

Measuring the Impact of Insurance on Urban Recovery with Light

The 2010 - 2011 CANTERBURY EARTHQUAKES

Research Questions:

- Was there a short-term impact of earthquake damage on local economic activity in Greater Christchurch?
- What were the effects of EQC insurance payments on the recovery of residential areas in Greater Christchurch?
- Did different aspects of the insurance payments (cash vs. repairs) and their timeliness have any impact on the recovery?

Descriptive Statistics

Table 1 - Summary statistics of claim payment data

VARIABLES	Building (N = 143,545)		Content (N = 68,324)		Land (N = 73,123)		Total (N = 220,898)	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Total claim payment (USD)	462,695	696,423	17,347	43,840	60,240	1,424,564	540,284	1,642,358
Total exposed value of the assets (USD)	6,680,840	7,645,051	274,319	52,982	694,532	2,844,193	7,651,877	9,406,143
Proportion of cash paid/total settlement	0.73	0.26	1.00	0.00	0.55	0.41	0.71	0.35
Time to settlement (days)	845	538	489	439	688	514	984	542

Note: Summary statistics of variable "Time to settlement" are calculated at the individual claim level.



Methodology

1. Earthquake Damage and the Loss in Night-time Light

$$Economic_Loss_i^{eq} = \alpha + \beta_k Damage_{i,k} + \gamma X_{i,t} + \varepsilon_i$$

$$Damage_{i,k} = \frac{\sum_k Claim_payment_{i,k}}{\sum_k Asset_value_{i,k}}$$

$$Economic_Loss_i^{eq} = \Delta NTL_i^{2019-2011} = \ln(NTL_{i,2009}) - \ln(NTL_{i,2011})$$

2a. Insurance settlement and Christchurch recovery

$$Economic_Recovery_{i,t}^{Post} = \alpha_i + \tau_t + \beta_k Ins_{i,t,k} + \gamma X_{i,t} + \varepsilon_{i,t}$$

$$Ins_{i,t,k} = \ln(\sum_k Claim_payment_{i,t,k})$$

$$Economic_Recovery_{i,t}^{Post} = \Delta NTL_{i,t}^{Q2.2012-Q3.2016} = \ln(NTL_{i,t}) - \ln(NTL_{i,t-1})$$

2b. Robustness check - Spatial regression

$$SAR) \quad Y_{i,t} = \alpha_i + \tau_t + \rho W Y_{i,t} + \beta X_{i,t} + \varepsilon_{i,t}$$

W is referred to the non-negative spatial weighted matrix ($N \times N$) that describes the spatial structure of dependence between AUs. In this study, we employ the row-standardized contiguity weighted matrix. The elements w_{ij} of matrix W equals to 1/ the number of neighbors of AU i if AU i and j share the border, otherwise $w_{ij} = 0$.

$$SEM) \quad Y_{i,t} = \alpha_i + \tau_t + \beta X_{i,t} + \vartheta_{i,t} \quad \text{where } \vartheta_{i,t} = \lambda W \vartheta_{i,t} + \varepsilon_{i,t}$$

These models include three different types of interaction effects among units:

(i) Endogenous spatial interaction effects among the dependent variable ($WY_{i,t}$);

(ii) Exogenous spatial interaction effects among the explanatory variables ($WX_{i,t}$);

(iii) Spatial interaction effects among the error terms ($W\vartheta_{i,t}$).

$$SDM) \quad Y_{i,t} = \alpha_i + \tau_t + \rho W Y_{i,t} + \beta X_{i,t} + W X_{i,t} \theta + \varepsilon_{i,t}$$

$$SAC) \quad Y_{i,t} = \alpha_i + \tau_t + \rho W Y_{i,t} + \beta X_{i,t} + \vartheta_{i,t} \quad \text{where } \vartheta_{i,t} = \lambda W \vartheta_{i,t} + \varepsilon_{i,t}$$

EQC: New Zealand Earthquake Commission

- Capped insurance to residential buildings, land and contents
- De facto compulsory addendum to standard fire insurance policies

=> Over 95% NZ residential properties were covered by EQC

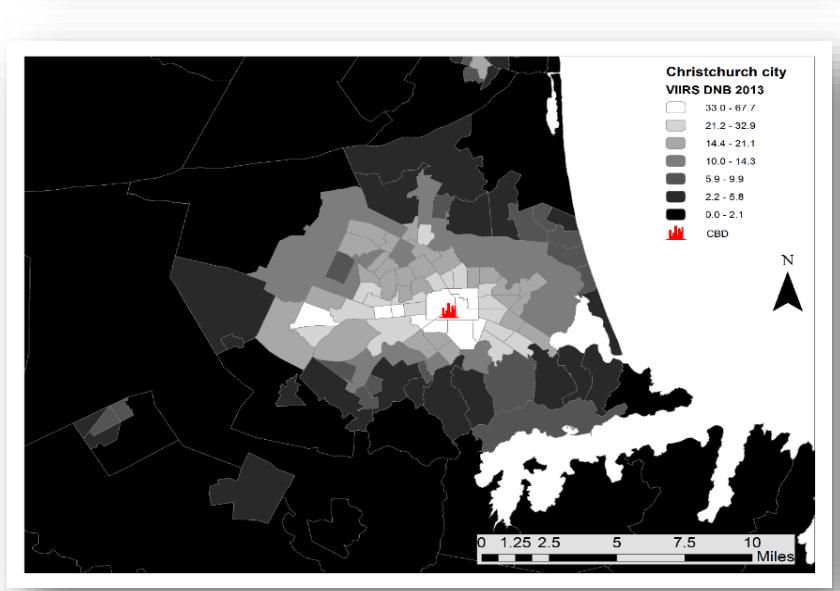
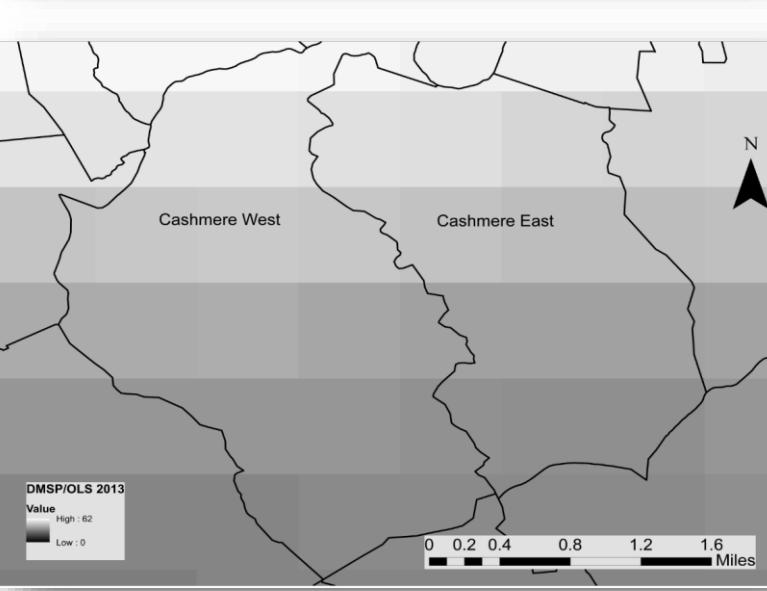
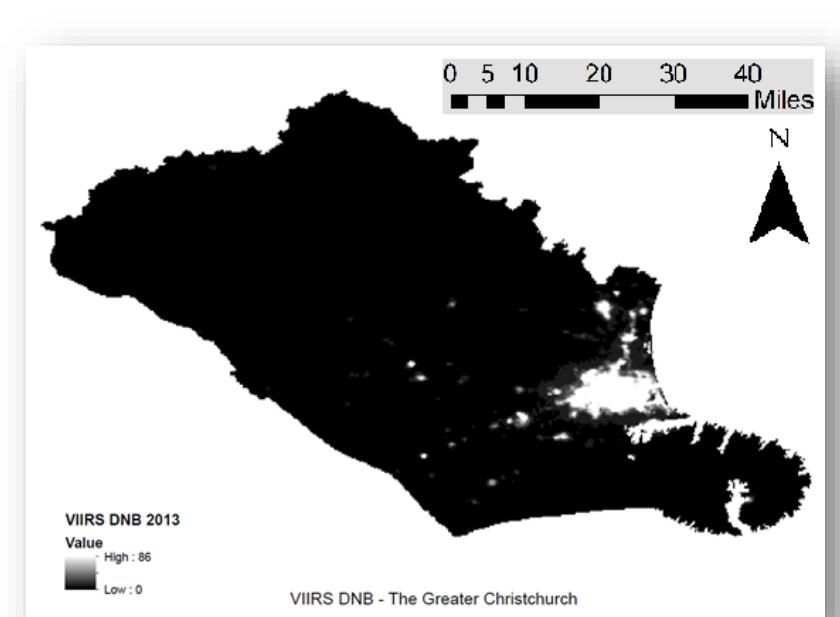
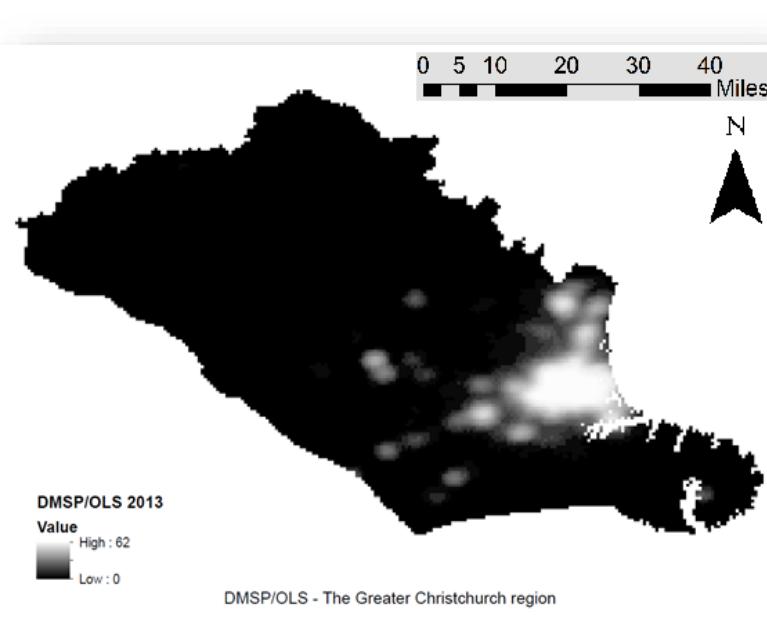
❖ Insurance settlement post Canterbury earthquakes

- EQC:** USD 7.2 billion for residential claims
 - Over 460,000 claims involving 167,000 buildings
- Private insurers:** USD 7.1 billion for commercial and residential claims
 - 26,273 (commercial), 27,617 (over cap), and 63,992 (out of scope)

Night-time light imagery

Nightlight intensity

- Indicator of economic activity
- Available to use in greater spatial detail and higher frequency than macro-economic statistics
- Change in nightlight**
 - Capture disaster impact and recovery process
 - Bertinelli & Strobl, 2013; Elliott et al., 2015; Mohan & Strobl, 2017; Tanaka et al., 2000
 - Few papers use nightlight to estimate earthquakes' impact and recovery
 - Gillespie et al. (2014) using household survey in Sumatra after its earthquake, tsunami and reveal the link between night-time brightness and spending per capita at community level.



Example of area unit polygons in south Christchurch and the DMSP/OLS light intensity pixels

Average annual night-time light in 2013 at the area unit level

Estimation results

Table 3 - Short run economic impact of the earthquakes using the damage ratio variable

VARIABLES	Dependent variable: Change in night-time light between 2010 and 2011											
	Building			Content			Land			Total		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Damage ratio	0.559*** (0.186)	0.416** (0.078)	0.957** (0.401)	0.757** (0.367)	0.379 (0.389)	0.379 (0.389)	0.016 (0.051)	-0.008 (0.068)	0.747 (0.493)	0.474*** (0.181)	0.343** (0.162)	0.912** (0.415)
Household Income	0.008 (0.037)	0.003 (0.045)			0.007 (0.036)	0.007 (0.036)	0.012 (0.038)	-0.025 (0.049)	0.007 (0.037)	-0.007 (0.041)		
Night-time Population	0.018 (0.012)	0.017 (0.012)			0.019 (0.012)	0.019 (0.012)	0.019 (0.012)	0.021* (0.012)	0.019 (0.012)	0.019 (0.012)	0.019 (0.012)	0.017 (0.012)
Number of Bedrooms	-0.060 (0.094)	-0.019 (0.119)			-0.071 (0.092)	-0.071 (0.092)	-0.093 (0.092)	0.023 (0.144)	-0.061 (0.092)	-0.061 (0.092)	-0.061 (0.092)	-0.011 (0.114)
Area square Km	0.006 (0.008)	0.005 (0.008)			0.006 (0.008)	0.006 (0.008)	0.006 (0.009)	-0.012 (0.018)	0.005 (0.008)	0.005 (0.008)	0.005 (0.009)	0.003 (0.009)
Constant	-0.086*** (0.016)	-0.237 (0.312)	-0.251 (0.367)	-0.076*** (0.016)	-0.210 (0.301)	-0.210 (0.301)	-0.052*** (0.008)	-0.228 (0.309)	0.011 (0.362)	-0.079*** (0.0151)	-0.224 (0.305)	-0.221 (0.335)
Observation	158	158	158	158	158	158	158	158	158	158	158	158
R-squared	0.045	0.097	0.058	0.022	0.079	0.079	0.000	0.074	0.031	0.037	0.093	0.043
IV	40.349				35.301				3.171		22.043	

***/**/*/ Indicating the significance levels of respectively 1%, 5% and 10%. AU cluster - robust standard errors are shown in parentheses. All regressions are estimated with OLS. IV is the robust Kleinbergen-Paap Wald F statistic for test of weak instruments. IV regressions have overidentification's p-value approximately equal to zero, except for land regression.

Table 5 - Economic recovery following the earthquakes (Claim payment) - Direct and Indirect effects

VARIABLES	Dependent variable: Quarterly change in night-time light											
	SAR			SAC			SEM			SDM		
	Building	Content	Land	Building	Content	Land	Building	Content	Land	Building	Content	Land
Direct effect												
Insurance payment	0.434*** (0.161)	-0.057 (0.078)	0.136*** (0.052)	0.491*** (0.178)	0.389** (0.167)	-0.051 (0.078)	0.122** (0.050)	0.422** (0.186)	0.456*** (0.157)	-0		