Increase data sharing or die? An initial view for natural catastrophe insurance

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Abstract

This article is an illustration of Geography in action, recounting an investigation into an industry's views of data sharing. The insurance sector is fundamentally analytics driven and based on geospatial data. One option for more effective and efficient insurance for natural hazard risks (e.g. flooding, earthquake) is, in theory, to increase the sharing of data between the various (re)insurance organisations. However, it remains unclear to what extent this is desirable or practical for commercially sensitive data. This work creates a conceptual model of data sharing in (re)insurance, focussing on loss (claims) data for natural hazards as an illustrative microcosm, including barriers and solutions to sharing. In light of this, an initial view on the future shape of insurance data sharing is given, finishing with an opinion on whether or not new external disruptors (start-ups, tech giants - e.g. Google, Amazon, Tencent) pose an existential threat to incumbent firms.

1. Geography in action

This article is designed to illuminate a real-world situation in which geography has been used, focussing on the way the social science techniques used in geography can be deployed. The multi-stage, iterative, collaborative process of investigation is deliberately laid bare to give you, the reader, a sense of how research like this is conducted. The situation in question also involves physical geography as it relates to insurance for natural hazards. Insurance is vital to the UK's financial stability and resilience to weather-related extremes, and is a valuable element of the UK's financial sector.

2. Introduction

As introduced in '*Natural Catastrophe Risk Management & Modelling*' (Mitchell-Wallace et al., 2017), insurance is a financial mechanism designed to provide resilience to risks, including from natural hazards such as flooding and earthquakes, by sharing (pooling) risk. All insurance products (policies) are based on an insurer's view of how severe and likely a risk is, based on past experience and/or additional numerical modelling. So, data driven analytics are fundamental to the insurance sector, as evidenced by the existence of the actuarial profession (IFA, 2020).

Machine learning in the form of neural networks and other adaptive algorithms, sometimes called Artificial Intelligence (AI), is becoming increasingly integrated into various aspects of the (re)insurance industry (Balasubramanian et al., 2018; Bank of England, 2019; SCOR, 2018). With this comes the spectre of a new generation of insurance providers (start-ups, tech giants) who have significant data-handling expertise, and so might claim a share of the insurance market (Catlin et al., 2017; Holland, 2019). Thus, an incentive exists for incumbents in the market to consider sharing data more effectively between their individual organisations for mutual benefit to mitigate this threat. However, ethical, regulatory, commercial and practical barriers are believed to exist (Gunnar, 2011; ICO, 2018; KPMG, 2018; Minty, 2018). Consequently, the extent to which data sharing is desirable or practical is currently under debate amongst established players within the sector.

This research is a first attempt to capture in detail opinions from a range of stakeholders about contemporary data sharing practice in the (re)insurance sector. By collecting these, and contextualising them within experience of recent technology-driven changes in other sectors (manufacturing, retail, banking), this study shines a light on the debate and strategic implications for the insurance market.

3. Experience from other sectors (i.e. opportunities)

Recently the manufacturing (Du et al., 2012; Wiengarten et al., 2019), retail (Legner and Schemm, 2008), and banking (Brodsky and Oakes, 2017) sectors have implemented strategic initiatives at the level of the supply chain or market rather than the individual firm. This was done to improve performance because each firm has fundamental limits on how it can improve its operations, analytics and decision-making based only on its internal data and market intelligence. It was facilitated by machine learning approaches, and required lots of 'big' data (Gandomi and Haider, 2015).

Sharing data at the supply chain level can lead to significant operational and strategic benefits, exemplified by Motorola's supply chain integration, which links partners in its manufacturing supply chain to its financial systems (Blackman et al., 2013). This Motorola case demonstrates clearly that this is not a zero-sum game; i.e. all partners benefit, rather than there being winners and losers within the participating organisations. Indeed, many of the new strategies in manufacturing such as Just-In-Time (JIT) and quality-control initiatives can only exist when there is strong collaboration, trust and detailed data sharing between all members of the supply chain; an example of this is Toyota's application of its 14 Management Principles (Liker, 2004).

In insurance, whilst data sharing is already widespread, there may be significant opportunities to implement new data sharing projects in order to reduce the administrative cost structure, build better analytics systems and to create new business models through strategic innovation (Holland, 2019).

4. Data types relevant to (re)insurance

In this study, the focus is on natural catastrophe risk and thus four main categories of data; exposure, environmental hazard, vulnerability, and loss (claims). These are typically integrated in tailored GIS software tools called Catastrophe Models (Mitchell-Wallace et al., 2017). Insurance products (policies) are designed using these GIS tools to estimate likely losses. *Exposure* data are the assets at risk (e.g. houses), which the tools associate with a constructed understanding of how these assets suffer in response to *hazards*, created by using claims (*loss*) data or modelling. Specifically, the derived data that create numerical functions bridging between hazard and loss are called *vulnerability*. In addition analytics may be augmented by other, externally derived data to enhance understanding of the environmental process that drive hazards; illustratively, if earthquakes (Parsons, 2004), European windstorms (Hillier and Dixon, 2020), or tropical cyclones (Lloyd's, 2016; Steptoe et al., 2017) are better understood then better decisions can be made about insuring for them.

Exposure data represent the assets to be modelled (assets at risk). Typically, this includes a building's value and characteristics (roof type), geographic location, and details of insurance financial structure (such as deductibles and limits). Environmental hazard data are any form of data used to build a picture of hazard (e.g. stochastic event sets) or otherwise enhance risk estimates for natural catastrophes. These data might be from global climate models (GCMs).

Loss data are any form of data related to a claim for which loss has occurred, perhaps during a storm. These come in two broad classes:

- *Detailed data* are information relating to an individual policy and insured asset, and might be thought of as 'house-by-house' data.
- *Aggregated data* are data grouped into a total amount by some criteria, perhaps across a set of insurance policy holders in a geographic region within time-window or hazardous event.

5. Targeting the research

There are many types of data shared across the insurance sector, for a variety of reasons. This study focuses specifically on the sharing of loss data related to natural hazards, either in detailed (location specific) or in aggregate form. Loss data are a useful illustrative microcosm since this type of data is generally perceived as highly-sensitive and thus hard to share. Barriers against the sharing of claims data should therefore be readily evident whist still representative of those affecting exposure data, and thus also vulnerability as it is a derivative of these two types. Environment science data pertaining primarily to hazard are a different case, where vast quantities of *raw* data are already freely available if non-trivial to use (CDS, 2020; Editorial, 2016; Popkin, 2019; Thornley and Claghan, 2019) and the opportunity firms have to differentiate themselves is by the analytics and the derived data products they can produce internally. It is possible that this is where other data landscapes will move to.

6. Study design

The overarching aim of the study was to gain insights into whether or not existing (incumbent) firms in the (re)insurance sector should increase data sharing. In order to achieve this, a diversity of views was collected relating to the following questions:

- How are data shared already and, if so, why?
- Is sharing loss data difficult, and what are the main barriers to sharing?
- What might some solutions be, now and in future?

A two-phase approach was adopted, iteratively working with insurance practitioners to develop insights using data collection methods designed to engage efficiently with these busy professionals who have little time to spare.

6.1 Phase A: Brief interviews at conferences

There are a range of archetypal roles within the (re)insurance sector, ranging from the primary insurer who sells policies to parties who want insurance, to 'Commercial Modellers' who design catastrophe models. Any one organisation (e.g. SwissRe, Willis Towers Watson, AIR, Bank of England, Zurich Plc.), may undertake one or a few of these roles, and may share catastrophe-related loss data in detail or in aggregate with other organisation. As a basis for discussion a conceptual model, presented as a diagram (**Fig. 1**), was created by co-author Hillier from a catastrophe modelling textbook (Mitchell-Wallace et al., 2017) and his experience working in (2008-2010) and with (2010-) the insurance sector. Similarly, initial mind-maps about barriers and solutions to data sharing were created. As a starting point, Phase A sought views on

- the conceptual model (**Fig. 1**)
- barriers and solutions to data sharing with university-based scientists. (**Fig. 2**)

In total, 26 industry practitioners and 22 academics participated. Only individuals who self-assessed as 'having enough experience to form a view' participated. All talked individually for 2-10 mins with Hillier, also marking their views on an A0 poster. The participants annotated the conceptual model and, for the partially-filled mind-maps provided, added up to 3 dots to indicate which of the options they believed (in their experience) were most significant barriers/solutions to the sharing of loss data with academics. Empty space was available, and participants were encouraged to add alternative barriers to the mind map, but suggestions were sufficiently similar to existing options that they were merged for analysis. Participants were asked to assume a good inter-personal relationship between academic and insurer, although this is a non-trivial prerequisite (Hillier et al., 2018). The interviews were conducted during poster sessions, or tea-breaks, at events that the participants were already attending so the time cost to them was minimal.

The three conferences were attended in 2019, and all had a mixture of academics and practitioners attending: (1) The General Assembly of the EGU (European Geosciences Union), 11th April 2019; (2) 9th Annual Conference of the IRDR (Institute for Risk and Disaster Reduction) at University College London, 19th June 2019; (3) TECHNGI Conference on AI & Next Generation Insurance Services at Willis Towers Watson in London, 26th November 2019. No information was carried over between conferences (new poster used), to minimize the influence of prior opinions on participants.

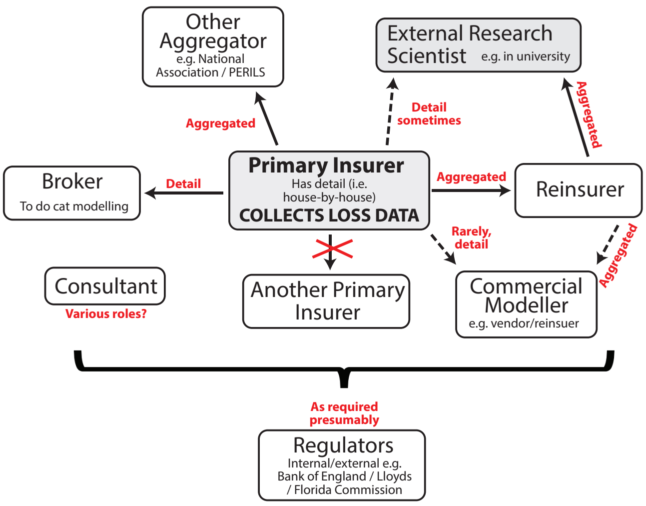

Fig. 1 - Model assessed in Phase A of how loss (claims) data are shared between the main organisational types within the (re)insurance industry and with academia.

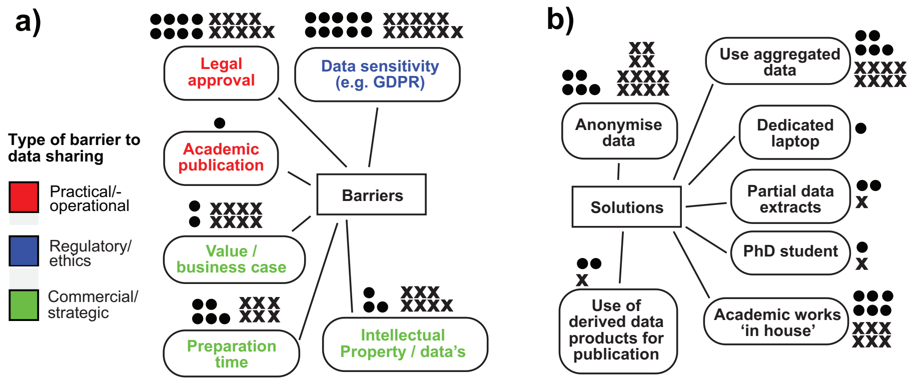

Fig. 2 - Mind maps of (a) barriers and (b) solutions to sharing loss (claims) data sharing with academics. Dots and crosses are votes for the most significant of these, from industry practitioners and academics respectively. Barriers are categorised and colour coded accordingly - see Section 6.2.

6.2 Phase B: Online survey

In order to test the robustness of the conceptual model, and refine it further if necessary, an online survey was conducted, wherein respondents were asked to evaluate the model as revised after Phase A (**Fig. 3**). An online survey was made necessary by COVID-19. It was co-designed, with input from Willis Towers Watson, a (re)insurance broker with a research network, and four themes were investigated:

1. The value of sharing data in the insurance value chain
2. On how loss data are currently shared between archetypal (re)insurance roles
3. Strategies and mechanisms to make data sharing more effective
4. Visions of the future of data sharing in (re)insurance

These place the model of current data sharing into a wider context and help to shape an initial view of its implications. Phase B targeted 22 participants to provide viewpoints that together cover a spectrum of practitioner perspectives from across the industry, and is fully described in a report aimed at (re)insurance practitioners (Hillier et al., 2020). Reference will be made to the headline results of other elements, but theme 2 is the primary focus in this paper. Respondents were asked if they agreed with the statement "*The diagram* (**Fig. 3**) *accurately captures how loss data is currently shared in the insurance sector*", and to make comments about the accuracy of the diagram.

6.3 Ethics

Data collected at the conferences and in the survey were undertaken in accordance with good practice, and clearance was given in accord with Loughborough University's ethics process.

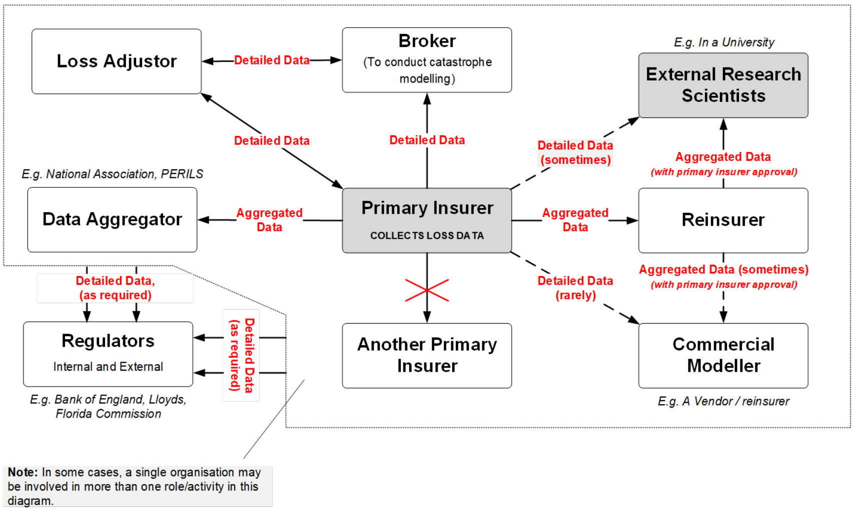

Fig. 3 - Model assessed in Phase B of how loss (claims) data are shared between the main archetypal functional roles within the (re)insurance industry, and with academia.

7. Results

7.1 Existing loss data sharing within (re)insurance

The primary, overarching feature of the conceptual model (**Figs. 1,3**) is that it is deliberately and explicitly centred around the source of data, defined as a 'primary insurer' who directly interacts with the insured in event of a loss. The second critical feature is the presence of arrows indicating data flow between organisations. Importantly, no interviewee in Phase A disagreed with these assertions, and in Phase B the perspective of the survey respondents is encapsulated in a comment: "*it is an accurate depiction of a low-resolution picture*". 76% of respondents agreed or strongly agreed that, as it purports to, the relationship diagram accurately depicted how claims data are shared between organisations in the (re)insurance industry. Only 19% disagreed, although numerous caveats about detail were suggested. No one strongly disagreed with the diagram, suggesting that any inaccuracies were tolerable.

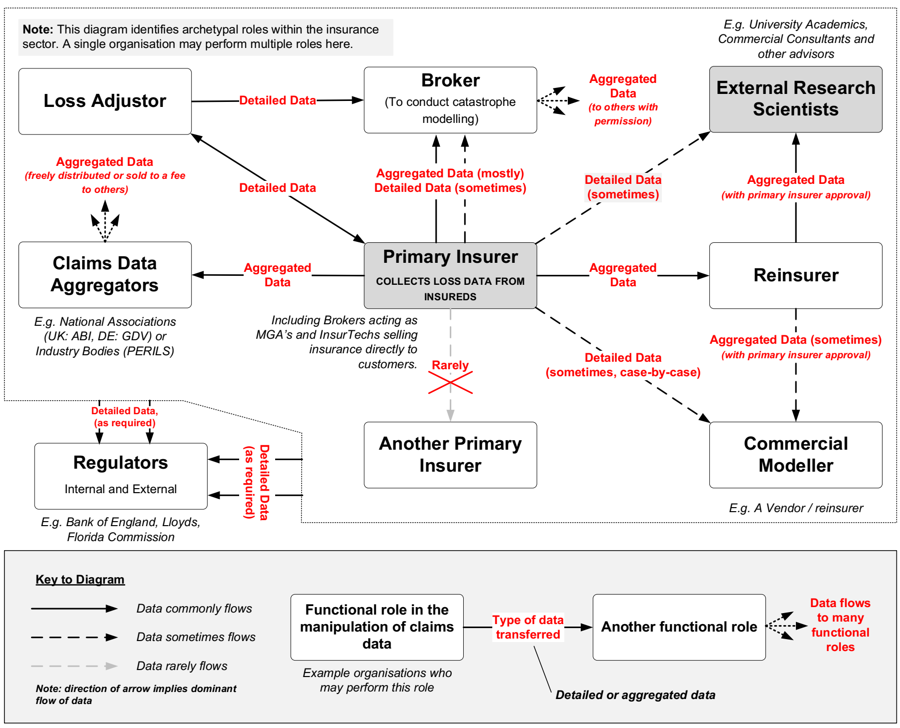

Fig. 4 - Final conceptual model of how loss (claims) data are shared between the main archetypal functional roles within the (re)insurance industry and associated organisations.

Fig. 4 is a revised model, with alterations based upon a synthesis of respondents' comments. For clarity, it very deliberately remains a simple descriptive model; upon attempting to add all connections, the diagram became unreadable. For instance, because it is of claims data flowing from insured parties, via a primary insurer, it does not emphasise the possibility of brokers acting as intermediaries between the primary insurer and reinsurer. However, in response to comments, a splay of arrows was included to indicate that brokers might share aggregated data with a range of organisations, provided permission is given by the organisation supplying the data to the broker. Exceptions and caveats that respondents identified, and are acknowledged but not incorporated include:

- “The diagram is not taking treaty and binder policies into concern”.
- “[The diagram] does not reflect the variability with respect to types of product or line of business (e.g. parametric versus indemnity, commercial property, household), nor the data flows for catastrophe pools, mutuals, or special purpose vehicles. In addition, products such as binders, facilities and other mechanisms”.
- “It’s important to consider different classes of business – e.g. property catastrophe reinsurance is high quality - but many other areas less good”.
- “contractual understanding needs to be depicted where the loss chain is beyond the simple insured-insurer-reinsurer chain”.

In **Fig. 4**, loss data are shown as only collected by the 'primary insurer' functional archetype because this is defined in the model as the organisation in direct contact with the insured. Some respondents identified the broker as an additional primary collection source if they are acting as a Managing General Agent (MGA) for a primary insurer, however we consider a broker operating in this capacity to be part of the primary insurer archetypal role. Similarly, some new InsurTech firms may also be operating in this primary insurer archetypal role if they are providing insurance directly to customers. In summary, practitioners confirm that (i) data flows radiate outwards from a 'primary insurer' role and (ii) data do move between organisations if value in doing so can be identified.

In the Phase B survey (Hillier *et al* 2020), eleven distinct benefits stemming from increased data sharing are identified in responses that relate to customers (e.g. better understanding of risk), society (e.g. reduced protection gaps), individual firms (e.g. operational efficiency), product innovation and delivery (e.g. faster development), and market-wide (e.g. improved market stability). Significant business advantages are clearly recognised, although these are typically indirect or inferred outcomes of sharing rather than immediately tangible.

7.2 Is sharing loss data difficult, and what are the main barriers to sharing?

Phase A interviewees rated the difficulty of sharing both loss data and academically produced environmental science data (e.g. outputs of GCMs). Environmental science data were chosen as a reference as there is a strong drive to share such data freely and openly. A scale of 1-5 from 'very easy' to 'very hard' was used, and participants answered based upon their personal experience. Overall, the sharing of environmental science data was rated easier than loss (claims) data (2.47 vs 4.31, $p \ll 0.01$, 2-tailed). There was no significant difference when responses were separated into academics and practitioners, and each conference produced the same pattern. So, this explicitly confirms that there are barriers to loss data sharing.

What are these barriers? Options (**Fig. 2**) were classified into a typology, consistent with research in other sectors (Kembro et al., 2017): Non-optional factors based on ethics and/or regulation such as GDPR (ICO, 2018); Commercial factors (e.g. IP, competition, lack of overarching common goal between all participants, complexity of market structure) that have their origin in a businesses' approach or strategy (Arunachalam et al., 2018); practical barriers with operational, technical or logistical origins (Kembro et al., 2017). In both Phase A (**Fig. 2**) and Phase B (**Fig. 5**), data sensitivity and the value (business case) for the activity rated highly. For collaboration with university-based scientists in Phase A, legal approval to send data to a very different (non-commercial) environment was seen as problematic, whilst for sharing with other insurance organisations in Phase B intellectual property was understandably a far more prevalent concern. Irrespective of detail, however, it is clear that barriers are recognised.

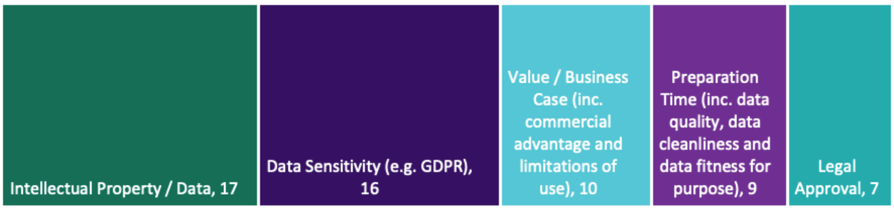

Fig. 5 - Barriers identified in the survey (Phase B) having the greatest impact on data sharing within the insurance sector (Hillier et al., 2020).

7.3 Potential solutions to improve data sharing

When presented with the specific scenario of sharing loss data with a university-based scientist, Phase A participants identified a range of practical, operational-level solutions to overcome barriers (**Fig. 2**b), although they confirmed a long-term trusting relationship as a pre-requisite (Hillier et al., 2018). In addition to the pre-prepared solutions, legally mandated data sharing was noted as a means of eliminating these issues entirely, and a standard template for data sharing for use by legal departments was postulated as a mechanism to reduce friction in data movement. However, the three favoured solutions for sharing detailed (house-by-house) data between organisations have one key shared characteristic; essentially, they limit the movement of detailed loss data outside of the primary insurer. Either the data are degraded to make them less sensitive (anonymise and aggregate), or work is *de facto* in house so that the data can be viewed as never having moved. This echoes the reluctance for data to flow found above.

In Phase B (Hillier et al., 2020), to achieve multi-organisational benefits by sharing data as is done in other sectors (manufacturing, retailing and banking) (Du et al., 2012; Wiengarten et al., 2019), respondents were of the opinion that *Marketplace agreements*, i.e., sharing data in prescribed format(s) in an electronic marketplace, will be the most significant mechanism for the insurance sector in 3-5 years' time and expect a large increase in the usage of *Commonly agreed voluntary standards* and *Open access data hubs*. In short, a change to a configuration where market benefit outweighs the advantage of individual firms is anticipated. A common characteristic of such initiatives is that, to succeed, they need to be trusted by the organisations providing the data, and not seek competitive advantage in themselves. This 'trusted broker' concept (Zarkadakis, 2020) also arose in the Phase A. Insurance bodies (e.g. Association of British Insurers), academic set-ups (e.g. *https://www.cdrc.ac.uk/*), or commercial players (e.g. PERILS, Oasis) could be well placed to serve these needs.

In terms of a vision for the future, on a 3-5 year time horizon, but not within 12 months, respondents in Phase B (Hillier et al., 2020) expect that data sharing in (re)insurance will change from the status quo, likely to a mix of three alternative operating models that are known in other sectors: industry-wide electronic marketplaces (Malone et al., 1987); competing smart networks (Van Heck and Vervest, 2007); or a new entrant (InsureTech start-up or tech giant) that could transform the existing arrangements by offering insurance services using radically new business models that exploit network economics, business peer-to-peer, and consumer peer-to-peer arrangements, all supported by advanced AI and analytics capabilities (Catlin et al., 2017). It is not clear which (if any) will dominate, though the participants favoured electronic marketplaces.

8. Implication: Increased data sharing seems inevitable for natural hazard insurance

The current sub-optimal flow of data (barriers), combined with existing technologies and examples of more effective data handling in other sectors creates the opportunity for disruption to the status quo in insurance (Catlin et al., 2017; Van Heck and Vervest, 2007). Currently, firms in the archetypal 'primary insurer' role restrict data (exposure/loss) flows, and as the party at the point closest to data capture have market power, but at a cost to the efficiency of the overall market. Following other sectors, early technology developments have focused on defining common technical standards for the exchange of data for standard processes (e.g. ACORD, Oasis Open Data Protocol), however later-stage changes also reflect a change in the business patterns such as shared *systems* (Holland et al., 2005) and smart business (Heck and Vervest, 2007). In firms using blockchain/distributed ledger technology (Cognizant, 2020) there are signs of change in (re)insurance despite the cultural challenges of apparently altruistic data sharing. So, change seems likely either through more extensive use of existing mechanisms or by a more dramatic paradigm shift, as discussed below.

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Why is increased data sharing likely, or perhaps inevitable, within the part of the insurance sector dealing with risk from natural hazards? While the attitude of interviewees demonstrated that primary insurers are reluctant to allow data flow, it was also the attitude that solutions could be found if a clear business benefit can be demonstrated. For example, outside the context of university-based scientists, fraud prevention is an area where a clear and quantifiable mutual benefit to all companies involved has been identified and data are now shared (Radford, 2019), e.g. the 'Claims Underwriting Exchange'.

The pressure for change in natural hazard risk can be understood by considering a fundamental quirk of the insurance business – that correct risk pricing is the best strategy – and by analogy with recent changes in motor insurance (EIOPA, 2019). The need for an ecosystem of firms to assess natural hazard risk (**Fig. 4**), and thus sharing between them, is directly a result of the scale and complexity of natural hazard risks.

The quirk of insurance is that anything readily realisable that leads to better pricing is inevitable in the scenario of a functional market. Pricing risk correctly (at least internally) is the route to business success if other factors (e.g. firm management, marketing) are equal; under-price high risks, and a firm loses money, over-price good (low) risks with respect to competitors and the firm loses customers. Critically, better risk pricing only needs to be true for a small fraction of the market initially for change to take hold. Consider 10% of a pool of customers have better data, and risk pricing. If half of these are good risks, and can be offered a lower premium, they will likely take it, and illustratively a small company offering these would tend to be successful. This causes the level of risk, and thus average premium (offered to all) in the undifferentiated remaining customers to rise. Then, more customers may be prepared to offer data. A convincing recent example of this type of behaviour is telematics ('black boxes') in cars (e.g. Insurethebox).

For car insurance, all the analytics to translate data into pricing are readily done within one firm; so, no sharing of data between organisations is forced. However, catastrophe risk for natural hazards is much more difficult to assess (see Mitchell-Wallace *et al*, 2017). Not only is it based upon a highly complex, non-linear and changing set of physical systems (atmospheric, hydrological, etc.), it combines this with an interacting set of engineered human systems spread across large spatial areas so that losses '*accumulate*' (>10,000 things damaged at once) in a way that motor accidents do not; this results in very large loss events (e.g. storms) that are also rare and thus poorly observationally constrained. Given this complexity, no single firm is able to undertake all aspects of the natural hazard risk assessment. Thus, it is not just the obtaining of data (now actually of a number of types from a number of sources) but the sharing of it that will

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lead to effective and efficient pricing of risk. Placing this back in context of the initial assertion, that whatever leads to better pricing of risk (if reasonably practical, given data availability, analytical tools) is inevitable, it is clear why the advent of increasingly sophisticated and available data, analytical tools (e.g. machine learning) along with clear examples of transformation in other sectors (e.g. banking, retail) imply that increased data sharing for natural hazard risks is rather likely and perhaps inevitable.

The caveat to this argument is a new entrant (e.g. Tech giant) capable of internalising all or most of the current archetypal insurance functions needed to assess natural hazard risk, which would render the concept of sharing obsolete.

9. Conclusions

This report illuminates and clarifies an emerging consensus amongst practitioners, rather than generating a revelation to them, but is arguably more powerful for that. By brief interviews and a survey, including 47 (re)insurance practitioners, a view is documented in which:

1. Currently, the flow of loss data is seen as radiating out from organisations with the archetypal '*primary insurer*' function that tightly control it, with substantial barriers.
2. Significant business advantages are clearly recognised to data sharing between organisations, but a transition to new mechanisms and models of working is typically expected on a 3-5 year time-frame.

By combining these it can be concluded that this sub-optimal data flow and thus market inefficiency presents a clear opportunity for disruption, especially when tools, technologies and approaches to data handling are well-established and have substantially increased efficiency in comparable sectors. What is not known is whether or not incumbent insurers will innovate sufficiently rapidly to mitigate the threat of a new, disruptive entrant(s) in InsurTech or a tech giant (e.g. Amazon, Google) acquiring a substantial share of the value within insurance related to natural hazard risk. This '*innovator's dilemma*' is typical of markets in transition where incumbents wish to maintain the status quo because embracing a new innovation is inherently risky (Christensen, 1997). The study illustrates that, as geographers, we can contribute by engaging positively with industry partners to co-create knowledge and insights.

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