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Natural disasters and household welfare: A case study of rural Vietnam

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Abstract

This study aimed to investigate the short–run effects of natural disasters on household's welfare in rural Vietnam over the period from 2014 to 2016 by exploiting the panel regression (FEM and REM) to analyze the data from the Vietnam Household Living Standard Survey (VHLSS). The results show that natural disasters are negatively associated with household's welfare. In particular, households in flood-affected areas and storm-affected areas have 8.8 percent and 8.65 percent lower per capita household income than the households in non-affected areas respectively. Likewise, households in flood-affected areas have 7.54 percent lower per capita household expenditure than households in non-affected areas. Similarly, storms reduce per capita household expenditure by about 4.5 percent.

Introduction

According to the World Bank (2017), more than 70 percent of Vietnam's population every year faces risks from natural disasters. Natural disasters have impacts on all aspects of people's socio-economic life, such as causing serious damage to people and properties, destroying crops, affecting income, spending, livelihoods, health, education, and other social issues. In Vietnam, it is estimated that on average, each year natural disasters leave more than 300 people dead and missing, causing economic losses of about 1–1.5 percent of GDP and possibly up to 4 percent of GDP in great disasters, in which agriculture is the most vulnerable sector. According to statistics, in the past 20 years, the total number of deaths due to natural disasters has reached 13,000 people, and the total economic loss is 6.4 billion USD. In 2016, natural disasters left 264 people dead and missing, 431 injured, 5,431 houses destroyed, 364,997 houses damaged, 828,661 hectares of rice and crops damaged; and hundreds of millions of cubic meters of rock, traffic, irrigation, and embankments were changed, causing a total economic loss of about 39,726 billion VND (about 1.7 billion USD). This was the largest economic loss caused by natural disasters in the past 40 years (Central Steering Committee for Natural Disaster Prevention and Control, 2016).

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Many empirical studies have been conducted to assess the impact of disasters on economic and social aspects. Most studies found negative impacts of disasters on income and expenditure in many different countries such as by Arouri et al. (2015); Baez and Santos (2008); Bui et al. (2014); Dercon et al. (2005); Kurosaki (2010); Masozera et al. (2007); Mottaleb et al. (2013); Thomas et al. (2010); and Skoufias et al(2020). (Dercon et al. (2005). Natural disasters directly impact agricultural income or production because agricultural productivity is highly dependent on temperature and rainfall. Low rainfall conditions can reduce agricultural and fodder production (Warner & Van der Geest, 2013) or if excessive, flood crops , injure or kill livestock, destroy houses and infrastructure leading to a significant reduction in the total income of households in rural areas. Depending on the ability of each household to cope with income fluctuations, the degree of impact is more or less, but in general, negative weather-related shocks reduce household expenditures (Dercon & Krishnan, 2000; Jacoby & Skoufias, 1998). In addition, a decline in agricultural output will push up food prices. In the context of falling incomes and rising food prices, many households have chosen to consume less quality food to reduce spending (Gibson & Kim, 2013). In addition, households often deal with the effects of weather shocks by actively cutting back substantial amounts of their investments in their children's education and health care, and children often drop out of school, and participate in labor to help support their families (Sawada, 2007).

In the meantime, Vietnam has a large population (ranked 15th in the world), and it is one of twelve countries most severely affected by climate change (World Bank, 2010). Vietnam is also in the area of tropical monsoon climate, so it cannot escape this trend. The evaluation of the impacts of natural disasters on household welfare in Vietnam not only provides the policy implications and suggestions for poverty alleviation but also acts as a reference for the development literature. This study aimed to estimate the impacts of the typical natural disasters, such as storm, drought, flood, on household welfare in rural Vietnam. The study attempted to fulfill two objectives. The first objective was to measure the impacts of natural disasters on the per capita household income. The second objective was to estimate the impacts of natural disasters on total expenditure and food expenditure of households. To achieve these objectives, a multivariate linear regression model was used to analyze panel data collected from the Vietnam Household Living Standard Survey (VHLSS) from 2014 to 2016.

Our findings showed that floods and storms have negative influences on the welfare of rural citizens in Vietnam, but the level of impacts of floods and droughts is different. Particularly, two out of three types of natural disasters, floods, and storms harm per capita household income and per capita household expenditure. For the households who live in flood-affected areas, per capita household income decreased by 8.65 percent, and per capita household expenditure decreased by 7.54 percent. Similarly, compared with the unaffected households, the storm also reduced per capita household income by 8.8 percent and per capita household expenditure by 4.5 percent among the affected households. In addition, the study also showed that some demographic characteristics and assets of the household also affect income and expenditure. These findings provide clear evidence for policymakers and organizations in order to propose effective measures for preventing, managing, and overcoming the repercussions of natural disasters in terms of welfare.

The rest of the paper is structured as follows. Section 2 reviews empirical studies about the relationship between natural disasters and household welfare, and presents a general overview of the natural disaster situation in Vietnam. Section 3 introduces the data and main variables of the empirical model. Section 4 discusses the estimation strategy while section 5 summarizes estimation results. Section 6 concludes and suggests policy recommendation.

Literature Review

Empirical Studies About the Effects of Natural Disasters on Household Income and Expenditure

The relationship between natural disasters and household welfare (income and expenditure) has attracted the attention of numerous researchers such as Arouri et al. (2015); Baez and Santos (2008); Bui et al. (2014); Dercon et al. (2005); Mottaleb et al. (2013); and Thomas et al. (2010), and the more recent papers, such as Nguyen and Scrimgeour (2022); Pipitpukdee, et al. (2020); Skoufias et al. (2020); and Verschuur et al. (2020). Most studies found the evidence that disasters reduce household incomes. For example, Dercon et al. (2005) assessed the impact of a series of climate, economic, health, political, and other shocks on the well-being of rural households in 15 villages in Ethiopia. Using a fixed-effects model (FEM), the study found evidence demonstrating that climate shocks, particularly drought, have an important

impact on the well-being of households in Ethiopia. Specifically, drought reduces household income, consumption levels, and increases the poverty levels. Similarly, Baez and Santos (2008) estimated the impact of two large earthquakes in El Salvador in 2001 on rural household income using the difference in difference (DID) estimation method. As a consequence of the two earthquakes, household income was reduced by one-third compared to before the earthquakes. In addition, seismic shocks not only harm the income of current generations but also negatively affect the income of future generations through a reduction in the accumulation of physical and human capital. Arouri et al. (2015) measured the effects of three common types of natural disasters in Vietnam, namely, storms, floods, and droughts, on social welfare and resilience of households in rural areas by using a fixed-effects model (FEM). Storms, floods, and droughts reduced median household income by 1.9 percent, 5.9 percent, and 5.2 percent respectively. Recently, Verschuur et al. (2020) showed that natural disasters caused 7 percent of the asset losses and 42 percent of the welfare losses in coastal Bangladesh. Moreover, Pipitpukdee et al. (2020) examined the effect of climate change on land use, yield, and production of cassava in Thailand. The research points out that harvested area and yield of cassava were projected to reduce 12.49–16.05 percent and 2.57–6.22 percent in 2016–2055 from the baseline 1992–2016 due to climate change, respectively. Thereby, cassava production in Thailand was predicted to decline 14.74–21.26 percent from the baseline. The well-being of a half-million farmers in Thailand plus actors in the global supply chain of cassava will be vulnerable to climate change. Similarly, Nguyen and Scrimgeour (2022) investigated the economic impacts of changes in climatic conditions on Vietnam agriculture by using two-step Hsiao method. The results indicated that the temperature increase in winter, summer, and autumn are harmful to agriculture, while the opposite is true for spring temperatures. More rainfall in winter and spring is likely to reduce agricultural income. Besides, climate impacts predict the marginal losses to agricultural productivity, with net losses ranging from 0.02 percent to 2.6 percent from 2030 to 2100. Trinh, Feeny, and Posso (2021) used the household survey data (2004–2012) and the two-stage Hsiao technique to estimate the effect of climate change on Vietnam agriculture. Findings showed that climate change has significant impacts on net revenue and its impacts vary across seasons. In particular, in the dry season, the increase in temperatures is beneficial to all farms in the South region, while increases in precipitation will damage only irrigated farms in the Central and South region. More rainfall in the wet season will increase net revenue in the North region only. Ozdemir (2022) also found similar results, climate change has a negative effect on agricultural productivity. Specifically, a 1 percent increase in CO2 emission level would lead to a reduction in agricultural productivity by 1.94 percent, and 1 percent increase in temperature would result in lower productivity by 2.28 percent.

After a disaster, households have to deal with the economic shocks due to damage to crops and property. To adapt to the sudden drop in income, households are likely to cut their overall spending and restructure the proportion of expenditure so that it is appropriate with their demand and their financial situation (Arouri et al., 2015; Lohman & Lechtenfeld, 2015; Mottaleb et al., 2013; and Sawada, 2007). Sawada (2007) examined the impacts of natural and human-made disasters on the wellbeing of households. The findings showed that households reduce spending on health care, education, and other purposes in order to maintain a minimum expenditure on food. Similarly, Arouri et al. (2015) found that 3 common types of natural disasters such as storms, floods and droughts reduce per capita expenditure of Vietnamese households by 1.5 percent, 4.4 percent and 3.5 percent respectively. Skoufias et al. (2020) showed that when natural disasters occur, household consumption falls below the poverty line. Specifically, when the wind damage index takes the value of 1, per capita expenditure declines by 15.7 percent, per capita expenditure on food declines by 23.5 percent while per capita expenditure on non-food is not significantly affected. Also, per capita expenditure on protein seems to be negatively affected (decline by 48.3 percent) whereas per capita expenditure on fruits and vegetables, cereals, education and medical services appear to be unaffected. By contrast, Mottaleb et al. (2013) employed a database from the survey of household income and expenditure in Bangladesh to assess the impacts of hurricane Aila. They concluded that hurricane Aila caused injuries to humans, polluted water sources, and had negative impacts on human health, raising health-related costs. Likewise, Lohmann and Lechtenfeld (2015) indicated that the incidence of illness due to droughts increases health spending per capita to 115 US dollars and increases financial burdens for many households because the medical costs rise by 9–17 percent in the total expenditure.

Natural Disasters in Vietnam

Vietnam is frequently affected by natural disasters such as storms, droughts, and floods. In comparison with other countries in Southeast Asia, Vietnam has a significantly higher number of natural disasters each year. Throughout the period from 2010 to 2017, Vietnam suffered from more than 50 natural disasters and particularly 10 natural disasters in 2013, while the figures for Cambodia, Malaysia, and Thailand were 6, 15, and 31 respectively (Centre for Research on the Epidemiology of Disaster, 2018).Importantly, the frequency of natural disasters in Vietnam has continuously gone up in the period 2014–2017, from 3 natural disasters in 2014 to 9 natural disasters in 2017. Vietnam is also considered to be severely affected by natural disasters. Figure 1 shows the distribution of natural disasters across the country. The natural disasters are heterogenous by the regions. The Central coastal region is the most affected area with the highest frequency of annual flood, storm, flash flood, drought and rising sea water level. The northern mountainous area is the poorest region in Vietnam. The local people often face flash floods, landside and cyclones, which makes it hard to earn sufficient food from planting trees. Drought and cyclones are also common in the highlands and the middle of the Mekong Delta River, and have caused significant impact on annual harvests recently. The number of people affected by floods is ranked fourth, the number of people affected by storms and cyclones is ranked tenth, and the number of people affected by droughts is ranked sixteenth compared to other countries (United Nations International Strategy for Disaster Reduction Secretariat, 2009)

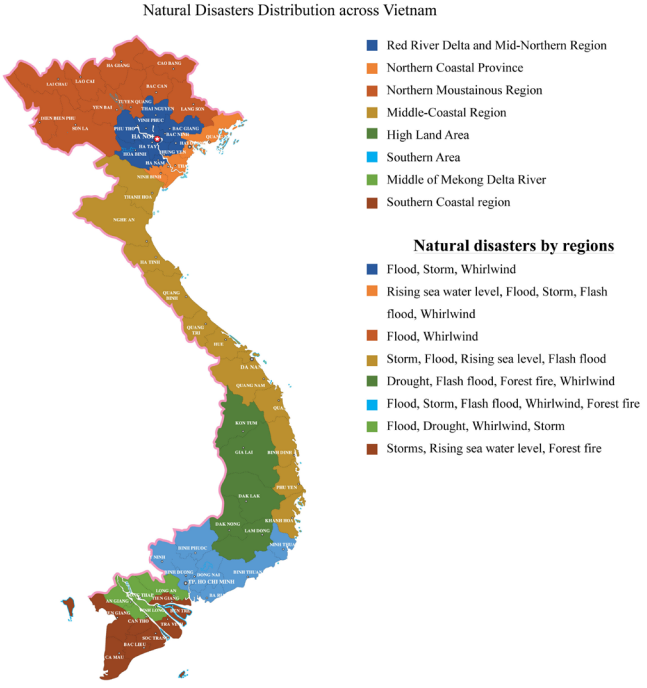

Figure 1 Natural disasters distribution in Vietnam
Source: UNDP and National Center for Hydro-Meteorological Forecasting

According to World Bank (2017), more than 70 percent of the Vietnamese population has to face risks and consequences of natural disasters annually, including serious impact on humans and property, crop destruction, as well as impacts on income, expenditure, means of living, health, education, and other social problems. Vietnam faced an average of 6 natural disasters each year in the period 2010–2017 (Centre for Research on the Epidemiology of Disaster, 2018). The average loss of people was 235 people per year, and the average loss of property was 18.6 billion VND per year. For the entire period, 1,880 people died and went missing, 3,920 people were injured, 1.1 million hectares of rice and crops were damaged, 29,644 houses were destroyed, thereby causing a total economic loss of 148,467 billion VND (General Statistics Office, 2011–2017). It is noticeable that the extent of economic loss caused by natural disasters has been growing in Vietnam. The average of damage per year multiplied sevenfold, from 90 million US dollars in the period 1990-1994 to 570 million US dollars in the period 2010–2014 (Hieu, 2017). Although the number of natural disasters in two years of 2016 and 2017 was less than in 2013, with 6, 7 and 10 respectively, the value of economic loss was considerably greater in former years. Specifically, the value of economic loss in 2016 was 1.3 times higher than that in 2013, and the value of economic loss in 2017 was 2 times higher than that in 2013 (Centre for Research on the Epidemiology of Disaster, 2018; General Statistics Office, 2011–2017).

Apart from the impact on humans and property, natural disasters also directly affect the living environment and the incidence of diseases on Vietnamese people. Typically, floods in the Mekong Delta not only increase the proportion of people with diarrhea and skin diseases as a consequence of seriously polluted water sources but also increase the proportion of people with malaria, hemorrhagic fever, and influenza (Few & Pham, 2010). The report by Roger, Tran, and Chinh (2007) showed that a rise of 20 percent people with diarrhea was seen in Cao Lanh city - Dong Thap province in the times of floods. The Centre for Environment Monitoring (2016) also showed that the outbreak of pinkeye spread quickly in the flooded areas, such as Thuong Hoa and Trung Hoa- Quang Binh Province, with more than 200 cases of infection. Huong Khe - Ha Tinh province is

another example, where there were 3,000 cases of athlete's foot, 600 cases of diarrhea, and 2,000 cases of trachoma after the flood in June 2007. Additionally, 745 health centers were destroyed and swept away, and 8,954 centers were damaged by natural disasters during the period from 1996 to 2008.

Methodology

Data

This research used a panel data of the Vietnam Household Living Standard Survey from 2014 to 2016 (VHLSS 2014–2016), which is conducted every two years by the General Statistics Office (GSO) with the support of the World Bank (WB). The survey uses the stratified sampling method with the sample size of 46,995 households selected from 3,133 locations, including 883 urban areas and 2,250 rural areas. The household-level data provide information about demographic characteristics, income, total expenditure, household assets. However, only information on expenditure from 9,399 households was collected in both 2014 and 2016, in which, 6,000 households were in rural areas. Moreover, 1,500 of these rural households in 2014 were repeatedly surveyed in 2016. Because our study focused on the rural households, our sample size was reduced significantly compared to the original survey sample. In the commune level data, the information about infrastructure, economic development, education, and healthcare that had been collected was collected from 2,100 communes in 2014 and from 1,500 communes in 2016. The information about disaster was collected from this data. With the small sample size of commune-level data, only 647 rural households were surveyed for the information of disaster. Therefore, with the study objective of the impact of the disaster on the per capita household income and per capita household expenditure in the rural areas, only 647 rural households had both the information of household income, household expenditure and the impact of disaster in 2014 and 2016, or 1,294 households in the longitudinal panel data.

Identification strategy

The study used the panel models to estimate the effects of natural disasters on welfare of household. The analytical model is shown in Equation (1):

$$Yidt = \beta_0+\beta_1 X_{idt}+\beta_2 A_{idt}+\beta_3 \beta_{idt}+\gamma_i+\mu_{idt} \quad (1)$$

Y_{idt} includes welfare variables measured by the household income and per capita expenditure of household i in district d in year t. These variables are continuous variables which are transformed to the logarithm transformation to reduce the skewness of the original data. X is the main variable of this study, which include the dummy variables of flood, storm and drought of the household i in districts d affected by disasters in year t. The control variable vector A includes demographic characteristics of the household such as age, gender and educational level of the household head, ethnicity, the total number of household members, the ratio of the dependents, the percentage of women. The control variable vector B represents household assets, including the area of cultivated land, the area of residential land, and the type of housing. μ_{idt} is the error term of the model. We also control for household fixed effect γ_i to capture the time-invariant unobservable characters at household level.

Natural disasters often cause a significant effect on assets, harvests, livestock and healthcare not only at the disaster's occurrence but also after the disasters, which, in turn, affect the household income and expenditure in the long run. Therefore, it is necessary to use the longitudinal panel data and models for panel data to evaluate the impact of disasters. On the other hand, in order to reduce the biased estimation because of the unobservable household characters (e.g the heterogenous reaction to the disasters by the households), it is suggested to use the fixed effect model to estimate the causal effect. However, in order to examine the appropriation of the fixed effect model, the Hausman test was used to make the comparison between the fixed effect model and the random effect model. The results of Hausman test showed the fixed effect models are selected. In addition, the diagnose tests was also performed to detect the data issue (i.e heteroskedasticity). Although, the test results indicated that there was no heteroskedasticity in our data, in order to get the more accurate estimators, we also clustered the standard errors at the household by year level to eliminate the differences and autocorrelation across households and years.

Descriptive Statistics

The results of descriptive statistics are summarized in Table 1. The sample consists of 1,294 households who were surveyed in rural Vietnam, with 28.44 percent of people living in areas of floods, 28.9 percent of people living in areas of storms, and 72.1 percent of people living in areas of droughts. The average value of

per capita household income is 2,106 thousand VND while the average value of households' per capita expenditure is up to 5,672 thousand VND. For household assets, Table 1 shows that the average area of cultivated land and land for living of households is 10,041 square meters and 76.8 square meters, respectively. Most housing types are Semi-permanent, accounting for approximately 70 percent. In this sample, 73.72 percent of households are Kinh people, and 79.83 percent of households are led by a male head, 22.5 percent of household heads have no education. In addition, the average size of households is 3.91 people, the ratio of the dependents is 32 percent, and the ratio of females is 52 percent.

Results and Discussion

Effects of Natural Disasters on Househ old Income

Of the three types of natural disasters, floods and storms decrease per capita household income of households in rural Vietnam in both fixed effects model (FEM) and random effects model (REM). It is also noted that the impact level of floods and storms on per capita household income is different. Generally, floods tend to reduce per capita household income of households at a higher level than storms. Column 1 of Table 2 presents the results of fixed effects model, which is a suitable model after we use Hausman test. This result shows that households in flood-affected areas have 8.65 percent lower per capita income than households in non-affected areas, statistically significant at 1 percent level. Likewise, households in storm-affected areas have 8.8 percent lower per capita household income than households in non-affected areas. Our findings are in line with Bui et al. (2014); Krueger and Perri (2009); Masozera et al. (2007), who also reported a negative effect of natural disasters on household income. Although drought has a negative effect on per capita household income, the coefficient is not statistically significant. We could not make the conclusion about the relationship between drought and per capita household income, and the relationship between drought and per capita household expenditure.

In addition, other control variables in fixed effects model such as household head's age, the ratio of the dependents, female ratio, household size, living area also affect per capita household income. With a household head's age rising by 1 year, per capita household income grows 0.83 percent. The ratio of the dependents increases by 1 percent, per capita household income decreases 21.3 percent. As the family size increases by 1member, per capita household income falls by 8.1 percent. Living area also has a positive impact on per capita household income, but the level of impact is not significant. In this model, we did not find the effect of household head's education and religion on per capita household income.

Each regression includes the household fixed effect to capture the time-invariant unobservable characters at household level. Robust standard errors clustered at the household by year level are in parentheses.

Table 1 Descriptive statistics

N = 1,294

Variables	Mean	*SD*	Min	Max
Per capita household income (Thousand VND)	2,106	2,423	102	58,496
Per capita household expenditure (Thousand VND)	5,672	3,110	656	25,708
Crop land area (Square metre)	10,041	21,960	0	402,500
Living area (Square metre)	76.79	44.1	12	500
Age of head (Years)	50.85	13.84	19	94
Total members (Person)	3.89	1.63	1	10
Dependent share (Percent)	32.07	0.28	0	1
Female share (Percent)	52.37	0.21	0	1
Flood (Percent)	28.44	0.45	0	1
Drought (Percent)	72.10	0.45	0	1
Storm (Percent)	28.90	0.45	0	1
Male head (Percent)	79.83	0.40	0	1
Head's education (No unit)	1.52	1.49	1	5
Kinh (Percent)	73.72	0.44	0	1
Type of housing (No unit)	3.81	0.75	1	5

Table 2 The regression results for welfare of household

Dependent variable	Log of per capita household income		Log of per capita household expenditure	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Log of household income per capita			0.229***	0.289***
			(0.000)	(0.000)
Flood	-0.088***	-0.105***	-0.075***	0.001
	(0.010)	(0.000)	(0.009)	(0.960)
Storm	-0.086**	-0.056*	-0.045*	-0.041*
	(0.031)	(0.097)	(0.093)	(0.065)
Drought	-0.013	-0.003	-0.026	-0.019
	(0.722)	(0.935)	(0.276)	(0.401)
Age of head	0.008**	0.002	0.003	-0.0003
	(0.043)	(0.211)	(0.336)	(0.814)
Gender of head	-0.195	0.077	-0.119	0.125
	(0.183)	(0.199)	(0.252)	(0.002)
Head's education				
Primary school	0.009	0.044	0.027	0.031
	(0.900)	(0.378)	(0.624)	(0.354)
Secondary school	0.004	0.134***	0.087	0.089***
	(0.956)	(0.010)	(0.186)	(0.010)
High school	0.008	0.275***	0.059	0.117**
	(0.956)	(0.000)	(0.572)	(0.025)
College/University	0.174	0.541***	0.015	0.142*
	(0.596)	(0.000)	(0.948)	(0.074)
Religion	0.021	0.490***	0.072	0.054
	(0.923)	(0.000)	(0.621)	(0.137)
Total members	-0.082***	-0.087***	0.138***	0.156***
	(0.000)	(0.000)	(0.000)	(0.000)
Share of dependent people	-0.213*	-0.346***	-0.192**	-0.259***
	(0.104)	(0.000)	(0.038)	(0.000)
Share of female	-0.067	-0.185*	-0.119	-0.104
	(0.735)	(0.071)	(0.398)	(0.126)
Crop land area	1.27E-06	2.84e-07	1.08E-06	1.34e-06***
	(0.190)	(0.701)	(0.115)	(0.007)
Type of housing				
Permanent house closed	-0.328	-0.219	-0.291	-0.102
	(0.246)	(0.370)	(0.147)	(0.544)
Permanent house not closed	-0.297	-0.311	-0.234	-0.137
	(0.298)	(0.204)	(0.247)	(0.413)
Semi-permanent	-0.230	-0.284	-0.252	-0.158
	(0.404)	(0.238)	(0.201)	(0.339)
Temporary house	-0.324	-0.479**	-0.362*	-0.309*
	(0.263)	(0.052)	(0.077)	(0.068)
Living area	0.001***	0.003***	0.001	0.001***
	(0.006)	(0.000)	(0.165)	(0.001)
Constant	7.530***	7.445***	6.336***	5.808***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	1,294	1,294	1,294	1,294
R-squared	0.335	0.345	0.482	0.517

Note: * $p < .05$. ** $p < .01$. *** $p < .001$.

Effects of Natural Disasters on Household Expenditure

The results of fixed effects model in column 2 of Table 2 indicates that households in flood-affected areas have 7.54 percent lower per capita household expenditure than those in non-affected areas, statistically significant at 1 percent level. Similarly, storms reduce per capita household expenditure by about 4.5 precent, whereas drought variable is not statistically significant, so there is no difference in per capita household expenditure between households in drought-affected areas and non-affected areas. This result is supported by studies of Bui et al. (2014) and Sawada (2007). Especially, fixed effects model also shows that per capita household income is factor which has a significant effect on per capita household expenditure. If per capita household income increases by 1 percent, per capita household expenditure increases by 0.23 percent. Besides, some control variables also impact on per capita household expenditure such as, household size, the ratio of dependents and household asset. More specifically, when the ratio of the dependents increases by 1 percent, per capita, household expenditure decreases by 19.2 percent, while with a household size rise by 1member, per capita household expenditure decreases by 13.83 percent. At the same time, the results also show that wealthier households who own valuable houses have a higher per capita household expenditure than the other households. We did not find the difference in the per capita household expenditure between the male-head households and the female-head households, and between the households with the high educated head and the households with the low educated head.

Conclusion and Recommendation

By using the dataset from the Vietnam Household Living Standard Survey (2014–2016), this study evaluated the impact of disaster on the household welfare in terms of the per capita household income and per capita household expenditure. The results show that the natural disasters (flood and storm) significantly reduce the per capita household income and the per capita household expenditure. In particular, compared to the non-affected areas, households in the flood affected areas have their per capita household income reduced by 8.8% and per capita household expenditure by 7.5 percent. Similarly, households in the storm affected areas see their per capita household income drop by 8.6 percent and their per capita household expenditure by 4.5 percent. The reduction of the per capita household income results from the direct effect of flood and storm on the agriculture, such as destroying harvests, housing, production units or washing away livestock, etc… In order to confront the economic shocks, the households can reduce their expenditure, such as the expenditure for food, medical care, or education for their children, which will reduce their per capita household expenditure. However, in order to make the exact conclusion about the reduction of specific expenditure, it is necessary to have further research. Our result finding is consistent with the previous studies: (Arouri et al. (2015); Bui et al.(2014), Baez and Santos (2008); Dercon et al. (2005)). Our findings also show the relationship between the household asset and per capita household income and per capita household expenditure. Some of the demographic characters, such as the head's age, religion, family size, dependent share, female share, etc… affect the per capita household income and per capita household expenditure.

However, this study also has some limitations, which should be taken into account in further research. Firstly, our model has no control for the commune's characters, such as irrigation infrastructure, road, market, … that could affect the per capita household income and per capita household expenditure. Secondly, because the impact of disaster on household might be heterogenous across types of households, it is suggested that the heterogenous effect of disaster by different areas, different land sizes, or asset size should be considered by using the interaction variable between the dummy variables of disaster and these categories.

The results of the study confirm that natural disasters negatively affect the per capita household income and per capita household expenditure of people in rural areas of Vietnam. Therefore, it is necessary to have solutions to help reducing the economic risks for people after natural disasters. Within the scope of the research, the authors propose three groups of solutions as follows:

First, it is suggested that the government should invest to increase the capacity of disaster forecast. We cannot eliminate natural disasters, but we can prevent and mitigate the effect of disasters. However, according to the General Statistic Office of Vietnam, the economic effect of natural disaster (destroying the assets, harvests, and livestock) has tended to increase over the years. Therefore, it is necessary to increase the capacity of disaster forecasting to have the proper and quick information which, in turn, help the local government and people have the appropriate solutions to protect their assets, livestock and harvests from the disasters. Therefore, the government should increase the budget to invest in the monitoring system, hydro-meteorological forecasting system from the national to local level.

Second, implementing the support policies for people after natural disasters. In the short term, it is necessary to mobilize all resources to implement the policy of food relief and cash support for people during and immediately after the natural disasters, which would partially solve the essential needs of the people to stabilize life. In the long term, it is necessary to implement the credit supports to create the conditions for people to quickly restore their agricultural production, and re-establish their livelihoods. The financial support should be combined with the agricultural extension programs, so that people are supported with techniques, plant varieties, and livestock, ensuring people use capital efficiently. When production is maintained and people have a stable source of income, people can improve their spending on quality food, health care, and education, thereby contributing to increasing human capital.

Third, the government should encourage people to apply planting and livestock models which can adapt to natural disasters. However, the department of agriculture and related units need to well organize to transfer the natural disaster adapting models for the farmers, and provide people the seeds, plants, and livestock that can adapt to climate change. Furthermore, agricultural extension officers can guide people to choose the right planting time and type of cultivar to avoid the flood season, and the drought season. In addition, the government should train farmers on how to change their livelihoods to help them diversify and avoid being too dependent on the agricultural sector.

Four, implementing agricultural insurance program on a large scale. Developing a strategy to connect and share risks between financial institutions and farmers on the basis of good management practices, agricultural credit development, loan guarantee funds, crop insurance and building risk management capacity for producers. At that time, farmers are guaranteed a stable income and profit even when there is a risk of natural disasters or market fluctuations.

Conflict of Interest

The authors declare that there is no conflict of interest.

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