Analyzing the Relationship Between Exposure to Extreme Weather and Economic Inequality in the Philippines

Jaimie Kim Bayani-Arias[1] and Rosalina Palanca-Tan[2]

Abstract

This paper looks into the relationship between typhoon exposure and inequality in per capita income and per capita expenditure of households in the Philippines by comparing the change in the Theil L and Theil T inequality indexes between 2009 and 2012 across different exposure groups. A decomposition analysis of the Theil index was also undertaken to establish the relative contributions of within-exposure group inequality and between-exposure groups inequality to total inequality. Conforming to the paper's hypothesis, the group that has the highest exposure to typhoons was found to experience a worsening of both income and expenditure inequality while the group with the least exposure showed no change in expenditure inequality and an improvement in income equality. The result supports the importance of implementing policies that increase the resilience of local communities in the Philippines. Apart from short-term financial damages, exposure to adverse weather may also bring an added burden of worsening economic inequality.

Keywords: *inequality decomposition, extreme event exposure, Theil decomposition analysis*

Introduction

Developing countries, including the Philippines, are expected to sustain severe impacts from anthropogenic climate change, one consequence of which is the increased frequency of extreme weather events (IPCC 2014). In order to identify efficient solutions to minimize the impacts of extreme weather, economists conduct cost-benefit or valuation studies. However, concern for social justice necessitates going one step further and requires the analysis of the redistributive or inequality impacts of extreme weather events.

Studying inequality is important because this social problem is associated with various negative social impacts. Empirical studies have shown that rising inequality has an effect on environmental quality (Hao et al. 2016), on drug use and HIV prevalence among drug users (Friedman et al. 2016), on adolescents' physical health (Rözer and Volker 2016), on adolescents' emotional health (Vilhjalmsdottir et al. 2016), and on the incidence of violent crimes (Enamorado et al. 2016).

From a philosophical perspective, Cowell (1995) offered two explanations why individuals would prefer an "equal" society. The first explanation is based on preferences and risk aversion. In this explanation, individuals see being poor as a result of drawing a losing ticket in a lottery of life chances. This lottery is represented by the income distribution of the society. Being risk-averse, people will want to minimize their hypothetical risk of drawing a losing ticket and hence, they will prefer an income distribution that is more equal rather than unequal. The second explanation is based on altruism and envy. People care for the least advantaged but they are also envious of those that are inordinately rich, hence they will prefer a more equal distribution of income in the society.

[1] Assistant Professor, Department of Economics, College of Economics and Management, University of the Philippines Los Baños, College, Laguna. Email: jkbayani@gmail.com and jkbarias@up.edu.ph (Corresponding author)

[2] Professor, Department of Economics, School of Social Sciences, Ateneo de Manila University, Katipunan, Quezon City. Email: rtan@ateneo.edu.ph

The Philippines has one of the highest income inequality indexes among Southeast Asian countries (Bock 2014).Various studies (see for example, Estudillo 1997, Balisacan and Fuwa 2003, Zamora and Dorado 2015) have tried to identify contributory factors by employing inequality decomposition analysis, including decomposition by locality (e.g., rural versus urban, provincial, regional), by income source, and by household characteristics (e.g., educational attainment, gender, employment, source of remittances). However, the decomposition of inequality in the Philippines according to exposure to extreme weather has not been examined. A handful of studies on this topic exist but most were done in African countries. Moreover, the results of these studies were conflicting. For instance, some studies found that weather shocks exacerbate existing income and power disparities in some areas, while they reduce inequality in other areas (Silva et al. 2015 and Reardon and Taylor 1994). On the other hand, a study done in Ethiopia (Thiede 2014) showed that livestock asset inequality actually decreased in response to weather shocks. This study hopes to contribute to the existing empirical literature by examining the relationship between exposure to typhoons and inequality, in the case of the Philippines.

Conceptual Framework

This section explains the underlying process of how adverse weather may cause a rise in economic inequality. In formulating the hypothesis for the study, several assumptions were made. First, the study posits that different types of households, when exposed to the same weather shock, will experience varying degrees of impacts, depending on their degree of mobility and adaptive capacity. When households are immobile, they cannot easily shift from one source of livelihood to another, and hence they will sustain greater damage from extreme weather than mobile households. Borrowing from climate change literature, adaptive capacity is the ability of a system to minimize adverse impacts or even maximize potential benefits from climate change. Households with greater adaptive capacity will incur lower impacts than households with lower adaptive capacity (Mendoza et al. 2014).

Second, households that belong in the lower income category are expected to sustain more severe negative impacts from adverse weather. This is based from the observation that low-income households generally rely on livelihoods that are natural-resource dependent (e.g., fishing and farming) which means that they are more vulnerable to adverse weather. Studies have shown that agriculture and fisheries-dependent households have higher incidence of vulnerability than non-agriculture households (Arias et al. 2016), while rural households are more vulnerable than urban households (Günther and Harttgen 2009). Moreover, low income households have lower adaptive capacity and less mobility (in both spatial and economic terms), further adding up to their vulnerability.

Third, *ceteris paribus*, an increase in income or consumption of households in the lower strata improves equality, while a decline in their income or consumption worsens inequality. This is an implication of using the Theil index as a measure of inequality. One property of the Theil index is the 'weak principle of transfer', which means that a hypothetical transfer from the rich to the poor improves the inequality index.

Lastly, the heterogeneity or diversity of an area will determine whether inequality will change or remain the same given weather shocks. Heterogeneity can be measured in terms of economic and social characteristics such as income levels, types of livelihood, and even gender of the household head which are determinants of adaptive capacity and mobility.

Given these assumptions, the hypothesized economic inequality outcomes of combinations of weather scenarios and area diversity/heterogeneity are presented in Figure 1. Considering the extreme case of complete homogeneity, regardless of whether exposure is low or high, inequality is expected to remain constant. If weather is good, everyone will experience proportionate level of benefits, and when the weather is bad, everyone will sustain proportionate level of damages.

On the other end of the spectrum is complete diversity or heterogeneity. If exposure is low, inequality is expected to decrease. This is based from the assumption that those in the lowest income strata (the most vulnerable to adverse weather shocks) are also the ones who are expected to benefit the most from good weather. On the other hand, if exposure is high, inequality in a completely heterogeneous area will increase.

Lastly, an area with some degree of heterogeneity will sustain ambiguous inequality impacts. Low exposure may result in either a decrease in inequality index (if close to perfectly heterogeneous) or no change in inequality index, (if close to perfectly homogeneous). Correspondingly, high exposure may result in either an increase in, or a constant, inequality index.

		Exposure to Adverse Weather	
		Low	*High*
Diversity of the Area	*Completely Homogenous*	no change in inequality	no change in inequality
	In-between	no change or â ine-quality	no change or á inequality
	Completely Diverse	â inequality	á inequality

Figure 1. Inequality in response to exposure to adverse weather

Methodology

Data and Sources

The study used household-level micro data from the 2009 and 2012 Family Income and Expenditure Survey (FIES) undertaken by the Philippine Statistics Authority (PSA). Since the FIES does not include questions pertaining to household exposure to typhoons and meteorological hazards, household data were cross-referenced with the severe weather bulletin issued by the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), based from the provincial location of the households.

Categorization of Households

The study chose typhoon as the weather hazard to be examined since this is the most prevalent weather hazard in the country. Households were classified into four exposure groups based from their typhoon exposure in 2009, 2010, and 2011. The three-year period was deemed adequate since it has been observed that the impact of weather disasters on the economy has an expected turnaround of about three years (Chaiechi 2014). From the PAGASA bulletin, the total frequency of typhoons by province was tabulated.

The total frequency was divided by three (3) to get the average number of typhoons per year, and this was compared to the historical expected typhoon occurrence estimated by Concepcion (2004) as cited in Bareja (2011) (Table 1). Since the main interest is extreme weather, the deviation from the historical typhoon occurrence was used as the basis for the exposure categorization. The final categorization is as follows: less than 2; 2 to 3; 4 to 5; and 6 to 7.

Table 1. Historical mean annual rainfall and typhoon frequency by region, Philippines

Region	Average Annual Rainfall (mm)	Typhoon Frequency
CAR	2,500-3,600	2-2.5 times per year
Region I	2,000-2,750	1.7-2.5 times per year
Region II	1,700-3,000	1.7-2.5 times per year
Region III	1,800-3,800	1.7 times per year
Region IV	1,550-3,500	1.5 times per year
Region V	1,450-3,750	1.5 times per year
Region VI	2,250-3,350	once per year
Region VII	1,350-1,800	once per year
Region VIII	2,850-3,250	1.7 times per year
Region IX/ARMM	1,750-2,450	once in 12 years
Region X/CARAGA	2,150-3,650	once in 12 years to once per year
Region XI/CARAGA	800-4,500	once in 12 years to once per year
Region XII/ARMM	1,700-2,250	once in 12 years
Philippines	800-4,500	-

Source: Concepcion (2004) as cited in Bareja (2011)

Inequality Index

To assess the relationship between extreme weather and inequality, the change in the inequality index from 2009 to 2012 was examined and compared across the different exposure groups. In empirical research, welfare is usually proxied by variables such as utility, income, wealth, consumption, and expenditures. This study considered both total income and total expenditures. Adjustments were made on these variables to account for differences in the size of the households included in the FIES survey. Ideally, one wants to compute what is called the adult equivalence scale. The adult equivalence scale has an advantage over simply computing for per capita values since the former takes into consideration possible economies of scale in household consumption as well as the difference in the relative needs of adults versus children.

However, since the 2009 dataset and the 2012 dataset have different levels of disaggregation of household members according to age, the study resorted to the use of per capita income and per capita consumption.

There are several measures of inequality such as the Lorenz Curve, the Gini Coefficient, the Atkinson Index, and several General Enthropy Indexes which include the Theil L and Theil T indexes. The Theil index has several properties which make it a desirable measure of inequality (Cowell 1995): 1) Weak principle of transfer (a hypothetical transfer of income from a rich person to a poor person will result in a lower inequality index); 2) Income scale independence (a proportional increase in the income of everyone in the population will not alter the computed inequality index); 3) Principle of population (inequality index is not dependent on the size of the population); and 4) Decomposability (there is a coherent relationship between inequality in the whole of society and inequality in its subgroups).

Theil decomposition analysis was employed using the Stata[3] "ineqdeco" module (Jenkins 1999). Both the Theil T and Theil L measures were used. The Theil T is sensitive to changes in the upper income levels, while Theil L is sensitive to changes in lower income levels. The formula for the general Theil T and L inequality indexes are (Estudillo 1997):

$$T = \frac{1}{n}\sum_{i}^{n} \frac{y_i}{\bar{y}} log\left(\frac{y_i}{\bar{y}}\right) \tag{1}$$

$$L = \frac{1}{n}\sum_{i}^{n} log\left(\frac{y_i}{\bar{y}}\right) \tag{2}$$

The decomposition equations are:

$$T = \sum_{j}^{J}\left(\frac{n_j}{n}\frac{y_j}{\bar{y}}\right)T_j + \sum_{j}^{J}\left(\frac{n_j}{n}\frac{y_j}{\bar{y}}\right) log\left(\frac{y_j}{\bar{y}}\right) \tag{3}$$

$$L = \sum_{j}^{J}\left(\frac{n_j}{n}\right)L_j + \sum_{j}^{J}\left(\frac{n_j}{n}\right) log\left(\frac{y_j}{\bar{y}}\right) \tag{4}$$

Where n is the number of people in the population, y_i is the income of person i, $\bar{y}$ is the mean income of the population, n_j is the number of people in the population subgroup j, y_j is the mean income of population subgroup j, and Tj, Lj, is the Theil index (T and L) of population subgroup j.

The first term on the right-hand side of the decomposition equations is the within-group inequality component, while the second term is the between-group contribution to inequality. In the paper by Estudillo (1997), between-group inequality is considered a significant contributor to total inequality if its contribution is at least 20% of total inequality.

To formalize the measure of group diversity/heterogeneity, a variation of the Herfindahl Index was estimated based on the major income source of the household. The Herfindahl Index is considered superior among other indices but it is criticized for assigning greater weights to large sectors of the economy (Palan 2010). As such, the version of the Herfindahl Index introduced by Keeble and Hauser (1971) as cited in Palan (2010) was used:

$$HD_i = 1 - \sqrt{\sum\left(\frac{e_{is}}{e_i}\right)^2} \tag{5}$$

Where e_{is} is the total number of households under exposure category i relying on source s as their main source of income, and e_i is the total number of households in exposure category i.

[3] StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP. Single-user Stata Perpetual License Serial number: 40120584463.

Results and Discussion

Descriptive Analysis

From 2009 to 2011, there were 35 typhoons/storms with public storm warning signal that entered the Philippine Area of Responsibility. Eighty-two provinces were categorized into four groups according to typhoon exposure defined in terms of deviations from the historical mean: Group A – less than 2 typhoons, Group B –2 to 3 typhoons, Group C – 4 to 5 typhoons, and Group D – 6 to 7 typhoons. Five provinces posted the highest exposure to typhoons (Abra, Ifugao, Kalinga, Mountain Province, and Apayao), all of which are located in the Cordillera Administrative Region. The provinces with the next highest exposure (between 4 to 5, Group C) are also in Luzon; and these are Pangasinan, Isabela, Benguet, Quezon, Nueva Ecija, Cagayan, Zambales, Aurora, and Batanes. A total of 23 provinces have an exposure of between 2 to 3 (Group B), and they are mostly in Central and Southern Luzon. Those with exposure of less than 2(Group A) number 45, and are mostly located in the Visayas and Mindanao (Table 2).

Table 2. Categorization of provinces by level of exposure to typhoon (in terms of deviation from historical mean)

Group/ Frequency	No. of Provinces	Provinces
A: less than 2	45	Cebu, Davao del Sur, Negros Occidental, Leyte, Iloilo, Zamboanga del Sur, South Cotabato, Misamis Oriental, Maguindanao, Sulu, Cotabato, Zamboanga del Norte, Agusan del Norte, Palawan, Negros Oriental, Bukidnon, Bohol, Lanao del Sur, Oriental Mindoro, Davao, Surigao del Sur, Sultan Kudarat, Lanao del Norte, Agusan del Sur, Capiz, Masbata, Western Samar, Compostela Valley, Misamis Occidental, Eastern Samar, Davao Oriental, Saranggani, Zamboanga Sibugay, Occidental Mindoro, Romblon, Southern Leyte, Aklan, Antique, Basilan, Biliran, Isabela City, Guimaras, Cotabato City, Siquijor, Camiguin
B: 2 to 3	23	Metro Manila, Cavite, Bulacan, Laguna, Batangas, Camarines Sur, Pampanga, Rizal, Albay, Sorsogon, Tarlac, La Union, Ilocos Sur, Surigao del Norte, Ilocos Norte, Camarines Norte, Northern Samar, Nueva Vizcaya, Bataan, Marinduque, Quirino, Tawi-Tawi, Catanduanes
C: 4 to 5	9	Pangasinan, Isabela, Benguet, Quezon, Nueva Ecija, Cagayan, Zambales, Aurora, Batanes
D: 6 to 7	5	Abra, Ifugao, Kalinga, Mountain Province, Apayao

Source of raw data: PAGASA Severe Weather Bulletin 2009, 2010, 2011, Philippine Atmospheric, Geophysical, and Astronomical Services Administration

Table 3 presents several socio-economic indicators for the four exposure groups. Groups A, C and D are predominantly rural, while Group B is predominantly urban. In terms of agricultural/non-agricultural share, the distribution has not significantly changed from 2009 to 2012. Group D has the highest proportion of agricultural households (about half of the sample), while Group B has the lowest proportion of agricultural households of about a tenth. Majority of households in all groups are male-headed. The proportions of male-headed households in 2012 are just 1-2% points higher than their corresponding proportions for 2009 for all groups.

Table 3. Selected socio-economic characteristics of households, by exposure group, 2009 and 2012

Item	Group A		Group B		Group C		Group D	
	2009	2012	2009	2012	2009	2012	2009	2012
No of households	18,883	19,917	13,476	13,926	5,152	5,390	889	938
Proportion (%) of total households								
Rural	67	68	33	44	61	79	86	90
Agricultural	35	33	11	10	29	28	43	43
Female-headed	18	19	24	25	19	21	17	18
Highest educational attainment	100	100	100	100	100	100	100	100
No grade completed	5	4	1	1	2	2	8	5
Elementary undergraduate	29	28	14	13	17	17	29	28
Elementary graduate	18	19	18	18	24	24	20	18
High School undergraduate	13	13	11	11	11	11	10	10
High School graduate	16	17	28	28	26	27	15	19
At least College	19	19	28	29	20	19	19	20

Source of raw data: Family Income and Expenditure Survey, 2009 and 2012, Philippine Statistics Authority

Generally, Table 3 reveals that the profiles of households for each of the four exposure groups between 2009 and 2012 are similar, and hence comparable. Moreover, it was observed that the distribution of households based on income source also has not changed much between the two periods (Table 4).

All of the exposure groups show a relatively high degree of heterogeneity with Herfindahl indexes ranging from 0.46 to 0.6.[4] Group B was the least heterogeneous, while Group A was the most heterogeneous (Table 5).

The population shares of the different groups remained constant from 2009 to 2012 as shown in Table 6. The highest population share was for Group A, followed by Group B, then Group C, and last by Group D. From 2009 to 2012, the mean expenditures and mean income for all groups have increased in nominal terms. For both years, the group with the highest mean per capita income and mean per capita expenditure is Group B, followed by Group C. In 2009, Group D had the lowest per capita expenditures and lowest per capita income while in 2012, Group D still had the lowest per capita expenditure, but Group A had the lowest per capita income.

[4] The index is between 0 and $1-\sqrt{(1/S)}$, where S is the number of sectors.Perfect homogeneity yields a value of zero while perfect heterogeneity yields a value of 0.796.

Table 4. Distribution of households according to main source of income, percentage share, by exposure group, 2009 and 2012

Main Source of Income	Group A		Group B		Group C		Group D	
	2009	2012	2009	2012	2009	2012	2009	2012
Wage/salary from agri. activity	10.7	12.0	3.3	3.6	10.3	11.9	7.1	7.2
Wage/salary from non-agri. activity	31.3	32.1	48.8	51.2	33.0	33.4	25.0	30.4
Crop farming and gardening	18.5	14.7	5.5	4.0	16.9	14.6	29.9	26.3
Livestock and poultry raising	0.5	0.5	0.4	0.2	0.4	0.5	2.4	0.7
Fishing	4.4	4.0	2.1	1.8	0.9	0.9	0.1	0.3
Forestry and hunting	0.5	0.5	0.2	0.1	0.6	0.4	-	0.2
Wholesale and retail	6.4	6.6	6.8	6.6	6.0	6.3	3.4	3.0
Manufacturing	1.1	1.0	1.0	0.9	0.7	0.8	0.3	0.9
Community, etc. services	1.2	1.0	1.8	1.7	1.1	1.0	0.2	0.6
Transport and communication	2.9	2.9	2.7	2.1	2.9	3.1	1.2	1.6
Mining	0.3	0.3	0.2	0.2	0.4	0.2	0.2	0.1
Construction	0.1	0.1	0.2	0.1	0.2	0.0	0.2	0.1
Entrep. activity N.E.C.	0.2	0.2	0.4	0.5	0.3	0.2	-	0.1
Net share of crops and others	0.9	0.9	0.5	0.3	1.0	0.6	2.0	1.6
Assistance from abroad	6.7	7.2	13.0	12.6	12.1	12.0	8.7	9.1
Assistance from domestic source	6.4	9.1	4.8	6.5	5.2	6.7	6.6	7.6
Rental of lands and other properties	0.3	0.3	0.5	0.6	0.3	0.3	0.3	0.1
Interests from banks / loans	0.0	0.0	0.0	0.0	-	0.0	0.1	-
Pensions and retirements benefits	2.7	3.0	2.4	3.0	2.4	3.1	2.2	3.8
Dividend from investments	0.0	0.0	0.1	0.1	0.0	-	-	-
Rental value of owner-occupied dwelling	1.8	1.3	3.5	2.9	2.9	2.5	4.4	1.9
Income from family sustenance activities	0.5	0.6	0.2	0.2	0.4	0.2	1.3	1.4
Received as gifts	2.4	1.6	1.5	1.0	2.0	1.3	4.2	2.9
Other income	0.0	0.0	0.0	0.0	0.0	0.0	-	-

Table 5. Herfindahl index of diversity in terms of income source, by exposure group, 2009 and 2012

Year	Group A	Group B	Group C	Group D
2009	0.60	0.48	0.59	0.58
2012	0.60	0.46	0.58	0.57

Source of raw data: Family Income and Expenditure Survey, 2009 and 2012, Philippine Statistics Authority

Table 6. Mean per capita expenditures and income, by exposure group, 2009 and 2012

Group	Population Share		Mean per Capita Expenditures (PhP)		Mean per Capita Income (PhP)	
	2009	2012	2009	2012	2009	2012
Group A	0.49	0.50	32,000	35,300	38,000	43,200
Group B	0.35	0.35	57,000	61,000	65,900	71,000
Group C	0.13	0.13	38,900	42,600	51,000	53,800
Group D	0.02	0.02	30,400	32,300	36,500	45,300

Source of raw data: Family Income and Expenditure Survey, 2009 and 2012, Philippine Statistics Authority

Theil Inequality Decomposition Analysis

Tables 7 and 8 show the Theil L and Theil T inequality indexes for per capita expenditures and per capita income, respectively. The trends were similar for both Theil L and Theil T categories although the Theil T estimates were consistently higher than the Theil L index. Also, the estimated inequality indexes were higher for per capita income than for per capita expenditure, suggesting the possibility that households undertake some form of consumption smoothing.

Table 7. Theil inequality index for per capita expenditures, by exposure group, 2009 and 2012

Group	Per Capita Expenditures					
	Theil L			Theil T		
	2009	2012	Change	2009	2012	Change
Group A	0.30	0.31	0.00	0.36	0.36	0.00
Group B	0.32	0.31	(0.01)	0.37	0.35	(0.02)
Group C	0.26	0.25	(0.01)	0.32	0.29	(0.03)
Group D	0.24	0.26	0.02	0.28	0.33	0.05

Source of raw data: Family Income and Expenditure Survey, 2009 and 2012, Philippine Statistics Authority

Table 8. Theil inequality index for per capita income, by exposure group, 2009 and 2012

Group	Per Capita Income					
	Theil L			Theil T		
	2009	2012	Change	2009	2012	Change
Group A	0.39	0.39	(0.01)	0.48	0.46	(0.02)
Group B	0.38	0.36	(0.02)	0.44	0.40	(0.04)
Group C	0.41	0.33	(0.08)	0.62	0.40	(0.22)
Group D	0.35	0.42	0.07	0.40	0.63	0.23

Source of raw data: Family Income and Expenditure Survey, 2009 and 2012, Philippine Statistics Authority

During the reference period (2009), Group B had the highest inequality index for expenditures, followed by Group A and Group C, while Group D exhibited the least inequality. During the same period, the highest per capita income inequality was estimated for Group C, followed by Group A, by Group B, and last by Group D.

Considering that Group D had the highest exposure to typhoons from 2009 to 2011, it is expected that income and consumption inequality for this group will increase in 2012 vis-à-vis 2009. Results of the analysis seem to suggest that the above hypothesis is true. It can be seen that Group D experienced a +0.02 rise in the Theil L per capita expenditure inequality, while the Theil T index rose by +0.05. In terms of per capita income, the Theil L index rose by +0.07, while the Theil T index rose by +0.23.

For the group with the lowest exposure (Group A), per capita expenditure inequality did not change from 2009 to 2012, but per capita income inequality declined. Specifically, the per capita income inequality changed by -0.01 using the Theil L index, and by -0.02 using the Theil T index. The group with the second lowest exposure (Group B), on the other hand, experienced a decline in both income and expenditure inequality.

An unexpected result was observed for Group C, the group with the second highest exposure. Among all the exposure subgroups, Group C exhibited the greatest decline in inequality, contradicting a priori expectations. Theoretically, the above result is possible if the households belonging in the upper income levels are the ones who are more vulnerable to adverse weather. Another possible explanation is that there may have been other shocks that could have adversely affected those in the higher income levels than those in the lower income strata, or there may have been positive shocks that benefited those in the lower income more than those in the higher income strata.

Lastly, the contribution of within-group and between-group inequality to total inequality is presented in Table 9. The within-group inequality is the weighted average of subgroup inequality values, while the between-group inequality represents the level of inequality obtained by using the mean income/expenditure of the respective groups instead of the income/expenditure of the household (Shorrocks and Wan 2004).

Table 9. Theil decomposition of per capita expenditures and per capita income

Theil Decomposition	Per Capita Expenditures				Per Capita Income			
	2009		2012		2009		2012	
	Theil L	Theil T	Theil L	Theil T	Theil L	Theil T	Theil L	Theil T
Within-group inequality	0.30	0.36	0.30	0.35	0.39	0.48	0.37	0.43
Between-group inequality	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Total inequality	0.34	0.40	0.33	0.38	0.42	0.51	0.40	0.45
Contribution of between group inequality (%)	10.66	9.35	9.75	8.75	7.69	6.35	6.56	5.80

Source of raw data: Family Income and Expenditure Survey, 2009 and 2012, Philippine Statistics Authority

It was estimated that the between-group inequality represents about 10% of total per capita expenditure inequality, while it represents about 6% of total per capita income inequality. However, one must not automatically dismiss adverse weather conditions as unimportant, since it can be seen in the previous analysis that significantly higher levels of inequality are present in the area with the highest exposure. Shorrocks and Wan (2004) also observed that low between-group component is typical in subgroup decompositions.

Conclusion

The study found that weather exposure played a role in determining the total inequality level of the Philippines in 2012. This is consistent with the findings of Datt and Hoogeveen (2000) which found that the El Niño phenomenon has an impact, albeit small, on household inequality in the country.

It was found that the group with the greatest exposure to typhoons (in terms of deviation from historical mean) was the only group that experienced a rise in inequality from 2009 to 2012. On the other hand, the group with the least exposure experienced no change in per capita expenditure inequality, and a decline in per capita income inequality. This finding supports the hypothesis of the paper that adverse weather conditions may be associated with the worsening of inequality in a particular area. It was also found that there is a higher per capita income inequality compared to per capita expenditure inequality in all subgroups. This suggests the presence of consumption smoothing among households especially those in the high exposure group. However, our finding that the group with the second highest exposure had a decline in inequality contradicts a priori expectations. Nonetheless, this scenario is possible if the households in the upper income levels are the ones more vulnerable to adverse weather.

It is important to highlight the limitations of the study. First, the study used the deviation of the actual frequency of typhoons from the historical mean over a three-year period instead of a longer period climatology as used in Silva (2004). Lastly, there may have been other shocks that affected the economy apart from adverse weather such as the global financial crisis of 2008, the effects of which are difficult to disentangle from the effects of weather during the period under study.

The results of the analysis magnify the importance of building the resilience of households and communities against weather shocks because of their possible repercussions that extend beyond financial losses. The social consequence seems to be equally serious, since it has been demonstrated that a rise in inequality is concurrent in areas with high exposure to typhoons. Building resilience entails government provision of safety nets such as insurance or disaster assistance, as well as strengthening the adaptive capacity of households through information and education, among many others. Moreover, this highlights the urgency of pursuing aggressive climate change mitigation at the global level, which the international community seems to be backtracking on in recent years.

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