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Insurance as a Double-Edged Sword?

Quantitative Evidence from the 2011 Christchurch Earthquake

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Abstract: We examine the role of business interruption (BI) insurance in business recovery following the Christchurch earthquake in 2011. First, we ask whether BI insurance increases the likelihood of business survival in the immediate (3-6 months) aftermath of a disaster. We find only very weak evidence that those firms that had incurred damage, but were covered by BI insurance, had higher likelihood of survival post-quake compared with those firms that did not have any insurance. For the medium-term (2-3 years) survival of firms, our results show a more explicit role for insurance. Firms with BI insurance experience increased productivity and improved performance following a catastrophe. Furthermore, those organisations that receive prompt and full payments of their claims have a better recovery than those that had protracted or inadequate claim payments (defined as less than 80% of their claim paid within 2.5 years). We find some tentative evidence that the latter group (inadequate payment) did worse than those organisations that had damage but no insurance coverage. In general, our analysis indicates the importance not only of adequate insurance coverage, but also of an insurance system that delivers prompt claim payments.

1. Introduction and Background Information About the Earthquake

The role of insurance in supporting 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 financial risk from individuals and organizations to insurance companies; (2) through premium prices, it provides signals on risk levels; (3) it incentives *ex-ante* risk mitigation through the design of premium-reducing incentives; and (4) by providing financial resources, it assists in speeding up reconstruction of destroyed or damaged assets and returning firms to normal operations.[1] 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. We ask: Post-catastrophe, do insured organisations find it easier to recover than non-insured ones following a natural catastrophe? Do insured organisations that get compensated fully and promptly for damages incurred find it easier to recover than insured organisations that are not?

Understanding how insurance aids, or fails to aid, recovery in the aftermath of a disaster is of clear interest to many stakeholders; and is globally relevant as both the frequency and impact 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, and we use the Christchurch earthquake in 2011 as our case study.

The Christchurch earthquake sequence of 2010-11 was the worst natural disaster in New Zealand's history, with an estimated loss of US$35 billion (Simpson, 2013). The first major quake in this sequence was in September 2010 with a magnitude of 7.1. The second and the third major quakes hit closer to the city of Christchurch on Feb. 22, 2011. The most destructive quake hit Christchurch with a magnitude of 6.3, caused 185 fatalities and damaged over

[1] See Zweifel & Eisen (2012), Kunreuther (1996), and Botzen et al. (2009) for discussions about the role of insurance.

100,000 buildings leading to over 450,000 residential damage claims submitted to the public insurer (the Earthquake Commission).[2]

After the earthquake in February, about 1,600 commercial buildings in the Central Business District (CBD) – about 60% of all the buildings in that area – were slated 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.

The February earthquake had an estimated insured loss of US$16.5 billion. As such, it is ranked as 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 (the 2011 Tohoku earthquake and tsunami) were insured (Höppe and Low, 2012).[3] This event was the most comprehensively insured earthquake disaster in history.

Within New Zealand there had been few damaging earthquakes before the Christchurch quake affecting densely populated areas within recent history. 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. 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 as the average size of commercial claims is much larger (ICNZ,

[2] Many properties were associated with multiple claims based on different earthquake aftershocks and on separate claims for building damage, land damage, and damage to contents, as these are insured separately. For analysis of the residential earthquake insurance scheme see Owen and Noy (2017); and Noy and Nguyen (2017) for a comparison of the NZ program to the programs in California and Japan.

[3] For discussion on why insurance coverage is usually quite low, see Kunreuther and Michel-Kerjan (2014) and Kusuma et al. (2017).

2015)[4]; this is in contrast with the 2011 earthquake in Japan (Tohoku) and the 2010 one in Chile (Concepcion) where practically all claims were fully settled in less than the two years following the event (Marsh, 2014).

Interviews and surveys with stakeholders, conducted by *Resilient Organisations* - a research organization based in Christchurch, 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. In light of the differing views about insurance and recovery in Christchurch, our objective here is to empirically investigate the role of business interruption insurance in business recovery.

We aim to examine the role of insurance in both the *short*- and *medium-term*. 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 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 affordable, and was therefore commonly purchased in New Zealand, thus making it easy to obtain a substantial sample of affected and unaffected insured parties. (2) The proportion of insured damage to total loss of the 2011 earthquake was substantial, so insurance was and still is playing a significant 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 costs for all personal injuries,

[4] 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.

insurance in New Zealand is very affordable. As such, this makes it less likely that financing would have been an inhibiting factor preventing firms from purchasing insurance.[5] These constraints, present elsewhere, are therefore less likely to create a material difference between insured and uninsured organisations 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 firms' 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 quantitatively 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., 2017, King et al., 2014, Seville et al., 2015).

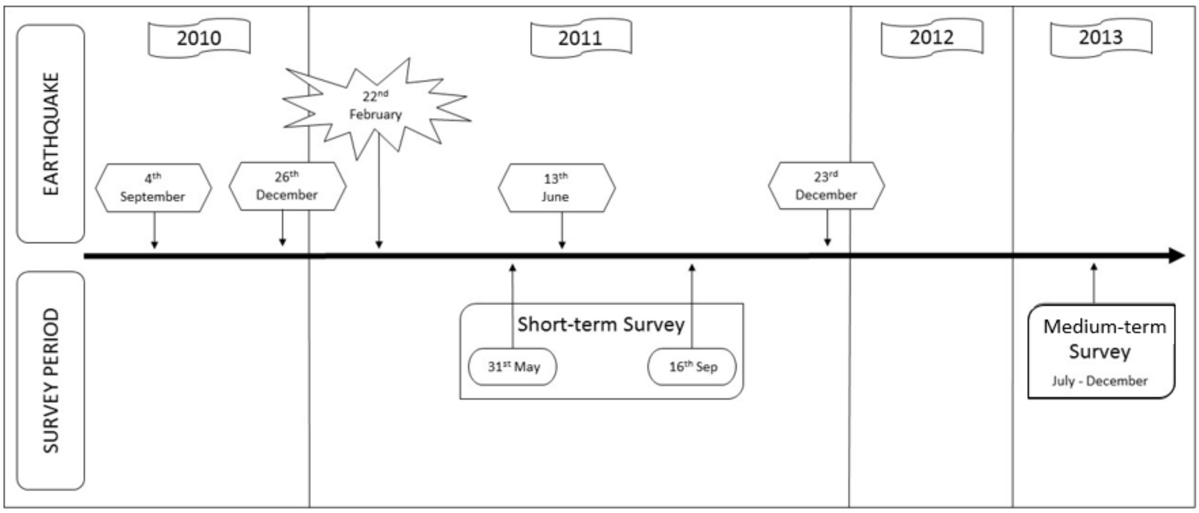
[5] The presence of the ACC scheme implies that any personal injury caused by an earthquake will not have to be covered by the commercial insurer (even if the damage occurred in the insured facility). The EQC scheme implies that insuring any mixed-use buildings will be cheaper as the residential part is covered (cheaply) by the public scheme (see Noy and Nguyen, 2017, for price information).

2. The Post-Earthquake Surveys

We utilize the data of two business surveys prepared and collected by *Resilient Organisations*. The surveys were designed to be a longitudinal study of organizational resilience following the first earthquake in 2010 (when there would be a series of much more destructive aftershocks). The questionnaire was sent to both for-profit and not-for-profit organizations located in the Christchurch CBD and the affected areas around the 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 short-term 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 more destructive 2011 earthquake. For our study, this survey is used to capture the role of insurance in supporting immediate post-quake business continuity. The medium-term 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 required 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.[6]

3. Insurance and Disasters: Literature Review

Insurance was recently recognized as one of the vital mitigation tools against the financial/economic loss and damage from natural disasters in the 2015 United Nations sponsored international agreement on Disaster Risk Reduction (The Sendai Framework, see 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 the economic consequences of 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. They find that 83% of the damage

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

caused by the Great East Japan earthquake and tsunami of 2011 was not insured. New Zealand has much higher insurance cover, but even there the uninsured portion was still significant in the commercial sector (Muir-Wood, 2012; Deloitte, 2015). Globally, Schanz and Wang (2014) cite figures from SwissRE that this uninsured gap (the gap between realized disaster damages and how much of these damages were insured) has widened during the past 40 years, from 0.02 percent to 0.13 percent of global GDP. They argue this is largely as a result of a more rapid increase of the value of damaged assets than reduction in insurance coverage.

Possibly the only paper that has quantitatively looked directly at the role of insurance in post-disaster recovery is von Peter et al. (2012), though it approached this question from a macroeconomic aggregate 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.[7] In an example more pertinent to our investigation here, residential earthquake risk is typically sold separately from the fire/theft/damage insurance contracts in California (a distinctly quake-prone region), and nowadays mostly through a publicly-supported insurance program. In New Zealand, the public sector is not involved in the commercial insurance sector, and commercial earthquake insurance cover is included as a standard part of property insurance policies.[8] The typical insurance coverage for non-residential entities available in New Zealand is commercial property insurance which is a cover for physical loss or damage to tangible property including assets, buildings, plant and equipment, and movable contents; it may include business interruption insurance (BI) for additional premium (ICNZ, 2013). Typical covered perils include fire, flood, windstorm, and earthquakes. BI insurance provides additional funds to cover for loss of revenue and/or increased cost of working as a

[7] Knowles & Kunreuther (2014) and Botzen & Van Den Bergh (2008) describe the two markets, respectively.
[8] 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.

direct result of insured damage.[9] The combination of both property damage and business interruption insurance could provide comprehensive coverage for material reconstruction and financial indemnification to the insured firm.

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 will 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 between insured and uninsured firms in surviving the disaster, 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, estimating the impact of insurance take-up on any outcome would involve dealing with a '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, however, is done on observables (i.e. the different characteristics of treatment and non-treatment firms are observable) then there are several ways to overcome this bias.

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.[10]

[9] Significantly rarer would be coverage for losses associated indirectly with the insured direct damages.
[10] 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 uncommon, as it would require a large enough pool of observations to allow for perfect matching.

Our approach relies on a 'matching' algorithm, matching the pre-treatment observations using estimated propensity scores for treatment (Rosenbaum and Rubin, 1983). The propensity score is an estimated value that describes the probability of 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 matching 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 (the outliers). 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 to purchase insurance and firms that did not. We define insured firms as firms that were covered by property damage insurance, as this type of insurance is the basic cover for commercial property. 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 property damage 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 by 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 any of the 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 score estimation and matching.[11]

In addition to property damage insurance, we focus on the impact of business interruption insurance (BI) on the likelihood of business survival. The model to estimate the effect of insurance on short-term business continuity is thus:

$$\Pr(Y_i = 1 | INS_i, BI_i, Z_i) = \alpha + \tau^1 INS_i + \tau^2 BI_i + \gamma\, Z_i + u_i \qquad (1)$$

Where Y_i is the outcome variable (this variable notes whether the firm continued its operation after the earthquake) and 0 otherwise. INS_i notes if the firm had property damage insurance at the time of the earthquake and 0 otherwise (same is true for BI_i for business interruption insurance). 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 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 used 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 the propensity-score regression. The mean and the standard deviation of the estimated propensity scores are 0.76 and 0.18, respectively. The range of the estimated propensity scores is between 0.26 and 0.99. As noted by Schafer and

[11] Imbens (2004) argued 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.

Kang (2008), the fit statistics of the propensity model are more important in the first-stage 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].[12]

It may be useful at this point to re-emphasize that the propensity score modelling can only account for different observable characteristics between the two groups of firms. It may still be the case that there are important unobservable differences that both determine whether a firm purchases and insurance, and also how likely it is to survive a big shock such as an earthquake. Unfortunately, our modelling cannot account for these unobservables. Nevertheless, 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.[13] 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 that consequently have similar likelihood of acquiring 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 similar (pre-quake) in all ways except the treatment conditions - purchase of insurance (Angrist and Pischke, 2009).

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[12] This removes 35 outliers from the estimation. 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).

[13] 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 examine 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 3.

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 they have 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 BI and the control variables —those that control for the damage of the earthquake. The 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. Overall, 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

By the time the medium-term survey was conducted, all insured firms have notified their claims to their 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. The objective, in our analysis of the second survey, is to investigate the more direct role of insurance payments 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.[14]

Participants were required to have had one or more premises located in one of the districts that experienced serious physical damage by the 2011 earthquake: Christchurch city, Selwyn, and Waimakariri. Firms were sampled from 19 different sectors.[15] The questionnaire was sent to 2,176 unique organizations; response rate was approximately 25%. After removing non-valid responses and uninsured firms, the sample we used included 432 participant firms.[16] These are firms with property damage insurance; 67% of these firms were additionally insured with business interruption insurance. About one-half of the sample firms employ less than 10 people, with most of these organizations employing between 1 to 5 people. Just 1% of our

[14] See Brown et al. (2014) for detailed description of the survey.
[15] Sectors were defined according to the Australian and New Zealand Standard Industrial Classification (ANZSIC).
[16] 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.

survey respondents were no longer in operation, so the survey results reported here do not represent ceased businesses.[17]

We focus on the insured observations for the analysis in this section. Therefore, we removed the uninsured observations from the analysis, in order to prevent any unobserved differences between insured and uninsured parties. From our data, only 70% of the sample had filed an earthquake-related claim. This is surprising since practically everyone in the affected districts experienced some impact from the earthquakes. Two plausible explanations are that their insurance terms and conditions 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 adequate. Of those that had filed a claim, nearly 45% reported they received almost full payout (defined as >80%) on their filed claims. But, only 38% of this group which filed claims had responded saying they believed their coverage was adequate given the amount of damage and loss they experienced.

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:

$$\Pr(Y_i = 1 | INS_i, X_i) = F(\alpha + \rho^1 \, BI_i + \rho^2 TA_i + \beta X_i) \quad (2)$$

Where Y_i is the outcome variable denoting 1 if the response to the survey question was positive, and 0 otherwise. BI_i and TA_i are the independent variables denoting if the insured firms also had BI insurance and whether they received timely and adequate payment, respectively. 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. ρ is the estimated average treatment effect of the insurance measures on the outcome variable. β is a vector of the estimated coefficients associated with X_i. F is the cumulative distribution function of the logistic distribution.

[17] It is interesting to note, however, that the average annual closure rate for businesses in Canterbury (which is normally around 10 percent) did not change significantly in the years following the earthquake. Annual closure rates of businesses were at 9.7%, 10.1% and 9.1% in 2011, 2012, and 2013, respectively (Statistics New Zealand, 2014).

TABLE 5 ABOUT HERE

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

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

Where $z\beta = (\alpha + \rho^1 BI_i + \rho^2 TA_i + \beta X_i + u_i)$.

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

Our analysis uses three different perspectives to evaluate whether organizations have recovered from the disaster: profitability, productivity and whether the firms perceived themselves to be better or worse off after the earthquakes. In terms of profitability, 48% of the sample are firms with BI and are reported as 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 reportedly increased their productivity in the aftermath. However, only 19% of the sample firms claim to have been adequately insured. Only 28% of the sample indicated that they were adequately insured and profitable. There were roughly an equal number of firms that increased their productivity level versus otherwise (decreased or unchanged). The survey also asked 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 with business interruption insurance and firms with adequately and timely insurance payout.

Many 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 the 6 biggest sectors for analysis. These are: health care and social assistance, manufacturing, construction, accommodation, financial services and insurance, and retail and wholesale trade.[18] 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 insurance.

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 their business sites.

In estimating equation (2), there are three possible outcome (dependent) 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.[19] The second outcome variable is the productivity of firms after the disaster. The survey question asked if 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; this question is subjective. This variable is coded as 1 if the firm is reported to be significantly or slightly better off as a result of the earthquake and 0 otherwise.

[18] Sectors are not included due to small number of observations (less than 10), because businesses in this sector are uninsurable (e.g. agriculture), or we found no way to interpret the economic implications of disaster impact (e.g. arts). There are few sectors with few observations that are left out of the model because the overall fit of the model is better without their inclusion even after accounting for the inclusion of more observations (a higher pseudo R^2). This suggests that these (economically less important) sectors may react differently to an external shock in the presence of insurance coverage.

[19] 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. For for-profit organizations, we note whether profitability is moderate or high.

There are two core (independent) variables of interest. The first is whether the organization had business interruption insurance at the time of the earthquake. This variable is a binary indicator 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, 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 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.[20] This analysis asks whether the business interruption insurance provides additional benefit to organizational recovery as opposed to those with property insurance but without BI coverage.[21]

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 at least 80% of their claimed amount. Each category was set as a binary variable with 1 if they belonged to the category and 0 otherwise. These variables proxy the extent that insurance provides a supportive role for recovery when the affected organization received a timely payment and/or was adequately insured.

In total, we use 25 control variables from this survey; these can be categorized into five main categories. The first category is industry sector (six binary variables). Four indicator 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

[20] 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.
[21] We exclude motor insurance from this analysis because business interruption insurance is available only with property damage insurance policy.

brought about by 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 available (purchased) business interruption insurance (BI) at the time of the earthquake. Initially, we analyze the difference-in-mean of each core variable conditional on having business interruption insurance using one-way ANOVA. We found that the difference-in-mean of profitability and productivity between the parties with BI and without BI coverage are both statistically significant (at 10% and 5% level, respectively). This initial analysis showed that there are some differences between the level of profitability and productivity between the two groups.[22]

Table 6 displays the estimation results using our logit model. 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 effect on profitability no longer statistically significant and the effect on subjective perception of improved circumstances (better-off) now statistically significant. While none of these results are conclusive, they do suggest some evidence that having business interruption insurance does have positive effect on business productivity.

[22] These results are available in the online appendix.

TABLE 6 ABOUT HERE

Given the perceptions in Christchurch about delayed payments, we are also interested in our second core variable - the timeliness and adequacy of insurance payments (Marsh, 2014). We split the observations into two groups: those that had been paid fully (over 80% of their claim) and believe that their claim payment is adequate, and others. Initially, we analyze the difference-in-mean of each core variable for those with/without adequate claim payment using standard ANOVA. We found that the difference-in-mean of profitability between those with/without adequate claim payment is statistically significant at 10% level.[23]

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 self-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). The difference among these coefficients, however, is not statistically significant. In addition, not having insurance or having a fully settled claim were statistically significant predictors of perceiving to be '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. To summarize this, having BI insurance seems to be quite useful according to all three measures, and the distinction between settled or inadequately-settled claims seems to manifest itself mostly in the subjective measure of being 'better-off.' This might be because the inadequacies that were perceived in the claim settlement process mostly affected subjective views about the process of recovery rather than the objective successes or failures of that process.

TABLE 7 ABOUT HERE

[23] Results are available in the online appendix.

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 4% (8%) with (without) control variables on profitability; i.e., having business interruption insurance, *ceteris paribus*, increased the probability of being profitable by 4 percentage points (but this is small enough to be statistically indistinguishable from a zero impact). Similarly, by having BI insurance, an organisation has increased its probability of experiencing an increase in productivity post-event by 16 percentage points. For the subjective measure ('better-off'), the equivalent estimate is 9 percentage points.

TABLE 8 ABOUT HERE

For our measures for adequate and timely insurance payments, we see that having a protracted or inadequate insurance payment can be seen to potentially have an adverse impact. However, these results are only significant without control variables, and the distinction between the coefficient of protracted claims vs. fully settled claim is never statistically robust. Thus, our results may be suggestive that having unsettled insurance claims may hinder the recovery process, but they do not prove this possibility conclusively at all.

6. Conclusions

We examine the role of insurance in business recovery following the Christchurch earthquake in 2011. The central question we pose, in the short-term analysis, is whether insurance increases the likelihood of business survival in the immediate 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 organisations dealt with business continuity in the immediate aftermath of the Christchurch earthquake, remains an open question.

For the 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 increased productivity and improved performance following the catastrophe. Business interruption insurance significantly increases the likelihood of enhanced productivity – by approximately 15 percentage points. This analysis points out that having business interruption insurance does have positive impact on firm's survival and profitability after a natural disaster.

A second line of analysis was carried out to better understand the impact of timely and sufficient insurance payment 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 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., 2017, King et al., 2014, Seville et al., 2015). Most strikingly, firms that had no insurance performed better than firms that had insurance but their claims were not settled promptly (in 2-3 years).

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). Relying on binary survey answers, as we inevitably do, can introduce some bias into the analysis, as we cannot rely on objectively-observed quantifiable data. *A priori*, however, we cannot assess the direction of this bias.

Second, details on the exact timing of claim payments would help to further clarify the impact of payment delays. Third, information on non-insured losses would help us understand the issue of adequacy of insurance and to distinguish and separate this from the timeliness of claim settlement. Fourth, if we 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. Answering the many as yet unanswered questions about the role of insurance in post-disaster recovery would shed light on the precise benefits of using insurance as a disaster recovery tool, and would enable a more comprehensive cost-benefit analysis of disaster insurance, more generally.

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

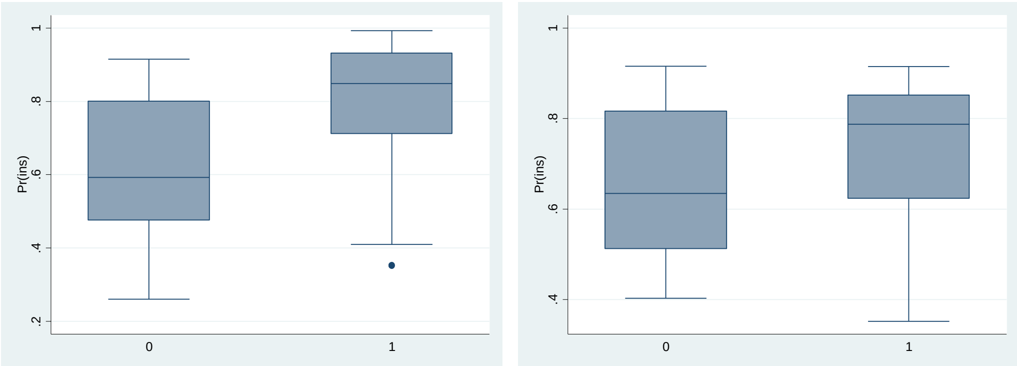

Table 1: Pre-earthquake variables for estimating propensity scores

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 χ2	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 χ2	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	0.08	*	0.15	**	0.07	
• With Control Variables	0.04		0.16	***	0.09	*
Insurance status						
• No Control Variables						
o had insurance but did not lodge claim	0.12		0.38	***	0.16	*
o claim with protracted settlement	0.04		0.37	***	0.08	
o settled claim	0.14	*	0.34	***	0.15	*
• With Control Variables						
o had insurance but did not lodge claim	0.03		0.31	***	0.11	
o claim with protracted settlement	0.02		0.35	***	0.04	
o settled claim	0.06		0.29	***	0.09	

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