Do Natural Disaster Affect the Poor Disproportionately? Price Change and Welfare Impact in the Aftermath 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. We find that fish prices dropped sharply due to the damage caused to fish pens near the village, leading to positive net welfare gains among the wealthy. In contrast, the poor do not consume much fish and thus did not gain from the sharp decline in prices. Finally, consumption reallocation played an important role as an ex post risk-coping measure, albeit only among the wealthy, who are relatively well-protected against typhoons.

Keywords: natural disaster, risk coping, compensating variation, welfare analysis, Asia, the Philippines

Acknowledgements

The authors would like to thank Joel Reaño, Teodora Malabanan, Ester Marciano, Vivencio Marciano, Mena Aguilar, Sylvia Sardido, Perla Cristobal, Freia Sardido, Florie Suguitan, and the staff of the Social Sciences Division of the International Rice Research Institute (IRRI) for the survey implementation and useful suggestions. The authors would also like to thank Yujiro Hayami, Hidehiko Ichimura, Keijiro Otsuka, and Kei Kajisa for their valuable comments and suggestions. The usual disclaimers apply.

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, Typhoon Yolanda, and the earthquakes in Haiti, Sichuan province in China, northern Pakistan, and Japan's Tohoku region. Disasters can generate grave consequences for local infrastructure and thus survivors' livelihoods (Barro, 2009). Noy (2009) reveals that, in the short term, developing countries face more severe damage to GDP growth than do developed countries because low-income economies have less ability to cope with sudden shocks, especially to agricultural sectors.

A large body of economic research on natural disasters has developed over the decades, particularly concerning their short- and long-term impacts and ex ante and ex post household coping strategies. Many studies have investigated the impact of idiosyncratic shocks on households. For instance, households in developing countries experience negative short-term birth outcomes and occupational changes as a result of significant damage (Currie & Rossin-Slater, 2013; Kochar, 1999). Deuchart and Felfe (2015) study natural disasters' impact on child outcomes in the Philippines, finding negative effects on children's education, particularly for girls and children from poor households, but no evidence of a long-term effect on children's health. Other studies have tried to identify effective policies for facilitating livelihood recovery after a disaster. It is imperative to identify distinctions between how a disaster affects households and their ex post coping strategies. Del Ninno, Dorosh, and Smith (2003) compare private rice imports and government policy following the 1998 flood in Bangladesh, concluding that private borrowing played an important role in maintaining consumption. While almost all micro household studies on disasters focus on coping strategies, especially on the role of public and/or private transfers (Takasaki 2011, 2012), it is not clear how households incorporate multiple coping strategies and how their welfare is affected as a consequence. Indeed, recent

works have begun to investigate the welfare impacts of price changes (Porto, 2008, 2010; Wood, Nelson & Nogueira 2011; Ferreira et al., 2011). To the best of our knowledge, however, no study has examined the welfare impacts of price changes in the context of a natural disaster in a rural developing country. Since the poorest of the poor in the Philippines are particularly vulnerable to food inflation (Fujii, 2013), studying the impacts of a natural disaster on the welfare of the poor should generate important policy implications.

This paper is the first attempt to fill this gap in the literature. While Fujii (2013) focuses on food price inflation over a period of two years, the price shock analyzed in this paper may be a shorter-term phenomenon; a monetary policy designed to stabilize inflation could be an appropriate policy response to the former, but a rapid response via food aid may be more effective for the latter type of price shock.[1] We quantify the short-term welfare impacts of the devastating typhoon Milenyo of 2006 using unique data collected in a rural Philippine village. Village households were affected not only by the damage to their houses and crops but also by changes in food prices. We thus focus on the welfare impacts of the typhoon via the price changes, which reflect people's responses to the covariate shocks caused by the typhoon, as well as agricultural and other price changes that occurred through market and non-market adjustment mechanisms. Designing and implementing an effective support system for disaster-affected households requires that we identify the victims accurately and quantify the damage. To this end, we adopt a methodology developed by Friedman and Levinsohn (2002) to estimate the changes in household welfare caused by the direct and indirect effects of price changes. Specifically, we employ consumption prices and quantitative data drawn from the village. These data allow us to observe changes in the prices of 11 food categories between one week before and one week after the typhoon. Our data also include detailed information on the damage caused by Milenyo and the coping strategies each household adopted. We examine the heterogeneous effects caused by the typhoon by dividing our sample households into two

groups: agricultural and non-agricultural households. As the physical damage caused by the typhoon was mainly restricted to crops, the price of agricultural products substantially changed, and the extent of the welfare impacts may differ between the agricultural households that consume home-produced agricultural products and the non-agricultural households that purchase these items at a market.

Briefly stated, our empirical results reveal three findings. First, fish prices 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. Second, we uncover important heterogeneous effects of the typhoon, finding that its welfare impacts differed significantly between poor and non-poor households: the poor do not consume much fish and thus did not gain from the sharp decline in the price of fish. Finally, in response to immediate price changes after the disaster, consumption reallocation played an important role as an ex post risk-coping measure only among the wealthy, who are relatively well-protected against typhoons.

The rest of the paper is organized as follows. In Section 2, we describe typhoon Milenyo and then present our data and the analytical framework for our empirical analysis in Section 3. In Section 4, we present our empirical results, and Section 5 concludes the paper.

2. TYPHOON MILENYO AND THE DATA

We use data obtained from an original survey conducted in a Philippine village that was affected by the super typhoon Milenyo, which hit 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, classifying it as a severe tropical storm. The National Disaster Risk Reduction and Management Council reported that Milenyo affected 277 municipalities and caused damage

worth PHP6.6 billion (US$137 million). Government and non-government organizations provided assistance amounting to US$ 1.9 million, illustrating that Milenyo inflicted an enormous amount of damage on the lives and livelihoods of many Filipinos, with a substantial amount of that damage borne by households.

We conducted a survey in a village located in Laguna province, about 70 kilometers southeast of Manila. The village, also known as the East Laguna village, has been repeatedly surveyed since 1966 (e.g., Hayami & Kikuchi, 1981; Hayami & Kikuchi, 2000; Kajisa, 2007).[2] According to the PAGASA, the Calabarzon region containing Laguna province was one of the regions most severely affected by the typhoon, with more than half of the damage borne by Calabarzon and Bicol regions. Compared to the regular typhoons during the monsoon months in the Philippines, the damage caused by Milenyo to our study village was exceptionally severe. Typhoon damage with severe economic consequences appears to occur relatively infrequently, at least in the East Laguna village. A 2003 survey conducted in the village reveals, for example, that only 2% of the households experienced crop damage due to typhoon and 8% reported property damage in the past 10 years, from 1994 to 2003 (Fuwa, Marciano, & Reaño, 2006). This suggests that the damage to 11% of households caused by Milenyo was a largely unexpected shock. In addition, during our informal interviews, a few long-time residents compared Milenyo to Rosing, a legendary typhoon that hit the village in the 1970s.

The survey was conducted from January 20 to February 15, 2007, to collect retrospective information on the households' responses to the typhoon (Sawada, Estudillo, Fuwa, & Kajisa, 2009). We covered all the agricultural and non-agricultural households in the village (see Table 1). Agricultural households include farmer households with cultivated land of their own or leasehold and landless households with agricultural laborers. Their main income source is agricultural activity, while non-agricultural households mainly live on non-agricultural wage labor or self-employment. The collected information includes data on self-

reported damage caused by Milenyo, household coping mechanisms in the aftermath of Milenyo, detailed expenditures on food and nonfood items, and the prices of basic items such as rice, chicken, pork, sugar, bread, and fish. The information on expenditures and prices covers the one-week period before Milenyo and the week afterwards.

(a) Damage and Households' Coping Mechanisms

Table 1 shows the damage to the poor and non-poor households in terms of assets and income lost due to Milenyo in our sample village.[3] We categorize the households into poor and non-poor groups by setting the households' median total expenditure in the village as the poverty threshold. There were no reported deaths or serious injuries thanks to extensive early warnings via television and radio. As Table 1 shows, agricultural and non-agricultural households had heterogeneous damages because Milenyo hit the village during the rice-harvesting season, and the high winds and water logging caused serious damage to the rice crops. Accordingly, a significantly larger proportion of agricultural households than non-agricultural households reported a decline in income after Milenyo. As Table 1 shows, however, there was a homogenous impact on income between poor and non-poor households.

Table 1 here.

Our survey asked how the households coped with the damage caused by Milenyo. The main coping strategies were as follows: (1) reducing food consumption; (2) switching consumption from purchased to home-produced items; (3) obtaining emergency loans from relatives, village moneylenders, or *sari-sari* (village variety) stores; (4) receiving remittances; (5) receiving aid from the local government and NGOs; and (6) engaging in non-farm employment. We find that non-farm employment plays a key role as an effective insurance for

households. As mentioned, non-agricultural households were less prone to income fluctuation. Furthermore, Milenyo created demand for some non-agricultural labor. Labor demand increased in carpentry and construction, needed to repair damage to houses and roofs. Labor demand for fishing also increased. The typhoon destroyed fish pans for tilapia farms located on the section of Laguna Lake the sample village faces. A large volume of tilapia was set loose, and nearby residents started to catch the fish by themselves.

Table 1 shows that more than half of the households received aid from the local government and NGOs. The local government immediately responded to the disaster through the village chieftain by using the village meeting hall as a temporary shelter for households that had lost their roofs or were affected by flash floods. In addition, the local government and a candidate for a local political post distributed food baskets to 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 in order to effectively service the most severely affected households. The village chieftain was able to identify these families immediately because of his many years of association with the villagers. He reported to and received aid from the local town mayor. The food basket was one of the most important coping mechanisms for households in our sample village. The local government is clearly effective and important during a disaster. The severity of Milenyo's damage, combined with the prospect of the then-upcoming local elections, probably necessitated a larger-scale relief operation of the government.

Households typically coped with the damage by borrowing money and receiving private transfers, as has been reported (e.g., Glewwe & Hall, 1998; Shoji, 2006; Sawada & Shimizutani, 2008). Private money lenders and nearby sari-sari stores played an important supportive role by providing emergency funds or credit for basic needs such as rice, canned goods, candles, and kerosene. In addition to the emergency borrowing, 19.8% of households

reported having received remittances after Milenyo. Estudillo, Sawada and Otsuka (2008) illustrate that, aside from their general importance in rural Philippines, remittances also played a key role in the aftermath of the disaster for both poor and non-poor households.

Although these strategies were employed by households to cope with the damage, a larger proportion of our sample households reported having reduced consumption. Poor households differ significantly from non-poor households in reducing their consumption of rice, the primary food in the Philippines, suggesting that coping strategies such as non-agricultural employment, aid from central government and NGOs, emergency borrowing, and remittances were not sufficient for weathering the damage of Milenyo. The income shock was so strong that many households were forced to reduce their food consumption. Therefore, household welfare can be expected to be negatively affected by changing food consumption.

(b) Price and Consumption Changes

This section describes the changes in the prices of food items and consumption patterns before and after Milenyo. Table 2 shows the price changes for basic food items faced by the households one week before and one week after Milenyo. We focus on the consumption of main food items (i.e., rice, bread, noodle soup, fresh chicken, fresh pork, egg, bangus fish, tilapia, and sugar), partly because the price changes for these items show sufficient variation[4] and because expenditures on these items account for 45% of total household expenditure.

Table 2 here.

Table 3 here.

Table 2 shows that the price of rice (both special and ordinary) increased, while the price of fish (bangus and tilapia) decreased. These two fish are the most widely consumed kinds in

the Philippines because they are affordable. The decline in tilapia prices was due to the damage caused to the fish pens, as described. The price of bangus also declined, as it is considered a tilapia substitute. The price change in fish does not show a significant difference between agricultural and non-agricultural households. Table 2 also reveals that the rice price of the National Food Authority (NFA) remained almost constant. The NFA, responsible for food security in the Philippines, tried to maintain their food price, and their counter-measure seems to have worked after Milenyo. The prices of NFA rice appear to confirm the credibility of our self-reported data. As Table 2 shows, changes in food prices, except for special rice, are almost identical among the households; thus, food price change is a covariate shock in the village.

Table 3 shows expenditure changes for major food items among agricultural and non-agricultural households. We can verify the heterogeneous impacts among poor and non-poor households. Poor households of both agricultural and non-agricultural types increased their expenditures on ordinary rice. Table 2 indicates that the price of ordinary rice rose among poor households. This price increase directly affected poor households' expenditures. In addition, expenditure on NFA rice rose more than seven times more for poor non-agricultural households but remained unchanged for other households. Expenditure on special rice declined, indicating the substitution of cheaper NFA rice for the more expensive rice. In addition, significant differences between poor and non-poor households appear in the consumption of fresh chicken and eggs. The price of fresh chicken declined among all households, and poor non-agricultural households expanded their share more than did other households. On the other hand, the price of eggs increased after the typhoon for all households, but the change in expenditure differs significantly between poor and non-poor households. While self-consumption of tilapia increased sharply due to its price decline, the overall expenditure on tilapia did not increase significantly.

We have so far described the major short-term changes in prices and consumption patterns among agricultural/non-agricultural households and poor/non-poor households. We have seen that the households experienced comparable price shocks due to the typhoon. However, significant heterogeneity in the shift of consumption schedule between poor and non-poor households appears. Accordingly, the welfare impacts on poor and non-poor households should be different. To formalize this expectation, we use the compensating variation framework, with a focus on the differentiated welfare impacts between the poor and non-poor and between agricultural and non-agricultural households in the village.

3. DIRECT AND INDIRECT WELFARE IMPACTS: AN ANALYTICAL FRAMEWORK

As we saw in the previous section, the typhoon induced food price changes, possibly due to supply changes. We examine the welfare impacts of the typhoon through such price changes, following Friedman and Levinsohn (2002), by constructing a framework for the impacts using compensating variation (CV). Compensating variation measures the expenditure needed to sustain the initial level of utility given price changes; CV must satisfy the condition in which $u(P_0, E_0) = u(P_1, E_0 + CV)$. Unlike the textbook treatment, such as in Varian (1992), a positive CV indicates that households suffer from the typhoon, as they need extra expenditures to sustain the initial level of utility, while a negative CV indicates that households gain from the typhoon due to reduced prices and determines how much money should be taken away from the households to retain the current utility level. Given $E^h(u, P)$, the standard minimum expenditure function for household h to satisfy a certain utility level, u, given a price vector, P, we have

(1) $$CV^h \equiv E^h(u, P_1) - E^h(u, P_0).$$

where the prices before and after the typhoon are denoted by P_0 and P_0, respectively.[5] Taking a first-order Taylor approximation to the expenditure function around the prices before the typhoon, P_0, and adopting Shephard's lemma, we obtain the approximate CV for household *h*, CV^h as $CV^h = Q'(P_1 - P_0)$, where Q is a consumption quantity vector. This can be written in a budget share as follows:

$$\Delta \ln E^h \approx \sum_{i=1}^{n} w_i^h \Delta \ln p_i^c, \quad (2)$$

where Δ is a first-difference operator, w_i^h denotes the budget share of household *h* for good *i* before the crisis, and p_i^c is the price of good *i*—that is, an element of the price vector, *P* in cluster *c*. We employ Shephard's lemma to derive Equation 2.

Equation 2 quantifies the impact of the typhoon under an assumption of invariable consumption demand—that the food market works and household consumption are representative of demand for consumption given household type. The CV estimated by Equation 2 shows the *direct* welfare impacts of price changes. Facing price changes, households naturally reallocate consumption toward less costly products. To capture this ex post risk-coping behavior, we incorporate the substitution effects in the estimation of CV. Specifically, we follow Friedman and Levinsohn (2002) and employ a second-order Taylor expansion of the logged expenditure function to derive

$$\Delta \ln E^h \approx \sum_{i=1}^{n} w_i^h \Delta \ln p_i^h + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} w_i^h \theta_{ij} \Delta \ln p_i^h \Delta \ln p_j^h, \quad (3)$$

where w_i^h is the pre-typhoon budget share of good *i* for household *h*, and θ_{ij} is the cross-price elasticity of good *i* demand with respect to good *j* price. When $i = j$, it is the own-price

elasticity of good *i*. The second term in Equation 3 shows the substitution effects, capturing the *indirect* welfare impacts of the typhoon through the allocation of consumption. We follow the steps developed by Deaton (1987, 1988, 1997) to estimate the own-price elasticity of demand for individual households using Equation 4 and extend it to obtain cross-price elasticity later, because we do not have market price data for each item but only the households' unit value, which is related to market prices:

$$\ln q^{hc} = \theta_p \ln p^c + \alpha^0 \ln X^{hc} + \beta^0 z^{hc} + f^c + \varepsilon^{0hc}, \tag{4}$$

where q^{hc} is the quantity of goods consumed by household *h* in cluster *c*, p^c is the price of goods of cluster *c*, X^{hc} is total household expenditures, and z^{hc} represents the observed household characteristics such as the ratio of infants, ratio of young people, ratio of old people, log of expenditure, and log of the number of family members. We postulate the Deaton (1988) assumption, under which all households within the same cluster face the same market prices because households are clustered in the survey. Therefore, Equation 4 includes clustered fixed effects f^c. We use 7-sitio, a smaller territorial enclave in Tubuan, as the cluster in this analysis. The error term ε^{0hc} incorporates the unobserved characteristics and any measurement error in the budget share. We have only unit value π^{hc}. However, we cannot substitute unit values into true market prices in the analysis. The unit value may be correlated with the unobserved quality of goods, and it may be negatively correlated with measured quantities. Thus, Deaton suggested considering Equation 5 below in addition to 4 to correct the bias and obtain price elasticities, while we lack information on market prices:

$$\ln \pi^{hc} = \varphi \ln p^c + \alpha^1 \ln X^{hc} + \beta^1 z^{hc} + \varepsilon^{1hc}. \tag{5}$$

In the first step, we estimate α and β with cluster-demeaned household expenditures and characteristics by OLS. These parameters can be estimated consistently because prices are constant within clusters. We generate two variables from the estimated coefficients for each good *i*:

$$\hat{y}_{hc}^{0} = \ln q^{hc} - \hat{\alpha}^{0} \ln X^{hc} - \hat{\beta}^{0} z^{hc}, \tag{6}$$

$$\hat{y}_{hc}^{1} = \ln \pi^{hc} - \hat{\alpha}^{1} \ln X^{hc} - \hat{\beta}^{1} z^{hc}. \tag{7}$$

The second step is to calculate the cluster level average of $\hat{y}_{hc}^{0}$ and $\hat{y}_{hc}^{1}$, then obtain the estimate of the ratio of θ_p to φ:

$$\frac{\theta_p}{\varphi} = \frac{cov(\hat{y}_c^0, \hat{y}_c^1)}{var(\hat{y}_c^1)}. \tag{8}$$

We estimate own-price elasticity θ_p by combining the above equation and estimated φ in equation 5. In the final step, we rearrange the above equation based on Deaton (1987) so that we obtain cross-price elasticities θ_{ij}. We plug the calculated price elasticity and π_{hc}^{i} as p_{ht}^{i} into Equation 3 to generate CV. While Deaton's method is designed to handle errors in measuring true prices, CV in Equation 3 may still be biased because we use self-reported household data. However, we can still estimate the "lower-bound" of the true welfare effects. The village-level price elasticities for 10 food items are presented in the appendix, Table A1. We use these price elasticities to compute CV through Equations 2 and 3 in Section 4.

4. EMPIRICAL RESULTS

(a) Direct Welfare Impacts

First, based on Equation 2, we compute 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. As we intend to analyze the short-term impacts due to the market price changes caused by a natural disaster, our CV consists only of purchased goods with market price changes. In our data, agricultural households consume more self-produced goods than do non-agricultural households. Thus, agricultural households may be better able to cope with price risk by changing their consumption of self-produced foods. We therefore investigate the possibility that the reaction to the shock differed between agricultural and non-agricultural households. Furthermore, and more importantly, price changes triggered by natural disasters could affect household welfare heterogeneously, as was found in the case of an Indonesian economic crisis studied by Friedman and Levinsohn (2002).

Table 4 here.

Figure 1 here.

Table 4 shows the estimated CV for poor and non-poor agricultural and non-agricultural households. The CV is calculated based on the price elasticities presented in Table A1. Surprisingly, the welfare impacts of the price changes resulting from the typhoon were mostly positive, as illustrated by the negative CVs shown in Table 4 and Figure 1. However, the welfare impact of the typhoon differed significantly between poor and non-poor households. Among both agricultural and non-agricultural households, non-poor households encountered significantly positive welfare impacts, though significantly different from zero.[6] Figure 1

depicts the change in the calculated CV as per capita consumption changes.[7] Our findings are consistent with Friedman and Levinsohn (2002) in that welfare gains increase (or welfare losses decrease) as household consumption increases. However, the total magnitude of the welfare impacts of price changes was smaller than that during the financial crisis in Indonesia. Figure 1 also indicates that, among the poorest of the poor non-agricultural households, whose per capita consumption is lower than 2, the welfare impact may have been negative, although we cannot reject the null hypothesis of zero welfare impact among them.[8]

Table 4 shows that the net welfare impact resulting from the price changes after the typhoon was positive (as shown in the negative CVs) and that its magnitude was equivalent to 25% of the total consumption before Milenyo for non-poor, non-agricultural households. Such large and positive welfare gains were generated by sharp price reductions in bangus fish and chickens after Milenyo (see Table 2). To verify this result, we calculated the CV with and without the consumption of fish; the results are presented in Figure 2(a). The CV with fish consumption has a much greater negative value than that without, especially among the rich households, because their consumption share of fish is relatively large. By contrast, our data show that almost all the households in the lowest expenditure strata do not consume fish at all. Both agricultural and non-agricultural households have the same tendencies.

Figure 2(a) here.

Figure 2(b) here.

Along with fish, chickens became significantly cheaper after Milenyo. To quantify the welfare effects of such price reductions, we calculated the CV with and without the consumption of chicken (Figure 2[b]). We obtain a pattern of welfare change similar to that of the fish price reduction, but the change in the chicken price is smaller than that in the fish price.

Table 2 shows the decline in the chicken price after Milenyo, but the consumption share of chicken out of total expenditure is relatively small. Moreover, chicken expenditures dropped among non-poor households, possibly because (as many households reported) people received chicken as "gifts" from other households rather than purchasing them. The average amount of chicken received as a gift was 0.9 kilograms and 11.3 kilograms before and after Milenyo, respectively. This supports the mutual insurance hypothesis that village households helped each other after the typhoon by sharing products in an attempt to mitigate the negative shocks, though this insurance effect is limited to non-poor households and is rather small, especially for chicken transactions. We should also note that Figures 2(a) and 2(b) show that only wealthy households received benefits from the fish and chicken price reductions.

(b) Indirect Welfare Impacts

We investigate whether and how direct negative welfare impacts are indirectly softened by ex post consumption reallocation decisions by computing a CV allowing consumption substitution by estimating Equation 3. Figures 3(a) and 3(b) show the computed CV for agricultural and non-agricultural households respectively with and without explicit consumption substitution. To compare the direct and indirect welfare consequences via the price changes, we present both CV with substitution and that without. Figure 3(a) shows that, for agricultural households, the CV without substitution effects is of a substantially smaller negative value (implying smaller welfare gains from the decline in prices) than is that with substitution effects for wealthy households. By contrast, among the relatively poor households, we do not see any effectiveness of consumption reallocation. The households that did not benefit from substitution have a special characteristic. After Milenyo, the price of rice increased, while the price of bread changed little (see Table 2). In response, most of the households shifted their consumptions from rice to bread in order to mitigate the negative welfare impact of the price increase, shifting

consumption away from those goods whose prices increased and toward those goods whose prices dropped. There were some exceptions, however; some households were reluctant or less able to reduce their expenditure on rice because they included a greater proportion of elderly (24%) than other households (6%). In the Philippines, rice is the staple food in a traditional diet, and the elderly are likely to find it more difficult to deviate from their principal diet after a shock. The average expenditure on bread among those households was 27 PHP, compared to 56.8 PHP among other households.

Figure 3(a) here.

Figure 3(b) here.

Figure 3(b) shows that CV for non-agricultural households decreases with substitution effects, indicating the moderately effective risk-coping of households through the reallocation of consumption. While substitution effects are, at most, marginal or zero among poor non-agricultural households, welfare improves among the wealthy non-agricultural households, suggesting the importance of consumption reallocation as an ex post risk-coping strategy among such households.

5. CONCLUSION

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

While the prices of most food items (including rice) rose, the price of fish (tilapia and bangus) dropped sharply because its supply increased after a large volume of cultured fish in

the nearby lake was set loose when the typhoon damaged fish pond facilities. As a consequence, the positive village-level welfare effects of the fall in fish prices outweighed the negative effects of price increases for other food items. Such average welfare effects, however, mask the sharp contrast in the welfare impacts of price changes between the village's poor and non-poor. While the net welfare impact among non-poor households was positive, thanks to their higher consumption share of fish, the net welfare impact on poor households was negligible. Among the poor, the negative effects of the increased prices of food other than fish seemed to cancel out the small or negligible positive benefits of the sharp drop in the price of fish because their fish consumption share was negligible. We also found that agricultural households that could not change consumption schedules because of their household characteristics experienced negative impacts from price changes for principal goods. We also found that consumption reallocation is an important ex post risk-coping measure, but only among wealthy households, who are relatively well-protected against typhoons.

One caveat in our analysis is, however, that it focuses on the relatively localized and short-term welfare effects arising from the typhoon but does not consider the longer-term impacts due to asset damage. Damage to productive assets such as fruit trees is likely to have negative impacts on their owners' future income streams. Moreover, the short-term gains from the increased fish supply need to be balanced against the negative welfare impacts on fish farm owners. Hence, the overall social welfare impacts may not be positive. Despite these limitations, this study illustrates the critical importance of a distributional welfare analysis of the short-term impacts of natural disasters.

References

Barro, R. J. (2009). Asset prices and welfare costs. *American Economic Review*, *99*(1), 243–264.

Bernard, T., de Janvry, A., & Sadoulet, E. (2010). When does community conservatism constrain village organizations? *Economic Development and Cultural Change*, *58*(4), 609–641.

Cavallo, E., & I. Noy. (2009). The Economics of Natural Disasters: A Survey. *IDB Working Paper 124*.

Currie, J. & Rossin-Slater, M. (2013). Weathering the storm: Hurricanes and birth outcomes. *Journal of Health Economics 32*, 487–503.

Dzanku, F.M., Jirstrom, M. & Marstorp H. (2015). Yield gap-based poverty gaps in rural Sub-Saharan Africa. *World Development 67,* 336–362.

Deaton, A. (1987). Estimation of own- and cross-price elasticities from household survey data. *Journal of Econometrics*, *36*(1-2), 7–30.

Deaton, A. (1988). Quality, quantity, and spatial variation of price. *American Economic Review*, *78*(3), 281–309.

Deaton, A. (1989). Rice prices and income distribution in Thailand: a non-parametric analysis. *Economic Journal*, 99, 137

Deaton, A. (1990). Price elasticities from survey data: Extensions and Indonesian results. *Journal of Econometrics*, *44*(3), 281–309.

Deaton, A. (1997). *The analysis of Household surveys: A microeconometric approach to development policy*. Baltimore, MD: Johns Hopkins University Press.

Dercon, S. (2005). *Insurance against poverty*. Oxford, UK: Oxford University Press

de Janvry, A., Fafchamps, M., & Sadoulet, E. (1991). Peasant household behaviour with missing markets: Some paradoxes explained. *The Economic Journal*, *101*(409), 1400–1417.

del Ninno, C., Dorosh, P. A. & Smith, L.C. (2003). Public policy, markets and household doping strategies in Bangladesh: Avoiding a food security crisis following the 1998 floods. *World Development*, *31*(7), 1221–1238.

Deuchert, E. & Felfe, C. (2015). The tempest: Short- and long-term consequences of a natural disaster for children's development. *European Economic Review*, *80*, 280–294

Estudillo, J. P., Sawada, Y., & Otsuka, K. (2008). Poverty and income dynamics in Philippines villages, 1985-2004. *Review of Development Economics*, *12*(4), 877–890.

Estudillo, J. P., Sawada, Y., Kajisa, K., Fuwa, N., & Kikuchi, M. (2010). The transformation of Hayami's Village. In Otsuka, K. & Kalirajan, K. *Community, Market and Development*, 1st.ed (pp. 224–244), Hampshire, UK: Palgrave Macmillan

Fafchamps, M. (2003). *Rural poverty, risk, and development*. Cheltenham, UK: Edward Elgar Pub.

Ferreira, F. H. G., Fruttero, A., Leite, P., & Lucchetti, L. (2011). Rising food prices and household welfare: Evidence from Brazil 2008. World Bank Policy Research Working Paper, No. 5652.

Friedman, J., & Levinsohn, J. (2002). The distributional impacts of Indonesia's financial crisis on household welfare: A "rapid response" methodology. *World Bank Economic Review*, *16*(3), 397–423.

Fujii, T. (2013). Impact of food inflation on poverty in the Philippines. *Food Policy 39*, 13–27.

Fuwa, N., Marciano, E., & Reaño, J. (2006). *Report on the 2003 livelihood systems of rural households survey in the Philippines*. Los Baños: International Rice Research Institute.

Glewwe, P., & Hall, G. (1998). Are some groups more vulnerable to macroeconomic shocks than others? Hypothesis tests based on panel data from Peru. *Journal of Development Economics, 56*(1), 181–206.

Griliches, Z., & Hausman, J. A. (1986). Errors in variables in panel data. *Journal of Econometrics, 31*(1), 93–118.

Hayami. Y., & Kikuchi, M. (1981). *Asian village economy at the crossroads: an economic approach to institutional change*. Tokyo: University of Tokyo Press.

Hayami, Y., & Kikuchi, M. (2000). *A rice village saga: Three decades of green revolution in the Philippines*. Lanham, MD: Barnes & Noble.

Kajisa, K. (2007). Personal networks and non-agricultural employment: the case of a farming village in the Philippines. *Economic Development and Cultural Change, 55*(4), 699–707.

Kochar, A. (1999). Smoothing consumption by smoothing income: Hours-of-work responses to idiosyncratic agricultural shocks in rural India. *The Review of Economics and Statistics, 81*(1), 50–61.

Jensen, R. T., & Miller, N. H. (2008). Giffen behavior and subsistence consumption. *American Economic Review, 98*(4), 1553–1577.

Levinsohn, J., Berry, S., & Friedman, J. (2003). Impacts of the Indonesian economic crisis. Price changes and the poor. In P. D. Michael, & A. F. Jeffrey (Eds.), *Managing currency crisis in emerging markets* (pp. 393–428). Chicago: University of Chicago Press.

Mundlak, Y. (1978). On the pooling of time series and cross section data. *Econometrica, 46*(1), 69–85.

National Economic and Development Authority. (November 15, 2006). Government's response to Milenyo. Retrieved August 5, 2012 from http://www.neda.gov.ph/devpulse/pdf_files/devpulse%20%2015%20Nov.%202006.pdf.

Niimi, Y. (2005). An analysis of household responses to price shocks in Vietnam: Can unit

values substitute for market prices? Poverty Research Unit Working Paper No. 30, University of Sussex.

Noy, I. (2009). The macroeconomic consequences of disasters. *Journal of Development Economics 88*(2), 221-231.

Porto, G. G. (2008). *Estimating household responses to trade reform: Net consumers and net producers in rural Mexico, Mimeo*. Washington, DC: World Bank.

Porto, G. G. (2010). Food prices: Household responses and spillovers. In M. A. Aksoy, & B. Hoekman (Eds.), *Food prices and rural poverty* (pp. 167–184). Washington, DC: World Bank.

Republic of the Philippines (Eds.) (January 19-24, 2009). Proceedings from ESCAP/WMO Typhoon Committee 41st Session. Republic of the Philippines, Philippines.

Robles, M., & Maximo, T. (2010). Understanding the impact of high food prices in Latin America. *Economia*, *10*(2), 117–164.

Sakai, Y. (2012). *The analysis of impact on household welfare from the typhoon Milenyo in the Philippines*. Unpublished master's thesis, The University of Tokyo, Tokyo.

Sawada, Y., Estudillo, J. P., Fuwa, N., & Kajisa, K. (2009). How do people cope with a natural disaster? The case of super typhoon Milenyo in the Philippines. In L. S. Gabanilla & G. P. Carnaje (Eds.), *Development, Natural Resources and the Environment* (pp. 116–150). Los Banos: College of Economics and Management University of the Philippines.

Sawada, Y., & Shimizutani, S. (2008). How do people cope with natural disasters? Evidence from the great Hansin-Awaji (Kobe) earthquake. *Journal of Money, Credit, and Banking, 40*(2-3), 463–488.

Sawada, Y., Higuchi, Y., Kajisa, K., Fuwa, N., Esther, M. B. M., & Estudillo, J. P. (2012). The East Laguna Village: Four decades of studies in a Filipino village. PRIMCED discussion paper no. 18.

Shoji, M. (2006). Limitation of quasi-credit as mutual insurance: coping strategies for covariate shocks in Bangladesh. COE Discussion Paper F-138. Retrieved from http://www2.e.u-tokyo.ac.jp/cemano/research/DP/documents/coe-f-138.pdf.

Skoufias, E. (2003). Economic crisis and natural disasters: coping strategies and policy implication. *World Development 31,* 1087–1102.

Takasaki, Y. (2014). How is disaster aid allocated within poor villages? Risk sharing and social hierarchy. *Journal of International Development. 26*(8), 1097–1114.

Takasaki, Y. (2012). Natural disasters, gender and handicrafts. *Journal of Development Studies, 48*(1), 115-132.

Takasaki, Y. (2011). Do local elites capture natural disaster reconstruction funds? *Journal of Development Studies, 47*(9), 1281–1298.

Townsend, R. M. (1994). Risk and insurance in village India. *Econometrica*, *62*(3), 539–591.

Varian, H. (1992), *Microeconomics analysis*, 3rd edition, New York, W. W. Norton & Company.

Wood, B. D. K., Nelson, C. H., & Nogueira, L. (2012). Poverty effects of food price escalation: The importance of substitution effects in Mexican households. *Food Policy*, *37*(1), 77–85.

Endnotes

[1] We would like to thank an anonymous referee for drawing our attention to this point.

[2] Estudillo et al. (2010) review the development of this village over 40 years, and Sawada et al. (2012) list the 18 village surveys conducted since 1966.

[3] Please see Sawada et al. (2009) for a detailed description of the damage.

[4] We omit households that reported that their consumption of rice and bread, including self-consumption, was zero, because rice and bread are the main foods in the Philippines;this leaves us with 389 households. We also omit "others," comprising the jobless and those whose main income source is support by children.

[5] While we follow Fredman and Levinsohn (2002), a conventional textbook definition of compensation variation is $E^h(u, P_0) - E^h(u, P_1)$. See, for example, Varian (1992).

[6] P-values for a null hypothesis of zero welfare impact is 0.0017 and 0.0084 for poor agricultural and non-agricultural households.

[7] We incorporate consumption of self-produced goods in log per capita consumption.

[8] P-values for null hypothesis of zero welfare impact is 0.5. This could be attributable to the fact that the main income source for poor agricultural laborers is rice harvesting, where wages are often, if not always, paid in rice, while the non-agricultural laborers are usually paid in cash. Moreover, they could switch consumption to self-produced goods. 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, the poor non-agricultural households were directly hit by price increases, leading to the net negative welfare impact shown in Figure 1.

Table 1

Number of Sample Households and Description of Damage and Household Coping Strategy

	Agricultural HH		Non-agricultural HH		Total	p-value (agri vs. non-agri)	p-value (poor vs. non-poor)
	poor	non-poor	poor	non-poor			
Damage (%)							
None	28.4	41.2	41.3	56.1	42.4	0.00	0.02
Lost house	0.0	0.0	1.0	0.0	0.3	0.37	0.32
House seriously damaged	13.6	11.8	12.5	6.5	10.9	0.31	0.19
Lost productive assets	2.3	2.4	0.0	1.9	1.6	0.28	0.41
Lost job	2.3	0.0	3.8	0.9	1.8	0.38	0.06
Income declined	36.4	27.1	4.8	4.7	16.9	0.00	0.22
Crop damage	17.0	11.8	7.7	10.3	11.5	0.10	0.75
Roof damage	22.7	17.6	25.0	16.8	20.6	0.88	0.10
Other damage	6.8	4.7	7.7	9.3	7.3	0.30	1.00
Coping strategy (%)							
Reduce food	44.3	35.3	32.7	31.8	35.7	0.12	0.34
Rice	15.9	7.1	9.6	6.5	9.6	0.25	0.06
Protein	26.1	17.6	14.4	10.3	16.7	0.01	0.10
Food taken others	35.2	24.7	22.1	26.2	26.8	0.20	0.57
Switch consumption	31.8	24.7	25.0	17.8	24.5	0.11	0.10
Reducing child schooling	0.0	2.4	5.8	2.8	2.9	0.07	0.76
Reducing medical expense	1.1	2.4	6.7	0.9	2.9	0.23	0.13
Sale of valuable items	2.3	3.5	5.8	6.5	4.7	0.13	0.63
Emergency borrowing	26.1	15.3	16.3	18.7	19.0	0.42	0.36
Emigration	0.0	3.5	5.8	5.6	3.9	0.05	0.43
Received remittances	15.9	21.2	19.2	22.4	19.8	0.57	0.31
Aid from local government and NGOs	70.5	51.8	71.2	45.8	59.6	0.56	0.00
Non-farm employment	65.9	61.2	95.2	93.5	80.5	0.00	0.52
N	88	85	104	107	384		

Note: We categorize households into poor and non-poor. The household is considered poor if its total expenditure is below the median of the total expenditure in the village. The numbers are the damaged household percentages out of total households in each category. Multiple answers are allowed. We show p-values of the t-test to show the difference between agricultural households (both poor and non-poor) and non-agricultural households (both poor and non-poor) and between poor households (both agricultural and non-agricultural) and non-poor households (both agricultural and non-agricultural).

Table 2

Price Change of Food Items from Before to After Milenyo

	Agricultural HH		Non-agricultural HH		Total	p-value (agri vs. non-agri)	p-value (poor vs. non-poor)
	Poor	non-poor	poor	non-poor			
Special rice (kg)							
Before Milenyo	23.4	23.2	23.1	23.0	23.2		
After Milenyo	25.1	23.2	26.1	26.8	25.5		
Change (%)	7.4	0.1	12.9	16.2	9.7	0.03	0.84
Ordinary rice (kg)							
Before Milenyo	22.2	22.4	22.2	23.6	22.6		
After Milenyo	22.7	22.7	22.5	23.8	22.9		
Change	2.4	2.1	0.6	0.2	1.3	0.07	0.68
NFT rice							
Before Milenyo	19.9	19.8	19.8	19.8	19.8		
After Milenyo	19.9	19.8	19.8	19.8	19.8		
Change (%)	0.0	0.0	0.0	0.1	0.0	0.32	0.28
Pandesal bread							
Before Milenyo	1.2	1.4	1.2	1.2	1.2		
After Milenyo	1.2	1.5	1.2	1.2	1.3		
Change (%)	0.4	3.1	0.5	0.5	1.0	0.42	0.43
Noodle soup							
Before Milenyo	6.0	5.9	6.0	6.3	6.1		
After Milenyo	6.2	5.9	6.0	6.4	6.1		
Change (%)	5.7	-0.1	0.4	0.9	1.7	0.22	0.21
Fresh chicken							
Before Milenyo	106.8	104.4	105.5	107.6	106.2		
After Milenyo	101.2	102.2	102.6	106.0	103.1		
Change (%)	-3.7	-0.4	-0.5	-0.3	-1.3	0.53	0.12
Fresh pork							
Before Milenyo	126.8	124.1	128.0	119.5	124.2		
After Milenyo	131.7	124.0	133.6	126.1	129.2		
Change (%)	3.0	5.0	3.2	13.9	6.5	0.36	0.21
Egg							
Before Milenyo	4.6	5.0	4.3	4.5	4.6		
After Milenyo	4.6	5.2	4.4	4.6	4.6		
Change (%)	0.4	1.2	2.3	0.7	1.1	0.31	0.55
Fish (bangus)							
Before Milenyo	76.8	78.2	80.8	79.2	78.8		
After Milenyo	26.5	24.6	26.4	25.8	26.1		
Change (%)	-64.0	-67.8	-66.2	-65.4	-65.8	0.96	0.45
Fish (tilapia)							
Before Milenyo	73.1	75.7	70.3	71.0	72.4		
After Milenyo	63.0	62.4	60.8	61.5	61.8		
Change (%)	-8.4	-12.9	-14.8	-10.1	-11.5	0.58	0.90
Sugar (brown)							
Before Milenyo	30.1	33.7	31.9	31.7	31.8		
After Milenyo	29.8	33.1	31.8	31.7	31.6		
Change (%)	0.3	-0.2	-0.6	3.2	0.7	0.49	0.25
N	23.4	23.2	23.1	23.0	23.2		

Note: Change (%) is the average of the price change. We show p-values of the t-test to show the difference between agricultural households (both poor and non-poor) and non-agricultural households (both poor and non-poor) and between poor households (both agricultural and non-agricultural) and non-poor households (both agricultural and non-agricultural).

Table 3

% Change in Expenditure of Each Food Item from Before to After Milenyo

	Agricultural HH		Non-agricultural HH		Total	p-value (agri vs. non-agri)	p-value (poor vs. non-poor)
	poor	non-poor	poor	non-poor			
Special rice	-17.0	-16.5	-13.8	-22.1	-17.5	0.62	0.99
Ordinary rice	26.9	-28.2	128.7	-22.8	35.4	0.42	0.03
NFA rice	-16.7	-17.0	742.1	-2.2	439.9	0.51	0.52
Pandesal bread	203.0	31.5	-17.3	-23.0	35.2	0.07	0.73
Noodle soup	-1.6	-31.1	-2.3	-24.2	-14.9	0.98	0.34
Fresh chicken	25.6	-28.5	162.8	-17.4	16.3	0.69	0.06
Fresh pork	-58.3	-38.8	-41.2	-24.5	-37.7	0.39	0.83
Egg	-20.3	-24.1	8.4	-14.4	-12.5	0.84	0.06
Fish (bangus)	-1.0	29.0	-50.7	303.8	110.3	0.73	0.71
Fish (tilapia)	-54.3	-41.7	-32.9	-39.1	-40.1	0.25	0.11
Sugar (brown)	-11.8	-16.7	-15.6	-11.3	-13.8	0.32	0.19
Total Expenditure	2.9	-21.2	0.7	-19.6	-9.2	0.88	0.00
N	88	85	104	107	384		

Note: We show p-values of the t-test to show the difference between agricultural households (both poor and non-poor) and non-agricultural households (both poor and non-poor) and between poor households (both agricultural and non-agricultural) and non-poor households (both agricultural and non-agricultural).

Table 4
Compensating Variation (%)

	Poor Households	Non-poor Households	All	*p*-value for the same mean between the poor and the non-poor
Agricultural Household	-6.5	-11.7	-14.4	0.030
Non-agricultural Household	-23.2	-26.7	-18.9	0.077
All	-9.3	-25.2	-16.9	0.006
p-value of the same mean for the agricultural and non-agricultural households	0.365	0.741	0.438	

Note: Compensating variation measured by 2006 average household expenditures. P-values are for the null hypotheses of the same mean.

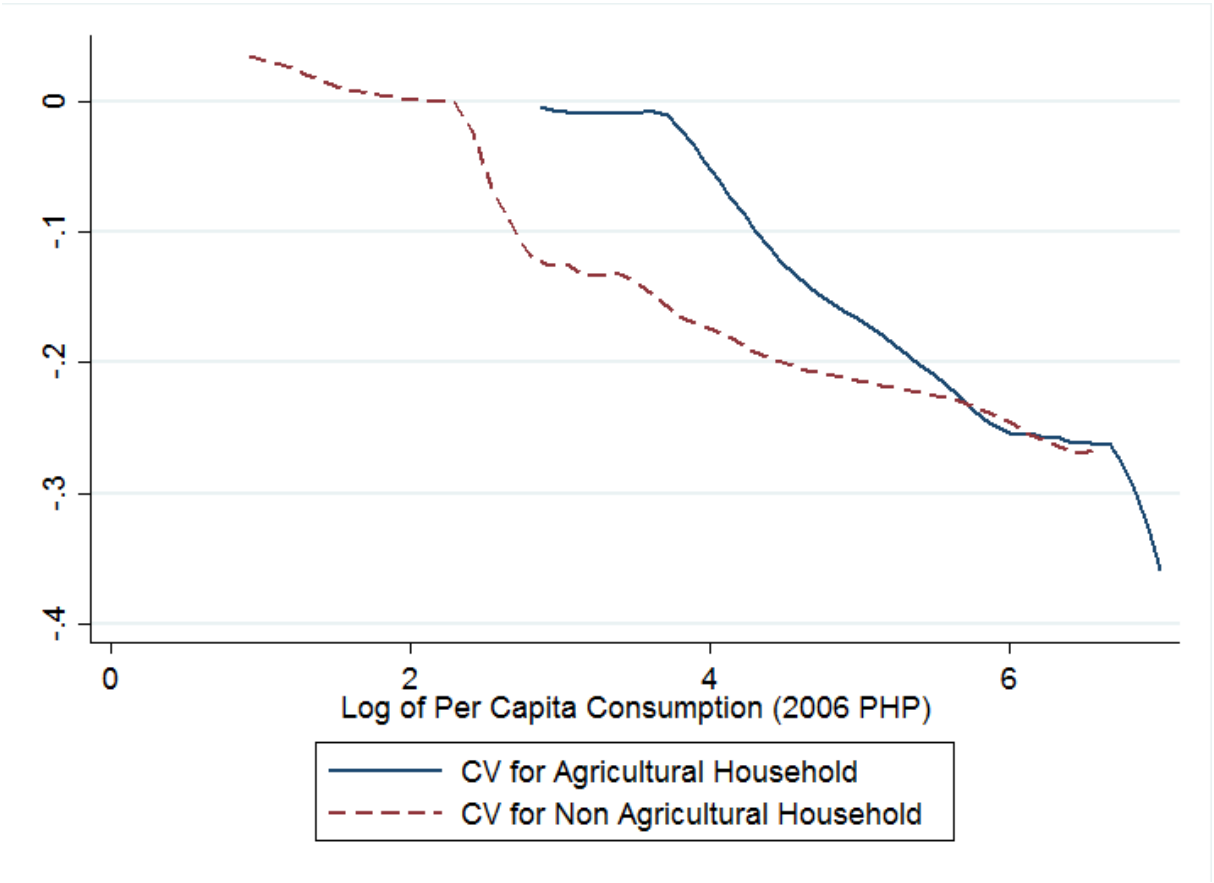

Figure 1. Compensating variation for agricultural and non-agricultural households

Note: log of per capita consumption is calculated by purchased goods and self-consumption.

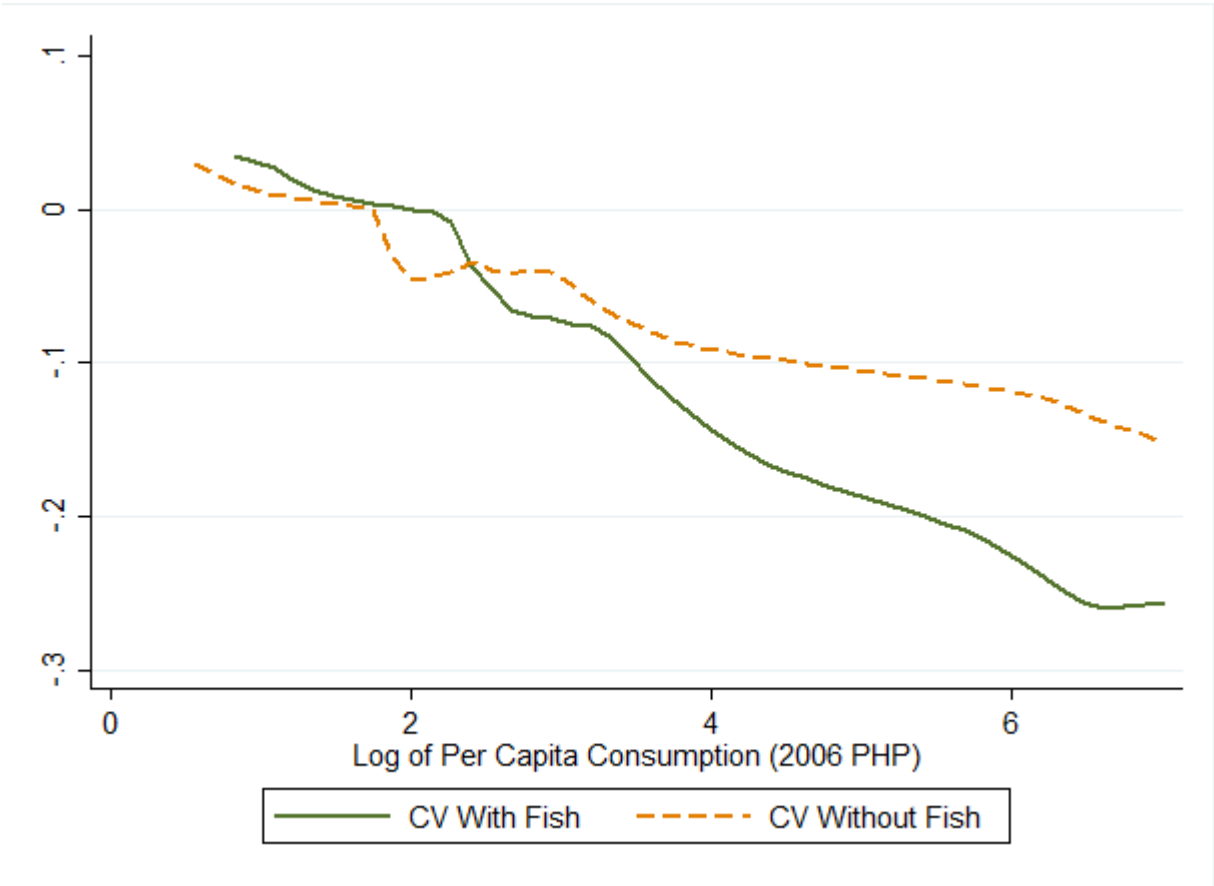

Figure 2(a). Compensating variation with and without fish (bangus and tilapia) for households

Note: Log of per capita consumption is calculated by purchased goods and self-consumption.

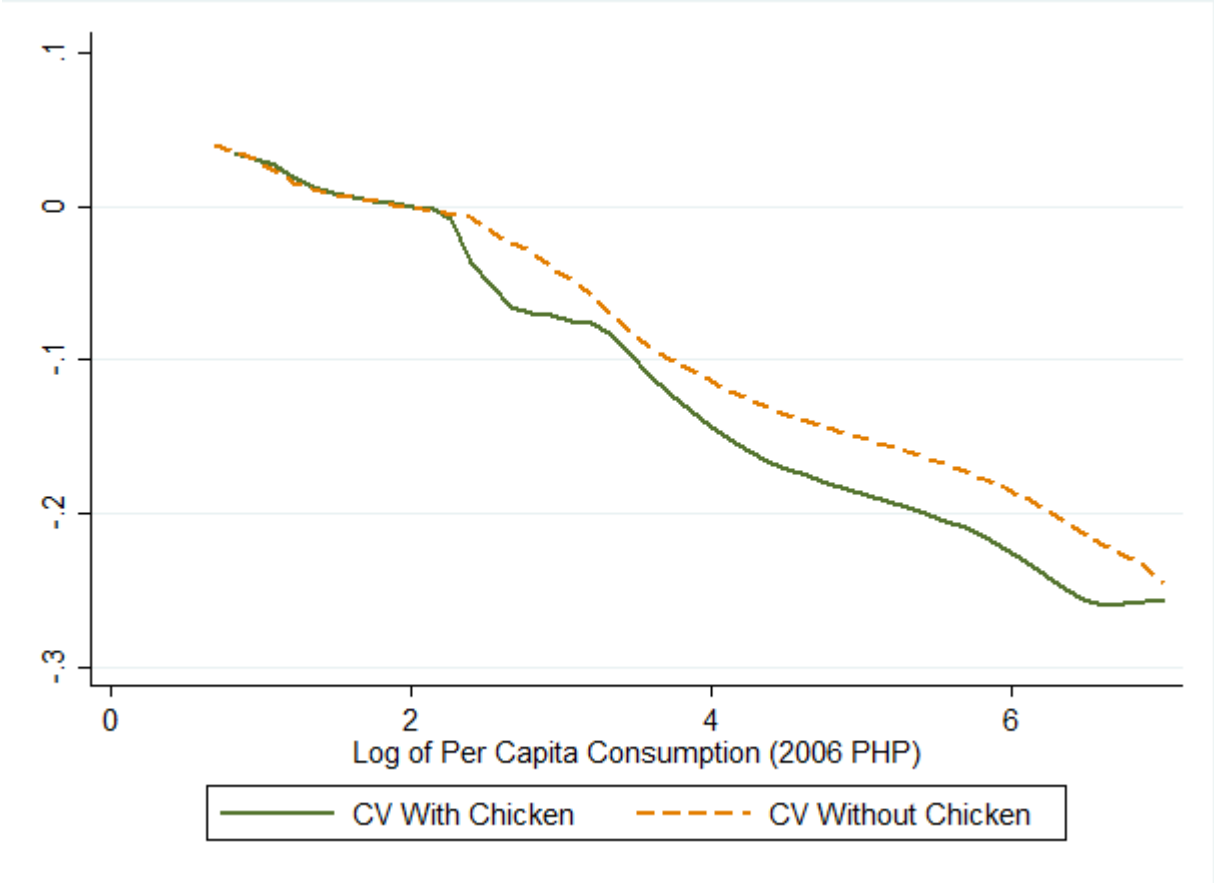

Figure 2(b). Compensating variation with and without chicken for households

Note: Log of per capita consumption is calculated by purchased goods and self-consumption.

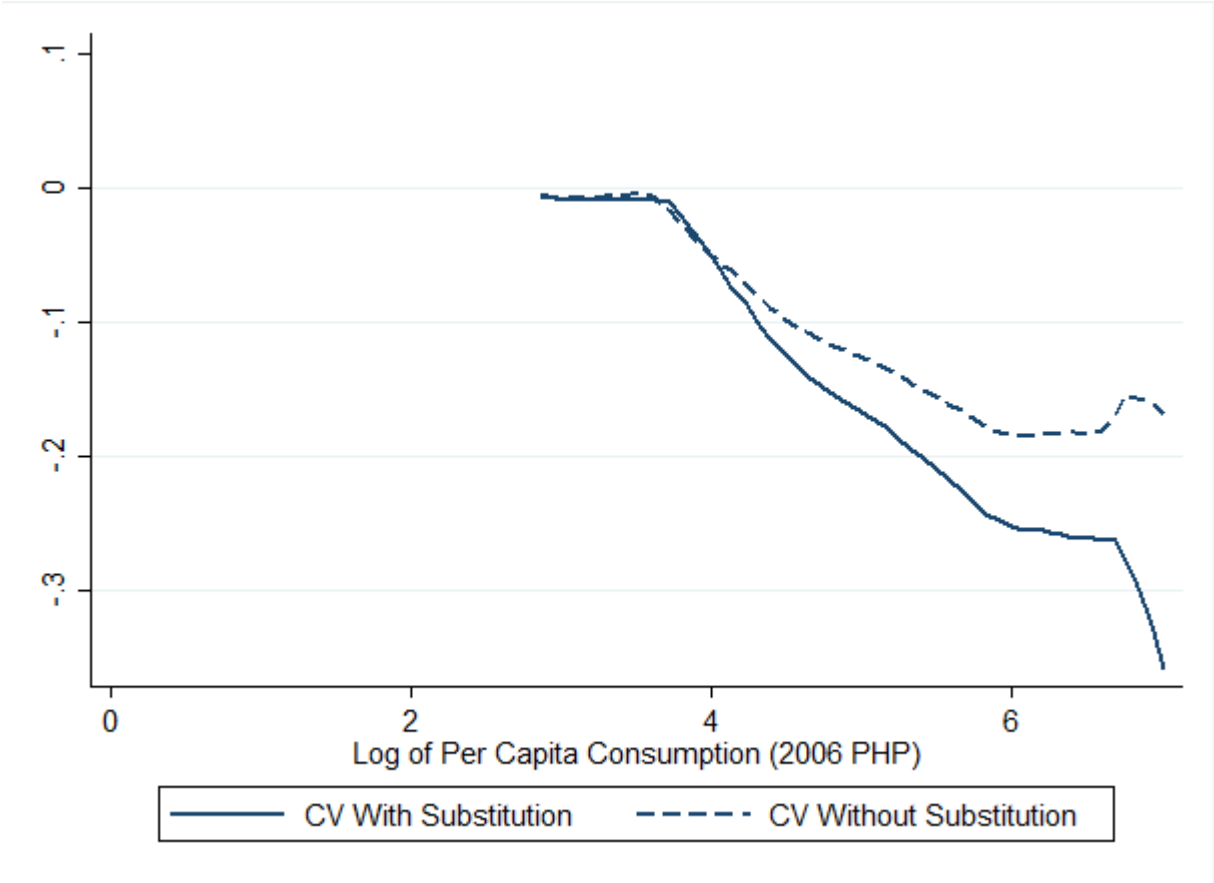

Figure 3(a). compensating variation with and without substitution effects for agricultural households

Note: Log of per capita consumption is calculated by purchased goods and self-consumption.

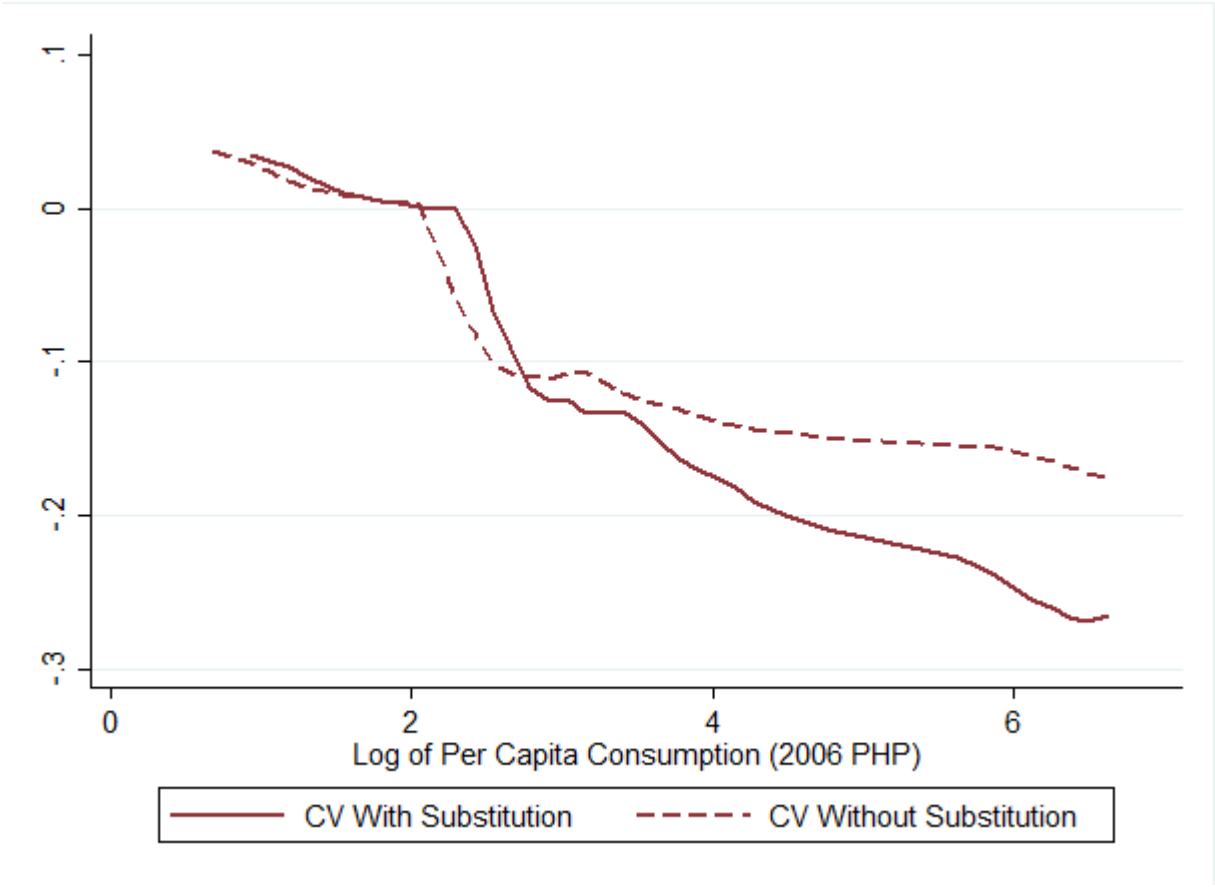

Figure 3(b). Compensating variation with and without substitution effects for non-agricultural households

Note: Log of per capita consumption is calculated by purchased goods and self-consumption.

Appendix Table A1: Estimated Price Elasticities for Food Items

Product	Special Rice	Normal Rice	Bread	Noodle Soup	Chicken	Pork	Egg	Bungus	Tilapia	Sugar
Special Rice	0.0318	1.1532	2.8294	0.1343	-0.0744	0.0016	-2.5199	-0.1791	0.0942	2.6786
Normal Rice	0.4426	0.9465	-0.3818	0.2201	-0.1026	0.1371	-0.7890	0.0570	-0.0547	1.2668
Bread	-0.5676	0.0738	-5.2692	4.8066	-0.1659	-0.2045	0.2395	0.0492	0.1157	-2.8329
Noodle Soup	-0.0651	-1.9167	-4.4475	1.7037	-0.0497	0.2298	-3.4695	-0.0804	-0.1174	-0.4015
Chicken	-0.0204	-0.4373	0.2515	0.1013	-0.1111	-0.0707	0.0738	-0.0932	0.0193	-0.4106
Pork	0.1003	0.6702	2.6010	-0.0381	-0.1691	-0.3650	2.3185	-0.1407	0.0190	0.5416
Egg	-0.6133	0.6525	1.5947	-1.2244	-0.2615	-0.7463	6.9878	-0.3196	-0.0054	-2.1438
Bungus	0.4902	1.4265	-3.1774	-0.6733	-0.0206	-0.4767	4.3756	-0.8302	0.1515	1.9971
Tilapia	-0.0489	-0.4962	5.9317	0.0701	-0.0889	0.0536	-2.7964	-0.0756	0.0426	-0.3270
Sugar	-0.5092	-0.4640	-2.7640	0.2170	0.0375	-0.2684	4.3605	0.2438	-0.0828	-1.5804

Note: θ_{ij} is estimated cross-price elasticity of good *i* demand with respect to good *j* price. The row is good *i* and the column is good *j*.