to why children aged 6 to 11 in affected regions have completed 0.54 less years of education. Additionally, we suspect that amongst those who were temporarily relocated in the wake of the disaster, those with the means (i.e. economic resources) to permanently relocate to urban areas may have done so; meaning that those 'left' in rural areas (which are already less economically developed) may have been from less fortunate economic backgrounds. Furthermore, as explained by Reyes and Randell (2023), rural areas are more vulnerable to environmental shocks as agricultural losses may erode household income; and thus, these types of shocks drive households to redirect resources for schooling towards more immediate household needs.

Finally, we consider the results observed for differences in household size. In affected regions, students aged 12 to 15 in 2013 - who we presume were in junior highschool at the time - from small households were 10.5% more likely to have progressed to and completed senior education. Simultaneously, amongst the students who were of senior school age in 2013, i.e. 16 to 17 years old, those from larger households were 7.8% less likely to have completed a senior/diploma-level education. Both these results reflect Björkman-Nyqvist's (2013) findings in her study on income shocks and gender gaps in Uganda; that older children are the first group that households turn to for the provision of labour after a disaster.

## 8.2 Methodological Limitations

### 8.2.1 Educational Attainment vs Effectiveness of Schooling

Our study suggests that overall and on average, students in affected regions were just as likely to continue their education, regardless if they were in an affected or unaffected region. While this is a positive for this aspect of education, we do not consider other dimensions of education as a measure for human capital.

For instance, we do not investigate the effect on the quality of education through literacy test scores <sup>41</sup> due to a lack of availability of such data, on an individual household level. This could be an important determinant in assessing the effect of lost school time due to the disaster, even if it eventually meant that children resumed their education. Another aspect we do not consider is the rate of over-aged pupils. In 2014, the rate of over-age students at primary school in the Philippines stood at 14%, according to the World Bank, a relatively

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<sup>41</sup>Specific measures include, reading, vocabulary and math scores.

high rate for an East Asian country<sup>42</sup>. Our data does not allow for us to track whether student are up to date with their education or if the Typhoon caused delayed schooling. Note that our study focuses only on those aged 6-31 at the time of the Typhoon. So, the youngest cohort are at primary school age. With that we are unable to analyse the effect of children that were in-utero at the time of the disaster and whether their likelihood of educational attainment was altered. Studies that do choose to investigate in-utero effects of a disaster recognise impacts on these children once born, especially on their cognitive capacity which is linked to high school grades later on in life, Almond *et al.* (2009). Effectiveness of schooling is an indicator of the success of the disaster response and relief schemes following the Typhoon. Previous studies that like us, did not find an effect on educational attainment as a result of a disaster, did find considerable differences in test scores between affected and unaffected regions Andrabi et al. (2021).

### 8.2.2 Measuring Impact

In order to consider a region as "affected" in our study, we considered a composite measure. This includes the percentage of population affected in a region as a percentage of the total regional population and damages as a percentage of regional GDP. The measure chosen reflects the damage caused by the disaster in relative regional terms, but assumes *ceteris paribus* in other aspects. One important element which it does not consider is the regional response to the disaster that may have mitigated part of the effects. When Typhoon Haiyan struck, regions were separated through the a Post Disaster Needs Assessment (PDNA), and distributed aid accordingly. This lead to differences in which areas received assistance first, the amount of assistance, and prioritisation of receiving emergency supplies. While one can assume that the regions we define as "affected" were the ones that received a higher influx of aid at a faster rate, we have no measure of this. An interesting extension of our study would be to incorporate a consideration of aid in the composite measure of affected regions.

### 8.2.3 Intra- and Inter-Regional Migration

Our study uses data from the 2019 FLEMMS survey conducted 6 years after the Typhoon. This means that the reported region of each household member is applicable for 2019, but does not specify which region the individual lived in at the time of the disaster. In cases where the individual migrated within the region (intra-regional migration), this does not pose an issue. However, in cases where individuals migrated between regions (inter-regional migration), we report their educational attainment outcomes from their 2019 region, not the 2013, one which may be misleading. However, we speculate that in most cases where families

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<sup>42</sup>According to the World Bank, the same figures in 2014 for other East Asian countries were 6% in India is 3% in Indonesia and 28% in Nepal.

were forced to migrate, there may have been both inter- and intra-regional migration within the first 12 months of the Typhoon. Considering rigorous relocation schemes, we believe that by the time the FLEMMS survey was conducted migration patterns may have returned to present a similar landscape as before the Typhoon.

### **8.3 General Discussion**

#### **8.3.1 Returns to Preparedness**

As established, the Philippines is highly prone to natural disasters. While this high vulnerability is the unfortunate consequence of their geographic positioning, the insignificant impact of Typhoon Haiyan on educational attainment at large is, from our perspective, highly reflective of their awareness of and responsiveness to said environmental risk. This even goes for psychological preparedness that comes with residing in perpetually disaster-struck regions where being informed and having an understanding of likely and current hazard events leads to quicker recovery Paton (2019). If anything, this is then also somewhat illustrative of the returns to investments in disaster preparedness for the Filipino government - at the national and regional levels-, and even for the importance of foreign aid in times of emergency. Again, while we cannot be sure of the extent to which the reported disaster response measures wholly, or partially, mitigated the negative impacts of Typhoon Haiyan that the NDRRMC and other case studies reported (i.e., the destruction of schools, individuals' health, the psychological toll of displacement, etc.), we consider the apparent resilience of the Philippines educational system (in the medium-run) an important policy consideration for other developing nations vulnerable to natural disasters. With that, we hope that more, similar studies to ours can be conducted on the impact of natural disasters on educational attainment in developing countries, especially, can be conducted to further investigate not only the most vulnerable student groups <sup>43</sup> but also potentially the most resilient systems of schooling if studies comparing different country cases were also conducted.

#### **8.3.2 Long Term Implications**

Our findings investigate the medium-term and, as such, any long-term implications are only speculative. Considering that Typhoon Haiyan did not have a significant impact on differences in the average educational outcomes for affected and unaffected regions, we would argue that our findings are a positive indicator of educational attainment outcomes at the national level. Despite this, we cannot overlook the negative impact of the disaster on different demographic groups that we observed. Especially with the issues of economic development pertaining to rural areas in affected regions; this is considering the Typhoon worsened their

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<sup>43</sup>We suspect that this can be done using educational attainment as we have done, alongside aforementioned measures of effectiveness, especially with more observations over time, for example.

pre-existing 'disadvantage', and the absence of continued development to improve infrastructure in these areas would only leave them more exposed to the future natural disasters that the Philippines will certainly have to face. The same can be said for larger households; whereby the redirection of resources from children's education that tends to occur when a disaster strikes will only continue to delay their upward mobility. These speculations for the future are why a long-term study of the disaster could be interesting to see if the inequalities we observe persist or if the Philippines' proactive approach to education (as evidenced by the mission and implementation of the K-12 system) is successful .

## 9 Conclusion

Typhoon Haiyan was among the most prominent natural disasters to strike globally, with an undoubtedly disastrous impact on a large portion of the Philippines. The true implications of such an event, especially in developing country, demand recognition and inspired our investigation. Our study investigates the medium-run effects of Typhoon Haiyan, focusing on educational attainment as a human capital measure. To do this, we employ a difference-in-difference model for our empirical strategy. Using an individual's age at the time of the typhoon and whether or not they belong to an 'Affected' region, we were able to examine the varying effect (or lack there of) of the Typhoon on different levels of educational attainment. Motivated by previous literature, we also then explore the heterogenous impact of the typhoon on the educational attainment outcomes of different demographic groups within affected regions. Recall the research question: *What are the direct medium-run effects of Typhoon Haiyan on the educational attainment outcomes of individuals in highly impacted regions?*

In other words; Can Education Survive a Crisis? Our results suggest that education can indeed survive a crisis. At large, we find no significant differences in the average educational attainment outcomes between affected and unaffected regions in the medium-run, across all cohorts. We suspect that this insignificance is reflective of the efficiency of the Philippines' disaster response initiatives in the immediate aftermath of the disaster, and argue that this emphasizes the importance of infrastructure and foreign aid in ensuring recovery. We do, however, also find suggestive evidence that different demographic groups are impacted by the disaster differently. This is true for non-compulsory higher education (i.e., short-tertiary, vocational, and college-level studies), where we find that, within affected regions: female students (aged 18 to 21) were 4.3 percentage points less likely to complete college-level education; and students belonging to larger households (aged 16 to 17) were 7.8% less likely to complete diploma-level education. For compulsory education, we find that students between the ages of 6 to 11 (in 2013) completed 0.54 less years of education if they lived in rural areas (compared to their urban-dwelling peers), and that those between the ages of 12 to

15 were more likely to complete junior education if they belonged to smaller households. As such, while educational attainment levels on average are not impacted for any of the different cohorts, the shock of Typhoon Haiyan would appear to have exacerbated certain socioeconomic inequalities within the different cohorts.

We want to emphasise that our results are from a specific disaster in a particular geographic, economic and social context. Thus, the external validity of our findings are inconclusive, as common with case studies. Our reasoning is based on the fact that the effect of each individual disaster depends greatly on the response to the shock. Regardless, there is value in our results, reinforcing the fact that with the right mitigation, preparedness, response and recovery<sup>44</sup>, education can survive a crisis - even if it is of great magnitude, like a 'super typhoon'.

Finally, we have a number of recommendations for this area of research. The first is to evaluate the external validity of our case study through applying a similar empirical model as ours on similar disasters in or beyond the Philippines. Another suggestion is to mimic an identical study in the Philippines but on a provincial level rather than regional level. The motivation for this is that exploring inter-provincial characteristics within of a region (e.g. coastal proximity, elevation, emergency infrastructure, policy, etc.) - that we control for with fixed effects in our study -, could better explain the channels through which a shock, such as a natural disaster, is translated into an impact on education (or mitigated entirely). A third encouragement is to replicate the study but expand the definition of human capital to include measures of educational effectiveness through test scores, in-utero effects, cognitive and health measures. This would encompass a more holistic view of Haiyan's effects beyond just educational attainment. Lastly, we recommend more in-depth case studies on the immediate effects of natural disasters, looking at educational attainment with more frequent observations (i.e. 3-, 6-, 12-, 18- and 24-months post-disaster). While it would probably be on a smaller scale (e.g. one affected region, one unaffected), this would be more reflective of the effectiveness of the emergency management and school administrative efforts in getting children back to school than educational surveys conducted every five years or so, as with the 2019 FLEMMS survey we used.

Overall, we hope to have inspired further research on the impact of single-event shocks, whether that be natural disasters or otherwise, on education (and human capital more broadly). Since, thus far, the proven impact of disasters is still quite varied in research. This can be especially valuable for most developing nations - which tend to be the at high-risk of natural (e.g. typhoons, earthquakes) and man-made disasters (i.e. political instability) - in order to establish a higher standard of understanding of potential impacts and adjust recovery efforts accordingly.

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<sup>44</sup>Defined as the 4 stages of Emergency Management by the US Federal Emergency Management Agency (FEMA).

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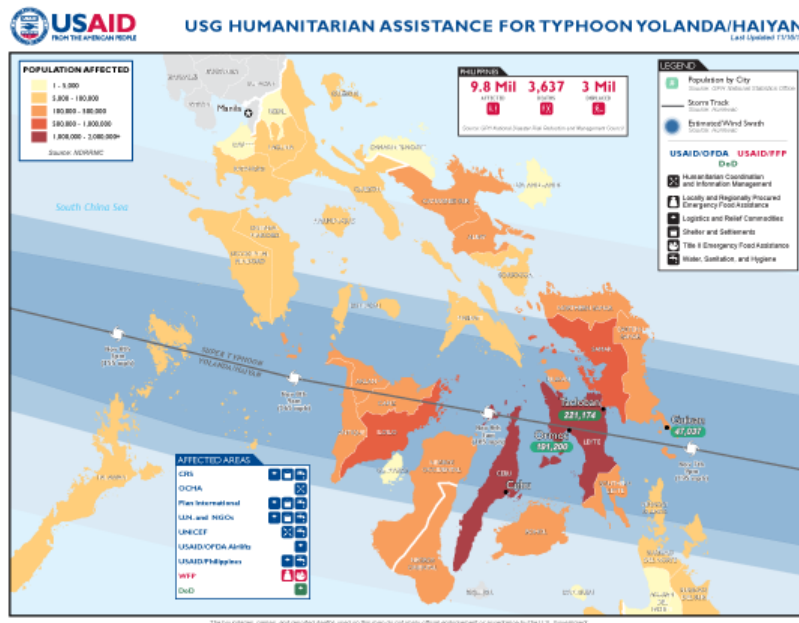
## Appendices

### Appendix A: Map of the Path of Super Typhoon Haiyan



Source: Encyclopedia Britannica

## Appendix B: Map of the Distribution of Population Affected by Typhoon Haiyan and it's Path



Source: USAID

## Appendix C: Calculations for Producing Map of Affected Regions

| Region       | Affected persons/2013 Population | Total Infrastructure Damage*/Regional 2012 GDP | Affectedness |
|--------------|----------------------------------|------------------------------------------------|--------------|
| PH-01        | 0.0%                             | N/A                                            | 0,00%        |
| PH-02        | 0.0%                             | N/A                                            | 0,10%        |
| PH-03        | 0.0%                             | N/A                                            | 0,20%        |
| PH-40        | 0.2%                             | N/A                                            | 0,20%        |
| <b>PH-05</b> | 12.3%                            | 0.24%                                          | 12,54%       |
| <b>PH-06</b> | 89.0%                            | 1.01%                                          | 90,01%       |
| <b>PH-07</b> | 100.0%                           | 0.14%                                          | 100,14%      |
| <b>PH-08</b> | 100.0%                           | 2.19%                                          | 102,19%      |
| PH-09        | 0.0%                             | N/A                                            | 0,00%        |
| PH-10        | 0.4%                             | N/A                                            | 0,40%        |
| PH-11        | 0.1%                             | N/A                                            | 0,10%        |
| PH-12        | 0.0%                             | N/A                                            | 0,00%        |
| PH-00        | 0.0%                             | N/A                                            | 0,00%        |
| PH-15        | 0.0%                             | N/A                                            | 0,00%        |
| PH-14        | 0.0%                             | N/A                                            | 0,00%        |
| PH-13        | 2.8%                             | 0.01%                                          | 2,81%        |
| <b>PH-41</b> | 16.3%                            | 0.72%                                          | 17,02%       |

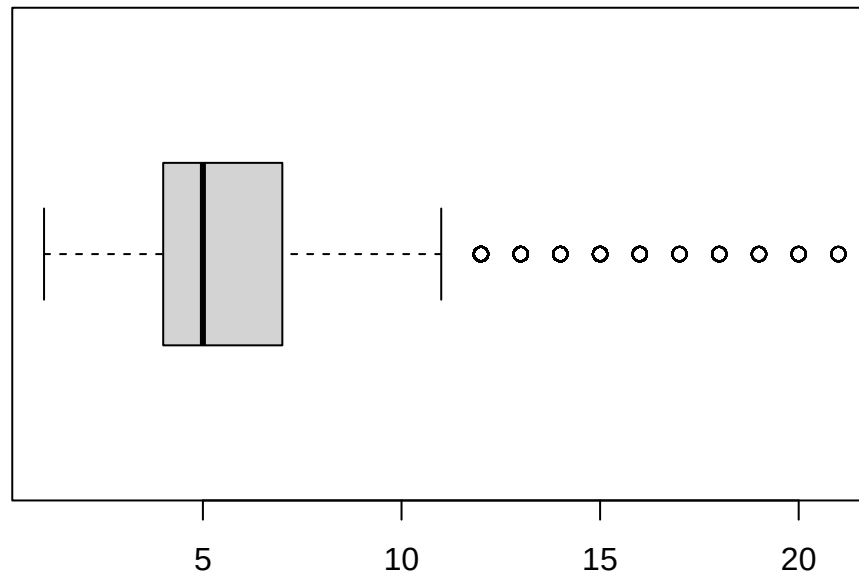
N/A: No damage data available for region

\* Total Damage within and outside PDNA region

*Source: NDRRMC Report on Effects of Typhoon Haiyan*

## Appendix D: Box Plot to determine Household Sizes

The horizontal axis shows the number of household members. The "minimum" is 1, the median is 5, the "maximum" is 11. *Source: Based on 2019 FLEMMS Survey*



## Appendix E: Cohorts and Education Levels in the Philippine Educational System

*Source: iEducation Philippines - Commission on Higher Education: Potential connotations of the change from the K-10 to K-12 system*

The Philippines was one of the last countries in the world to adopt the K-12 system of education, and enacted the K-12 system into law in 2012. The K10 system that had previously been in place since 1945 before the change included one-year of optional kindergarten, 6 years of compulsory primary education, followed by 4 years of a compulsory highschool education. The new system requires an additional two years of what they now consider 'senior highschool education'. This senior highschool education is essentially composed of specialized tracks that enable students to learn more specific skills and/or cover basic education models that are no longer offered at the collegiate level. Before this shift, many Filipinos would still pursue short-cycle, non-teritary degrees/certificates, especially before pursuing a college degree - if they chose to (or had the means to) do so at all. The implementation of the new system, however, was not immediate; the first to experience the change of system in full would have

been those starting primary school in 2012/2013 and across the country there were varied implementations of the system for those of junior and senior highschool age (i.e. some schools had also been ‘testing’ the system before it was enacted into law officially). As such, in an attempt to account for this ‘overlap’ between the old and new systems, in our categorization of educational attainment we grouped together the FLEMM’s survey categories for upper secondary, post-secondary non-tertiary and short-cycle tertiary education under the umbrella term ‘Diploma’ (see below). We are considerate of this in our interpretation of educational outcomes for both the sen.CH and coll.CH cohort groups as those between the ages of 16 to 21.

|                                                          |       |       |
|----------------------------------------------------------|-------|-------|
| 12. Highest educational attainment                       |       |       |
| No grade completed                                       | 0     |       |
| Level 0 - Early Childhood Education                      | 1000  | 2000  |
| Level 1 - Primary Education Elementary                   | 10011 | 10018 |
| Level 2 - Lower Secondary Education (Junior High School) | 24011 | 24015 |
| Level 3 - Upper Secondary Education (Senior High School) | 34011 | 35033 |
| Level 4 - Post-Secondary Non-Tertiary Education          | 40001 | 49999 |
| Level 5 - Short-Cycle-Tertiary Education                 | 50001 | 59999 |
| Level 6 - Bachelor Level Education or equivalent         | 60001 | 69999 |
| Level 7 - Master Level Education or equivalent           | 70010 | 79999 |
| Level 8 - Doctoral Level Education or equivalent         | 80010 | 89999 |

*snippet from the 2019*

*FLEMMS survey dictionary*

Considering all of the above, we were also generous so-to-say in our assignment of years of education for all post-secondary education. Specific grade-level attainments were specified for Primary to Senior highschool education (so Grade 1 to 12), but the length of study was less clear in the classification of the aforementioned variety of post-secondary degrees and bachelor level or equivalent education. As such, since years of education is meant as more of an indicative variable in our study we assigned the following ‘years of education’ to the different educational categories - when codes didn’t specify (e.g. Code 60001 = 1st year of Bachelor or equivalent), generally assuming that being assigned the code for a degree meant completion of said degree:

Table 7: Cohorts and their respective Age Ranges

| <i>Cohort</i>          | <i>Age Range</i> |
|------------------------|------------------|
| Primary:               | 6 to 11          |
| Junior:                | 12 to 15         |
| Senior:                | 16 to 17         |
| Diploma/College:       | 18 to 21         |
| Control <sub>A</sub> : | 22 to 26         |
| Control <sub>B</sub> : | 27 to 31         |

Table 8: Education Levels and Equivalent Years of Education

| <i>Cohort</i> | <i>Years of Education</i> |
|---------------|---------------------------|
| Primary:      | 6                         |
| Junior:       | 10                        |
| Senior:       | 12                        |
| Diploma       | 13                        |
| College:      | 16                        |

We assigned the ‘Diploma’ category 13 years short-cycle accreditations can take anywhere between 6-months to three years to complete, and it still captures the equivalence between them and the recently introduced (in 2013) Senior highschool specialized tracks. College is assigned 16 years as it usually takes 4 years to complete in the Philippines and, as mentioned, most would take preparatory post-secondary courses before College.

Finally, we also want to make a brief note of the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM). As of 2019, it was fully established as an autonomous region; in addition to a recently established parliament, system of governance, etc - it also has its own system of education, the ‘Alternative Learning System’ (ALS), separate to the K-12 system. Prior to its ‘independence’ of sorts, the region repeatedly ranked lowest amongst poverty incidence, educational attainment, gender rights etc. As such, there could be a concern that its inclusion as a comparative ‘unaffected’ region, creates a drag on the unaffected regions’ educational attainment levels downwards, biasing any appearance of ‘affected’ regions higher performance upwards; essentially skewing the comparison. However, our province fixed effects control for time-invariant qualities that include not only demographic and geographic differences, but also cultural differences (such as different learning practices different provincially dispersed ethnic groups practices) and we have controls for gender, urbanity, household size etc. Further more, the ALS system is accounted for in FLEMMS and appears to have been ranked accordingly with the K-12 levels of education that it matches. As such, we are not concerned that its inclusion in our study creates any significant oversight.

## Appendix F: Screenshot of our Population Estimations

| 2019 population figures and growth rates are based on the 2015 censuses from Philippines Statistics Authority. 2021 estimated population figures are calculated using simple growth formula (2019 pop)*1+growth rate)*2. |           |             |                |                          |                            |                         |                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|----------------|--------------------------|----------------------------|-------------------------|-------------------|
| Region                                                                                                                                                                                                                   | 2010 Pop. | growth rate | 2013 est. Pop. | Affected (yes**1, no**2) | Number of affected persons | Affected persons % Pop. | Damaged houses*** |
| Region I - Ilocos Region                                                                                                                                                                                                 | 1         | 3,748,372   | 1.09%          | 4,905,542                | 0                          | 0.0%                    | -                 |
| Region II - Cagayan Valley                                                                                                                                                                                               | 2         | 3,329,163   | 1.27%          | 3,353,763                | 0                          | 0.0%                    | -                 |
| Region III - Central Luzon                                                                                                                                                                                               | 3         | 10,137,737  | 1.85%          | 10,742,434               | 0                          | 0.0%                    | -                 |
| Region IV - CALABARZON                                                                                                                                                                                                   | 4         | 12,649,803  | 2.58%          | 13,611,109               | 1                          | 0.0%                    | 840               |
| Region V - Bicol                                                                                                                                                                                                         | 5         | 5,420,411   | 1.29%          | 5,632,899                | 1                          | 27.02%                  | 12.3%             |
| Region VI - Western Visayas                                                                                                                                                                                              | 6         | 4,134,579   | 1.23%          | 4,353,850                | 1                          | 3,873,700               | 89.0%             |
| Region VII - Central Visayas                                                                                                                                                                                             | 7         | 5,513,314   | 1.86%          | 5,869,791                | 1                          | 5,000,065               | 111.31%           |
| Region VIII - Eastern Visayas**                                                                                                                                                                                          | 8         | 4,101,322   | 1.52%          | 4,291,199                | 1                          | 5,015,434               | 118.9%            |
| Region IX - Zamboanga Peninsula                                                                                                                                                                                          | 9         | 3,427,253   | 1.21%          | 3,552,543                | 0                          | 0.0%                    | -                 |
| Region X - Northern Mindanao                                                                                                                                                                                             | 10        | 4,297,233   | 1.68%          | 4,517,567                | 0                          | 0.0%                    | 20                |
| Region XI - Davao                                                                                                                                                                                                        | 11        | 4,468,565   | 1.74%          | 4,705,504                | 1                          | 15,602                  | 0.1%              |
| Region XII - SOCCOGRANDEN                                                                                                                                                                                                | 12        | 4,139,571   | 1.94%          | 4,352,413                | 0                          | 0.0%                    | -                 |
| National Capital Region                                                                                                                                                                                                  | 13        | 11,855,075  | 1.58%          | 12,425,874               | 0                          | 0.0%                    | -                 |
| Cordillera Administrative Region                                                                                                                                                                                         | 14        | 1,616,887   | 1.70%          | 1,706,737                | 0                          | 0.0%                    | -                 |
| Bangsamoro Autonomous Region in                                                                                                                                                                                          | 15        | 9,256,140   | 2.89%          | 9,546,085                | 0                          | 0.0%                    | -                 |
| Region XII - Caraga                                                                                                                                                                                                      | 16        | 2,429,244   | 1.38%          | 2,553,726                | 0                          | 0.0%                    | 2.8%              |
| MINDANAO (IVB)                                                                                                                                                                                                           | 17        | 2,744,671   | 1.47%          | 2,867,499                | 1                          | 69,566                  | 16.3%             |

\*\*REGION VI 2015 POP = 6,043,903  
 \*\* REGION VII 2015 POP = 4,440,150  
 \*\*\* = number of houses completely destroyed

(Source: Philippines Statistic Authority)

Our estimated 2013 population figures mostly aligned with other reports of 2013 regional populations but we couldn't find exact figures for each region, nor was it clear whether they'd been taken pre- or post- the typhoon in November. One issue was that the reported number of affected persons for region VIII, Eastern Visayas, was greater than even the official 2015 population figures for that region, and we couldn't find any clear reason in the NDRRMC's report for why this could be - hence we opted to simply consider 100% of the population affected. For region VII, Central Visayas, based on the official 2015 population numbers, we'd assume that the our population estimation was appears to have been just short the actual 2013 population, hence why the affected population would appear to be 101.7% of the actual population, but we simply assigned it as 100% of the population being affected.

## Appendix G: 3-way Interaction Terms

These tables are simply a reference for p-values of the three-way-interaction terms mentioned in the text.

Table 9: Gender, p-values of 3-way interaction terms

| <i>Interaction Term</i> | <i>Interaction Term</i> | <i>P-value</i> |
|-------------------------|-------------------------|----------------|
| COLLEGE                 | Affected*coll.CH*Female | 3.158785e-02   |
| edu_years               | Affected*coll.CH*Female | 4.126607e-03   |

Table 10: Urbanity, p-values of 3-way interaction terms

| <i>Dependent variable</i> | <i>Interaction Term</i> | <i>P-value</i> |
|---------------------------|-------------------------|----------------|
| edu_years                 | Affected*prim.CH*Urban  | 4.344535e-02   |
| edu_years                 | Affected*sen.CH*Urban   | 2.670243e-01   |
| PRIMARY                   | Affected*sen.CH*Urban   | 1.313962e-01   |

Table 11: Household size, p-values of 3-way interaction terms

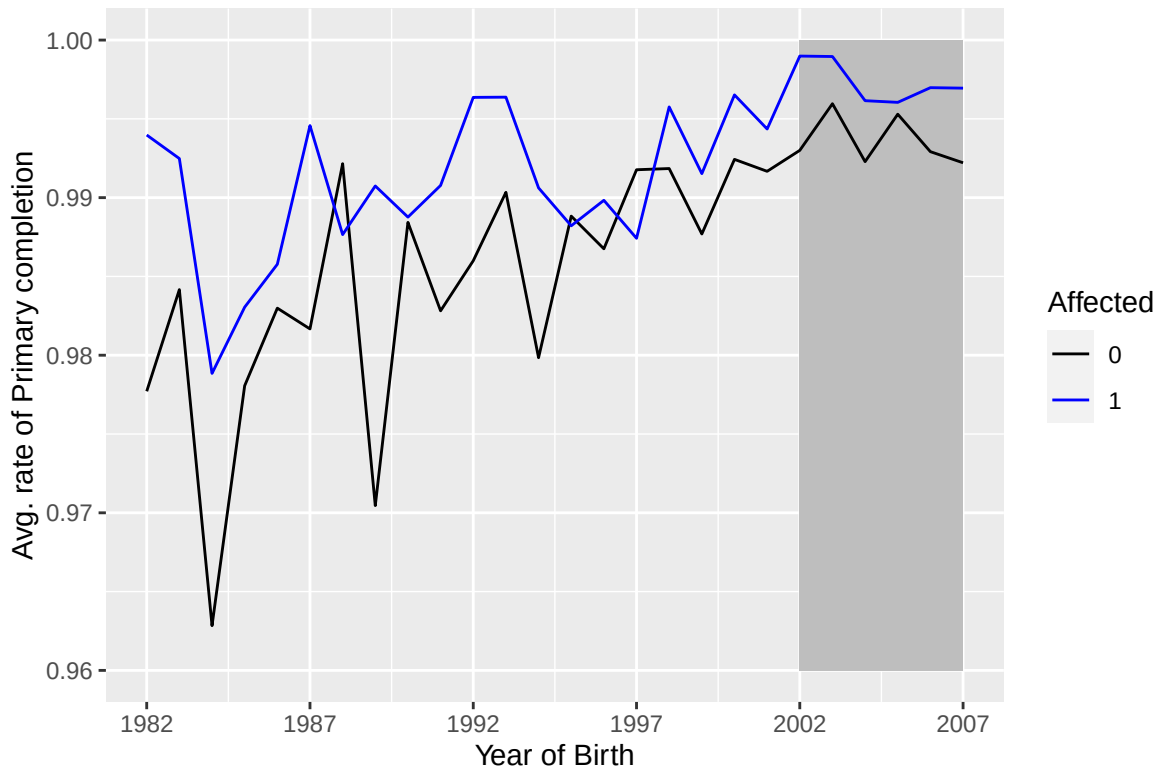
| <i>Dependent variable</i> | <i>Interaction Term</i>      | <i>P-value</i> |
|---------------------------|------------------------------|----------------|
| DIPLOMA                   | Affected*jun.CH*small_house  | 1.166014e-02   |
| DIPLOMA                   | Affected*jun.CH*medium_house | 2.050293e-01   |
| DIPLOMA                   | Affected*jun.CH*large_house  | 7.841967e-01   |
| DIPLOMA                   | Affected*sen.CH*small_house  | 4.856189e-01   |
| DIPLOMA                   | Affected*sen.CH*medium_house | 3.529048e-02   |
| DIPLOMA                   | Affected*sen.CH*large_house  | 1.718601e-02   |

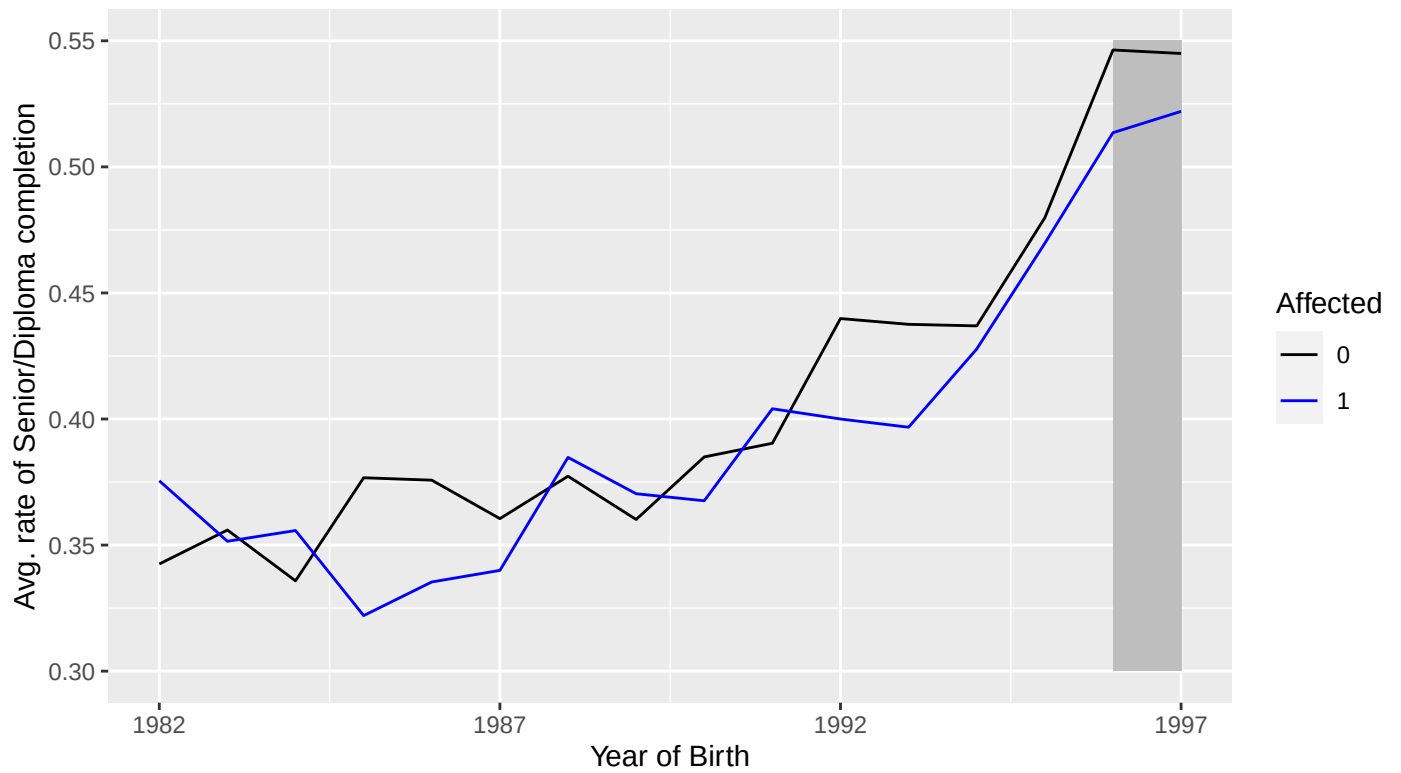
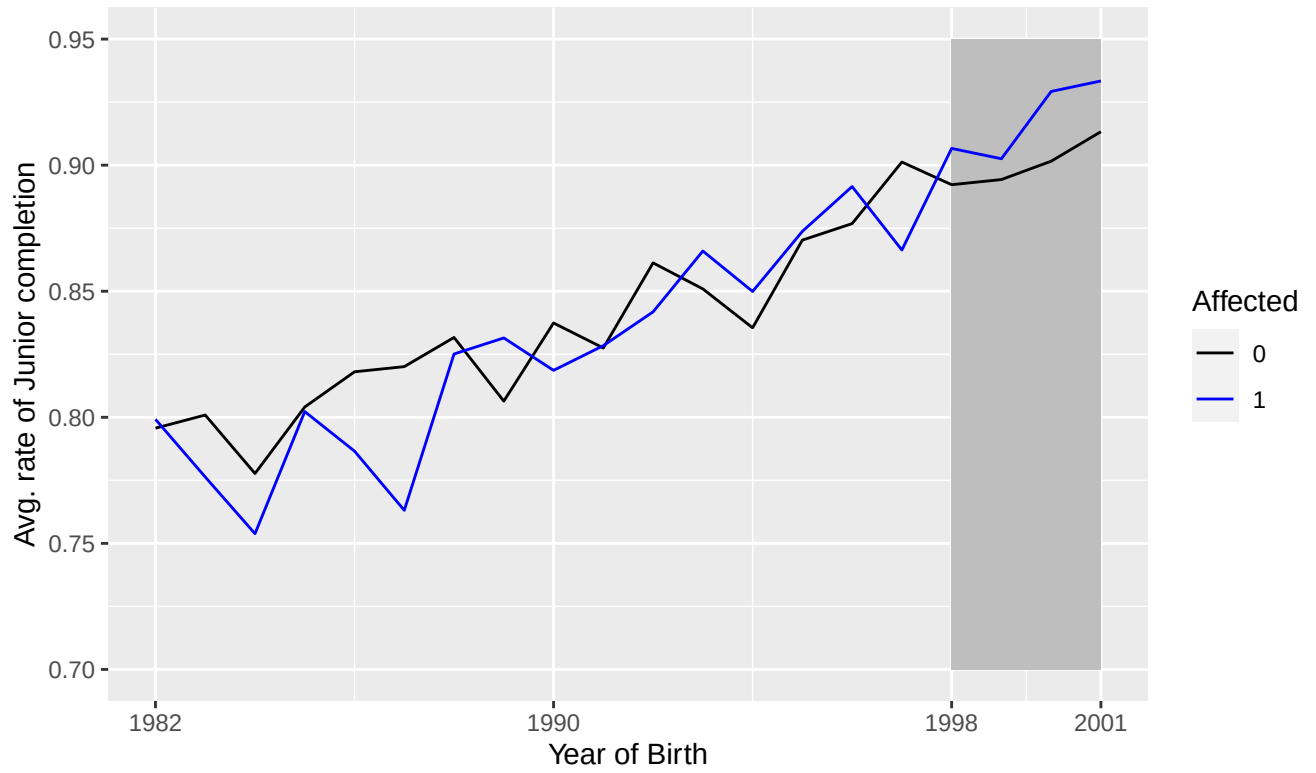
## Appendix H: Parallel Trends

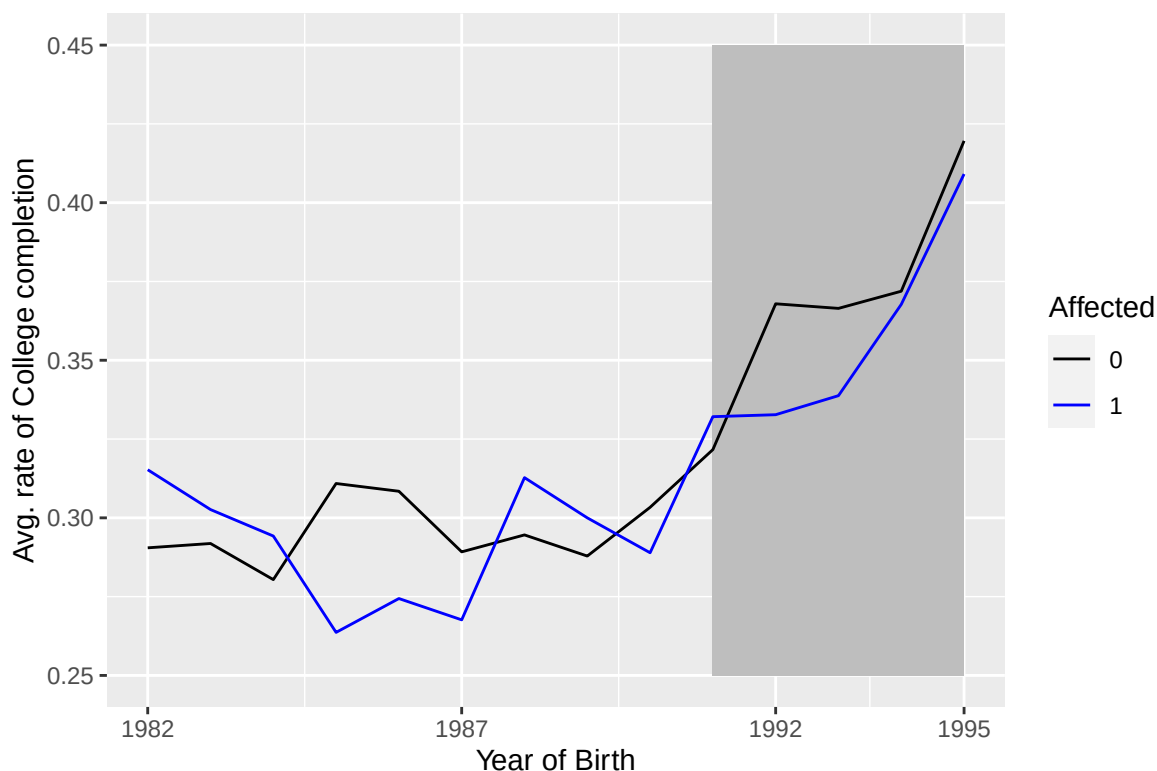
The following graphs illustrate the average rates of completion for primary, junior highschool, senior/diploma-level, and college-level studies, by birth year, for individuals in affected and unaffected regions. For each level of study, the graphs are limited from the control cohorts' birth years to those of the cohort that would have been studying the level of education at 2013. For example, in the first graph on average rates of primary school completion, the highlighted area is for birth years 2002-2007 which is when those aged between 6 to 11 in 2013 were born.

The trends in educational attainment, based on these graphs alone, appear to be generally similar in affected and unaffected regions in their upward movement as time passes, but they are far from identical - with the evident gaps between the two types of regions in certain years (e.g. 1984 - there was a recession; and 1988 - there was a massive military coup)

As such, to compensate for the lack of clarity in these plotted trends, we use Duflo's sound logic; seeing that the coefficient on the interaction terms of older cohorts is near-zero in absolute terms and insignificant. We also note that these graphs underline the importance of birth year fixed effects.







## Appendix I: Use of Generative AI

*OpenAI ChatGPT (2023) ChatGPT responses to Anastasia Efsthathiou and Emma Johnson, Jan 16 to May 12, 2023*

The AI tools ChatGPT and the generative communication assistant AI have been used as tools in our thesis writing process.

The former has been used to clarify the meaning of errors in R code and explain how functions, such as `feols()`. The latter have been used as a chrome extension to help making the writing more concise.

We recognise that the risks of AI in producing answers to certain question, such as those pertaining to coding that we have had, that are not entirely correct. To reduce these risks we've also referred to several online forums outlining the use of R to run econometric regression, and asked ChatGPT to be more detailed in its explanations so that it 'reflects' on the correctness of its suggestions.

The main insights gained were the increase in efficiency in so far as finding solutions to problems that might have otherwise required inquiries with professors and peers, which can also tend to give different answers and take a lot of time. Additionally, the use of a writing tool like Grammarly has been a great aid in so far as our personal reflections on how we can be more concise in our language moving forward.