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The choice of trigger in an insurance linked security: The mortality risk case☆

Richard MacMinn [a,b,*], Andreas Richter [c]

[a] National Chengchi University, Taipei, Taiwan
[b] The University of Texas, Austin, TX, United States
[c] Ludwig–Maximilians-Universität, Munich, Germany

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ABSTRACT

In 2003, Swiss Re introduced a mortality-based security designed to hedge excessive mortality changes for its life book of business. The concern was mortality risk, i.e., the risk of premature death. The mortality risk due to a pandemic is similar to the property risk associated with catastrophic events such as earthquakes and hurricanes and the security used to hedge the risk is similar to a CAT bond. This work looks at the incentives associated with insurance linked securities. It considers the trade-offs an insurer or reinsurer faces in selecting a hedging strategy. We compare index and indemnity-based hedging as alternative design choices and ask which is capable of creating the greater value for stakeholders. Additionally, we model an insurer or reinsurer that is subject to insolvency risk, which creates an incentive problem known as the judgment proof problem. The corporate manager is assumed to act in the interests of shareholders and so the judgment proof problem yields a conflict of interest between shareholders and other stakeholders. Given the fact that hedging may improve the situation, the analysis addresses what type of hedging tool would be best. We show that an indemnity-based security tends to worsen the situation, as it introduces an additional incentive problem. Index-based hedging, on the other hand, under certain conditions turns out to be beneficial and therefore dominates indemnity-based strategies. This result is further supported by showing that for the same sufficiently small strike price the current shareholder value is greater with the index-based security than the indemnity-based security.

1. Introduction

The threat of SARS in 2003 and avian flu in 2004 subsequently have provided reminders that life insurers face correlated mortality risks on a large scale when pandemics occur. In December 2003, Swiss Re introduced a mortality-based security designed to hedge excessive mortality changes for its life books of business.[1] The motivating concern was mortality risk, i.e., the risk of premature death. Mortality risk can be managed with the standard tools as long as there are no correlated mortality surprises. Such would not be the case with a recurrence of the 1918 flu or more generally with the occurrence of a new avian flu. The potential for pandemics introduces correlated risks on a large scale and so the potential for mortality surprises. The mortality risk due to a pandemic is similar to the property risk associated with catastrophic events such as earthquakes and hurricanes and the security used to hedge the risk is similar to a catastrophe (CAT) bond that pays the insurer or reinsurer when the option component of the bond is triggered by a catastrophe (Dubinsky and Laster, 2003). These instruments help hedge risk when the catastrophe generates correlated risks in the tails of the distribution.

The model constructed here is designed to analyze the potential usefulness of mortality-based securities in hedging risk. A publicly held and traded corporation with a book of life business is constructed or equivalently a portfolio of life risks. The corporation may be an insurer or reinsurer; it will be referred to as a reinsurer throughout this article. The organization is structured so that it faces mortality risk in addition to other risks such as credit and interest rate risk. Under these conditions, a reinsurer facing a capital constraint may find a mortality-based security to be a natural risk management tool and therefore turn to the capital markets to hedge the risk. It may also retrocede its book of business. The model employed here is sufficiently general to allow for both types of instruments to be considered. The focus, however, is highlighting

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* Corresponding author at: National Chengchi University, Taipei, Taiwan.
E-mail address: richard@macminn.org (R. MacMinn).

[1] A similar mortality-based instrument was introduced by Swiss Re in April 2005 and there have been subsequent issues including Vita Capital V Ltd in 2012. There have also been a number of other mortality bond issues; in 2013 SCOR's Atlas Capital IX Limited issued a mortality bond. See Artemis—the alternative risk transfer portal.

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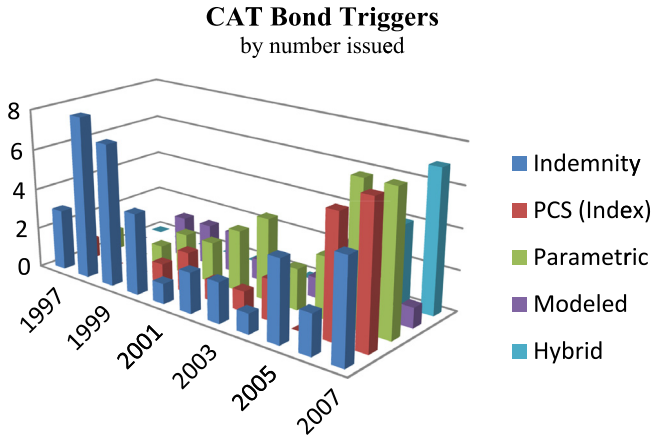

Fig. 1. CAT bond triggers by number issued.

a design choice that is particularly important in catastrophe bond issues; the question is whether an index or indemnity trigger should be used as the underlying for such a transaction.

The literature on Alternative Risk Transfer (ART) explains how the securitization of catastrophic exposures can create value. Some articles have identified the trade-offs involved in the design of optimal risk management programs integrating traditional insurance, reinsurance and ART instruments, i.e., see (Doherty, 1997; Froot, 1997; Croson and Kunreuther, 2000); also see (Cummins, 2008; Bouriaux and MacMinn, 2009; Cummins and Weiss, 2009). On the one hand, securitization of insurance risk offers advantages over traditional reinsurance arrangements, such as the potential to substantially reduce moral hazard, credit risk and transaction costs. On the other hand, possible improvements typically come at a cost of the basis risk incurred by an index-linked transaction; this is true since an index cannot perfectly represent the individual risk and would therefore only provide an imperfect hedge.

This recent literature focuses on transactions based upon index triggers. This approach seems justified in light of empirical observations in the CAT bond market: While earlier CAT bond issues were mainly based upon indemnity triggers (which have also traditionally been used in insurance and reinsurance coverage), transactions in the available data show a greater use of indexed instruments, e.g., see McGhee et al. (2005) and Fig. 1 which is based on data obtained from Goldman-Sachs.[2] As index-based solutions create the problem of basis risk, their recent popularity naturally raises the question of why the industry prefers index over indemnity triggers. The straightforward answer is that, besides potentially reducing transaction cost, an appropriately constructed index reduces or eliminates moral hazard. The introduction of a catastrophe index in a CAT bond issue or the use of a population's average life expectancy in a mortality-based security solves the moral hazard problem inherent in almost any insurance transaction.

An index trigger is a new device for addressing moral hazard. If compensation from a reinsurance contract or any other hedging instrument is based upon an index beyond the hedging party's control, this party will still reap the entire benefit of loss control in addition to the hedge. The other party, e.g., a reinsurer or the investors in an insurance linked security, do not need to be concerned about monitoring the cedent's or issuer's risk selection or loss-handling practices. A trade-off results between these benefits and the basis risk that is incurred due to the index.

A few papers have addressed the trade-offs analytically: Cummins and Mahul (2000) consider an insurance product that is subject to credit risk as well as basis risk,[3] as the insurer's payment is tied to an exogenous index. The interaction between these two factors is also analyzed by Richter (2004) albeit with two different instruments: On the one hand, insurance is subject to credit risk but can be used to generate a perfect hedge while, on the other hand, risk securitization comes without credit risk but incurs basis risk. The analysis shows that under these conditions the indexed security is beneficial whenever the credit risk on the reinsurance exists. As a tool that mainly counteracts reinsurance credit risk, securitization primarily replaces reinsurance for high levels of the loss. The latter result is confirmed by Nell and Richter (2004) who study the trade-off between the implicit transaction cost incurred by a reinsurer's risk aversion and the basis risk of a CAT bond.

The trade-off between moral hazard and basis risk has been discussed analytically by Doherty and Mahul (2001) and Doherty and Richter (2002), who investigate the interaction of these two problems, when insurance can be used to cover the basis risk of an index-linked transaction. It is shown that combining the two hedging tools might extend the possibility set and therefore lead to efficiency gains.

This analysis is constructed to examine the choice of the insurance linked security that best hedges corporate value. Like Doherty and Mahul and Doherty and Richter we consider index and indemnity triggers; the focus here, however, is on a publicly held and traded corporation acting in the interests of shareholders rather than on a risk averse manager maximizing expected utility. Rather than considering a mix of hedging instruments, we compare index and indemnity-based hedging as alternative design choices and ask which is capable of creating the greater value for corporate stakeholders. Additionally, and quite importantly, we model a reinsurer that is subject to insolvency risk[4] ; this risk of insolvency creates an additional incentive problem known as the judgment proof problem. The corporate manager is assumed to act in the interests of shareholders and so the judgment proof problem yields a conflict of interest between shareholders and other stakeholders. The judgment proof problem then yields a situation in which management does not have an incentive to select the socially optimal level of care.

A solution for the underinvestment problem suggested in the risk management literature is that potential creditors demand that the corporation hedge insolvency risk, e.g., (Jensen and Meckling, 1976; Smith and Stulz, 1985; Mayers and Smith Jr., 1987; Froot et al., 1993; Garven and MacMinn, 1993; MacMinn, 2005). This requirement can be enforced, for instance, by adding a covenant to the debt that requires the company to hedge. Given the fact that hedging improves the situation, the following analysis will address, in light of the new financial instruments described above, what type of hedging tool would be best to use. We ask whether one of

[2] A recent study by Guy Carpenter & Company (Guy Carpenter 2005), for instance identifies new risk capital in the amount of $915.3 million ($1.47 billion) that was provided through index-linked CAT bonds in 2004 (2003), while new indemnity-based transactions only amounted to 227.5 (260) million. Contrasting this, indemnity-based transactions in 1998 (1997) amounted to $846.1 ($431) million while index-based CAT bonds generated risk capital in the amount of $0 ($202 million).

[3] We refer to one of the risks as credit rather than default risk since the organization that is the object of analysis is not subject to default but rather owns a contract that is subject to default. The recently published version of (Cummins and Mahul, 2000), however, does not include the basis risk.

[4] Insolvency risk is difficult to quantify for life reinsurers. One indication of the importance of insolvency risk is represented in the impairment due to catastrophe losses of eight reinsurers between 2000 and 2011, i.e., see (2012). Credit Risk of Property Catastrophe Reinsuers. Chicago, Illinois, AON Benfield. Another indication of its importance came in 2009 when Swiss Re found it necessary to seek an injection of capital from Berkshire Hathaway, i.e., see (2009). "Swiss Re seeks injection from Berkshire Hathaway". *The Actuary* Retrieved 01/16/2017, from http://www.theactuary.com/archive/old-articles/part-4/swiss-re-seeks-injection-from-berkshire-hathaway/.

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