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The Role of Commercial Insurance in Post-Disaster Recovery: Quantitative Evidence from the 2011 Christchurch Earthquake

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Quantitative Evidence from the 2011 Christchurch Earthquake

Abstract:

We examine the role of business interruption insurance in business recovery following the Christchurch earthquake in 2011 in the short- and medium-term. In the short-term analysis, we ask whether insurance increases the likelihood of business survival in the aftermath of a disaster. We find only weak evidence that those firms that had incurred damage, but were covered by business interruption insurance, had higher likelihood of survival post-quake compared with those firms that did not have insurance. This absence of evidence may reflect the high degree of uncertainty in the months following the 2011 earthquake and the multiplicity of severe aftershocks. For the medium-term, our results show a more explicit role for insurance in the aftermath of a disaster. Firms with business interruption insurance have a higher probability of increasing productivity and improved performance following a catastrophe. Furthermore, our results show that those organisations that receive prompt and full payments of their claims have a better recovery, in terms of profitability and a subjective '"better off" measure' than those that had protracted or inadequate claim payments (less than 80% of the claim paid within 2.5 years). Interestingly, the latter group does worse than those organisations that had damage but no insurance coverage. This analysis strongly indicates the importance not only of good insurance coverage, but of an insurance system that also delivers prompt claim payments. As a first paper attempting to empirically identify a causal effect of insurance on business recovery, we also emphasize some caveats to our analysis.

1. Introduction and Background Information on the Earthquake

The role of commercial insurance in supporting firms' and organisations' economic recovery in the aftermath of disasters is under-investigated. In theory, catastrophe insurance fulfills several roles. In particular, it is widely assumed that it: (1) transfers risk from individuals and organizations to insurance companies (Zweifel & Eisen, 2012); (2) through premium levels, it provides signals on risk levels faced by the insured firms (Kunreuther, 1996); (3) it provides for *ex-ante* risk mitigation to be undertaken by the insured firms through the design of premium-reducing incentives (Kunreuther, 1996; Botzen et al., 2009); and (4) by providing financial resources, it assists in speeding up recovery of destroyed or damaged assets and returning firms to normal operations. Surprisingly, it is only mechanisms (1) and (2) that have been investigated in any detail. There is little evidence that convincingly demonstrates the last two hypothesized impacts of insurance contracts in assisting the commercial sector in dealing with catastrophe risk. Here, we focus on (4), and leave (3) for future examination of its efficacy. We ask: Post-catastrophe, do firms indeed face easier recovery if they were insured against that catastrophic risk?

Understanding how insurance aids, or fails to aid, recovery in the aftermath of a natural disaster is of clear interest to many stakeholders; and is globally relevant as both the frequency and magnitude of disasters are increasing almost everywhere. Our objective is to investigate the role of insurance in business recovery in the aftermath of a catastrophic disaster. We use the Christchurch earthquake in 2011 as our case study.

The Christchurch earthquake of 2011 was the worst natural disaster in New Zealand's history, with an estimated loss of US$35 billion (Simpson, 2013). The quake hit Christchurch with a magnitude of 6.3 and with several big aftershocks in the following months. It caused 185 fatalities and damaged over 100,000 buildings leading to over 450,000 residential damage claims submitted to the public insurer (the Earthquake Commission).[1] The first major quake in this sequence was earlier in September 2010 with a magnitude of 7.1. The second and the third

[1] Many properties have multiple claims based on different earthquake aftershocks and separate claims for building damage, land damage, and damage to contents (Marsh, 2014).

major quakes hit closer to the city of Christchurch on Feb. 22, 2011 and caused the most destructive loss.

After the earthquake in February, about 1,600 commercial buildings in the Central Business District – about 60% of all the buildings in that area – were marked to be demolished (Stevenson et al., 2012a). As this earthquake was followed by over 3,000 aftershocks, the whole CBD area was cordoned off for a prolonged period of time, with the last cordoned area being made accessible almost two and a half years after the earthquake. This restricted access of the CBD constrained many businesses, including businesses that did not experience direct damage to their premises or property from the earthquake event (Stevenson et al., 2012b).

The February earthquake has an estimated insured loss of US$16.5 billion. As such, it is ranked the sixth most expensive insured event to the insurance industry globally since 1980 (MunichRe, 2015). The proportion of insured loss is exceptional for this event. About seventy percent of the direct recovery and reconstruction costs in Christchurch are expected to be covered by insurance (Wood et al., 2016). As a comparison, less than 20% of the estimated direct losses in Japan were insured (Höppe and Low, 2012).

Estimates suggest that this is the most comprehensively insured earthquake in history, and maybe the most comprehensively insured natural hazard event as well (the only possible exception being some floods in European countries with mandatory insurance schemes like France (Michel-Kerjan and Kousky, 2010).

Within New Zealand there had been few damaging earthquakes affecting large population areas within recent history before the Christchurch quake. Consequently, local insurance offices (typically subsidiaries of multi-national insurance companies) had little experience in dealing with such a large volume of claims in the immediate aftermath of the earthquake (ICNZ, 2014a). Since then, there have been continuing delays in claim settlement (Muir-Wood, 2012). About four years after the earthquake, between 10-40% of claims (by value) have not been settled, with large diversity across insurance firms (Wood et al. 2016). It appears that the majority of unsettled claims, by value, are commercial claims (ICNZ, 2014b, and 2015)[2]; this is in contrast with the 2011 earthquake in Japan and the 2010 one in Chile where practically all claims were been completely settled in the two years directly following the event (Marsh, 2014).

Interviews *Resilient Organisations* conducted with stakeholders yielded conflicting information about the speed of claim resolution. Many businesses felt that the claims resolutions proceeded too slowly, particularly business interruption claims and relocation assistance. Insurance industry interviewees, however, believed that on the whole the insurance industry performed well and processed commercial claims in a timely manner given their complexity. Deloitte (2015), reports that one insurance company has, as of mid-2014, settled about the same share of its residential and commercial portfolios (about 80% each).

The objective here is to investigate the role of commercial insurance in business recovery by using the 2011 Christchurch earthquake as a case study. We aim to examine the role of insurance in both the *short*- and *medium-term* contexts. For the short-term investigation, we aim to find out whether insurance affected business continuity in the immediate aftermath, before most claims had even been examined. Our purpose is to observe if insurance increases the likelihood of business survival as the insured entities are aware of their insurance cover, and can expect to be able to fund their recovery through insurance claims (and payments). For the medium-term, we aim to investigate the role of insurance payments in supporting business recovery in terms of profitability and productivity.

The earthquake in Christchurch is useful as a case study for several reasons: (1) Insurance cover was widely available and commonly purchased in New Zealand, making it easier to obtain a substantial sample of affected and unaffected insured firms. (2) The proportion of insured damage to total loss of the 2011 earthquake was substantial, so insurance is playing a big role in the general recovery of the region. (3) Given the existence of a public residential insurance scheme (EQC) and a public accident insurance scheme (ACC) that covers all healthcare-related

[2] For instance, Deloitte (2015) reported that one of the larger general insurers in New Zealand "had made $3.8 billion in damage and business continuity claims payments, which represents about 80.0% of its total estimated costs. Of this, around 25.0% of claims payments have been made to residential policyholders, and the remaining 75.0% to…commercial clients." Their data is from mid-2014, three and a half years after the earthquake.

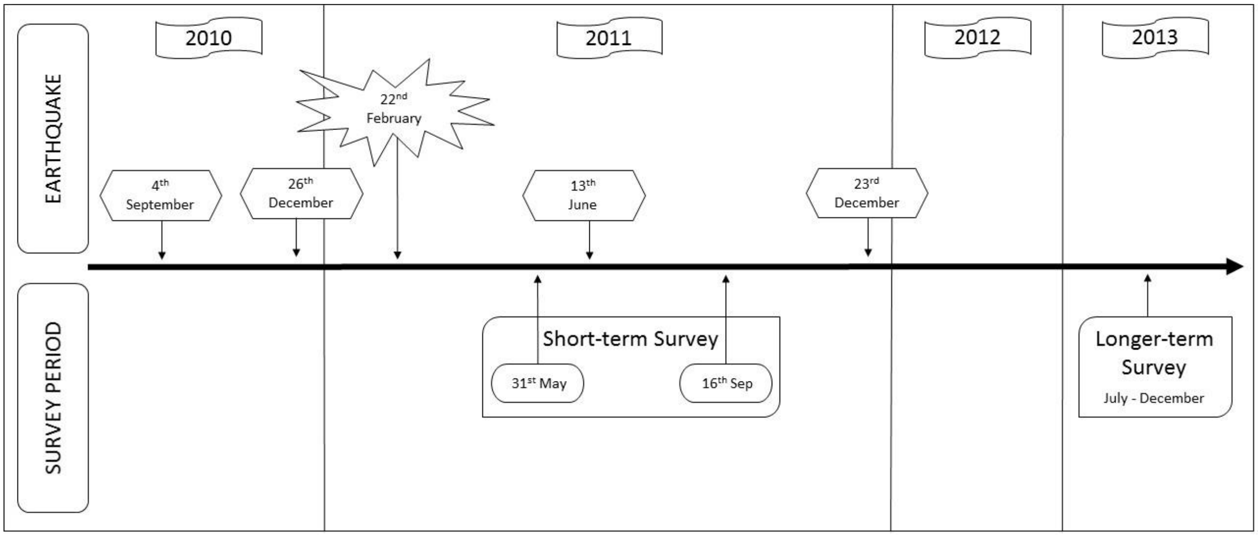
costs for an injury (by anyone present in New Zealand and including events like earthquakes), insurance in New Zealand is very affordable. As such, budget and credit constraints are less likely to have been inhibiting factors preventing firms from purchasing insurance. These constraints, present elsewhere, are therefore less likely to create a material difference between the insured and uninsured firms and that can bias statistical comparisons. (4) The surveys we use in the empirical analysis are detailed post-disaster surveys that include both questions about the nature of insurance coverage, the impact of the earthquake, and the nature and extent of continued post-disaster operations. It is this information that enables us to conduct the empirical study described herein. To our knowledge, this is the first research that examines empirically the role of commercial insurance in business recovery following a natural disaster but it builds on several qualitative analyses of the role of commercial insurance in organizational disaster recovery (Brown et al., 2013; Brown et al., in press, King et al., 2014, Seville et al., 2015).

2. The Surveys

We utilize the data of two business surveys prepared and collected by *Resilient Organisations*, a research organization based in New Zealand. The surveys were designed to be a longitudinal study of organizational resilience following the first earthquake in 2010 (when few predicted there would be a series of more destructive aftershocks). The questionnaire was sent to both for-profit and not-for-profit organizations located in Christchurch Central Business District and the affected areas around the Christchurch city. The questionnaire was primarily designed to measure the impact of the earthquakes on organizations and it asked firms about the level of damage and the disruption they experienced and how they were recovering. There was, however, a section devoted to capturing insurance data; and it is this section that enables us to undertake this empirical study on the role of insurance in the aftermath of a natural disaster.

The data collection methods of both survey rounds were similar. Participants were initially contacted by phone in order to establish contact with the heads of the organizations. The questionnaire was then sent to their nominated person via physical or electronic address. The firms were able to respond via phone call, online, or by mail. Figure 1 displays the survey timeline along with the date of the earthquakes.

Figure 1. Survey timeline



The first survey was conducted in the three to six months period after the February 2011 earthquake. It was initially intended for following-up on the recovery process of the 2010 earthquake but was then revised to also capture the short-term impact of the 2011 earthquake. For our study, this survey is used to capture the role of insurance in supporting immediate post-quake continuity. The medium-term second survey was completed in 2013. It was designed to examine the progress of recovery a couple of years after the event. We use this survey to investigate the role of insurance claim payments in supporting reconstruction and recovery of business operations. The survey questions mostly require binary or scaled (Likert) responses. This includes most of the insurance related questions as well. More details on both surveys are available in an online appendix.[3]

3. Insurance and Disasters: Literature Review

[3] The online appendix is available at: https://sites.google.com/site/noyeconomics/research/natural-disasters.

Insurance was recently recognized as one of the vital mitigation tools against loss and damage from natural disasters in the newly agreed Sendai Framework for Disaster Risk Reduction (UNISDR, 2015). Insurance allows individuals and businesses to transfer all or part of their risk exposure to insurance companies in exchange for a premium payment. It is important as a mitigation tool especially in the case of catastrophic loss when the magnitude of loss is large and the affected entities require external financial resources to support their recovery. As catastrophic disaster risk is spatially much more concentrated than more standard insured risk (e.g., risk of fire), insurance can play a critical role in providing funds to support recovery in the disaster's aftermath. However, the literature on this role for insurance is very limited. What is the extent to which insurance assists or can assist individuals and businesses to recover?

In reviewing the literature on natural disaster insurance, we focus on the role of insurance as a tool of mitigation against natural disasters. In particular, some literature focuses on the study of underinsurance. For example, CEBR (2012) found significant under-insurance in all the recent major disasters they examined. For instance, 83% of the damage caused by the Great East Japan earthquake and tsunami of 2011 was not insured (CEBR, 2012). New Zealand has much higher insurance cover, but even there the uninsured portion is significant in the commercial sector (Muir-Wood, 2012; Deloitte, 2015). Schanz and Wang (2014), moreover, found that this insurance gap has widened during the past 40 years, from 0.02 percent to 0.13 percent of global GDP.

Possibly the only paper that has looked directly at the empirical role of insurance in post-disaster recovery is von Peter et al. (2012), though it approached this question from a macroeconomic perspective. Using panel cross-country growth regressions, it found that while the uninsured part of disaster losses adversely impacts the entire economy, insured losses seem to be benign, in terms of their impact on economic growth post-event.

It is important to note that in many cases, extreme catastrophic risk insurance is not available from private insurers (Kleindorfer & Kunreuther, 1999). For instance, flood insurance in both the U.S. and the Netherlands is not available from commercial insurers but is only offered by government entities (Knowles & Kunreuther, 2014; Botzen & Van Den Bergh, 2008). In an example more pertinent to our investigation here, residential earthquake risk was typically excluded from insurance contracts in California (a distinctly quake-prone region) until the government established a publicly funded insurance program. Interestingly, in New Zealand, there is no public sector involvement in the commercial insurance sector, yet commercial earthquake insurance is widely available and is typically included as a standard part of fire insurance policies. As stated earlier, the wide availability and affordability of commercial earthquake insurance in New Zealand is most likely due to the availability of public first-tranche residential insurance, the universal coverage for any injury-related healthcare costs, and very intensive marketing of insurance by banks.

4. **Method, Data, and Results – First Survey**

One of the value propositions of commercial earthquake insurance is that insured firms are aware that costs associated with damages incurred by an earthquake could be reimbursed. The first hypothesis examined in this paper is that, given the 'promise' of future reimbursement, firms are more likely to take steps that will enable them to continue operations. To examine this question we use data from the first Christchurch business survey, done only a few months after the earthquake.

In analyzing the difference in survival rates between insured and uninsured firms, we use a combination of Propensity Score Matching (PSM) and a Linear Probability Model (LPM). This approach is used to overcome a number of methodological challenges.

Potentially, the set of firms that had purchased insurance before the earthquake may be different than the set of firms that had not. If this is the case, it would be an example of 'selection bias' when the selection for treatment (to use the terminology common in micro-econometrics) is not random and the different characteristics of treatment and non-treatment firms lead to misleading statistics when measuring treatment effects. If the selection bias, however, is observable (i.e. the different characteristics of treatment and non-treatment firms are observable) then there are several ways to overcome this bias. In an ideal case, and with enough observations, one could potentially find firms that have exactly the same observable characteristics but differed in their decision as to whether to purchase insurance. The best analogy for this is the twins' studies that are common in, for example, psychological research on the nature/nurture dichotomy. This approach is very uncommon, as it would require a large enough pool of observations to allow for this perfect matching.

A 'matching' algorithm was proposed by Rosenbaum and Rubin (1983), matching the pre-treatment observations using estimated propensity scores for treatment. The propensity score is an estimated index that describes the probability of receiving treatment (in this case, the purchasing of insurance). The propensity scores for each observed unit are typically calculated from a limited dependent variable model (Caliendo & Kopeinig, 2008). Once every firm has an associated propensity score, the balancing between the treatment and control groups is done in two steps. First, the sample is reduced by removing all those observations whose associated propensity scores fall outside the common support for the treated and control groups. In the second stage, Dehejia & Wahba (2002) described several potential matching algorithms, including stratification matching, one-to-one nearest neighbor matching, and radius matching.

For our purpose, the use of propensity score estimation as a means to control for selection bias allows us to 'ignore' the differences between firms that chose insurance and firms that did not. Thus, the propensity score in this study is the probability of insurance adoption prior to the earthquake, which we estimate as follows: $\Pr(INS_i = 1|X_i) = F(X_i'\beta)$. Where INS_i is a binary indicator that denotes 1 if the firm had insurance at the time of the earthquake and 0 otherwise. X_i is a set of pre-treatment observables. β is a vector of the estimated coefficients of X_i. F is the logistic cumulative distribution function.

We match the observations by stratifying the sample into quartiles using the propensity scores associated with each observation. Stratification matching based on the estimated propensity scores is preferable for this study because we have a relatively small number of observations. Implementing other matching algorithms would have reduced the sample further. Besides, it allows us to add other control variables to capture the post-quake damage and disruption that are not included in the propensity scores estimation and matching.[4] The model to estimate the effect of insurance on short-term business continuity is thus:

$$\Pr(Y_i = 1 | INS_i, Z_i) = \alpha + \tau\, INS_i + \gamma\, Z_i + u_i \qquad (1)$$

Where Y_i is the outcome variable (this variable notes whether the firm continued its operation after the earthquake and is not permanently closed) and 0 otherwise. Z_i is a vector of control variables. τ is the estimated average treatment effect of insurance on the outcome variable. γ is a vector of the estimated coefficients of Z_i. u_i is the error term. After we stratify the sample by the estimated propensity scores into four strata, we estimate the model for each stratum separately. White's standard errors are used to correct for heteroskedasticity.

We categorize the variables into two groups: variables for propensity scores estimation (likelihood of purchasing insurance) and variables for the regression analysis (eq. 1). We adapt the list of explanatory variables that potentially influence business continuity from Webb et al. (2002).

The sixteen pre-treatment variables using in estimating the propensity scores, including the means and standard deviations, are listed in Table 1; these include variables measuring firm size, ownership, location, sector, and risk management practices.

TABLE 1 ABOUT HERE

Table 2 shows the estimated coefficients of logit regression. The mean and the standard deviation of the estimated propensity scores are 0.757 and 0.184, respectively. The range of the estimated propensity scores is between 0.261 and 0.993. As noted by Schafer and Kang (2008), the fit statistics of the propensity model are more important in propensity scores estimation than the coefficient results for each variable (or their statistical significance). The common support from the estimated propensity scores in our study is [0.351, 0.915]. Consequently, we

[4] Imbens (2004) proposed that a combination of propensity score matching and regression estimation would provide more efficient estimators than propensity score matching alone because the propensity score method does not account for the correlation between the outcome variables and other post-treatment variables.

remove 35 outliers from the estimation.[5] Figure 1 shows the boxplot before and after eliminating the outliers. After removing the outliers, the estimated propensity scores of the treated and control units are better matched.

TABLE 2 ABOUT HERE

FIGURE 1 ABOUT HERE

We next stratify the data into four sub-groups based on the estimated propensity scores.[6] After stratifying the data, we find that there is no significant difference-in-mean of propensity scores between the treated and the non-treated firms in each stratum. This indicates that each stratum contains only firms with similar characteristics and have identical likelihood to acquire insurance. We further test the difference-in-mean of all covariates in each stratum. While we find some significant differences in the mean of some covariates in some blocks, minor covariates' imbalance is allowed, as we do not implement exact one-to-one matching. At this stage, the observations in each stratum are assumed to be indifferent (pre-quake) in all ways except the treatment conditions (Angrist and Pischke, 2009).

[5] These are firms with very high propensity scores (those firms that have high likelihood to purchase insurance) and firms with very low scores (those firms that have low likelihood to purchase insurance).
[6] We initially tested the differences-in-mean of the covariates in both five and four strata using the standard t-test as suggested by Dehejia and Wahba (2002). The covariates between the treatment and the control groups in each block are more similar when stratifying into four sub-groups.

For the Linear Probability Model, which allows us to control for post-quake conditions, the main outcome of interest is whether the firm survives in the aftermath of the earthquake. Most firms temporarily closed in the immediate aftermath. Therefore, we define survival as firms that were not permanently closed three to six months after the incident. Two insurance variables, property damage insurance (INS) and business interruption insurance (BI) are included in the model to see the effect of insurance on the outcome variables. The control variables include the post-quake change in revenue, the structural and non-structural damage, the impact of the earlier 2010 earthquake, and the financial recovery plans of the firms. The descriptive statistics of these are provided in table 2.

TABLE 3 ABOUT HERE

After stratifying the data based on the estimated propensity scores discussed previously, we estimate the LPM on each block separately, using White's standard errors. These results are reported in Table 4.

In the upper panel, we provide results for the specification without control variables using only the insurance variable (INS) as an independent variable. The coefficient in the 4th stratum, which includes the firms that have the highest likelihood of acquiring insurance, is positive, whereas for the other strata it is negative (in block 2, the negative sign is statistically significant at the 10% level). We note that the positive coefficient is much larger in absolute value, so on balance we conclude that there is little evidence to suggest that the knowledge of the insurance coverage had much impact on firms' decisions in the immediate and short-run aftermath of the earthquakes. These results do remain once we add the control variables —those that control for the damage of the earthquake. The overall fit of the models is not very high, and while the P-value is still statistically significant for the overall model and the first two strata, over all, our model is not able to predict firm short-term survival very well.

TABLE 4 ABOUT HERE

Nevertheless, once we include all the control variables, the insurance variable in all blocks becomes positive. The firms in the highest stratum, which are the firms with the highest likelihood of acquiring insurance, seems to get the highest survival benefit from insurance – they are 13.1 percentage point more likely to survive the earthquake than comparable firms (firms with similar likelihoods of purchasing insurance). We reiterate, however, that these positive results are not statistically robust. Intriguingly, the results for business interruption insurance are even less encouraging, with some of the estimated coefficients being negative. Again, however, none of these results are statistically significant under typical confidence levels. We therefore conclude that we find little evidence to support the hypothesis that insurance supports immediate business recovery in the aftermath of a disaster.

5. Method, Data, and Results: Second Survey

In the time frame considered in the second survey, all insured firms have notified their claims to the insurance companies. In this instance, the role of insurance should be more apparent as in many cases at least some insurance funds were already disbursed. Therefore, the objective in our analysis of the second survey is to investigate the more direct role of insurance claims in supporting firms' recovery. The insurance section in the questionnaire asked firms if they planned to finance their recovery through insurance, what type of insurance they had at the time of the earthquake, whether they had submitted claims, whether they believed their insurance coverage was adequate, and what proportion of their claim was already paid out.

This survey was undertaken in 2013.[7] Participants were required to have had one or more premises located in the districts that experienced serious physical damage by the 2011 earthquake: Christchurch city, Selwyn, and Waimakariri districts. Firms were sampled from 19 different sectors.[8] The questionnaire was sent to 2,176 unique organizations; response rate was approximately 25%. After removing non-valid and incomplete responses, the sample we used included 461 participant firms.[9] About one-half of the sample firms employ less than 10 people,

[7] See Brown et al. (2014) for detailed description of the survey.
[8] Sectors were defined according to the Australian and New Zealand Standard Industrial Classification (ANZSIC).
[9] Responses were considered non-valid in cases of duplicates responses from the same firm, surveys with missing information for some of the key questions, and responses from public sector.

with most of these organizations employing between 1 to 5 people. 432 observed firms were insured with property damage insurance; 288 (67%) were insured with both property damage and business interruption insurance; and 375 observations had all three types of insurance. Just 1% of our survey respondents were no longer in operation, so the survey results reported here do not adequately represent ceased businesses. It is interesting to note, however, that the average annual death rate for businesses in Canterbury (which normally sits at around 10 percent) did not change significantly in the years following the earthquake. Annual death rates of businesses were at 9.7%, 10.1% and 9.1% in 2011, 2012, 2013 respectively (Statistics New Zealand, 2014).

We focus on the insured observations for the analysis in this section, in order to prevent any unobserved differences between insured and uninsured firms.

Only 70% of the insured firms had filed an earthquake-related claim. Since practically everyone in the affected districts experienced some impact from the earthquakes, two plausible explanations are that their insurance terms did not cover the damage they incurred and/or the cost of damage for these organizations may have been lower than the policy deductible. Notably, only half of the sample believed their insurance was/is adequate. Of those that had submitted a claim, nearly 45% had received almost full payout (defined as >80%) on their submitted claims. However, only 38% of the total sample of insured firms had received almost full payout by the time of the survey and also believed that their coverage was adequate.

As we are constrained by the survey questions, the outcome variables of interest we are considering are all binary. As such, we use a logistic model in this analysis. The model to estimate the effect of insurance on business recovery is as follows:

$$\Pr(Y_i = 1 | INS_i, X_i) = F(\alpha + \tau\, INS_i + \beta X_i) \quad (2)$$

Where Y_i is the outcome variable denoting 1 if the response to the survey question was positive, and 0 otherwise. X_i is a vector of control variables. The list of outcome variables and independent variables and some descriptive statistics are included in Table 5. τ is the estimated average treatment effect of insurance on the outcome variable. β is a vector of the estimated coefficients of X_i. F is the cumulative distribution function of logistic distribution.

TABLE 5 ABOUT HERE

With a logistic specification for the probability function, the marginal effect is given by:

$$\frac{\partial \Pr(Y=1)}{\partial (z_i)} = \frac{e^{z\beta}}{\left(1+e^{z\beta}\right)^2}\frac{\partial (z\beta)}{\partial (z_i)} = \frac{e^{z\beta}}{\left(1+e^{z\beta}\right)^2}\beta \tag{3}$$

Where $z\beta = (\alpha + \tau\, INS_i + \beta X_i + u_i)$.

In this study, we emphasize two insurance questions: whether the firm had business interruption insurance, and whether the firm received an adequate and timely payout.

Our analysis uses three different perspectives to evaluate whether organizations have recovered from the disaster: profitability, productivity and whether they are better or worse off after the earthquakes. In terms of profitability, 48% of sample are firms with BI and are profitable. Overall, there are more profitable firms in the sample than firms considering themselves unprofitable. In terms of increased productivity, 37% of the sample had BI and increased their productivity in the aftermath. However, only 19% of the sample firms were adequately insured. Only 28% of the sample indicated that they were adequately insured and profitable. There was roughly an equal number of firms that increased their productivity level versus otherwise (decreased or unchanged). In the survey, there was one question asking whether the firm was better off after the earthquake. Approximately 30% of firms with BI were better off, while only 17% of adequately and timely insured firms were better off. The number of observations is detailed in the Appendix, which also presents the total number of observations in different categories, classified into firms that had business interruption insurance and firms that were adequately insured with nearly full payout.

A large share of the firms in our sample are in retail and wholesale trade, or manufacturing. The original survey has a total of 19 different sectors but we use only 6 sectors for analysis. The six sectors are health care and social assistance, manufacturing, construction, accommodation, financial services and insurance, and retail and wholesale trade.[10] Within each industry, the majority of firms also adopted business interruption insurance except in construction, which had approximately equal share of firms with or without BI.

Regarding the damage from the earthquake, most firms experienced damage and loss but not all of them reported that their business operations were also disrupted. Three main statistics are presented, including structural damage, nonstructural damage and difficulties accessing the premises. The business operations of most firms were disrupted by nonstructural damage (47%), which includes damage to furniture, fixture, fittings, inventory, motor, and equipment, and machinery breakdown. Approximately 38% of the total sample also experienced structural damage, and 29% of firms were disrupted because of difficulties of getting access to the business sites.

In estimating equation 2, there are three possible outcome (dependent) variables, two core (independent) variables of interest, and a number of control variables. The first outcome variable is the profitability of firms after disaster. Current positive financial status of the affected organizations after a disaster is a proxy for measuring how well a firm is performing after the disaster. As there are both for-profit and not-for-profit organizations in this study, we use the status of financial surplus for the not-for-profit organizations instead of profitability.[11]

The second outcome variable is the productivity of firms after the disaster. The survey question asked firms if their current productivity greatly/slightly increased, decreased or remained the same. We note 1 if the organization’s level of productivity has slightly/greatly increased and 0 otherwise. The third outcome variable is whether the firm is better-off as a result of the earthquake. Even though this question is especially subjective, it may still be informative. This

[10] Some sectors are not included due to small number of observations (less than 10), uninsurable for property and business interruption insurance (e.g. agriculture), and no literature of economic implications of disaster impact (e.g. arts). In addition, some sectors are left out of the model because the overall model is better fit without (higher pseudo R^2).

[11] For for-profit organizations, we note whether profitability is moderate or high; for not-for-profit organizations, whether they had a financial surplus at the time of the survey.

variable equals 1 if the firm is significantly or slightly better off as a result of the earthquake and 0 otherwise.

There are two core (independent) variables of interest for us. The first is whether the organization had business interruption insurance at the time of the earthquake. This variable is a binary choice that equals 1 if the firm had business interruption insurance at the time of the earthquake and 0 otherwise. Since all units in this study had property damage insurance (which includes insurance coverage for furniture, fixture, fitting, contents, equipment, and machinery breakdown), this variable captures the additional/marginal impact of adding business interruption coverage to the property insurance. Business interruption insurance (BI) covers loss of revenue and/or increased cost of working following a damage to the insured property. The claim payout from BI is mainly expected to lower the adverse impact of the loss of revenue. The 'increased cost of working' coverage provides support for increased expenditures such as hiring temporary stuff, and/or renting temporary facilities.[12] This analysis asks whether the business interruption insurance provides additional benefit to organizational recovery as opposed to those without BI coverage. We exclude motor insurance from this analysis because business interruption insurance is covered only with property damage insurance policy.

The second core variable is whether the firm had received a timely and/or adequate insurance payout. In this analysis, we focus on the organizations that had all the three types of insurance, i.e. property damage, business interruption, and motor insurance. We separate the organizations into three categories: (1) those that did not make a claim; (2) those that made a claim, but less than 80% had been paid out at the time of the survey (2.5 years after the earthquakes); and (3) those that had received over 80% of their claimed amount. Each category was set as a binary variable with 1 if they belonged to the category and 0 if not. These variables proxy the extent that insurance provides a supportive role for recovery when the affected organization receives a timely payment and/or is adequately insured.

[12] The coverage for increased cost of working is an add-on option with additional premium. We are not able to identify which type of BI coverage is available for each firm.

There are a total of 25 control variables we use from this survey; these can be categorized into five main categories. The first category is industry sector. We use six binary variables to represent industry sectors: health care and social assistance, manufacturing, construction, accommodation and food services, financial and insurance services, and retail and wholesale trade. We use four variables to represent ownership structure: sole proprietorship, partnership organizations, private limited liability company, and public limited liability company. The third category is the organizations' size, as measured by the number of employees. The fourth category is the causes of disruption brought about by the earthquake. We have three variables capturing different causes of business disruption after the earthquake: whether the firm was disrupted by structural damage, by non-structural damage, and whether the firm had difficulties accessing their business premises (these are not mutually exclusive). Additionally, we have three variables to capture the financial situation of each firm: The proportion of the firm's revenue coming from the Canterbury region prior to the earthquake; the presence of high outstanding debt; and whether the firm finances its recovery by spending from its own sources. All three can potentially affect a firm's ability to recover successfully, and might also be correlated with the presence of insurance. Last, we also measure the total number of locations in Canterbury and the rest of New Zealand for each firm, the number of years that the firm had been operating prior to the earthquake, whether the firm is for-profit, and whether the firm had emergency plans in place at the time of the earthquake. The regression of core variables without any control variables has 432 observations, but only 416 observations for the regression when including the control variables.

As discussed earlier, the first core variable is whether the firm had adopted business interruption insurance at the time of the earthquake. Table 6 displays the estimated results: When regressing without any control variables, the presence of additional business interruption coverage seems to positively affect both firms' profitability and their productivity. These results largely remain when adding control variables, even if the pattern of statistical significance changes somewhat, with the affect on profitability no longer statistically significant and the affect on subjective perception of improved circumstances (better-off) now statistically significant (at 5% level).

TABLE 6 ABOUT HERE

The second core variable is the timeliness and adequacy of insurance payments. As we detailed earlier, we split the organizations that had all three types of insurance coverage into three groups: those that did not claim insurance, those that claimed but had not been paid fully, and those that had been paid fully (over 80% of their claim). Table 7 shows the logit regression results for this variable. Without control variables, those organizations that did not claim insurance and those that received a timely, full payment of their claim reported being better off and having higher profitability compared to those that experienced protracted or inadequate claim payments (less than 80% of claim had been paid at the time of survey). In addition, not having insurance or having a fully settled claim were statistically significant predictors of being 'better off' after the earthquakes. When adding the control variables, the same patterns in the data are evident, however these groupings are not statistically significant predictors of post-earthquake performance. In terms of productivity, the three groupings all show statistically significant, positive effects on increased productivity. Interestingly, when the control variables are added, those with protracted or inadequate claim settlements indicate higher levels of productivity than the other two groups. This may potentially be because the organisations were having to work harder to make up for the slow or inadequate insurance settlement.

TABLE 7 ABOUT HERE

Table 8 summarizes the information and displays the average marginal effects of the core variables measuring insurance coverage on the outcome variables (profitability, productivity, and subjective perception). Having business interruption insurance has an average marginal effect of 3.5 (8.11) with (without) control variables on profitability. The result is significant without control variables. This means that having business interruption insurance, holding other things equal, increased the probability of being profitable by 3.5 percentage points. When a firm adopted business interruption insurance, it has a probability of increasing its productivity level post disaster that is higher by 15 percentage points. For the subjective measure, business interruption insurance shows significant results; a firm that chose to take out business interruption insurance had a higher probability of being better off after the earthquake by approximately 8.6 percentage points.

TABLE 8 ABOUT HERE

The measure for adequate and timely insurance payments, however, shows that having a protracted or inadequate insurance payment can have a notable impact on post-earthquake performance. However, the results are only significant without control variables: having a fully settled claim 2.5 years after the earthquakes increased an organisation's profitability level by 14 percentage points, compared to just 4 percentage points for those with protracted claims. Similarly, those with fully settled claims (and those with no claim) indicated they were better off (15 and 16 percentage points respectively) than those with a protracted or inadequate claim payment (8 percentage points).

6. Conclusions and Discussion

We examine the role of insurance in business recovery following the Christchurch earthquake in 2011 in the short- and medium-term. The central question we pose, in the short-term analysis, is whether insurance increases the likelihood of business survival in the aftermath of a disaster. We find only weak evidence that those firms that had both property damage and business interruption had higher likelihood of survival post-quake. Whether this failure to find more robust evidence of insurance impact is an attribute of our data, or of problems in the way the insurance sector operated in the immediate aftermath of the Christchurch earthquake, remains an open question. For medium-term analysis, our results show a more explicit role for insurance in the aftermath of the disaster. Firms with business interruption insurance have higher probabilities of increasing productivity and improved performance following the catastrophe. Business interruption insurance significantly increases the likelihood of enhanced productivity – by approximately 15 percentage points. However, it is possible that this is a reflection on the type of businesses that take out business interruption coverage, rather than on the actual post earthquake impact of the insurance. A second line of analysis was carried out to better understand the impact of insurance post-disaster. Our results show that those businesses that received prompt and full payments of their claims had a better recovery, in terms of profitability and a subjective 'better off' measure,' than those that had protracted or inadequate claim payments (less than 80% of the claim paid within 2.5 years). This latter analysis strongly indicates the importance not only of good insurance coverage but of an insurance system that also delivers prompt claim payments. These results support earlier qualitative analysis into the role of insurance on business recovery, which found that high levels of under-insurance and delayed claim settlements resulted in delayed recovery (Brown et al., 2013; Brown et al., in press, King et al., 2014, Seville et al., 2015).

As a first paper attempting to empirically identify a causal effect of insurance on business recovery, we emphasize some caveats. First, we would have preferred to have data on the actual property damage claims and the amount of business interruption claims each firm had (and relative to each firm's size and revenue). Second, details on the timing of claim payments would help to further clarify the impact of payment delays. Third, information on non-insured losses would help to understand the issue of adequacy of insurance and to distinguish and separate this from the timeliness of claim settlement. Fourth, if we had had the actual break-down of BI claims, into loss of revenue and increased cost of working, we would have been able to further provide details on the precise role of business interruption insurance in determining firm performance.

Insurers are not willing to provide coverage for natural disasters for several reasons (e.g. Kunreuther, 1996; Jaffee & Russell, 1997; Kunreuther & Michel-Kerjan, 2009a; Kousky, 2010; Linnerooth-Bayer et al., 2011). One of these reasons is that catastrophic risk is often an unknowable risk, which makes it difficult to estimate future occurrences, which in turn makes determining actuarially fair pricing impractical (Kunreuther & Pauly, 2006). Consequently, the insurers charge higher premiums to compensate for the unknown risk of a disaster (Kunreuther & Michel-Kerjan, 2009b). As a result, the higher premium rate discourages individuals and businesses from buying insurance protection and hence demand for disaster insurance is lower. The high cost of protecting future uncertainty may be unattractive as compared to the needs of day-to-day expenditures; this is especially true for budget-constrained individuals (Kunreuther & Michel-Kerjan, 2009c; Linnerooth-Bayer et al., 2011; OECD, 2013).

In addition, insurers are reluctant to insure catastrophic risk because it requires them to accumulate high loss reserve due to the potential severity of disaster risk (Jaffee & Rusell, 1997; Kunreuther & Michel-Kerjan, 2009b). Jaffee and Russel (1997) pointed out that there are additional costs associated with carrying capital as loss reserve, such as tax and accounting expenses, and these additional costs further discourage insurers from supplying disaster insurance.

The most notable paper examining the role of insurance in recovery from disasters is the paper by Kunreuther (1996). He pointed out that insurance has two main roles in dealing with natural disasters. The first is that it provides indemnification for any loss or damage from natural disasters, and hence, it relieves the cost to recover physical loss and/or financial loss for the affected policyholders. The second role of insurance is to encourage implementation of loss prevention programs. Insurers have a role in promoting the application of loss preventive measures by offering incentives, such as premium reductions, to encourage the insured to apply preventive measures. In addition, insurance provides price signals regarding the degree of expected risk in different locations and by different asset types (Kunreuther, 1996). However, as in some cases disaster insurance is subsidized through public insurance programs, this lower premium might misrepresent the actual degree of risk and lower the effort of implementing mitigation tools (Cummins and Mahul, 2009). In practice, insurance companies do not commonly offer sufficiently deep discounts on premium to make investment in effective prevention an attractive enough proposition (Doherty et al., 2008).

What is not addressed in this literature is how well insurance is performs as a mitigation tool in the aftermath of a natural disaster. How does insurance support disaster recovery? In which areas or sectors is it more efficient? To what extent? To our knowledge, these questions have not been answered. Analyzing these questions would shed light on the precise benefits of adopting insurance as a means to support reconstruction and/or recovery in the aftermath of a natural disaster, and would enable a more comprehensive cost-benefit analysis of disaster insurance.

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Figure 1: Boxplot of estimated propensity scores before (left) and after (right) matching

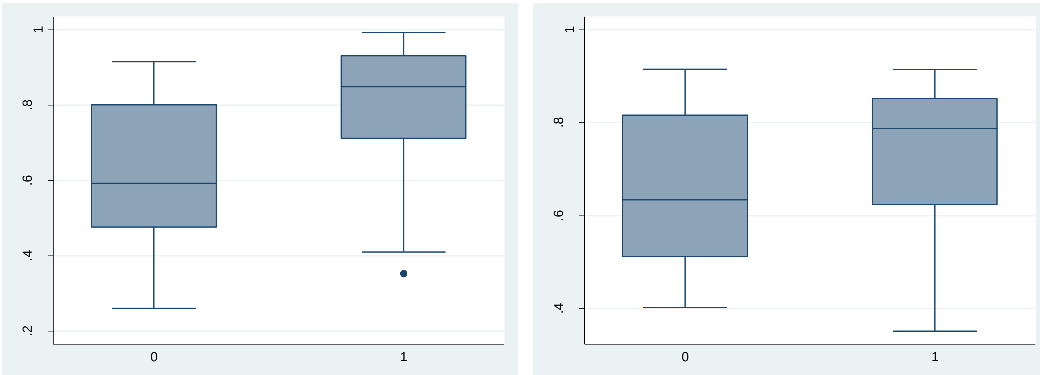

Table 1: Pre-earthquake variables for estimating propensity scores

Variable		Insured		Uninsured	
		M	**SD**	**M**	**SD**
Firm Size					
ESMALL5	1 = Less than 5 full-time employees	0.5	0.51	0.71	0.47
ELARGE50	1 = More than 50 full-time employees	0.18	0.39	0.18	0.39
Organisational Ownership Structure					
OSOLE	1 = Sole proprietorship	0.33	0.47	0.3	0.47
OLTD	1 = Limited liability company	0.29	0.46	0.39	0.5
Location Before the Earthquake					
LCBD	1 = Located in Central Business District	0.1	0.3	0.15	0.36
LLYT	1 = Located in Lyttleton Town Centre	0.28	0.45	0.18	0.39
Sector					
BRT	1 = Retail trade	0.26	0.44	0.27	0.45
BFMCG	1 = FMCG (Fast-Moving Consumer Goods)	0.17	0.37	0.09	0.29
BUTIL	1 = Lifeline utilities	0.13	0.33	0.09	0.29
Risk Management Practice					
RDPT	1 = Have risk management department/staff	0.79	0.42	0.74	0.45
RBCM	1 = Have business continuity plan	0.29	0.46	0.36	0.49
REMG	1 = Had practiced emergency response	0.32	0.47	0.36	0.49
Other					
ROI	1 = Positive average annual return on investment in the past 5 years	0.41	0.5	0.21	0.42
OWN	1 = Own the business premises	0.32	0.47	0.15	0.36
PROF	1 = For-profit organization	0.91	0.3	0.77	0.44
NSITE	Number of sites (nationwide)	54.56	485.89	16.21	53.34

Table 2: Estimated coefficients of propensity scores

Variable	Coefficient		Robust S.E.
ESMALL5	-1.33	**	0.62
ELARGE50	-1.27	*	0.84
OSOLE	-0.32		0.59
OLTD	-0.92		0.74
LCBD	-0.30		0.68
LLYT	0.60		0.67
BRT	-0.29		0.54
BFMCG	1.34	*	0.78
BUTIL	0.86		0.93
RDPT	0.51		0.52
RBCM	-1.00	*	0.63
REMG	-0.43		0.59
ROI	0.72		0.56
OWN	0.00		0.00
PROF	0.92	*	0.61
NSITE	1.08		0.65
Constant	1.05		0.80
Log-likelihood	-64.6207		
Wald $\chi 2$	26.9		
P-value	0.0426	**	
Pseudo R2	0.1674		

Significance level 0.01***, 0.05**, 0.1*

Table 3: Post-earthquake variables for estimating firm survival, including insurance takeup

Variable	**Definition**	**Insured**		**Uninsured**	
		M	**SD**	**M**	**SD**
Outcome Variable					
SURV	1 = Still operating / not permanently closed	0.9	0.31	0.89	0.33
Insurance					
INS	1 = Had property damage insurance	0.76	0.43	N/A	
BI	1 = Had business interruption insurance	0.64	0.48	N/A	
Change in Revenue After the Earthquake					
REVDE	1 = the firm's revenue had decreased	0.5	0.51	0.45	0.51
REVCH	Percentage change in revenue	-18.02	40.38	-18.21	32.96
Structural and Non-Structural Damage					
DSTRUC	1 = Moderately or highly disrupted by structural damage	0.53	0.51	0.45	0.51
DNONSTR	1 = Moderately or highly disrupted by non-structural damage	0.53	0.51	0.36	0.49
Affected by the earlier 2010 Earthquake					
BREVDE	1 = Firm's revenue had decreased post 2010 eq	0.41	0.5	0.33	0.48
Financial Recovery					
RINS	1 = Plan to recover through insurance	0.43	0.5	N/A	
RCF	1 = Finance recovery with cash flow	0.72	0.46	0.62	0.5
RWAGE	1 = Entitled to earthquake wage subsidy	0.34	0.48	0.18	0.39
CDAY	Number of closing days	8.27	24.53	10.22	28.05

Table 4: Estimated coefficients of Limited Probability Model (LPM)

Variables	All		Block 1		Block 2		Block 3		Block 4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
No control variables										
INS	0.014	0.063	-0.013	0.153	-0.15	0.083*	-0.091	0.064	0.286	0.206
_cons	0.882	0.056	0.846	0.104	1	N/A	1	N/A	0.667	0.2
With control variables										
INS	0.062	0.065	0.096	0.187	0.077	0.133	0.065	0.133	0.131	0.373
BI	-0.029	0.057	-0.238	0.274	-0.237	0.166	0.018	0.169	0.192	0.191
CDAY	0.003	0.001	0.001	0.001	0.005	0.003	0.003	0.002	0.088	0.07
REVDE	-0.064	0.08	-0.341	0.171	0.352	0.208	-0.036	0.165	0.059	0.216
REVCH	0.001	0.001	-0.002	0.003	0.009	0.003	0.004	0.002	0.002	0.003
DSTRUC	-0.123	0.056	0.014	0.225	-0.114	0.115	0.127	0.187	-0.311	0.18
DNONSTR	-0.085	0.05	-0.375	0.315	0.132	0.135	-0.229	0.171	0.029	0.088
BREVDE	0.068	0.059	0.052	0.309	0.049	0.12	0.203	0.138	0.057	0.135
RINS	0.022	0.063	-0.048	0.317	0.124	0.129	0.077	0.183	-0.057	0.116
RCF	-0.112	0.069	-0.305	0.207	-0.231	0.123	-0.354	0.224	0.285	0.219
RWAGE	0.102	0.059	0.26	0.142	0.169	0.121	0.125	0.135	-0.029	0.21
_cons	0.92	0.055	1.025	0.14	0.81	0.125	0.884	0.114	0.668	0.209
Obs.		140		25		27		26		27
P-value		0.043	**	0.047	**	0.046	**	0.962		0.326
Adjusted R^2		0.151		0.282		0.254		0.029		0.294

Significance level 0.01***, 0.05**, 0.1*

Table 5: Second survey sample descriptions
(Classified into firms that had BI insurance and firms that were adequately insured)

Definition	Total Obs.	BI	No BI	Adequately Insured	Not Adequately Insured
		%	%	%	%
Industry Sector					
Health Care And Social Assistance	44	70.5%	29.5%	34.1%	65.9%
Manufacturing	78	76.9%	23.1%	42.3%	57.7%
Construction	41	48.8%	51.2%	24.4%	75.6%
Accommodation	46	82.6%	17.4%	56.5%	43.5%
Financial Services And Insurance	21	81.0%	19.0%	57.1%	42.9%
Retail And Wholesale Trade	79	72.2%	27.8%	31.6%	68.4%
Ownership Structure					
Sole Proprietorship	66	65.2%	34.8%	33.3%	66.7%
Partnership	34	61.8%	38.2%	44.1%	55.9%
Private Limited Liability Company	262	70.2%	29.8%	38.5%	61.5%
Public Limited Liability Company	14	71.4%	28.6%	28.6%	71.4%
Size of Organization					
10 Employees Or Less	216	61.6%	38.4%	31.5%	68.5%
Greater Than 50 Employees	73	80.8%	19.2%	41.1%	58.9%
Disruption by the EQ					
Structural Damage	162	67.9%	32.1%	41.4%	58.6%
Non-Structural Damage	201	68.2%	31.8%	42.3%	57.7%
Difficult Access to Premises	127	61.4%	38.6%	38.6%	61.4%
Other					
Currently have High Debt	36	66.7%	33.3%	36.1%	63.9%
Finance its Recovery with Organizational Cash Flow	197	72.1%	27.9%	43.7%	56.3%
Located in CBD	316	67.7%	32.3%	39.6%	60.4%
Had Emergency Plan in Place	308	68.2%	31.8%	39.6%	60.4%
For-Profit Organization	398	68.3%	31.7%	36.7%	63.3%
Own The Current Property	188	63.8%	36.2%	37.2%	62.8%

Table 6: Logit regression results of adopting Business Interruption (BI) insurance, Coefficients (Standard Deviations)

Variables		Profitability		Productivity		Better-off	
No Control Variables							
BI	1 = had business interruption insurance	0.39	*	0.62	**	0.31	
		(0.22)		(0.21)		(0.21)	
	_cons	0.58	***	-0.43	**	-0.55	**
		(0.18)		(0.18)		(0.18)	
With Control Variables							
BI	1 = had business interruption insurance	0.20		0.76	**	0.44	*
		(0.27)		(0.25)		(0.25)	
	Industry Sector						
SHEA	1 = health care and social assistance	-0.46		-0.27		-0.88	**
		(0.42)		(0.37)		(0.44)	
SMAN	1 = manufacturing	-0.40		-0.66	*	-0.83	**
		(0.35)		(0.36)		(0.35)	
SCON	1 = construction	0.67		1.89	***	1.22	**
		(0.47)		(0.43)		(0.42)	
SACC	1 = accommodation	0.36		1.17	**	1.53	***
		(0.47)		(0.46)		(0.44)	
SFIN	1 = financial services and insurance	2.03	**	0.19		-0.18	
		(0.88)		(0.52)		(0.54)	
SRW	1 = retail and wholesale trade	0.22		0.14		0.04	
		(0.33)		(0.3)		(0.3)	
	Ownership Structure						
OSOLE	1 = sole proprietorship	0.58		-0.15		0.06	
		(0.59)		(0.52)		(0.53)	
OPART	1 = partnership	0.67		0.35		-0.26	
		(0.64)		(0.6)		(0.61)	
OPRIV	1 = private limited liability company	0.20		0.61		0.27	
		(0.51)		(0.46)		(0.46)	
OPUB	1 = public limited liability company	1.79	*	0.03		-0.03	
		(1.01)		(0.73)		(0.75)	
	Size of Organization						
ELE10	1 = employ 10 employees or less	-0.59	**	-0.40		-0.32	
		(0.29)		(0.27)		(0.27)	
EGR50	1 = employ greater than 50 employees	-0.43		-0.07		-0.62	
		(0.4)		(0.38)		(0.39)	

Variables		Profitability		Productivity		Better-off	
	Level of Disruption by the EQ						
DSTRUC	1 = disrupted by structural damage	-0.34		-0.02		0.05	
		(0.32)		(0.3)		(0.29)	
DNONST	1 = disrupted by non-structural damage	0.30		0.35		0.52	
		(0.3)		(0.28)		(0.28)	
DPREM	1 = difficulties accessing premises	-0.62	**	-0.26		-0.32	
		(0.31)		(0.3)		(0.31)	
	Financial Status						
FREVC	% revenue from Canterbury prior to the EQ	-0.01		0.01		0.01	**
		(0.01)		(0.01)		(0.01)	
FDEBT	1 = currently have debt	-1.92	***	-1.09	**	-1.21	
		(0.4)		(0.42)		(0.48)	
FOCF	1 = finance its recovery with organizational cash flow	0.01		-0.24		-0.43	
		(0.26)		(0.24)		(0.25)	
LCANT	current number of locations in Canterbury	0.04		-0.08		-0.03	
		(0.05)		(0.09)		(0.03)	
LNZ	current number of locations in New Zealand	0.01		-0.01		0.01	
		(0.01)		(0.01)		(0.01)	
LCBD	1 = located in CBD	0.40		-0.21		0.08	
		(0.27)		(0.26)		(0.25)	
NYR	number of years operating before the EQ	0.01		0.01		-0.01	
		(0.01)		(0.01)		(0.01)	
EMG	1 = had emergency plan in place	k0.44		-0.19		-0.02	
		(0.28)		(0.27)		(0.27)	
PROF	1 = for-profit organization	1.03	*	0.24		0.69	
		(0.63)		(0.54)		(0.57)	
OWN	1 = own the current property	-0.23		-0.55	**	-0.20	
		(0.26)		(0.23)		(0.24)	
_cons		-0.15		-0.66		-1.63	
		(0.69)		(0.66)		(0.67)	
	Log pseudo-likelihood	-222.74299		-248.06692		-242.67464	
	Wald χ^2	63.94		63.15		61.62	
	P-value	0.000	***	0.000	***	0.000	***
	Pseudo R^2	0.1325		0.1393		0.1397	

Significance level 0.01***, 0.05**, 0.1*

Table 7: Logit regression results of insurance status analysis

Variables		Profitability		Productivity		Better-off	
No Control Variables							
NOCLA	1 = had insurance but did not lodge claim	0.59		1.6	***	0.69	*
		(0.37)		(0.42)		(0.37)	
PTCLAIM	1 = claim with protracted settlement	0.21		1.56	***	0.35	
		(0.36)		(0.42)		(0.38)	
SETTLED	1 = settled claim	0.66	*	1.44	***	0.64	*
		(0.35)		(0.4)		(0.36)	
	_cons	0.38		-1.4	***	-0.86	***
		(0.3)		(0.38)		(0.32)	
With Control Variables							
NOCLA	1 = had insurance but did not lodge claim	0.19		1.56	***	0.6	
		(0.45)		(0.5)		(0.46)	
PTCLAIM	1 = claim with protracted settlement	0.14		1.72	***	0.2	
		(0.43)		(0.49)		(0.47)	
SETTLED	1 = settled claim	0.31		1.42	***	0.45	
		(0.41)		(0.48)		(0.45)	
	Industry Sector						
SHEA	1 = health care and social assistance	-0.43		-0.13		-0.8	*
		(0.42)		(0.39)		(0.43)	
SMAN	1 = manufacturing	-0.4		-0.64	*	-0.84	**
		(0.35)		(0.37)		(0.35)	
SCON	1 = construction	0.63		1.63	***	1.07	***
		(0.48)		(0.42)		(0.41)	
SACC	1 = accommodation	0.34		1.15	**	1.62	***
		(0.48)		(0.46)		(0.45)	
SFIN	1 = financial services and insurance	2.02	**	0.3		-0.22	
		(0.87)		(0.53)		(0.57)	
SRW	1 = retail and wholesale trade	0.25		0.09		0.07	
		(0.33)		(0.3)		(0.3)	
	Ownership Structure						
OSOLE	1 = sole proprietorship	0.57		-0.07		0.05	
		(0.59)		(0.55)		(0.54)	

Variables		Profitability		Productivity		Better-off	
OPART	1 = partnership	0.66		0.48		-0.3	
		(0.64)		(0.6)		(0.61)	
OPRIV	1 = private limited liability company	0.19		0.7		0.28	
		(0.51)		(0.5)		(0.46)	
OPUB	1 = public limited liability company	1.8	*	0.01		0.03	
		(1.01)		(0.75)		(0.74)	
	Size of Organization						
ELE10	1 = employ 10 employees or less	-0.58	**	-0.45	*	-0.35	
		(0.29)		(0.27)		(0.27)	
EGR50	1 = employ greater than 50 employees	-0.42		-0.07		-0.66	*
		(0.4)		(0.38)		(0.39)	
	Level of Disruption by the EQ						
DSTRUC	1 = disrupted by structural damage	-0.33		-0.04		0.12	
		(0.32)		(0.3)		(0.31)	
DNONST	1 = disrupted by non-structural damage	0.29		0.35		0.58	**
		(0.3)		(0.29)		(0.29)	
DPREM	1 = have difficulty accessing premises	-0.62	*	-0.25		-0.33	
		(0.32)		(0.31)		(0.32)	
	Financial Status						
FREVC	% revenue from Canterbury prior to the EQ	-0.01		0.01		0.01	**
		(0.01)		(0.01)		(0.01)	
FDEBT	1 = currently have debt	-1.93	***	-1.15	***	-1.25	**
		(0.4)		(0.43)		(0.49)	
FOCF	1 = finance recovery with organizational cash flow	-0.01		-0.23		-0.41	*
		(0.27)		(0.24)		(0.25)	
LCANT	current number of locations in Canterbury	0.04		-0.09		-0.04	
		(0.04)		(0.1)		(0.03)	
LNZ	current number of locations in New Zealand	0.01		-0.01		0.01	
		(0.01)		(0.01)		(0.01)	
LCBD	1 = located in CBD	0.42		-0.15		0.13	
		(0.27)		(0.26)		(0.25)	

Variables		Profitability		Productivity		Better-off	
NYR	number of years operating before the EQ	0.01		-0.01		-0.01	
		(0.01)		(0.01)		(0.01)	
EMG	1 = had emergency plan in place	0.42		-0.29		-0.04	
		(0.28)		(0.27)		(0.26)	
PROF	1 = for-profit organization	1.04	*	0.13		0.68	
		(0.63)		(0.6)		(0.59)	
OWN	1 = own the current property	-0.23		-0.6	**	-0.16	
		(0.26)		(0.24)		(0.24)	
_cons		-0.21		-1.37	*	-1.74	**
		(0.71)		(0.77)		(0.74)	
	Log pseudolikelihood	-222.682		-244.905		-242.931	
	Wald $\chi2$	63.44		71.87		62.94	
	P-value	0.000	***	0.000	***	0.000	***
	Pseudo R2	0.1328		0.1503		0.1388	

Significance level 0.01***, 0.05**, 0.1*

Table 8: Average marginal effects of core variables

Variables	Profitability		Productivity		Better-off	
Adopting business interruption insurance						
• No Control Variables	0.0811	*	0.1513	**	0.0734	
• With Control Variables	0.0350		0.1558	***	0.0860	*
Insurance status						
• No Control Variables						
○ had insurance but did not lodge claim	0.1223		0.3813	***	0.1644	*
○ claim with protracted settlement	0.0425		0.3716	***	0.0834	
○ settled claim	0.1379	*	0.3434	***	0.1536	*
• With Control Variables						
○ had insurance but did not lodge claim	0.0324		0.3138	***	0.118	
○ claim with protracted settlement	0.0246		0.3472	***	0.0384	
○ settled claim	0.0555		0.2853	***	0.0896	

Significance level 0.01***, 0.05**, 0.1*

Appendix Table 1. Number of insured vs uninsured firms by firm characteristics

Definition	Had insurance		No insurance	
	Obs.	**%**	**Obs.**	**%**
Organisational ownership structure				
Sole proprietorship	34	77.3%	10	22.7%
Partnership/JV partner	30	85.7%	5	14.3%
Limited Liability	30	69.8%	13	30.2%
Location before the earthquake				
CBD	10	66.7%	5	33.3%
Lyttleton	29	82.9%	6	17.1%
Kaiapoi	8	72.7%	3	27.3%
Business Sector				
Retail trade	27	75.0%	9	25.0%
Wholesale trade	6	100.0%	0	0.0%
Manufacturing	9	75.0%	3	25.0%
Construction	3	75.0%	1	25.0%
Transportation and Warehousing	3	50.0%	3	50.0%
Fast-moving consumer goods (FMCG)	17	85.0%	3	15.0%
Lifeline utilities	13	81.3%	3	18.8%
Ownership of Properties				
Own	33	86.8%	5	13.2%
Rent	73	71.6%	29	28.4%
For-profit organizations				
For-profit	96	78.7%	26	21.3%
Not-for-profit	10	55.6%	8	44.4%
Positive Return on Investment (ROI) in the past five years				
Positive ROI	43	86.0%	7	14.0%
Risk Management Practice				
Risk management officers	83	76.9%	25	23.1%
Written BCM	30	71.4%	12	28.6%
Had practiced emergency response	33	73.3%	12	26.7%

Appendix Table 2. Number of insured vs uninsured firms by the impact of the earthquake

Definition	Had insurance		No insurance	
	Obs.	%	Obs.	%
Business Closure				
Permanently closed	11	73.3%	4	26.7%
Temporarily closed	56	75.7%	18	24.3%
Ongoing closing	13	81.3%	3	18.8%
The change in revenue after the earthquake				
Decreased	52	77.6%	15	22.4%
Increased	31	91.2%	3	8.8%
Unchanged	22	68.8%	10	31.3%
Structural and non-structural damage				
Structural damage	81	78.6%	22	21.4%
Non-structural damage	77	81.1%	18	18.9%
Disrupted by structural damage	56	78.9%	15	21.1%
Disrupted by non-structural damage	56	82.4%	12	17.6%
Affected by the 2010 earthquake				
Affected by the 2010 earthquake	91	76.5%	28	23.5%
Revenue decreased	43	79.6%	11	20.4%
Financial Recovery Plan				
Plan to recover through insurance	45	100%	N/A	
Plan to recover through organization's cash flow	76	78.4%	21	21.6%
Expected to receive wage subsidy	35	85.4%	6	14.6%

Appendix Table 3. Average percentage change in revenue after the 2010 and 2011 earthquake

Description	Insured			Uninsured		
	Obs. %	Mean (SD)	Min, Max	Obs. %	Mean (SD)	Min, Max
Percentage change in revenue	76 85.4%	-25.13 (45.84)	-100%, 100%	13 14.6%	-47.62 (38.33)	-100%, 5%
Percentage change in revenue after the first EQ	61 84.7%	-12.84 (25.77)	-100%, 25%	11 15.3%	-24.28 (23.24)	-60%, 20%

Appendix B: Propensity Score Assumptions

Rosenbaum and Rubin (1984) demonstrate that stratification based on estimated propensity scores balances the X covariates if the *unconfoundedness* and the *common support/overlap* assumptions hold:

Assumption 1 *Unconfoundedness*: if $(Y_1, Y_0)\ \Pi\ T_i \mid X_i$ then $(Y_1, Y_0)\ \Pi\ T_i \mid P(X_i)$

Assumption 2 *Overlap*: $0 < P(T_i\ = 1|X) < 1$

The *unconfoundedness* assumption states that if the outcomes (Y_1, Y_0) are independent (Π) of the treatment (T_i) given a set of X covariates, then the outcomes (Y_1, Y_0) are independent of the treatment (T_i) given propensity scores, $P(X_i)$. The *common support/overlap* assumption states that the estimated propensity scores of the treated and control units must overlap and lie between 0 and 1. This assumption ensures that, at the same estimated propensity score, there are observations in the treatment and control group that have nearly identical probability of receiving treatment. When the two assumptions hold, Rosenbaum and Rubin (1983) call it 'strong ignorability', i.e. "when treatment assignment is strongly ignorable given the observed covariates X". By imposing the matching conditional on the estimated propensity scores, we remove the correlation between treatment assignment and X covariates, i.e. $X_i\ \perp\ T_i \mid P(X_i)$.

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