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Catastrophe Bonds and Finite Risk:

Two Controversial ARTs

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EXECUTIVE SUMMARY

This dissertation defines the traditional reinsurance concept, introduces the alternative risk transfer (ART) mechanisms and focuses on the definition and polemic of catastrophe bonds (CAT bonds) and finite risk reinsurance. The traditional reinsurance is a contract which aims at transferring the underwriting risk from a primary insurer to the reinsurer. Due to the very cyclic traditional reinsurance marketplace, ART techniques developed as tailored solutions to specific problems such as catastrophe losses. CAT bonds are an ART tool which transfers insurance risks from disastrous events to the capital markets at a very expensive price. Finite risk contracts offer the insurer a coverage on a limited amount of underwriting, investment, credit and timing risk, but their past bad reputation echoes today. This dissertation concludes that CAT bonds are increasing its popularity year over year and finite risk reinsurances must be dealt with caution.

Keywords: traditional reinsurance, ART, catastrophe bond, moral hazard, basis risk, SPV, finite risk, loss portfolio transfer, offshore, regulation

RESUMEN EJECUTIVO

Este trabajo de fin de grado que lleva por título Bonos catastróficos y el reaseguro financiero: Dos ARTs muy polémicas define el concepto de reaseguro tradicional, introduce los mecanismos de transferencia alternativa de riesgos (ART) y se centra en la definición y polémica de los bonos catastróficos (*CAT bonds*) y el reaseguro financiero o *finite risk*. El reaseguro tradicional es un contrato que transfiere el riesgo de suscripción de un asegurador directo al reasegurador. Debido a la gran volatilidad de precios del reaseguro tradicional, las técnicas ART se desarrollaron como soluciones para problemas específicos tales como siniestros catastróficos. Los *CAT bonds* son una herramienta ART que transfiere los riesgos de un asegurador provenientes de sucesos catastróficos a los mercados de capitales a costa de un alto precio para el reasegurador. Los contratos *finite risk* ofrecen al asegurador directo cobertura en una cantidad limitada de riesgo de suscripción, inversión, crédito y de tiempo; pero su mala reputación del pasado aún sigue recordándose. Este trabajo concluye que los *CAT bonds* están aumentando su popularidad año tras año y que los contratos *finite risk* deben ser tratados con máxima precaución, pues pueden desarrollar problemas legales que se pueden traducir en multas millonarias.

Palabras clave: reaseguro tradicional, ART, bono catastrófico, riesgo moral, riesgo base, SPV, reaseguro financiero, transferencia de carteras de siniestros, paraíso fiscal, regulación

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0. Introduction

Insurance companies offer services that usually imply some risks that cannot be covered by their entire fully-owned reserves (i.e. natural disasters such as earthquakes, hurricanes, floods…). Therefore, they must seek risk protection provided by an external agent: the reinsurer.

A reinsurance is a contract or agreement that allows an insurer (the ceding company) to transfer totally or partially a risk portfolio in order to reduce greater losses derived from an insurance claim. The aim of this dissertation is to define the traditional reinsurance, introduce alternative risk transfer (ART) mechanisms by reviewing its origin and their purpose and focus on two of them: the catastrophe bond the finite risk reinsurance contract. These two innovative ART forms have gained ground over the past decade and a public debate has been opened wide across the world on whether they are less costly than traditional reinsurance and whether they seek to just cover risks or also to ease financial tensions in the insurers' balance sheets that can trigger some legal penalties and multimillion dollar fines.

Through the use of a large variety of literature review going from journal articles and books to news, seminars and US Security and Exchange Commission government archives, this in-depth study is divided in four sections: an insight on traditional reinsurance, an explanation of ART mechanisms and an approach to catastrophe bonds and finite risk reinsurance and their controversy raised over the past two decades. Conclusions and recommendations can be found at the end of this work.

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1. An insight on traditional reinsurance

Based on the set of definitions that Sarrasí (2017) takes from *Rückversicherung eine Einführung* (Grossmann), the Mapfre Dictionary, the *History of Reinsurance* book (Golding), the German Commercial Code and the law firm Garrigues; a reinsurance can be defined as the contract or instrument whose aim is to totally or partially transfer risks from a primary insurer (the ceding company) to the reinsurer in order to homogenise and reduce portfolio risks so as to cut down losses from insurance claims and strengthen the insurer's solvency and its credibility to meet future payments in the original business-to-consumer contract. Therefore, the reinsurer's client is an insurer or another reinsurer; but not the general public.

When a reinsurer agrees to transfer some risks from the primary insurer, this last one may accept higher than usual risks and enhance its underwriting capacity, attending customers who would like to contract certain types of insurances that, in other circumstances, the insurer would be bound to reject. The risk transfer between these two parties can be done in different ways and methods.

From a legal perspective, the reinsurance can be classified as obligatory, facultative or mixed. The obligatory reinsurance aims the entire insurer's portfolio or just a specific line of insurance making both parties bind together to accept and cede the agreed risks, guaranteeing the reinsurer a certain volume of premiums, reducing administrative costs (i.e. the reinsurer is obliged to automatically accept all those future risks taken on by the insurer if they obey the agreed reinsurance contract) but distancing the reinsurer from accepting those risks which go beyond the agreed limits of the contract. In this way, the facultative reinsurance allows both the ceding company and the reinsurer to freely accept an agreement on transferring an individual risk that may hold the same original contractual conditions between the insurer and its insured or not (i.e. some excluded risks or geographical zones from the obligatory reinsurance or great sums that exceed the limits stipulated in obligatory contracts can be individually transferred with a facultative contract). Finally, the mixed or obligatory-facultative contract consists of that case where one party (usually the reinsurer) is bound to accept, within a few limits, those individually-selected risks that the ceding company wants to transfer in order to enhance its underwriting capacity with greater covered sums (Sarrasí, 2017).

From a technical point of view, reinsurers use two main methods to offer their coverage: the proportional and the non-proportional reinsurance. On one hand, the proportional reinsurance (called this way because of the direct proportionality between ceded risks and premiums), the reinsurer takes a proportion of the sum insured which reveals its responsibility in case of insurance claims and also unveils the percentage of the premium it is entitled to:

$$\frac{\text{Sum reinsured}}{\text{Total sum insured}} = \frac{\text{Reinsurer's loss}}{\text{Total loss}} = \frac{\text{Reinsurance premium}}{\text{Total insurance premium}}$$

Within this method, a reinsurance commission goes to the ceding company in order to compensate those administrative costs it will continue to incur. Minzoni (2009) describes three subgroups in this method -the quota share, the surplus and the mixed reinsurance- and Sarrasí (2017) expresses their mathematical formalisation. In the first one, the reinsurer fixes a percentage on all the ceding company's portfolio risks or just a chosen line of business to assume responsibility for the losses occurring during the contract period. It is easy to manage, saves costs and is adequate for brand-new insurers but its main disadvantage is that it does not homogenise the portfolio, leaving aside those top risks with the highest sums insured and ceding away profitable business (little losses still will cost the same premium percentage compared to larger ones).

Quota share reinsurance mathematical formalisation

$$\left.\begin{array}{l} S = S_c + S_r \\ S_c = k \cdot S \\ S_r = (1 - k) \cdot S \end{array}\right\} \; k = \frac{S_c}{S} \quad ; \quad 1 - k = \frac{S_r}{S}$$

$$\left.\begin{array}{l} X = X_c + X_r \\ X_c = k \cdot X \\ X_r = (1 - k) \cdot X \end{array}\right\} \; k = \frac{X_c}{X} \quad ; \quad 1 - k = \frac{X_r}{X}$$

$$0 < k < 1 \qquad X \leq S$$

Legend

S: Policy total sum insured

S_c: Policy sum insured by the ceding company

S_r: Policy sum reinsured by the reinsurer

k: Quota rate that the ceding company retains

1 – k: Remaining quota rate taken by the reinsurer

X: Policy total loss

X_c: Policy Insured loss

X_r: Policy reinsured loss

The second method, the surplus reinsurance, consists in fixing a retention (or a net line) on a policy sum insured from a certain line of insurance making the reinsurer responsible for the amount that exceeds that retention within the pre-established contract limits (cases that exceed contractual limits shall be dealt with a facultative reinsurance). Therefore, the quota rate is not constant and depends on the policy sum insured (S) and the ceding company's net line (M),

which is the maximum loss quantity the insurer can assume for the policy. This method allows the reinsurer to limit the excessive risk and correctly homogenises its portfolio but it is more difficult to manage (Macedo, 2010).

Surplus reinsurance mathematical formalisation

$$S = S_c + S_r \quad ; \quad X = X_c + X_r$$

$$S_c = k \cdot S \quad ; \quad X_c = k \cdot X$$

$$k = \begin{cases} 1 & \text{if} \quad S \le M \\ \dfrac{M}{S} & \text{if} \quad S > M \end{cases} \qquad S_c = \begin{cases} S & \text{if} \quad S \le M \\ M & \text{if} \quad S > M \end{cases} \qquad X_c = \begin{cases} X & \text{if} \quad S \le M \\ \dfrac{M}{S} \cdot X & \text{if} \quad S > M \end{cases}$$

$$S_r = k \cdot S \quad ; \quad X_r = k \cdot X$$

$$1 - k = \begin{cases} 0 & \text{if} \quad S \le M \\ 1 - \dfrac{M}{S} & \text{if} \quad S > M \end{cases} \qquad S_r = \begin{cases} 0 & \text{if} \quad S \le M \\ S - M & \text{if} \quad S > M \end{cases} \qquad X_r = \begin{cases} 0 & \text{if} \quad S \le M \\ \dfrac{S - M}{S} \cdot X & \text{if} \quad S > M \end{cases}$$

Legend

S: Policy total sum insured

S_c: Policy sum insured by the ceding company

S_r: Policy sum reinsured by the reinsurer

k: Quota rate that the ceding company retains

1 – k: Remaining quota rate taken by the reinsurer

M: Ceding company's net line

X: Policy total loss

X_c: Policy Insured loss

X_r: Policy reinsured loss

Finally, the mixed reinsurance is a combination of the previous, operating a quota share until it reaches the retention and operating a surplus from then on. This type of contracts are mostly used when the insurer is in solid financial conditions and their advantage relies on the surplus coverage that offers protection and lets property portfolios grow faster (Méndez, 2005).

On the other hand, the non-proportional reinsurance is based on fixing a maximum loss quantity that the ceding insurer will be able to pay leaving the reinsurer what remains, within the pre-established contract limits. Due to the fact this method is not ceding a proportional part of the primary insurer's portfolio but just the excess-loss from the pre-established limit upwards, there

is no sense to talk about a reinsurance commission as it does not apply (Minzoni, 2009). According to Macedo (2010), two types of non-proportional contracts can be distinguished: the excess-loss (and its Cat XL or Catastrophe version) and the stop-loss. The first one covers the insurer from those losses that go over the limit or "priority" established by the ceding company. The Cat XL version focuses on the sum of the losses occurred by one identical incident (for example, an earthquake) and establishes the priority on this sum. Finally, in the stop-loss reinsurance the primary insurer fixes a percentage on the total loss that it is able to absorb for a specific line of business in an entire fiscal year (Alegre *et al.*, 2017), leaving what remains to the reinsurer (for example, if the loss ratio priority is 110% and the actual loss ratio has been 130%, the reinsurer will pay those 20 points above the priority).

Excess-loss reinsurance mathematical formalisation

$$X_c = \begin{cases} X & \text{if} \quad X < M \\ M & \text{if} \quad X \geq M \end{cases} \qquad X_r = \begin{cases} 0 & \text{if} \quad X < M \\ X - M & \text{if} \quad X \geq M \end{cases}$$

Legend

X: Claim amount of a policy

X_c: Policy insured loss

X_r: Policy reinsured loss

M: Priority

Stop-loss reinsurance mathematical formalisation

$$Z_c = \begin{cases} Z & \text{if} \quad Z < M \\ M & \text{if} \quad Z \geq M \end{cases} \qquad Z_r = \begin{cases} 0 & \text{if} \quad Z < M \\ Z - M & \text{if} \quad Z \geq M \end{cases}$$

Legend

Z: Total portfolio loss of a specific line of business in an entire fiscal year

Z_c: Total insured loss

Z_r: Total reinsured loss

M: Priority

The traditional reinsurance encompasses all these types of contracts and usually lasts a year. It can be prospective (covers future losses) or retrospective (covers losses that already occurred) and it only takes into account the underwriting risk. When investment risk and timing risk are added to the reinsurance designing, it comes up the financial reinsurance, an alternative risk transfer which is gaining ground over the past few years. Taking into account the moment of time the insurance claims must be paid and the interest rates of the financial returns, the mathematical formalization of the financial reinsurance would be:

$$\left.\begin{array}{ll} Z_c = \sum_{i=1}^{N} X_{c,i}\, f_c(T_i,0) & Z_r = \sum_{i=1}^{N} X_{r,i}\, f_r(T_i,0) \end{array}\right\} \quad (X_1, X_2, \ldots, X_N, T_1, T_2, \ldots, T_N, N)$$

Legend

Z_c Total insured loss

Z_r Total reinsured loss

N: Number of losses occurring in the interval [0, t]

T_i: Moment of the *i*th loss payment in years

$X_{c,i}$: Insured loss at the *i*th accident

$X_{r,i}$: Reinsured loss at the *i*th accident

$f_c(T_i,0)$ Ceding company's discount factor. The interest rate is based on the financial returns that the ceding company obtains from the retained premium.

$f_r(T_i,0)$ Reinsurer's discount factor. The interest rate is based on the financial returns that the reinsurer obtains from the collected premiums.

2. Alternative risk transfer mechanisms

2.1 Origin

When traditional reinsurance cover becomes expensive due to new emerging risks such as cyber, terrorism and liability risks that change the insurance prices over the course of the cycles, alternative risk transfer (ART) mechanisms appear as an innovative opportunity of cost effective techniques ready to be seized (Sibindi, 2015a).

The very first time an ART form came up in the market was in the 1960s when organisations began to fully focus on risk management designing systems for loss prevention (Dionne, 2013; Giddy, 2006; Doherty, 2000) such as captive insurance companies and risk retention groups (Schanz, 1999). Captives are self-insurance programs developed in order to reduce transactions costs from the insurance industry (caused by adverse selection, moral hazard, credit risk, basis risk, etc) and to obtain more investment control of premiums (Dionne, 2013). If located in offshore domiciles, they can have tremendous tax-advantages. In 2012, the world's three largest captive domiciles were Bermuda with 856 captives, the Cayman Islands with 741 and Vermont with 586 (Zolkos, 2013). According to Dionne (2013), “risk retention groups (RRG) are a special type of group captive authorized by Congress in response to the liability insurance crisis of the 1980s to provide additional liability insurance capacity to businesses”. They account for only a small proportion of the US liability market and their main lines of insurance are liability coverage for professionals, the healthcare industry and educational institutions.

According to Ostaszewski (2006), the field of ART grew out when insurance capacity was not sufficient and in the 1970s through 1990s insurers were driven from looking for traditional coverage to seek alternative ways to buy protection. Most of these techniques permit investors in the capital markets to take a more direct role in providing insurance and reinsurance protection, hence bringing up a convergence of insurance and financial markets. An ART form which reduces moral hazard and passes the risk to the financial market is through securitization such as reinsurance sidecars (financial structures that allow external market investors to take on the risk and benefit from the return of specific insurance or reinsurance active business), swaps and catastrophe bonds. Catastrophe bonds, linked to a catastrophic-loss index, are insurance-linked securities that appeared first in 1992 on the Chicago Board of Trade ready to be launched (Dionne, 2013; Minzoni, 2009). Later on, this article gives a complete explanation of them and their controversy.

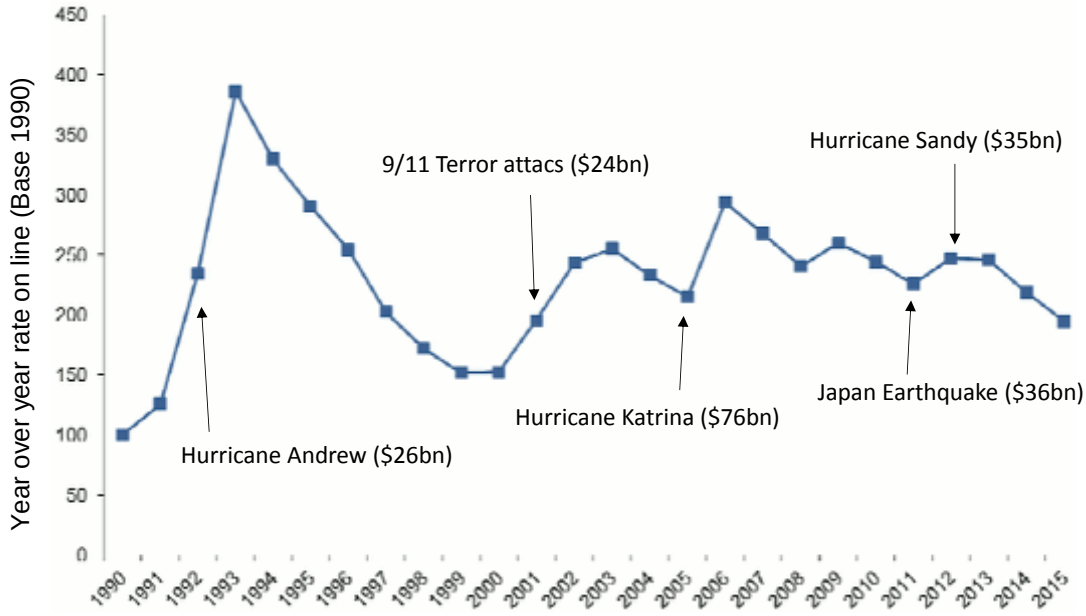
Some key market participants in ART operations are investment banks such as Goldman Sachs and Citibank, insurers such as AIG, Zurich and XL, reinsurers such as Munich Re, Hannover Re, Swiss Re, brokers like AON, Willis Towers Watson or Marsh and consultants such as Deloitte and ABS Consulting (Ostaszewski, 2006). Ultimately, the alternative risk transfer

market has grown an average of 6% per year since the mid-1980s, about twice the growth rate in the commercial insurance market (Andre and Sodowsky, 1997).

2.2 Definition and purpose of the ART mechanisms

Recently, ART has acquired a broader meaning and blends risk retention and risk transfer at the lowest total cost of risk resulting in mutually aligning the financial interests of both the insurer and the insured (Giddy, 2006). Today, there exist two broad segments to the ART market: risk transfer through alternative carriers, such as self-insurance, pools, captives and RRGs; and risk transfer through alternative products such as insurance-linked securities or CAT (catastrophe) bonds, credit securitization, committed capital, weather derivatives and finite risk products. Schanz (1999) describes ART mechanisms as tailored solutions to specific problems, multi-year and multi-line cover, a diversification and spread of risk over time that allows to insure those traditionally uninsurable risks and, finally, a way to transfer to risk to non-(re)insurers (to investors in stock markets). Dionne (2013) states that reinsurance prices are highly volatile over the course of the cycle especially for reinsuring catastrophic losses. Rohe *et al.* (1998) also explains ART activity has developed in the property and casualty industry because of the very cyclic reinsurance marketplace. When a large event occurs, capacity dries up and makes pricing more expensive. Later, as time goes by and capacity recovers, reinsurance pricing becomes more competitive again. Graph 1 represents the rate on line index evolution year over year as historical events occurred, considering 1990 as the base year. As stated by the International Risk Management Institute, the rate on line is the ratio or percentage derived by dividing the reinsurance premium by the reinsurance limit or loss recoverable and the inverse is known as the payback period. The higher rate on line, the higher reinsurance premium to be paid. In 1992, Hurricane Andrew wiped out Florida escalating the insured losses to astronomical levels, larger than any model had predicted before. The industry experienced losses of $26 billion (Artemis, 2015; Gonzalez and Sparrow, 2012) and the models had predicted that a bad hurricane would cause $2 billion in claims. As everyone was reconsidering their pricing strategy, reinsurance rates became more expensive and insurance companies realized that they needed much more coverage than they ever thought about (Rohe *et al.*, 1998). Later, as time passed reinsurance prices became more competitive until another big event took place (i.e. 9/11 terror attacks, Hurricane Katrina, 2011 Japan Earthquake, Hurricane Sandy…) which would trigger another big increase in the rate on line index making reinsurance premiums more expensive and thereby strengthening the cyclic feature of the reinsurance pricing.

Graph 1. Global property catastrophe rate-on-line index evolution.



Source: Guy Carpenter, Morgan Stanley Research, Artemis.bm (Evans, 2015a; Evans, 2015b)

Alternative risk transfer methods such as CAT bonds or Finite Risk reinsurance can provide this capital coverage without these traditional reinsurance pricing market fluctuations that make it difficult for insurers to satisfy their capacity needs and also to reinsurers who do not offer coverage due to lack of capacity and risk-layering (Rohe *et al.*, 1998). Nevertheless, Sibindi (2015b) concludes in his study that ART techniques "must be understood as compliments rather than substitutes to traditional insurance products" and the underlying reason for this argument could be their complexity and controversy.

3. Catastrophe bonds

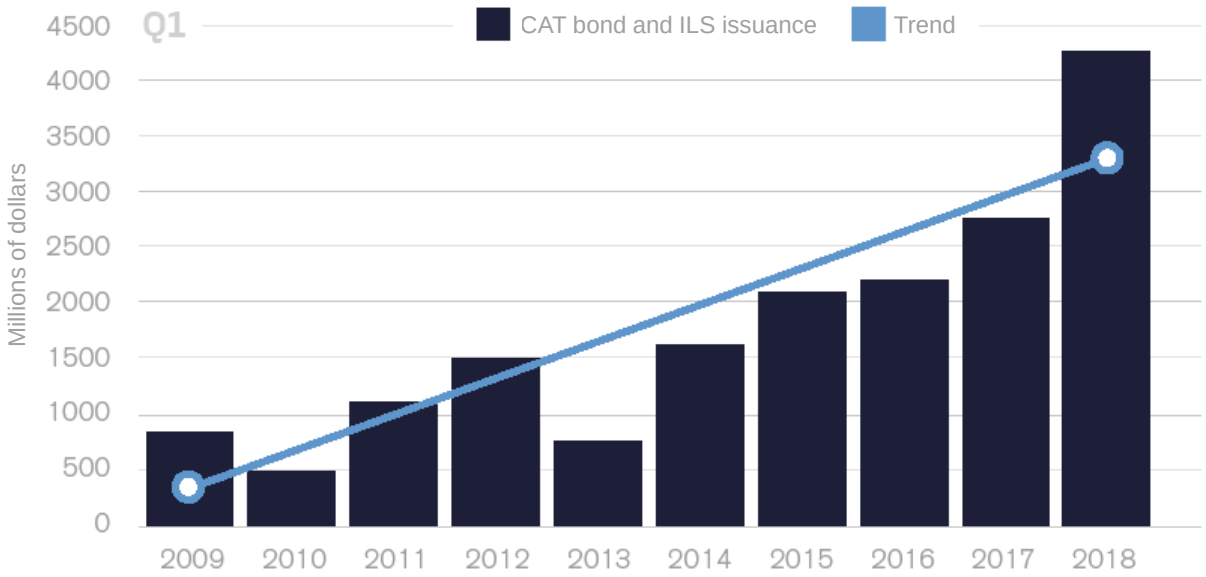
3.1 Definition and purpose

Over more than 15 years, catastrophe bonds or CAT bonds have served as a means to transfer insurance risks from events such as hurricanes, earthquakes and floods from insurers, reinsurers and other corporations to institutional and retail investors in the capital markets. The mechanism consists of a bond whose principal and coupons, designed with a Libor, Euribor or Treasury benchmarked spread, may be lost if a significant pre-defined event occurs (Ng, 2012). However, (Rohe *et al.*, 1998) explains there exist CAT bonds that act like a zero-coupon bond in the event of a catastrophe where coupons are lost but the principal remains safe. This is possible because of the assembly of a bond defeasance or a provision in which the borrower sets some of the proceeds aside (in a protected account) to pay off the principal over an extended period of time if the catastrophe did finally occur (Saint-Leger, 2011; Ostaszewski, 2006). Due to fears of losing the principal for disastrous events, investors such as life insurers or pension funds were to make catastrophe securitisation look unfeasible and illiquid. The first successful deal with these "defeased" CAT bonds was what Mr. Egan from Rohe *et al.* (1998) calls the St. Paul Re bond in 1996 and involved a five-year deal that covered existing exposure and new business to be written in the future. Part of the bond was invested in zero-coupon Treasury bills to guarantee the payment of the principal, thus not putting it at risk. The St. Paul Re deal was sold to US institutional investors such as Winterthur, which issued a three-year convertible bond -into Winterthur's equity- where interests were at risk for adverse European hailstorm losses. Winterthur bonds were sold to retail investors, beginning the first insurance securitisation. Later, in 1997, USAA could successfully issue a $500 million deal containing the defeasance clause. Next, Swiss Re launched its Swiss Re Earthquake Fund which covered California earthquake exposure and it had only a partial defeasance element, so not all of the principal was protected. Finally, Tokyo Marine did a transaction called Parametric Re which covered the perils of a Japanese earthquake. The CAT bond evolution had to be this way because before the St. Paul deal, USAA failed to do a $500 million transaction as investors were not keen on losing both the principal and coupons in case of a massive loss triggered by a single windstorm event on the East Coast.

Nowadays, catastrophe bond and insurance-linked securities (ILS) issuance are breaking records year over year since the first quarter (Q1) of 2014 (Evans, 2018a). Graph 2 shows that in 2018 Q1 approximately $4.24 billion of new risk capital was brought to market from 23 tranches of notes via 17 deals, being the first time that Q1 issuance surpasses $4 billion and keeping an upward trend since 2009 Q1; and the average transaction size in 2018 Q1 was approximately $249 million across 17 deals, which is above the ten-year average size of $187

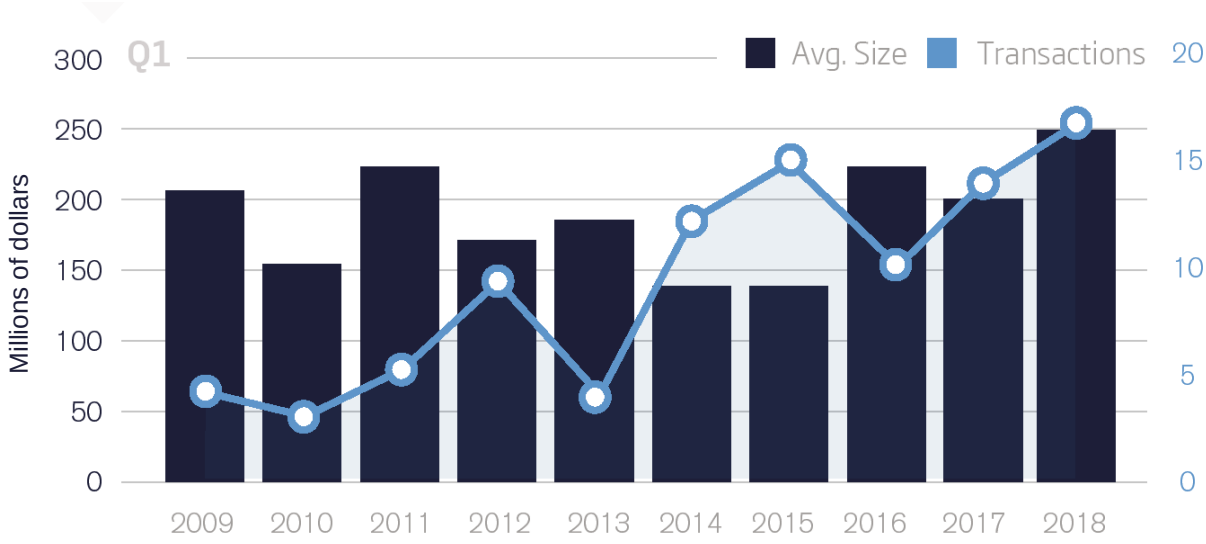
million, and eight above the average number of transactions completed, making it the most active Q1 ever (see Graph 3).

Graph 2. 2018 Q1 ILS issuance by year ($M).



Source: Artemis.bm (Evans, 2018a)

Graph 3. 2018 Q1 ILS average transaction size & number of transactions by year ($M).



Source: Artemis.bm (Evans, 2018a)

CAT bonds were firstly developed to offset the decrease in insurance capacity in response to the lack of wind coverage when Hurricane Andrew took place and their utilisation had been modest at the start even though transactional costs were declining and their acceptance was increasing (Indiviglio, 2011; Giddy, 2006). The main buyers of CAT bonds are life insurers, money managers, mutual funds, investment banks and hedge funds and their maturities range from one to three years (Wiedmeyer, 2012; Rohe et al., 1998). Although some authors argue that this ART form should be embraced as it is a cost effective technique (Sibindi, 2015a; Giddy

2006) which is uncorrelated with other asset classes, it is good to achieve diversification even though its typical below-investment-grade rating (Ostaszewski, 2006), there is a variety of perils to be covered (Ng, 2012), it has no credit risk (Dionne, 2013) and very attractive yields; Doherty (1997) argues that CAT bonds are not necessarily cheaper for reinsurers than traditional reinsurance.

3.2 Controversy over CAT bonds

There exist a public debate on whether CAT bonds are really a good coverage alternative or instead are just a simple financial instrument meant to enrich investors who buy them. For example, Indiviglio (2011) argues that despite the number of significant natural disasters occurred, for instance earthquakes and the 2011 earthquake and tsunami in Japan, these bonds have performed better than other asset classes because of their specific designing criteria which aims to protect investors from paying reinsurers. For example, as 2011 Japan's earthquake was more than 70 miles away from Tokyo, CAT bond investors would only had to pay less than 10 percent of the $1.7 billion of debt sold to help cover losses. Keogh *et al.* (2011), from Bloomberg, states CAT bonds could have ended up unscathed after Japan's worst earthquake "outperforming stocks, commodities, junk-rated debt and the reinsurers they're meant to protect".

In this type of securitised contract, both the advantages and disadvantages are related to basis risk and moral hazard (Dionne, 2013), two concepts where one is the flip side of the other (Doherty, 1997) or, in other words, they are inversely related (Ostaszewski, 2006). Gorvett (1999) explains these two concepts. On one hand, basis risk appears when the reinsurer who issued CAT bonds is experiencing bigger losses than the industry as a whole, that is, the debt relief provided by the bond (which depends on an industry catastrophe experience and consists in forgiving the insurer to pay back part of the principal and/or interests) will not be enough to offset its own losses, thus, mismatching the hedge. On the other hand, moral hazard may occur when due to a catastrophe loss meeting the CAT bond criteria, the company experiences a decrease in debt obligations (principal and/or interests are not bound to be given back) and seizes the opportunity to act unfaithfully and inflate its losses in order to be relieved from bigger debts and improve its financial rating to obtain better financing conditions at the expense of CAT bond investors.

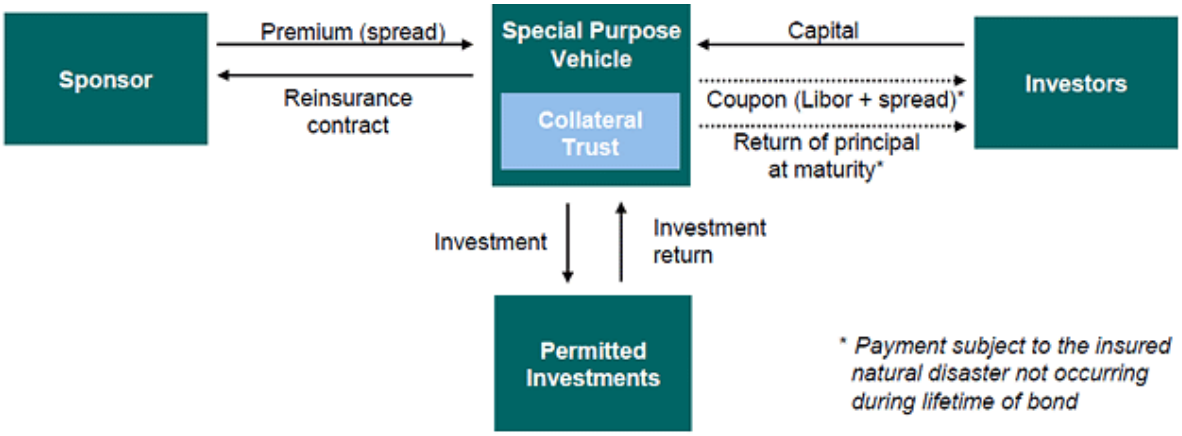
The reinsurance indemnity can be triggered by parametric triggers that Gorvett (1999) defines as three types: Direct, Industry and Event. The "Direct" trigger means the payoff of the CAT bond is based on just the company's losses, so basis risk does not exist. On the contrary, the "Industry" parametric trigger has basis risk as it depends on how the index of insurance industry losses performed but it does not have a significant amount of moral hazard. In the 1990s, a lot of insurers were not interested in an indexed transaction because they were afraid their loss

experience could be higher than index, thus, they feared basis risk (Rohe *et al.*, 1998). Finally, the "Event" trigger depends on the magnitude of a pre-defined disaster (e.g., Richter scale for earthquakes), its location and the occurrence. If the event does not occur, there is no payoff. This implies some basis risk.

Aside from the risks carried by these insurance-linked securities, another downside to these insurance-linked securities is its liquidity, which is affected by the size of the deal and depends on whether investment banks want to place these bonds into the market as they only want to do it with deals they get involve (Rohe *et al.*, 1998). Besides, investment banks charge reinsurers advising fees and spreads between the prices at which they purchase issues and the prices at which they sell them to the capital markets. Other costs of the CAT bond issuance are the high yields which consists of the LIBOR plus spreads over it ranging from 500 bps to 1500 bps (Dionne, 2013; Wiedmeyer, 2012; Ostaszewski, 2006), legal fees and the setting up of a special purpose vehicle (captive) or SPV.

According to Gorvett (1999), the issuance structure of this ART mechanism implies setting up an SPV to intermediate between the company and the capital markets. This SPV, which is typically an offshore reinsurer domiciled in the Cayman Islands, Bermuda or Ireland (Ostaszewski, 2006), aims to maintain favourable tax and accounting treatments. Figure 4 shows how the CAT bond issuance works (Evans, 2018b; Wiedmeyer, 2012). The Sponsor or the reinsurance company creates an SPV which issues individual bond notes to capital markets investors. The money contributed by investors is then deposited in a collateral trust or collateral account owned by the SPV (not the original sponsor, hence the favourable accounting treatments) whose goal is to invest it in low-risk highly-rated securities, such as U.S. treasuries among other permitted investments. Finally, the coupon paid to investors is made up from the investment return the SPV achieves from the collateral trust and the premiums the sponsor pays. If an event meeting the trigger conditions to activate a payout occurs, the SPV will use those cash flows coming from the invested premiums and from the invested bond proceeds to pay the sponsor while it stops paying coupons to investors and retaining their principal in case of no "defeasance" clause in the CAT bond. If that event does not occur, the principal is returned at maturity date.

Figure 4. Catastrophe bond issuance structure.



Source: Artemis.bm (Evans, 2018b), Wiedmeyer (2012)

To sum up, not only risks and high yields make the CAT bond an expensive ART but insurers begin to realise they seek for protection from events that have a 1% probability to occur at a very high cost (Wiedmeyer, 2012; Indiviglio, 2011). Nevertheless, insurers are interested in sharing risks in other to smooth annual results as well (Dionne, 2013). Another type of ART mechanism is the finite risk reinsurance, which has raised a public debate on whether it really is a form to tackle risks or it just conceals the ceding company's losses and pretties up its financial statements to such a degree that it might cross some legal boundaries (Wiggins, 2004; Álvarez, 1995).

4. Finite risk reinsurance

4.1 Definition and purpose

Appearing in 1960s' insurance marketplace and peaking its popularity in the late 1990s (Wiggins, 2004), finite risk reinsurance is one of the several ART tools companies use to increase their capacity and transfer high risks when natural disasters and traditional insurance losses escalate in times of uncertainty (Minzoni, 2009; Zolkos, 2003).

Contrary to traditional reinsurance, as Table 5 shows, finite risk transactions can be defined as multi-line, multiyear contracts where the reinsurer offers the insurer a coverage on a limited amount of risk relative to the aggregated premiums (Dahlen, 2007). This coverage extends to investment risk (i.e. real investment return resulting lower than expected), credit risk (i.e. the ceding company cannot pay the reinsurer the premiums), underwriting risk (uncertainty on the final cost of an insurance claim) and timing risk, which is the uncertainty on the period of time where the insurance claims must be paid off (Minzoni, 2009; Méndez, 2005). These contracts are based on assembling an account or fund, called experience fund, in which the reinsurance premium, which takes into account interest rates, is put in there as well as its investment return and as time goes by, insurance claims and administrative costs from the reinsurer are paid off through the experience fund (Sarrasí, 2017). At the end of the contract, in case there is a positive balance in the fund (i.e. because the reinsurer has obtained an investment return higher than expected), the reinsurer usually gives back 100% of the remaining amount.

Table 5. Differences between finite risk and traditional reinsurance

Traditional reinsurance	Finite risk reinsurance
Annual and single line contracts	Multiyear and multiline contracts
Does not take into account interest rates to calculate the reinsurance premium	Takes into account interest rates to calculate the reinsurance premium.
Premium is pre-fixed and is not returned	Premium is usually returned if there are no losses
Covers underwriting risk	Covers underwriting, investment, credit and timing risk
No experience fund	There is an experience fund
Combination of risks	Risks treated individually during a few years
Limited lines of business covered	Covers lines of business that traditional reinsurance cannot
Focuses on the risk transfer and reducing underwriting risk	Focuses on obtaining an investment return, managing liquidity and long-term planning

Source: Sarrasí (2007), Álvarez (1995)

Finite structures can be prospective (deals with future losses), taking the forms of spread loss cover and financial quota share, or retrospective (deals with past losses that have already occurred), in which time and distance policy, loss portfolio transfer (LPT) and adverse development cover (ADC) can be distinguished as the most relevant actual retrospective forms (Minzoni, 2009; Sarrasí, 2007; Greig, 2005).

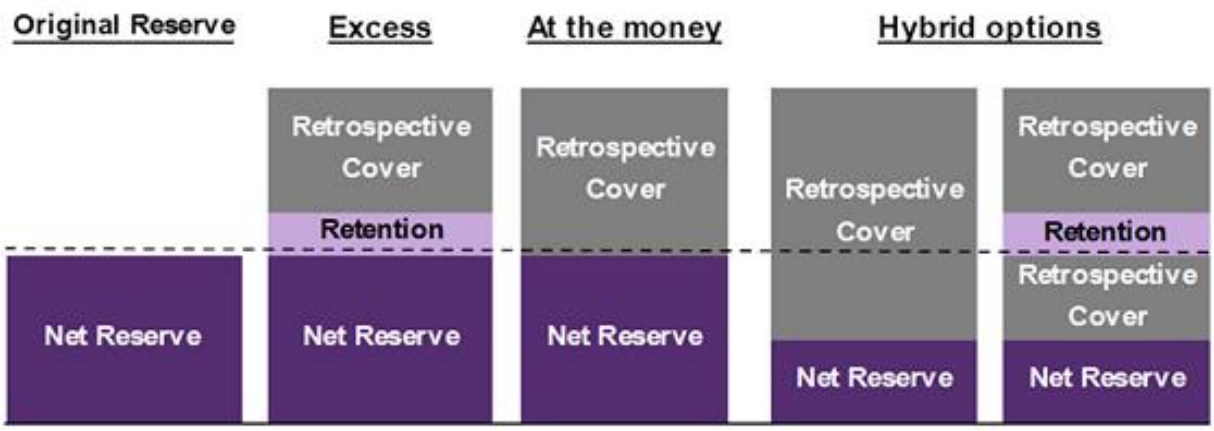
The spread loss cover is a prospective contract that affects an entire risk portfolio and is based on spreading losses over several earnings reporting periods in exchange of the ceding premium which is put in an experience fund to obtain investment return (Minzoni, 2009; Álvarez, 1995). It provides financing, liquidity management and long-term planning.

The financial quota share is another prospective contract where the reinsurer agrees to take a percentage of the cedent's premiums, which is the potential loss limit the reinsurer is going to be liable to, in exchange for a ceding commission that enables the cedent to increase its writing capacity as it arises surplus relief from transferring a portion of its risk to the reinsurer (Greig, 2005).

The time and distance policy is a retrospective contract where the reinsurer guarantees the cedent specific payments at pre-established future periods of time which are funded with the initial cedent's premium and the return on capital the reinsurer expects from its investments, therefore, timing risk could be a threat in this case (Minzoni, 2009).

The loss portfolio transfer (LPT) is a retrospective reinsurance transaction in which cedent's loss obligations are partially or totally transferred to the reinsurer (Partlow, 2012; Minzoni, 2009). When the deal includes known and unknown claims or IBNRs (Incurred But Not Reported), it is known as an Adverse Development Cover (ADC) which works like a stop-loss (Sarrasí, 2007). Figure 6 shows the ADC can take the form of "at-the-money" cover, making the reinsurer assume the excess loss above a fixed limit on the cedent's net reserves; "excess" cover, fixing a limit plus a retention on the cedent's net reserves; or "hybrid options", attaching cover within net reserves with the possibility to incorporate additional retentions or loss corridors (Mounty, 2016).

Figure 6. Types of ADC covers



Source: Willis Towers Watson (Mounty, 2016)

In order to calculate the premium for the LPT contracts to the reinsurer, the time value of money is considered making the premium less than the ultimate amount expected to be paid (Palmer *et al.*, 2015; Koegel, 2003). The LPT contracts, designated by Giddy (2006) as the most used finite product, can be used to exit a line of business, to transfer risk, to eliminate long-term liabilities from a company during merger and acquisition activities or transfer historical losses of the parent company to a captive where tax advantages appear in the form of deductible reimbursement programs, making the LPT formal legal transaction require sometimes the approval from the regulator and triggering a public debate on whether the finite risk scheme purpose is to transfer risk or to keep a company afloat by "making-up" its balance sheet losses (Zolkos, 2003; Quane *et al.*, 2002).

4.2 Controversy over finite risk reinsurance

In 2001, Enron filed for bankruptcy with an aggregate asset value of $65.5 billion due to the scandal it got involved with its fraudulent accounting practices (Howe, 2011). Finite risk reinsurance began to be highly repudiated by companies as Enron used it as a means to conceal financial problems and reduce balance sheet volatility while involving almost no actual risk transfer (Zolkos, 2002). As reported by Minzoni (2009), finite risk deals were firstly meant to distort balance sheet accounts until new stricter regulatory rules came up. Either way, this ART product helps the buyer to reduce their cost of capital while spreading losses over different earnings reporting periods in order to publish steady profits on their annual reports, thereby, "smoothing earnings" to satisfy shareholders (Giddy, 2006; Wiggins, 2004; Zolkos, 2003). In the past, the finite risk used to be sold by reinsurers to insurers but also by insurers to non-financial clients, such as the Enron case (Wiggins, 2004). Due to the later Enron scandal and AIG settling with US Security and Exchange Commission (SEC) over allegations that through a finite product the cell phone distributor Brightpoint concealed $11.9 million of losses (Carlin and Schonfeld, 2003), finite risk products were seen as something negative that hurt firms' reputation and transparency (Wiggins, 2004; Wojcik, 2004; Zolkos, 2003). But Enron scandal also affected its auditor, Arthur Andersen, who according to Walker *et al.* (2001) agreed to settlement "resulting in first antifraud injunction in more than 20 years and largest-ever civil penalty ($7 million) in SEC enforcement action against a Big Five accounting firm". Consequently, auditors began to look more carefully if a finite risk product was misused and purposed to distort or smooth financial accounts because if that were the case, it would not be condoned (Zolkos, 2003).

At the beginning, it was difficult to put the finite risk reinsurance in a legal framework as there was no regulation on the reinsurer insolvency, the aggregate limit in case of high losses, tax evasion, unfair competition (i.e. banks credit-and-corporate-loan business could be threatened by finite deals) and the accounting method which could vary depending on the type of risk

(Álvarez, 1995). The measures taken by some countries to overcome finite risk abuses are mainly focused on the actual risk transfer and the accounting system for finite risk transactions (Culp and Heaton, 2005; Álvarez, 1995). In the US, the Financial Accounting Standard Board (FASB) considers the existence of risk transfer as crucial for the transaction to be accounted as an insurance contract, otherwise, if there is little or no risk then the transaction translates into a deposit, credit or loan which must be accounted as such, losing the financial advantages of accounting it as a part of the reserves generated by the financial reinsurance. UK acts similarly to the US with its public organisms such as "Statement of recommended Practice" (SORP) or the "Accounting Standards Committee" (ASC). As stated by Zolkos (2002), UK and Australia are carefully inspecting how finite risk and other structured products hide failing insurance companies' financial problems. Tax discounts via accounting finite risk transactions as loss reserves are prohibited in France, Germany, Netherlands and Sweden. From an international point of view, the International Association of Insurance Supervisors (IAIS) works to achieve full transparency and disclosure over the finite reinsurance-related risk transfer to avoid favourable accounting treatments within cases of abuse and to regulate and supervise the finite reinsurance marketplace (Dahlen, 2007).

Last but not least, reinsurers tend to establish their operations in offshore countries (Cayman Islands, Bermuda, etc) where tax evasion is favourable mainly through their special purpose vehicles (SPV) or captives which lack of transparency in most of their lines of business such as personal, commercial, life insurance and property and casualty and deteriorate their trust and credit ratings threatening the ceding company's solvency (Wojcik, 2004; Álvarez, 1995).

5. Conclusion

The present dissertation has defined the traditional reinsurance concept out of words and mathematical expressions. It has also introduced the alternative risk transfer (ART) mechanisms and has broken down the catastrophe bond and finite risk reinsurance concepts and their controversy. Even though traditional reinsurance pricing is volatile due to its variations in capacity when a large event takes place, the ART techniques seem to be still acting as complements rather than substitutes. This is due to their complexity and distrust.

On one hand, catastrophe bonds do not seem to be less costly than traditional reinsurance because their assembling through special purpose vehicles is quite expensive and their contractual conditions are very strict, as it has been proven that when a disaster such an earthquake or a hurricane occurs this ART mechanism fails to cover a big part of the insured losses because the contractual conditions for the bond to be triggered are not met. In addition, the probability for such event to occur is 1%, what makes investors have 99% chance of receiving their principal and coupons (usually with high yield rates) intact.

On the other hand, finite risk contracts cannot be defined as less costly than traditional reinsurance yet due to their high controversy that exist around them. Since their establishment in the reinsurance marketplace, these deals have faced legal penalties, some of them prosecuted by the US Security and Exchange Commission accompanied by multimillion dollar fines. Part of their questionable features are their tax advantages from being produced in offshore locations and their multiyear character which implies smoothing losses over several earnings periods at risk is transferred. As a result of abuses and misuses of this ART technique and past accounting scandals such as Enron's, defenders and critics have gotten involved in a long dispute over its legitimacy and continuity.

To sum up, the increasing popularity trend of catastrophe bonds is confirmed over time. Besides, they do not represent a direct threat for reinsurers, insurers or policyholders as the risk is widespread in the financial markets. However, further research and investigation on finite risk transactions throughout the world would be needed to figure out what countries are buying finite risk policies, who gets the most profit of it and how governments regulate and supervise this marketplace because most of the authors consulted in this dissertation agree that without transparency and disclosure of finite risk reinsurance products (specially the most popular form called loss portfolio transfer), the ceding company and its policyholders are put in danger.

6. References

Alegre *et al.*, (2017). *Teoría General del Seguro.* Cátedra de Seguros y Fondos de Pensiones ICEA-UB. Asociación ICEA: Madrid.

Álvarez Martín, R. (1995). *El Reaseguro Financiero. Análisis.* Centro de Documentación de Fundación MAPFRE.

Andre, J. E. and Sodowsky R. (1997). *Considering the alternative market*. Best Rev/Prop-Casual Insur, Ed 98:42.

Carlin, W. and Schonfeld, M. (2003). *SEC Charges American International Group and Others in Brightpoint Securities Fraud; AIG Agrees To Pay $10 Million Civil Penalty | US Security and Exchange Commission.* [online] Available at: www.sec.gov/news/press/2003-111.htm [Accessed 02 June 2018].

Culp, C. and Heaton, J. (2005). The Uses and Abuses of Finite Risk Reinsurance. *Journal of Applied Corporate Finance, 17 (3),* pp.18-31

Evans, S. (2015a). *Reinsurance market cycle has changed, responds locally to losses: Guy Carpenter | Artemis.bm.* [online] Available at: www.artemis.bm/blog/2015/01/13/ [Accessed 18 May 2018].

Evans, S. (2015b). *Slowing reinsurance price decline a "glimmer of hope": Morgan Stanley | Artemis.bm*. [online] Available at: www.artemis.bm/blog/2015/07/14/ [Accessed 18 May 2018].

Evans, S. (2018a). *Q1 2018 Catastrophe Bond & ILS Market Report: Artemis.bm.* [online] Available at: www.artemis.bm/artemis_ils_market_reports/ [Accessed 19 May 2018].

Evans, S. (2018b). *What is a catastrophe bond? - Artemis - Resource Library*. [online] Artemis.bm. Available at: www.artemis.bm/library/what-is-a-catastrophe-bond.html [Accessed 22 May 2018].

Dahlen, S. (2007). Finite Reinsurance: How does it Concern Supervisors? Some Efficiency Considerations in the Light of Prevailing Regulatory Aims. *The Geneva Papers on Risk and Insurance - Issues and Practice, 32(3),* pp.283-300.

Dionne, G. (2013). *Handbook of insurance*. New York, NY: Springer New York.

Doherty N. (1997) *Financial innovations in the management of catastrophic risk*. J Appl Corp Finance 10:84–95.

Doherty, N. (2000). *Integrated Risk Management: Techniques and Strategies for Managing Corporate Risk*. McGraw Hill Professional.

Giddy, I. (2006). *What is Alternative Risk Transfer?* [online] New York University Stern School of Business. Available at: pages.stern.nyu.edu/~igiddy/articles/alternative_risk_transfer.htm [Accessed 10 May 2018].

Gonzalez, J. and Sparrow, T. (2012). *Hurricane Andrew: Florida residents remember the storm* [online] BBC News. Available at: www.bbc.com/news/world-us-canada-19349266 [Accessed 18 May 2018].

Gorvett, R. W. (1999). *Insurance Securitization: The Development of a New Asset Class.* Casualty Actuarial Society. The College of Insurance: New York.

Greig, R. (2005). *An Introduction to Finite Reinsurance / Risk Transfer Issues.* Caribbean Actuarial Association Seminar. Towers Perrin

Howe, A. (2011). *The 11 Largest Bankruptcies in American History.* Business Insider, November 29

Indiviglio, D. (2011). *Does Japan's Earthquake Show That Catastrophe Bonds Are Useless?.* [online] The Atlantic. Available at: www.theatlantic.com/business/archive/2011/03/does-japans-earthquake-show-that-catastrophe-bonds-are-useless/73032/ [Accessed 19 May 2018].

International Risk Management Institute, Inc. (2018). *Rate on Line (ROL) | IRMI.com*. [online] Available at: www.irmi.com/term/insurance-definitions/rate-on-line [Accessed 31 May 2018].

Keogh, B. *et al.* (2011). *'Hole-in-One' Cat Bonds Are Top Asset Eluding Quake's Grasp.* [online] Bloomberg.com. Available at: www.bloomberg.com/news/articles/2011-03-22/-hole-in-one-cat-bonds-rank-as-top-asset-eluding-japan-disaster [Accessed 19 May 2018].

Koegel, D. (2003). *Finite Risk in 2003: Times Change, Yet Fundamentals Remain The Same.* Imagine Group and Enterprise Advisors: New York.

Macedo, P. (2010). *Introducción al reaseguro*. Madrid: Fundación MAPFRE, Instituto de Ciencias del Seguro.

Méndez Frias, M. (2005). *Creación de un Factor de Rentabilidad para el Reaseguro de Incendio de Casa-Habitación en México*. Tesis Licenciatura. Actuaría. Departamento de Actuaría, Escuela de Ciencias, Universidad de las Américas Puebla.

Minzoni Consorti, A. (2009). *Reaseguro (3a. ed.).* Distrito Federal: UNAM.

Mounty, J. (2016). *How does retrospective reinsurance work? | Willis Towers Watson Wire* [online] blog.willis.com. Available at: https://blog.willis.com/2016/08/how-does-retrospective-reinsurance-work/ [Accessed 30 May 2018].

Ng, A. (2012). *Alternative Risk Transfer – Capital Markets Update*. Financial Institutions Group, Australasia. Actuaries Institute 2012 General Insurance Seminar. BNP Paribas.

Ostaszewski, K. (2006). *Alternative risk transfers*. Normal: Illinois State University.

Palmer, J. *et al.* (2015). *Commutations, Novations and Other Alternative Loss Transfer Strategies.* Hawaii Captive Insurance Council Seminar. Willis, J.F. Shea Co. Inc., AIG.

Partlow, J. (2012). *Transferring Risk: A Look Into Loss Portfolio Transfer's, Novations and Commutation Agreements.* South Carolina Captive Insurance Association Seminar. Johnson Lambert.

Quane, A. *et al.* (2002). *Loss Portfolio Transfers.* Giro Working Party Paper. Institute and Faculty of Actuaries (IFoA): London.

Rohe, M. *et al.* (1998). *The "Art" Of Alternative Risk Transfer*. RECORD, Volume 24, No. 3. Society of Actuaries. Session 116PD. New York Annual Meeting, October 18-21, 1998.

Sarrasí Vizcarra, F. J. (2017). *Matemática del Reaseguro.* Colección de Publicaciones del Departamento de Matemática Económica, Financiera y Actuarial, nº 61. Barcelona: Universidad de Barcelona.

Sarrasí Vizcarra, F. J. (2007). *El Reaseguro Financiero.* Master in Management of Insurance and Financial Organisations Seminar. Universitat de Barcelona.

Saint-Leger, R. (2011). *What Is a Bond Defeasance? | Sapling* [online] Sapling.com. Available at: www.sapling.com/12110587/bond-defeasance [Accessed 18 May 2018].

Schanz, K. (1999). *Alternative Risk Transfer (ART) for corporations: A passing fashion or risk management for the 21st century?* Sigma Report No. 2/1999, Swiss Re.

Sibindi, A. (2015a). The ART of Alternative Risk Transfer Methods of insurance. *Risk Governance and Control: Financial Markets & Institutions, 5(4).*

Sibindi, A. (2015b). A Comparative Study of the Application of Alternative Risk Transfer Methods of Insurance in South Africa and Zimbabwe. *Journal of Governance and Regulation, 4 (3).*

Walker, R. *et al.* (2001). *Arthur Andersen LLP Agrees to Settlement Resulting in First Antifraud Injunction in More Than 20 Years and Largest-Ever Civil Penalty ($7 Million) in SEC Enforcement Action Against a Big Five Accounting Firm | US Security and Exchange Commission.* [online] Available at: www.sec.gov/news/headlines/andersenfraud.htm [Accessed 02 June 2018].

Wiedmeyer, J. (2012). *Catastrophe Bonds: An Innovative Renewable Energy Risk Management Tool? | Renewable Energy Project Finance.* [online] Financere.nrel.gov. Available at: https://financere.nrel.gov/finance/content/catastrophe-bonds-innovative-renewable-energy-risk-management-tool#references [Accessed 22 May 2018].

Wiggins, J. (2004). *On Wall St: The days of finite risk are numbered.* [online] Ft.com. Available at: www.ft.com/content/0d9930b2-4538-11d9-8fcf-00000e2511c8 [Accessed 22 May 2018].

Wojcik, J. (2004). *Probes transfer attention to finite risk - Business Insurance.* [online] Business Insurance. Available at: www.businessinsurance.com/article/20041121/ISSUE01/100015752 [Accessed 20 May 2018].

Zolkos, R. (2002). *Post-Enron, finite re deals will be different.* Business Insurance, March 17

Zolkos, R. (2003). *Some seek alternatives to traditional reinsurance.* Business Insurance, September 11

Zolkos, R. (2013). *Captive insurance market grows as economy recovers*. Business Insurance, March 10