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Disproportionately?**

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The Case of Typhoon Milenyo in the Rural Philippines**

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**Abstract**

This paper illustrates the sharp contrast in welfare impacts between the rich and the poor caused by typhoon Milenyo in a Philippine village. Fish price dropped sharply after a large volume of cultured fish was set loose due to the damage caused to fish pens near the village, leading to positive net welfare gains among the wealthy. Among the poor, however, the negative effects of food (other than fish) price increase outweighed the positive benefit of the fish price decrease, and the poor non-agricultural households (who receive their income by cash rather than by rice) were the most severely hit.

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## 1. INTRODUCTION

Recently, a number of devastating natural disasters have hit both developed and developing countries. Hundreds of thousands of lives were lost in the Indian Ocean tsunami, Hurricane Katrina, and the earthquakes in central Chile, Haiti, Sichuan province of China, and northern Pakistan. We see vividly the 2011 devastating earthquake and tsunami in Japan that killed tens of thousands of people and resulted in damages of around 200 to 300 billion USD dollars (Cabinet Office, 2011). In 2011, the floods in Thailand involved relatively few human calamities but caused US\$45.7 billion in damages mainly in the manufacturing sector, as seven major industrial estates were inundated by floods (World Bank, 2011). Accordingly, disasters can have serious negative effects not only on lives, but also on the survivors' livelihoods in the aftermath (Barro, 2009).

To identify effective policies to facilitate livelihood recovery of the victims of a disaster, it is imperative to clarify whether the disaster affects the poor disproportionately. Yet, there exist few rigorous studies on this issue. One notable exception known to us is the study by Friedman and Levinsohn (2002) which develops a methodology to measure the welfare effects of price changes and which analyzes the case of the Indonesian economic crisis in 1997. The study found that poor urban households were the most fragile and suffered damage caused by price shock. While recent work has begun to investigate the welfare impacts of price changes [Porto (2008 and 2010); Wood, Nelson and Nogueira (2011); and Ferreira et. al (2011)], to the best of our knowledge, no study has examined the welfare impacts of price changes caused by a natural disaster in a rural setting. This paper is the first attempt in the literature to fill this gap. We use a unique data set collected from a village in the Philippines, which was hit by a strong typhoon in 2006, to quantify heterogeneous welfare impacts of the typhoon. Our focus is on the overall welfare impact of the typhoon, which reflects people's responses to the shocks caused by the typhoon, as well as agricultural and other price changes that emerged through market and non-market adjustment mechanisms. Indeed, the Philippines suffer from tropical depression nearly every year. The country experiences about 20 tropical storms usually occurring during the monsoon season (June to December). While there are empirical studies on household behavior toward risks (Fafchamps, 2003; Dercon, 2005), changes in household behavior

caused by disasters have not been well understood. Therefore, our research also contributes to reveal household's coping mechanisms with disasters especially in developing countries that are frequently affected by natural disasters.

In our analysis, we first divide households into two groups—agricultural and non-agricultural households—in order to capture the heterogeneous impacts of the shocks caused by the typhoon, which were mainly crop damages. To preview our empirical results, we find that the short-term price changes due to the typhoon led to sharply contrasting welfare consequences between the poorer and the wealthier households. For the relatively wealthier households, the *positive* welfare effects outweighed the negative effects of price increase in other food items, leading to a net positive short-term impact. In contrast, for the poorer households, especially for poor non-agricultural laborer households, the net welfare impact was negative.

The rest of the paper is organized as follows. In Section 2, we select some related literatures and give a brief review. Section 3 presents an analytical framework for our empirical analysis, which is followed by a description of the typhoon Milenyo and our data in Section 4. In Section 5, we exhibit our empirical results, and Section 6 summarizes the concluding remarks.

## **2. A BRIEF REVIEW OF THE RELATED LITERATURES**

The research on the impact of food price changes on household welfare has been developed for a long time. Deaton (1988) develops a technique to estimate demand system by using unit value of actual food prices in Cote d'Ivoire, and Deaton (1989) analyzes the effects of rice prices on distribution of household welfare in Thailand by non-parametric analysis. This non-parametric approach is based on first-order approximation in consumption and production. To assess the welfare impacts, he considers how household's expenditure on each commodity changes directly by price changes of goods across geographical areas and income distributions.

Friedman and Levinsohn (2002) examine how price changes affected household's welfare during the Asian economic crisis in Indonesia. They basically follow Deaton (1980, 1990, and 1997) and include substitution effects. They capture total welfare changes due to both direct and indirect

impacts. Households change their consumption by substituting away from expensive goods to cheaper ones. They estimate own and cross price elasticities that substitution effects depend on. They use the data from Indonesian SUSENAS for 21 aggregate food goods. From the results, damages on household welfare decrease with substitution effects than without these effects in every household. They also show that urban poor households get more damages from price changes of foods. It is related to their results which say welfare loss with self consumption is lower than without self consumption.

In Latin America, there are studies that analyze the relationships between household welfare and price changes of foods. Robles and Torero (2010) investigate the effects of food price changes on consumption across different types of households in Latin America; Guatemala, Honduras, Nicaragua, and Peru. In Latin America, both demand and supply had been driven by the 2007-08 food price crisis. The Price of commodities, not only of foods but also of energy, increased with negative welfare effects on households. Robles and Torero (2010) analyzed the effects in both urban and rural areas, and find that the negative impacts were larger in urban areas than rural in every countries. This result is consistent with Friedman and Levinsohn (2002). In rural areas, most of the households are engaged in agricultural works and they would have benefited from higher food prices. They also find the food price shock increases poverty rates. Their results show a 2 percent rise in poverty for a 10 percent increase in food prices.

Porto (2010) studies the impact of price changes through three types of adjustment. In the first step, the households change their consumption behaviors adjusting production and consumption when price of goods increase. The next possible step is intra-household spillovers. The Changes in food prices affect other activities of households. He assumes that agricultural income increases with higher food prices. In that case, the agricultural households may be able to invest in more technological instruments. The third step is inter-household spillovers such as impacts on local labor markets. Porto uses a dataset from Mexico and estimates how price changes impact on consumption, production, and labor market. He finds that agricultural households benefit from higher food prices after the shock, because they tend to sell their own production which they used to consume before the shock.

Ferreira et. al (2011) examine household welfare loss due to rising international food prices in 2007-2008 in a similar manner as in Friedman and Levinsohn (2002) and Robles and Torero (2010) by using data from Brazil. They estimate compensating variation and find that negative impact on consumption was large. On the other hand, agricultural households had positive income effects in rural areas. Brazil is a net exporter of food, so households gain from increasing food prices. However, positive income effects are found only for the agricultural households. In contrast, the urban poor households are found to suffer from serious welfare losses.

In this paper, we contribute to these literatures in at least two ways. First, we study the impacts of price changes on household welfare in the context of a natural disaster. There is no paper to adopt these methodologies for estimating damages from natural disasters. As we see in section 4, we find that consumption reallocation was one of the main coping strategies in our survey village. In the village, households got shocks not only on houses or crops but also from changes in food prices. We need to understand how households are affected by a shock from many aspects in order to set up an effective support system for the households affected by the shock. We adopt a methodology to estimate household welfare and to capture direct and indirect effects on households. Second, we use unique data on consumer prices and on the volume of consumptions in a Philippine village. The data allow us to observe changes in the prices of 11 food categories between one week before and one week after Milenyo. The data reveal immediate damages suffered by the households. Our data also include detailed information on the coping strategies and the damages suffered for each household. Based on this dataset, we focus on the contrast between the poor and the wealthy households in the welfare consequences caused by the natural disaster.

### **3. DIRECT AND INDIRECT WELFARE IMPACTS: AN ANALYTICAL FRAMEWORK**

We follow Friedman and Levinsohn (2002) to construct a framework to capture the welfare impacts of price changes caused by the typhoon. The starting point for our analysis is to estimate the resulting change in consumer surplus. We denote by  $E^h(u, P)$  the standard minimum expenditure

function for household  $h$  to satisfy a certain utility level,  $u$ , given a price vector,  $P$ . Taking a first-order Taylor approximation to the logged expenditure function around the prices before the typhoon,  $P_0$ , we get the compensating variation for household  $h$ ,  $CV^h$ , which measures the amount of expenditure needed to sustain the initial level of utility given price change:

$$(1) \quad CV^h \approx \sum_{i=1}^n w_i^h \Delta \ln p_i^h,$$

where  $CV^h \equiv \Delta \ln E^h$ ;  $\Delta$  is a first-difference operator;  $w_i^h$  denotes the budget share of the household  $h$  to good  $i$  before the crisis; and  $p_i^h$  is the price of good  $i$ , that is, an element of the price vector,  $P$ .

Note that we employ Shephard's lemma to derive equation (1).

Equation (1) quantifies the impact of the typhoon under an assumption of invariable consumption demand. The compensating variation value based on equation (1) shows direct welfare impacts arising from price changes. We may interpret this value as *direct* welfare impacts arising from the typhoon through market and non-market mechanisms. Yet, facing price changes, households naturally reallocate consumption. To capture such an ex post risk coping behavior of households, we incorporate the substitution behavior of households toward relatively less costly products. More specifically, we follow Friedman and Levinsohn (2002) to employ a second-order Taylor expansion of the logged expenditure function:

$$(2) \quad CV^h \approx \sum_{i=1}^n w_i^h \Delta \ln p_i^h + \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n w_i^h \theta_{ij} \Delta \ln p_i^h \Delta \ln p_j^h.$$

where  $\theta_{ij}$  is the price elasticity of good  $i$ . The second term of equation (2) shows substitution effects due to the household's risk coping behaviors or *indirect* welfare impacts of the typhoon through such behaviors. The substitution effect is represented as a function of the full vector of price changes.

To estimate price elasticity  $\theta_{ij}$ , we follow the steps that Deaton (1989; 1990; 1997) developed. He estimates the demand system for all products initially. To estimate cross-price elasticities, we consider how household income, other characteristics, and the price of good  $j$  which

households face, affect the consumption of good  $i$ . Then, we aggregate the results of all goods. In this study, since we focus on one village, which is affected by a typhoon, we have no regional variation of damages. The main problem in the data is that each household reported only the unit price of goods that they face, so we need to correct the measurement error of a household's unit price of goods. We use the methodology that Griliches and Hausman (1986) introduced, and then we construct a consistent estimator in (3) of the true parameter  $\theta_{ij}$  according to the formula:

$$\theta_{ij} = \frac{2\varphi_{ij}var(\bar{v}) - \frac{T-1}{T}\varphi'_{ij}var(\Delta v)}{2var(v') - \frac{T-1}{T}var(\Delta v)}, \text{ where } T = 2, \mathbf{v}' \text{ is the deviation of the log of price in time } t \text{ for each}$$

household from the mean log of price of goods across whole time periods, and  $\Delta v$  denotes first difference of log of price. We plug  $\theta_{ij}$  into equation (2) to quantify compensating variation with substitution effects. We report CV obtained by (1) and (2) in section 5 by using our data and compare household welfare losses with and without substitution effects.

#### 4. THE TYPHOON MILENYO AND THE DATA

##### (a) Typhoon Milenyo

The super typhoon Milenyo hit the Philippines on September 28, 2006. The Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) reported that Milenyo had maximum sustained winds of 130 kilometers per hour and gusts of up to 160 kilometers per hour, thereby classifying it as a severe tropical storm. The National Disaster Risk Reduction and Management Council reported that Milenyo affected 277 municipalities and caused damages worth US\$ 137M (PhP 6.6 billion). The average amount of losses per household was estimated to be more than US\$ 230. The Bicol region suffered most heavily accounting for more than half of the total amount of damages followed by the CALABARZON region including the provinces of Cavite, Laguna, Batangas, Rizal, and Quezon. Government and non-government organizations provided assistance amounting to only US\$ 1.9M. This means that Milenyo inflicted an enormous amount of



damage on the lives and livelihoods of many Filipinos, with a substantial amount of damages borne by households (Sawada et al., 2009).

Our study village is located in one of the affected provinces, the Laguna province, about 70 kilometers southeast of Manila, facing the east coast of Laguna de Bay. The village, called the East Laguna village, has been surveyed repeatedly since 1966 (Hayami and Kikuchi, 2000).<sup>1</sup> Therefore, the village has an enormous amount of benchmark information collected and compiled earlier by Hayami and Kikuchi (1981), Hayami and Kikuchi (2000), and later by Fuwa et al. (2006), and Kajisa (2007). Our survey was conducted in this village from January 20 to February 15, 2007 (Sawada et al., 2009). At the time of survey, there were 404 households, and our survey covers all the households (Table 1). The questionnaire consists of five modules: (1) household characteristics such as landholding and characteristics of each household member such as age, schooling, gender, occupation, and membership in an organization; (2) damages of Milenyo to households' physical and human assets including farm endowments and human lives; (3) household coping mechanisms in the aftermath of Milenyo; (4) detailed expenditure on food and nonfood items as well as on utilities and tobacco; and (5) prices of basic goods such as rice, chicken, pork, sugar, bread, and fish one week before the survey and one week before and after Milenyo. We categorize the households into farmers, landless, and non-agricultural households: the farmer households consist of those that own cultivated land; the landless households consist of those that do not own cultivated land, most of who are agricultural workers, and non-agricultural households include those whose main income sources are from non-agricultural wage employment or self-employment. In the analysis, we treat farmer households and landless households together as agricultural households.

#### (b) Damages

Table 2 shows the damages to the households in terms of assets and income lost due to Milenyo in our studied village<sup>2</sup>. As regards human losses, there were no reported dead or seriously injured household members, which can be attributed to extensive early warnings made by television

and radio broadcasts. Indeed, 33 percent of farmer households, 40 percent of landless households, and 50 percent of non-agricultural households reported no damages at all. Yet, Milenyo hit the village during the rice-harvesting season, so the major damage to the rice crop was made by high wind as well as water logging. According to the villagers, the decline in the unit value was because their paddy got wet when the fields were submerged in water and wet paddy commanded a lower price in the market.

Table 3 shows the reported damage to crop income, which is the difference between the counterfactual income without Milenyo and the actual income. To quantify the counterfactual income, in our survey we asked about expected crop price and harvests without Milenyo damage. On average, the expected crop income before Milenyo was PHP 36,819 while the actual crop income was PHP 20,261, based on the subjective assessments. Milenyo caused around an eighty percent decline in crop income. On the other hand, there are few non-agricultural households that reported decline in income after Milenyo. As we see in Table 2, only 5 percent of non-agricultural households experienced a decline in their income. In contrast to existing literatures which analyzed household welfare changes by financial shocks or increasing food prices, agricultural income had negative impacts from the shock and non-agricultural one did not.

Overall, including the cases of multiple damages, more than half of the households in the village reported having suffered damages from Milenyo. While typhoons occur in most parts of the Philippines almost regularly during monsoon months, the extent of the damage caused by Milenyo in our study village was by far exceptionally large. In fact, typhoon damage with severe economic consequences appears to occur relatively infrequently, at least in the East Laguna village. The 2003 survey conducted in the village, for example, reveals that only 2 percent of the households experienced crop damage due to typhoon and 8 percent reported property damage in the past ten years, that is, 1994–2003 (Fuwa et al. 2006). This suggests that the damage caused by Milenyo was largely an unexpected shock. In addition, during our informal interviews, a few of the long time residents compared Milenyo with Rosing, a legendary typhoon which hit the village in the 1970s.

### (c) Households' coping mechanisms

In our survey, we asked how the households coped with the damage caused by Milenyo. As summarized in Table 4, the main strategies with which the households coped with the Milenyo damage were as follows: (1) reducing their food consumption; (2) switching consumption from purchased food to own produce; (3) obtaining emergency loans from relatives and village moneylenders; (4) receiving remittances; (5) receiving aid from the local government and private individuals; and (6) engaging in non-farm employment. In particular, we find that non-agricultural employment plays a key role as an effective insurance for households. As we have seen in 3(b), Milenyo caused about an eighty percent decline in agricultural income. Non-agricultural income is not associated with fluctuations in agricultural income.

Table 5 shows the primary occupation of economically active household members (15 to 65 years old who are not in school at the time of the survey) before and after Milenyo. The agricultural workers account for the largest portion of primary occupations in the village except for housekeeping and no primary occupation. We do not find major changes in the primary occupation after Milenyo. With respect to secondary occupation, we see a relatively larger number in carpentry and construction work among those who were employed even after Milenyo perhaps because of the greater demand for house repair after the typhoon. Also, the number of workers who engaged in fishing as secondary occupation increased after Milenyo. As we see in 3(c), fish pens for tilapia farms were destroyed in the part of Laguna Lake. Therefore, people could catch fish easily in the bay than before and tried to enter the local fish market.

As shown in Table 4, more than half of the households received aid from the local government and NGOs. The local government, through the village chieftain, immediately responded to the disaster by opening the village meeting hall as a temporal shelter to households that lost their roofs or were affected by flash floods. In addition, the local government and a political candidate for a local post released food baskets to the affected families. The food bags contained rice, noodles, and canned goods and were valued at about US\$2 per household. These food bags were distributed to the households through the office of the village chieftain purposely to effectively identify the poor and the

severely affected households. The village chieftain immediately identified the badly affected families because of his many years of association with the village people. Therefore, he could report to and get aid from the local town mayor. The food basket was one of the most important coping mechanisms especially for poor households in our study village. It is clear that the role of the local government is effective and important during disaster.

Some households coped with the damages by borrowing money and receiving private transfers, consistent with past studies. (Glewwe and Hall, 1998; Shoji, 2006; Sawada and Shimizutani, 2008) . The portion is higher for the landless households. Interestingly, the money lenders played a role to support households that got damages as sources of emergency funds. For the landless, nearby sari-sari (village variety) stores provided either in the form of credit or cash purchase the most basic needs such as rice, canned goods, candles, and kerosene. It shows there may be risk sharing mechanism between households in the village. Estudillo, Sawada and Otsuka (2008) states remittances have become an important source of income in the rural Philippines as a result of the increasing number of OFWs (Overseas Filipino Workers). As shown in Table 4, 25 percent of the farmer households, 16 percent of the landless households, and 21 percent of the non-agricultural households reported to have received remittances after Milenyo. In brief, the availability of emergency borrowing and remittances indicate the importance of personal network in surviving a crisis.

A larger proportion (76 percent) of the landless households compared to farmers (27 percent) and non-agricultural households (47 percent) reported to have decreased their food consumption (Table 4). Reducing protein intake was the more common coping strategy among the landless while about one fourth of the farmer households have reduced their consumption of food taken outside, which is more expensive than home prepared food. Switching consumption to own produce, which is cheaper than those bought in the market, is another coping strategy for 34 percent of the landless, 22 percent of the non-agricultural, and 12 percent of the farmer households. Perishable fruits of backyard trees such as mangos, banana, and rambutan, which were fallen by Milenyo became substitute to fruits bought in the market shortly after Milenyo. Indeed, prices of these fruits decreased after Milenyo (Table 6). Because fish prices went down sharply, many households shifted to own fish catch (or given by relatives) to fill up their daily protein requirements. <sup>3</sup>

To compare with the results from the 2003 survey which included a set of questions regarding the type of shocks and coping behavior during the previous decade (Fuwa 2006), we find some major and minor differences. From the 2003 survey, “own savings and income” and “help from relatives” were the main coping mechanisms while sales of physical assets, such as land or animals, and consumption reallocation played minor roles regardless of the type of shocks (e.g. natural calamities, demographic shocks including the death or illness of household members).

Comparing household responses to Milenyo as reported above with the responses to the typhoon damage to crops or property as reported in the 2003 survey, we find that the minor role of physical asset liquidation and the important roles of borrowing and receipts of assistances/remittances were found in both the responses to Milenyo and those to earlier typhoons in the 1990s. A major difference, however, appears to be the importance of the reduction in food consumption (as well as consumption reallocation) in response to Milenyo in contrast with the conspicuous absence of such behavior in response to earlier typhoon shocks in the 1990s. Such a contrast appears to reflect the sheer magnitude of the damage due to *Milenyo*, which was likely to be much larger than that of the typhoons in 1994-2003, as suggested by our informal interviews with village residents. This interpretation is also consistent with the fact that a much larger proportion of households reported government aid as a coping mechanism after Milenyo compared to those found in the 2003 survey. The severity of the Milenyo damage, combined with the prospect of the then-upcoming local elections, probably necessitated a larger scale relief operation on the part of the government. While village households were mostly able to shield their consumption from income fluctuations caused by earlier typhoons through various informal insurance schemes (including own savings and incomes, borrowings and assistance from relatives), the extent of income shock due to Milenyo was sufficiently large so that many households were forced to reduce their food consumption. Therefore, it is easy to expect that household’s welfare is affected negatively by changing food consumption.

#### (d) Price and consumption changes

As described in 4(c), consumption reallocation is one of the main coping mechanisms. In this subsection, we describe detailed prices of food items and household's consumption behaviors before and after Milenyo. We collected detailed data on price and consumption before and after Milenyo respectively. Consumption is further disaggregated into purchased quantity (expenditure) and self-consumption quantity. Table 6 shows price changes of basic food items faced by households in the village one week before and one week after Milenyo. In our analysis, we focus on the consumption of main food items, that is, rice, bread pandesal, noodle soup, fresh chickens, fresh pork, egg, bangus, tilapia, and sugar, because we have sufficient variation in price of only these items.<sup>4</sup> Expenditure on these items accounts for 45 percent of a household's total expenditure. According to our data, the price of rice, bread pandesal, noodle soup, fresh chicken, fresh pork, egg, and sugar increased while the price of fish (bangus and tilapia) decreased. Importantly, the price of National Food Authority (NFA) rice did not change substantially, indicating that the food program of the country worked effectively after Milenyo.

Table 7 shows expenditure on major food items. Remarkably, the expenditure on NFA rice rose by 25%, while the expenditure on special rice and ordinary rice declined, indicating the substitution of cheaper NFA rice for the more expensive rice. Indeed, while the expenditure for NFA rice and bangus increased, we found that expenditure for other goods declined. Bangus and tilapia are the most widely consumed fish in the Philippines because of their affordable prices. When the typhoon hit the village, fish pens for tilapia farms were destroyed in the part of Laguna de Bay that is adjacent to the village. A large volume of tilapia was set loose, and nearby residents were able to catch the fish by themselves. As a result, the amount of self-consumption of tilapia increased sharply in the locality. Moreover, in the market, the supply of tilapia increased, pulling down its price.<sup>5</sup>

We have so far described the major short-term price changes and consumption behavior at the village aggregate level. As we see in the next section, however, such an aggregate analysis can mask important heterogeneity among the village social strata in the welfare impact of price changes due to the typhoon. We now turn to an examination of the distributional consequences of the price changes

and consumption behavior in response to such price changes, with a focus on the differential impact between the poor and the wealthy in the village.

## 5. EMPIRICAL RESULTS

### (a) Direct welfare impacts

First, based on Equation (1), we compute compensating variations (CV) to quantify the direct impacts of the typhoon. We calculate CV for agricultural households and non-agricultural households separately because there is important heterogeneity in the amount of self-production of goods between the two household types. In our data, agricultural households have a relatively larger amount of consumption of self-produced goods than non-agricultural households. Agricultural households can cope with price risk by changing consumption of self-produced foods: for example, consumption of self-produced special rice by agricultural households increased to about 4.5 kilograms from 1.8 kilograms before the typhoon. Similarly, consumption of self-produced ordinary rice doubled after the shock. On the other hand, self-consumption by non-agricultural households did not change before and after Milenyo. Therefore, we analyze the possibility that the reaction to the shock was different between agricultural and non-agricultural households. Price changes triggered by natural disasters could affect household welfare disproportionately, as was found in the case of the Indonesian economic crisis studied by Friedman and Levinsohn (2002).

Figure 1 here.

Figure 1 shows the estimated CV (Equation (1)) at different levels of per capita consumption expenditure among the village households. While the total magnitude of the welfare impacts of price changes was relatively smaller than that during the financial crisis in Indonesia as reported in Friedman and Levinsohn (2002), it seems obvious that the poor non-agricultural households faced a larger welfare decline than other groups.

Surprisingly, the middle and high-income households gained from the price changes caused by the typhoon. Basically, this welfare gain was generated by a sharp price drop of bangus and tilapia (Table 6). To verify this, we calculated the CV with and without the consumption of fish; the results are shown in Figure 2. In Figure 2, CV with fish consumption is much lower than CV without fish for middle and high-income households. Indeed, fish consumption is concentrated among richer households (Figure 3).

Figure 2 here.

Figure 3 here.

Along with the damages to the standing rice crop, another major damage caused by Milenyo was the felling of fruit trees, such as mango trees, leading to a sharp increase in the supply of both mango fruit and firewood. As described in Sawada et al. (2009), the village households increased their consumption of mango and shifted their source of fuel from charcoal and LPG to firewood. In order to examine the welfare effects of such price declines, we calculated the CV with and without the consumption of mango fruit. Unfortunately, we have not been able to conduct a similar analysis for firewood because firewood was mostly self-produced rather than purchased and thus no price data were available.

Figure 4 here.

The CV computed with and without mango consumption is reported in Figure 4, where we can see a negligible welfare impact of the decline in the prices of mango. Indeed, Table 6 shows that the price of mango decreased after Milenyo. However, there were relatively few cases of mango consumption reported by the village households. We observe that the number of households that reported receipt of mango “as gift” from other households increased by threefold after the typhoon. The average amount of mangos received as gift was 12 kilograms and 25 kilograms before and after Milenyo, respectively. This is consistent with the mutual insurance hypothesis that village households helped each other after the typhoon by sharing the fallen fruit in their attempt to mitigate the negative shocks, albeit that such insurance effect is small for mango transactions.



(b) Indirect welfare impacts

Figure 5 here.

Figure 6 here.

In order to investigate whether and how direct negative welfare impacts are weathered indirectly by ex post risk coping behaviors of consumption reallocation, we compare estimated CV with and without consumption substitution quantified by Equation (1) and (2), respectively<sup>6</sup>. Figure 5 and 6 show the CV with and without substitution effects for agricultural and non-agricultural households, respectively. These results are consistent with Friedman and Levinsohn (2002) in the sense that households improve their welfare (or mitigate welfare losses) with substitution effects in response to changing food prices. According to Figure 5 for agricultural households, CV with substitution effects is lower than CV without substitution effects. This indicates that there are additional welfare improvements by shifting consumption away from those goods whose prices increased and toward those goods whose prices dropped.

Figure 6 shows that CV for non-agricultural households also decreases with substitution effects, indicating the effective risk coping of households by reallocating consumption. Yet, among the poor, we can find a striking difference between agricultural households in Figure 5 and non-agricultural households in Figure 6. While substitution effects are at most marginal or zero among the poor agricultural households, welfare improves significantly among the poor non-agricultural households. This suggests the importance of the consumption reallocation of the poor non-agricultural as an ex post risk coping strategy. Yet, unlike the agricultural poor, the non-agricultural poor still encounter the overall negative welfare impact even after the consumption substitution effect is taken into account. A possible reason for such a differential welfare impact of food price increase between agricultural and non-agricultural households among the poor is the way they receive their income. One of the main income sources for the poor agricultural laborers is rice harvesting where wages are often, if not always, paid in rice paddy, while non-agricultural laborers are frequently paid in cash. As a

result, the poor agricultural households were likely to be somewhat shielded from the negative effects of food price increases. On the other hand, poor non-agricultural households were directly hit by price increases leading to the net negative welfare impact as shown in Figure 6. In fact, as Figures 5 and 6 make clear, the poor non-agricultural households were the only household category whose net welfare impact arising from the food price changes was negative, while the net welfare impact among non-poor households, both agricultural and non-agricultural, and poor agricultural households was either positive or zero.

## **6. CONCLUSION**

While the damages caused by various natural disasters have been well documented, the distributional consequences due to such damages among different income strata and especially among the poor have not been well understood. Our case study in a Philippine village that was hit by a strong typhoon in 2006 is an attempt to address such a lacuna in the literature. We focused on the distributional welfare impact of the food price changes caused by the typhoon.

We found that the negative income shock due to the typhoon consisted mainly of damages to the standing rice crop and to fruit trees, principally affecting farm households, which are the wealthier group in the village. While the price of most food items (including rice) rose, the price of fish (tilapia and bangus) dropped sharply, as its supply increased after a large volume of cultured fish in the nearby lake was set loose when the typhoon damaged the fish pond facilities. As a consequence, at the village level, the positive welfare effects of the fall in fish prices outweighed the negative effects of price increase in other food items. Such average welfare effects, however, mask the sharp contrast in the welfare impacts of price changes between the poor and the wealthy in the village. While the net welfare impact among the wealthy households was in fact positive, thanks to their higher consumption share of fish, the net welfare impact on the poor households was negative. Among the poor, the negative effects of the food price increase, other than fish price, seemed to outweigh the small or negligible positive benefit of the sharp drop in the price of fish because the fish consumption share was negligible among them. Among the poor households, however, agricultural households appear to

have been somewhat shielded from the food price increase because they often receive their wages in rice paddy rather than in cash, while such was not the case for the poor non-agricultural households. Thus, the poor non-agricultural households were the most severely hit by the changes in food prices caused by the typhoon. We also found the importance of consumption reallocation as ex post risk coping, especially among the non-agricultural poor, who are least protected against the typhoon. The government's targeted interventions such as food transfers and food discount vouchers to the non-agricultural poor could be an effective and efficient strategy to ease negative welfare impacts arising from a typhoon disaster.

One caveat in our analysis, however, is that our analysis focuses on the relatively localized and short-term welfare effects arising from the typhoon but does not consider the longer-term impact due to asset damages. The damages to fruit trees are likely to have some negative impacts on the future income stream of their owners. Also, the short-term gains from the increased fish supply need to be balanced against the negative impact on the fish farm owners. Despite such limitations, this study illustrates the critical importance of distributional analysis of even such a short-term impact of natural disasters.

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<<http://go.worldbank.org/1FYZRPKI60>>.

## Figures

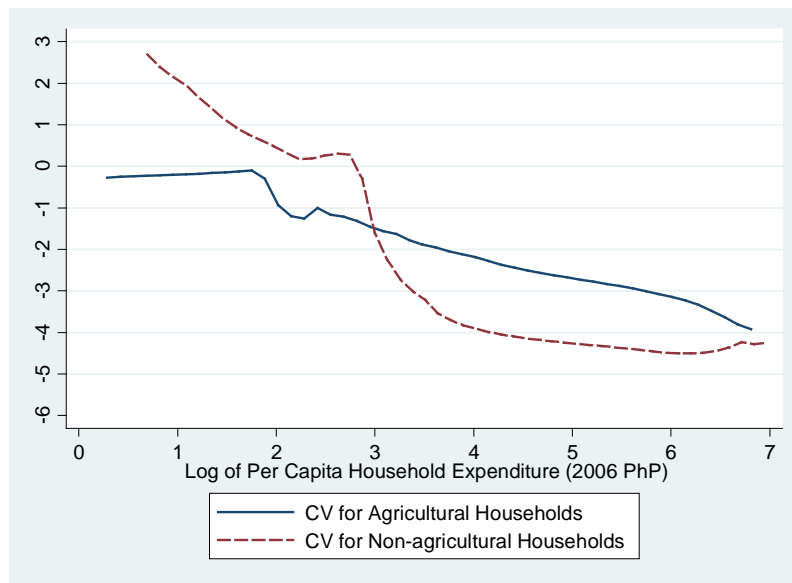


Figure 1: Compensating Variation for Agricultural and Non-agricultural Households

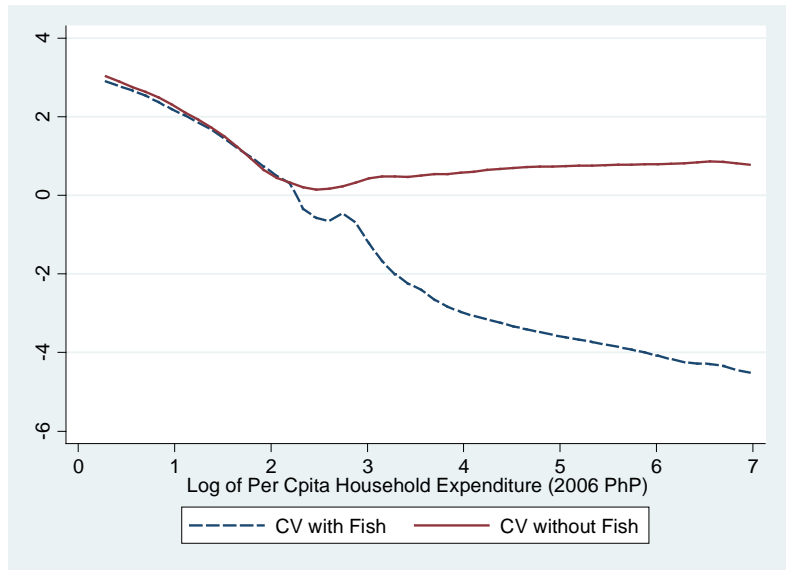


Figure 2: Compensating Variation with and without Bangus and Tilapia Fish



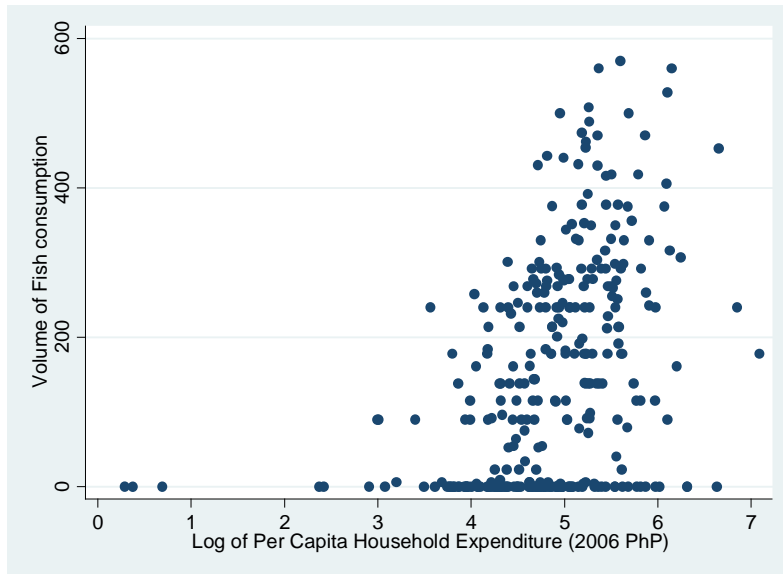


Figure 3: Scatter Chart of Fish Consumption Volume (Unit)

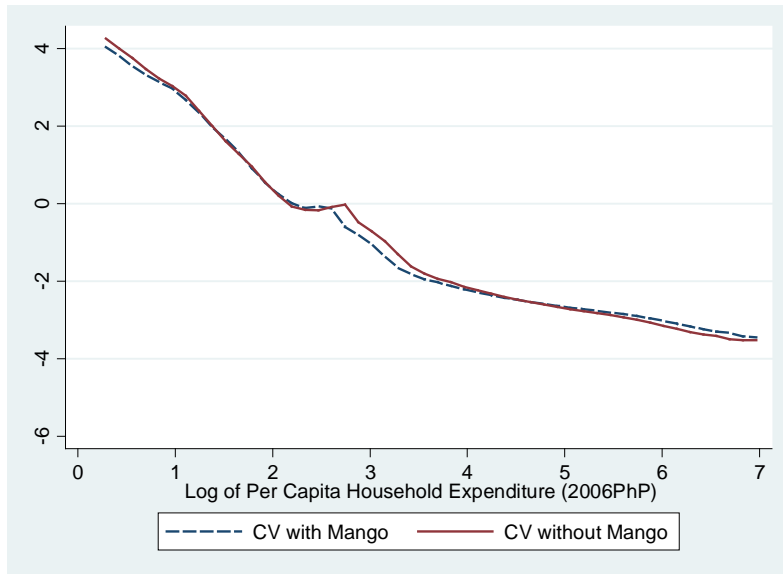


Figure 4: Compensating Variation with and without Mango Consumption

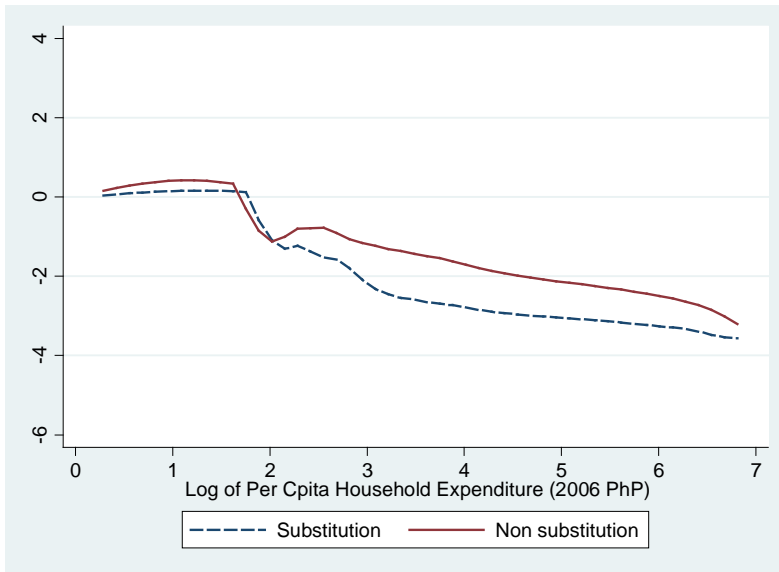


Figure 5: Compensating Variation with and without Substitution Effects  
for Agricultural Households

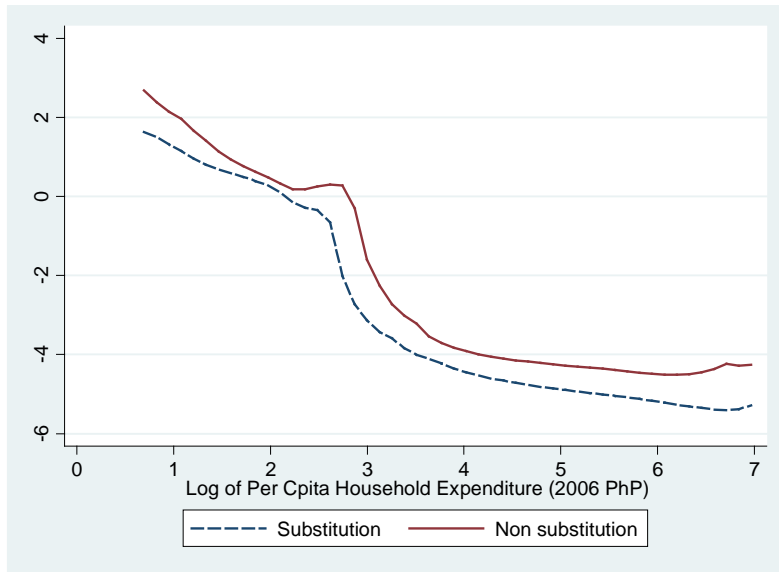


Figure 6: Compensating Variation with and without Substitution Effects  
for Non-agricultural Households

## Tables

Table 1: The Number of Respondent Households, East Laguna Village, Philippines, 2006

Description	Number	%	
Agricultural Households	Farmer Households	40	9.9
	Landless Households	142	35.15
Non-agricultural Households		206	50.99
Others		16	3.96
Total		404	100

Table 2: Description of Milenyo Damages to the Households, 2006

Kind of Damage	Agricultural Households				Non-agricultural Households	
	Farmer		Landless		Number	Percent
	Number	percent	Number	Percent		
None (0)	13	32.5	57	40.1	103	50
Lost house (1)	0	0	0	0	1	0.5
House seriously damaged (2)	2	5	11	7.7	16	7.8
Lost utensils (3)	0	0	0	0	0	0
Lost productive assets (4)	1	2.5	1	0.7	1	0.5
Lost job (5)	0	0	1	0.7	5	2.4
Income declined (6)	8	20	15	10.6	5	2.4
Lost members (7)	0	0	0	0	0	0
Members got injured or sick (8)	0	0	0	0	0	0
Crop damage (9)	2	5	5	3.5	13	6.3
Roof damage (10)	2	5	27	19	42	20.4
Other damage (11)	1	2.5	8	5.6	15	7.3
(2) and (5)	1	2.5	0	0	0	0
(2) and (6)	2	5	4	2.8	1	0.5
(2) and (9)	1	2.5	0	0	2	1
(4) and (6)	0	0	2	1.4	0	0
(6) and (9)	5	12.5	9	6.3	1	0.5
(6) and (10)	0	0	1	0.7	0	0
(1), (6) and (9)	0	0	0	0	1	0.5
(2), (6) and (9)	2	5	1	0.7	0	0
Total	40	100	142	100	206	100

Table 3: Damages to Crop (Average)

Expected price without Milenyo	PHP	8.88
Actual price	PHP	7.25
Expected harvest without Milenyo	Kg	3644.23
Actual harvest	Kg	2412.77

Table 4: Household Coping Mechanisms for Milenyo

Coping Mechanism	Agricultural Households		Non-agricultural Households
	Farmer (%)	Landless (%)	(%)
1. Reduce food consumption	27	76	47
1.1 Rice	0	15	8
1.2 Protein	5	27	13
1.3 Food taken outside	22	34	26
2. Switch consumption to own produce	12	34	22
3. Reducing child schooling	2	1	4
4. Reduce medical expenses	0	3	3
5. Sale of valuable items	0	4	6
6. Emergency borrowing	33	50	30
6.1 Bank	5	3	2
6.2 Relatives	12	13	10
6.3 Friends	3	7	3
6.4 Neighbors	0	6	0
6.5 Moneylender	10	6	5
6.6 Pawnshop	0	0	0
6.7 Sari-sari store	3	15	10
7. Emigration	0	0	0
8. Received remittances	25	16	21
9. Aid from local government and NGO	46	65	58
10. Non-farm employment	85	60	94



Table 5: Primary Occupation of Economically Active Population (15 to 65 years old who are not in school) Before and After Milenyo

Primary Occupation	Before Milenyo		After Milenyo	
	Number	%	Number	%
<b>Self-employed</b>				
Farm: Rice production	21	3	22	3
Duck raising	5	1	5	1
Fishing and fish ponds	1	0	1	0
Non-farm: Commerce and trade	28	4	29	4
Transportation	42	6	42	6
Carpentry and electrical	36	5	37	5
Rural industry	4	1	4	1
<b>Hired work:</b>				
Farm hired work	157	22	152	21
Paid domestic work	13	2	11	2
Personal services	4	1	4	1
Causal work	88	12	87	12
Religious	1	0	1	0
Factory work	35	5	35	5
Professional services	14	2	14	2
Education and government	17	2	16	2
Overseas work	31	4	31	4
Housekeeping/none	230	32	236	32
<b>Total</b>	<b>727</b>	<b>100</b>	<b>727</b>	<b>100</b>

Table 6: Price Change of Food Items

Food Item	Unit	Price before	Price after	% change
		Milenyo (PHP)	Milenyo (PHP)	
Special rice	kg	23.04	24.67	7.08
Ordinary rice	kg	22.41	22.89	2.15
NFA rice	kg	19.89	19.95	0.32
Pandesal bread	piece	1.18	1.21	2.26
Noodle soup	pack	6.03	6.07	0.58
Fresh chicken	kg	105.35	101.05	-4.08
Fresh pork	kg	122.92	127.33	3.59
Egg	piece	4.53	4.62	2.02
Fish (bangus)	kg	83.71	26.22	-68.68
Fish (tilapia)	kg	71.13	61.59	-13.41
Sugar (brown)	kg	31.96	31.61	-1.09
Mango	kg	65	60.49	-6.93

Table 7: Change in Expenditure between before and after Milenyo

Food Item	[A] One week before Milenyo	[B] One week after Milenyo	% change from [A] to [B]
Special rice	20.41	19.32	-5.34
Ordinary rice	114.12	94.52	-17.17
NFA rice	4.63	5.81	25.58
Pandesal bread	62.18	48.68	-21.70
Noodle soup	99.74	78.76	-21.03
Fresh chicken	55.98	39.52	-29.40
Fresh pork	84.01	57.18	-31.94
Egg	112.73	96.28	-14.59
Fish (bangus)	24.84	74.24	198.80
Fish (tilapia)	85.15	74.03	-13.06
Sugar (brown)	142.42	115.72	-18.74
Mango	7.66	4.33	-43.47

Table 8: Expenditure per capita (for 11 goods, one week)

	Unit	One week before Milenyo	One week after Milenyo
Agricultural Households	PhP	183.53	156.47
Non-agricultural Households	PhP	219.61	177.79

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<sup>1</sup> Sawada et al. (2012) lists the total 18 rounds of survey conducted in the village since 1966.

<sup>2</sup> Sawada et al. (2009) reported the detailed description of damages.

<sup>3</sup> Sawada et al. (2009) reported the detailed food expenditures.

<sup>4</sup> In our analysis, we omit households that reported that the consumption of any rice and bread including self-consumption is zero, because rice and bread are main foods in the Philippines; this leaves us 353 households.

<sup>5</sup> In addition, as can be seen in Table 6, the price of *bangus*, another type of local fish that can be thought of as a *tilapia* substitute, also declined sharply.

<sup>6</sup> The results of estimated elasticities are available from the corresponding author upon request.