

# **Dual Insurance Model and the Implications to Insurance Demand and Supply Post-Christchurch Earthquakes in New Zealand**

## **Abstract**

This paper gives an empirical analysis of post-Christchurch earthquakes insurance reactions. In a broad sense, the paper examines earthquakes ramification to supply-side for the entire insurance industry in New Zealand as well as goes further to give a narrow analysis of the quake implication to individual insurance company. The research has been motivated by the unique attribute of the New Zealand nature disaster insurance. This has helped the private insurance companies to provide insurance coverage at competitive premium rates even when the probability of a catastrophic event is considered high in New Zealand. The study starts by a market analysis that point to the need for government intervention in natural disaster insurance provision in Countries prone to disasters. In the end this paper will be able to illustrate the framework for natural disaster in New Zealand as well as give supply-side changes that were experienced in the aftermath of Christchurch quakes.

**KEY WORDS:** Christchurch Earthquake; Insurance; Loss Ratio; Premium

## **1. INTRODUCTION**

### **1.1. Overview**

This paper looks at the empirical implication of the earthquake to the insurance market. The research is centered on the supply-side of the insurance market post Christchurch earthquakes. The analyses thus start by first introducing the events leading to the Christchurch catastrophes. Second, the study looks at how catastrophe risks are insured in New Zealand by giving a diagnostic analysis of the natural disaster insurance market for residential property and contents. Third an empirical analysis using data sets for business statistic in all business line and later for particular class of business, domestic building and contents, is done. Lastly, the role played by governments in provision (and/or interventions) and how this has helped both private insurance and reinsurance providers to meet consumer's reasonable expectations is described.

In summary then, the most interesting contributes in the paper is what happened in the New Zealand insurance market post-Christchurch earthquakes. That is, (i) the change in contract from full replacement cost to sum insured and the effect of the change to the insurance market, (ii) the rise in the premium rate and why the premium changed, (iii) the increase in the total amount of premiums written showing business growth; to what extent this is depended on the increase in premium rates, changed in contract formation or change in property value, and (iv) the values of the loss ratio pre- and post-quakes.

### **1.2. Introductory Background of Events Leading to Christchurch Earthquakes**

Over 20,000 earthquakes are recorded by New Zealand's geological hazard monitoring system (most of them being minor) every year, with approximately 200 of them being strong enough to be felt. In 2010 and 2011, two major earthquakes occurred in Christchurch City. In

particularly the first strong quake at a magnitude 7.1 on the Richter scale occurred at 4.35 am on September 4, 2010, the epicenter was 40 km west of Christchurch City and the depth of the quake was at 10 km (Wu, Cheung, Cole, & Fink, 2014). In the aftermath of the first earthquake, dozens of its aftershocks followed causing moderate damage. The first earthquake sequence initiated three other significant earthquakes close to the Christchurch city culminating to an aftershock of the second major earthquake, measuring 6.3 on the Richter scale, which struck at 12:51 pm on February 22, 2011. The location of the second major quake was within 5 km south-east of Christchurch City, at a shallow focal depth of 5 km (Wu et al., 2014). This second quake produced damage labeled as destructive by GeoNet (the builder and operator of modern geological hazard monitoring systems in New Zealand); unreinforced masonry buildings were severely damaged with liquefaction occurring in many parts of the eastern suburbs rendering entire neighbourhoods completely uninhabitable (Buchanan, Carradine, Beattie, & Morris, 2011; Bull, 2013).

**Table 1:** Five Major Canterbury Earthquakes

<b>Time</b>	<b>Location</b>	<b>Magnitude</b>	<b>Intensity</b>
4:35am, September 4, 2010	840M from Ansons Road, Charing Cross	7.10	X
10:30am, December 26, 2010	40M from Brougham Street, Sydenham, Christchurch	4.91	V
12:51pm, February 22, 2011	340M from Rapiki Road, Hillsborough, Christchurch	6.34	VIII
2:20pm, June 13, 2011	690M from Barnett Park Track, Redcliffs, Christchurch	6.41	VIII
3:18pm, December 23, 2011	250M from 466-68 marine Paradel South New Brighton, Christchurch	6	VII

**Source:** (GeoNet 2014)

Estimates of the total economic cost of the two earthquakes vary and are subject to considerable uncertainty. The biggest challenge was the ongoing nature of the earthquake

sequence, and the need to treat each of the 5 major separate events (Table 1), identified by the Earthquake Commission (EQC) as one independent insurance claim.

Until the full payment of all claims and complete recovery is done, it remains a difficult task to give an exact figure of the total economic cost and insured loss paid out. There have been differences between the market value of assets destroyed, the cost of replacing those assets over time, and the additional value of rebuilding to a higher standard or other discretionary improvements. In addition, disruption to businesses and to the lives of individuals following a natural disaster can be substantial, but is difficult, if not impossible, to measure the financial implications of all these accurately. The Christchurch earthquakes provided an unprecedented challenge for the insurance industry and indeed to the entire New Zealand economy. New Zealand Treasury estimated a total cost of insurance claims for the earthquakes at a value above NZ\$30 billion, which is equivalent to 15 to 20 per cent of the Gross Domestic Product GDP (Kachali et al., 2015; Parker & Steenkamp, 2012).

Taking into account the complications with claims involving multi-unit buildings, retaining walls and land issues, the private insurers had paid out almost NZ\$14 billion in settling claims resulting from the Christchurch earthquakes in 2010 and 2011 as at the end of December 2014. The payments was comprised of NZ\$8.17 billion been paid to settle commercial claims and NZ\$5.69 billion for domestic claims. This represented a significant contribution towards the new estimated NZ\$40 billion economic loss suffered in Canterbury region. This has allowed business and households to recover and rebuild almost five years after the tragedy. The figure includes damages to buildings and contents, as well as disruption to business activities and does not include underinsured or uninsured losses (Brookie, 2014; Kachali et al., 2015). The fact that natural disasters have both immediate and long-term economic effects has not been captured in any of these estimates, it is therefore prudent for this study to come up with that the actual economic impact is much higher. An early estimate

by Aon Benfield had put the Christchurch earthquakes amongst the most significant natural disaster events in the insurance world, with insurance losses initially estimated at US\$13.5 billion. Later in 2013 these estimates had been adjusted to US\$16.5 billion and now stands beyond US\$40 billion going by the Reserve Bank estimates (Parker & Steenkamp, 2012; Potter, Becker, Johnston, & Rossiter, 2015).

Table 2 indicates the top ten insurance loss estimates from natural disaster worldwide; Christchurch quakes loss even at the most conservative figures stood at position two worldwide in the year ending 2011 (Swiss-Re, 2012).

**Table 2:** Christchurch earthquakes compared to global events in 2011

Top ten insurance loss events in 2011	Estimated losses in \$ (USD)
Earthquake Japan	35.00 billion
Earthquake New Zealand, 22 February 2011	13.50 billion
Flooding Thailand	10.78 billion
Severe Weather U.S. Southeast, Plains, Mid-West	7.30 billion
Severe Weather U.S. Plains, Mid-West, Southeast	6.75 billion
Severe Weather Hurricane Irene	5.00 billion
Flooding Australia	2.42 billion
Severe Weather U.S. Southeast, Plains, Mid-West	2.00 billion
Earthquake New Zealand, 22 December 2011	1.80 billion
Severe Weather U.S. Plains, Mid-West, Southeast	1.70 billion

**Source:** (Aon/Benfield, 2013)

(Swiss-Re, 2012) sigma report shows the reinsurance industry in 2011 suffered one of the highest, if not the highest, insured losses ever. That year also saw the tsunami in Japan, an active windstorm season in North America and Thailand and Queensland floods. As a result, there was a tightening of the reinsurance market, leading to a very significant increase in reinsurance costs. The costs were global and translated into the significant increase in premiums for households in New Zealand and in comparison to other nation prone to natural disaster.

The paper proceeds in seven sections as follows: In the next section, we present in general the challenges faced post-quake and the role of the government in natural disaster insurance. Section three describes the New Zealand natural disaster insurance through earthquake commission. New Zealand ranked second highest for non-life insurance penetration relative to GDP and with residential insurance penetration at above 90%, this section discusses how the high penetration of insurance in the residential market can largely be attributed to the fact that New Zealand is ranked third in the world for expected losses and to the program offered by the EQC. In section four, this study reviews the literature of government involvement in natural disaster insurance programs worldwide. Section five expounds on the description introduced in section three to demonstrate how the EQC Vs Private Insurance Company's dual insurance model framework is structured. This section also describes the reinsurance market for New Zealand catastrophe risk and goes further to introduce a concept that can be used as an alternative to traditional reinsurance mechanism currently used the insurance market. Section six uses industry business statistics to describe the supply-side reaction and the implication on the insurance market post-Christchurch earthquakes. Section seven gives a further government intervention analysis for the case for red-zone state property acquisition. The analysis of the state settlement of red-zone properties and the choices made by the homeowner reveals; the importance of state intervention in extreme natural disaster events and the insured perception, decision and choices when faced with the situation of the state taking over all insurance claims for damage to the property. In this analysis, the study aims to describe the circumstances in which the insured finds themselves when their properties are deemed unfit for habitation and the prevailing chose parameters thereof. Section eight gives a further general observation on the market reaction post-Christchurch earthquakes in line with the prior literature. The last part of the paper concludes with a brief discussion on the findings of the study.

## **2. NATURAL DISASTER INSURANCE**

### **2.1. Need for Government Participation in Natural Disaster Insurance**

Table 2 in Section 1.1 illustrates how devastating natural disasters can be to the normal operations of the economy. The magnitude of the economic shock from catastrophes can thus never be left to the traditional insurance mechanism to fully protect the economy and to rebuild society back to smooth daily affairs. Thus, insurance for natural disasters is not a matter to be left to the private insurance players alone. This study demonstrates for an insurance market faced with catastrophe exposure; that if this have to happen, private insurers would require premiums which are unaffordable to the insured. In the end this leads to market failure as suggested in (Nguyen, 2013). In order to avoid the insurance market inefficiency due to extremely high premiums, government-sponsorship (or subsidies) is hence necessary. In cases of no state participation or subsidies, the private insurance markets would totally collapse for extreme catastrophic exposures.

Thus, in Countries prone to specific natural disasters, governments have found it necessary to intervene in insurance provision. While the participation in insurance solutions in form of state sponsored insurance programs differ in principle; generally they are all designed to offer insurance to individuals (mostly homeowners) who would otherwise find it unaffordable to buy policies in the private insurance market. The government and the private insurance companies can further participate in elaborative reinsurance mechanisms to cede part of the underwritten risk.

The next section demonstrates how natural disaster risk is insured in New Zealand residential property and contents market together with a brief literature on countries with similar State-sponsored systems.

## **2.2. New Zealand Natural Disaster Insurance through the Earthquake Commission**

In the study of 42 high risk countries in 2011, New Zealand ranked second highest for non-life insurance penetration relative to GDP (with premiums equivalent to 5.2% GDP) and highest in the world in the residential insurance penetration (CEBR, 2012). Although the residential insurance penetration is very high in New Zealand; over 90%, earthquake insurance penetration in general is about 80%, as compared to that in North America at 20%; virtually everyone has an insurance policy protecting their home (Pierepiekarz et al., 2014). In other parts of the world, underinsurance continues to be a problem. For example, only 17% of the economic losses of Japan following their 2011 tsunami were covered by insurance (Cooper, Donnelly, & Johnson, 2011; Marquis, Kim, Elwood, & Chang, 2015). The high penetration of insurance in the residential market can largely be attributed to two factors; to the fact that New Zealand is ranked third in the world for expected losses that could occur from a natural disaster as a percentage of GDP in any given year (Brown, Seville, & Vargo, 2013) and to the program offered by the EQC. The EQC is a Crown entity that has its origins in an insurance pool set up in 1941 to address war damages. It was later expanded to cover earthquake damages and in 1993 became the EQC. The EQC provides natural disaster cover for buyers of residential insurance provided by private insurers. This is a unique natural disaster insurance provided as a rider on Fire and General peril cover offered by the private general insurance market in New Zealand. Therefore, all residential property owners who buy fire insurance automatically acquire EQC Insurance. Under the domestic building and contents insurance cover provided, all general insurers in New Zealand collect a levy on behalf of the EQC. As important as it is to homeowners, those who do not buy private insurance cover for their residential properties for whatever reason do not receive this cover. The EQC's main function is to insure residential properties, their contents and the land around the properties against damage by earthquake, volcanic eruption, natural landslip,

hydrothermal activity, and tsunami. The cover also includes fire following any of these disasters and residential land damaged by storm or flood. In addition to managing the fund, EQC buys international reinsurance and is government guaranteed. This provides assurance to insurance consumers that if EQC has a very large number of claims and cannot cover its obligations from the Natural Disaster Fund and its reinsurance, then the government will pay the shortfall as the reinsurer of last resort.

Through its Natural Disaster Fund, cover is provided for residential properties to a maximum of NZ\$100,000 excluding GST and contents to a maximum of NZ\$20,000 excluding GST; this amount of insurance is available for each event of natural disaster damage. From February 1, 2012, the EQC levy on residential property and contents insurance increased from 5c to 15c per NZ\$100 of insurance cover (this is equivalent to 200% increment). The maximum total levy that a policy holder pays per residence is now at NZ\$150 for home policies and NZ\$30 for contents policies, (excluding GST). The most a policyholder can pay as levy, per year, for one home and its contents is therefore NZ\$180 excluding GST. The levy is normally loaded to the underwriter's premium and passed on to EQC once the premium is received by the insurance company. The increases applied if the policyholder took out new residential property and contents policies on or after 1 February 2012 or had an existing annual policy with a renewal date within the 12 month period from 1 February 2012. A possible explanation to the increment is an intention to help rebuild the EQC's Natural Disaster Fund following the Christchurch earthquakes and to ensure that the EQC has the capacity to meet its obligations in the future as well as cope with the new reinsurance underwriting requirements. Private non-life insurers provide natural disaster damage cover to a level beyond the maximum cover that EQC provides. This is often referred to as EQC top-up cover.

### **2.3. Natural Disaster Insurance Programs Worldwide With Government Involvement**

Literature from previous studies (Atreya, Ferreira, & Michel-Kerjan, 2014; Martin F Grace & Klein, 2003; Grossi, Kunreuther, & Patel, 2005; Klein & Kleindorfer, 1999) points to the fact that State participation in insurance market is not only unique to New Zealand. The National Flood Insurance Program (NFIP) managed by the Federal Emergency Management Agency (FEMA), California Earthquake Authority (CEA) and Japanese Earthquake Reinsurance (JER) have similar natural disaster programs while Turkey has one of the newest such program now in place. However, the unique features of EQC in New Zealand's government involvement reveal the greater semi-autonomous role that States could play in the private insurance market.

In the US, standard homeowners insurance don't cover flooding and associated natural hazard perils. The federal government established the NFIP in 1968 (Dacy & Kunreuther, 1969; Michel-Kerjan & Kousky, 2010) to help provide a means for property owners to protect themselves financially; from the floods associated with hurricanes, tropical storms, heavy rains and other conditions that heavily impact some states in the US. Managed by the FEMA which maps flood risks and sets flood insurance premiums; the programme is designed as a voluntary partnership between the federal government and local communities. The NFIP provides insurance up to a maximum limit for residential property damage, now set at US\$250,000 for building coverage and US\$100,000 on contents coverage. The underlying principle of the program is to subsidise the cost of flood insurance on existing homes, in order to maintain property values, while charging actuarially fair rates on new construction. Similarly, the California Earthquake Authority (CEA) established by the California legislature in 1995 following the 1994 Northridge earthquake is designed to preserve the state-mandated offer of earthquake coverage. The CEA requires the participation of 70% of

California homeowner insurers before it could begin operation. Insurers choosing not to participate are required to offer a similar brand of earthquake coverage to residential policyholders. The CEA offers a scaled-down policy covering homes and certain apartment buildings, but not other structures such as swimming pools, garages and driveways. Unlike New Zealand's EQC no public funds are pledged or available to cover CEA-insured losses. If an earthquake causes damage greater than the CEA's claims-paying capacity then policyholders will be paid on a prorated basis. The prorated claims would be calculated on the basis of the total amount of expected claims compared to the remaining available funds.

Elsewhere in Japan, the 1966 Earthquake Insurance Law (enacted after the Niigata earthquake of 1964) established the Japanese Earthquake Reinsurance (JER), to whom private nonlife insurers were obliged to offer earthquake insurance and cede 100% of the earthquake premium and liabilities (Tsubokawa, 2004). The JER thus acts as the sole earthquake reinsurer for the private insurance market. The total claims-paying capacity of the program is currently ¥5,500 billion (US\$45 billion), which is estimated to correspond to the scenario of the 1923 Great Kanto earthquake with a return period of 220 years. In the event the insured earthquake losses exceed this amount, claims would be prorated accordingly. The maximum liability of the government of Japan, JER, and private insurers is 87%, 10%, and 3%, respectively.

In the aftermath of the two major earthquakes in 1999, the Government of Turkey decided to enforce earthquake insurance on a nationwide basis with the sole purpose of privatising the potential risk by offering insurance via the Turkish Catastrophic Insurance Pool (TCIP). This program bundle the major part of disaster risk and exports it to the international reinsurance and capital markets (Bommer et al., 2002). This measure was aimed at reducing government's fiscal exposure in the event of major catastrophic earthquake, as well as to encourage risk mitigation and safer construction practices. To achieve these goals all

registered residential properties in Turkey (the total number currently is about 19 million) are required to be in the compulsory earthquake insurance coverage.

Initially funded by the World Bank, the TCIP program became effective as of March 2001 and is currently one of the most renowned insurance brands in the Turkish insurance market. High brand recognition and increasing earthquake insurance awareness among homeowners gives leverage to take-up rate in earthquake insurance (TCIP policy count was about two million as of September 2004, increasing to 7 million by end of 2014). The TCIP policy offers coverage on a first-loss basis, meaning that it does not impose underinsurance penalties when the value of a dwelling is significantly higher than the limit of coverage obtained from the TCIP. Unlike the CEA, which imposes a deductible of 10%, the TCIP applies a minimum 2% deductible to the sum insured to avoid small claim, reduce moral hazard and reduce the pools' administrative and reinsurance cost.

This study examines examples of three state-sponsored programs to emphasize the central important role played by such programs in the natural disaster insurance. An audit of governments' involvement in insurance provision worldwide set New Zealand as the only country with unique compulsory Natural Disaster Fund to only those who buy private home insurance cover and 100% government guaranteed. The role played by the EQC in the aftermath of Christchurch quakes cannot be understated; without the EQC, it would be almost impossible for the private insurance to single handedly rebuild Christchurch City back to normalcy.

### 3. DUAL INSURANCE MODEL FRAMEWORK IN NEW ZEALAND

This section examines the structural framework and formation of the natural disaster insurance in New Zealand. In the aftermath of the 2010 and 2011 Canterbury earthquakes, questions have emerged on whether the dual-insurance model in New Zealand for earthquake claims worked as was envisaged by EQC and the wider insurance industry. This section deduce how such risk is written which lays a foundation for natural disaster specific risk rating and proposes an alternative risk hedging mechanism that can be explored together with the existing traditional reinsurance arrangements. It is now clear that, the New Zealand residential property and contents insurance constitute two layers of insurance contract run in a dual-insurance model. As described in the preceding section, the first contract layer is cover by EQC; the second contract layer is covered by the private insurance market. The EQC cover is against natural disaster perils to a prescribed policy cap in return for a premium, a statutory levy charged to all residential property fire and general underwritten premium rates. An outlook of the contract for this insurance arrangement is given as follows. Suppose the proportion covered by EQC contract is up to a predetermined sum insured denoted by  $Q$  (now set at a maximum of NZ\$100,000 excluding GST for residential properties and to a maximum of NZ\$20,000 excluding GST for contents). The second component of the contract covered by the private insurer to a maximum sum insured be denoted by  $M$ . The primary insurer is in this case responsible for any claim's cost associated with random loss  $X$ , if and only if the gross loss amount is between  $Q$  and the maximum nominated sum insured  $M$  subject to all other policy conditions within the contracted period denoted as  $T$  (i.e. provide indemnification per occurrence for loss  $X$  that exceed the EQC level  $Q$  and given that its less or equal to  $M$ ).

Thus we present the above insurance arrangement as follows:

- (i.) If  $X < Q$  then the primary underwriter pays nothing;
- (ii.) If  $X \leq M / X > Q$  then the primary underwriter pays  $X - Q$ ; and
- (iii.) If  $X > M$  then the underwriter pays  $M - Q$  and the exceeding portion  $X - M$  is borne by the homeowner.

For an insurance pay-out denoted by  $P$ , the above contractual agreement on the insurers' side is as follows:

$$P = \begin{cases} \text{Min}(X - Q, M - Q) & \text{for } Q < X \\ 0 & \text{elsewhere} \end{cases} \dots\dots\dots \text{Eq 1}$$

*Eq 1* presents contracts formulation that forms the basis for pricing the liability undertaken by the EQC. Currently, the EQC imposes a blanket levy across all residential property buying insurance coverage based on actuarial pricing of totally different risk category (i.e. fire and general peril). In this study it is proposed that the levies could be based on the actual risk factors based on *Eq 1* that have relevancy to occurrence of natural disaster as opposed to a fixed levy on the premiums to totally different risks. Second, *Eq 1* can as well be re-expressed as the difference between two call options with different exercise price, that is, a call-option spread, written on the loss exposure of the underlying event as suggested in (Cummins, Lewis, & Phillips, 1999):

$$P = \text{Max}(0, X - Q) - \text{Max}(0, X - M) \dots\dots\dots \text{Eq 2}$$

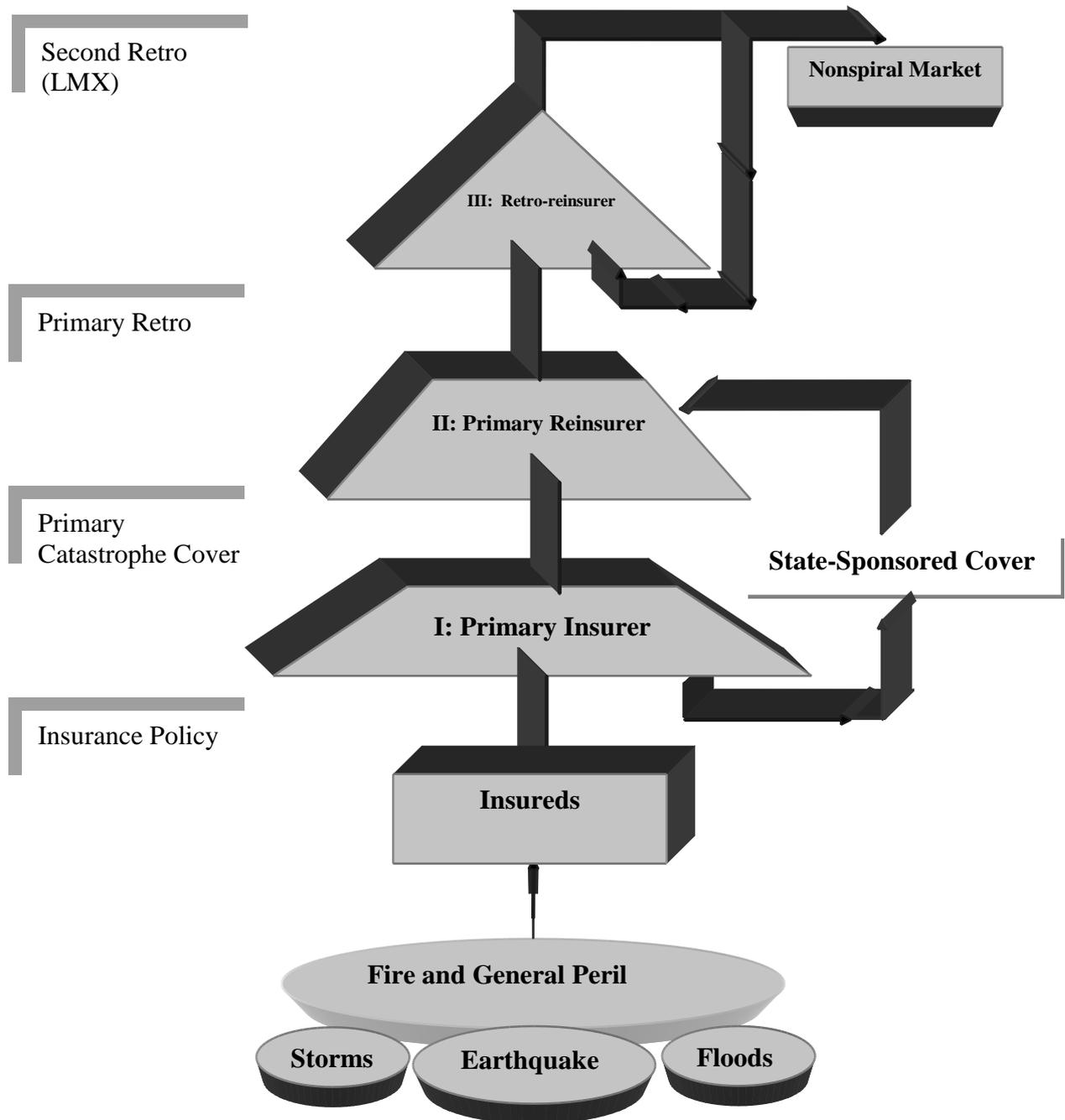
As an alternative to traditional reinsurance arrangements the EQC together with the private insurers can write a hedging contract which could be tradable in derivative market. Under the current residential insurance structure shown by *Eq 2*, the EQC and insurance providers can directly write and sell contingent claims against the upper cap of natural disaster losses on a per occurrence basis and trade in the catastrophic tradable market.

This study finds that the key to success of property insurance in New Zealand even with such high catastrophe risk is the elaborate reinsurance arrangements in place. Led by the Syndicates at Lloyd's of London the crucial role played by the reinsurance market post-Christchurch catastrophe cannot be overstated. The complex structure of the reinsurance arrangement is shown in Figure 2; it depicts the stages in catastrophe insurance market through which New Zealand natural disaster business is insured. This is grouped into three levels (i.e. primary insurers, primary reinsurers and retro-reinsurers) based on their position in the chain of insurance and reinsurance buyers and sellers.

On Level I are the primary insurance companies that issue homeowners policies (i.e. fire and general peril with natural disaster bundled as a rider). The direct writers in turn purchase reinsurance contracts normally referred to as catastrophe covers from primary reinsurers on Level II.

On Level II are companies such as large professional reinsurers, many syndicates at Lloyd's of London as well as large and small broker market reinsurers worldwide. Some reinsurers specialise in this business. Typically, those companies would be leads, who would quote terms on contracts which other companies would then follow (i.e., sign on to). Occasionally and more so in highly catastrophe prone markets, reinsurers directly influence the premium rate and other policy conditions at level I. For example the Christchurch earthquakes led to a switch from total replacement home insurance to sum insured, for reinsurers to better understand their maximum liability for residential properties in New Zealand.

On Level III are companies who reinsure the primary reinsurers. They provide catastrophe covers referred to as primary retrocessional contracts for the primary reinsurers. Although many of the primary reinsurers will write a handful of these primary retro contracts, the number of companies that specialise in and write a significant volume of this business is a small sub-set of the universe of reinsurers. Some syndicates at Lloyd's are specialists in this type of business.



**Figure 1:** Structure of Natural Disaster Insurance and Reinsurance Transfer

These companies on Level III themselves buy secondary retrocessional catastrophe covers referred to as LMX (London Market Excess of Loss business). There is not a distinct fourth level of companies writing these, but they are written by a subset of Level III companies themselves. This study finds that an estimated 37% of Lloyd's total business in reinsurance

has most relevance to New Zealand. A gross written premiums amount to NZ\$340 million is generated from New Zealand customers each year. This places the market at position 47 amongst the 200 countries Lloyd's business works in (Franco, 2014). In this light, on Wednesday, February 18, 2015 Lloyd's of London Chairman John Nelson made his first visit to Christchurch, a manifest of the importance of New Zealand market to the syndicates and the fundamental need for catastrophe insurance cover. As at April 2015, the Lloyd's syndicates had paid out NZ\$4.2 billion of reinsurance and insurance claims for two Christchurch earthquakes. This figure is estimated to increase to NZ\$5.8 billion as further reinsurance payments are paid to EQC and others (King, Middleton, Brown, Johnston, & Johal, 2014; Merkin, 2012).

## **4. INSURANCE MARKET POST-QUAKES**

### **4.1. Some literature on Post disaster reactions**

Prior literature points that when insurers' risk-taking capacity as determinant for the insurers' willingness to provide coverage is strictly disrupted; see (Cagle & Harrington, 1995; Gron, 1994; Harrington, Niehaus, & Yu, 2013; Winter, 1994), a reduction of insurance supply immediately after major catastrophic losses is predictable. However, (Cagle & Harrington, 1995; Ragin & Halek, 2015), suggests that the price effect of a negative shock to capital depends on the price elasticity of demand. And therefore; insurers' ability to recover from a catastrophic loss by increasing insurance premiums is limited when policyholders respond to prices and especially when there are recently bankruptcy in the industry in the aftermath of a disaster. (Born & Viscusi, 2006) observe a negative supply effect of both large and unexpected catastrophes and that insurers are able to improve their loss ratios in the medium term after large catastrophes by raising insurance premiums. These shift the cost of a capital shock to the policyholders resulting to depressed demand. (Klein & Kleindorfer, 1999) and (Martin F Grace & Klein, 2009) who investigate the impact of hurricanes on the Florida insurance market documented similar results. They found an increase in prices and a decrease in availability of insurance coverage due to the increased hurricane risk. (Martin F Grace, Klein, & Liu, 2005) examines insurance market reactions after the catastrophic hurricane seasons of 2004 and 2005 and identify three major effects on insurance supply. Firstly, a reduction in insurers' and reinsurers' capital due to the loss shock, secondly an increase in the volatility of insurers' net income which aggravates the take-up of new capital due to an increase in risk. Lastly, a disruption of insurers' own confidence in risk assessment (or risk models) which reduces the willingness to write new business. (Browne & Hoyt, 2000) provide the first empirical analyses of homeowners' demand for flood insurance through a state-level analysis across the US. Their empirical analysis suggests that both price and income are influential factors in one's decision to purchase flood insurance, and flood insurance purchases at the state level are found to be highly correlated with the losses in the

state during the prior year. (Kousky, 2010) examined the demand for flood insurance in St. Louis, Missouri and found that take-up rates increase with more land in the high risk floodplains and the rates to decline with levee protection along major rivers. However, most of these papers have not examined the supply and demand for insurance contracts post major catastrophic event holistically at the primary level where the direct insurers, individual insureds and reinsurers interact. (Martin F. Grace, Klein, Kleindorfer, & Murray, 2003) points out that, analysing the supply and demand for residential property insurance after a mega-disaster and integrating this analysis with research on risk diversification and mitigation is critically essential, in order to formulate a more complete picture of the catastrophe risk problem and evaluating viable solutions.

#### **4.2. Insurance Industry Reaction Post-Christchurch Earthquakes**

This section examines the post-quake reaction on supply-side. The main objective is to show how the 2010-2011 earthquake impacted on the performance of the insurance market. The study has gathered data from the Insurance Council of New Zealand (ICNZ) and one private insurer for the purposes of this analysis. The data from the ICNZ give a broader representation of the business statistics of both the entire industry and a specific class of interest from 2010 to 2014; this information is published annually as from 2010 for the few insurance companies who are members of ICNZ. The data constitutes industry statistics for premiums, claims and loss ratios by class of business. Using the data, the study gives a brief analysis of how New Zealand's insurance business is organised as well as any noticeable reactions in the aftermaths of the Christchurch earthquakes. The second set of data comes from a private insurance company for the period 2006 to 2014. In order to give a clear and coherent reaction of the insurance companies involved in the Canterbury region residential

property and contents insurance market, this section gives a descriptive analysis of the two data sets.

In the end, this study aims to illustrate the implication of the two earthquakes to the normal daily operations of insurance markets. The major obstacle this research is gripped with is unwillingness of many organisations to share data. So an opportunity to rigorously analyse the insurance market pre-quakes has been missed which would otherwise inform this study of the trends and market dynamics then.

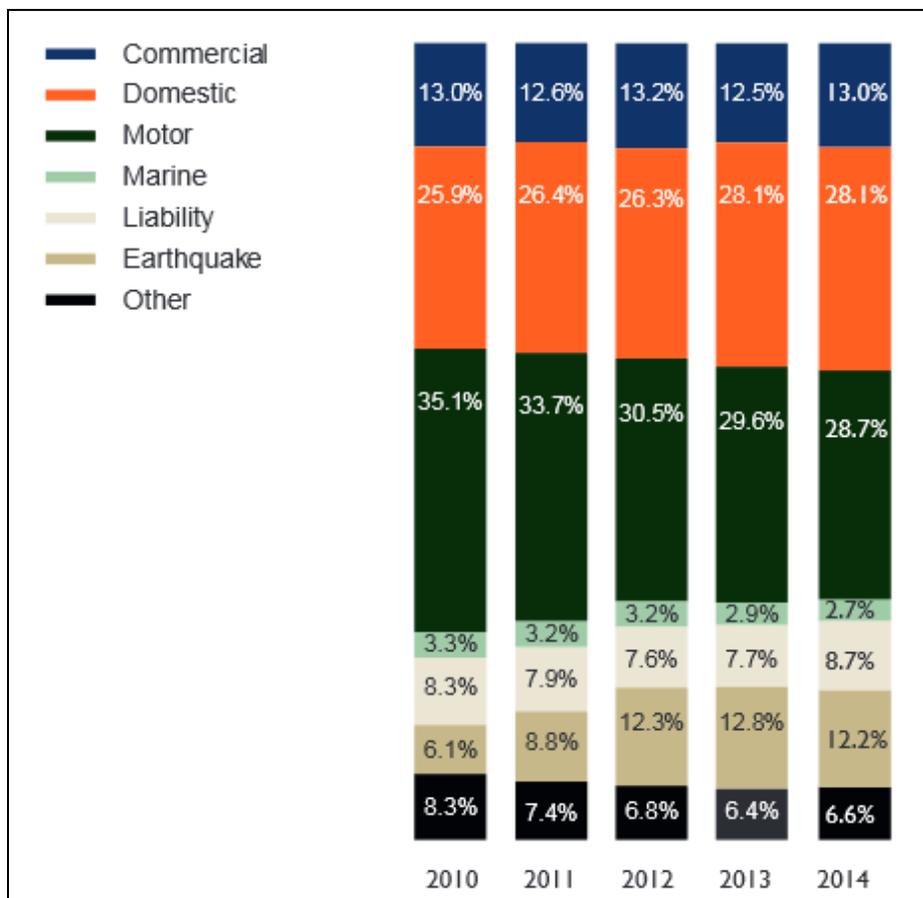
**Table 3:** Gross Written Premiums of Business Classes 12 months to September 2010 - 2014

Year-End	2010	2011	2012	2013	2014
Commercial (\$)	469,043,879	502,455,302	589,915,428	598,432,282	684,399,324
Domestic (\$)	933,495,375	1,052,270,223	1,170,172,533	1,342,027,881	1,477,326,975
Motor (\$)	1,266,098,899	1,339,829,531	1,355,055,482	1,410,050,905	1,509,389,417
Marine (\$)	126,435,782	119,594,972	144,329,385	137,235,745	140,528,421
Liability (\$)	298,229,655	313,644,264	337,991,478	368,972,214	457,406,090
Earthquake (\$)	220,172,442	350,256,36	548,513,318	608,686,700	642,638,358
Other (\$)	297,466,741	295,688,731	302,747,572	304,742,946	346,524,892
Total (\$)	3,604,101,963	3,979,548,054	4,448,725,196	4,770,148,673	5,258,213,477

**Source:** (Insurance Council of New Zealand 2015)

A general analysis of ICNZ data broadly reveals that the premiums for New Zealanders are driven by a number of factors including domestic market competitiveness and how global capital market changes influence reinsurance. The industry all business data for the last five years indicates demand for domestic and earthquake insurance covers has been on an increasing trend with Earthquake Insurance doubling from 6.1% in 2010 to 12.2% in 2014. In

dollar terms the aftermaths of the quakes the gross written premium for earthquake has grown three folds from \$220,177,442 to \$642,638,358. Domestic Buildings and Contents Insurance also recorded a similar increasing trend from 25.9% in 2010 to 28.1% in 2014; the chart in Figure 2 and the data in Table 3 show Earthquake Insurance and Domestic Buildings and Contents Insurance as the only two lines of businesses that recorded a continuously increasing gross written premium between the periods 2010 to 2014. Despite the fact that, other business lines recorded some growth in premiums, each class's growth was decreasing progressively.



**Figure 2:** NZ Insurance Industry all business data for the period 2010-2014

The study postulates that the increase in premium can be interpreted in two ways; first, it can be assumed that the demand for these two classes of business has sharply been increasing since 2010 and second; the increase in gross written premium can be attributed to increase in the premium rates in the aftermath of the 2010-2011 earthquakes.

This study set out an objective to investigate residential property and contents insurance coverage post-quakes. There have been fundamental changes in contract design and wording in the residential property insurance market; on residential property and contents the biggest effect and changes in the last five years is solely attributed to the earthquakes. The industry data for this line of business indicates higher loss ratios in the years 2010 and 2011, computed to be 62.55% and 62.30% respectively, although the ratios are within the acceptable margin, the 2 years' ratio figures are slightly above the 5 year ratio which stood at 58.88%. Insurance underwriters like the regulators use loss ratio as one of the tools with which to gauge company's suitability for coverage. A period with a high loss ratio, say exceeding 100%, means that the ability to pay claims might become increasingly impaired.

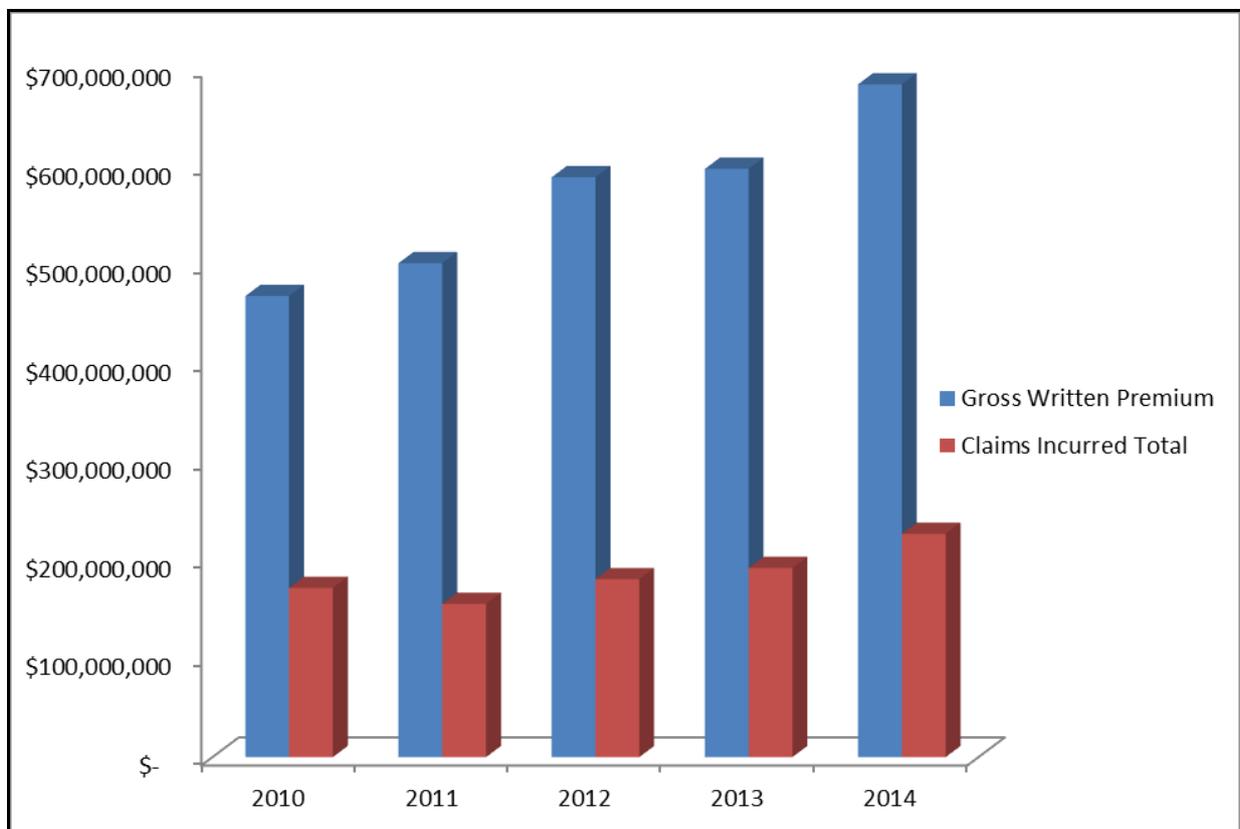
**Table 4:** Domestic Buildings and Contents 12 months to September for period 2010 - 2014

Year-End	2010	2011	2012	2013	2014
Gross Written Premium (\$)	933,495,375	1,052,270,223	1,170,172,533	1,342,027,881	1,477,326,975
Net Written Premium (\$)	866,335,821	904,836,784	963,207,401	1,082,408,518	1,219,945,738
Net Earned Premium (\$)	839,897,275	826,974,807	898,261,166	1,002,937,356	1,168,935,364
Claims Incurred (\$)	525,356,791	515,234,420	532,924,232	582,828,477	609,645,684
Loss Ratio (%)	62.55%	62.30%	59.33%	58.11%	52.15%

**Source:** (Insurance Council of New Zealand 2015)

In summary, a critical look at Table 3- 4 and Figure 2 shows that in general the domestic buildings and contents insurance coverage in New Zealand post-earthquake has an average loss ratio equal to 58.88% in the last five years. Comparing this to US property and casualty insurance industry result for the same period, the loss ratio is slightly above

70%.(Hagendorff, Hagendorff, & Keasey, 2015) confirms the fact that the insurance industry as a whole in New Zealand was not extremely affected. The sustained growth in gross written premiums, along with continued soft market conditions-characterized by slight premium rate increases and low catastrophe losses after the 2011 quake has since then strengthened this particular business line to unprecedented levels against any possible ruin. In the end what these figures do show us is that New Zealand has been a relatively good market for insurance with a loss ratio below 100% and that has encouraged reinsurers to stay in New Zealand following the Christchurch earthquakes.



**Figure 3:** Gross Written Premium Vs Total Amount of Claims Incurred (Industry Business Statistic for Domestic Buildings and Contents Insurance in New Zealand)

Figure 3 depicts the overall situation in the industry, showing the total claims incurred in the last 5 years verses the gross written premium for the same period. A general look at Figure 3 at glance depicts New Zealand insurance as a hard insurance market place for insurers. A

further look to the financial reports of the two big brands in the New Zealand insurance industry (IAG and Suncorp), points to the fact that in the aftermath of the quakes underwriters have taken-out more reinsurance arrangements than before. They have taken a view that, it is perhaps more risky hence have bought as much cover as they can get. The private insurance companies under the Insurance Prudential Supervision Act are required to buy a certain quantum of reinsurance. The study confirms that the biggest insurance groups have gone further to strengthen their future financial position. So while the price of reinsurance might be going down to a certain degree, having to buy more reinsurance progressively over time has kept the reinsurance total premium high. For example, the IAG increased its reinsurance protection for New Zealand to reinsurance pay-outs of NZ\$7 billion for a single big quake within the 2015 year. It was also protected with NZ\$6.75 billion for a second large seismic event in the same year. This is a 75% increase in reinsurance compared to 2011 reinsurance figures which stood at NZ\$4 billion. According to the ICNZ data and the insurer's new policy wording, there has been a fundamental and permanent shift in the insurance market as a result of the earthquakes. In particular, lesser availability of insurance for high risk properties, an increase in the cost of insurance premiums, some insurers having changed how deductibles are calculated, moving from a percent of claim value, to a percentage of insured value and with the residential policy changes from full replacement to sum insured (Sands, Fillion, & Skidmore, 2015). The onus now goes on homeowners to determine what their house will cost to rebuild. This came along to help better define risks for insurers; reinsurers likewise can now better understand their maximum liability for residential properties. The increased premiums are understandable given that most of insurers are keen to work together across the industry in an effort to reduce their risk exposure and spur a sharp increase in demand for insurance. In addition, the study finds that some insurers are moving towards specific site risk assessments to improve the accuracy of their underwriting process.

Further to all these efforts, insurers now consider factors such as region (physical hazard risk), age of building, construction and height of building and land status similar risk factor to proposition in (Freudenburg, 1988).

Insurers now approach the market more cautiously and have learnt the important lesson to treat each risk independently. To demonstrate the challenges faced by some insurance companies with considerable presence in the Christchurch residential property insurance market, this study goes further to investigate the catastrophe effect on specific business line for an individual insurance company. With this analysis, it is shown that the implication of the earthquake on individual underwriter level in a magnitude of the cost on a scale that cannot be seen from the industry aggregated data.

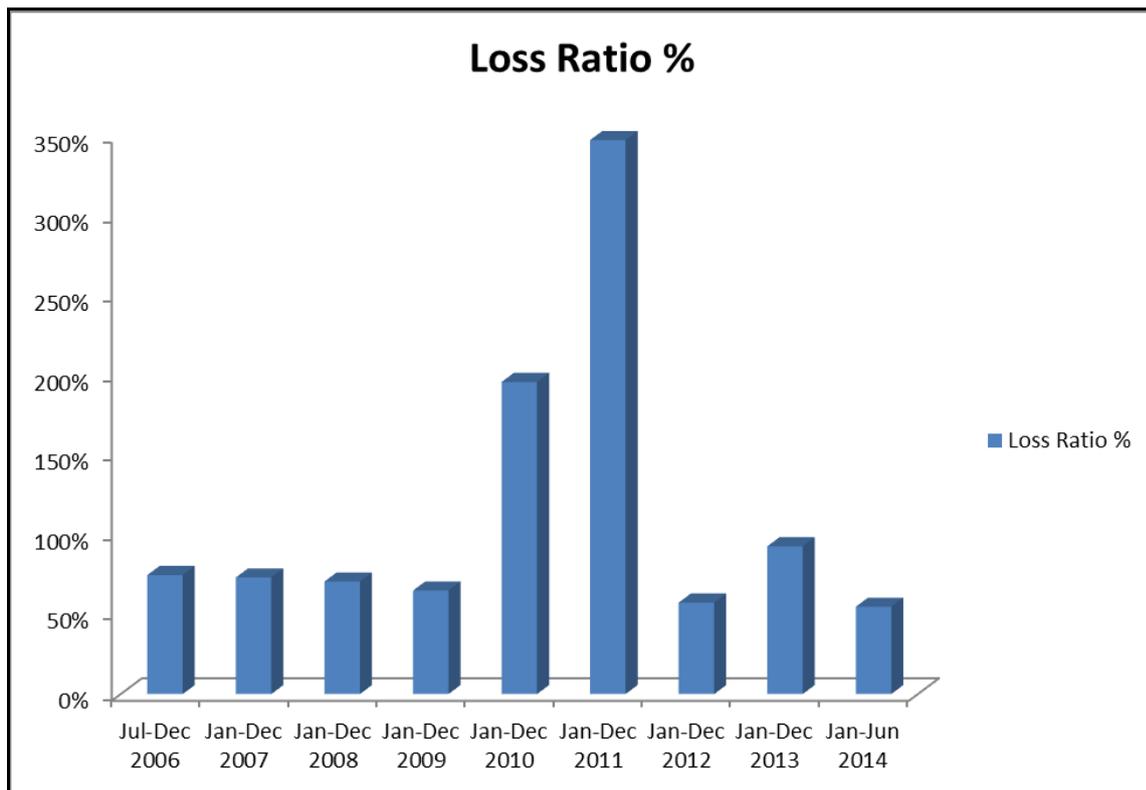
**Table 5:** Domestic Buildings and Contents 12 months to June for period 2006 - 2014

	Jul-Dec 2006	Jan-Dec 2007	Jan-Dec 2008	Jan-Dec 2009	Jan-Dec 2010	Jan-Dec 2011	Jan-Dec 2012	Jan-Dec 2013	Jan-Jun 2014
Gross Written Premium (\$,000)	20,100	45,600	51,600	56,900	63,000	77,500	84,700	89,600	50,000
Net Written Units	86,600	171,200	178,500	184,100	193,300	193,200	184,600	194,700	102,400
Claims incurred total (\$,000)	15,010	33,380	36,460	36,960	123,370	269,440	48,640	83,080	27,400
Number of claims	13,160	27,090	26,270	24,230	27,270	29,930	22,500	22,620	12,520
Loss ratio	74.68%	73.20%	70.66%	64.96%	195.83%	347.66%	57.43%	92.72%	54.80%

**Source:** Undisclosed Private insurance Company in New Zealand

The data used in this analysis is sourced from an undisclosed insurance company involved in Christchurch residential insurance earthquake claims. We spent nearly one year negotiating with various local underwriter to release to us some business statistics for the purposes of this analysis. The local insurance companies proved to be very conservative and reluctant to work

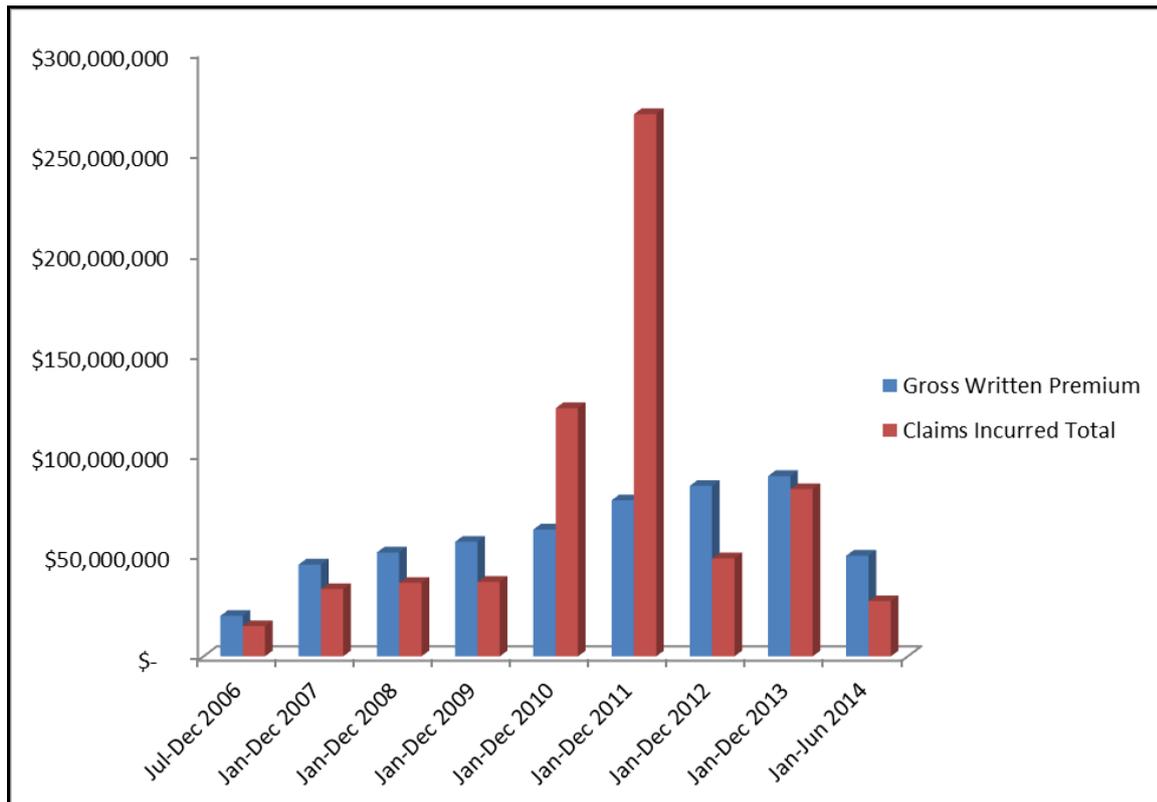
with academic studies, and getting larger data set for more rigorous exploratory was nearly impossible task. The study was only able to source statistics from one undisclosed insurance company for the periods 2006 to 2014. Although these statistics are not sufficient for the study to form some trends in the insurance business cycle, it proves to be useful in illustration of the impact of the two quakes from an individual insurer perspective.



**Figure 4:** Business Statistic for Domestic Building and Contents Insurance

It is rather straightforward to pick the business implications of the quakes from the loss ratio figures. In 2010 and 2011 the company registered a loss ratio of 195.83% and 347.66% respectively. As mentioned earlier the loss ratio may not necessary imply that insurance inadvertently made losses, however, the magnitude of the ratio should communicate the claims experience of the insurance company. Therefore if the two ratios do not in totality mean the underwriters made losses in this line of business in the wake of the quakes, it is indicative of the challenges faced by the underwriters in settlement of claims especially those associated with the devastating February 22, 2011 earthquake. In most cases the study

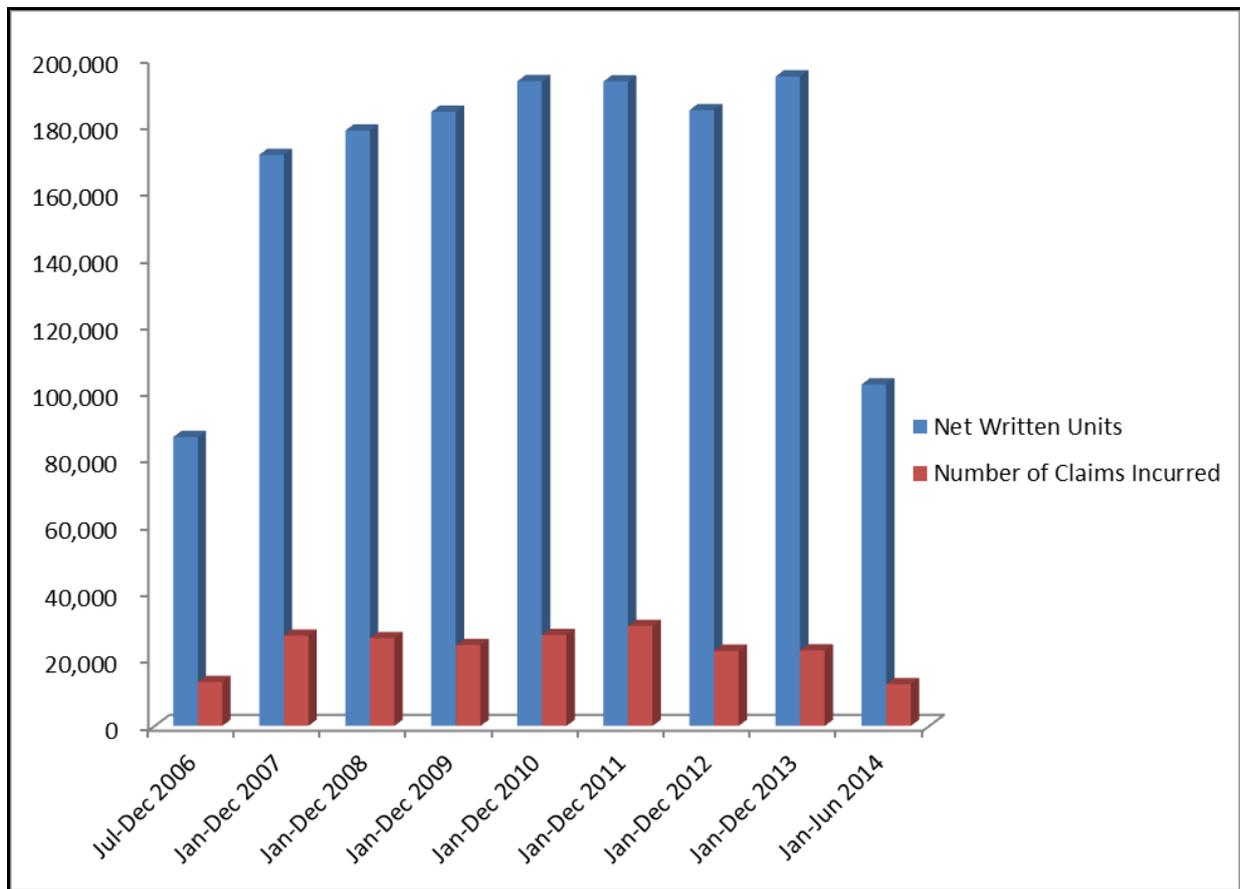
reiterates the purpose of a loss ratio is to tell whether, and by how much, claims costs are rising or falling. In this instant therefore the ratios show how devastating the two earthquakes hit the underwriters with high proportions of business in Christchurch. However, the ratio figures are more meaningful when looked at over a decade rather than year on year to understand various changes and derive some trend.



**Figure 5:** Gross Written Premium Vs Total Amount of Claims Incurred (Business Statistic for Domestic Buildings and Contents Insurance)

A plot of loss ratio of the undisclosed insurer for the periods June 2006 to June 2014 is presented in Figure 4. The study finds that the two loss ratios for the 2010 and 2011 to be very high when compared to the average loss ratio for the 9 years; with that from 2011 being almost 250% above the 100% the maximum equal proportionality of incurred claims verse earned premium. In such a scenario, the insurance company begins to worry about its ability to meet all the insured clams once they fall due. In most cases however, insurers find

themselves fully protected either by digging in to its catastrophes reserves or claims apportioning to reinsurance companies.



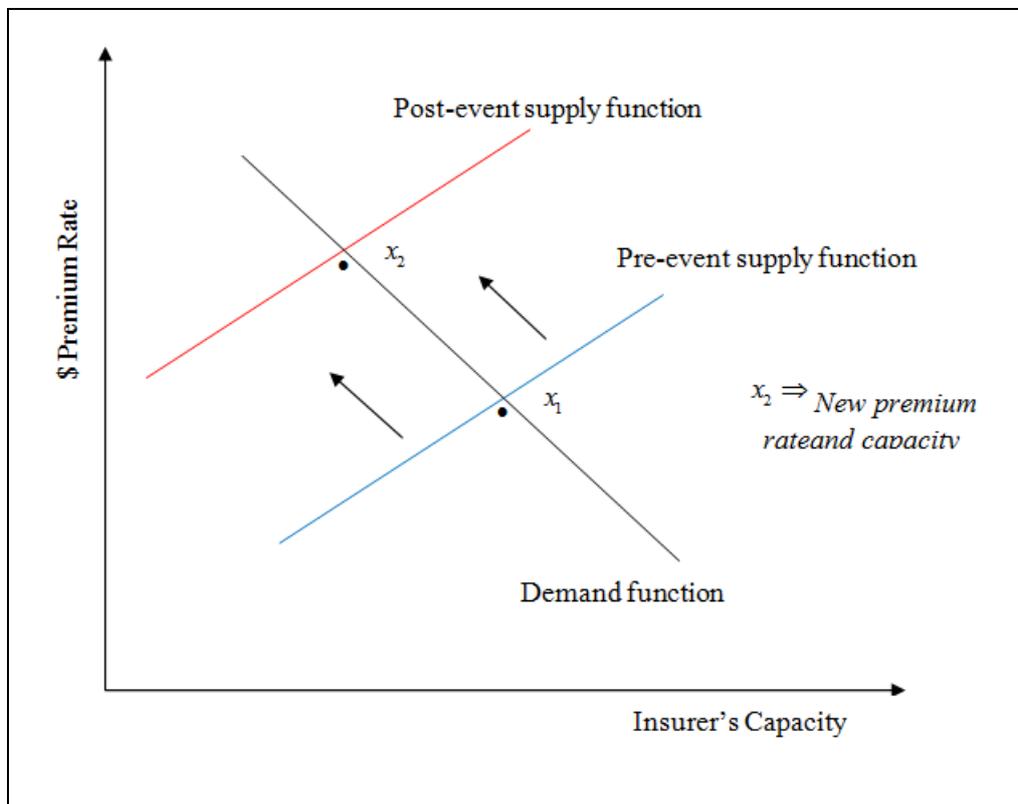
**Figure 6:** Net Written Units Vs Number of Claims Incurred (Business Statistic for Domestic Building and Contents Insurance)

The proportion of properties on claims against the total net written unit is presented in Figure 6. This shows that the number of claims filed in 2010-2011 was quite small compared to the total business of the company in this line of business. The study demonstrate that it is the magnituded of the damage for those properties on damage.

### 4.3. Further Observation on the Market Reaction Post-Christchurch Earthquakes in Line to the Prior Literature

#### 4.3.1. Supply shift and demand effect after catastrophe

Following the Christchurch catastrophe, there are number of changes that have occurred in the insurance market. This alludes to the fact that; post-disaster insurance market changes are not exceptional within the insurance market context, it is globally observed that a unique type of market adjustments effect occurs when a major disaster spends significant portions of insurer's and reinsurer's capacity.



**Figure 7:** Supply shift and demand effect after catastrophe

All these market adjustment effects essentially reflect supply constraints which result in higher contracts pricing shifting the supply-demand equilibrium to new level as seen in figure 7. Such adjustments are widely recognized by insurers and reinsurers alike, and reflect market recovery efforts. It is widely acknowledged in the insurance industry therefore that, post large catastrophe exposure, low premium rates are sub-optimal. However, a look on the

demand-side, individuals and businesses are indicative that it is uneconomic to maintain full-insurance coverage at such increased premiums, despite the potential higher risk. In such scenario, property and business owners carefully re-assess their risk management strategies in handling risks before deciding to approach insurer.

Based on the individual insurance data and ICNZ all industry data and financial reports, this study finds that there has been a fundamental shift in the insurance market as a result of the 2010-2011 earthquakes. In particular, lesser availability of insurance for high risk properties, an increase in the cost of insurance premiums, deductibles changing from a percentage of the claim to a percentage of the insured value and a shift from full replacement to sum insured.

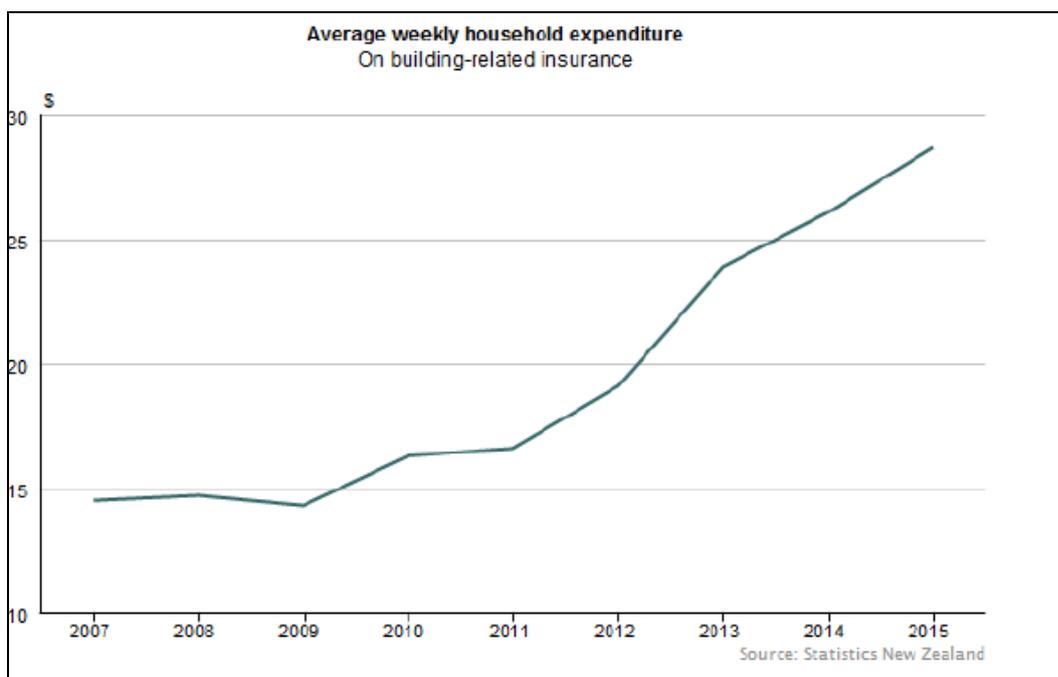
#### **4.3.2. Fundamental change from full replacement cost to sum insured insurance coverage**

Until June 2012, the New Zealand insurance industry provided a residential property insurance policy that covered properties for the cost of full replacement. This meant an insurer would pay to rebuild the insured property without any upper limit. These policies previously used the size of property in square meters as the basis for the cover. In the aftermath of the quakes, the way industry insures properties changed to sum insured. Instead of being insured for an unspecified replacement cost residential properties are insured for up to a maximum specified amount. This means cover will still be offered for the costs of rebuilding the property, but there is a maximum amount of liability payable, even if the actual cost of rebuilding turned out to be greater than that. The move was spurred by a number of reinsurers, the companies who cover insurance companies against natural disasters and catastrophes, requiring residential properties in New Zealand to be insured for a specified amount. This is because after reinsurers reassessed their view of New Zealand realised that the risk is greater than they previously thought and wanted to know the maximum amount that insurers would have to pay to rebuild the residential properties they insure.

In a sum insured environment customers are working out how much it costs to replace their property upfront, before the event, this is a much more effective way of doing insurance business. Under the new environment, suppose there is another similar Christchurch situation, the industry is in a position to be much quicker in terms of settling claims, particularly for policyholders that want to take cash settlement. This changes also allows introduction of partial cover (e.g. 75% insure, 25% self-insure) for those that want to reduce the risk but are willing and able to take on a small amount of it.

### 4.3.3. The rise in the premium rate

The weekly spending on residential property related insurance increased 9.9% in the year 2015, to NZ\$28.70. The increase was particularly evident in Canterbury region, where this spending is up 16.1%.



**Figure 8:** Average weekly household expenditure on residential property insurance

Since the 2010-2011 earthquakes, residential property related insurance payments have increased by over 70%. On average, most households now spend \$12.10 more a week than in 2011. At one instead, we can conclude the increased premiums are understandable given the

number of insurers wanting to reduce their risk exposure and a sharp increase in demand for insurance. Interestingly, in Christchurch premium increases could not have been significantly driven by demand because the demand was essentially curtailed by insurance restriction on new risks in the period immediately after the earthquakes.

In that effect, then, the major reasons that can be attributed to these increases is that, in the aftermath of the catastrophes when the insurance industry has paid-up claims in billions of dollars they is no other choice than increase the premium across the board whether a policyholder have been previously affected or not. The industry spread the losses to all the policyholders by a way of a percentage increase to the premium rate, spreading the price tag across the country.

## 5. CONCLUSIONS

This paper has argued that without government participation, the private insurance markets can collapse for some catastrophe event. To this effect, many developed and developing countries have implemented some sort of disaster insurance program based on their own unique disaster risk experience. More importantly, the study illustrates the crucial role played by the State in natural disaster insurance market.

While plans are in place for such state-sponsored systems to kick-in in the occurrence of a particularly severe disaster or series of disasters; the severity of disasters have highlighted existing deficiencies in private insurance coverage and the cost of disaster insurance, either in terms of the premiums paid by policyholders or the structural efficiency of some of the state-sponsored systems.

It is illustrated herein that the dual insurance system and how it has enabled the private insurers to previously provide residential property and contents insurance cover to over 90% of homeowners in Christchurch. The main criticism of the dual systems is centered on its systematic inefficiency in claims handling process. In comparison to other state-sponsored systems worldwide, the study finds that the EQC's low levies have previously allowed private insurers to offer in New Zealand what could not be realistically offered by other insurers in any other market. The analysis finds that New Zealand insurance contributes a miniscule 0.67% of premiums to the global insurance underwriting pool and yet recently necessitated one of the top 10 global insurance payouts in the last four decades as mentioned in (SwissRE, 2012). With this risk premium disproportionality the global reinsurers have been forced to look very closely at their exposure to the New Zealand market. This has necessitated the change in the manner into which contract cover is designed; from open-ended full-replacement contract to predetermined sum insured contract that specifically defines the liability undertaken by both insurance and reinsurance market.

In general the study finds an average loss ratio equal to 58.88% for domestic buildings and contents insurance coverage in New Zealand post-earthquake. Comparing this to US property & casualty insurance industry result for the same period, the loss ratio is slightly above 70% (Hagendorff et al., 2015). What this figures does show us is that, New Zealand has been a relatively good market for insurance with loss ratio below 100% and that has encouraged reinsurers to stay in market following the Christchurch earthquakes. To that effect, the supply of insurance contract in New Zealand had not been marginally affected by the two earthquakes.

For those properties condemned as uneconomical to repair this study observe that vast majority of homeowners, 74%, elected to retain the benefit of all their insurance claims for the red-zoned property rather than transfer these to the State organs (CERA). In this case insurance companies seemed to have prioritised the settlement of properties from these heavily affected areas. A further observation from this analysis finds that these State interventions de-risked the insurance process for homeowners and simplified claims handling process for insurers, giving them just one big owner to deal with.

This study proposes that; in general premiums increases after catastrophic events is driven by both risk capital reduction and the fact that insurance companies updates the assumed risk exposure of the affected areas. If they anticipate that a certain region will be affected more frequently or more severely in the future then the premium can be set at a higher rate. (Froot & O'Connell, 1999) disentangle both effects by analysing reinsurance prices in the aftermath of different types of natural catastrophes. Since they also observe price increases outside of the affected area independent of the actual exposure to a certain hazard, they conclude that capital market imperfections (a shortage of capital) are the main reason for the price increases.

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