

Natural Disasters and Differential Household Effects: Evidence from the May 2006 Java Earthquake

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Background: Natural Disasters

- Natural disasters happen, around the world, frequently.
- Big ones happen multiple times each year. 2010 to date: Haiti earthquake (Jan. 12), Chile earthquake (Feb. 27), China earthquake (Apr. 14), Brazil floods/mudslides (Jan., Apr.), *etc.*
- Death.
- Trauma.
- Damage (private and public capital).

Background: Natural Disasters Research

Not much in economics literature, but some work:

- Disaster frequency and long-run growth (Cuaresma, Hlouskova, and Obersteiner (2008); Skidmore and Toya (2007))
- International financial flows (Yang (2008))
- Average income and disaster risk (Kellenberg and Mobarak (2008))
- Differential effects of disasters by country characteristics (Noy (2008))
- Aggregate economic effects of Hurricane Hugo (Guimaraes, Hefner, and Woodward (1992))
- Migration as risk-coping, applied to earthquakes in El Salvador (Yang (2008))
- Mental health effects from 2004 Indian Ocean tsunami (Frankenberg *et al.* (2008); de Mel, McKenzie, and Woodruff (2008))

Question

- Within an area struck by a natural disaster, are richer residents affected differently than their poorer neighbors?
- If so,
 - is this due to a differential direct effect? (*E.g.*, if poor people live in less structurally sound houses.)
 - or does this difference arise in the recovery period? (*E.g.*, if richer victims are better able to obtain government aid.)
- Qualitative/preliminary evidence (Bates *et al.* (1963); Cochrane (1975); Hass *et al.* (1977); Geipel (1982)) for differential impact from both direct and indirect mechanisms.
- Can I find empirical evidence for these from the May 2006 earthquake in Indonesia? Is this empirical method easily applied to data from other countries?

Setting (1)



Figure: Map of earthquake epicenter, 27 May 2006, 5:54am local time

Setting (2)



Figure: Map of Yogyakarta province (technically Special Region), pop. ~3 million, 97% Javanese

Setting (3)



Figure: Map of Kabupaten Bantul, Yogyakarta

Setting (4)

“[T]he Yogyakarta earthquake claimed more than 5,000 lives, injured almost 40,000 others and left an estimated 1.5 million homeless in May 2006. Long after the cleanup, the economic devastation remains.” (Jakarta Globe)

Data: Indonesia Family Life Survey (IFLS)

- Public domain data from RAND.
- Panel. Used waves IFLS3 (2000) and IFLS4 (2007/2008).



Figure: Map of IFLS coverage

Data: Sample

- Filter: HH in both periods, either affected by May 2006 quake or no natural disaster at all, food expenditure in 2000 not missing.

Table: Number of observations in basic categories

Affected by May 2006 Quake	Yogya. Prov. (2007)		Total
	0	1	
0	5155	39	5194
1	7	188	195
Total	5162	227	5389

Data: Measures

- Expenditure: food, education, utilities, durables, *etc.*
- Assets: farm business, non-farm business, non-business
- Earthquake effects: business assets lost, non-business assets lost, degree of house damage, government/NGO assistance, *etc.*
- Adjustments: annualized; HH size; used IMF CPI for Indonesia to adjust for inflation, and converted to PPP.

Table of Means (1)

per HH		Quake- affected	Rest of Yogya.	Outside Yogya.
	HH size (2000)	3.58	4.28	3.76
	HH size (2007)	5.15	5.67	5.64
Expenses	Total (2000)	2963	7972	3454
	Total (2007)	8840	2169	6705
	Food (2000)	1524	2762	2041
	Food (2007)	2076	1989	2642
Assets	Farm (2000)	18338	9882	9028
	Farm (2007)	15177	9161	10179
	Non-farm Bus. (2000)	3524	21174	3781
	Non-farm Bus. (2007)	4404	7700	3907
	Non-bus. (2000)	18008	27416	13548
	Non-bus. (2007)	20781	18410	17083

Table of Means (2)

per capita		Quake- affected	Rest of Yogya.	Outside Yogya.
	HH size (2000)	3.58	4.28	3.76
	HH size (2007)	5.15	5.67	5.64
Expenses	Total (2000)	827	1862	918
	Total (2007)	1715	383	1188
	Food (2000)	425	645	542
	Food (2007)	403	351	468
Assets	Farm (2000)	5116	2308	2400
	Farm (2007)	2945	1617	1804
	Non-farm Bus. (2000)	983	4945	1005
	Non-farm Bus. (2007)	855	1359	692
	Non-bus. (2000)	5024	6403	3601
	Non-bus. (2007)	4032	3249	3028

Table of Means (3)

	N=195	Mean
Bus. Assets Lost (41 non-zero)		172
Non-bus. Assets Lost (171 non-zero)		3502
Injury/Death Cost ¹ (8 non-zero)		3381
Assistance ² (169 non-zero)		2186
Death?		0.04
Injury/Illness?		0.08
Light House Damage?		0.48
Heavy House Damage?		0.17
Repair/Rebuild?		0.94
Homeless/Temp. Housing?		0.86

¹Out-of-pocket medical or funeral cost due to quake.

²From anywhere except friends and family; incl. domestic and foreign, government, NGO, firm.

Direct Effect of Earthquake (1)

“This is a disaster-prone area and if people don’t build back better the houses will fall down again, and we’ll end up back here again.” (David Hodgkin, UN Development Program, re: more recent quake in Indonesia, quoted in Jakarta Globe)

“ ‘It’s important for people to be aware that how a house is constructed makes a big difference when an earthquake hits,’ he said, stressing that a well-structured house would save lives and reduce the damage inside houses.” (Edie Prihantoro, State Ministry of Research and Technology, quoted in Jakarta Globe)

“Most homes in the area were built with low-quality materials without structural frames and reinforcing pillars. Many deaths and injuries occurred when buildings and walls collapsed.” (Wikipedia)

Direct Effect of Earthquake (2)

“The father of four, who eked out a living making traditional daggers known as *kris*, said the Rp 15 million (\$1,600) he received in aid was only sufficient to build a semipermanent house, let alone replace his tools that were destroyed when his home collapsed.”
(Jakarta Globe, re: May 2006 quake)

“In Yogyakarta, many women lost livestock and their small businesses.” (ALNAP, “Responding to Earthquakes 2008”)

Direct Effect of Earthquake (3)

Is lower pre-quake expenditure correlated with more damage?

Table: Correlation of pre-quake expenditure with measures of direct damage

	Quake- affected ¹ (1)	Any Damage (2)	Heavy Damage (3)	Temp/ Homeless ¹ (4)	%Assets Lost (5)
Ln(1+Exp00)	-0.08* (0.025)	-0.08* (0.036)	-0.08* (0.029)	-0.10* (0.028)	-0.04* (0.018)
R^2	0.04	0.03	0.04	0.05	0.03
N	253	191	191	253	195

* Significant at 5 percent.

¹Sample: subdistricts with at least one HH reporting affected by quake.

Direct Effect of Earthquake (4)

Is lower pre-quake expenditure correlated with more damage?

$\ln(1+\text{AssetsLost})$	Coeff.	SE	p-val (coeff=1)
$\ln(1+\text{Assets00})$	0.69	0.186	0.09
R^2	0.07		
N	195		

Note: "Assets" are non-business assets only here.

Indirect Effect of Obtaining Assistance (1)

“I am only one of the little people, I do not know how to request aid.” (Jimah, snack seller at Royal Cemetery whose house collapsed, quoted in Jakarta Globe; before quake, made Rp 1 million per month)

Is lower pre-quake expenditure correlated with lower assistance received, controlling for degree of damage/need?

			If reported house damage	
	Asst? (1)	Amt (2)	Asst? (3)	Amt (4)
Ln(1+Exp00)	-0.02 (0.026)	-0.56 (0.419)	-0.03 (0.024)	-0.41 (0.403)
R^2	0.00	0.01	0.01	0.01
N	195	195	127	127

Note: “Assets” are non-business assets only here.

Indirect Effect of Obtaining Assistance (2)

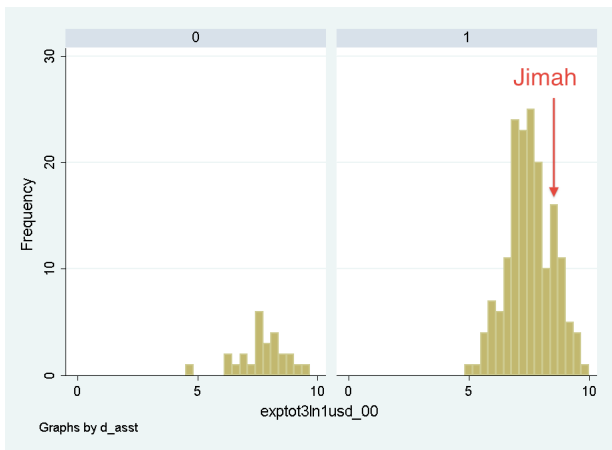


Figure: Log expenditure in year 2000 by whether received assistance or not.

Effect on Households Not Directly Damaged (1)

- What effect on expenditure do we see on households not directly damaged?
 - Local infrastructure damage. “Not only were his tools and inventory destroyed, but so was the souvenir market where he sold his goods.” (Jakarta Globe)
 - Local economic downturn. “In fact, many silversmiths who once worked in the back rooms of Yogyakarta’s silver stores in Kota Gede were forced to return to their villages jobless after the quake.” (Jakarta Globe)
- $\ln(Y_{ist}) = \alpha + \delta_1 1\{s = \text{AFFECTED AREA}\} + \delta_2 1\{t = 2007\} + \delta_3 1\{s = \text{AFFECTED AREA}\} * 1\{t = 2007\} + \epsilon_{ist}$, where Y_{ist} is some measure of expenditure for household i in state $s \in \{\text{AFFECTED AREA}, \text{Elsewhere}\}$ at time $t \in \{2000, 2007\}$, where “AFFECTED AREA” indicates being in an area with other HH reporting quake effects (but no HH in sample), and “Elsewhere” is areas where zero HH reported quake effects.

Effect on Households Not Directly Damaged (2)

Table: Comparing (reported unaffected HH in Yogyakarta) with (unaffected HH in other provinces). Dep. var. is log per capita food expenditure.

	OLS (1)	q05 (2)	q20 (3)	q80 (4)	q95 (5)
1{s=YOGYA}	-0.03 (0.155)	-0.32 (0.215)	-0.39 (0.302)	0.02 (0.240)	-0.14 (1.178)
1{t=2007}	-0.25 (0.023)	-0.25 (0.057)	-0.24 (0.028)	-0.28 (0.023)	-0.34 (0.045)
1{s and t}	-0.03 (0.255)	-0.03 (0.458)	0.30 (0.509)	0.15 (0.389)	0.23 (1.183)
(Pseudo) R^2	0.02	0.01	0.01	0.01	0.00
N	7283	7283	7283	7283	7283

Note: standard errors, in parentheses, are bootstrapped with 200 replications.

Effect on Households Not Directly Damaged (3)

Table: Comparing (reported unaffected HH in districts with affected HH) with (unaffected HH in other districts). Dep. var. is log per capita total expenditure.

	OLS (1)	q05 (2)	q20 (3)	q80 (4)	q95 (5)
$1\{s=\text{AffdDist}\}$	0.15 (0.129)	-0.17 (0.310)	-0.15 (0.168)	0.25 (0.174)	0.64 (0.723)
$1\{t=2007\}$	-0.25 (0.023)	-0.34 (0.055)	-0.27 (0.028)	-0.26 (0.031)	-0.14 (0.078)
$1\{s \text{ and } t\}$	-0.14 (0.204)	0.28 (0.450)	0.18 (0.254)	0.00 (0.287)	-0.46 (0.808)
(Pseudo) R^2	0.02	0.01	0.01	0.01	0.00
N	7317	7317	7317	7317	7317

Note: standard errors, in parentheses, are bootstrapped with 200 replications.

Overall Effect on Expenditure (1)

“The poorest of the poor may never recover.” (Hodgkin)

Table: For Yogyakarta, per capita total and food-only expenditure before and after earthquake; number of observations in parentheses

	Reported quake-	
	affected	Did not
Exp00/HHsz	780 (188)	4873 (39)
Exp07/HHsz	1864 (188)	867 (23)
Food00/HHsz	427 (188)	1178 (39)
Food07/HHsz	431 (188)	469 (23)

Note: as before, expenditure is inflation- and PPP-adjusted.

Overall Effect on Expenditure (2)

- Using a difference-in-difference framework, what was the overall net effect of the earthquake on expenditure as surveyed a year after?
- Does this effect differ significantly by expenditure quantile?
- $\ln(Y_{ist}) = \alpha + \delta_1 1\{s = \text{QUAKE}\} + \delta_2 1\{t = 2007\} + \delta_3 1\{s = \text{QUAKE}\} * 1\{t = 2007\} + \epsilon_{ist}$, where Y_{ist} is some measure of expenditure for household i in state $s \in \{\text{QUAKE}, \text{Elsewhere}\}$ at time $t \in \{2000, 2007\}$, where “QUAKE” indicates reporting being affected by the quake and “Elsewhere” may be restricted to Yogyakarta or certain other control district(s).
- Stata `sqreg`: simultaneous quantile regression with bootstrapped SE; can test for differences in coefficient across quantiles.

Overall Effect on Expenditure (3)

	q05	q20	q80	q95
$\ln(\text{Exp}/\text{HHsz})$	(1)	(2)	(3)	(4)
$1\{s=\text{QUAKE}\}$	0.04 (0.235)	0.14 (0.260)	-0.52 (0.208)	-0.42 (1.653)
$1\{t=2007\}$	-0.07 (0.425)	0.02 (0.399)	-0.19 (0.400)	-0.52 (1.683)
$1\{s \text{ and } t\}$	-0.44 (0.464)	-0.11 (0.417)	0.16 (0.411)	0.91 (1.742)
(Pseudo) R^2	0.03	0.00	0.02	0.02
N	438	438	438	438

Note: w/in Yogya. Standard errors bootstrapped with 120 replications. $p\text{-val}=0.49$ for test of equal $1\{s \text{ and } t\}$ at 0.05 and 0.95 quantiles, $=0.36$ for 0.05 and 0.80.

Overall Effect on Expenditure (4)

	q05	q20	q80	q95
$\ln(\text{Exp}/\text{HHsz})$	(1)	(2)	(3)	(4)
$1\{s=\text{QUAKE}\}$	-0.04 (0.175)	-0.07 (0.083)	-0.11 (0.093)	-0.26 (0.126)
$1\{t=2007\}$	-0.36 (0.097)	-0.30 (0.051)	-0.24 (0.052)	-0.36 (0.137)
$1\{s \text{ and } t\}$	-0.15 (0.289)	0.26 (0.161)	0.20 (0.133)	0.72 (0.414)
(Pseudo) R^2	0.02	0.01	0.01	0.01
N	2168	2168	2168	2168

Note: control=E. Java. Standard errors bootstrapped w/ 120 replications. p-val=0.08 for test of equal $1\{s \text{ and } t\}$ at 0.05 and 0.95 quantiles, =0.27 for 0.05 and 0.80.

Induced Relocation

“Population displacement was negligible in Yogyakarta.” (ALNAP, “Responding to Earthquakes 2008”)

- Did households relocate differently after the earthquake depending on initial expenditure quantile?
- Of 195 reporting quake-affected, only 24 moved: 7 within village, 7 within district, 9 within province, and 1 to a different province.
- Probit model (and OLS) for whether HH moved outside village: p-value of 0.60 (in each) for log per capita expenditure in 2000.
- Note that I only looked at the HH level and did not look for individuals within a HH migrating per Yang (2008) in El Salvador.

Further Effects (1)

“Many families have used up their savings over the past months, setting back their life plans and ambitions.” (Jakarta Globe)

“Bejo said that to pay off his debt, he had to seek high-interest loans from other sources. ‘I am trapped by multiple loans now, as I have to pay high interest.’ ” (Jakarta Globe)

“In Yogyakarta there are families that might have previously owned a 100- to 200-square-meter house before the [2006] quake that are currently living in a 50-square meter house and slowly extending.” (Hodgkin)

Further Effects (2)

Some effects may not be captured by the above analyses, and would be insightful for future analysis:

- How were debt and savings levels affected by the earthquake, by quantile?
- Or, were changes in income significantly different than those in expenditure, implying changes in debt also?
- Were poorer families more likely to (have to) move in with extended family after the earthquake? (Initial HH size evidence ambiguous.)

Conclusion

- Small but significant negative correlation between pre-quake economic well-being and damage done by quake on a variety of measures.
- No evidence for differential receipt of assistance.
- Inconclusive results for households in affected areas but not directly affected.
- Hint of divergent effect of earthquake on total expenditure, but no hints with food-only expenditure.
- Data support the ALNAP statement that “population displacement was negligible.”
- Many further important measures of interest, motivated by anecdotes and previous case studies: debt/savings, income, household size.

Thanks for your kind attention

