Chapter 2

THE EFFECT OF THE WENCHUAN EARTHQUAKE AND GOVERNMENT AID ON RURAL HOUSEHOLDS

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The 2008 Wenchuan earthquake caused extensive damage in the rural areas of Sichuan. Natural disasters such as the Wenchuan earthquake disrupt social and economic systems in a variety of ways, and as shown by Kahn (2005) and Stromberg (2007), when it comes to natural disasters, the poorer the country, the more people die. Besides loss of life, though, natural disasters can lead to losses in income and declines in consumption for households that may in turn reduce the accumulation of human capital and long-term economic growth (Baez and Sontos 2008). These changes in income, consumption, and the returns to education could exacerbate inequality in rural areas or lead to an increase in poverty.

Developing countries are more likely to face these long-term effects because, compared to developed countries, they are less able to withstand the initial shocks. With inadequate infrastructure, second-rate healthcare facilities, and weak economies, the rural areas of developing countries are particularly vulnerable to the adverse effects of natural disasters, and they are consequently more likely to suffer from a severe negative shock than are urban areas (van den Berg 2010). Therefore, when a natural disaster strikes, relief agencies must target aid appropriately and deliver it quickly to rural areas. In response to the Wenchuan earthquake, the Chinese government provided living allowances and reconstruction aid to rural households. This chapter examines the impact government aid had on income and consumption of rural households and the role it played in mitigating the potential negative effects (as identified above) of the Wenchuan earthquake. We find that the government aid kept consumption from falling dramatically despite a large drop in income and that, at least temporarily, it reduced inequality.

The earthquake, with its epicenter in Wenchuan, Sichuan, registered 8.0 on the Richter scale and was one of the most damaging ever in terms of property value; the total economic loss from the earthquake is estimated to be RMB 845 billion (US$132 billion). It left nearly 88,000 people dead (including those still listed as missing) and directly affected 46 million people.

Skyscrapers shook in Shanghai, more than 1,600 kilometers away.[1] The severity of the earthquake led to worldwide media attention and a swift response by the Chinese government.

The Chinese government provided immediate humanitarian aid to households and communities that were affected by the earthquake. It furnished grain, rations of edible oils, and other necessities worth nearly US$50 per month per family for at least three (and usually six) months after the earthquake. It also provided aid for housing reconstruction, based on a formula involving household size and pre-earthquake income. The response, both in terms of its size and the openness with which the aid was allocated, provides a unique opportunity to look at the effect of government aid in China.

Besides giving aid to households, the government also rebuilt critical infrastructure. The Wenchuan Earthquake Restoration and Reconstruction Plan was publicized by the State Council in September 2008, four months after the earthquake, and promised that RMB 1 trillion (US$157 billion) would be spent on rebuilding affected areas. By May 2011 the reconstruction was almost complete: 95 percent of the 41,130 national reconstruction projects were finished, and RMB 885 billion (US$138 billion) had been spent. The government had helped to build 1.9 million homes in rural areas, 288,300 homes in urban areas, 3,839 schools, and 2,169 of various types of healthcare and rehabilitation facilities. It had also supplied funding for more than 5,000 key infrastructure projects (Jiang and Yang 2011).

The majority of the jurisdictions affected by the earthquake were rural, and consequently most of the recovery aid went to rural households and to build rural infrastructure. More than 10 percent of the RMB 1 trillion (US$157 billion) promised was distributed in the seven months after the earthquake: RMB 40 billion in direct aid, RMB 40 billion for reconstruction, and RMB 24 billion for low-interest loans to farmers so they could rebuild their homes. The speed of aid disbursement and the focus on rural areas allow us to examine key questions about government's aid and the role of the aid in helping rural households recover. The study uses a unique dataset collected from primary sources. The dataset consists of a household survey conducted in August 2007, 9 months before the earthquake, and a follow-up survey conducted in August 2009, 15 months after the earthquake.

Few studies have been conducted on the effect of government aid in the recovery process following a large natural disaster. This study helps fill a gap in the literature in general, and it appraises the effectiveness of government aid

1 For a discussion of the damage and costs of the earthquake, see *New York Times* 2009.

in China, a developing country, in particular. This study aims to answer two questions: (1) What effect did the earthquake have on rural households? (2) Did government aid adequately address the needs of rural households affected by the earthquake?

The study focuses on income and expenditure of rural households to examine the effects of the earthquake and the role of government aid. It finds that household income did decrease after the earthquake but that government aid kept consumption from falling dramatically. But even though the living subsidies were effective in maintaining consumption, the aid for home reconstruction was inadequate: government grants and loans met less than 60 percent of the needs of rural households.

The next section reviews the related literature. The chapter then introduces the household survey data and provides the main empirical results. The last section concludes with policy recommendations.

Literature Review

A large literature focuses on the income and consumption patterns of rural households in China. Recent studies suggest that nonfarm work and human capital play a large role in determining the level, growth, and distribution of household income. Nonfarm work refers to people running their own businesses or working for family enterprises or doing other work for wages. Off-farm work not only raises household income and consumption but also loosens the liquidity constraint—that is, the limitation on saving or borrowing money—many rural households face, and it allows them to invest in agricultural production, leading to a decrease in rural poverty (Taylor, Rozelle, and de Brauw 2003; Zhu and Luo 2006, 2008; de Brauw and Giles 2008). Human capital also plays a similar role in reducing poverty and increasing income. Chen and Xing (2004) find that education improves the chances that a rural worker becomes involved in nonfarm work. They estimate that the returns to one year of education are 5–7 percent. Other studies find that education increases the likelihood that a rural worker will be employed in a high-wage sector. For instance, de Brauw and Rozelle (2008) estimate that, for off-farm workers, the average return to one additional year of education is 6.4 percent, and Zhou, Xu, and Xia (2010) estimate the average annual return to vocational education is 9 percent.

The role of nonfarm work and human capital in increasing household income provides potential channels by which policymakers could reduce poverty and decrease income inequality. Policies such as increasing access to

education in rural areas, strengthening infrastructure, or removing restrictions on a farmer's ability to engage in nonfarm activities could decrease income inequality and poverty in rural areas. However, when we consider household well-being, income is only one part of the picture. This is especially true in China, where rural households receive substantial amounts of government subsidies. Thus, we must also consider what affects household consumption and expenditure.

Recent research on rural household consumption provides some insights into what could stimulate expenditure. For instance, decreasing household uncertainty regarding income and relaxing the liquidity constraint could both help stimulate consumption. Several studies show that uncertainty, precautionary savings, and life-cycle patterns are key factors in explaining household consumption (Zhou 2005; Zang and Pei 2007).

Giles and Yoo (2007) find that with the expansion of migrant networks, rural households have an additional means of coping with unexpected shocks and consequently decrease their precautionary savings. Ai and Wang (2010) find that when rural households have access to nonfarm work, they can offset adverse income shocks and smooth consumption by working off-farm more. Thus, the permanent income hypothesis explains consumption well when farmers have access to off-farm work or other ways of relaxing their liquidity constraint.[2] These findings all suggest that if rural households faced less income uncertainty or had more access to credit, they would be less prone to put aside precautionary savings and would thus increase their consumption.

When natural disasters occur, households can suffer large losses in assets and income. Recent literature has shown that these types of effects can lead to a decrease in household consumption. Van den Berg and Burger (2008) examine the reactions of rural households in Nicaragua to Hurricane Mitch and find that all households decreased their consumption in response to the loss of assets. However, only poorer households cut their consumption because of transitory income losses, suggesting that the poorer households were liquidity constrained. Despite the difference in the effects on consumption, van den Berg (2010) finds that poorer households were no less likely to move into or out of poverty because of the hurricane.

Although no study has looked at how the Sichuan earthquake affected household income and expenditure, some studies have examined the effect of the earthquake on corporate donations (Shan, Gan, and Zheng 2008) and

2 The permanent income hypothesis supposes that a person's consumption at a given point is determined by his or her lifetime expected income, that is, the person's "permanent income."

China's stock market (Shan 2011). One study, Sun et al. (2010a), does investigate the earthquake's effect on the determinants of household income. The study examines the similarities and differences of the determinants of household income by estimating household income equations before and after the earthquake. However, the survey sampled only 319 rural households and relied on recall data for pre-earthquake income. Recall error is likely to be correlated with one's experience of the earthquake, and thus it biases all results. No work has been done to look at the role of government aid in recovery.

Data and Empirical Results

Data

Our analysis uses data from the Sichuan rural household and migration survey. The survey was conducted in County M. County M was one of the hardest-hit areas in the earthquake. First, we randomly chose two towns from all towns in County M: Town S and Town X. Then, we randomly chose three villages in each town. Last, we surveyed all the households in each village. The survey was conducted in two waves, in August 2007 and August 2009. The survey was funded by Shanghai University of Economics and Finance and the University of Essex; the collection of survey data was overseen by researchers from both universities. Town S and Town X both suffered heavy damage from the Sichuan earthquake. Town X is roughly 30 kilometers closer to the epicenter of the earthquake than Town S, so Town X suffered much more loss of life and property than did Town S.

The 2007 survey covers 787 households, and the 2009 survey covers 780 households; 683 households can be matched across the two waves. The questionnaire gathered basic demographic information (age, sex, education level, etc.); information on the acreage of land owned, farming activities, ownership of livestock, individual business activities, off-farm work, and household income and assets; and information on cash consumption. The expenditure data focuses on the month before each survey wave. The 2009 questionnaire also gathered information regarding damage and loss caused by the earthquake and the type and amount of government aid received.

Table 2.1 presents the summary statistics for household heads. The vast majority of household heads are male; on average they are 51 years old and had five years of schooling in 2007. Table 2.1 also shows the summary statistics for household heads from the matched sample. The results are similar to those from the whole sample. Our empirical analysis below uses the whole sample

TABLE 2.1 Summary statistics for household heads, Town S and Town X, 2007 and 2009

	Whole Sample						Matched Sample					
	Town S		Town X		All		Town S		Town X		All	
Characteristics	2007	2009	2007	2009	2007	2009	2007	2009	2007	2009	2007	2009
Age	51.42	53.04	51.22	52.82	51.32	52.93	51.88	53.60	50.97	53.04	51.40	53.30
Sex (female = 1)	0.06	0.07	0.11	0.13	0.09	0.10	0.06	0.07	0.11	0.12	0.08	0.09
Schooling (years)	5.55	5.66	5.06	5.17	5.29	5.41	5.57	5.63	5.08	5.13	5.31	5.36
Household size	2.99	2.95	2.93	2.86	2.96	2.91	2.99	2.99	2.87	2.87	2.92	2.92
Observations	370	382	417	398	787	780	320	320	363	363	683	683

Source: Authors' compilation.

for two years. For robustness check, we have also analyzed the matched data; the results are robust. Because of space limitations, we do not report those results below.

Empirical Results: Household Income

We divided the net annual income of the household (August 2006 to July 2007 and August 2008 to July 2009) into five sources: crop income, livestock income, individual business income, off-farm wage income, and other income. Table 2.2 presents summary statistics for income variables by years and towns. Figure 2.1 depicts income composition.[3]

Table 2.2 demonstrates that the level of household income in both towns declined after the earthquake. The average household income declined by 16 percent in Town S and 13 percent in Town X while per capita income decreased by 17 percent in Town S and 12 percent in Town X. The change in income levels varied dramatically by the income source: the average household livestock income declined sharply, by 52 percent in Town S and 44 percent in Town X; off-farm income declined only slightly in both towns; the average individual business income rose significantly, by 192 percent in Town S and 134 percent in Town X. The dramatic rise in business income is due in part to business opportunities associated with the reconstruction after the earthquake.

Figure 2.1 depicts the changes in the composition of household income between 2007 and 2009. The share of livestock income fell significantly, the share of individual business income rose sharply, and the share of off-farm wage income also increased to some extent. This simple comparison shows the changes in importance of different categories of household income: households began to rely more on individual businesses and off-farm work when livestock raising suffered serious earthquake damage. Crop income remained about the same, both in level and proportion. The earthquake did not affect the off-farm household income, although some off-farm work was interrupted temporarily by the earthquake. Off-farm income was the main household income source before and after the earthquake.

Empirical Results: Government Aid

Earthquake-stricken households received two types of aid from the Chinese government: a living allowance, and a mix of subsidies and loans for home reconstruction. With respect to the living allowance, the Ministry of Civil

3 All income variables are expressed in year 2007 RMB.

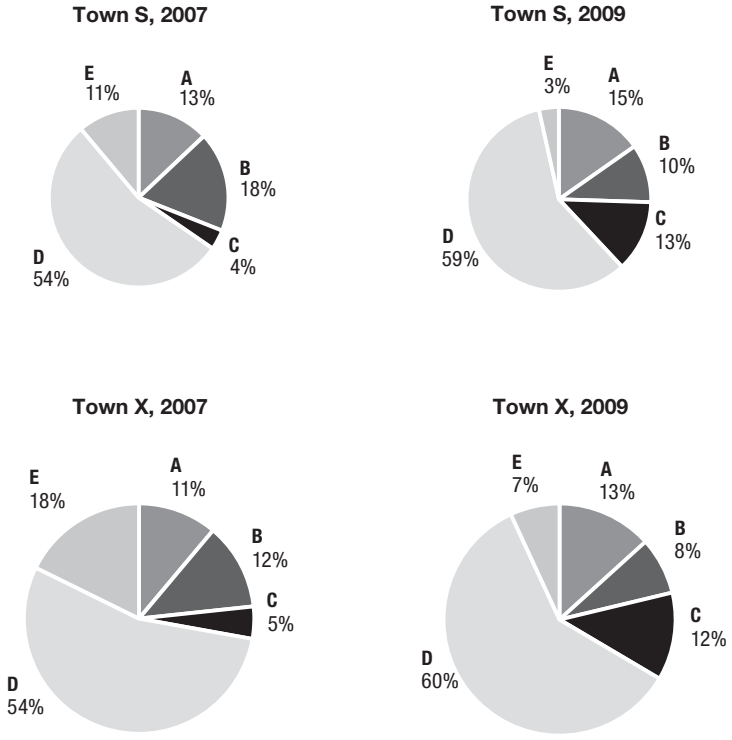
TABLE 2.2 Summary statistics for household income, Town S and Town X, 2007 and 2009, RMB

Average annual household income characteristics	Town S			Town X			All		
	2007	2009	Change	2007	2009	Change	2007	2009	Change
Household income	15,543	13,076	–16%	12,712	11,028	–13%	14,043	12,031	–14%
	(17,819)	(12,856)		(14,742)	(14,106)		(16,312)	(13,539)	
Income per capita	5,290	4,401	–17%	4,261	3,737	–12%	4,744	4,062	–14%
	(6,748)	(4,227)		(5,396)	(4,560)		(6,087)	(4,410)	
Crop income	2,013	1,994	–1%	1,411	1,460	3%	1,694	1,722	2%
	(1,557)	(1,262)		(1,300)	(1,032)		(1,457)	(1,180)	
Livestock income	2,798	1,339	–52%	1,548	875	–44%	2,136	1,102	–48%
	(11,308)	(5,061)		(6,640)	(2,079)		(9,152)	(3,845)	
Individual business income	561	1,636	192%	574	1,345	134%	568	1,487	162%
	(2,376)	(6,811)		(3,408)	(10,226)		(2,966)	(8,718)	
Off-farm wage income	8,430	7,641	–9%	6,917	6,549	–5%	7,628	7,084	–7%
	(11,066)	(10,017)		(9,280)	(9,063)		(10,181)	(9,551)	
Other income	1,723	455	–74%	2,249	758	–66%	2,002	609	–70%
	(6,311)	(2,234)		(7,445)	(3,162)		(6,936)	(2,749)	
Observations	370	382		417	398		787	780	

Source: Author's compilation.

Note: Standard deviations in parentheses.

FIGURE 2.1 Household income composition, Town S and Town X, 2007 and 2009



A = Crop income; **B** = Livestock income; **C** = Individual business income; **D** = Off-farm wage income; **E** = Other income.

Source: Authors' compilation.

Affairs, the Ministry of Finance, and the State Administration of Grain joined together to provide each individual in the earthquake-stricken areas with RMB 300 (US$47) per month and to provide households with rations and edible oils in the first three months after the earthquake. After the first three months had passed, the State Council continued to provide needy individuals RMB 200 (US$31) per month for an additional three months. The living allowance was larger for areas and households that were most severely affected by the earthquake.

With respect to subsidies and loans for home reconstruction, Sichuan Provincial People's Government provided reconstruction subsidies to rural households whose homes had collapsed or been damaged in the earthquake.

TABLE 2.3 Summary statistics for income losses and government aid, Town S and Town X, 2007 to 2009

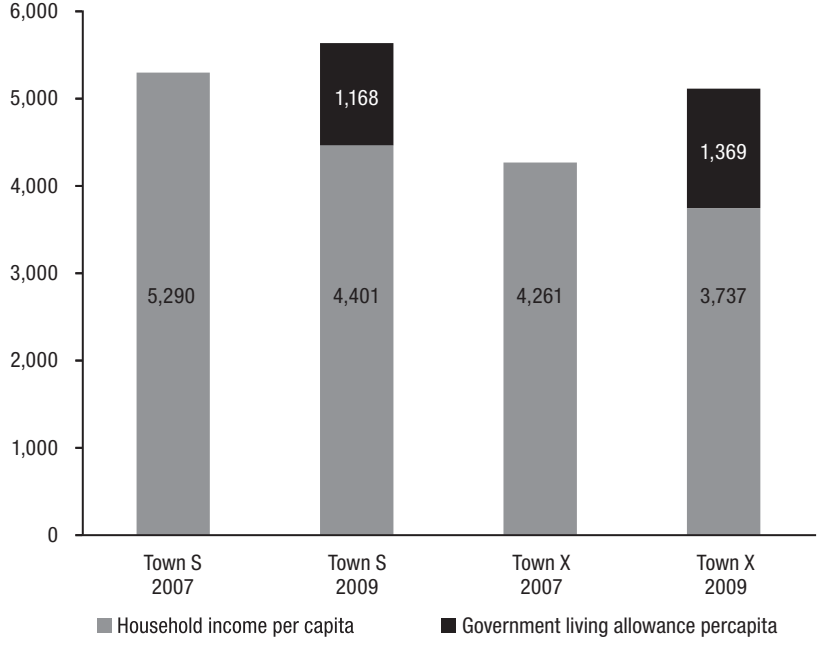
Income loss/government aid	Town S	Town X
Crop income (RMB)	–359	–512
	(407)	(478)
Livestock income (RMB)	–370	–606
	(2,714)	(2,175)
Individual business income (RMB)	–1,196	–603
	(7,557)	(3,123)
Off-farm wage income (RMB)	–2,052	–3,166
	(4,054)	(5,657)
Crop yield (½ kilogram)	–479	–723
	(545)	(666)
Housing rebuilding cost (RMB)	64,345	65,927
	(50,982)	(67,464)
Housing loan (RMB)	12,153	14,418
	(10,129)	(10,961)
Government living allowance (RMB)	3,391	3,734
	(2,688)	(3,966)
Expected housing subsidy (RMB)	3,551	3,742
	(3,480)	(3,057)
Final housing subsidy received (RMB)	17,550	19,133
	(14,748)	(13,291)
Observations	382	398

Source: Authors' compilation.
Notes: Standard deviations in parentheses; all in 2007 RMB.

On average, each household received RMB 20,000 (US$3,100). Subsidies for reconstruction were distributed based on household income and size: for households with one to three people, RMB 16,000 was provided; for households with four or five people, RMB 19,000; for households with six or more people, RMB 22,000. If households were deemed to have a greater need than what their entitled subsidies would provide, they received an additional RMB 4,000. If households had to build their own transitional places to live, they received RMB 2,000 for construction.

Table 2.3 provides summary statistics, based on data gathered directly from households, for the types of loss caused by the earthquake and the government aid received by households. On average, households in Town X had

FIGURE 2.2 Household income per capita and government living allowance per capita, Town S and Town X, 2007 and 2009, RMB



Source: Authors' compilation.

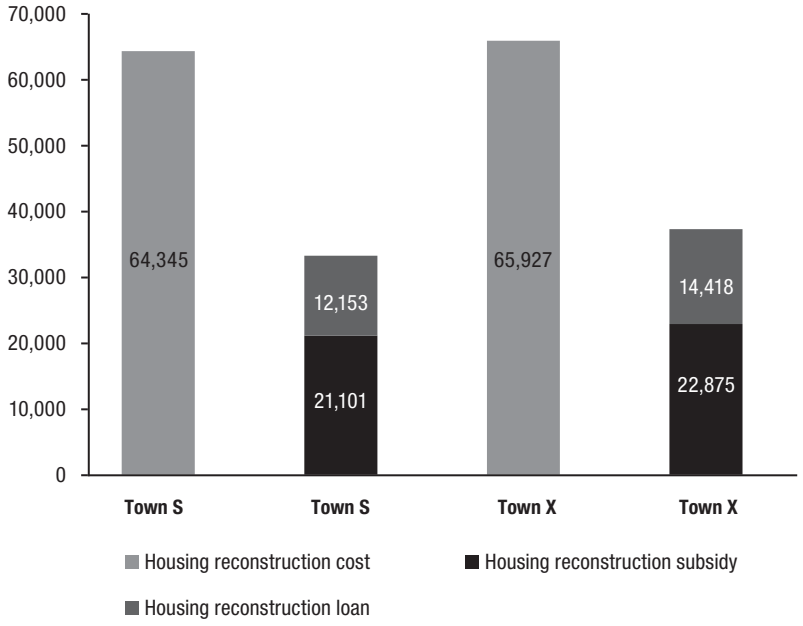
Note: The government provided no living allowance in 2007; household income per capita is determined by calculating income per capita for each household and then determining the average of all households at the town level.

greater losses of income from all income sources, except for business income, than those in Town S. Not surprisingly, households in Town X received more aid than those in Town S. These summary statistics are consistent with Town X being closer to the epicenter of the earthquake.

Figure 2.2 illustrates the role government aid played in helping households recover after the earthquake. The figure shows per capita income before and after the earthquake and the living allowance provided by the government. Income per capita in Town X was lower than that in Town S for both years. Income per capita decreased from RMB 5,290 to RMB 4,401, or 17 percent, in Town S, compared to RMB 4,261 to RMB 3,737, or 12 percent, in Town X from 2007 to 2009. The living allowance for individuals in Town X was higher than that for individuals in Town S.

To examine the role of reconstruction aid on recovery, we calculated the average cost of repairing or rebuilding a home and compared it to the average

FIGURE 2.3 Average housing reconstruction costs, subsidies, and loans, Town S and Town X, 2009, RMB



Source: Authors' compilation.

Note: Housing reconstruction subsidy includes both the subsidy expected and that received.

subsidy received by each household (Figure 2.3). The average cost of repairing or rebuilding residents' homes was larger in Town X at RMB 65,927 than in Town S at RMB 64,345. The government subsidy for reconstruction, on average, accounted for only RMB 21,101, or 32.8 percent, of the total average cost of repairing or rebuilding in Town S, and RMB 22,875, or 34.7 percent, of those costs in Town X. The combination of this reconstruction subsidy and loans for home reconstruction (the latter offered by government-assigned banks at a low interest rate) accounted for, on average, only RMB 33,254, or 52 percent, of the costs of repairing or rebuilding in Town S and RMB 37,293, or 57 percent, of the costs in Town X. These figures show that the housing damage was greater in Town X and that the government housing reconstruction subsidies together with housing loans could not fully compensate for all the repairing or rebuilding costs.

Empirical Results: Household Consumption

Consumption is an important indicator of household welfare, and with the large amount of subsidies that rural households in China receive, analyzing consumption might provide a slightly different story about the effects of the earthquake compared to the income regressions. This section analyzes the change in household consumption after the earthquake and the impact of the government living allowance on consumption.

The data collected consist of detailed household cash expenditure information for the months prior to the surveys (July 2007 and July 2009). We divide household expenditures, aside from the expenditure on housing maintenance, into five categories: food, clothing, health and education, transportation and public utilities, and other expenditures.[4] Table 2.4 presents summary statistics for expenditures (in 2007 RMB). Figure 2.4 depicts the composition of consumption.

Table 2.4 shows that expenditure per capita rose after the earthquake by 22 percent in Town S and 35 percent in Town X. Considering that households in Town X, on average, received a larger living allowance, we hypothesize that the higher increase in consumption in Town X is related to the living allowance; we examine this in the regression analysis below. Food expenditure increased by 48 percent in Town S and by 46 percent in Town X. Figure 2.4 suggests that the proportion of expenditure on food and the proportion of expenditure on transportation and public utilities increased; the proportion of expenditure on clothing decreased. These results suggest that the direct and indirect effects of the earthquake might have changed the structure of households' consumption.

Previous empirical studies on rural household consumption have used different specifications for the consumption equation. Different specifications were used because of the different theoretical hypotheses that underlay the empirical models (that is, absolute income hypothesis, relative income hypothesis, and life cycles/permanent income hypothesis). Our goal is not to test a specific theoretical hypothesis but to investigate the possible determinants of household consumption and the effect of the living allowance on consumption. Therefore, we will use a reduced-form consumption regression equation:

$$ln(exp)_i = \hat{a}_0 + \hat{a}_1 ln(inc)_i + \hat{a}_2\, kid\_6\_num_i + \hat{a}_3\, kid\_14\_num_i + \hat{a}_4 old\_65\_num_i + \hat{a}_5 educ_i + \hat{a}_6 town\_x_i + \mathring{a}_i \quad (1)$$

4 Because of the earthquake, expenditures on housing maintenance rose sharply in 2009, making comparisons before and after the earthquake unproductive.

TABLE 2.4 Summary statistics for household expenditure, Town S and Town X, 2007 and 2009, RMB

Average annual expenditure	Town S			Town X			All		
	2007	2009	Change	2007	2009	Change	2007	2009	Change
Household expenditure	1,090	1,295	19%	1,048	1,472	40%	1,067	1,385	30%
	(1,104)	(1,398)		(1,236)	(1,344)		(1,175)	(1,373)	
Household expenditure per capita	379	462	22%	393	532	35%	387	498	29%
	(350)	(416)		(577)	(457)		(484)	(438)	
Food expenditure per capita	165	244	48%	169	247	46%	167	245	47%
	(130)	(237)		(146)	(163)		(138)	(202)	
Clothing expenditure per capita	30	20	–33%	35	26	–26%	33	23	–30%
	(69)	(54)		(74)	(55)		(71)	(55)	
Health and education expenditures per capita	66	86	30%	96	103	7%	82	95	16%
	(164)	(189)		(492)	(274)		(376)	(236)	
Transportation and public utilities expenditures per capita	46	62	35%	35	64	83%	40	63	58%
	(114)	(209)		(58)	(89)		(89)	(160)	
Other expenditures per capita	73	50	–32%	59	93	58%	65	72	11%
	(168)	(100)		(82)	(271)		(130)	(207)	
Observations	370	382		417	398		787	780	

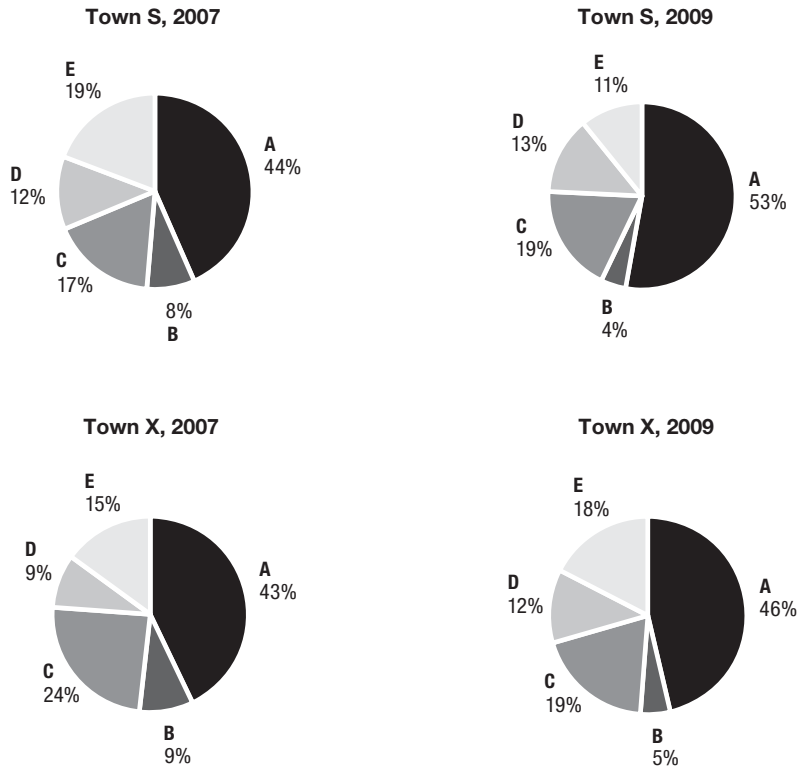
Source: Authors' compilation.

Notes: Standard deviations in parentheses; household expenditure excludes housing maintenance expenditure; because of rounding, totals might not exactly equal sums of numbers in table.

The dependent variable in equation (1) is the natural logarithm of household income. The independent variables include the natural logarithm of household income, the number of children under the age of 6, the number of children ages 6–14, the number of persons above the age of 65, the median number of schooling years for laborers, and a dummy variable for Town X.

Table 2.5 presents variable definitions and summary statistics. In the regression we also include the natural logarithm of the 2009 living allowance so we can examine its effect on consumption. Since the living allowance was exogenous and temporary (lasting no longer than six months), we regard it as a different type of income, that is, different from the household income listed above it. Table 2.6 presents estimation results.

FIGURE 2.4 Composition of household consumption, Town S and Town X, 2007 and 2009



A = Food; **B** = Clothing; **C** = Health and education; **D** = Transportation and public utilities; **E** = Other.

Source: Authors' compilation.

Table 2.6 demonstrates that household consumption was highly correlated with household income in both years. The living allowance was also highly correlated with household consumption in 2009, and its estimated elasticity was nearly four times larger than that of household income; holding all else equal, a 1 percent increase in the living allowance led to a 0.207 percent increase in household consumption. This suggests that the living allowance from the government played an important role in stabilizing household consumption after the earthquake. On average, households with more children under the age of 6 and children ages 6–14 consumed more; households having more people above the age of 65 consumed less. The coefficient on the number of children ages 6–14 is close to zero and is not significant in 2009. One

TABLE 2.5 Variables and summary statistics for consumption regressions, Town S and Town X combined, 2007 and 2009

Variables	Definition	Mean (2007)	Mean (2009)
ln(exp)	log of household consumption (RMB)	6.62 (0.89)	6.95 (0.77)
ln(inc)	log of household income (RMB)	8.73 (1.81)	8.65 (1.68)
ln(aid)	log of living allowance (RMB)	n.a.	8.04 (0.53)
kid_6_num	number of children under age 6	0.10 (0.30)	0.07 (0.27)
kid_14_num	number of children ages 6–14	0.21 (0.41)	0.18 (0.39)
old_65_num	number of people above age 65	0.30 (0.58)	0.35 (0.63)
educ	median of laborers' schooling years	5.70 (3.13)	5.87 (3.11)
town_x	regional dummy for Town X	0.53 (0.50)	0.50 (0.50)
Observations		785	758

Source: Authors' compilation.
Notes: Standard deviations in parentheses; laborer refers to people ages 15–64; n.a. = not applicable.

possible explanation is that the earthquake interrupted education for children; another is that the government education subsidies crowded out expenditure on children's education. The coefficient in 2009 on the Town X dummy is 0.136 and is significant in 2009; the 2007 coefficient is not significant, however. Table 2.4 shows that the regional consumption differential after the earthquake can be attributed to the significant increase in "other expenditures" for Town X, which may be directly related to the expenditure on earthquake relief.

Empirical Results: Economic Inequality

The decline in household income because of the earthquake could have caused greater economic inequality: if poorer households were less prepared for the earthquake, lived in homes that were more likely to be damaged, or worked in sectors that were more likely to face downturns (such as agriculture), then economic inequality could have increased because of the damage caused by the earthquake. The analysis below shows that, despite the likelihood of greater inequality, income inequality actually did not increase after the earthquake. If we look at the Lorenz curves (a common graphical way of representing income distribution) and a cardinal comparison based on a number of commonly used inequality indexes, we find no change in income inequality.

Cardinal indexes of inequality differ in their sensitivities to income differences at different ranges of the income distribution: an index might be sensitive to income differences among higher incomes, lower incomes, or those

TABLE 2.6 Regression results for household consumption, Town S and Town X combined, 2007 and 2009

Dependent Variable: ln(exp)			
Independent variables	Definition	2007	2009
ln(inc)	log of household income (RMB)	0.066***	0.053**
		(0.021)	(0.022)
ln(aid)	log of living allowance (RMB)	n.a.	0.207***
		n.a.	(0.058)
kid_6_num	number of children under age 6	0.198**	0.232**
		(0.082)	(0.116)
kid_14_num	number of children ages 6–14	0.236***	–0.020
		(0.072)	(0.070)
old_65_num	number of people over age 65	–0.157***	–0.212***
		(0.056)	(0.051)
educ	median of laborers' schooling years	0.042***	0.036***
		(0.011)	(0.009)
town_x	regional dummy for Town X	–0.019	0.136***
		(0.061)	(0.052)
constant		5.788***	4.657***
		(0.195)	(0.471)
Observations		785	758
R^2		0.099	0.164

Source: Authors' compilation.

Notes: Robust standard errors in parentheses; n.a. = not applicable; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; ln(exp) = log of household consumption (RMB); laborer refers to people ages 15–64.

somewhere in between (Atkinson 1970). For this reason, we use multiple inequality indexes in a systematic way to get a robust picture of the change in income inequality.

We focus on the following indexes when examining income inequality: the mean log deviation (MLD), the Theil index, half the coefficient of variation squared ($CV^2/2$), and the Gini coefficient. The first three indexes belong to the one parameter generalized entropy class of measures, GE (α), and each corresponds to a specific parameter: $\alpha = 0$, 1, or 2 respectively. These measures range from being sensitive to income differences at the bottom of the distribution (MLD) to being sensitive to those at the top ($CV^2/2$); the Theil index is sensitive to differences between the middle and the top of the distribution. The commonly used Gini coefficient is an inequality index sensitive to differences

toward the middle of the distribution, although not as close to the middle as the Theil index. We computed distribution-free variance estimates for the inequality indexes according to formulas provided by Biewen and Jenkins (2006) for GE indexes, and by Kovačević and Binder (1997) for the Gini index.

The standard procedure for ranking Lorenz curves is to simply compare ordinates. According to Foster (1985), if there is statistically significant Lorenz dominance, then there is a unanimous ordering of income distributions according to all standard inequality indexes. With this in mind, we checked whether our estimates of inequality trends were robust to the choice of the inequality measure by employing Lorenz dominance analysis; we checked whether or not Lorenz curves of income distributions for pairs of years crossed. Although the form of the stochastic process generating income or consumption is not a priori known in statistical analysis of inequality, one can use asymptotically distribution-free statistical procedures such as those developed by Beach and Davidson (1983). We define L^i as the i^{th} Lorenz ordinate (cumulative income share) $i = 1, 2, \ldots, k-1$, where the k^{th} ordinate is equal to 1. For the $k-1^{th}$ pair-wise comparison between years 2007 and 2009, each test statistic T_i is $T_i = (\hat{L}_i^{2009} - \hat{L}_i^{2007}) / \sqrt{\hat{V}_i^{2009} + \hat{V}_i^{2007}}$, where $\hat{L}_i$ is the estimate of the Lorenz ordinate and $\hat{V}_i$ is the estimate of its variance.

Our hypothesis testing uses the multiple comparison union intersection method of Bishop, Formby, and Smith (1991). Following standard practice in the literature, the income shares were computed at the 19 vingtiles. Tests are based on a 5 percent significance level and take account of the fact that each dominance test is based on 19 simultaneous tests. To draw inferences about the Lorenz curves based on the $k-1^{th}$ sub-hypotheses, we follow Beach and Richmond (1985) and test the T_i as a student maximum modulus variate. The critical value is therefore obtained from the student maximum modulus (SMM) distribution: SMM $(19,\infty) = 3.01$.

To partially order the Lorenz curves, statistical tests must distinguish between four possible outcomes. First, there may be no statistically significant difference between any pair of Lorenz ordinates, which means we must rank year 2007 and year 2009 as equivalent in terms of inequality (that is, equality is taken as the null hypothesis): this occurs when $|T_i| \leq 3.01$ for all i. Second, if there are positive and statistically significant differences in ordinates and no negative and statistically significant differences, then 2009 Lorenz dominates 2007: inequality is lower according to all standard inequality indexes ($T_i > 3.01$ for some i and $|T_j| \leq 3.01$ for $j \neq i$). Third, if there are negative and statistically significant differences in ordinates and no positive and statistically significant differences, then 2007 Lorenz dominates 2009 ($T_i - 3.01$ and $|T_j| \leq$

3.01 for $j \neq i$). Fourth, if there are negative and positive differences that are statistically significant, then the Lorenz curves cross and a unanimous inequality ranking cannot be derived ($T_i > 3.01$ for some i and $T_j - 3.01$ for some $j \neq i$).

Table 2.7 suggests that, according to the point estimates of the ordinates (cumulative income share or cumulative consumption share), the Lorenz curves of both income and consumption moved slightly inward between 2007 and 2009, which indicates greater equality. The inward shift is even greater when we include the government living allowance as part of household income in 2009 (2009G). However, all the test statistics T_i are smaller than 3.01 except when household income includes the 2009 government living allowance. Thus, we cannot reject the null hypothesis of equality of ordinates: that is, there is no greater inequality in household income and consumption after the earthquake, although there was a decline in the level of income and consumption compared to 2007.

Therefore, the data suggest that, despite the large effect of the earthquake on infrastructure and production, there was no change in household income or consumption inequality between 2007 and 2009. When we consider the government living allowance that was provided to households after the earthquake, we find a different result: the 2009 income distribution Lorenz dominates the 2007 distribution. This implies that the government support increased income and consumption equality after the earthquake. This can be seen by comparing 2009G (household income including living allowance) and 2007 in Table 2.7 and noting that $T_i > 3.01$ for $10 \leq i \leq 18$ and $0 < T_i < 3.01$ otherwise. We are thus able to reject the null hypothesis of no statistically significant difference between Lorenz ordinates for pair-wise comparisons undertaken between 2007 and 2009G. Thus, according to Lorenz dominance tests, we will get the same results by computing standard inequality indexes.

Table 2.8 shows estimates of inequality indexes and test statistics for pair-wise comparisons between 2009 and 2007. The test statistics are for pair-wise difference-in-means *t*-tests, so the relevant critical value for a 5 percent significance level is approximately 1.96. We find that the estimate of each index for household income decreased between 2007 and 2009 except for GE (2). When we look at consumption, though, every index decreased between 2007 and 2009. If we calculate from the numbers in Table 2.7, we see that the estimated decrease in household income between 2007 and 2009 is the largest for the GE (0) index (8.2 percent), and smallest for the Gini index (0.8 percent). Between 2007 and 2009G, the estimated decrease between 2007 and 2009G is the largest for the GE (0) index (57.9 percent), and the smallest for the Gini index (20.3 percent). In terms of household consumption, the

TABLE 2.7 Lorenz ordinates, standard errors, and test statistics for pair-wise Lorenz comparisons, Town S and Town X combined, 2007 and 2009

	Income					Consumption		
	Year			T_i		Year		T_i
Cumulative share	2007	2009	2009G	2009 vs. 2007	2009G vs. 2007	2007	2009	2009 vs. 2007
0.05	0.0009	0.0016	0.0079	0.03	0.30	0.0063	0.0071	0.03
	(0.0174)	(0.0178)	(0.0153)			(0.0189)	(0.0170)	
0.10	0.0048	0.0063	0.0208	0.06	0.69	0.0172	0.0208	0.14
	(0.0174)	(0.0177)	(0.0152)			(0.0189)	(0.0170)	
0.15	0.0107	0.0129	0.0357	0.09	1.09	0.0328	0.0383	0.21
	(0.0173)	(0.0177)	(0.0152)			(0.0188)	(0.0169)	
0.20	0.0194	0.0216	0.0537	0.09	1.50	0.0523	0.0586	0.25
	(0.0172)	(0.0176)	(0.0151)			(0.0187)	(0.0168)	
0.25	0.0310	0.0329	0.0726	0.08	1.83	0.0735	0.0831	0.38
	(0.0171)	(0.0175)	(0.0150)			(0.0186)	(0.0167)	
0.30	0.0457	0.0476	0.0953	0.08	2.20	0.0989	0.1089	0.40
	(0.0170)	(0.0173)	(0.0148)			(0.0185)	(0.0166)	
0.35	0.0645	0.0666	0.1210	0.09	2.55	0.1235	0.1380	0.59
	(0.0167)	(0.0170)	(0.0145)			(0.0184)	(0.0164)	
0.40	0.0906	0.0905	0.1514	0.00	2.80	0.1525	0.1702	0.72
	(0.0164)	(0.0167)	(0.0143)			(0.0183)	(0.0162)	
0.45	0.1216	0.1207	0.1856	–0.04	3.00	0.1854	0.2062	0.86
	(0.0161)	(0.0164)	(0.0140)			(0.0181)	(0.0160)	
0.50	0.1566	0.1549	0.2238	–0.07	**3.22**	0.2221	0.2428	0.87

(continued)

	Income					Consumption		
	Year			T_i		Year		T_i
Cumulative share	2007	2009	2009G	2009 vs. 2007	2009G vs. 2007	2007	2009	2009 vs. 2007
	(0.0158)	(0.0162)	(0.0136)			(0.0178)	(0.0158)	
0.55	0.1979	0.1958	0.2673	−0.09	**3.39**	0.2611	0.2825	0.91
	(0.0156)	(0.0158)	(0.0133)			(0.0176)	(0.0156)	
0.60	0.2438	0.2431	0.3168	−0.03	**3.66**	0.3044	0.3270	0.98
	(0.0152	(0.0155)	(0.0129)			(0.0173)	(0.0153)	
0.65	0.2967	0.2966	0.3704	−0.01	**3.78**	0.3533	0.3743	0.93
	(0.0149)	(0.0150)	(0.0125)			(0.0170)	(0.0150)	
0.70	0.3534	0.3570	0.4287	0.18	**4.00**	0.4060	0.4274	0.96
	(0.0144)	(0.0146)	(0.0121)			(0.0167)	(0.0146)	
0.75	0.4175	0.4253	0.4913	0.40	**4.07**	0.4638	0.4851	0.99
	(0.0138)	(0.0141)	(0.0117)			(0.0162)	(0.0141)	
0.80	0.4944	0.5006	0.5614	0.33	**3.90**	0.5315	0.5495	0.87
	(0.0132)	(0.0137)	(0.0110)			(0.0157)	(0.0135)	
0.85	0.5813	0.5878	0.6409	0.36	**3.65**	0.6045	0.6242	0.99
	(0.0126)	(0.0130)	(0.0103)			(0.0152)	(0.0127)	
0.90	0.6800	0.6864	0.7305	0.38	**3.34**	0.6907	0.7090	0.99
	(0.0116)	(0.0122)	(0.0097)			(0.0143)	(0.0118)	
0.95	0.8035	0.8086	0.8363	0.34	2.48	0.7972	0.8132	0.97
	(0.0104)	(0.0108)	(0.0082)			(0.0127)	(0.0105)	

Source: Authors' compilation.

Notes: Standard errors are in parentheses; 2009G refers to household income plus government living allowance; test statistics T_i that are greater than the student maximum modulus (SMM) distribution of 3.01 are in bold.

TABLE 2.8 Inequality indexes, standard errors, and test statistics for pair-wise comparisons, Town S and Town X combined, 2007 and 2009

	Income					Consumption		
	Year			Statistics		Year		Statistics
Index	2007	2009	2009G	2009 vs. 2007	2009G vs. 2007	2007	2009	2009 vs. 2007
Gini	0.4931	0.4894	0.3928	−0.35	**−10.39**	0.4173	0.3885	**−2.29**
	(0.0072)	(0.0075)	(0.0064)			(0.0095)	(0.0084)	
GE(0)	0.6617	0.6072	0.2784	−1.59	**−14.16**	0.3192	0.2602	**−3.15**
	(0.0256)	(0.0230)	(0.0089)			(0.0149)	(0.0114)	
GE(1)	0.4241	0.4178	0.2618	−0.28	**−8.33**	0.3258	0.2735	−1.75
	(0.0159)	(0.0165)	(0.0113)			(0.0245)	(0.0171)	
GE(2)	0.5353	0.5360	0.3328	0.01	**−3.85**	0.5626	0.4281	−1.28
	(0.0449)	(0.0472)	(0.0273)			(0.0941)	(0.0467)	

Source: Authors' compilation.

Notes: 2009G refers to household income plus government living allowance. GE (0, 1, 2) each represent one of the one parameter generalized entropy class of indexes, in which each number corresponds to a specific parameter. The GE class of indexes includes the mean logarithmic deviation (MLD, $\alpha = 0$), the Theil index ($\alpha = 1$), and half the coefficient of variation squared ($CV^2/2$, $\alpha = 2$). Test statistics with absolute values that are greater than the critical value (1.96) for a 5 percent significance level are in bold.

estimated decrease between 2007 and 2009 is the largest for the GE (2) index (23.9 percent) and the smallest for the Gini index (6.9 percent). When comparing 2007 and 2009, we find that *all* decreases in the inequality indexes are statistically significantly different from zero (2009G versus 2007). As a comparison, *no* index in household income is statistically different from zero in the same period (2009 versus 2007).

To better understand the evolution of income inequality, we follow Shorrocks (1982) to evaluate the contribution of each income source to total income inequality. Shorrocks shows that for any additively decomposable inequality measure, the contribution of an income source to total income inequality can be estimated by the covariance of that income source with total income divided by the variance of total income.

Table 2.9 presents decomposition results. We find that the contribution of off-farm wage income to total income inequality increased from 55 percent in 2007 to 62 percent in 2009. Individual business income increased dramatically, by almost 15 percentage points from 2007 to 2009. The increased importance of individual business reflects the increase in business opportunities that developed because of reconstruction after the earthquake. The contribution of livestock income and other income sources to total income inequality declined, by 7 and 15 percentage points, respectively. These

TABLE 2.9 Gini index decomposition by income components, Town S and Town X combined, 2007 and 2009

	2007		2009		2009G	
Components	Absolute	Relative	Absolute	Relative	Absolute	Relative
Crop income	0.0225	4.57%	0.0238	4.86%	0.0162	4.13%
Livestock income	0.0821	16.66%	0.0464	9.49%	0.0339	8.62%
Individual business income	0.0202	4.09%	0.0932	19.03%	0.0704	17.92%
Off-farm wage income	0.2733	55.42%	0.3028	61.88%	0.2246	57.18%
Other income	0.0950	19.26%	0.0232	4.73%	0.0161	4.10%
Government living allowance	n.a.	n.a.	n.a.	n.a.	0.0316	8.05%
Gini index	0.4931		0.4894		0.3928	

Source: Authors' compilation.

Note: 2009G refers to household income plus government living allowance. Because of rounding, the relative values listed above might not always match the results of dividing the absolute values by the total Gini index values; n.a. = not applicable.

TABLE 2.10 Gini index decomposition by consumption components, Town S and Town X combined, 2007 and 2009

	2007		2009	
Components	Absolute	Relative	Absolute	Relative
Food	0.1257	30.12%	0.1447	37.24%
Clothing	0.0489	11.72%	0.0273	7.02%
Health and education	0.1132	27.12%	0.0853	21.96%
Transportation and public utilities	0.0425	10.18%	0.0463	11.93%
Other	0.0870	20.85%	0.0848	21.84%
Gini index	0.4173		0.3885	

Source: Authors' compilation.

Note: Because of rounding, the relative values listed above might not always match the results of dividing the absolute values by the total Gini index value.

declines reflect losses in livestock income and other income sources such as housing rent that suffered severely because of the earthquake. The contribution of crop income to total income inequality showed no significant change despite the effect of the earthquake on agriculture.

We carry out the same exercise for household consumption. Table 2.10 presents decomposition results. We find that expenditure on food is a major component of overall inequality, with an increase from 30 percent in 2007 to 37 percent in 2009. The contributions of expenditures, including those on transportation and public utilities, to overall inequality increased slightly, by between 1 percent and 2 percent. The expenditure on health and education accounts for

more than one-fourth of total consumption inequality before the earthquake, 27 percent, but declines to under 22 percent after the earthquake. The expenditure on clothing contributes less than 10 percent in 2009, which is contrary to the consumption inequality in urban China (Cai, Chen, and Zhou 2010).

Conclusion

This chapter discusses the impact of the 2008 Sichuan earthquake on household income, consumption, and income inequality using a unique dataset collected in rural Sichuan. We find that household income fell by 14 percent because of the earthquake and that income inequality did not increase. With regard to government support, living subsidies were more than enough to offset losses in annual income, but reconstruction aid, such as grants and bank loans for housing, accounted for less than 60 percent of total house-rebuilding costs.

Household consumption continued to grow after the earthquake, increasing by 30 percent compared to the same period in 2007; however, this growth was mainly because of the government living allowance. The consumption elasticity of the living allowance was 0.207, much higher than that of other household income sources. Thus government support was essential for households to be able to maintain pre-earthquake consumption levels. Although the earthquake affected mean household incomes levels, it did not affect the household income distribution; income or consumption inequality did not change significantly because of the earthquake. Furthermore, when we include government support as part of household income, the 2009 household income distribution Lorenz dominates that of 2007, indicating that government living allowance played a role in reducing inequality.

Although this chapter is limited to analyzing household income and consumption in areas affected by the earthquake, the results do have broader policy implications. The importance of off-farm work in allowing rural households to cope with negative shocks shows that policies that make access to off-farm work easier will greatly benefit rural households. Thus, policies such as the *HuKou* system that discourage or restrict the ability of farmers to work in urban areas are likely to have a detrimental effect on the ability of farmers to deal with negative shocks from natural disasters. The government aid to the areas affected by the earthquake was provided in a timely fashion and kept the welfare of rural households from falling sharply; it even decreased inequality in the rural areas examined. However, the aid for families to rebuild their houses was inadequate, and further loans or grants to support reconstruction would benefit all rural households.