Capital assets framework for analysing household vulnerability during disaster

Huafeng Zhang Researcher, The Fafo Institute for Labour and Social Research, Norway, **Yandong Zhao** Researcher, Chinese Academy of Science and Technology for Development, China, and **Jon Pedersen** Researcher, The Fafo Institute for Labour and Social Research Norway

This paper examines the vulnerability of households to disasters, using an asset vulnerability framework to represent livelihoods. Such frameworks are widely employed to analyse household poverty and focus on living conditions and well-being rather than money-metric measures of consumption and income. The conceptualisation of household vulnerability is a challenge in current studies on coping with disasters. The paper considers whether a capital assets framework is useful in identifying and assessing household vulnerability in the context of the Wenchuan earthquake in China in 2008. The framework has five categories of assets (financial, human, natural, physical, and social capital) and attempts to measure the resilience and vulnerability of households. When applied to a major disaster, asset-based methods face the problem of heterogeneity of the population, such as with regard to livelihood type or residence. Moreover, the effect of external interventions, such as the provision of relief assistance, must be taken into account.

Introduction

The concept of household vulnerability is both controversial and multifaceted; hence, no consensus has been reached on it to date (Cannon, 1994; Alwang, Siegel, and Jorgensen, 2001). It is closely correlated with household poverty; in many cases, it is referred to as households' vulnerability to poverty (Chaudhuri, 2003). While poverty is the objective economic status of households, vulnerability to poverty can be considered as the risk that a household will remain or fall into poverty.

The vulnerability of households to a disaster triggered by a natural hazard can be rather different to their poverty status. Households with a relatively low income may not necessarily be vulnerable to a disaster, whereas non-poor households can be vulnerable to a disaster. Poverty status is easily observable and measurable by consumption or income level, for instance, while household vulnerability is not easily determinable owing to the difficulties associated with its definition as a concept. Furthermore, long-term panel data are often preferred in studies that attempt to gauge household vulnerability to a disaster (Landau, Klasen, and Zucchini, 2012; Bah, 2013).

Studies on vulnerability in a time of disaster are attracting more attention, principally because disasters triggered by natural hazards are becoming more common and

affecting more people in increasingly worse ways. The other important motivation to spotlight the matter is the dynamic changes involved in the recovery process. The studies that concentrate on the poverty status of households during a disaster are rather limited in gauging its direct causal relationship with the event.

This paper argues, using several large-scale surveys conducted during the reconstruction period following the Wenchuan earthquake in China on 12 May 2008, that a capital assets framework can be a useful tool in evaluating and predicting the degree of household vulnerability during and after a disaster in the country. The capital assets framework has numerous benefits, including its incorporation of numerous aspects of these two concepts (assets and capitals). Modelling the effect of various capitals on household vulnerability helps policymakers to target and guide a recovery effort more efficiently. The framework also allows household vulnerability to be predicted by cross-sectional data, instead of time-series data, which are not always available, especially in a disaster setting and in a developing country. Comprehending household vulnerability to a disaster triggered by a natural hazard while conducting a post-disaster assessment of an affected population will enable policymakers to make rapid, informed decisions under conditions of uncertainty.

The second section of the paper contains a review of the literature on the concept of household vulnerability and the capital assets framework. The third section describes the data, as well as the variables and methods employed in constructing the framework. The fourth section presents the results of the regression. The fifth section makes some concluding remarks.

Literature review

The definition of household vulnerability varies owing to emphasis on different impact phases and facets of vulnerability. Many analyses of vulnerability consider households' vulnerability to poverty, or seek to provide an ex-post measure of their well-being (Chaudhuri, 2003). Others define vulnerability in terms of exposure to adverse shocks. Blaikie et al. (1994, p. 11), for example, classify it as 'the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural disaster'. This paper views it from the standpoint of recovery (during the process of reconstruction) from the ramifications of a disaster triggered by a natural hazard.

Since the concept of 'vulnerability' was introduced in disaster management in the 1970s, it has changed from being predominantly concerned with critical infrastructure and physical losses to offering a more socialised interpretation of household vulnerability (Vatsa, 2004). Amartya Sen's work on poverty and famines in the early 1980s reinforced the social aspect of household vulnerability (Sen, 1981). Over the years, researchers have developed different approaches to explain various dimensions of physical and social vulnerability (Chambers, 1989; Blaikie et al., 1994; Cannon, 1994).

International organisations have developed an assortment of post-disaster needs assessments. Examples include the Needs Analysis Framework (IASC, 2007) and the Multi-cluster Initial and Rapid Assessment (UNICEF, 2009), which are emergency-focused; the Post-disaster Damage and Needs Assessment,[1] the Preliminary Damage and Needs Assessment (Asian Development Bank and World Bank, 2009), and the Post-disaster Recovery Guidelines,[2] which are recovery-focused; and the *Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters* (ECLAC, 2003), which is more reconstruction-focused. These tools provide important policy guidance on post-disaster reconstruction and recovery. However, the multidimensional nature of vulnerability makes it a challenge for such evaluations to determine household vulnerability. Most post-disaster needs assessments, therefore, have to concentrate to a large extent on physical losses and household poverty.

Numerous efforts have been made to measure or appraise household vulnerability to a disaster. Some studies do so using panel data that tracks the same households over a long period of time (Landau, Klasen, and Zucchini, 2012; Bah, 2013). Another group of studies uses repeated cross-sectional survey data (Christiaensen and Kalanidhi, 2005). To resolve the problem of a lack of panel data in a disaster situation, Chaudhuri (2003) proposed gauging vulnerability by utilising cross-sectional survey data, using income or consumption variability as a proxy for vulnerable. Blaikie et al. (1994) designed two models, the access model and the pressure and release model, to explain the causation, structure, and possible response of vulnerability. The pressure and release model adopts a structural view of vulnerability whereas the access model spotlights the relation between level of access to resources and degree of household vulnerability. Dercon (2001) offers a framework for analysing vulnerability to poverty in terms of its links to risk. As its starting point, the framework explores various household assets—human, physical, and social capitals—through the paradigm of a 'risk chain'. It considers not only the risks faced by these various household assets, but also the income that they generate and well-being as an outcome of a complicated decision-making process. The framework highlights the importance of assets in poverty risk reduction, shedding light on disaster vulnerability. However, the model presents an abstract framework that has not been validated by actual empirical observations.

Disaster mitigation initiatives have changed significantly over the years, notably by shifting from a sole focus on physical vulnerability to taking household economic and social vulnerability into account. An asset-based framework offers an innovative and comprehensive approach to the pursuit of disaster mitigation. What is key here is that assets play a central role in reducing vulnerability.

An asset can be seen as a 'stock of financial, human, natural or social resources that can be acquired, developed, improved and transferred across generations. It generates flows or consumption, as well as additional stock' (Ford Foundation, 2004, p. 2). Assets can be a stock of wealth in a household; this can be extended to include intangibles such as household relations, human capital, and social entitlements (Sherraden, 1991). In current poverty-related development debates, the concept of assets or capital

endowments includes tangible and intangible assets, with the capital assets of the poor commonly identified as being financial, human, natural, physical, and social (Moser, 2006). Tangible assets include consumer durables, housing, infrastructure, land, productive assets, and savings, whereas intangible assets include education, household relations, health, labour, skills, and social capital.

The critical role of ownership of household assets in vulnerability can be traced back to the entitlement approach of Sen (1983), developed in the context of famine. Thereafter, many studies developed a household asset-based approach to measure household vulnerability (see, for example, Swift, 1989; Maxwell and Smith, 1992; Moser, 1998). The social elements were later incorporated into the asset-based approach (Moser, 1998; Grootaert and Bastelaer, 2001).

The initial idea of the asset vulnerability framework was to assess structural poverty reduction interventions and livelihoods (Moser, 1998; Attanasio and Székely, 1999). Researchers subsequently applied an asset-based framework to investigate household vulnerability to disasters (Twigg, 2001; Vatsa, 2004; Birkmann, 2006; Sadeka et al., 2013). This is also called the sustainable livelihoods framework, which views people's capacities as livelihood assets (Siegel and Alwang, 1999).

The capital assets framework was adapted from the sustainable livelihood framework. It considers five types of capital assets (financial, human, natural, physical, and social) to understand livelihood outcomes and risk. Financial capital includes credit and savings, pensions, and subsidies; human capital encompasses myriad resources and social and personality attributes, such as education and knowledge, health, labour, and skills; natural capital comprises natural resources, such as fisheries, forest, land, and wild resources; physical capital encompasses the basic infrastructure and goods needed to support livelihoods; and social capital concerns the social resources embedded in the social structure and networks (Grootaert and Bastelaer, 2001; Hurlbert, Beggs, and Haines, 2001).

Despite the inquiries into the roles of the capital assets framework in disaster recovery, there are not many empirical quantitative studies that use capital assets to determine household vulnerability. One challenge here is defining household vulnerability using quantitative data. Another is that there is not much available data from disaster situations that include a measure of the five types of capital assets.

The surveys conducted after the Wenchuan earthquake in China were based on a living condition framework and yielded rich information on the capital assets accessible by disaster-affected households. Furthermore, they included questions on households' subjective evaluations of post-disaster recovery, which can serve as a proxy measurement of household vulnerability after the event. Lastly, the repeat administration of surveys based on similar sets of questions one and three years after the earthquake provided a rare chance to compare the impacts of various capital assets on household vulnerability in the short and longer run. A logistic regression was administered to evaluate the effects of the various capital assets. In sum, the model may be able to predict household vulnerability when a measurement of vulnerability is not directly available.

Data description and methods

Data description

The Wenchuan earthquake on 12 May 2008 was the most devastating such disaster in China since the Tangshan earthquake on 28 July 1976. The magnitude 8.0 earthquake affected at least 15 million people in 10 provinces; most affected was Sichuan Province and its surrounding area. More than 69,000 people were confirmed dead and at least 374,000 were injured; in excess of 18,000 were declared missing (United States Geological Survey, 2008). In addition, 5.36 million buildings collapsed and another 21 million suffered damage.

The General Office of the State Council announced an overall recovery plan on 23 September 2008 (The State Planning Committee for Post-Wenchuan Earthquake Restoration and Reconstruction, 2008). The *Overall Plan for Post-Wenchuan Earthquake Restoration* sought to guide post-disaster recovery and reconstruction work. The State Planning Committee for Post-Wenchuan Earthquake Restoration and Reconstruction requested a first rapid needs assessment to provide information on the requirements of affected people during the initial design stage of the plan. The Chinese Academy of Science and Technology for Development (CASTED) and Fafo, the Institute for Applied International Studies in Norway,[3] jointly undertook the survey in Sichuan Province in July, covering 51 counties that the Government of China officially pronounced as 'seriously' or 'very seriously' affected. Approximately 20 million people were living in these 51 counties. Second and third surveys, funded by the Chinese Ministry of Science and Technology and the Norwegian Ministry of Foreign Affairs, were conducted during and following reconstruction in the earthquake-affected areas.

This paper is based on data acquired during three large-scale household surveys in earthquake-affected parts of Sichuan. The first survey was administered in July 2008, while the second and third surveys were performed in July 2009 and July 2011, respectively. Some 4,000 households were interviewed during each one. Cluster sampling with proportional probability selection was used to choose households, based on the 2000 Census of China (National Bureau of Statistics of China, 2002). The sampling frame centred on 26 counties in 2009 and 30 counties in 2011,[4] identified by the China Earthquake Administration as 'seriously' or 'very seriously' affected by the Wenchuan earthquake. The sampling design for the surveys is a standard two-stage model, and the primary sampling units (PSUs) are the 2000 and 2010 Census enumeration areas, villages, and neighbourhood committees. The sample was stratified

Table 1. Sample and response rates

Year	Sampled clusters	Sampled households	Finished households	Response rate (%)
2008	174	4,526	3,652	80.7
2009	171	5,549	4,037	72.8
2011	195	4,875	3,841	78.8

Source: authors.

according to the degrees of seriousness (45 and 55 per cent of the sample in seriously and very seriously affected areas, respectively). The sample was allocated approximately equally within each group of affected areas with different degrees of seriousness. The aim of the sampling design was to produce representative survey data on all victims of the Wenchuan earthquake in Sichuan Province. Table 1 (above) contains figures for sample and response rates of the survey.

The surveys covered many objective living conditions of households, such as housing, income, and basic resources available to them in the earthquake zone. In addition, one randomly selected household member in each household was interviewed about their subjective perceptions of the situation. Hence, the surveys collected information on various capital assets owned by the participant households. The second and third surveys contained subjective evaluations by households of disaster recovery, offering a rare opportunity to utilise the capital assets framework in an assessment of household vulnerability.

Household recovery data

The dependent variable is households' subjective evaluations of disaster recovery. In the three surveys, the interviewed households were asked about how their living conditions had been influenced by the earthquake and whether they had returned to the level that existed before the disaster. If not, the households were asked to estimate when living conditions would recover.

The economic recovery of households turned out to be more rapid than anticipated in 2008. In the first survey, administered around two months after the earthquake,

Figure 1. Households' own perceptions or expectations of household living conditions reaching the pre-earthquake level (cumulative percentages)
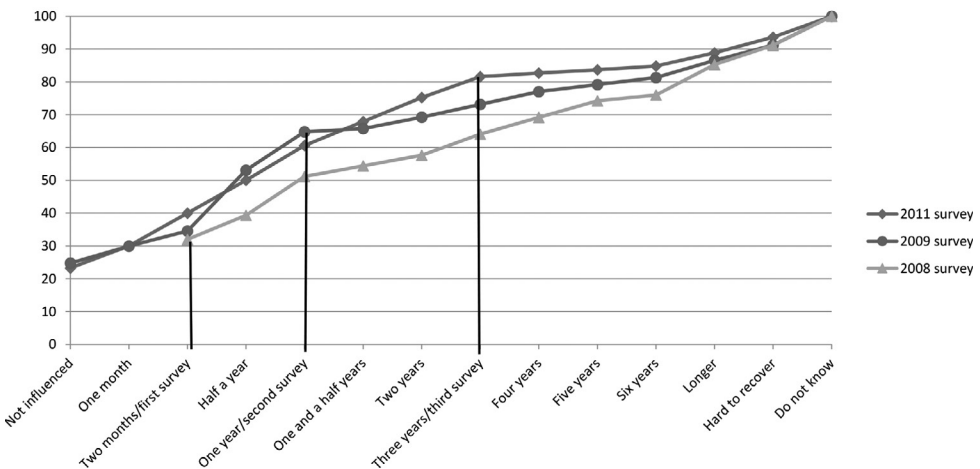
Note: based on the 2008 survey (sample size=3,642)—households' expectations of their living conditions—and the 2009 (sample size=4,018) and 2011 (sample size=3,803) surveys—households' perceptions of their recovery before the survey and expectations of recovery if it had not yet reached the pre-disaster level.

Source: authors.

32 per cent of households reported that living conditions had not been affected or recovered, 19 per cent expected them to recover within a year, 13 per cent expected them to recover in three years, and 10 per cent expected them to recover in five years. In the second survey, 65 per cent of households reported that they had returned to the same condition as before the earthquake, whereas 82 per cent of households stated during the third survey that they had recovered after three years. What is more, people became more optimistic about recovery. In 2008, one in four people expected it to take more than five years to recover to the pre-disaster level, declining to 21 per cent in 2009 and 16 per cent in 2011.

Some households, though, remained rather vulnerable in the longer run. Around 15 per cent of households estimated in 2008 that it would be very hard to return to the pre-disaster condition or were not sure about their future. The pessimism among this group of households fell only slightly in 2011, to 12 per cent. Also, another five per cent of households thought that they needed more than five years to recover. Three-year reconstruction and development in the earthquake areas resulted in significant improvements to the local economy but did not change vulnerable households' gloomy forecasts regarding their personal economies.

Capital assets framework and variables

The effects of the various assets and capitals of the aforementioned households are worth studying to understand the challenges posed and to support policies to help post-disaster recovery. Table 2 shows the capital assets framework employed in this paper and the variables used in five capital categories, and provides descriptive information for the independent variables included in the regressions in the 2009 and 2011 surveys. The paper focuses on the role of various household capital assets in disaster recovery. Information on individual characteristics, such as education, employment, health status, and party membership, is aggregated at the household level and included in the study. Furthermore, the earthquake-affected area is largely rural, and so only rural and urban status is included here; 'hukou' (household registration) status is not considered to be important in this context. Those households that did not report their living condition as having been affected by the earthquake are not included in the sample for analysis. The 2008 survey was conducted in an emergency context and thus information on some capital assets was not collected. And since households' subjective evaluations and estimations of recovery were not accurate enough right after the earthquake, only 2009 and 2011 survey data are used, therefore, to gauge household vulnerability with the capital assets framework.

Table 2 indicates that the seriously affected areas in Sichuan Province were mainly rural, and that rural households made up 85 per cent of the 2009 sample and 82 per cent of the 2011 sample. In addition, 4.6 per cent of the 2009 sample were living in camps during the interview period. Close to one-half of the sample included in the regression reported that their house had collapsed, and around one in four reported medium damage to the house. The mean household size was about 3.7 in both surveys, and the mean child dependency and elderly dependency ratios were both low.[5]

Table 2. Description of sample data in 2009 and 2011

Variables		2009	2011
Natural capital			
Size of cultivated land (mean, mu)		–	2.6 (3.7)
Lost cultivated land after the disaster (%)		20.8	15.7
Physical capital			
Asset (%)	Colour television	88.0	94.2
	Refrigerator	37.2	69.4
	Washing machine	52.3	74.8
	Air conditioner	4.2	14.0
	Camera	3.1	8.5
	Radio	9.7	8.6
	Bicycle	38.3	45.1
	Computer	6.7	19.2
	Truck/car	3.9	10.8
	Agricultural tricycle	8.8	17.7
	Motorcycle	36.2	49.7
	Microwave oven	3.2	8.8
	Water dispenser	21.8	47.8
	Mobile telephone	78.8	91.1
Financial capital			
Household annual income (mean, CNY)		23,892 (25,405)	28,852 (35,218)
Bank loan (%)	No need for a bank loan	60.1	77.0
	Needs a bank loan but cannot get one	21.3	–
	Has a bank loan	18.6	23.0
Other loan (%)		27.7	34.8
Subsidy (mean, CNY 1,000)		3.94 (12.15)	1.06 (14.6)
Human capital			
Mean employment rate among household members		60.9 (29.0)	68.6 (27.4)
Number of income source (%)	None	0.3	5.1
	One	9.8	43.1

Variables		2009	2011
	Two	40.4	41.3
	Three	46.1	9.9
	Four	3.4	0.7
Household member without chronic sickness (%)		35.0	36.5
Household head education level (%)	No school	11.3	10.5
	Primary	46.0	44.7
	Junior high	35.2	34.4
	Senior high and technical school	7.5	10.4
Social capital			
Size of personal network (mean)		19.4 (24.5)	19.6 (27.0)
Personal social source score (mean)		0.59 (1.05)	0.73 (1.22)
Trust (%)	High-level government	0.76	0.58
	Low-level government	0.58	0.63
	Social system	0.78	0.72
Location and demography			
Elder dependency ratio (mean)		0.13 (0.25)	0.16 (0.28)
Child dependency ratio (mean)		0.10 (0.14)	0.10 (0.14)
Household size (mean)		3.76 (1.41)	3.66 (1.42)
Location (%)	Urban	10.0	17.7
	Rural	85.4	82.3
	Camp	4.6	–
Disaster effect			
Households with a migrant who returned after the disaster to take care of the family (%)		9.7	11.4
House damage (%)	Light, no damage	26.6	29.9
	Medium damage	27.1	22.4
	Collapsed, serious damage	46.3	47.7
Sample size		**2,707**	**2,596**

Note: the standard deviation of the mean is provided in parentheses.

Source: authors.

As noted, the independent variables were split into five livelihood capitals. Natural capital includes the size of cultivated land[6] and lost cultivated land during the disaster. One in five people in the 2009 sample and one in six people in the 2011 sample said that they had lost cultivated land.

Physical capital is represented by an asset index, which is prepared by principal component analysis (PCA) transformation method based on 14 assets. The primary component loadings for the asset index are presented in Table 3. Ownership of all 14 assets dramatically increased from 2009 to 2011 (see Table 2).

Financial capital has income, credit, and subsidy components. Income is the natural logarithm of household annual income; credit is access to a bank loan and a loan from other people, such as friends and family members; and subsidy is various forms of financial aid or support from the government, a social organisation, and family or friends. Household income and access to credit both increased over time, whereas the subsidies received by households have declined, indicating that they were mainly emergency assistance for a short period after the disaster.

Human capital contains employment (percentage of employed household members), income diversity (number of income sources), party membership (of the household head), health (any household member with a chronic disease or disability), and education (the highest level of the household head). Around two-thirds of households had members with a chronic disease or disability. The percentage of employed individuals among all household members was quite high: on average, two in three members were working. Most households had one or two income sources in 2011, whereas most had two or three income sources in 2009. Disaster relief income was supplemented by one extra income source for a short period in 2009, dissipating among most households in the longer run.

Finally, social capital is represented by size of personal network, personal social resources, and three trust indexes. Personal network is the total number of families, friends, or acquaintances who visited the household during the Chinese Spring Festival. The average size of the personal network was reported to be about 20 persons and the mean personal social resource score—calculated using the position generator method (Lin, 2002)—was 0.59 in 2009 and 0.73 in 2011. A list of around 20 typical occupations was provided to the respondents, who were then asked to select those in which their social network members engaged. Each occupation was accorded a score of between zero and one, revealing the social power of the occupation. An aggregated mean of the scores was calculated to show the embedded social resource in each respondent's social networks. For the trust indexes, meanwhile, since macro–social capital is considered to be an asset of the collective, it is usually measured at the collective/community level rather than at the individual level. The three trust indexes were calculated at the community level, producing percentages for the households in each cluster[7] that reported complete trust in the central and provincial government, trust in all low-level governments, such as the city, county, town, and village government, and trust in courts, doctors, and the police.

Table 3. Primary component loadings for the capital asset index

Component	2009	2011
Colour television	0.428	0.415
Refrigerator	0.670	0.694
Washing machine	0.628	0.634
Air conditioner	0.562	0.564
Camera	0.522	0.523
Radio	0.233	0.149
Bicycle	0.308	0.356
Computer	0.564	0.636
Truck/car	0.285	0.426
Agricultural tricycle	0.157	0.091
Motorcycle	0.287	0.330
Microwave oven	0.500	0.523
Water dispenser	0.611	0.646
Mobile telephone	0.478	0.473

Source: authors.

Methods

One of the technical challenges to the use of the capital assets framework relates to the large number of variables involved. Given the five dimensions and the many variables indicating various assets in the physical capital dimension, it is important to employ certain approaches to reduce the number of dimensions or variables under review. The added benefits of applying such a methodology is that it can extract essential information from the dataset and discard noise variables. There are several methods available to decrease the number of dimensions, with PCA being one of the most popular. This is the most appropriate method when there is no special assumption about variables. PCA has been shown to provide a measure of economic status with a higher predictive value than other proxies (Houweling et al., 2003). Consequently, it is commonly used in constructing a wealth index, such as by the World Food Programme.

PCA is a statistical procedure that uses an orthogonal transformation to move 'n' coordinates of a dataset into a new set of 'n' coordinates called principal components. The principal components are orthogonal to (or uncorrelated with) the neighbouring components and the first principal component accounts for the largest possible variability in the data. The PCA transformation thus reduces the dimensionality of a dataset, by keeping the first few principal components, retaining the most important variation in the data. PCA is conducted in the SPSS statistical software package.

The dependent variable in this paper is households' own evaluations of disaster recovery. It is an ordinal dependent variable with a meaningful sequential order. Households were asked in the interview if and when their living condition had returned to the level before the earthquake. If it had not done so, they were asked to report when they expected it to happen. The dependent variable of the analysis, therefore, is the different stage of household recovery. Households that expect it to take a longer time to recover are defined as those who have higher vulnerability, and vice versa. Households who reported not having been affected by the earthquake were naturally not asked to report on their recovery from the disaster, and thus excluded from the sample. The entire sample was divided into seven different categories, based on the estimations of households regarding expectations of the time needed to recover to the same living condition as before the earthquake: 'within half a year'; 'one year', 'two years'; 'three years'; 'four to six years'; 'longer'; and 'hard to recover/not sure'.

An ordinal logistic regression based on a proportional odds model (McCullagh, 1980) was applied to discuss whether and how various capital assets are correlated with the level of household vulnerability. The dependent variable of the ordinal logistic regression is the logarithm of the odds ratio, the probability that the event occurs to the probability that the event does not occur. The probabilities of observing each category and the lower categories—that is, the cumulative probabilities of all categories (except the last one)—are estimated. The proportional odds model assumes that the coefficients of the regression models for all the cut points are the same, and hence only the intercepts are different:

$$\ln(\theta_i) = \alpha_i - \beta X$$

Where $\theta_i = \text{prob}(\text{score less than or equal to i})/\text{prob}(\text{score greater than i})$. Here, i is one less than the number of answer categories.

Results

The ordinal logistic regression was applied to households' own evaluations of returning to pre-disaster living conditions (see Table 4). Thresholds revealed the estimated cut points for the latent variables to differentiate the lower (households that took a longer time to recover) and higher (households that took a shorter time to recover) categories. In 2011, the cut points for the lowest (households that recovered after at least four years) and higher (households that recovered within two years) categories were significantly different; the cut points for the categories in between were not significant. In 2009, only the higher categories (households that recovered within two years) were significantly different; there was no significant difference among those that needed more than three years to recover.

The different impacts of the explanatory factors and the capitals on households' post-disaster recovery in the two surveys indicated their short- and long-term roles.

Table 4. Results of the ordinal logistic regression on household recovery, based on the capital assets framework

	2009		2011	
	Estimate	Standard error	Estimate	Standard error
Threshold				
Hard to recover/unsure	-0.520	0.386	-1.405***	0.313
Longer than six years	-0.055	0.386	-0.922***	0.311
Four to six years	0.305	0.386	-0.604**	0.310
Three years	0.588	0.386	-0.105	0.310
Two years	0.834**	0.386	0.804***	0.310
One year	1.827***	0.387	1.751***	0.312
Half a year	4.220***	0.396	3.356***	0.318
Demography				
Elder dependency ratio	0.589***	0.180	0.301**	0.147
Child dependency ratio	0.544	0.301	-0.119	0.310
Household size	-0.116***	0.033	-0.045	0.034
Female household head	-0.412***	0.129	-0.018	0.109
Location				
Camp	-1.010***	0.215	–	–
Rural	0.174	0.138	0.301***	0.121
Urban	0[a]	–	0[a]	–
Natural capital				
Natural logarithm of land size	–	–	0.164***	0.064
Lost cultivated land	-0.483***	0.094	-0.127	0.098
Physical capital				
Asset capital index	0.213***	0.047	0.178***	0.047
Financial capital				
Natural logarithm of household annual income	0.327***	0.091	0.316***	0.080
Bank loan				
No need for bank loan, 2009 No bank loan, 2011	0.326***	0.118	0.259***	0.093
Need a bank loan but cannot get one	-0.129	0.114	0[a]	–
Has a bank loan	0[a]	–	0[a]	–
Other loan	0.035	0.104	-0.234***	0.082
Subsidy	0.054*	0.033	-0.232***	0.072

	2009		2011	
	Estimate	Standard error	Estimate	Standard error
Human capital				
Percentage of employed members	0.034	0.151	0.049	0.153
Household head party membership	0.304***	0.120	0.028	0.112
Number of income source	0.076*	0.047	0.041	0.053
Member with chronic sickness	-0.141*	0.078	-0.219***	0.078
Household head education				
Senior high or higher	-0.243	0.186	0.050	0.172
Junior high	0.067	0.134	-0.153	0.132
Primary	0.192	0.128	0.121	0.125
No school	0[a]	–	0[a]	–
Social capital				
Size of personal network	0.001	0.002	-0.001	0.002
Personal social source score	0.115***	0.040	0.112***	0.036
Trust				
High-level government	0.675	0.401	-0.072	0.244
Low-level government	0.949***	0.228	1.035***	0.228
Social system	0.241	0.339	0.173	0.316
Disaster effect				
Migrant returned home	-0.428***	0.120	-0.106	0.112
House damage				
Serious	-0.813***	0.098	-0.815***	0.090
Medium	-0.642***	0.107	-0.362***	0.098
Light/no	0[a]	–	0[a]	–
Sample size	2,707	–	2,596	–

Notes: * Significance at the 10 per cent level; ** Significance at the five per cent level; *** Significance at the one per cent level. [a] Base category for the categorical independent variables.

Source: authors.

The estimated coefficients are the ordered log-odds (logit) regression coefficient. A one unit increase in the predictor would result, according to its respective ordered log-odds regression coefficient, in an increased chance of the household being in a higher recovery category, while the other variables in the model are held constant. The elder dependency ratio showed a positive role in households' post-disaster recovery whereas the child dependency ratio had no significant effect—the latter is generally low owing to the one-child policy and the low fertility rate in China. In the sample,

approximately 60 per cent of interviewed households did not have children of less than 15 years of age, and children comprised more than one-third of family members in only three per cent of households. It is not surprising to find, therefore, that the child dependency ratio had little effect on households' post-disaster recovery. About 31 per cent of the interviewed households had elderly member(s) and very few households had only elderly members of more than 65 years of age. Most families with elderly people were extended. Consequently, the statistically significant effect of the elder dependency ratio may be attributed to the positive role of extended families in post-disaster recovery. Giles and Mu (2007) suggest that the elderly in extended families are important in supporting decisions concerning migration. Few studies, however, have explored the roles of extended families in disasters.

Large households with many members and female-headed households had more difficulties in the short run (in 2009), but experienced no long-term effects (in 2011). Not surprisingly, the households living in camps in 2009 were the most vulnerable. Rural–urban differences were not significant in the short term, but rural households reported better progress with regard to post-disaster recovery in 2011. The extent of damage to the house was an important indicator of household vulnerability to the disaster in the 2009 and 2011 surveys. As expected, households that suffered more damage were more vulnerable. Lastly, households with a migrant member who had returned home were more likely to be vulnerable in the short run but not in the longer run.

Ownership of physical assets was important for households' post-disaster recovery, and the capital asset index coefficient was significantly positive in both the short and the longer term. Similarly, natural capital apparently plays a significant part in households' post-disaster recovery. Affected households with more cultivated land had a better chance of recovery in 2011. By contrast, loss of cultivated land in the earthquake influenced households' expectations of recovery in the short run, but was not significantly important in 2011.

Financial capital had different bearings on households' post-disaster recovery in different periods. The income capital coefficient was significantly positive in both surveys, indicating its key role in promoting recovery. The 2009 survey found that the primary factor was not whether the households actually had a bank loan, but whether they needed one. Households that required a loan were more vulnerable than those with no need of such an arrangement. The 2011 survey, though, did not collect information to differentiate households without bank loans—that is, whether they had no need of a bank loan or had no access to one. Households with a bank loan (needed or not needed) were still found to be more vulnerable than those without one in 2011. As for access to credit from family and friends, this was not significantly related to household recovery in 2009; in the longer run, though, those who sought to acquire it were more vulnerable.

Lastly, subsidies played a rather different role in the short and long term. In the short run, they were significant in promoting recovery, but became significantly negative three years after the survey, indicating that emergency assistance contributes

to recovery in the short term. Every CNY 1,000 subsidy will increase by five per cent the chance of households being in the higher recovery category. However, the households that still depended on external economic support in the longer run were vulnerable and had difficulty in recovering. The relationship between subsidies and household vulnerability is two-way in terms of causality. Disaster-affected households were more vulnerable if they had less access to subsidies, yet, in the longer run, households received government subsidies when they were considered to be vulnerable. An acknowledged limitation of this paper is not being able to provide statistical evidence of such a relationship.

Several types of human capital were important for households' post-disaster recovery in the short term, but only chronic sickness among household members mattered in the longer term. One of the most important human capitals in the short run was the party membership of the household head, although this was not significant in the longer run. Households with a head who was a member of the Communist Party had a 30 per cent better chance of being in the higher recovery category in 2009. The employment rate among household members was relatively high in Chinese households, and thus was not a factor that would influence households' post-disaster recovery. The education level of the household head was also found not to be important for the post-disaster recovery of households. Meanwhile, income diversity was important for household recovery in 2009, but not so three years after the disaster. In 2009, households' access to one or more income sources increased by eight per cent their chance of being in the higher recovery category. Furthermore, households with chronically sick members were generally quite vulnerable. In 2009 and 2011, respectively, they were 14 and 22 per cent more likely to be in a lower recovery category.

Lastly, social capital is important in facilitating households' post-disaster recovery. The size of a personal network is not significantly important. The personal social resource score is significantly positive, with one extra score making it about 10 per cent more likely that a household will be in a higher recovery category. Communities' average level of trust in low-level government reveals a high positive effect on households' post-disaster recovery. In both years, households in communities with a low level of trust on average in lower levels of government were twice as likely to be in a higher recovery category. However, trust in high-level government and the social system had no significant bearing on household vulnerability.

Conclusion

This study applied ordinal logistic regression to subjective self-evaluated household vulnerability, using the capital assets framework. The data from two surveys administered after the Wenchuan earthquake in 2008 afforded a good opportunity to explore the effects of various capitals on household vulnerability, and point up the possibility of predicting household vulnerability after a disaster in the Chinese context. The

study suggests that numerous capitals can contribute to a large extent to households' post-disaster recovery and reduce their vulnerability. The results of the logistic regression show that there is a proportional and interchangeable relationship between various capitals. In addition, the data from the two surveys were collected one year and three years after the disaster, demonstrating potentially different roles of capital assets in household vulnerability in the short and longer run. Some capital assets make equally important contributions both during reconstruction and afterwards, whereas some other capitals can be available only temporarily, meaning that their inputs need to be interpreted carefully when assessed with respect to a chronic disaster.

All five types of capital assets (financial, human, natural, physical, and social capital) were found to be important determinants of households' post-disaster vulnerability, suggesting that a variety is vital to support recovery. At the same time, capitals can be interchangeable. Disaster-affected households that lack certain kinds of capital assets may still be able to recover better if they rely more on other capital assets. For example, some households depend more on natural capital (agricultural land by rural households), others rely more on human capital (such as healthy persons, party membership, or a wide range of income sources), while yet others enjoy better access to social capital (social networks and macro social trust capital). The coefficients of variables representing different capital assets reveal a proportionally interchangeable relationship between assets with regard to reducing households' post-disaster vulnerability.

Rural households were considered to be over-representative among the poor and thus seen as more vulnerable, but the 2011 survey discovered that urban households can find it more difficult to recover from a disaster in the longer run (three years after the earthquake). Also, large and female-headed households are especially vulnerable immediately after a disaster, but they do not experience long-term effects. Different capitals play different roles in different recovery phases. The data from the two household surveys after the Wenchuan earthquake show that several types of capital are vitally important to affected households right after a disaster, but the effect may dissipate in the longer run.

Households that lost cultivated land reported being more vulnerable one year after the earthquake; however, loss of cultivated land during a disaster does not seem to affect households in the longer term. The 2011 survey found that a large part of the land reported as lost after the earthquake was not a direct consequence of the event itself. Instead, much land was acquired for reconstruction; the government compensated for the loss and provided alternative resources. Households that lost natural capital, such as cultivated land, were more vulnerable than others in the short run. The study demonstrates, though, that what really matters in the longer term is the total amount of natural and physical capital possessed by households.

Financial capital, such as a subsidy, was very important straight after the disaster for household recovery, but dependency was temporary. Those that had to rely on a subsidy in the longer term were highly vulnerable. Similarly, those in desperate need of loans were also vulnerable households. When they could not acquire enough

through formal channels, they had to rely on informal loans from friends and relatives. Households that depended on informal loans in the longer term were most vulnerable.

As for human capital, factors such as education and employment do not influence economic recovery after a disaster in China. Some types of human capital, such as party membership of the household head and a variety of income sources, were important resources for households' post-disaster recovery in the short term, but the health status of household members was key in the longer term. Those with household members with chronic sickness were more vulnerable than others in the longer run.

The important part played by social capital in disaster recovery has been highlighted in recent studies. Researchers have found that micro-level social capital, including the density, heterogeneity, and size of social networks and the resources embedded in social networks, has contributed to the recovery of disaster-affected individuals, whereas macro-level social capital, such as norms, participation in voluntary activities, and social trust in local communities, has had a positive impact on the recovery of affected communities after a disaster (Nakagawa and Shaw, 2004; Zhao, 2007; Aldrich, 2012). The survey data indicate that the size of a personal social network is not a critical factor; rather, the personal social source score matters. In other words, the resources embedded in personal social networks are important for households' post-disaster recovery.

Another important finding for social capital is that households living in a community with more trust in local government are less vulnerable than a community with a lower level of trust. A high level of trust in local government may signify people's satisfaction with communities' rescue and reconstruction efforts following a disaster, which help to improve households' recovery capabilities. However, people's trust in higher-level government does not seem to be relevant to households' post-disaster recovery. Surveys conducted by Fafo after the Wenchuan earthquake suggest that the Chinese generally have very high trust in central government (Dalen et al., 2012). Furthermore, earlier studies show that Chinese people have different levels of trust in higher and lower levels of government, as they distinguish between the intent and actual capacity of the central administration (Li, 2008). The findings of this study are consistent with existing research, signifying that micro- and macro-level social capital constitute the assets that significantly reduce households' post-disaster vulnerability.

This paper illustrates the key roles of capital assets in household vulnerability after a disaster in China. It demonstrates that the capital assets framework can be a useful tool in predicting household vulnerability in the context of disaster studies. In addition, visible (financial, natural, and physical capital) and invisible (especially social capital) assets are important in predicting household's post-disaster vulnerability. It is not only the economic subsidies that are vital to recovery, but also investments in human and social capital. Finally, various capitals can all make major contributions to developing the capabilities of households to recover from a disaster. Consequently,

when disaster-affected households lack certain capital assets, policymakers can compensate for their absence by supplying other types of capital.

Correspondence

Huafeng Zhang, The Fafo Institute for Labour and Social Research, Borggata 2b, Oslo 0608, Norway. E-mail: zhu@fafo.no

Endnotes

[1] The Post-disaster Damage and Needs Assessment project is a cooperative endeavour between United Nations agencies led by the United Nations Development Programme, as the chair of the Cluster Working Group on Early Recovery, the World Bank, and the European Commission. For more details, see European Commission, United Nations Development Group, and World Bank (2013).

[2] For more information, see UNDP (2011).

[3] The centre is now called the Fafo Institute for Labour and Social Research. For more information, see https://www.fafo.no/index.php/en/ (last accessed on 11 February 2020).

[4] Four counties were not accessible in 2009.

[5] The child dependency ratio is the proportion of children of 15 or less years of age to household size, and the elderly dependency ratio is the proportion of people of 65 or more years of age to household size.

[6] Not available in the 2009 data.

[7] Selected clusters in the survey are either the village or residence committee.

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