Measuring the Impact of Typhoons on Different Social and Economic Outcomes in the Philippines

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Abstract

The Philippines experiences multiple natural disasters each year, with typhoons being the most prevalent and damaging in terms of social and economic impact. This paper aims to measure the effect of typhoons on critical dimensions of human development in the Philippines by exploiting the exogeneity and randomness of Typhoon Washi. Using a difference-in-differences approach, the paper examines both the long and short term effects of this particular typhoon on unemployment, primary education dropout and infant mortality in a region that has historically been free of typhoons. Results show a significant increase in unemployment over the long term, while primary education dropout showed a significant increase immediately after the typhoon. Although the effect on infant mortality increased in the short term and decreased in the long term, these estimates are not statistically significant. In terms gender-specific outcomes, I find that the effect on girls are higher than that of boys in education and health.

Acknowledgements

I would like to express my sincere gratitude to my thesis supervisor, Dr. Anand Murugesan, for which the completion of this study could not have been possible without his consistent support, guidance and expertise. Special thanks is also given to the Philippine Statistics Authority and the Philippine Department of Education for their support in providing statistics used in conducting this research.

Table of Contents

List of Figures

List of Tables

1 Introduction

The Philippines experiences multiple natural disasters each year, with typhoons being the most prevalent and damaging in terms of social and economic impact.[1] Its geographic location, astride both the typhoon belt and the Pacific Ring of Fire in Southeast Asia, makes it one of the most disaster-prone countries in the world, experiencing an average of twenty typhoons each year.[2] In general, these typhoons can cause serious damage to livelihoods, health, infrastructure and education.

Natural disasters bring with them devastating effects on different aspects of people's lives, and it is typically the poor or disadvantaged people who bear the brunt of the impacts. This paper will begin by discussing some of the factors that make the poor more vulnerable to natural disasters and how these can lead to adverse effects that make it more difficult for them to escape poverty. Generally, with less (or lack of) resources, the poor may struggle more to cope with and recover from natural disasters. Shocks may force them to make choices with long term effects, such as withdrawing a child from school, reducing health care expenses, among others.[3]

This paper investigates the impact of typhoons on various social and economic outcomes in the Philippines by using a difference-in-differences (DiD) approach, with Region 10 as the treatment group and Region 12 as the control group. These two regions are both located in the island of Mindanao, which geographically, is typically a typhoon-free island compared to the rest of the country. However, in December 2011, Typhoon Washi crossed this southern island and made landfall over Region 10, causing catastrophic damage—with the cities of Cagayan de Oro and

[1] "Philippines: WB, AIIB Approve Funding for Flood Management in Metro Manila." World Bank, September 28, 2017. https://www.worldbank.org/en/news/press-release/2017/09/28/philippines-wb-aiib-approve-funding-for-flood-management-in-metro-manila.
[2] Idah Pswarayi-Riddihough. "Natural Disaster Risk Management in the Philippines: Reducing Vulnerability ." The World Bank, June 2005.
http://documents1.worldbank.org/curated/en/456511468333585589/pdf/380630PH0Natur1ver0P08487001PUBLIC1.pdf.
[3] Stephane Hallegatte et al. 2017. Unbreakable : Building the Resilience of the Poor in the Face of Natural Disasters. Climate Change and Development;. Washington, DC: World Bank. World Bank.
https://openknowledge.worldbank.org/handle/10986/25335

Iligan bearing the brunt of the disaster. As a relatively new phenomenon for the region, DiD estimation would allow me to measure the effects of this sudden change in the environment.

Effects will be identified by comparing the changes in outcomes in health, education and unemployment (separately) over time between a region that was hit by the typhoon and one that was not. Region 10 will be the treatment group while Region 12 will be the control group, as it was not affected. Since the typhoon occurred in December 2011, years prior to 2012 will be considered pre-treatment. The results are consistent with my hypothesis that, generally, typhoons increase unemployment, primary school dropout and infant mortality in subsequent years. If other parts of the country are affected by typhoons in the same way and extent as Region 10, then it may (or may not) be for the same vulnerabilities outlined in this paper—it is beyond the scope of this paper to answer this. Since the Philippines frequently experiences typhoons, lowering these vulnerabilities may be an important ingredient in increasing the country's score on the Human Development Index.

The analysis of this paper is, however, subject to several limitations. First, it only focuses on one particular event, Typhoon Washi, which makes it difficult to assess its external validity claim. Second, since I did not measure the intermediate variables, I cannot identify the exact channels through which typhoons affect the outcomes. Thus, I cannot prove that the vulnerabilities exist. Lastly, due to data constraints, the paper cannot provide evidence that the effects on the poor are worse than the nonpoor. This means that the results may reflect outcomes that include those of both the poor and nonpoor. Therefore, I cannot conclude that any of the findings suggest the poor are disproportionately affected by typhoons.

The remainder of this paper is organized as follows. The second chapter provides a background of Typhoon Washi, as well as a review of the existing literature on the impact of natural disasters on unemployment, education and health. The third chapter will discuss the research design, which includes the method, data and limitations. This is followed by chapters that present and discuss the findings. Finally, the conclusion and policy implications are presented in the sixth chapter.

2 Background of the Study / Literature Review

In the Philippines, typhoons most frequently make landfall on the islands of Luzon and Visayas; whereas the southern island, Mindanao, is largely free of typhoons.[4] Although the Philippines is struck by an average of twenty typhoons a year, these disasters are not usual in Mindanao. As an island that lies below the typhoon belt, its climate is more favorable than that of Luzon or Visayas to the north.[5] In fact, there was only an average of one typhoon every ten years crossing Mindanao from 1947 to 2008.[6]

For a long time, this southern part of the Philippines was believed to be immune from typhoons and large-scale disasters. However, in December 15, 2011, Typhoon Washi entered the Philippine Area of Responsibility and crossed the island of Mindanao. Among all the regions, Region 10 and its cities of Cagayan de Oro and Iligan were the most affected.[7] About a month's worth of rain poured down in a period of only 10 hours, resulting in the overflowing of rivers and triggering deadly flash floods and landslides.[8] Water reached formal and informal settlements at a height of 9-10 meters.[9] Entire neighborhoods and villages were swept away. This made Typhoon Washi the world's second deadliest disaster of that year. The destruction was massive, unprecedented, and caused the displacement of around 229,000 people (70,000 families) in Cagayan de Oro City alone.[10] This represents almost 40% of the total city population. Overall, the typhoon destroyed

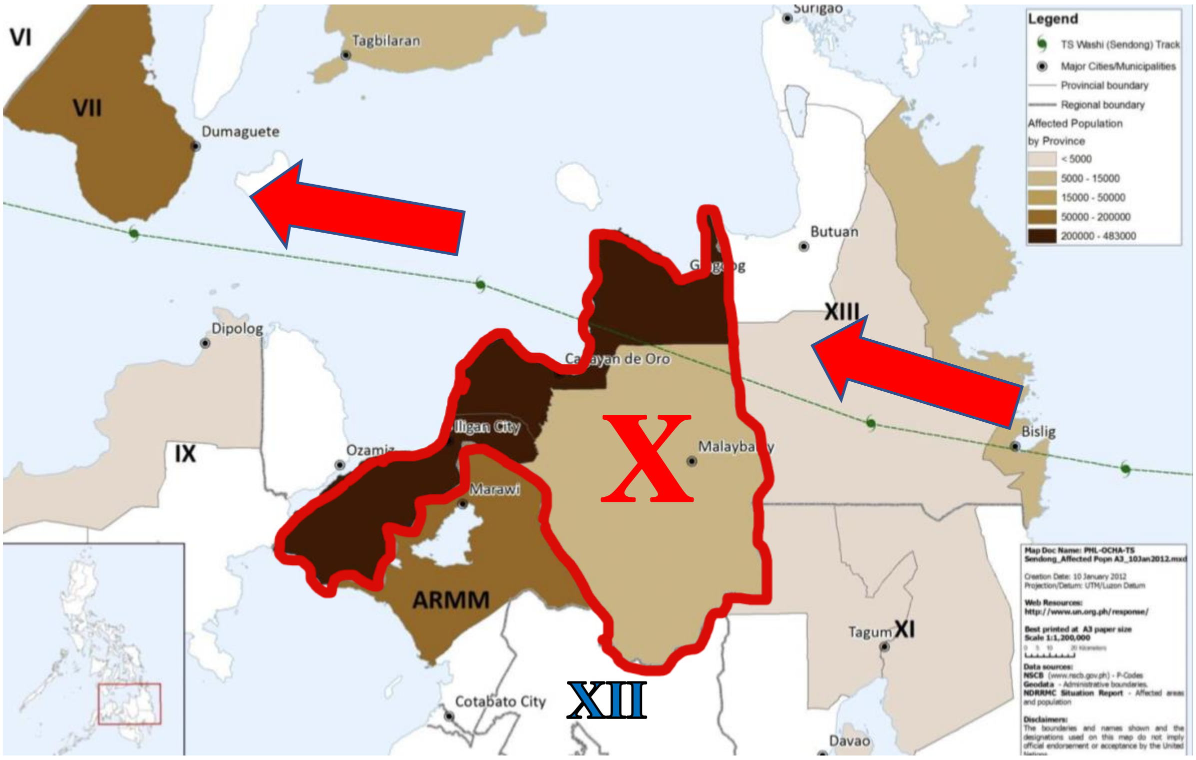
[4] "Story Map Journal." arcgis.com. Accessed April 4, 2021. https://www.arcgis.com/apps/MapJournal/index.html?appid=586f9150ae87491a8c7f1b86db7952a9.
[5] "Philippines." Places in the News . Library of Congress. Accessed May 28, 2021. https://www.loc.gov/today/placesinthenews/archive/2011arch/20111219_philippines.html.
[6] Sandra Carrasco et al. "Disaster Induced Resettlement: Multi-Stakeholder Interactions and Decision Making Following Tropical Storm Washi in Cagayan De Oro, Philippines." *Procedia - Social and Behavioral Sciences* 218 (2016): 35–49. https://doi.org/10.1016/j.sbspro.2016.04.008.
[7] Olavo Rasquinho, Jinping Liu, and Derek Leong. "Assessment on Disaster Risk Reduction of Tropical Storm Washi." *Tropical Cyclone Research and Review* Volume 2, no. Issue 3 (2013): 169–75. https://doi.org/https://doi.org/10.6057/2013TCRR03.04.
[8] Grünewald, François, and Béatrice Boyer. "Lessons Learnt on Typhoons in the Philippines ." Urgence Réhabilitation Développement, November 2013. https://reliefweb.int/sites/reliefweb.int/files/resources/LessonsLearntTyphoons_Philippines_GroupeURD.pdf.
[9] Olavo Rasquinho, Jinping Liu, and Derek Leong. (2013).
[10] Sandra Carrasco et al, (2016): 35–49.

and damaged around 19,000 houses, killed 1,300 people, injured 2,000 and almost a thousand were reported missing.[11]

Mindanao is divided by six administrative regions, namely: Region 9 (Zamboanga Peninsula), Region 10 (Northern Mindanao), Region 11 (Davao Region), Region 12 (Soccsksargen) Region 13 (Caraga Region) and the Autonomous Region in Muslim Mindanao (ARMM). As regions belonging to one island, all share similar characteristics, customs, languages and even good climate for agriculture—distinct from those in Luzon and Visayas.[12] However, Typhoon Washi did not affect the regions to the same degree. This paper will exploit the exogeneity and randomness of Typhoon Washi to estimate the impact of exposure on unemployment, primary education dropout and infant mortality.

As "ground zero" of this typhoon, Region 10 will be the treatment group while its neighbor to the south, Region 12, will serve as the control group. As shown in Figure 1 below, Region 12 was the only region in Mindanao unaffected by the typhoon. Region 10 and Region 12 have similar populations at 4,857,341 and 4,780,211, respectively (as of 2017).[13]

[11] Sandra Carrasco et al, (2016): 35–49.
[12] Valdeavilla, Ronica. "Luzon, Visayas, Mindanao: The 3 Island Groups of The Philippines." Culture Trip. The Culture Trip, January 20, 2018. https://theculturetrip.com/asia/philippines/articles/luzon-visayas-mindanao-the-3-island-groups-of-the-philippines/.
[13] National Nutrition Council. Accessed June 9, 2021. https://www.nnc.gov.ph/.



(Source: OCHA)

Figure 1: Geography

This map illustrates the path of Typhoon Washi. As the colors on the map indicate, Typhoon Washi did not affect the regions to the same degree. Most of those affected belong to Region 10 (encircled in red).

2.1 Trapped in Poverty

Numerous studies have found evidence that suggests that the poor are significantly more vulnerable and exposed to the economic and human capital losses caused by natural disasters.[14] In other words, they are more vulnerable to shocks. Any impact on their consumption levels or assets threatens subsistence and long-term prospects.[15] In addition, the poor are more likely to live and work in hazardous and disease environments, making them especially vulnerable to risks. Oftentimes, natural disasters exacerbate these existing vulnerabilities. In other words, being poor usually entails inadequate housing, poor sanitation, fragile health and limited resources to buffer

[14] Jun E. Rentschler. "Why Resilience Matters: The Poverty Impacts of Disasters." The World Bank. The World Bank, November 2013.

[15] Stephane Hallegatte et al. From Poverty to Disaster and Back: a Review of the Literature. *EconDisCliCha* **4,** 223–247 (2020). https://doi.org/10.1007/s41885-020-00060-5

disaster losses. Generally, with less resources, the poor struggle more to cope with and recover from natural disasters. Shocks may force them to make choices with long term effects, such as selling assets, reducing health care expenses, reducing food consumption, withdrawing a child from school, etc.

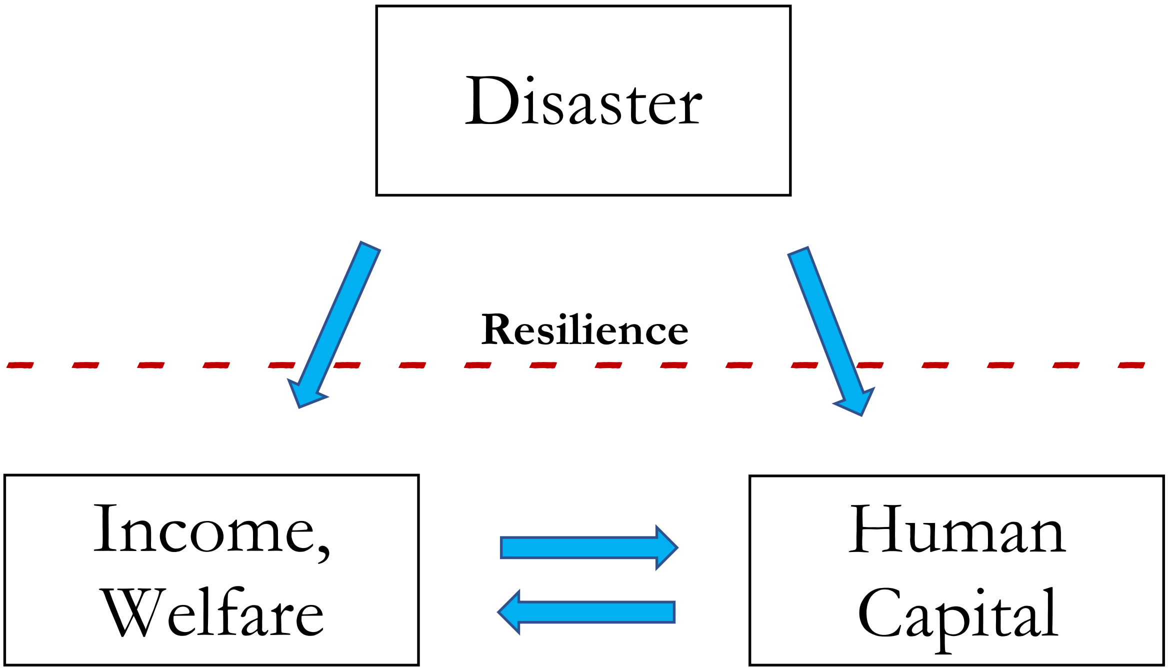
Shocks such as loss of livelihood can have dreadful impacts on human capital—making it difficult for those in the poorest households to escape the cycle of poverty. For instance, disinvesting in a child's education may, in the long run, reduce his or her lifetime earnings when he or she reaches adulthood.[16] However, it is also important to note that poverty also affects the environment negatively. The lack of resources such as potable water and sanitary toilets can create negative externalities that can further prevent them from accessing good health—thereby reinforcing this vicious circle.

It is evident that there is a relationship among the dimensions affected by natural disasters and there is no one single channel through which one affects another. For instance, shocks to health can be disastrous, not only for education, but also unemployment and income. The income shocks can cause poor households to reduce spending on important aspects of human development: education and health. In other words, the coping strategies of the poor can have serious long-term consequences in human development. For example, poor households may not have enough means to access healthcare and therefore may either be stuck with poorer health or result to selling off valuable assets in order to pay off hospital bills. Therefore, in theory, poor households may not only suffer the most in times of natural disasters but may also push them deeper into poverty.

[16] Chuang, Erica, Jessie Pinchoff, and Stephanie Psaki. "How Natural Disasters Undermine Schooling." Brookings. Brookings, January 23, 2018. https://www.brookings.edu/blog/education-plus-development/2018/01/23/how-natural-disasters-undermine-schooling/.

Figure 2: The Trap

Natural disasters negatively affect the income and human capital levels (e.g. education, malnutrition) of the poorest households and a decrease in either of them can result in a reduction of the other, thus creating a poverty trap.[17]



(Source: Jun E. Rentschler, "Why Resilience Matters: The Poverty Impacts of Disasters," 2013.)

2.1.1 Unemployment

Much like the Covid-19 global health crisis, natural disasters can impact jobs and incomes negatively. The impact of the current pandemic on employment has been especially severe for informal economy workers, for whom staying home means losing their jobs and their livelihoods.[18] The closure of shops and borders means economic havoc to many lives and livelihoods. In the context of typhoons, this can also mean the destruction of tangible assets such as buildings, equipment and human capital.[19] Sometimes these effects may be fatal and result in firms being

[17] Jun E. Rentschler, "Why Resilience Matters: The Poverty Impacts of Disasters," 2013.
[18] "The Impact of the COVID-19 Pandemic on Jobs and Incomes in G20 Economies." ILO-OECD. International Labour Organization, 2020.
[19] Uchida, Hirofumi, and Arito Ono. "Disasters and Firm Exit: Lessons from the Tohoku Earthquake." CEPR Policy Portal.

forced to close down or downsize.[20] Suffice to say, labor demand is affected. Firms may be forced to lay off employees, permanently or temporarily, as they deal with physical damages and/or loss of customers.

Typically, it is work in the informal economy that tend to be the worst-hit. While employment in the informal economy is not exclusive to the poor, a great proportion of the poor work in the informal economy.[21] For many, their workplace and house are one and the same place. Therefore, when disasters strike, they not only lose their home but also their livelihood. Furthermore, some livelihoods are directly climate sensitive, such as employment in agriculture and fishing; so, when typhoons destroy crops and flood farming regions, it impacts those whose livelihoods depend on these activities.

2.1.2 Education

Places directly hit by typhoons may sustain severe damages to school infrastructure, causing serious disruption to education. But even when they are not damaged, schools can be converted into temporary shelters, which make accessing school for educational purposes physically impossible.

There are many other channels through which natural disasters can prevent a child from attending school, such as loss of family livelihood, health and nutrition.[22] Since education is a normal good, its demand will decrease as a result of income reduction. Some people may not be able to recover their livelihoods and perhaps may have had their houses and belongings swept away by a typhoon. As a result, they may not have the means to obtain things necessary for life (food, water, shelter, health care, education, etc.). [23] Parents may no longer have the means to send their children to

VOX, February 11, 2015. https://voxeu.org/article/disasters-and-firm-exit-lessons-tohoku-earthquake.

[20] Uchida, Hirofumi, and Arito Ono. "Disasters and Firm Exit: Lessons from the Tohoku Earthquake," 2015.

[21] Informal Economy: A Hazardous Activity. Accessed June 7, 2021. https://www.ilo.org/safework/areasofwork/hazardous-work/WCMS_110305/lang--en/index.htm.

[22] "One Million Children Have Education Disrupted as Typhoon Destroys Schools in Philippines." Theirworld. Theirworld, September 17, 2018. https://theirworld.org/news/typhoon-mangkhut-destroys-schools-in-philippines.

[23] Mark Lawrence, Alexandra King and Julius Holt. (2012). "Chapter 2: Livelihood Zoning" in Practitioners' Guide to HEA by Regional Hunger and Development Programme.

school or they may need them to work in order to help the family generate additional income. In this case, they would have no choice but to take their children out of school—thereby increasing the drop-out rates and decreasing total school enrollment among primary school children.[24] However, one should not discount the possibility that children from nonpoor households can also drop out due to intra-household inequality.[25]

Household poverty also means that children can miss out on school to help their families boost family income. After Ebola in Liberia, it was found that two-thirds of girls who dropped out of education was due to poverty. Many of the girls interviewed by Street Child said they needed to help their families earn money by farming, hawking, and trading on the streets.[26] However, the findings of earlier studies on gender-specific probabilities of school dropout are mixed. While some studies have found that a greater proportion of girls drop out due to higher perceived returns of education for boys, others have found a lower dropout probability among girls—that boys are more likely to leave school in order to work and generate additional income for the family through employment in agriculture.[27]

2.1.3 Health

Vulnerability to diseases and poor health can result from undesirable living conditions. The poor, such as the informal settlers living near riverbanks (i.e. flood-prone areas), most of the time have little to no access to clean water, basic sanitation and sanitary toilet facilities, which therefore, significantly increases their risks of catching certain types of diseases in times of massive flooding.

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[24] Cuong Viet Nguyen and Nguyet Minh Pham. The Impact of Natural Disasters on Children's Education: Comparative Evidence from Ethiopia, India, Peru, and Vietnam. *Rev Dev Econ.* 2018; 22: 1561– 1589. https://doi.org/10.1111/rode.12406.
[25] Caitlin Brown et al, 2021. "Sharing the Pie: An Analysis of Undernutrition and Individual Consumption in Bangladesh," CEPR Discussion Papers 15925, C.E.P.R. Discussion Papers.
[26] Kieran Guilbert. "Poverty and Work Means Girls Miss Out on School in Post-Ebola Liberia." Theirworld. Theirworld, May 16, 2017. https://theirworld.org/news/liberia-girls-miss-education-through-poverty-and-work.
[27] Aniceto C. Orbeta Jr., and Ma. Teresa Sanchez (1995), "Population Change, Development and Women's Role and Status and Development in the Philippines," ESCAP Population and Development Asian Population Studies Series No. 134.

Informal settlers often live in makeshift housing. Therefore, following a disaster, they have a higher chance of being displaced and directed to evacuation centers which are usually overcrowded, thus increasing their exposure to diseases even further. Worse, health care facilities may be damaged by the typhoon and thus the availability of medical care may be reduced. In addition, children are more vulnerable to communicable diseases than adults.[28] As such, this not only affects their health in general, but educational outcomes as well.

Anttila-Hughes and Hsiang have found that the risk of a baby girl dying after a typhoon doubles if she has older sisters in the home and the risk nearly doubles again if she has older brothers.[29] This suggests that female infant mortality may be driven by resource scarcity within households (e.g. competition among siblings) and not by physical exposure to typhoons. [30] They uncovered an elevated mortality risk among baby girls that lasts up to two years after a typhoon.[31] The authors suggest that parents may be giving less weight to girls' outcomes when making decisions about intrahousehold resource allocations.[32] Furthermore, the study found that spending on medicine and education were cut by about 25 percent, transport and communication by about 35 percent and high-nutrient foods about 30 percent.[33] This kind of behavior can have short and long term effects, particularly on children.

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[28] Miguel Antonio Salazar et al. "Health Consequences of Typhoon Haiyan in the Eastern Visayas Region Using a Syndromic Surveillance Database." *PLoS currents* vol. 9 ecurrents.dis.4a3d3b4474847b2599aa5c5eefe3a621. 6 Feb. 2017, doi:10.1371/currents.dis.4a3d3b4474847b2599aa5c5eefe3a621

[29] Kathleen Maclay. "Report Details High Costs of Philippine Typhoons for Families, Baby Girls." Berkeley News, November 19, 2013. https://news.berkeley.edu/2013/11/19/report-details-high-costs-of-philippine-typhoons-for-families-baby-girls/.

[30] Jesse Anttila-Hughes and Solomon Hsiang, *Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster* (February 18, 2013). Available at SSRN: https://ssrn.com/abstract=2220501 or http://dx.doi.org/10.2139/ssrn.2220501.

[31] Jesse Anttila-Hughes and Solomon Hsiang, *Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster*, 2013.

[32] Jesse Anttila-Hughes and Solomon Hsiang, *Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster*, 2013.

[33] Jesse Anttila-Hughes and Solomon Hsiang, *Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster*, 2013.

3 Methodology

The aim of this paper is to measure different social and economic outcomes in the Philippines using a difference-in-differences approach, where Region 10 is the treatment group and Region 12 is the control group. This approach allowed me to make assumptions about how the region would have fared in the absence of the typhoon. Harnessing the exogeneity of typhoons in the difference-in-differences analysis strengthened the credibility of the effects.

3.1 Difference-in-Differences

The objective of this study is to attribute several observed impacts to Typhoon Washi. I used the difference-in-differences (DiD) method to identify the causal impact of typhoons on different outcomes. Effects were identified by comparing the changes in outcomes in health, education and unemployment (separately) over time between a region that was hit by the typhoon and one that was not. In other words, I estimated the average treatment effect (ATE) by comparing the average change in outcomes experienced by the treated group to the average change in outcomes experienced by the control group. Simply observing the before and after change of the outcomes for the treatment group will not give a causal impact because many other factors are also likely to influence the outcomes over time. Calculating the difference in the before and after outcomes for Region 10 will control for factors that are constant over time in that region (i.e. first difference).[34] This not only cancelled out the effect of observed time-invariant characteristics, but also the effect of unobserved time-invariant characteristics. To control for the time-varying factors, I also measured the before and after change in outcomes for Region 12 (i.e. second difference). I "cleaned" the first difference of other time-varying factors that affect the outcome by subtracting the second difference, which eliminated the main source of bias.

[34] Paul J. Gertler et al. *Impact Evaluation in Practice*. Seconded. World Bank, 2016.

I conducted a DiD analysis using two regions, Region 10 (treatment) and Region 12 (control), both located in the island of Mindanao. Since the typhoon made landfall over Region 10, it will be the treatment group while Region 12 will be the control group, as it was not affected. The treatment year will be 2012, seeing as Typhoon Washi occurred in December 2011. This means that years prior to 2012 will be considered pre-treatment.

Lastly, falsification tests were performed. These tests of validity allowed me to confidently assume that the path of outcomes for Region 10 and 12 would not be systematically different in the absence of the typhoon; therefore, any difference in outcomes after the treatment can be attributed to the typhoon.

3.2 Equal Trends Assumption

The study will rely on the assumption of parallel trends, which is the main assumption in DiD designs. This is needed in order to identify a causal effect. To test the validity of this assumption, I compared changes in outcomes for the treatment and control groups before the typhoon to check the validity of the equal trend assumption (i.e. years prior to 2012). It was important that these outcomes exhibit similar trends before the typhoon in order to gain confidence that outcomes would have continued to move in tandem after the disaster. This was done visually with multiple pre-treatment time periods through line charts and graphs.

I also performed placebo tests to test this assumption by conducting another DiD analysis using a "fake" treatment group. This allowed me to further probe the soundness of the research design by checking for an association that should be present if the design is flawed. In other words, there should be zero impact; otherwise, I cannot assume that my treatment and control group have equal trends in the absence of the typhoon.[35]

[35] Paul J. Gertler et al. *Impact Evaluation in Practice*. Seconded. World Bank, 2016.

3.3 Data

Time-series statistical data was taken from the Philippine Statistics Authority (PSA) and the Education Management Information System Division - Planning Service (DepEd-EMISD) of the Philippine Department of Education. The PSA is the primary statistical arm of the government, and therefore "responsible in the conduct and content of all national censuses and surveys, gathering of sectoral statistics, consolidation of selected administrative recording systems and compilation of national accounts".[36] The yearly statistics for infant mortality rate and unemployment rate used in this paper are part of the 2019 Philippine Statistical Yearbook (PSY), which is an annual publication prepared by the PSA. The primary education dropout rates were directly provided by the DepEd- EMISD. Due to data constraints, statistics for employment and health can only be analyzed at the regional level.

3.4 Intermediate Variables

Typhoons do not directly affect health and education; it only affects these outcomes through intermediate variables or channels that connect the destruction caused by typhoons to infant mortality and primary education dropout (see Figure 3 below). Unfortunately, these intermediate variables will not be measured in this paper.

The number of children in poor households will be used as a channel linking typhoons and educational outcomes: primary school drop-out rates. Though being poor does not necessarily imply being vulnerable, poverty certainly makes people relatively more vulnerable to natural disasters.[37] The poor are more likely to be displaced or negatively affected by typhoons. Following a disaster, oftentimes children are unable to go back to school because (1) loss of livelihood of parents, (2) schools are destroyed/damaged or being used as shelter and (3) health issues. Children

[36] "About OpenSTAT." OpenSTAT. Philippine Statistics Authority, n.d. Accessed June 10, 2021.
[37] Jun E. Rentschler, "Why Resilience Matters: The Poverty Impacts of Disasters," 2013.

are forced to drop-out or discontinue schooling due to these issues. While studies suggest that these problems are more likely to interrupt the education of poor children after a disaster, the effect on nonpoor children should not be ruled out, especially in the case of dropouts due to school infrastructure damage.

I will estimate the effect of typhoons on infant mortality rates by using the proportion of families without access to potable water and sanitary toilet facilities as an intermediate variable. Those with little to no access to toilets or clean water are most likely to be among those living in informal settlements. These people do not formally own land and often live in makeshift housing, which more often than not have poor sanitation. The lack of access to clean water and sanitary toilet facilities increases the likelihood that they drink, eat and bathe in contaminated water. Similar to education, the effect on nonpoor children should not be excluded from the typhoon's impact on infant mortality. Damage to health care centers may reduce the availability of medical care for both the poor and nonpoor.

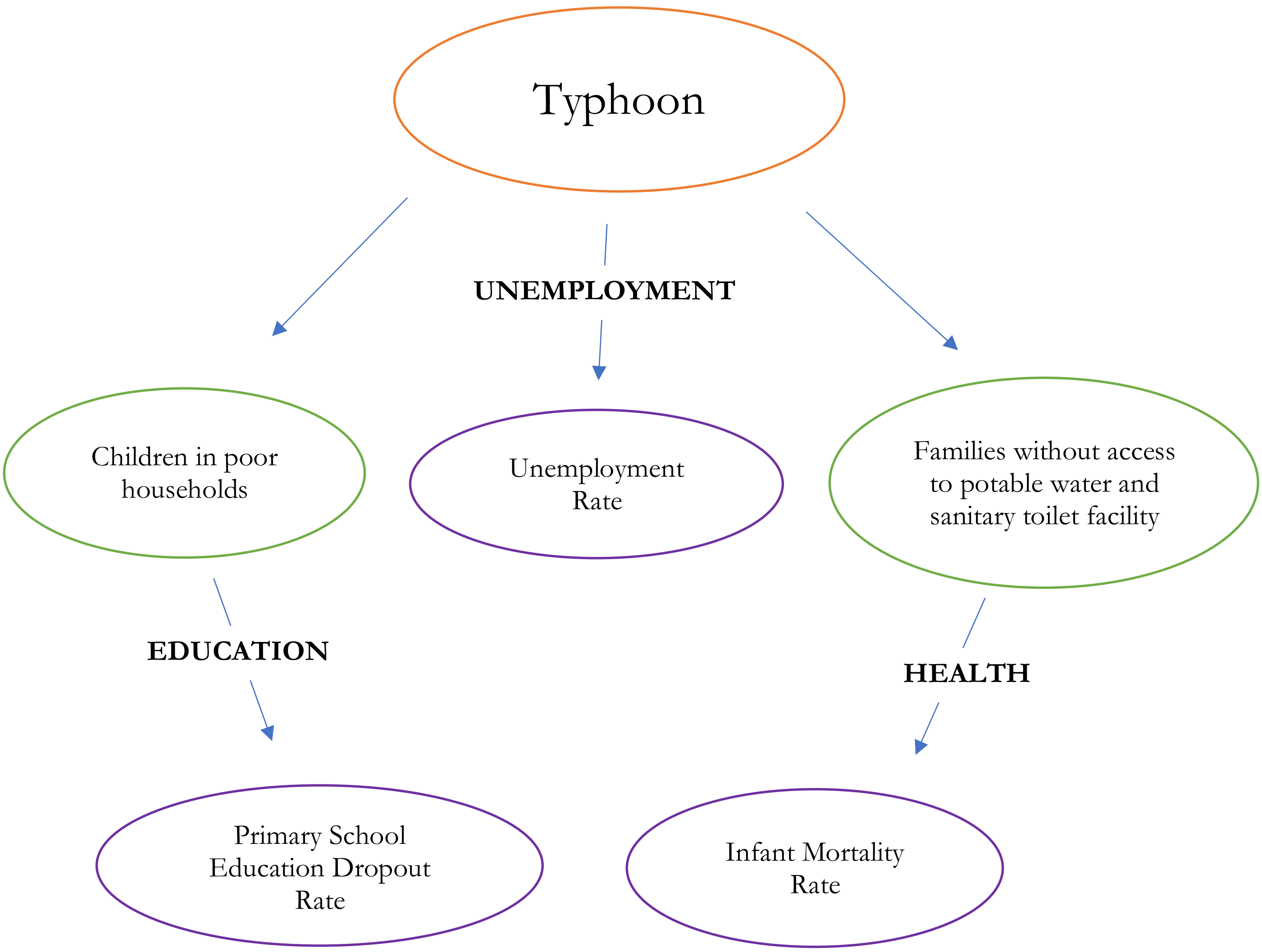
3.5 Limitations

The difference-in-differences method will take out the effects of the time-invariant unobserved factors, as well as any time-varying common shocks. However, a limitation of DiD is that it will not address the region time-varying effect or the differences between the treatment and control group that did change over time. For instance, this can include those policies, programs or reforms that may have decreased the student dropout rate or decreased the unemployment rate in Region 12 in the years after the typhoon. Any factor that affects the difference in trends between the two groups (and is not accounted for in the regression) would lead to biased results.[38] In that case, I may need to consider a different control group.

[38] Paul J. Gertler et al. *Impact Evaluation in Practice*. Seconded. World Bank, 2016.

3.6 Causal Graph

Figure 3: Causal Graph



Note: This graph is only a simplified version of the channels through which typhoons impact education, health and unemployment. They can be affected through other mechanisms. Typhoons do not directly affect health and education; it only affects these outcomes through the intermediate variables.

4 Results

In this section, I summarize the results in unemployment rate, primary education dropout rate and infant mortality rate. Region 12 served as the control group.

4.1 Unemployment Rate in Region X

Effect of Typhoon Washi on **Unemployment Rate** in Region 10

Table 1: Unemployment Rate in Region X

Unemployment Rate in Region X

	Dependent variable:					
	Long Term			Short Term		
	(1)	(2)	(3)	(4)	(5)	(6)
treat	1.184***	1.184***	0.604	0.738**	0.738*	0.604
	(0.200)	(0.202)	(0.373)	(0.295)	(0.292)	(0.452)
treat_year		0.196	-0.190		0.312	0.179
		(0.233)	(0.305)		(0.292)	(0.452)
treat:treat_year			0.773*			0.266
			(0.431)			(0.640)
Constant	3.993***	3.846***	4.136***	4.225***	4.069***	4.136***
	(0.141)	(0.226)	(0.264)	(0.209)	(0.253)	(0.320)
Observations	16	16	16	8	8	8
R^2	0.715	0.730	0.787	0.509	0.600	0.617
Adjusted R^2	0.695	0.688	0.734	0.428	0.441	0.330
Residual Std. Error	0.400 (df = 14)	0.404 (df = 13)	0.373 (df = 12)	0.418 (df = 6)	0.413 (df = 5)	0.452 (df = 4)
F Statistic	35.111*** (df = 1; 14)	17.546*** (df = 2; 13)	14.764*** (df = 3; 12)	6.231** (df = 1; 6)	3.757 (df = 2; 5)	2.148 (df = 3; 4)
Significance levels						*p**p***p<0.01

Note: The long term refers to years 2010 to 2017 (Columns 1-3) and the short term refers to years 2010 to 2013 (Columns 4-6).

Table 1 presents the average treatment effect on unemployment rate in Region 10 over the long and short term. The DiD estimate for the long term shows that the typhoon increased unemployment rate in Region 10 by 0.773, which is statistically significant at 10%. This is approximately a 19% difference from the average of the control region, Region 12. Interestingly, the treatment effect is smaller in the short term at 0.266 and is not statistically significant. The standard error is high relative to the coefficient.

4.2 Dropout Rate in Region X

Effect of Typhoon Washi on **Primary Education Dropout Rate** in Cagayan de Oro City

Table 2: Dropout Rate in CDO

Dropout Rate in Cagayan de Oro City

	Dependent variable:					
	Long Term			Short Term		
	(1)	(2)	(3)	(4)	(5)	(6)
treat	1.887^{***}	1.887^{***}	1.155	2.660	2.660	0.249
	(0.630)	(0.565)	(0.790)	(1.397)	(1.471)	(1.583)
treat_year		-1.625^{***}	-2.357^{***}		0.944	-1.467
		(0.565)	(0.790)		(1.471)	(1.583)
treat:treat_year			1.464			4.822^{*}
			(1.117)			(2.239)
Constant	2.279^{***}	3.092^{***}	3.458^{***}	2.755^{**}	2.283	3.489^{**}
	(0.445)	(0.489)	(0.558)	(0.988)	(1.274)	(1.119)
Observations	32	32	32	8	8	8
R^2	0.230	0.401	0.436	0.377	0.424	0.733
Adjusted R^2	0.205	0.360	0.375	0.273	0.193	0.533
Residual Std. Error	1.782 (df = 30)	1.599 (df = 29)	1.579 (df = 28)	1.976 (df = 6)	2.081 (df = 5)	1.583 (df = 4)
F Statistic	8.977^{***} (df = 1; 30)	9.710^{***} (df = 2; 29)	7.207^{***} (df = 3; 28)	3.623 (df = 1; 6)	1.840 (df = 2; 5)	3.666 (df = 3; 4)
Significance levels						*p**p***p<0.01

Note: The long term refers to years 2008 – 2015 (Columns 1-3) and the short term refers to years 2011 – 2012 (Columns 4-6). Cagayan de Oro City and Koronadal City are the regional centers of Region 10 and 12, respectively.

Table 2 indicates that exposure to typhoons negatively affects children's education at the division level. Immediately after the typhoon, the primary education dropout rate in Cagayan de Oro City increased by 4.822, which is statistically significant at 10%. This is approximately a 138% difference from the average of the control region, Koronadal City. In other words, there is a significant increase in dropouts among children immediately after the typhoon. Over the long term, the average treatment effect again increased, showing a 42% difference from the average, which is much lower compared to the difference calculated in the short-term. This estimate is not statistically significant.

4.3 Infant Mortality Rate in Region X

Effect of Typhoon Washi on **Infant Mortality Rate** in Region 10

Table 3: Infant Mortality Rate in Region X

Infant Mortality Rate in Region X

	Dependent variable:					
	Long Term			Short Term		
	(1)	(2)	(3)	(4)	(5)	(6)
treat	3.277***	3.277***	3.427***	3.585***	3.585***	3.170**
	(0.610)	(0.614)	(0.944)	(0.816)	(0.821)	(1.174)
treat_year		0.157	0.288		0.565	0.150
		(0.620)	(0.883)		(0.821)	(1.174)
treat:treat_year			-0.262			0.830
			(1.249)			(1.660)
Constant	6.131***	6.041***	5.967***	5.815***	5.533***	5.740***
	(0.431)	(0.560)	(0.668)	(0.577)	(0.711)	(0.830)
Observations	70	70	70	40	40	40
R^2	0.298	0.299	0.299	0.337	0.345	0.350
Adjusted R^2	0.288	0.278	0.268	0.320	0.310	0.296
Residual Std. Error	2.550 (df = 68)	2.568 (df = 67)	2.586 (df = 66)	2.580 (df = 38)	2.598 (df = 37)	2.624 (df = 36)
F Statistic	28.904*** (df = 1; 68)	14.285*** (df = 2; 67)	9.402*** (df = 3; 66)	19.314*** (df = 1; 38)	9.760*** (df = 2; 37)	6.458*** (df = 3; 36)
Significance levels						*p**p***p<0.01

Note: The long term refers to years 2009 – 2015 (Columns 1-3) and the short term refers to years 2010 – 2013 (Columns 4-6).

Table 3 shows that the effect of typhoons on infant mortality rate is not statistically significant for either period when Region 12 was used a control group. Nonetheless, it seems that infant mortality rate increased by 0.83 in the short term but decreased by 0.262 in the long term. Note, however, that the coefficient for the long-term has a high standard error and an R^2 of 0.299—which means that only 29.9% of the total variation is explained by the model.

5 Discussion

Based on the results in the previous section, Typhoon Washi increased unemployment, primary education dropout and infant mortality in Region 10. The impact on primary education dropout and infant mortality are large immediately after the typhoon, while the increase in unemployment is larger and more significant in the long term. It is important, however, to bear in mind that I did not measure the intermediate variables; therefore, I cannot identify the exact channels through which typhoons affected the outcomes.

5.1 Impact on Unemployment

Prior to Typhoon Washi, the primary source of income or livelihoods in affected areas required only elementary education such as crafts and related trades, micro-enterprise, elementary occupation and subsistence agriculture.[39] These include jobs as street vendors, construction workers, farmers, general unskilled workers, etc. This means that a great number of people were engaged in precarious work situations.[40]

Although there was an increase in unemployment immediately after Typhoon Washi, this finding is not significant. One possible explanation for this is the public and private entities that extended livelihood opportunities to victims whose livelihoods were damaged by the typhoon. These opportunities include emergency cash for work schemes which involved roads and canal cleaning, food preparation, loading/unloading goods, repacking of relief goods, sorting and inventory of damaged property, clearing of debris, among other things. In other words, the effect may not be significant because jobs were created through government programs, livelihood support and work during the rebuilding phase. In contrast, the high increase in unemployment over the long term

[39] "Rapid Impact Assessment of Disaster on Sources of Livelihood and Employment Opportunities." MSU-Iligan Institute of Technology. International Labour Organization, December 2012.
[40] Pablo Acosta et al. "Investing in Skills to Promote Inclusive Growth in Mindanao." The World Bank, September 2019. https://openknowledge.worldbank.org/bitstream/handle/10986/32508/Investing-in-Skills-to-Promote-Inclusive-Growth-in-Mindanao.pdf?sequence=1&isAllowed=y.

may suggest that while the government is effective in assisting victims in the short term, its policies or programs may be lacking or ineffective in the long term—that although the cash for work program filled an immediate need, it is disconnected from longer-term livelihood resumption.[41] Also, the rebuilding phase may have finished and those who benefited from the livelihood support programs may be left jobless once again.

To check the validity of the equal trend assumption, I performed a difference-in-differences analysis using two comparison groups. In this case, I used Region 12 and Region 11 and found zero impact over the years 2010 to 2017. This means that there is no underlying difference in trends between these two control groups. Therefore, I can assume that Region 10 and Region 12 have equal trends before the typhoon, and the effect on unemployment in Region 10 after the disaster can be attributed to the typhoon.

5.2 Impact on Dropout

The difference-in-differences estimates calculated at the regional level did not show statistically significant results for primary education dropout rates, both over the long and short term. In fact, the standard errors relative to their coefficients are quite high. This is likely due to the scope or size of the unit of analysis. Nonetheless, both DiD estimates measured at the regional level seem to show an increase in dropouts among primary school children in Region 10—with a larger increase in the short term.

Another DiD analysis was conducted using data disaggregated by division level—narrowing the focus on just Cagayan de Oro City. Results indicate that exposure to typhoons negatively affects children's education at this level. Results in Table 2 show that over the long term, the dropout rate increased by 1.464. This estimate is not statistically significant. However, immediately after the

[41] Thomas Bowen, "Social Protection and Disaster Risk Management in the Philippines The Case of Typhoon Yolanda (Haiyan)." World Bank Group, November 2015.

typhoon, the dropout rate in CDO was more than three times as high at 4.822 (compared to the long term DiD estimate) and is statistically significant at the 10%. The regional estimates show a similar pattern (see Table 5)—suggesting that in both analyses, primary education dropout is lower in the long term compared to the short term.

This high increase in primary education dropout immediately after the typhoon is possibly driven by either (1) a shift in parental investments made to cope with the economic consequences of typhoon damages, (2) health conditions of children or (3) damage to school infrastructure. Children may have dropped out due to sickness (e.g. diarrheal disease after floods), injury, displacement or damage to schools and infrastructure—especially since repairs to schools tend to be slow and delayed.[42] This would make accessing school physically impossible immediately after the typhoon. Even when they are not damaged, schools can be used as temporary shelters, which can last months or years. The lower dropout rate, in the long term, may then suggest that children recovered from sickness and/or school infrastructure had been repaired—both allowing children to return to school. But I repeat, this estimate is not statistically significant (i.e. the standard error is high).

Female and male dropout rates were also measured separately. The effect on girls' dropout rates seemed to increase in 2012 by 4.11 and is statistically significant at 10%. This is a 191% difference from the average. Conversely, the DiD estimate on boys' dropout rate was not statistically significant. Nonetheless, it showed a 4.152 increase, which is about an 83% difference from the average. These findings suggest that, in proportion to their respective averages, female dropouts were not only more than that of boys but also statistically significant. Perhaps this differs from earlier studies that report a higher increase in dropouts among boys because those findings may be reflecting the outcomes of older boys—those in secondary school. The boys in the age group

[42] Chuang, Erica, Jessie Pinchoff, and Stephanie Psaki. "How Natural Disasters Undermine Schooling." Brookings. Brookings, January 23, 2018. https://www.brookings.edu/blog/education-plus-development/2018/01/23/how-natural-disasters-undermine-schooling/.

measured in this study might not fall under those who drop out due to employment opportunities in agriculture.

The validity of the parallel trends assumption has been verified for primary education dropout rates through an examination of the trends of Cagayan de Oro City and Koronadal City in years prior to 2012. I can confidently assume that the outcomes of the treatment and control would continue to move in tandem after the typhoon. To further test this assumption, I performed a placebo test and found zero impact.

5.3 Impact on Infant Mortality

The effect of typhoons on infant mortality rate is not statistically significant for either period (long or short) when Region 12 was used a control group. This may suggest that Region 12 is not a reliable control group for measuring infant mortality rate. It may not be a good counterfactual because Region 12 poses one of the highest prevalence of undernutrition among children in the Philippines.[43] Most of its provinces also register a high proportion of food insecure children. Nonetheless, according to Table 3, it seems that infant mortality rate increased by 0.83 immediately after the disaster but decreased in the long term.

Part of the explanation for the increase (in the short term) in infant mortality lies in the proportion of families without access to potable water and sanitary toilet facilities. According to a post-disaster assessment report of Typhoon Washi, a great majority of those who were displaced had been living in extremely high-risk informal settlements prior to the disaster. Oftentimes, those who live in these informal settlements are those who lack basic hygiene and sanitation services. Therefore, immediately after Typhoon Washi, the stagnant flood waters compounded by the lack of potable water and basic sanitation exposed these populations to the risk of all sorts of diseases and health

[43] Elma Laguna. "Sizing Up: The Stunting and Child Malnutrition Problem in the Philippines." Save the Children Philippines, 2015.

issues. For instance, polluted water may cause weaning foods (e.g. rice gruel) to be fatal.[44] Furthermore, after the typhoon, most of these people were evacuated from their ruined neighborhoods to overcrowded shelters. These shelters had limited food, water and basic sanitation which inevitably increased the exposure to diseases even further.

Another possible explanation for the immediate increase in infant mortality is the inadequate emergency preparedness of the region's health services for a disaster of this scale and magnitude. Hospitals and the whole region, in general, were unprepared and ill-equipped when the massive flash floods swept through Region 10.[45] Since the region is not known to be flood-prone, it does not have flood drills.[46] In fact, most of the residents have not seen floods to anywhere near this scale in their entire lives. In addition, health care facilities may have also been destroyed by the typhoon, leaving people without access to emergency health services.

Conversely, the decrease in infant mortality rate over the long term suggests that health services in Region 10 may have improved and/or health care facilities that were destroyed by the typhoon may have been fully restored and rehabilitated. But I repeat, the standard error of the long-term estimate is high.

The validity of the parallel trends assumption has been verified for infant mortality rate through an examination of the trends of Region 10 and 12 in years prior to 2012. However, the parallel trend does not exactly equal to 0; it is not exactly parallel. Therefore, while the similar trend enables a comparison, the point estimates may not be credible because underlying the precise results are strong assumptions. In this case, it may be better to use Manski and Pepper bounds—wherein

[44] Debora Mackenzie. "Typhoon Haiyan: Baby Girl Death Toll Will Rise." New Scientist, November 25, 2013. https://www.newscientist.com/article/dn24644-typhoon-haiyan-baby-girl death-toll-will-rise/#ixzz6wG0RwiWB.
[45] "Hospital Assessment to Test Disaster Resilience." The New Humanitarian, March 13, 2012. https://www.thenewhumanitarian.org/fr/node/251753.
[46] The New Humanitarian. 2012.

bounds of estimates are used instead of point estimates.[47] Since the pre-treatment trend is not exactly parallel, the maximum and minimum difference between the two regions before the typhoon provided the upper and lower bounds. This allowed me to see how different the estimates can be before the treatment. While this weaker assumption may provide less precision (bounds) than the parallel trends assumption, it is more credible. The lower and upper bounds are represented visually in Appendix D.

To further check the typhoon's effect on infant mortality rate in Region 10, the same difference-in-differences analysis was conducted using Region 9 as a comparison group. Based on the output of the regression model, the average treatment effect in the short term is 3.83 and is significant at the 5% level. In other words, Region 10 witnessed an increase in the infant mortality rate by an average of 3.83. This is a 39% difference from the average. The results also show an increase in the infant mortality rate by 2.11 in the long term, which is statistically significant at the 10% level. Unlike the average treatment effects in Table 3, both of the DiD estimates are positive. Taken together, these estimates have larger differences from the averages than the differences when Region 12 was used as a control group. The fact that infant mortality rate is lower (although still a positive coefficient) in the long-term suggests that (similar to the DiD analysis with Region 12 as the control group) health services in Region 10 may have improved and/or health care facilities that were damaged by the typhoon may have been fully restored and rehabilitated. Taken together, in both analyses, it seems that the DiD estimates are lower in the long term compared to the short term.

Similar to the results for education, the female under one mortality estimate is statistically significant, while male infant mortality rate is not. Results show that the impact on females increased by an average of 49 two years after the typhoon. This finding is statistically significant at

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[47] Charles F. Manski and John V. Pepper; How Do Right-to-Carry Laws Affect Crime Rates? Coping with Ambiguity Using Bounded-Variation Assumptions. *The Review of Economics and Statistics* 2018; 100 (2): 232–244. doi: https://doi.org/10.1162/REST_a_00689

the 10% level and therefore consistent with Anttila-Hughes and Hsiang's findings that in times of economic duress, parents give less weight to girls' outcomes.[48] Therefore, this may indicate that after the typhoon, resource scarcity played a role in intrahousehold resource allocations. Although male under one mortality seemed to increase by 59, it is not statistically significant.

[48] Jesse Anttila-Hughes and Solomon Hsiang, *Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster*, 2013.

6 Conclusion

This paper has provided evidence that exposure to typhoons increase unemployment, primary education dropout and infant mortality. Unfortunately, due to data constraints, the results are not exclusive to the outcomes of the poor. The data used in this paper limits the analysis to the overall effect of a typhoon. Although the intermediate variables may theoretically be more likely among the poor, the paper could not provide evidence that the effects on the poor are indeed worse than those of the nonpoor. Nonetheless, it has offered a selection of variables that may help in explaining the outcomes.

First, the statistically significant increase in unemployment over the long term may suggest that while the government is effective in assisting victims in the short term, its policies or programs may be lacking or ineffective in the long term. Second, primary education dropout increased both in the short and long term; however, the former showed a larger increase and is statistically significant. This may suggest that the damages to school infrastructure have been repaired over the long term, allowing children to return to school. Therefore, reopening schools should be one of the top priorities of disaster relief efforts. Lastly, infant mortality increased in the short term and decreased in the long term; however, neither of these estimates are statistically significant. Therefore, another difference-in-differences analysis was conducted using Region 9 as a control group. This analysis showed an increase in infant mortality rate both in the short and long term, which were both statistically significant. Similar to dropout rates, the effect is much larger in the short term, which may reflect the importance of reopening health care facilities, when safe. It is important to note, however, that the effects identified for Region 10 may be due, in part, to the fact that Mindanao is not prone to disasters and thus was just not prepared.

Since this study did not measure the intermediate variables, it cannot identify the exact channels through which typhoons affected the outcomes (i.e. mechanisms). However, drawing on the literature that has supported this paper, I argue that policies that address the intermediate variables (access to clean water and sanitary toilet facilities, environment and poverty among children) could potentially lower the Filipino people's vulnerability to typhoons. This is important especially if other parts of the country are affected by typhoons in the same way and extent as Region 10. Since the Philippines frequently experiences typhoons, lowering these vulnerabilities "may" be an important ingredient in increasing the country's score on the Human Development Index. I emphasize the word "may" because this paper cannot assert for certain that these vulnerabilities do exist.

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8 Appendices

8.1 Appendix A: Unemployment

Table 4: Placebo Test for Unemployment Rate

Placebo Test for Unemployment: Region XII and XI, 2010-2017

	Dependent variable:		
	unemp_rate		
	(1)	(2)	(3)
treat	-1.653***	-1.653***	-1.610**
	(0.296)	(0.305)	(0.635)
treat_year		-0.162	-0.133
		(0.352)	(0.518)
treat:treat_year			-0.057
			(0.733)
Constant	5.645***	5.767***	5.745***
	(0.210)	(0.341)	(0.449)
Observations	16	16	16
R^2	0.690	0.695	0.695
Adjusted R^2	0.667	0.648	0.618
Residual Std. Error	0.593 (df = 14)	0.610 (df = 13)	0.635 (df = 12)
F Statistic	31.100*** (df = 1; 14)	14.778*** (df = 2; 13)	9.101*** (df = 3; 12)
Significance Levels			*p**p***p<0.01

8.2 Appendix B: Dropout

8.2.1 Regional Level

Table 5: Dropout Rate in Region X, Regional Level

Dropout Rate in Region X: Regional Level

	Dependent variable:					
	Long Term			Short Term		
	(1)	(2)	(3)	(4)	(5)	(6)
treat	0.482	0.482	0.312	0.467	0.467	-0.066
	(0.599)	(0.534)	(0.819)	(0.999)	(1.009)	(1.440)
treat_year		-3.364***	-3.539***		-0.474	-1.082
		(0.531)	(0.832)		(0.998)	(1.539)
treat:treat_year			0.296			1.065
			(1.083)			(2.036)
Constant	5.465***	7.387***	7.487***	6.811***	7.048***	7.352***
	(0.461)	(0.510)	(0.629)	(0.755)	(0.911)	(1.089)
Observations	154	154	154	42	42	42
R^2	0.004	0.213	0.214	0.005	0.011	0.018
Adjusted R^2	-0.002	0.203	0.198	-0.019	-0.040	-0.059
Residual Std. Error	3.655 (df = 152)	3.259 (df = 151)	3.269 (df = 150)	3.204 (df = 40)	3.235 (df = 39)	3.266 (df = 38)
F Statistic	0.646 (df = 1; 152)	20.494*** (df = 2; 151)	13.604*** (df = 3; 150)	0.218 (df = 1; 40)	0.220 (df = 2; 39)	0.235 (df = 3; 38)
Significance levels						*p**p***p<0.01

Note: The long term refers to years 2009 – 2015 and the short term refers to years 2011- 2012.

Table 6: Placebo Test for Dropout Rate – Regional

Placebo Test for Dropout Rate: Region XII and XI, 2009-2015

	Dependent variable:		
	dropout_rate		
	(1)	(2)	(3)
treat	-0.003	-0.003	-0.003
	(0.007)	(0.006)	(0.009)
treat_year		-0.035^{***}	-0.035^{***}
		(0.006)	(0.008)
treat:treat_year			-0.001
			(0.012)
Constant	0.058^{***}	0.078^{***}	0.078^{***}
	(0.005)	(0.005)	(0.006)
Observations	126	126	126
R^2	0.002	0.229	0.229
Adjusted R^2	-0.006	0.217	0.210
Residual Std. Error	0.037 (df = 124)	0.032 (df = 123)	0.032 (df = 122)
F Statistic	0.229 (df = 1; 124)	18.279^{***} (df = 2; 123)	12.088^{***} (df = 3; 122)
Significance levels			*p**p***p<0.01

8.2.2 Division Level

Table 7: Female and Male - Dropout Rate in CDO, 2010-2012

Female and Male: Dropout Rate in Cagayan de Oro City, 2010-2012

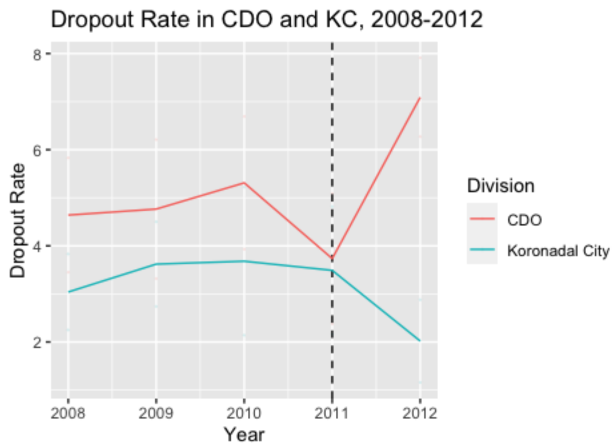
	Dependent variable:					
	Female			Male		
	(1)	(2)	(3)	(4)	(5)	(6)
treat	2.376	2.376	1.007	2.257	2.257	0.873
	(1.178)	(1.232)	(0.774)	(1.089)	(1.257)	(0.825)
treat_year		1.061	-0.993		-0.058	-2.134
		(1.307)	(0.948)		(1.333)	(1.010)
treat:treat_year			4.110*			4.152
			(1.341)			(1.428)
Constant	1.820*	1.467	2.152*	4.307***	4.326**	5.018**
	(0.833)	(0.974)	(0.548)	(0.770)	(0.994)	(0.583)
Observations	6	6	6	6	6	6
R^2	0.504	0.594	0.929	0.518	0.518	0.908
Adjusted R^2	0.380	0.323	0.822	0.397	0.197	0.769
Residual Std. Error	1.443 (df = 4)	1.509 (df = 3)	0.774 (df = 2)	1.333 (df = 4)	1.539 (df = 3)	0.825 (df = 2)
F Statistic	4.067 (df = 1; 4)	2.191 (df = 2; 3)	8.673 (df = 3; 2)	4.296 (df = 1; 4)	1.613 (df = 2; 3)	6.563 (df = 3; 2)
Significance levels						*p**p***p<0.01

Table 8: Placebo Test for Dropout Rate – Division

Placebo Test for Dropout Rate: Koronadal City and Tacurong City, 2008-2016

	Dependent variable:		
	dropout_rate		
	(1)	(2)	(3)
treat	-0.387	-0.387	-0.183
	(0.876)	(0.613)	(0.949)
treat_year		-2.590^{***}	-2.407^{**}
		(0.617)	(0.901)
treat:treat_year			-0.367
			(1.274)
Constant	2.474^{***}	3.913^{***}	3.811^{***}
	(0.619)	(0.553)	(0.671)
Observations	18	18	18
R^2	0.012	0.546	0.548
Adjusted R^2	-0.050	0.485	0.452
Residual Std. Error	1.858 (df = 16)	1.301 (df = 15)	1.343 (df = 14)
F Statistic	0.195 (df = 1; 16)	9.009^{***} (df = 2; 15)	5.666^{***} (df = 3; 14)
Significance levels			*p**p***p<0.01

Figure 4: Parallel Trends - Dropout Rate in CDO and KC, 2008-2012



8.3 Appendix C: Infant Mortality

Table 9: Female and Male - Infant Mortality Rate, Region X and XII, 2010-2013

Female and Male: Infant Mortality Rate in Region X and XII, 2010-2013

	Dependent variable:					
		Female			Male	
	(1)	(2)	(3)	(4)	(5)	(6)
treat	142.000***	142.000***	146.000***	145.250***	145.250***	172.500***
	(11.314)	(6.914)	(10.559)	(22.597)	(19.268)	(23.598)
treat_year		23.000**	27.000*		34.750	62.000*
		(6.914)	(10.559)		(19.268)	(23.598)
treat:treat_year			-8.000			-54.500
			(14.933)			(33.373)
Constant	201.500***	190.000***	188.000***	310.500***	293.125***	279.500***
	(8.000)	(5.987)	(7.467)	(15.979)	(16.687)	(16.686)
Observations	8	8	8	8	8	8
R^2	0.963	0.989	0.989	0.873	0.923	0.954
Adjusted R^2	0.957	0.984	0.981	0.852	0.892	0.919
Residual Std. Error	16.000 (df = 6)	9.778 (df = 5)	10.559 (df = 4)	31.958 (df = 6)	27.249 (df = 5)	23.598 (df = 4)
F Statistic	157.531*** (df = 1; 6)	216.454*** (df = 2; 5)	123.821*** (df = 3; 4)	41.315*** (df = 1; 6)	30.040*** (df = 2; 5)	27.592*** (df = 3; 4)
Significance levels						*p**p***p<0.01

Table 10: Infant Mortality Rate, Region X and IX

Infant Mortality Rate in Region X and IX

	Dependent variable:					
	Long Term			Short Term		
	(1)	(2)	(3)	(4)	(5)	(6)
treat	0.730	0.730	-0.473	1.025	1.025	-0.890
	(0.638)	(0.632)	(0.952)	(0.926)	(0.931)	(1.249)
treat_year		-0.909	-2.079**		-0.722	-2.850**
		(0.635)	(0.938)		(0.926)	(1.316)
treat:treat_year			2.106*			3.830**
			(1.259)			(1.766)
Constant	8.679***	9.198***	9.867***	8.375***	8.736***	9.800***
	(0.475)	(0.595)	(0.709)	(0.690)	(0.834)	(0.931)
Observations	63	63	63	36	36	36
R^2	0.021	0.053	0.096	0.035	0.052	0.174
Adjusted R^2	0.005	0.022	0.050	0.006	-0.005	0.096
Residual Std. Error	2.515 (df = 61)	2.493 (df = 60)	2.457 (df = 59)	2.761 (df = 34)	2.777 (df = 33)	2.633 (df = 32)
F Statistic	1.311 (df = 1; 61)	1.693 (df = 2; 60)	2.095 (df = 3; 59)	1.225 (df = 1; 34)	0.910 (df = 2; 33)	2.242 (df = 3; 32)
Significance levels						*p**p***p<0.01

Note: The long term refers to years 2009 – 2015 and the short term to years 2010 – 2013.

Table 11: Infant Mortality Rate, Region X and IX, 2010-2012

Infant Mortality Rate in Region X and IX, 2010-2012

	Dependent variable:		
	IMR		
	(1)	(2)	(3)
treat	0.510	0.510	-0.890
	(1.100)	(1.120)	(1.306)
treat_year		-0.417	-2.750
		(1.180)	(1.687)
treat:treat_year			4.200*
			(2.263)
Constant	8.883***	9.022***	9.800***
	(0.820)	(0.923)	(0.974)
Observations	27	27	27
R^2	0.009	0.014	0.142
Adjusted R^2	-0.031	-0.069	0.030
Residual Std. Error	2.840 (df = 25)	2.891 (df = 24)	2.754 (df = 23)
F Statistic	0.215 (df = 1; 25)	0.166 (df = 2; 24)	1.270 (df = 3; 23)
Significance levels			*p**p***p<0.01

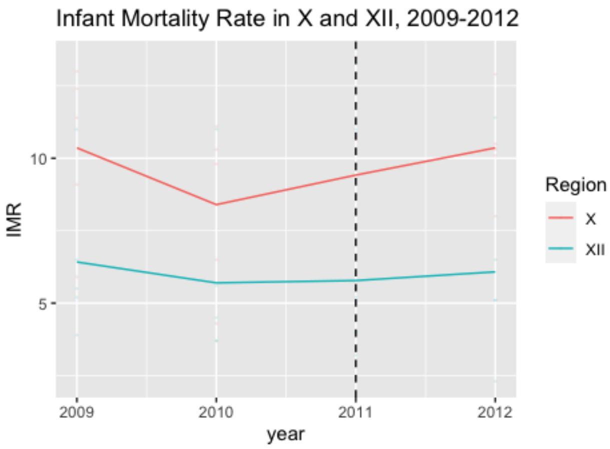
Table 12: Female and Male - Infant Mortality Rate, Region X and IX, 2010-2013

Female and Male: Infant Mortality Rate in Region X and IX, 2010-2013

	Dependent variable:					
		Female			Male	
	(1)	(2)	(3)	(4)	(5)	(6)
treat	123.000***	123.000***	98.500***	147.000***	147.000***	117.500**
	(12.649)	(13.636)	(12.835)	(25.399)	(26.026)	(35.472)
treat_year		-5.500	-30.000*		-22.000	-51.500
		(13.636)	(12.835)		(26.026)	(35.472)
treat:treat_year			49.000*			59.000
			(18.152)			(50.165)
Constant	220.500***	223.250***	235.500***	308.750***	319.750***	334.500***
	(8.944)	(11.809)	(9.076)	(17.960)	(22.539)	(25.082)
Observations	8	8	8	8	8	8
R^2	0.940	0.942	0.980	0.848	0.867	0.901
Adjusted R^2	0.930	0.919	0.964	0.823	0.814	0.827
Residual Std. Error	17.889 (df = 6)	19.285 (df = 5)	12.835 (df = 4)	35.920 (df = 6)	36.806 (df = 5)	35.472 (df = 4)
F Statistic	94.556*** (df = 1; 6)	40.762*** (df = 2; 5)	63.771*** (df = 3; 4)	33.496*** (df = 1; 6)	16.308*** (df = 2; 5)	12.167** (df = 3; 4)
Significance levels						*p**p***p<0.01

Figure 5: Parallel Trends - Infant Mortality Rate, Region X and IX, 2009-2012

Figure 6: Parallel Trends - Infant Mortality Rate, Region X and XII, 2009-2012



8.4 Appendix D: Manski Pepper Bounds

Figure 7: Manski Pepper Bounds

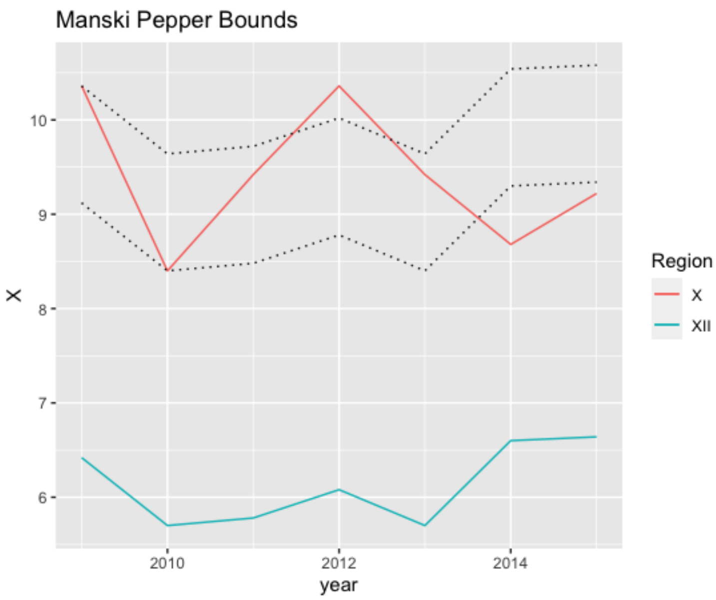


Figure 8: Lower and Upper Bounds of the Estimated Treatment Effects