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The reinsurance bond as a new technique of alternative risk transfer. The case of a non-life insurance company

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Introduction

The thesis aims to explore the evolution and innovation in the field of reinsurance and risk transfer, highlighting how these mechanisms adapt and respond to the changing needs of the insurance market. Through the analysis of alternative risk transfer (ART) instruments and comparison with traditional reinsurance, this research provides a comprehensive overview of the current state and potential future directions of the industry, as well as the study of a specific ART instrument being developed in the market. This research is situated in the context of an insurance market in continuous evolution, where companies seek innovative solutions to manage risks effectively and sustainably.

The first chapter addresses the concept of traditional reinsurance, contrasting it with financial reinsurance. Starting from a historical analysis, we examine the foundations of reinsurance, dating back to 1370 in Italy, with the introduction of the first reinsurance contract in the maritime transportation of goods. This chapter highlights how reinsurance functions as "insurance for insurance companies," allowing the transfer of a portion of the risk to another entity in exchange for the payment of a premium. We explore the distinction between types of reinsurance, *inward* and *outward* and discuss the role of reinsurance as an indemnity contract that responds to economic losses. The chapter also focuses on the complexity and importance of reinsurance in the current context, highlighting how it has become an essential component of the global insurance industry. Through the analysis of different types of reinsurance, we discuss how reinsurance helps mitigate financial risks, promotes market stability, and supports insurance companies' ability to provide coverage in high-risk situations. In particular, proportional reinsurance with quota share and surplus treaties, non-proportional reinsurance with excess of loss and stop-loss treaties, and financial reinsurance with retrospective and prospective treaties are described. Finally, there is a comparison between traditional and financial reinsurance, posing the question of whether the latter can actually be considered a true form of reinsurance. In conclusion, the first chapter establishes the foundation for understanding reinsurance as a critical tool for risk management in the insurance sector, laying the groundwork for further discussions on how reinsurance techniques have evolved and how they can be effectively applied in various risk contexts.

The second chapter shifts towards ART methodologies, examining how they offer an effective alternative to traditional reinsurance. The chapter describes two main segments of the ART market: risk transfer through alternative vehicles and risk transfer through alternative products. Among the alternative vehicles are mechanisms such as self-insured retention (SIR), captives, and pools, while risk transfer through alternative products includes a range of transactions such as multiline products, insurance-linked securities (such as catastrophe bonds), credit securitization, committed capital, weather derivatives, and finite risk products. Finally, it offers a comparison between traditional reinsurance and ART solutions, and how the latter can be a strong alternative but also how the two can coexist. In summary, the second chapter of the thesis illustrates how ART provides substitute or complementary tools to traditional reinsurance, in addition to conventional methods of capital raising through debt or equity issuance. These mechanisms allow the transfer of assets and liabilities from the balance sheets of insurance and reinsurance companies to capital markets, shifting risks to investors and thereby influencing insurers' capital positions similarly to traditional reinsurance, freeing up previously tied capital to support risk. This released capital can then be directed towards new business opportunities.

The third chapter focuses on the analysis of a case study exploring the issuance of a bond by a non-life insurance company as an alternative financial instrument for risk mitigation in reinsurance. The redemption value of this bond is correlated with the company's technical performance, specifically the loss ratio. This chapter details the risk expectation associated with loss ratio volatility, bond characteristics, and methodologies for calculating the components necessary for cash flow modeling and determining the coupon value. The chapter continues with a discussion on the criteria for recognition, measurement, and accounting classification according to the IFRS 9 "Financial Instruments" standard, emphasizing how this standard influences bond accounting. It concludes with a cost-benefit analysis comparing this financial instrument with traditional reinsurance, highlighting the advantages of bond issuance in terms of risk management and financial impact for the insurance company.

Therefore, this thesis not only outlines a detailed framework of reinsurance and ART but also delves into an in-depth analysis of how innovations in these sectors can provide effective solutions for risk management, offering new and improved perspectives for the global insurance market.

Chapter 1

Traditional vs. financial reinsurance

1.1 Overview of traditional reinsurance

1.1.1 The basics of traditional reinsurance

The first episode of a reinsurance contract occurred in 1370 in Italy and concerned the maritime transportation of goods from Genova to Sluis. The contract established that the *insurer*[1] would insure himself by transferring the riskier part of the travel to another insurer, called *reinsurer*. Through this agreement the reinsurer assumed a part of the risk without a contractual relationship with the original insured.[2]

The *reinsurance* is therefore the contract that represents the *insurance for insurance companies* because it allows the insurer, also called *reinsured* or *cedent* to transfer a part of the risk assumed to the reinsurer through the payment of a premium.

Reinsurance is an effective contract of indirect insurance, in fact it is subject

[1]This term make reference to the first example of insurance's contract (Italy, 1343) where a lender would lend money to a merchant that wanted to transport by sea his goods; if the goods had reached their destination intact the merchant had to return the loan with interests, if, on the other hand, the ship had sunk the merchant could have kept the loan. This type of agreement forms the basis for insurance arrangements of assumption of risks against payment of a premium or fee. Cfr Di Groppello G., Manghetti G., *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*,LINT, Trieste, 1996, p.23

[2]ivi, p.24

to the *utmost good faith*[3] defined by the *Cambridge Business English Dictionary* as *the legal duty of someone who is buying or selling something to provide full and correct information*, which therefore provides that all parties involved have to act in good faith and so have to present a good representation of all the facts and make all the elements of the contract known to the counterparty. It is possible to make an initial distinction between two types of reinsurance: the *inward reinsurance*, i.e. the reinsurance business accepted by an insurer or reinsurer (also known *assumed reinsurance* , and the *outwards reinsurance*, i.e. the reinsurance business ceded by an insurer or reinsurer (also known *ceded reinsurance*).

The term *risk* relates to the present and future losses insured by the cedent under the insurance contracts. This transfer of risk, or losses, occurs through the payment of the premium (or part of the premium) previously collected by the insurer from the policyholder. Therefore the basic concept is as follows:An insurance company collects premiums to cover potential financial losses from risks that may result in compensation payouts to policyholders for claims. The company may choose to transfer some of these potential losses to a reinsurer, who then receives the premiums.

Reinsurance consists in a contract of indemnity. A contract of indemnity is one that responds to economic loss, not merely damage. In fact if the cedent suffers an economic loss related to a claim a portion of that loss is covered by the reinsurer. There is no relationship between the policyholder and the reinsurer: the former has no right to take action against the reinsurer and the latter doesn't cover the policyholder's risk because being a contract of indemnity towards the insurer reinsurance applies when the latter has incurred in an economic loss damage.[4]

1.1.2 Markets and operators

It is possible to dinstinguish three different reinsurance markets: the international market, the London market and the LLoyd's market. The first consists in a network of companies which have representatives in the most important cities, such as New York, London and Tokyo in order to underwrite a huge volume of reinsurance

[3] in Latin *Uberrima Fides*

[4] Ross Phifer, *Reinsurance fundamentals. Treaty and Facultative*, John Wiley, New York, 1996, p. 5-6

contracts and have access to a great deal of information that allow to operate more successfully. The London market includes all English companies and all international companies with whom they do reinsurance business; is a very large market relegated to a limited area, making it easier to place risks.[5] The Lloyd's market has traditionally been a landmark for the placement of certain classes of business like transport and special risks (contingency).

Lloyd's started in 1688 when Edward Lloyd, who owned a cafe in London, began gathering sailors there. His cafe became a place for maritime news and a basic market for insurance. He also published a bulletin called *Lloyd's News*, which later evolved into *Lloyd's List*, a detailed source of ship news from 1734. Edward Lloyd's established a rudimentary insurance market renting out tables where entrepreneurial businessmen took the opportunity to sell insurance to ship owners in the event their ship did not return. Today is a international leader in the insurance and reinsurance market with more than 50 insurance companies, 380 brokers and 4000 local cover holders that fuel the business in the Lloyd's market. [6]

In the reinsurance market there are buyers and sellers of reinsurance and intermediaries acting as broker[7]. There are different types of buyers but the most important one comprises the insurance companies, in term of volume of premium exchanged. In addition, Lloyd's are part of the reinsurance buyers because of their business and investment portfolio of international standing. Another type of buyer are the *insurance captive*, i.e. an insurance company established and owned by another company to insure all or some risks of the parent company and the subsidiaries. [8] Furthermore the reinsurance companies could enter into reinsurance contract with another reinsurer to protect themselves from risks that exceed their risk capacity.[9]

The main sellers are professional reinsurance companies or companies that have

[5]Di Groppello G., Manghetti G., *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*, LINT, Trieste, 1996, p.28

[6]https://www.lloyds.com

[7]Is a financial intermediary that plays the role of acqusition and placement of reinsurance business between the cedent and the reinsurer. Cfr Di Groppello G., Manghetti G., *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*, LINT, Trieste, 1996

[8]Weterings W.,*(Re)Insurance Captives, Efficiency and Moral Hazard: An Attractive Manner of Risk Financing and Risk Management for Companies in Certain Circumstances*,Tilburg Law School, December 2, 2013

[9]This practice is called "*retrocession*"

as their only business the signing of reinsurance contracts; are multinational companies that operate in the international market in all the branches of insurance directly or with the brokers. The following table shows the top 10 reinsurance companies in the world according to Standard & Poors in terms of premiums collected.

Ranking	Company	Country	Rating	Net Reinsurance Written Premiums (mil.$)	Pretax Operating Income (mil.$)
1	Munich Reinsurance Co.	Germany	AA-	48,747.9	1,623.3
2	Swiss Reinsurance Co. Ltd.	Switzerland	AA-	43,917.0	654.0
3	Hannover Rueck SE	Germany	AA-	31,969.8	2,027.0
4	Berkshire Hathaway Insurance Group	United States	AA+	22,147.0	1,389.0
5	SCOR Group	France	A+	17,046.9	-615.8
6	China Reinsurance (Group) Corp.	China	A	15,452.7	1,509.1
7	Lloyd's	United Kingdom	A+	14,302.8	765.1
8	Reinsurance Group of America Inc.	United States	AA-	13,078.0	1,261.0
9	Everest Group Ltd.	Bermuda	A+	12,344.2	1,146.4
10	PartnerRe Ltd.	Bermuda	A+	7,544.2	N.A.

Table 1.1: S&P Global Ratings Top 10 Global Reinsurers 2023. Data source: S&P Global Ratings

The others typologies of sellers are the Lloyd's, that operate exclusively through Lloyd's brokers, and the direct insurance company that could also underwrite reinsurance business. The Lloyd's Act of 1982 established rules for Lloyd's management, overseen by the Council regulated by the UK Financial Services Authority. In 2003, Lloyd's introduced a new franchising system.

To place risks, clients provide details to brokers who negotiate with underwriters. Once terms are agreed, brokers prepare insurance slips signed by lead underwriters. They then seek other underwriters to complete the placement, aiming for 100% participation.

The insured pays the premium to the broker, who retains a percentage and forwards the rest to Lloyd's Central Accounting, which allocates it to the managing agent of the involved syndicate.

1.1.3 Functions and purposes of traditional reinsurance

Each type of function meets a particular ceding counterpart's need arising out of risk management considerations about insurance business portfolio and is related with a particular purpose.

Insurance companies are concerned that a single policy with high risk could significantly impact their financial stability. To manage this, they may choose to either reject high-risk policies or transfer a portion of the risk to a reinsurer. This enables them to increase their *capacity* to underwrite more policies while minimizing the potential adverse effects of any individual policy.

Reinsurance allows to limit the impact of a catastrophic event on the assets of the insurance company, where *catastrophe* refers to multiple claims or losses arising out of a single same occurrence[10] related to an event such as storm, earthquake, flood or multiple accidents resulting from a single cause. If an insurance company was alone in coping with a catastrophic event, its economic stability could be jeopardize, while with a reinsurance coverage, it can assume risk greater of a certain amount and insure from catastrophic events.

One of the most important purposes of reinsurance is the year-by-year achievement of level results and this is possible thanks to the *stability* of the company. Stable results produce a stable situations in term of plannings, investments, requirements to borrow capital but always within the sphere of risk assumption that is, by nature, volatile. Therefore a reinsurance coverage minimizes the fluctuations in the insurer's result due to an increased frequency of major claims or for a catastrophic loss, limits the risk exposure and reduces the amount of the claims to which a portfolio is exposed.

The insurer must keep the portfolio balanced by ensuring that the likelihood of a claim matches the statistical probability of the event as closely as possible. The law of large numbers, a key concept in insurance economics, states that the more independent and identically distributed risks there are in a risk pool, the lower the variance of losses. Therefore, it's safer to insure many small risks rather than a few large ones to maintain a homogeneous risk portfolio. To achieve this, it's necessary to transfer some major risks, reducing the insurer's risk exposure and keeping the portfolio balanced.

Reinsurance is likewise a tool to enhance the *financial strength* of an insurance

[10] Ross Phifer, *Reinsurance fundamentals. Treaty and Facultative*, John Wiley, New York, 1996, p.6

company. A method to assess this strength is by measuring the solvency of the company. The use of reinsurance allows the company to enforce its financial strength by increasing its solvency. As Solvency II comes into effect, the reinsurance has a further impact on the financial strength of the insurance company because takes effect on the company's Solvency Ratio, defined by IVASS[11] as "*The ratio of Eligible Own Funds (EOF) to Solvency Capital Requirement (SCR) and expression of the capitalization's level of insurance companies.*".

$$Solvency\ Ratio = \frac{Own\ Funds}{SCR} \tag{1.1}$$

The term Own Funds refers to surplus capital that remains when the liabilities are deducted from the total assets and, for the Solvency II regime, it refers to the market value of assets net of the market value of liabilities[12]. The term solvency capital requirement (SCR), on the other hand, corresponds to the (economic) capital that should be held to ensure that the insurance company can meet its obligations towards policyholders and beneficiaries with certain probability and should be set to a confidence level of 99.5% over a 12-month period. The purchase of reinsurance affects both the numerator (own funds) and the denominator (solvency capital requirement): the reinsurance agreement can significantly impact the risk margin[13] on the economic balance sheet, with minimal impact on its other components.This entails an increase of Own Funds (OF), consequently leading to an elevated Solvency Ratio post-reinsurance. The transfer of risk through reinsurance also exerts an influence on the SCR. It mitigates the gross SCR (pre-reinsurance) to a net SCR (post-reinsurance), which may represent a fraction of the initial gross SCR amount. This reduction in the denominator of the Solvency Ratio equation contributes to an enhanced level of solvency.[14]

[11] Istituto per la Vigilanza sulle Assicurazioni

[12] Under Solvency II the liabilities for insurance companies consist in the market value of technical provisions, equal to the value of Best Estimate Liabilities and the value of Risk Margin

[13] Under the European Union's Solvency II directive, represents the potential costs of transferring insurance obligations to a third party should an insurer fail. It is equal to an insurer's baseline solvency capital requirement for unhedgeable risks multiplied by the cost of capital at 6% and discounted at current interest rates.

[14] https://www.genre.com/us/knowledge/publications/2015/august/what-you-need-to-know-about-solvency-ii-and-reinsurance-en

1.2 Typologies and characteristics of traditional reinsurance

There are two different types of traditional reinsurance: facultative reinsurance, whereby the reinsurer holds the option either to accept or to reject each risk submitted by the insurer; obligatory reinsurance (or treaty), whereby the transfer of certain risks takes place automatically, or *obligatorily*, in force of an agreement(treaty) stipulated a priori between the insurer and the reinsurer. Regardless of whether treaty or facultative reinsurance is used, reinsurance may be provided on a proportional or a non proportional basis. The former can take the form of quota share or surplus reinsurance, while the latter can be agreed as excess of loss reinsurance or stop loss reinsurance.

1.2.1 Proportional reinsurance

In the *proportional* reinsurance the reinsurer receives an agreed proportion of the premium, net of commission, and pays the same proportion of the (possible) claims. Pure proportional quota share (QS) reinsurance is characterized by the cedant ceding to the reinsurer a fixed percentage of all risks assumed during a given period and for specific Line of business or products. The insurer calculates the premium including acquisition and administration costs and cedes the part of the original premium, including the portion attributable to costs to the reinsurer. The reinsurer reimburses the costs through the payment of a commission[15] and the percentage of losses.[16] The percentage of the proportion is fixed and is generally applied to the whole portfolio of risks with exception of the risk that exceed the quota share limit[17].

Given a retention rate [18] α, a percentage to reinsurer (1 - α) and a value of a single Premium P, the value of a single premium keep by the insurer and ceded to

[15]The commission's value varies according to the country of origin of the deal and the line of insurance

[16]Sindiswa Mabelwane, *Basics of Reinsurance*, 3 June 2021, Munich Re

[17]In the Quota Share treaty reinsurance is the maximum amount of a claims that the reinsurer can reinsure. The amount of claims that exceed the limit remains in charge of the insurer

[18]The fixed percentage of premiums keep by the insurer

the reinsurance are, respectively

$$P_i = P \cdot \alpha$$
$$P_r = P \cdot (1 - \alpha) \tag{1.2}$$

The claims will be divided in the same portions.

From a portfolio's point of view the global compensation, borne by the insurer, is defined as the sum of the n-th compensation Y for each N-th claim multiplied by α, where N is the total number of claims of the portfolio in a specific period.

$$X^I = \alpha \cdot \sum_{j=0}^{n} \sum_{i=0}^{N} Y_i, j \tag{1.3}$$

While the global compensation ceded to the reinsurer is

$$X^R = (1 - \alpha) \cdot \sum_{j=0}^{n} \sum_{i=0}^{N} Y_i, j \tag{1.4}$$

Quota share reinsurance, while operationally simple, effectively enhances the insurer's risk-bearing capacity. Although it mitigates the variability (in absolute terms) of the overall compensation burden on the insurer, it falls short of achieving a substantial standardization of insured values. Consequently, it does not yield a satisfactory reduction in portfolio risk. From the reinsurer's point of view, it is important to emphasize the positive aspect of its involvement in all commitments undertaken by the insurer.[19]

The second type of proportional reinsurance is the Surplus reinsurance where, unlike quota share, the transfer of risks doesn't occur through a fixed percentage rather through the transfer of risks that exceed a predetermined threshold called *net retention*, or *line* within a transfer limit, usually expressed like integer multiples of the net retention. The essence of the treaty's proportionality lies in the manner in which premiums and losses are transferred. More specifically, these are allocated using the same ratio as the insured sum is divided between the ceding company and the reinsurer.

[19] Swiss Re Company, *Proportional and non-proportional reinsurance*, Zurich, 1997.

Given a portfolio with n contracts, values insured V_n and a net retention C, the retention rate α, given the j-th risk, is:

$$\alpha_j = \min(\frac{C}{V_j};1) \tag{1.5}$$

The value insured by the insurer is:

$$V_j^I = \min(C;V_j) \tag{1.6}$$

and the value insured transfer to the reinsurer, called *surplus*, is:

$$V_j^R = max(V_j - C;0) \tag{1.7}$$

From a portfolio's point of view the global compensation, borned by the insurer is:

$$X^I = \sum_{j=0}^{n}\sum_{i=0}^{N} \alpha \cdot Y_i, j \tag{1.8}$$

While the global compensation ceded to the reinsurer is

$$X^R = \sum_{j=0}^{n}\sum_{i=0}^{N} (1-\alpha) Y_i, j \tag{1.9}$$

The following table shows a numeric example that explain how the surplus and QS treaties work, assuming a portfolio with three different contracts.

	Contract A		Contract B		Contract C	
	Surplus	XL	Surplus	XL	Surplus	XL
Value Insured	500	500	250	250	200	200
Insurer retention	200	150	200	75	200	40
Transfer to reinsurance	300	350	50	175	-	160
% retention	40%	30%	80%	30%	100%	30%
% reinsurance	60%	70%	20%	70%	-	70%
Premium	300	300	150	150	120	120
Premium retention	120	90	30	45	120	36
Premium to reinsurance	180	210	120	105	-	84

Table 1.2

Table 1.2 compares the different effects in terms of premium and claim allocation between insurer and reinsurer for QS and surplus treaties, respectively, on three different indicative contracts.

As it turns out in the surplus treaty reinsurance the percentage transfer to the reinsurer change for each risk and, therefore, this allows the insurance company to standardize the insured values in the portfolio, however in QS treaty the percentage transfer to reinsurer is the same in each contract and therefore the insurer cannot vary the retention of each individual risk; in fact, it may happen to cede smaller risks (and therefore premiums) that it could actually bear on its own (see Contract C). Moreover, by retaining a fixed percentage of risks of different sizes, the insurance company does not improve portfolio balance. Quota share reinsurance, while operationally simple, effectively enhances the insurer's risk-bearing capacity. Although it mitigates the variability (in absolute terms) of the overall compensation burden on the insurer, it falls short of achieving a substantial standardization of insured values. Consequently, it does not yield a satisfactory reduction in portfolio risk. From the reinsurer's point of view, it is important to emphasize the positive aspect of its involvement in all commitments undertaken by the insurer.[20]

This type of reinsurance makes the insurer's portfolio more balanced, since it retains a fixed cap (as opposed to a fixed quota as is the case in the quota share treaty) and also, by retaining a greater number of smaller risks (the best) and a minor number of higher risks (the worst)in the portfolio, it has a greater profit potential than ceding to the reinsurer. In the other hand surplus reinsurance appears more complex to administer, given the specific calculation to be made for each risk to be reinsured and the specific analysis in terms of retention, type of risk, quality, risk exposure ecc... Furthermore the commissions paid by the reinsurer are lower than Quota Share since the transfer concerns the largest risks and the profits expected transferred to the reinsurer are therefore significantly reduced.[21]

It thus appears more disadvantageous for the reinsurer because in exchange for a lower commission to pay (the only benefit) receives a greater amount of higher risks (the worst) and the total amount of premium received is much smaller than

[20] Swiss Re Company, *Proportional and non-proportional reinsurance*, Zurich, 1997.

[21] Di Groppello G., Manghetti G., *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*, LINT, Trieste, 1996, p. 96

the quota share.[22]

It's also possible to define a new type of reinsurance that is an intermediate instrument between facultative reinsurance and the reinsurance treaty proper: the *Facultative-Obligatory Reinsurance (Fac-Ob).* The Fac-Ob is an agreement where the insurer has the *faculty* to cede risks but the reinsurer has the *obligation* to accept a part of that risks.

1.2.2 Non proportional reinsurance

We speak of non-proportional reinsurance in all cases where the transfer of premium, risk and and claim (if it happens) does not occur in the same proportion. Non-proportional reinsurance consists of an agreement between the reinsured and the reinsurer where the latter agrees to pay the reinsured all risks, belonging to a specific protected portfolio, exceeding a certain threshold; different thresholds will correspond to different types of non-proportional reinsurance: the two main ones are excess of loss (XL) and stop loss.

The primary objective of non-proportional reinsurance is specifically to safeguard the financial stability of the ceding company's balance sheet in the face of claims surpassing predefined thresholds. These thresholds are determined based on various factors, including the scale of the portfolio (comprising both the number of risks and insured sums), claims patterns (both current and anticipated), the risk appetite of the ceding company, and the cost associated with reinsurance coverage. In non-proportional reinsurance arrangements, reinsurers assume responsibility solely for losses exceeding the insurer's retention, i.e., the portion of losses that the ceding company has determined it can bear independently.[23]

In the excess of loss reinsurance, the reinsurer undertakes to indemnify the insurer for that part of each claim that exceeds a fixed sum agreed upon (called *priority* or *deductible*) up to to the extent of another fixed sum also agreed upon. The amount between the two sums is called *layer*.

[22] ivi p.97

[23] Antonio Azzano, *Riassicurazione:come si assicurano gli assicuratori*, Assicurazioni Generali - Direzione Generale, Non-life treaty retrocession, 28 marzo 2013

The following numeric example explain the concept.

Let's assume that an insurance company decide to insure commercial property risks with policy limits up to 15 million, and then buy risk excess of loss reinsurance for 10 million in excess of 5 million. Later a claim worth 8 million occurs and so, given the reinsurance arrangement, the insurance company recover 3 million because is the amount that exceeds the priority of 5 million. In other words, the insurer will have its 8 million gross loss to 5 million net with a reduction of 37.5%, a loss level which the insurer is prepared to bear, but the actual net recovery from reinsurers would not be 3 million, but 3 million less the premium paid for the reinsurance protection. In this situation the surplus amount is lower than the layer's limit thus there is no need to resort to another reinsurer however if the surplus exceeds the layer the reinsured could:

- pay the priority and the amount that exceeds the layer;
- buy a further excess of loss reinsurance coverage that cover all the claims exceeding the first layer's limit, thereby constituting a second layer.

From a portfolio's point of view, defining the priority D and the layer's limit L, the global compensation ceded to the reinsurer is

$$X^R = \sum_{j=0}^{n} \sum_{i=0}^{N} \min(\max(Y_i, j - D; 0); L) \tag{1.10}$$

Unlike proportional treaties where the premium is divided between cedar and reinsurer through a given proportion per individual protected risk in the portfolio, in an XL treaty the premium is defined at the beginning of the coverage period.

The premium is calculated based on the *burning cost* i.e. the method used in reinsurance to define the technical excess of loss rate. It defines the amount useful to meet the expected claims in a specific layer. It is basically the ratio of the sum of claims borne by the layer reinsured[24] (defined a specific priority) to the summation of premiums for the years analyzed and to this amount will then be added loadings, which are the expenses that the reinsurance company will need to add to the pure

[24] the range of risk that is intended to be protected

premium, such as management fees and any desired profit.[25]

It essentially involves determining, based on past experience, the amount required by the reinsurer to cover the anticipated claims in a specified coverage period (typically one year).Assuming C_i represents the amounts paid and reserved by the reinsurer against claims incurred in the K years preceding the current year, and P_i denotes the premiums collected by the ceding company in those same years (for an accurate calculation, one should consider at least 3-5 years of claims experience), the reinsurer calculates the burning cost rate for the upcoming year as follows:

$$\tau = \frac{\sum_{i=1}^{K} C_i}{\sum_{i=1}^{K} P_i} \tag{1.11}$$

To the rate thus obtained τ you must then add the loads called η thus obtaining a new rate:

$$\tau^* = \tau \cdot (1 + \eta) \tag{1.12}$$

Afterwards this rate is applied to the EPI[26] i.e. the premiums that the insurer estimates it will underwrite for the reference period and refer to the protected portfolio. This gives the premium allocated to the reinsurer for the coverage it will provide that was first stated in the XL treaty.

$$P_t^{XL} = EPI \cdot \tau^* = EPI \cdot \tau \cdot (1 + \eta) \tag{1.13}$$

It is also possible that the company pays to the reinsurer a minimum premium P_t^{min}, generally equal to 80% of P_t^{XL}, and at the end of the year, known the actual premiums collected, will occur that:

- the insurance company will pay an adjustment equal to

$$\Delta P_t^{XL} = P_t^{XL} \tau - P_t^{min} \tag{1.14}$$

  if $\Delta P_t^{XL} > 0$

[25] https://www.insurancetrade.it/insurance/contenuti/glossario/12147/burning-cost
[26] Expected Premium Income

- vice versa the reinsurer will reimburse the adjustment if $\Delta P_t^{XL} < 0$

The excess of loss could be considered in three different categories: XL for risk and XL for event and XL aggregate. The first one covers individual claims from a single risk in the protected portfolio. The treaty does not cover any accumulation of multiple claims from multiple insureds occurring in a given period of time. The second one covers all events or accumulations of claims referring to the same event. A precise definition of an event is indispensable to allow the accumulation of claims from multiple policies according to a temporal, spatial or random logic.[27] The last one covers the insurer from all claims (single/event) that exceed an annual aggregate and up to a set maximum.

The second typology of non proportional reinsurance is the stop loss treaty. This type of reinsurance cover the insurer in circumstances where the global loss ratio[28], in a specific line of business, exceeds a fixed percentage. The reinsurer pays if and only if the loss ratio exceed the deductible[29] and also the reinsurance coverage is expressed in percentage. A stop loss coverage (typical for risks of an irregular catastrophic nature) can be expressed as follows: the reinsurer pays an amount in excess of 80% of the loss ratio with a cap set at 120%. The reinsurer sets a monetary limit beyond which the reinsurance coverage does not operate.

Let's assume that the insurance company has a premium amount of 500. The claim coverage will be equal to 40% (layer) in excess of 80% (deductible) of the loss ratio. The reinsurer sets the maximum exposure at their expense at 200. Here are three possible scenarios: in the first case, there is a claim amount of 300 with a loss ratio of 60%[30], so the amount will be entirely borne by the ceding company (because

[27] used for catastrophic events

[28] The percentage incidence, with respect to premiums earned in the current year, of the amounts paid and reserved for claims incurred in the current year only, including of related direct expenses and settlement costs. If one adds to the loss ratio for the year for claims incurred in previous years only, the percentage incidence, again in relation to premiums earned in the current year, of the sufficiency *rectius* surplus: positive income component) or insufficiency (*rectius* deficiency: negative income component) of the claims reserve set aside at the beginning of the fiscal year compared to the payments (inclusive of direct expenses and settlement expenses) that occurred during the fiscal year and the reserve set aside at the end of the fiscal year (also inclusive of direct expenses and settlement expenses) in relation to those claims, the loss ratio for the financial statements is obtained.Cfr IVASS, *Glossario. Allegato al Bollettino Statistico, L'attività assicurativa nel comparto auto (2013-2018)* Anno VI, n. 14, novembre 2019

[29] fixed percentage of premiums

[30] Loss ratio = 300/500 = 60%

is lower than the deductible. . In the second case, there is a claim amount of 500 with a loss ratio of 100%[31], so the amount will be 80% borne by the ceding company (deductible) and the remaining 20% by the reinsurer. In the third situation, there are claims for 700 with a loss ratio of 140%[32], so 80% will be borne by the ceding company (deductible), 40% by the reinsurer (layer), and the remaining 20% again by the ceding company.

1.2.3 Surplus vs. excess of loss

The XL treaty and the surplus treaty appear to have similarities in terms of "excess" because, in the former case, the insurer will reinsure only the risks that exceed a certain threshold (net retention or line) and within a specified cession limit expressed as a multiple of the line [33]. Being a proportional treaty, each risk exceeding the Line will be shared proportionally between the insurer and the reinsurer, and this percentage will be used to allocate the ceded premium and any related claims.

In the latter case, the reinsurer commits to paying all claims that exceed a specified threshold (priority or deductible) without any proportional sharing between the reinsured and reinsurer [34]. However, in this case as well, the reinsurer will establish an upper limit (layer) beyond which it will not pay, and thus, the insurer will bear the priority and the amount exceeding the layer unless it chooses to purchase an additional XL contract covering claims exceeding the limit of the first layer.

[31] Loss ratio = 500/500 = 100%

[32] Loss ratio = 700/500 = 140%

[33] if the insurer has a line of 100 and a cession limit of 5 times the Line, then it will reinsure all risks exceeding 100 and up to a value of X-100, up to a maximum value of 500. Any amount exceeding this value will remain with the ceding company unless the company takes out a second risk surplus contract with line = $100 + 100 \cdot 5$)

[34] the premium, in fact, will be calculated using the burning cost method and not through allocation

	Contract A		Contract B		Contract C	
	Surplus	XL	Surplus	XL	Surplus	XL
Value insured	1200	1200	500	500	200	200
Net retention	200	-	200	-	200	-
Transfer to reinsurance	800	-	300	-	-	-
% retention	17%	-	40%	-	100%	-
% reinsurance	67%	-	60%	-	-	-
Claim	1000	1000	400	400	100	100
Deductible	170	100	160	100	100	100
Layer 1 (300)	670	300	320	300	-	-
Layer 2 (500)	-	500	-	-	-	-
Additional	160	100	-	-	-	-

Table 1.3: Surplus vs. XL

The term *net retention* signifies the proportion of risk retained directly by the cedant, while *transfer to reinsurance* represents the fraction of risk transferred to reinsurance. These figures pertain to the surplus treaty.

In contrast, within the XL treaty framework, *layer* refers to the segment surpassing the deductible, for which the reinsurer is obligated to provide reimbursement in case of a claim.

1.3 Typologies and characteristics of financial reinsurance

Over time, the difficulty insurance companies have experienced in efficiently reallocating risks with international reinsurers has led them to seek new reinsurance methods classified as *non traditional.*

The second motivation for seeking new reinsurance techniques is related to the need for economic and financial stabilization of their balance sheets. Here, then, is the reason for a search for reinsurance treaties with a partially or predominantly financial content. This scenario leads to the emergence of so-called *financial reinsurance.*[35]

There is no uniform definition of financial reinsurance. The most common concept underlying various definitions is that such reinsurance refers to reinsurance arrangements in which the primary purpose is capital management. Risk transfer is secondary to the business objective. There is no insurance risk in the underlying business to transfer to the reinsurer, but there is timing risks.

Financial reinsurance constitutes a transaction between a reinsurance company and its client. This type of arrangement primarily emphasizes financial outcomes, including capital management, solvency relief, impact on financial and earnings positions, etc., as opposed to the conventional reinsurance model that centers on the transfer of insurance risk.

In particular financial reinsurance's contracts combine features of both: financial effects as financial instrument and risk transfer as traditional reinsurance.[36]

First and foremost, there are purely economic objectives such as *self-financing of claims* and consequent *stabilization of economic performance*, *improvement of solvency margins and underwriting capacity* , *protection of claims reserve growth* and *prevention of the accumulation of retentions* through additional coverage on risks

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[35] First regulated by EU Directive 2005/68/EC, and is currently contained in the Solvency II Directive (Directive 138/2009/EC as amended). IVASS in 2010 had dictated with detailed regulation by Regulation No. 33 of March 10, 2010.

[36] Eugene,N.,E., Itigin,A., Wiechert,R. *Insurance Risk Transfer and Categorization of Reinsurance Contracts,2016*, The World Bank Finance and Private Sector Development Non-Banking Financial Institutions, Policy Research Working Paper 6299, December 2012, p. 4

that have accumulated. There are also objectives of a more technical-insurance nature such as *protection* toward types of claims not considered by traditional reinsurance treaties and toward the closure of a line of business (insurance line).[37]

In an agreement of this nature, the reinsured insurer makes an upfront payment to the reinsurer. In exchange, the reinsurer commits to providing the reinsured with a sum of money, the value of which is tied to the performance of the premium. However, this amount is capped at a predetermined limit, known as the ceiling. Notably, this transaction stands apart as it is not contingent on the original insurance risks assumed by the insurer-reinsured. The primary risk for both parties is financial. At the contract's conclusion, based on the investment outcome of the premium, the reinsurer may pay a sum exceeding the initial premium, subject to the specified ceiling. Conversely, the reinsured faces the risk of paying an excessively high premium if their losses do not reach the predetermined ceiling established at the contract's inception.[38]

Financial reinsurance treaties are divided into *prospective*, concerning future assets and thus future premiums and risks of the company, and *retrospective*, concerning instead an asset that has already been purchased and thus risks that have already occurred.

1.3.1 Prospective reinsurance treaty

The first form of prospective treaty is the *proportional financial treaty*, characterized by the fact that the insurance company cedes to reinsurance the premium reserve not pertaining to the year, in doing so the reinsurer also takes over the claims related to the transferred premiums. The company receives a fee from the reinsurer, which is less than that of traditional reinsurance treaties given the smaller amount of risk transferred, and in so doing protects its capital to meet the solvency margin charge. In other words, the reinsurer finances the company's premiums by guaranteeing it, through the commission payment, capital protection; by doing so, the insurance

[37]Giulio di Groppello, Porf. Giovanni Manghetti, *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*, prima edizione, Trieste, LINT, 1996, p.151-153

[38]Elisabetta Piras, *La riassicurazione tra codice civile, codice delle assicurazioni e prass*, Assicurazioni, 2023

company will be able to underwrite new contracts, expanding its risk portfolio, and improve its portfolio economic performance ratios (ratios).[39]

The financial nature lies in the fact that the expected value of the transferred claims payable and commission must be equal to the value of the premium reserve, otherwise if the outcome for the reinsurer is uncertain here is the treaty of traditional reinsurer.

If one were to consider this form of reinsurance as traditional, at the portfolio level, one could calculate the overall commitment retained by the cedant as follows:

$$X^I = X_t^{tot} - X^{RE} = X_t^{tot} - (LR_t \cdot \alpha \cdot RP_t) \tag{1.15}$$

where X_t^{tot} is the overall amount of incurred claims during the period t and X^{RE} the overall amount of claims borne by the reinsurer. This value, in turn, is given by the products between the loss ratio of period t (LR_t), the percentage of premium reserve ceded to the reinsurer α and the premium reserve of the period t (PR_t)

The second typology of prospective treaty is the *prospective aggregate XL financial treaty* or *spread loss*, characterized by the fact that the ceding company agrees to pay, year by year, a premium that is calculated taking into account both the present value of the expected claims over the time frame of the treaty and the estimated income produced by the investment of these premiums. They will, in fact, be invested in a separate fund and the capital gain that this investment will produce will also be invested in that fund; by doing so, the reinsurer will self-finance the expected claims thanks to these investments while the ceding company will stabilize its income over time, as well as plan its cash flows. The characteristic feature of such paid premiums is that they do not depend on any insurance risk transfer, but on the present value of expected claims; therefore, they are limited (finite) with respect to that value. [40] The risk will therefore be finite, and the reinsurer will be liable for the value of an individual claim that does not exceed a specified retention percentage and, in aggregate, for a value that does not exceed another retention percentage.

[39] Giulio di Groppello, Porf. Giovanni Manghetti, *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*, prima edizione, Trieste, LINT, 1996, p.156

[40] Giulio di Groppello, Porf. Giovanni Manghetti, *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*, prima edizione, Trieste, LINT, 1996, p.158-159

The cedant therefore will have a limited overall commitment both at the individual claim level and in aggregate, as shown below:

$$X^I = \sum_{i=1}^{n} \sum_{h=1}^{N_i} b_i \cdot Y_h + \sum_{i=1}^{n} c_i \cdot X_i \tag{1.16}$$

where b and c are different retention percentage[41], Y^h is the n-th compensation on N-th claims[42] and X_i the sum of the random commitments relating to n contracts appearing in the insurer's portfolio.

The financial feature of this contract lies in the fact that this operation will see an equality of the present value of claims and investments with the value of premiums.

In case the claims do not occur the premiums remain with the assignor therefore they can be considered as a credit of the company and not immediately a cost. Given the equality of the two flows, the reinsurer runs no insurance risk, but will incur other forms of risk. A *timing risk*, given by the fact that premium payments could occur after claims have occurred and been paid, *credit risk* reflecting uncertainty in the actual collection by the reinsurer, and *investment risk* since the value of such investment may differ from the anticipated value. If the balance of these flows is positive, meaning that the value of premiums collected and income generated from investments is greater than the claims paid, the reinsurer will have to reimburse the company. On the other hand, if there is a deficit, indicating that the value of incurred claims is greater than the premiums collected and investments, the reinsurer will be compensated by the company through the payment of adjusted future premiums.[43].

1.3.2 Retrospective reinsurance treaty

The first form of retrospective treaty is the *claims reserve transfer treaty* or *loss/-portfolio transfer*. Under this treaty, the insurer transfers the claims reserve (including IBNRs[44]) to the reinsurer for a premium payment approximately equal to the present value of the reserves (discounted with an agreed interest rate). The

[41] are in fact indexed to i as they depend on the individual contract
[42] N is indexed to i as depend on the individual contract
[43] Future premiums revalued taking into account actual claims
[44] Incurrer But Not Reported

premium therefore will be less than the actual value of the reserves, given the discounting of the latter, and so the cedant's assets will be reduced by less than its liabilities thus recording an increase in capital. Obviously, the longer the period over which the premium reserve is dismantled, the lower the value of the premium will be (since the discount factor will be greater) and thus increase the capital gain. Also in this situation the reinsurer will incur in the timing risk, given by the uncertainty on the timing of disassembly of the reserve claims, and in the *investment risk*, given by the uncertainty on investment performance; indeed the reinsurer could may achieve a profit equal to the difference between the performance rate of investment and the discounting rate applied.[45]

The overall commitment retained by the insurer is the following:

$$X^I = X_t^{tot} - CR^R \tag{1.17}$$

where CR^R is the claim reserve transferred to the reinsurer.

[45] Giulio di Groppello, Porf. Giovanni Manghetti, *Principi di tecnica riassicurativa. La riassicuazione finanziaria e i derivati in riassicurazione*, prima edizione, Trieste, LINT, 1996, p.161-162

1.4 Comparison between traditional and financial reinsurance

In this chapter, traditional reinsurance and financial reinsurance have been respectively introduced, and it has emerged that the traditional form of reinsurance is so named because traditional reinsurance contracts are primarily motivated by competitive risk transfer, but they go beyond simple risk transfer. They address various needs of insurers, including the need for capital to write new business, address solvency issues, recognize early profits, utilize free capital tied in non-admissible or virtual assets, and enhance the internal rate of return on capital and economic value of the company.

On the other hand, financial reinsurance contracts have dual motivations, focusing on both financial objectives and risk transfer goals. They aim to address financial needs such as generating capital for new business, achieved through methods like cash injections from reinsurers or re-engineering future profits within new or existing business blocks.[46]

What is crucial to highlight is that the financial reinsurance cannot accurately denote a true form of reinsurance due to the absence of a genuine transfer of risk. The lack of risk lies in the requirement that the expected value of the transferred claims payable and commission must be equal to the value of the premium reserve, making it essentially a financial transaction.

For this reason, the term financial reinsurance must be closely associated with finite[47] treaties.

Such treaties are actually composed of an insurance component (premium in exchange for coverage) and a financial component (prepaid premiums calculated

[46]Madhusudhanan Sridharan,*Fin Re – Why do Companies Need it and What are the Regulatory Concerns?*, 5th Global Conference of Actuaries, 19-20 February 2000

[47]reinsurance under which the explicit maximum loss potential, expressed as the maximum economic risk transferred, arising both from a significant underwriting risk and timing risk transfer, exceeds the premium over the lifetime of the contract by a limited but significant amount, together with at least one of the following two features: 1) explicit and material consideration of the time value of money; 2) contractual provisions to moderate the balance of economic experience between the parties over time to achieve the target risk transfe. Cfr DIRETTIVA 2005/68/CE DEL PARLAMENTO EUROPEO E DEL CONSIGLIO del 16 novembre 2005 relativa alla riassicurazione e recante modifica delle direttive 73/239/CEE e 92/49/CEE del Consiglio nonché delle direttive 98/78/CE e 2002/83/CE

based on an estimated amount of claims). The peculiarity of these treaties is that the two flows are not equal; therefore, the final sum of the operation will not be zero, as in the previously analysed treaties. Instead, there may be a deficit for the reinsurer or a surplus. This form of treaty, which modifies the previous one that was exclusively financial, was introduced because on December 15, 1992, the American Institute of Accountants issued SFAS 113 regarding reinsurance contracts, with reference to the standard GAAP (Generally Accepted Accounting Principles). It specified that a reinsurance contract should be accounted for as such if the reinsurer had indeed assumed an actual risk and could thus incur a significant loss from managing the contract.

Finally, it is useful to add that from a Solvency II[48] point of view, considering that there is no actual risk transfer the financial reinsurance has no impact on the company's SCR.

[48]Solvency II is a European Union directive aimed at extending the Basel II regulations to the insurance sector. The Solvency II regime, implemented internationally, establishes a detailed regulatory framework for the insurance sector, structured on various levels. The Framework Directive 2009/138/EC introduces the fundamental principles of this regime, which is further specified by Regulation 2015/35/EU and its subsequent updates. The Implementing Technical Standards (ITS) and guidelines from EIOPA contribute to regulatory convergence and consistency in insurance supervision, requiring national authorities to comply or explain any deviations. Solvency II aims to modernize the supervision of the European insurance sector by introducing a risk-based approach that covers quantitative assessments, governance and qualitative requirements, as well as reporting obligations. The regime promotes harmonized supervision at the EU level, with particular focus on the management of insurance groups.

Chapter 2

The alternative risk transfer (ART)

2.1 Overview of ART

This chapter aims at describing an alternative to traditional reinsurance that can effectively be considered as reinsurance: the alternative risk transfer (ART).

ART comprises as all risk-transfer methods where ultimate counterparties are the capital markets players from reinsurers to pension funds, banks and hedge funds.[1] These products could be defined as *convergence products*[2] between capital and insurance markets, originated in the latter.

Thus, ART methods offer an alternative to traditional reinsurance and can be used to improve the efficiency of the insurance market. In essence, ART still represents risk transfer, but with an innovative approach that actively involves financial investors and products.

The ART market can be divided into two primary segments: risk transfer via alternative carriers and risk transfer via alternative products. In the alternative carrier segment, we find self-insurance, pools, captives, and risk retention groups (RRGs). Meanwhile, risk transfer through alternative products encompasses a range

[1] Pallara A., *Risk-mitigation techniques: from (re-)insurance to alternative risk transfer*, Università degli Studi di Roma *La Sapienza*, 14 febbraio 2023

[2] Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004

of transactions, including integrated multi-line products, insurance-linked securities (commonly known as CAT bonds), credit securitization, committed capital, weather derivatives, and finite risk products.

The ART market has developed mainly in the property and casualty (P&C) sector. The main reason is the reinsurance market's difficulty in sustaining some excessively high losses due to certain catastrophic events.

The reinsurance market operates in cycles: following a significant event, its capacity typically diminishes or becomes more expensive. Subsequently, as time elapses since the event, competition intensifies, and more capacity becomes accessible.

For example, in 1992, Hurricane Andrew struck Florida, causing insured losses far surpassing industry predictions. Estimated at $2 billion, actual losses reached $15-$16 billion and forced insurers to reevaluate their pricing strategies and market positions, leading to a surge in reinsurance rates. Furthermore, insurers realized that they required significantly more coverage than what was available in the reinsurance market. As described in the previous chapter, if an insurer buys catastrophic coverage, there would still be a limit at which the reinsurance would stop paying and the insurer would go back on the risk. Consequently, insurers sought additional sources of capital to meet their extended coverage needs. Investors began stepping into assuming some of the insurance risk.[3]

Alternative risk transfer instruments are often viewed as substitutes for or supplements to traditional reinsurance, as well as to conventional methods of raising capital through debt or equity securities issuance. Essentially, these mechanisms enable the transfer of assets and liabilities from the balance sheets of insurance and reinsurance firms to the capital markets, shifting inherent risks to investors. Consequently, employing these tools can have a similar impact on insurers' capital positions as traditional reinsurance, reallocating risks from their balance sheets and freeing up capital previously tied to supporting risk. This released capital can then be directed towards investment in new business opportunities.[4]

[3] Rohe M. A., *The* ***Art*** *Of Alternative Risk Transfer*, New York Annual Meeting, October 18-21, 1998

[4] Njegomir V., *Alternative risk transfer mechanisms application under Solvency II*, Faculty of Law and Business Studies Dr Lazar Vrkatic, Belgrade, January, 2011

The development of ART solutions is due to different factors. First of all is due to the capital market, that is an alternative source of capacity for catastrophe protection. Others factors are the need for economic value maximisation, taxes, regulatory constraints and deregulation of financial services industry. The factors mentioned above have all contributed to making these new solutions appealing to insurance and reinsurance companies. However, the growth of alternative risk transfer (ART) solutions primarily stems from investor's interest. These instruments are attractive to investors because insurance risk is typically uncorrelated with other risks in their portfolios, thus providing diversification benefits and relatively high risk-adjusted returns. Furthermore investors, that could tie up their capital for a shorter period, participate only in sharing specific risks and not all the risks in the insurance company portfolio. ART solutions became a new business opportunity for the financial market.[5]

The characteristic shared by ART solutions that have evolved over the years are the following[6]:

- tailoring to specific needs and problems of the risk taker;
- offering multi-line, multi-year and multi-risk coverage;
- spreading of risk over time and within a policyholder's portfolio. This is what makes the assumption of traditionally uninsurable risks possible;
- underwriting risk by parties other than (re)insurers.

In addition to the above cited features, IVASS[7], points out the folowing:

- replacing pure risk transfer with risk financing;
- incorporating financial instruments such as derivatives.

After showing the main features, it is fair to dwell on the objectives of ART solutions, which can be divided into three types. The first objective relates to the

[5]Njegomir V. and Maksimovic R., *Risk transfer solutions for the insurance industry*, Economic annals, Vol. 54, Br. 180, Faculty of Law and Business Studies Dr Lazar Vrkatic, Belgrade, 2009

[6]Dr Kai-Uwe Schanz was writing in Sigma Number 2/1999 commissioned by Swiss Reinsurance

[7]De Polis S., *The Alternative Risk Transfer mechanisms*, "Insurance Beyond Insurance-New challenges for market supervisors", Florence, 5 November 2021

improvement of the risk transfer system efficiency, through the participation in on own loss development, the decrease of overinsurance and the reduction of credit risk. The second is to increase the number of insurable risks, through diversification over portfolio and time. The last one is about increasing the company's capacity, through capital market.[8]

[8] *Alternative risk transfer (ART) for corporation: a passing fashion or risk management for the 21 st century?*, No. 2/1999, Swiss Re

2.2 Alternative carriers

2.2.1 Self-insured retention (SIR)

Self-insured retention (SIR) is a self-insurance mechanism used by some organizations to manage their insurance costs on their own . This mechanism involves an insured saving a certain amount of money to address potential losses independently. If the loss is fully within this amount, the insured will bear the burden of the loss and the handling of the claim without activating the insurance policy. The (re)insurance company only takes on risks above a certain amount.

SIR provisions are an alternative to deductible-based coverage (both are used to keep premiums down and require the insured to pay for a portion of the loss) but there are some key differences: under an SIR provision, the insured must pay the initial amount out-of-pocket with no input or support from the insurer, while with deductible-based coverage, the insurer pays losses up to the maximum limit of liability and is then reimbursed by the insured up to the deductible amount. With an SIR provision there is no collateral requirement, Conversely, deductible-based coverage usually requires a letter of credit or other collateral to cover any losses within the deductible.[9]

[9]https://ehdinsurance.com/self-insured-retentions-explained/

2.2.2 Captives

A captive is an insurance company owned by a non-insurer, called *parent company*, established for the specific purpose of insuring exclusively the exposures to various risks of the parent company and its subsidiaries.

Captives can be classified according to their mode of operation, scope of activity and corporate structure.[10]

Based on the mode of operation, we can distinguish *insurance* or *direct captive* and *reinsurance captives*. The former consists of an insurance company operating as an insurer of the parent company with a legal structure and minimum capital meeting the legislation of insurance companies in the country where it is domiciled.

The captive issues insurance policies covering specific risks, which the parent company underwrites by paying predetermined periodic premiums. These premiums are allocated as technical reserves to cover claims and are reinvested to enhance the parent company's financial position. Additionally, the captive may transfer the risks it assumes to international reinsurance markets.

The reinsurance captive acts as an intermediary between a regular insurance company and the reinsurance market. Initially, risks are transferred to an independent insurer, called a *front company*, which commits to reinsuring a portion of them with the insured's captive.

The company signs a policy and pays premiums to the front company which takes on the risk. Based on a fronting agreement, the front company transfers some of the risk to the insured's captive. The captive then recovers the premiums paid by the company and sets them aside in specific reserves. It may also choose to transfer some of the risks to the reinsurance market. This system is beneficial because it spares the captive from complex procedures to act as the primary insurer in all territories where the parent company or its affiliates operate. The front company, therefore, plays an intermediary role; it retains a fraction of the premium related to the retained risk, is reimbursed for the costs incurred for the service provided and for any other ancillary services, and is remunerated through the *fronting fee*.

[10] Tagliavini, P., *La captive Insurance Company come strumento di risk management*, EGEA, Milano, 1994

The usual distinction based on the scope of activity involves *pure captives*, which exclusively handle the risks of the parent and its affiliates, and *open-market captives* or *broad captives*, which broaden their activity to include assuming risks from third parties.

The latter, fewer in number than the pure ones, increase the number of exposures. So they collect additional premiums which, when reinvested, produce additional profits. However, by increasing exposures, it is riskier and less serving from the parent company.

Finally, according to social composition, *single parent captives* and *multi-parent* or *group captives* are distinguished.

A single-parent captive is controlled by a single shareholder and arranges insurance service specifically for the needs of the parent company. Multi-parent captives or group captives are controlled by multiple shareholders. They also allows SMEs[11] to access the benefits offered by them. Another element in favour of the multi-parent solution is the greater cost-effectiveness brought about by sharing start-up and operational costs. The heterogeneity of policies and members, however, can lead to situations of conflict and disagreement; such issues have often undermined the success of this solution.

A multi-parent captive may be part of an open group if it allows access to third-party members. Conversely, it falls into the category of a closed group if it restricts access to others.

In terms of the risks taken, captives can be homogeneous, if the members have the same business, or uneven otherwise.

In the former case we speak of association captive, or risk retention group. In the latter one speaks of agency captive, formed by a group of insurance agents; captive pool, a consortium of independent captives that aggregates the exposures of each and creates a larger set of risks; and the rent-a-captive, where a firm enjoys the services offered by the captive but does not own one.

One of the most recent forms of captive is the special purpose vehicle (SPV), whose main function is to facilitate the transfer of insurance risks to the capital

[11] Small and medium size enterprises

market through *securitization*. The most common forms of captives, however, are traditional captives, which operate as reinsurers (reinsurance captives), controlled by a single shareholder (single-parent captives) and which assume only the risks of the owner (pure captives).

2.2.3 Pools

Primary insurers have several alternative options available to them to transfer risk from their books. One of these is pooling. A pool refers to a collective of insurers or reinsurers that come together to underwrite specific types of risks, often those considered substandard. In this arrangement, premiums, losses, and expenses are shared among the members of the pool according to agreed-upon ratios. This pooling of resources allows insurers to spread the risk associated with these particular types of risks, thereby reducing the individual financial burden on any single participant.

The basic idea of pooling is to take advantage of diversification effects among the portfolios of different insurers.

Insurance pools operate by aggregating risks from various insurers. By sharing risks in a larger group, insurance pools can provide coverage for risks that would otherwise be unmanageable for individual insurers. An insurance pool consists of insurers who are bound together by a transfer cession agreement. When the pool is formed, the participating insurers determine various aspects, including the agreement's scope, the type of business covered, and the capacity provided by each insurer. The allocation of shares within the pool depends on the capacity that each member contributes. Premiums and claims are then distributed according to the proportion of each insurer's share within the pool. Typically, the insurer with the largest participation takes the lead in managing the pool. The risks accepted by the pool can originate from the member companies themselves or from external sources.

An insurance pool may also include companies engaged in reinsurance operations. It can function similarly to an insurance pool. Premiums and claims within the pool are distributed among the various reinsurers based on the percentage of their participation rate. Alternatively, an insurance pool can operate based on the premiums ceded by each member. In this scenario, the pool collaboratively reinsures treaties or facultative reinsurance contracts underwritten individually by each member. The share of each reinsurer is determined by the amount of premium it cedes to the pool. Since premium volumes fluctuate annually, members' shares may vary regularly.[12]

[12]https://www.atlas-mag.net/en/article/insurance-and-reinsurance-pools

Under a typical pool each pool member agrees to pay a set percentage of each loss (or a percentage of each loss above some retention level).In fact, a reinsurance pool is similar to a QS arrangement, but the pool provides a maximum loss limit to each participating insurer from any single loss; once a pool member suffers a loss in excess of the specified amount, pool members share the balance. This mechanism is used when a single reinsurer is unable to provide an insurer with sufficient risk coverage. [13]

In Italy there is an insurance pool called *Pool Ambiente*. It forms the consortium for insurance and reinsurance of liability for environmental damage. Established in 1979 under the name *Pool Inquinamento*, it underwent a name change in 2019 to become Pool Ambiente. The Pool was formed in response to the Seveso environmental accident[14], at a time when there was insufficient or specialized insurance coverage available for environmental risks to adequately support companies in managing and insuring such risks. Comprising companies operating in the insurance and reinsurance sectors, the Pool is capable of insuring risks located and activities conducted within the European Economic Area (EEA) and Switzerland. The Pool assists insured companies in resuming operations, carrying out remediation and restoration work required by agencies, and compensating injured third parties.[15]

Pool ambiente consists of 22 insurance and reinsurance companies: *Amissima, Assimoco, Axa MPS Danni, Axa Assicurazioni, BCC, Generali Italia, Groupama, Hannover RE, HDI Assicurazioni, Italiana, Itas Mutua, Le Assicurazioni Di Roma, Munich Re, Helvetia, New Re, Sara Assicurazioni, Scor Italia, Cattolica, Società Reale Mutua, Swiss Re Europe, UnipolSai, Vittoria*

[13]Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004, p. 85

[14]The Seveso disaster, occurring on July 10, 1976, at the ICMESA company in Meda, led to the release of a toxic cloud of TCDD dioxin, one of the most hazardous man-made substances. This incident affected a significant area of land in nearby municipalities, notably Seveso.

[15]https://www.poolambiente.it/about/

2.3 Alternative products

2.3.1 Finite risk

Finite risk programs are typically categorized as ART (Alternative Risk Transfer) products when assessed independently. As explained in the preceding chapter, finite risk programs represent contracts with minimal risk transfer. They serve as a method of risk financing preferred by companies focused on retaining, managing, and financing exposures rather than transferring them.

These contracts are employed to mitigate the risks associated with loss exposures or the rate of loss accrual. Their primary function lies in managing the timing of cash flows rather than transferring actual losses. As a result, they offer protection for both balance sheets and cash flows rather than guaranteeing capital protection.

These instruments are primarily concerned with managing time risks, that is, cash flows over time between losses, investment income, and reserve accumulation. The goal is to structure these elements in a way that keeps cash flows stable and predictable over multiple periods.

A finite contract is not simply a short-term risk hedge for a single exposure. Rather, it is designed as a long-term program that impacts the company's overall cash flows over several years.

Although the primary objective is not to transfer a large amount of risk, risk financing can still bring important benefits. These include a reduction in the variability of cash flows, a reduction in the cost of capital, a decrease in the probability of financial distress, and an improvement in the firm's ability to take on debt. These benefits are crucial to maximizing the company's overall value.

In addition, finished contracts that meet certain criteria of structure and risk transfer are considered insurance contracts in the eyes of the IRS and can generate tax benefits. The greater the risk transferred through these contracts, the greater the tax benefit obtained.

In essence, finite structures are sophisticated financial instruments designed to help companies manage their financial risks over time, improving cash flow stability and gaining fiscal and financial benefits.

Full insurance provides coverage for one year, while finite programs are multi-year. In full insurance, the risk is transferred to the insurer, while in finite programs the focus is on risk financing. In full insurance, the insurer retains the entire premium, while in finite programs profits are shared between the cedant and the insurer. The premium in full insurance depends on expected loss experience and underwriting costs, while in finite programs it depends mainly on investment income.

As noted in the previous chapter, finite programs must involve some degree of risk transfer to be considered insurance from an accounting and regulatory perspective. Even if this transfer is not as significant as in standard insurance policies, some exposure must still be ceded to the insurer. In general, the longer the duration of the finished program, the greater the extent of risk transfer. Gross premiums for a finished contract can be substantial, but they include profit sharing between the cedant and the insurer, which can make the net cost competitive with other mechanisms. In the long run, finite risk programs may be more advantageous than other risk transfer mechanisms because of the close link to the cedant's loss experience. Finally, in finite programs the total cost depends on the actual losses: if low, the transferor receives a refund of the premium; if high, he must contribute more. Premiums and investment returns go into an account, while losses and fees are charged. The balance is then divided between cedant and insurer. If losses exceed projections, the cedant must contribute additional funds. The insurer is exposed to limited risk through policy limits and deductibles.[16]

Finite programs can also be arrangements between a primary insurer and a reinsurer. Finite reinsurance is a financial structure with limited risk transfer offered by the reinsurer to the insurer. The insurer pays premiums into an experiential account and receives coverage for losses that exceed the amount financed, up to certain maximum limits. As in finite programs, profit is shared. This provides the insurer with cheaper coverage and the reinsurer with less exposure to losses.[17]

[16] Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004, p. 72-74

[17] Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004, p.86-87

2.3.2 Contingent capital

Contingent capital instruments ensure the availability of capital in appropriate amounts when the need arises. In essence, they are structured as a capital-raising option subject to predefined conditions. The terms defining when and in what manner capital can be accessed are established in advance, in the initial contract between the parties, and are known as *triggers* and *covenants*.

The word *contingent* is used to differentiate these structures from the *paid-in* capital, which understands classical meaning of capital that is available to insurance and reinsurance companies upon issuance of equities or bonds. Contingent capital structures provide insurers and reinsurers with the right, but not the obligation, to issue specified security in the future at specified terms regarding price, triggering event and the time frame. Thus, a contingent capital instrument can be regarded as a put option[18] The security is how the enterprise raises the capital it needs and may consist of stock, debt, or both in a given combination. The predetermined price is very important for insurance companies as after the occurrence of catastrophic event it is usually very hard to obtain financial resources at prices that were prevailing before the occurrence of the triggering event and in addition, reinsurance and retrocession markets capacity becomes scarce and expensive.

Additional benefits of contingent capital include balance sheet protection when it is most needed the access to financing with neither a corresponding increase in leverage nor a dilution of shareholders' equity[19]. However, because they are usually structured as private placements, by utilising contingent capital structures insurers and reinsurers are exposed to the increased credit risk of the option writer.

Insufficient capital post-loss can lead to financial distress and drives the development and use of risk management tools offering post-loss indemnification. Contingent capital enables firms to raise funds during a defined commitment period triggered by specific loss events. Notably, these arrangements are established pre-loss, so their cost doesn't reflect post-distress risk premiums, like reduced creditworthi-

[18]It consists of the right to sell a security, or a certain amount of securities, at a predetermined price, within a predetermined time horizon and can be exercised when and if the conditions and triggers established at the time of stipulation occur

[19]Wheeler, R. and L. Janeke (2008), *Monte Carlo 2008 - 1. Industry Loss Warranties*, Benfield Group Limited, London

ness and limited liquidity access, which typically result in higher capital costs. This makes contingent capital solutions cost-effective across various financial scenarios. Firms attempting to secure funding post-disaster face higher funding costs due to weakened financial health. Conversely, those impacted by the same disaster but with pre-arranged capital access are shielded and recapitalized at pre-agreed costs.

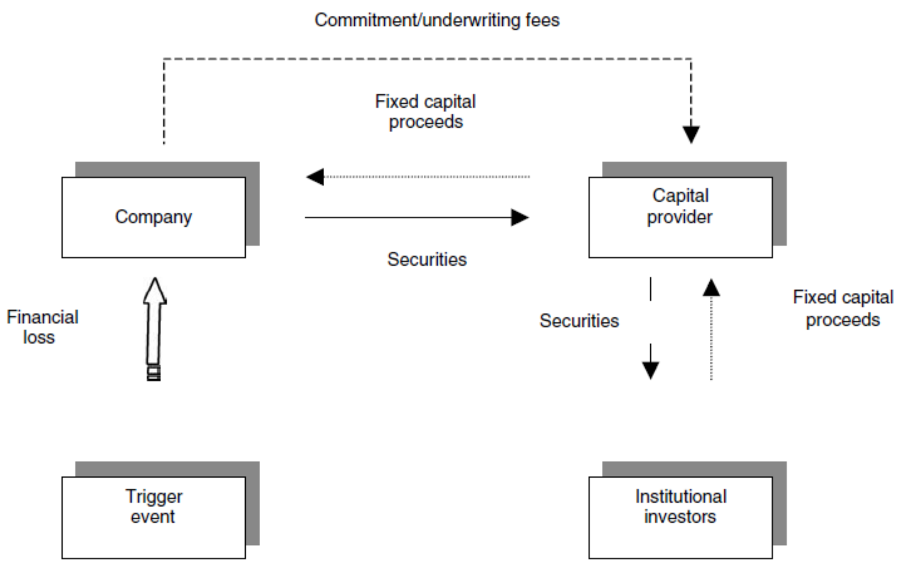

Figure 2.1: Generic contingent capital structure.
Source: Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004, p. 137

Through a generic contingent capital structure (Figure 2.1) a company identifies an amount of capital that it wishes to raise in the event it suffers a loss, determines the events that can trigger the loss, and the specific form of securities it will issue to raise capital. If the event happens, the capital provider provides funds by purchasing securities issued by the company at the predetermined price. In return, the company pays the capital provider a periodic or upfront non-refundable commitment fee, payable regardless of whether securities are issued, and an underwriting fee, payable only if securities are floated. Although the legal commitment rests with the capital provider, they typically distribute the securities to institutional investors. However, if the provider can't place the securities, they must still supply funds to the company, posing potential counterparty credit risk issues. Therefore, in underwriting terms, the capital-raising process is considered a firm commitment or bought deal, contingent on the triggering event, rather than a best efforts or agented transaction.[20]

The most widespread type of contingent capital structures utilised by insurance and reinsurance companies are catastrophe equity puts (Cat-E-Puts)[21]. This puts enable insurers and reinsurers to raise capital by issuing equities at a pre-agreed price after the occurrence of the catastrophic event. However, due to the exposure to credit risk they haven't attracted as much interest as catastrophe bonds.

Hence, a significant benefit associated with this financial insurance tool lies in the provision of contingent capital injections, enabling the insurance company to maintain its solvency despite the substantial economic losses incurred from a catastrophe. With CatEPuts, the value of insurance companies' shares remains stable, as does the price of new issuance. This pre-established equity reserve, available at a fixed price, serves as a cushion that the insurance company can utilize to restore its capital in the event of a catastrophe during the option's term. However, a drawback of CatEPuts is the potential fragmentation of the insurance company's ownership following a catastrophic event. Upon the exercise of the put option, the available equity increases, leading to a corresponding decrease in the ownership stake held by existing shareholders.[22]

[20]Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004, p. 135-137

[21]The structure first developed by insurance and reinsurance broker Aon Capital Market in 1994 in the wake of Hurricane Andrew and the Northridge Earthquake is the most popular transaction format used mainly by reinsurers

[22]Arnone M., Bianchi M. L.,Quaranta A. G.,Tassinari G.L.,*Catastrophic risks and the pricing of catastrophe equity put options*, Springer-Verlag GmbH, DE part of Springer Nature 2021, 18 march 2021

2.3.3 Integrated multi-line products

The multi-line, multi-year products (MMPS) allows, with a single agreement, to hedge the effects arising from different types of risk, over a multi-period time horizon.

In the financial markets, multiple-hedged products were introduced in response to a specific customer need and usually protect against a number of risks not exceeding two. Such instruments, in most cases with an annual time horizon, are called "baskets" and are constructed and contracted by dealers who, based on the correlation between the underlying risks, define the joint exposure and pricing. Although such products have been available since 1980, they have not found widespread acceptance.

In insurance markets, multiple-coverage products have long been prevalent. These products address various risks, requiring their duration to be aligned based on the oldest exposure, resulting in differing duration across risks. During periods of declining premiums, underwriters may seek annual premium renegotiation, while insurers prefer stability. Multi-line policies emerged in the early 1980s in response to industrial globalization, integrating diverse insurance lines over multiple periods. Unlike micro procedures focusing on individual risks, the approach here involves macro risk transfer, analysing aggregate positions. Multi-line products offer incremental advantages over separate-coverage policies due to the diversification effect.

First, the micro approach provides coverage with annual renewal and on separate lines while the macro approach provides multi-line and multi-year coverage. Following that, the micro approach entails engaging multiple providers (multiple lines, multiple providers), resulting in higher costs. Conversely, the macro approach involves fewer or only one provider, making it more cost-effective.

These contracts establish an aggregate limit for both retained and transferred risk. Historical experience of individual risks determines the optimal point for risk transfer, minimizing hedging costs and ensuring capital availability. Viewing hedging at the corporate level and distinguishing between retained and transferred risk aggregates helps identify the maximum loss and cost of capital required for coverage. Regarding the structure of multi-line, multi-year contracts, there are two types: single agreements or separate contracts, but in both cases, limit definition remains uniform. Unlike MMPs in financial markets, insurance companies typically retain a portion of the risk transferred to them by the company beyond simple correlation. The MMP market continually evolves, expanding in both the number and types of risks covered in a single program. It also coordinates insurable risks with financial risks and those lacking adequate protection.

2.3.4 Insurance-linked securities

Insurance-linked securities (ILS) are considered the principal method of transferring risk from insurers to the capital markets, not just an ART product.

The financial sector and the insurance industry share a mutually advantageous relationship. Insurance companies offer risk coverage to individuals and businesses, while financial markets provide various avenues for insurers to generate investment returns and manage reserves. In return, both life and non-life insurance sectors are significant purchasers of debt securities within financial markets. This relationship between financial markets and insurance industries has evolved into the transfer of exogenous risk through *securitization*[23].

Indeed, the drive to release capital, combined with apprehensions regarding the reinsurance sector's future hedging capabilities, has prompted the exploration of alternative risk management options.

The concept behind the issuance of ILS is as follows: issuing securities related to insurance risks to transfer exposures to the financial market and increase the issuer's risk capacity. The fundamental structure involves an insurance or reinsurance company issuing securities through a Special Purpose Entity (SPE) and tying the repayment of interest and/or principal to losses from specified insurance events. If losses surpass a predetermined threshold, the insurer or reinsurer is no longer obligated to pay interest to investors. If structured with an unprotected tranche of principal, all or part of the principal may also be deferred or eliminated. This structure creates new risk capacity by transferring specific risks to investors in the capital market. As a result, the issuer's overall risk exposure decreases, providing flexibility in terms of capital and reserves and enabling the pursuit of new business opportunities.[24]

[23] Transaction by which a set of rights to illiquid assets (receivables, real estate) are incorporated into a negotiable instrument. Securitization is a transaction aimed at creating marketable securities. These securities derive the cash flows that stand behind the remuneration they provide to underwriters from a pool of typically illiquid assets (loans, trade receivables, real estate). As a guarantee to investors, this pool of assets assumes subjectivity independent of the original owner of the assets, and for this purpose the assets are contributed to a special entity created specifically for this purpose (Special Purpose Vehicle, SPV).Cfr https://www.borsaitaliana.it/borsa/glossario/securitization.html

[24] Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004, p. 117-118

As for investors, they constitute an attractive opportunity. Indeed, they enable them to diversify financial portfolios and achieve good performance.

The market for ILS can be segregated into catastrophic and non-catastrophic risk issues based on index, indemnity, or parametric triggers. Catastrophic bonds can be subdivided into securities that reference hurricane, earthquake, windstorm, and other low-frequency/high-severity natural disasters; they may be created to cover single or multiple perils per bond or tranche. Non-catastrophic ILS can be classed into temperature, residual value, mortgage default, trade credit, and life acquisition costs. The following figure shows this structure.

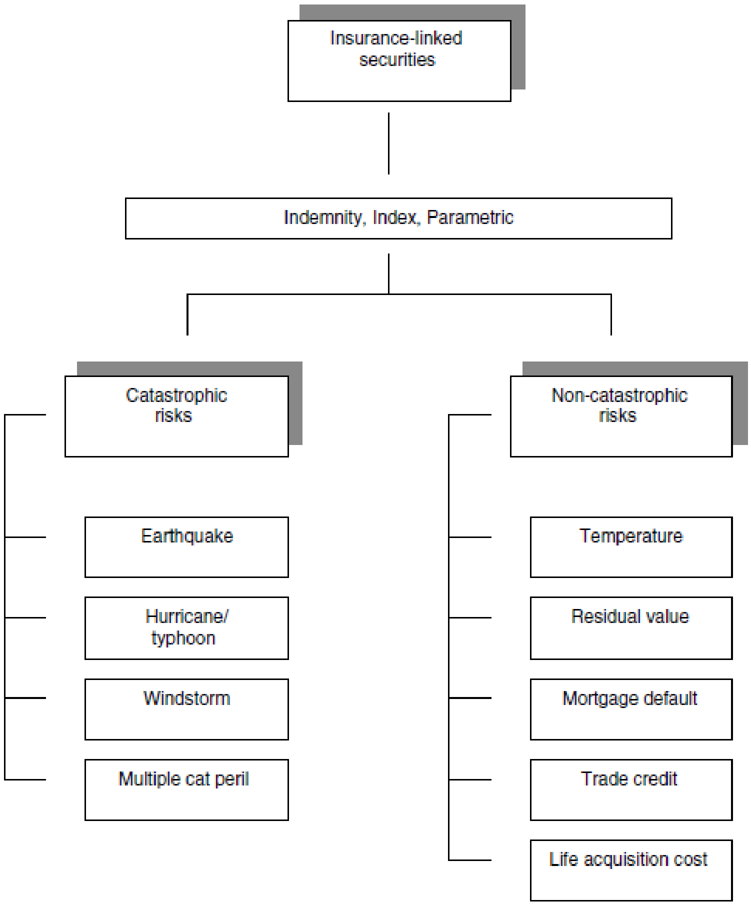

Figure 2.2: Insurance-linked securities structure.
Source: Banks E., *Alternative risk transfer: integrated risk management through insurance, reinsurance, and the capital markets* John Wiley & Sons, 2004, p. 120

Catastrophe bonds (CAT bonds)

Catastrophe bonds (*CAT bonds*) are the most important type of ILS. They're debt securities backed by insurance premiums, traded over the counter (OTC). Repayment depends on losses suffered by an insurance company or an enterprise. CAT bonds raise funds for potential insurance payouts from catastrophic events like earthquakes, floods or hurricanes. Investors receive interest payments from premiums. If the insurer faces losses from specified events, the bond repayment obligation may be mitigated or cancelled. CAT bonds offer high yields and diversify investors' portfolios. CAT bonds are issued by a special purpose vehicle (SPV) or a special purpose reinsurance vehicle (SPRV), specially established.

The structure of a CAT bond transaction consists of the cedant, SPV and investors. The ceding company seeking coverage for catastrophic risks transfers the premiums of such policies to the SPV in exchange for coverage. It enters into a reinsurance contract with the SPV, which issues securities, such as CAT bonds, to investors in the market. Investors purchase these bonds by transferring capital to the SPV, which can then offer coverage to the ceding company. Investors receive coupons at a rate determined by the underlying risk. If there are no losses related to that exposure, investors receive their capital back at maturity.

The cash flows follow a specific timeline. Initially, the ceding company purchases reinsurance and investors subscribe to the securities. The funds from investors are held in an escrow account by the SPV. Over time, accrued interest and premiums from the cedant are added to the account, while coupons owed to investors are deducted. Typically, the contract extends beyond the predetermined maturity date into a period known as the *loss development period*, during which any losses that have occurred are assessed. If no losses have occurred at maturity, investors receive their principal back along with the final coupon (the account balance minus SPV expenses). However, if losses have occurred, the SPV uses the funds to compensate the company, and investors receive the remaining amount.

Traditional CAT bonds can be augmented by more intricate structures. In one scenario, the cedent enters into an insurance contract where compensation is tied to the performance of a loss ratio. This introduces a *basis risk,* meaning the cedent risks losses exceeding those covered by the SPV. Another variation involves issuing different classes of securities with varying levels of risk and returns. This is achieved by guaranteeing different levels of capital repayment; higher risk corresponds to lower repayment percentages. In this scenario, if no damaging event occurs by contract maturity, investors receive the entire principal amount plus interest. However, if a loss occurs and the remaining amount is insufficient to fulfil commitments, the SPV can extend the contract maturity and invest the amount in a zero-coupon bond to meet obligations.

In addition to CAT bonds, ILSs can take the form of swaps, specifically *CAT swaps*. These involve fixed, predefined payments with variable amounts depending on the occurrence of a specific damaging event or, more commonly, linked to the performance of a particular index. Another innovation in CAT instruments is *CAT options*, which resemble traditional options but are essentially comparable to excess of loss reinsurance policies, with the addition of basis risk.

They provide insurance and reinsurance companies with supplementary capacity compared to traditional reinsurance and retrocession, particularly for peak catastrophe risks. Additionally, they eliminate counterparty credit risk by being fully collateralized and offer multi-year coverage, which helps to mitigate the unpredictability inherent in traditional reinsurance renewals. Moreover, they have the potential to improve the overall balance sheet position and stabilize earnings, thereby enhancing shareholder value. Like other alternative risk transfer solutions, catastrophe bonds allow investors to diversify their portfolios by investing in insurance risks that are uncorrelated with other risks, while also offering relatively high income. However, catastrophe bonds have some drawbacks, including basis risk, illiquidity, high expenses, and the need for extensive analytical work and modeling, which can result in relatively long setup times. In Europe, their development has been hampered by the lack of appropriate indexes, such as the Property Claims Services index in the US[25].

[25]Njegomir V. and Maksimovic R., *Risk transfer solutions for the insurance industry*, Economic annals, Vol. 54, Br. 180, Faculty of Law and Business Studies Dr Lazar Vrkatic, Belgrade, 2009

2.3.5 Insurance derivatives

Insurance derivatives are financial derivatives[26]used to hedge insurance risks.

Due to the success of financial derivatives in hedging interest rate and exchange rate risk, a similar approach was adopted for insurance risks in the 1990s. The distinguishing feature of insurance derivatives is that they are based on insurance risks rather than on financial market risks. These derivatives enable insurance and reinsurance companies to transfer insurance risks to capital market investors, complementing traditional reinsurance and retrocession methods. Simultaneously, investors have the opportunity to diversify their portfolios further. Moreover, investors can capitalize on speculation related to natural catastrophes[27]. Examples of insurance derivatives include catastrophe futures, options, swaps, and sectoral loss guarantees.

The first insurance derivatives were introduced in 1992 by the Chicago Board of Trade (CBOT) and were the catastrophe futures to hedge reinsurance risks. The insurance future has adapted the structure and technique of the financial future[28] to the insurance business.

The insurance future allows a given Loss Ratio value to be prefixed with reference to a future date. The price and the change in the price of the future is a function of the company's claims performance expectations. If an investor purchases a future with a lower loss expectation than what is actually experienced during the period, they will make a profit. This profit arises because the future's price increases as a result of a higher loss ratio. The profit earned serves to counterbalance the rise in the loss ratio, effectively acting as a form of reinsurance to maintain the loss ratio within a desired limit.

The market price of catastrophe futures relied on an index established by the insurance services office (ISO). ISO gathered data on catastrophe risks from more

[26]contracts whose value depends on (or "derives from") the value of an underlying asset, reference rate or index.Financial derivatives are essentially contracts traded in financial markets, either through organized exchanges (futures and options) or in over-the-counter markets (forwards, options and swaps).

[27]Doherty, N. A., *Integrated Risk Management: Techniques and Strategies for Managing Corporate Risk* , The Mcgraw-Hill Companies, Inc., New York, 2000

[28]Derivative futures contract traded on regulated markets through which the parties undertake to exchange a certain amount of a financial asset (an interest rate, a government bond or a stock market index, etc. ...) at a price predetermined at the conclusion of the contract. Cfr https://www.borsaitaliana.it/borsa/glossario/future-finanziario.html

than 100 companies and utilized this information to monitor catastrophic losses in the United States, primarily based on loss ratios. In 1993, the exchange introduced options on futures (cited in the previous subsection) in an attempt to stimulate growth. However, these efforts failed to generate significant activity, leading to the eventual abandonment of both contracts. Both instruments were substituted with options based on the property casualty services index, which quantifies loss rather than loss ratio. However, these new instruments encountered the same outcome as the 1992 and 1993 derivatives and were delisted in 2000. Until 2007, there had been no trading of insurance risks on the exchanges. However, in 2007, the New York mercantile exchange (NYMEX), the Chicago mercantile exchange (CME), and the Chicago climate futures exchange (CCFE) initiated trading in futures and options related to catastrophic insurance risks.

At the corporate level, two additional forms of derivatives have gained widespread use: *credit derivatives* and *weather derivatives*. Credit derivatives, introduced in the early 1990s, have become highly popular instruments utilized by industrial companies, banks, and insurance firms to enhance their creditworthiness. These entities are all susceptible to credit risk[29] which can lead to losses or financial instability. Credit derivatives have made credit risks negotiable, enabling organizations to assess and manage their risk profiles effectively. A credit risk derivative is a derivative instrument with the creditworthiness of a particular issuer as its underlying asset, typically measured by a rating agency or defined based on objective criteria. The primary function of credit risk derivatives is to manage credit risk associated with an asset without selling the asset itself. These derivatives are traded bilaterally over-the-counter (OTC), with high minimum denominations and adaptable terms tailored to each party's needs. In a typical credit derivative structure, the protection buyer pays a premium to the protection seller, who agrees to make payments upon the occurrence of a credit event, such as debtor default, insolvency, or changes in creditworthiness. Credit derivatives can be categorized into two main types: those where the protection seller's performance is contingent on a credit event and those where performance is not dependent on such events. Common types of credit derivatives include credit default swaps (CDS), where the protection buyer pays fixed-rate

[29] the possibility of debtors defaulting on payments

premiums, and the protection seller pays if a credit event occurs. Total return swaps involve both parties making periodic payments on a notional principal amount, with the protection buyer receiving proceeds from an underlying credit and the protection seller paying a predetermined rate. Credit linked notes (CLN) are bonds that pay above-market interest rates but repay less than face value if a specified credit event occurs.

Weather derivatives, introduced in 1999 by the Chicago mercantile exchange (CME), are a type of financial instrument that allows investors to manage risks associated with weather fluctuations. These derivatives enable investors to hedge against losses caused by weather-related events such as temperature changes, wind intensity, and precipitation. The development of weather derivatives has been facilitated by active participation from the insurance and finance sectors. Businesses in industries like food, tourism, and energy, whose revenues are directly impacted by weather conditions, have found these derivatives particularly useful for managing their exposure to weather-related risks. Weather derivatives differ from traditional financial instruments in that their underlying assets are atmospheric variables, which inherently lack intrinsic value and cannot be physically traded in a market. However, insurance and reinsurance companies have increasingly incorporated weather derivatives into their portfolios as a means of diversifying risk and providing additional protection against weather-related losses. Today, weather derivatives are widely used by economic institutions to mitigate the impact of adverse weather conditions on their operations. By utilizing weather derivatives, these institutions can stabilize their financial performance, reduce volatility in their profits, and improve their overall risk management strategies[30].

[30]Stephen J., Brix A., Ziehmann C., *Weather Derivative Valuation: The Meteorological, Statistical, Financial and Mathematical Foundations*,Cambridge University Press, Cambridge, 2005

2.3.6 Industry loss warranties (ILW)

Industry loss warranties (ILW) are contracts where insurers secure protection against the total loss incurred by the entire insurance industry due to a specific event, rather than their own individual losses. This is achieved through a derivative contract or private reinsurance arrangement. The insurer pays a premium to the ILW provider and, in exchange, receives coverage up to a specified limit if industry losses surpass a predetermined threshold set by the ILW trigger. While these contracts resemble reinsurance agreements, the triggering event is the aggregate loss experienced by the entire insurance industry, measured through an index, rather than individual loss experiences. The market for ILW contracts has experienced significant growth in recent years, with reinsurance companies and hedge funds emerging as typical providers of this type of protection. However, a potential drawback for insurers is the occurrence of basis risk, where the reinsured amount is not directly tied to the insurer's own loss experience. Although the industry index is typically correlated, this basis risk may result in protection inefficiencies.

2.3.7 Reinsurance side-car

Reinsurance sidecars are special vehicles that provide dedicated and collateralized reinsurance, often for a single ceding company that transfers a portion of its insurance risk and receives a ceding commission in return. A.M. Best (2006) defines them as special purpose entities that generally provide catastrophe quota-share reinsurance exclusively to their sponsor. This definition suggests that they have a limited lifespan in the sense that they serve to meet the specific reinsurance needs of the sponsor. They are typically used with the aim of providing additional short-term retrocession capacity for property or marine risks, although some sidecars have been used for life/health risks. The structure of sidecars is generally based on quota-share reinsurance. While sidecars are one way for capital market investors to gain exposure to insurance risk, the capital markets also offer other alternative investment vehicles, such as Insurance-Linked Securities (ILS).

2.4 ART vs. reinsurance

The evolution of alternative risk transfer (ART) solutions arises from the growing complexity of insurance risks, particularly those associated with natural disasters and climate change. These solutions integrate insurance and financial components, offering tailored approaches to mitigate specific risk challenges. CAT Bonds, in particular, bolster insurance capacity and market resilience against natural catastrophes, enhancing overall risk management capabilities.

ART and reinsurance are not mutually exclusive. They can be used together to design a tailored and effective risk transfer strategy. For instance, ART can be utilized to retain or finance a portion of the risk, while reinsurance can be employed to transfer the excess or catastrophic level of risk. Alternatively, ART can provide access to alternative capacity or coverage to complement an existing reinsurance program. Moreover, ART can be employed to hedge or diversify reinsurance exposures, or to enhance the terms of reinsurance contracts.

Combining ART and reinsurance provides numerous advantages. It optimizes risk management by lowering the total cost of risk, improving risk diversification, and enhancing risk coverage. ART provides flexibility in structuring solutions tailored to specific needs, strengthening risk resilience, and reducing frictional costs. It also allows for the design of risk transfer programs aligned with objectives, increasing access to capital and liquidity, and reducing dependence on the reinsurance market. Overall, the synergy between ART and reinsurance offers a comprehensive and flexible approach to risk management, enhancing efficiency and resilience for businesses.

Chapter 3

The case of a non-life insurance company

In a system where emerging risks increasingly surpass the capabilities of traditional forms of insurance and reinsurance, alternative risk transfer methodologies have become a well-established tool. This chapter aims to analyze the issuance of a bond by a non-life insurance company as an alternative financial instrument for risk mitigation in reinsurance. The substantial difference from a traditional bond lies in the redemption value, which remains uncertain as it is linked to the company's technical performance. The key metric representing this performance is the company's loss ratio. Within the chapter, the expected risk associated with the volatility of the loss ratio will be analyzed, along with the nature and characteristics of the instrument. The methodologies for calculating the necessary components for cash flow modelling, which are crucial for pricing, coupon calculations, and identifying refund flows, will be discussed too. Moreover, the analysis will take into account the criteria for recognition, evaluation, and accounting classification under the assumption of an IFRS Adopter, with a focus on IFRS 9 "Financial Instruments" as the accounting standard for bond accounting. Finally, the chapter will conclude with a cost-benefit analysis comparing this instrument with traditional reinsurance.

3.1 The operation

A bond is a debt instrument, more precisely a security, that allows an investor to acquire part of a company's debt, thereby becoming a creditor of the company. Following an immediate outlay (subscription to the bond), the buyer will receive the nominal value of the subscribed capital at maturity. Additionally, the buyer may receive coupons at predetermined intervals (quarterly, semi-annually, etc.), representing the periodic interest that the issuer pays to bondholders. A bond can be issued "at par" (par bond) when the nominal value coincides with the issue price. It is issued "below par" when the issue price is lower than the nominal value. The difference (known as the issue discount) represents the interest received in the case of zero-coupon bonds or enhances the investor's yield in the case of coupon bonds. Finally, it can be issued "above par" when the issue price is higher than the nominal value. The negative difference results in a negative yield for zero-coupon bonds or reduces the overall yield of the bond if it includes coupon payments. In theory, unless there's a default (i.e., bankruptcy) by the company or government, the creditor should receive the subscribed capital plus the contractually agreed interest at a predetermined maturity date. Thus, the only risk a subscriber faces is the counterparty risk of insolvency, which occurs in the event of a default by the company or government in question[1].

In this scenario, the bond allows the subscriber to receive, at predetermined intervals, the subscribed capital progressively, increased or decreased by an amount dependent on the performance of the company's loss ratio, in addition to accrued fixed-interest on the remaining capital, against an immediate outlay.

As previously mentioned, the loss ratio is the indicator representing the incidence of claims within a fiscal period on the earned premiums for that same period.

For the specific case at hand, the loss ratio pertains to the technical performance of the Credit Protection Insurance (CPI) line of business. This line comprises insurance products issued to guarantee loans provided by financial intermediaries. The purpose of such products is to protect the insured against unexpected events that may jeopardize their ability to repay the loan instalments to the financial interme-

[1] https://www.borsaitaliana.it/notizie/sotto-la-lente/differenza-tra-obbligazioni-e-azioni.htm

diary during the insured financing period.

Indeed, the duration of the policy, and thus the guarantee, is linked to the duration of the underlying financing.

The financing can have three alternative outcomes. Firstly, the insured may remain solvent and thus pay the entire amount at maturity. Secondly, they may repay the financing early, resulting in a partial cancellation of the paid insurance premium (cancelling the portion of claims that would have been collected from repayment until maturity). The last situation is default by the insured, resulting in a claim for the company. However, the company can activate the recovery credit, allowing them to recover part of the amount disbursed as a claim. This credit will be referred to as *recovery*

The structure is exactly as described for the issuance of ILS, but without the use of an SPV. The company issues a bond subscribed by investors, thus receiving capital from the market, which will be utilized as a form of reinsurance coverage. Subsequently, the company will use 100% of the capital to purchase securities that will serve as collateral, guaranteeing the repayment of the bond.

The bond will have a duration of 9 years with annual coupons. For each period, the bond will undergo two possible cash flow variations. In the first scenario, if an underlying financing contract expires, the calculation of the portion of the bond's face value to be repaid will be executed. In the second scenario, if an underlying financing contract is prematurely terminated, the calculation of the portion of the bond's face value to be repaid will occur. The capital to be repaid prematurely due to maturity or early termination will be adjusted based on the actual performance compared to the expected outcomes of claims, recoveries, and refunds.

At the end of each period, the accrued coupon will be calculated based on the remaining capital, and the respective payment will be made.

The bond will be extinguished, in whole or in part, under three different circumstances. First, it will mature naturally at the end of the ninth year. In the second scenario, it will mature annually at the end of each year. Lastly, it can be prematurely extinguished at the early final maturity if the underlying financing is repaid prematurely.

3.2 The expected risk associated with the loss ratio's volatility

The company in its operations is subject to various risks. One such risk is associated with the technical performance represented by the ratio of claims on premiums and how it varies. The loss ratio is the parameter that calculates this incidence and is also variable. Therefore, the variation in the loss ratio will be associated with an expected risk. This risk represents the exposure of the company to the potential increase in claim frequency, decrease in recoveries, or increase in early refunds.

The company has to mitigate that risk. So it was devised to use a hedging financial instrument. This instrument consists of the derivative that will be embedded in the bond.

Therefore, the value of that derivative will be included in the coupon. In order to calculate this value, it will be necessary to calculate the expected risk associated with the performance of the loss ratio. The expected risk will be calculated as the sum of 3 different components. Each of which represents a certain trend in the loss ratio.

The risk, as mentioned earlier, refers to an increase in the expected loss ratio. This increase is represented by the derivative component called the *risk premium.* So called because it corresponds precisely to the premium that the company expects to make up for the increase in the expected loss ratio. The increase in the loss ratio can be due to an increase in claims or a decrease in premiums collected.

The expected loss ratio, however, can also decrease. This decrease may be due to a reduction in claims incurred (resulting in lower payouts for the company) or an increase in premiums collected (resulting in greater capital for the company). For this reason, this component is called *excess of profit.*

Finally, the loss ratio can increase disproportionately, specifically beyond a certain threshold. This threshold represents the point beyond which the company is no reimbursed as it would nullify the value of the bond. This portion of risk remains on the company side.

The risk premium (RP) component will be decreased by the excess of profit

(EoP), due to a reduction in associated risk and the excess of loss (EoL), as repayment becomes zero.

The derivative component (DC) of the coupon will be calculated as follows:

$$DC = RP - EoP - EoL \tag{3.1}$$

Below is a simplified diagram illustrating the mechanism of the three components.

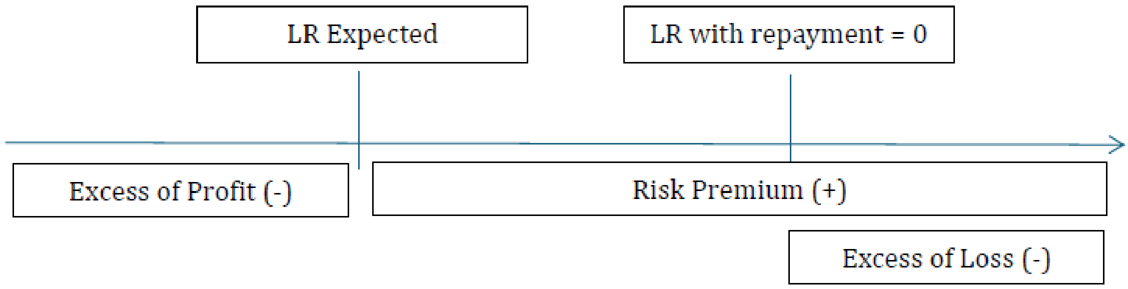

Figure 3.1: Mechanism of the three elements of the derivative component

In order to define the counter value of the derivative and include it in the coupon, the expected risk associated with the increase in the loss ratio is calculated as the sum of the three components. To calculate the value of the three components, it was decided to value them as three different options.

The first component to be evaluated is the excess of profit. It will be necessary to measure the possibility that the loss ratio falls below an expected value. This value will be calculated using the estimated expected cash flows at the initial valuation date. The expected value of the loss ratio will be expressed as a percentage and will be defined as the "strike." The company will need to sell a put option (as it appreciates when the reference parameter decreases); with this option, the company transfers to the subscriber the right to receive reimbursement of the nominal value of the bond increased based on the difference between the expected loss ratio and the incurred loss ratio at the valuation date. The put option is used because the value increases as the actual loss ratio decreases. In fact, the lower the incurred loss ratio, the better the result for the company, and therefore, the higher the reimbursement value for the subscribers.

The second component to be evaluated is the risk premium. The option should measure the risk that the incurred loss ratio increases beyond the strike. To hedge against this risk, the company will need to purchase a call option. With this option, the company secures the right to transfer to the subscriber the difference between a loss ratio higher than the strike, reimbursing a lower capital at maturity compared to the issuance value. A call option is purchased because its value increases as the expected loss ratio rises. In fact, the higher the incurred loss ratio, the worse the result for the company, and therefore, the lower the reimbursement value for the subscribers. The contribution of this component to the coupon is positive because there is a transfer of risk (increase in the loss ratio) to the subscribers.

The third component to be evaluated is the excess of loss. The third option will be used to limit the risk taken by the subscriber with the second option (risk premium). Thanks to this option, the subscriber cannot incur a loss exceeding the capital invested in the subscribed bond. In this case, the company will sell a call option where the strike is equal to the loss ratio that zeroes out the bond's reimbursement value. This value will be defined as the cap strike and will be calculated at the time of issuance. As the incurred loss ratio increases, the reimbursement value decreases. Without the excess of loss option, the risk premium could theoretically increase infinitely, but this could lead to a negative reimbursement value. Therefore, the last option allows limiting this increase by subtracting from the risk premium value that exceeds the cap strike. This is why the contribution to the coupon will be negative because it must limit the exposure of the first option.

Below is a simplified descriptive scheme:

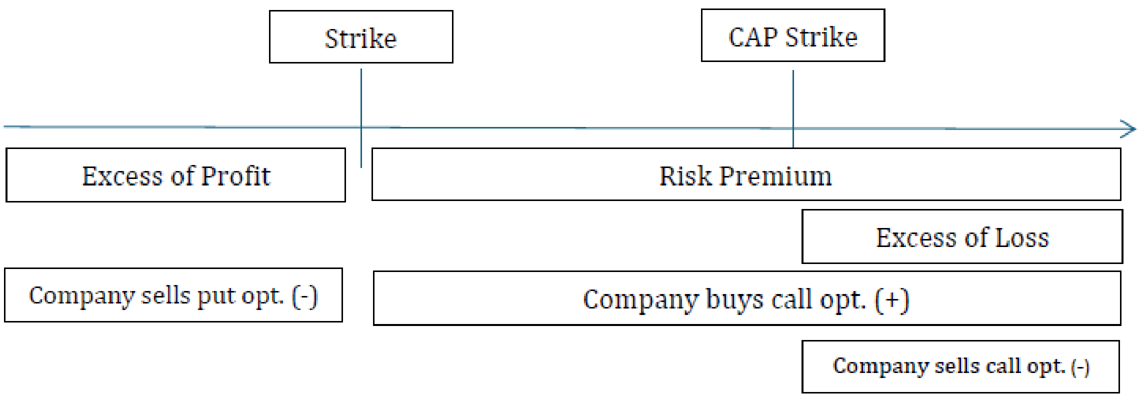

Figure 3.2: Mechanism of the three options

An Excel calculation tool was employed to determine the cost of the bond for the issuing company. The calculation tool will use the Black & Scholes formula to calculate the value of the optional components described.

The Black & Scholes formula is the expression for the no-arbitrage price of a European call/put option, obtained based on the Black & Scholes model[2].

According to the model the price of a european call option[3], with maturity T, evaluated at time t, is given by:

$$C(S,t) = S_t N_{d_1} - Ke^{-r(T-t)} N_{d_2} \tag{3.2}$$

while the price of a european put option[4], with maturity T, evaluated at time t, is given by:

$$P(S,t) = Ke^{-r(T-t)} N_{-d_2} - S_t N_{-d_1} \tag{3.3}$$

where:

- S_t is the price of the underlying asset;
- K is the strike price;
- r is the free risk interest rate, expressed on an annual basis;
- $N()$ is the the cumulative distribution function of a normal random variable

[2]The model for evaluating European options developed by Fischer Black and Myron Scholes.The Black-Scholes model is a "no-arbitrage" model, meaning it calculates the equilibrium price of options based on the assumption that there are no arbitrage opportunities in the market. Therefore, it begins with the construction of a risk-free portfolio composed of options and underlying assets and calculates its present value assuming that its return must necessarily be equal to the risk-free rate.Cfr https://www.borsaitaliana.it/borsa/glossario/modello-di-black-e-scholes.html

[3]A european call option gives the owner the right to acquire the underlying security at expiry. For an investor to profit from a call option, the stock's price, at expiry, has to be trading high enough above the strike price to cover the cost of the option premium.

[4]A European put option allows the holder to sell the underlying security at expiry. For an investor to profit from a put option, the stock's price, at expiry, has to be trading far enough below the strike price to cover the cost of the option premium.

and

$$d_1 = \frac{\ln\left(\frac{S_t}{K}\right) + \left(r + \frac{1}{2}\sigma^2\right)(T-t)}{\sigma\sqrt{T-t}} \tag{3.4}$$

$$d_2 = d_1 - \sigma\sqrt{T-t} \tag{3.5}$$

Finally σ^2 is the instantaneous percentage variance of the logarithm of the underlying stock price, also expressed on an annual basis.

The Black & Scholes model, to evaluate the described optional components, will be fed with the following inputs:

- the notional N is the residual capital for each year of remaining life of the bond;
- the rate r is the EIOPA[5] free risk rate and the corresponding forward rates, for each year of remaining life of the bond;
- the strike K is the strike or Cap strike depending on the type of option to be priced;
- the volatility σ^2 the standard deviation calculated on the historical series of the loss ratio associated with the Reference Portfolio for the past n years.

It is essential that the value of the optional component is related to a coupon flow. To achieve this target, the values of the three options are calculated for each residual capital as follows: the option values, obtained through the Black & Scholes model, are discounted and summed year by year; the total present value thus obtained is then compared to the residual capital of the BOND (obtained from the sum of the present value of the notional capital year by year) and transformed into a percentage value. This process ensures that the optional component is integrated into the coupon flows, allowing for a correct valuation and alignment with the cash flows of the bond.

[5]European Insurance and Occupational Pensions Authority

T0	1	2	3	4	5	6	7	8	9	TOT
Premiums	50.000	-	-	-	-	-	-	-	-	50.000
Refunds	- 100	- 1.000	- 1.200	- 1.500	- 6.000	- 2.000	- 1.000	- 900	- 600	- 14.300
Premium reserve	- 45.000	- 35.000	- 30.000	- 25.000	- 20.000	- 16.000	- 9.000	- 2.000	-	-
Claims	- 3.500	- 10.000	- 6.000	- 4.000	- 1.800	- 800	- 500	- 250	- 100	- 26.950
Recoveries	50	400	700	600	250	100	80	40	15	2.235
Loss ratio	-69,23%									

Table 3.1

The table 3.1 illustrates an example of how the expected loss ratio was calculated in the calculation tool. For reasons of confidentiality, different values have been used over a 9-year period. The table thus represents the expected loss ratio for the next nine years, calculated today. The term ”premium reserve” make reference to the outstanding premium reserve.

3.3 Bond characteristics

As mentioned above, an Excel calculation tool was employed to determine the cost of the bond for the issuing company. The following part will outline the characteristics of the bond and how they were utilized within the tool.

As mentioned earlier, the bond serves as an alternative to reinsurance. Therefore, there must be a transfer of risk. This is achieved by indexing the technical performance (loss ratio) of the credit protection branch (class XIV, non-life) to the bond redemption value. For this reason, a *reference portfolio* is required. It consists of the premiums of the policies issued in the Reference Period, with the underlying risk being credit protection branch. Each policy will have a natural expiration corresponding to the underlying financing's maturity and may be terminated early if the underlying financing is repaid in advance.

In addition to the reference portfolio, there will also be the *residual reference portfolio*. It consists of the premiums of the policies that are currently active. In other words, it is the reference portfolio reduced by policies ceased for expired loans, policies ceased for prematurely terminated loans, and policies ceased for claims.

The *issuance value* (IV) is the price set by the issuer for selling the security in the market. In this case, it consists of the *initial nominal value* increased or decreased by the positive or negative issuance discount or premium that the company decides to apply based on the demand gathered on the bond and reduced by the issuance expenses incurred.

If issued below par, it will be a discount because the issuance value will be lower than the nominal value. If issued above par, it will be a premium because the issuance value will be higher than the nominal value.

The initial nominal value is determined by the premiums (P) issued (net of expected reimbursements) in the reference period (the reference period will be the year 202X related to the reference portfolio). This value will then be multiplied by the *quota share*[6] and the expected loss ratio on the reference portfolio.

The premiums are multiplied by the quota share because it is a reinsurance

[6] It represents the percentage of premiums ceded in reinsurance useful for determining the proportional participation share of the subscriber in the technical result of the company.

bond, and only the premiums ceded in reinsurance are considered. To calculate the premiums ceded in reinsurance, the total value of the premiums is multiplied by the quota share.

The formula is as follows:

$$IV = P \cdot QS \cdot LR_{exp} \tag{3.6}$$

The nominal value comes in two types: expected and incurred.

The expected nominal value (NV_{exp}) refers to the expected performance of the premium reserve (PR_{exp}) in the reference period. It will then be multiplied by the quota share and the expected loss ratio defined for the reference portfolio.

The incurred nominal value (NV_{inc}), on the other hand, relates to the incurred performance of the premium reserve in the reference period. It is also multiplied by the quota share and the expected loss ratio defined for the reference portfolio.

They can be expressed as follows:

$$\begin{aligned} NV_{exp} &= PR_{exp} \cdot QS \cdot LR_{exp} \\ NV_{inc} &= PR_{inc} \cdot QS \cdot LR_{exp} \end{aligned} \tag{3.7}$$

In this chapter, the loss ratio has been used in two different contexts: expected and incurred.

Loss ratio expected refers to the anticipated loss ratio on the residual reference portfolio. Mathematically, this parameter is the ratio, for all remaining years until maturity, between the sum of expected claims paid less expected recoveries on claims, and the sum of expected premiums issued less cancellations of premiums issued for expected repayments on loans.

On the other hand, *loss ratio incurred* refers to the actual loss ratio on the residual reference portfolio. Mathematically, this parameter is the ratio, for all remaining years until maturity, between the sum of actual claims paid less actual recoveries made, and the sum of premiums issued reduced by cancellations of premiums issued for actual repayments on loans.

t	1	2	3	4	5	6	7	8	9
Earned premiums	50.000	45.000	35.000	30.000	25.000	20.000	16.000	9.000	2.000
Quota share	60,00%	60,00%	60,00%	60,00%	60,00%	60,00%	60,00%	60,00%	60,00%
Ceded premiums	30.000	27.000	21.000	18.000	15.000	12.000	9.600	5.400	1.200
Loss ratio expected	69,23%	69,23%	69,23%	69,23%	69,23%	69,23%	69,23%	69,23%	69,23%
NV	20.769	18.692	14.538	12.461	10.384	8.308	6.646	3.738	831

Table 3.2

The table 3.2 displays the calculation of the notional value of the bond, computed today with a projection for the next 9 years, according to the characteristics listed earlier. It is obtained by multiplying the issued premiums by the quota share (ceded premiums), further multiplied by the expected loss ratio. This latter parameter has been obtained in table 3.1

After analyzing the bond characteristics referring to premiums, the focus now shifts to claims.

Claims are analyzed in two categories: expected and incurred. In the calculation tool, the entry for expected claims is *claims & net refunds total recoveries expected*. It represents, for all years of the bond's duration, the following expected components on the residual reference portfolio: the sum of expected paid claims minus expected recoveries minus expected refunds on expected loans. This is then multiplied by the quota share value and the expected loss ratio.

The entry for incurred claims in the calculation tool is *claims & net refunds total incurred/revised*. It equals the sum of the following components calculated for all years of the incurred duration, as well as for all the same expected components for future years: incurred and expected paid claims minus incurred and expected recoveries minus incurred and expected refunds on incurred and expected loans. This is then multiplied by the quota share value and annually multiplied by the incurred or expected loss ratio value, depending on whether it concerns past or future periods.

The two components described above are then compared at the end of each year. The difference, at the end of each year, between *claims & net refunds total recoveries expected* and *claims & net refunds total incurred/revised*, cumulatively accumulated, corresponds to the entry in the tool called *cumulative claims, refunds, and recoveries* *delta*.

Finally, the difference between the cumulative claims, refunds, and recoveries delta at time t and the same quantity at time $t-1$ is calculated. This difference is defined as the *annual claims, refunds, and recoveries delta*.

Claims, refunds, and recoveries are extracted from table 3.1.

Lastly, let's examine the following features: the redemption value, the remaining principal, the maturity date, and, of course, the coupon.

The redemption value of a bond corresponds to what is paid to the holder of a security at the maturity of the bond itself. In this case, the overall redemption value of the bond will never be less than zero (see *excess of loss*). The bond is designed so that at each annual maturity, at the natural final maturity, or at the early final maturity, a redemption value will be paid. This value will be equal to the corresponding nominal value of the bond for which the maturity has been reached. This value will then be increased or decreased by an amount equal to the delta of claims, refunds, and recoveries for the year multiplied by the quota share and the incurred loss ratio. If the value of the delta of claims, refunds, and recoveries for the year exceeds the nominal value of the bond for which the maturity has been reached, the difference will be accounted for by recording a credit to the subscribers of the bond, and used in subsequent years until its complete utilization, subject to the maximum compensable limit of the remaining principal, which can never become negative. In other words if this delta exceeds the nominal value, the difference is credited to bond subscribers and used in subsequent years, respecting the maximum limit of the remaining principal, which can't be negative. The remaining principal is equal to the nominal value reduced, over time, by the redemption value matured at each maturity.

The maturity, as described above, can be of three types: natural final, annual, and early final.

The *natural final maturity* corresponds to the last contractual obligation of the bond. It will occur at the end of the ninth year from the date of issuance.

The *annual maturity* is at the end of each year. At this maturity, within 30 days from the end of the year, the bond will be redeemed for a nominal value equal to the absolute difference between the residual reference portfolio value at the end of each year and the residual reference portfolio value at the beginning of the same year.

Finally an is provided an *early final maturity.* This event occurs if the residual reference portfolio value at the end of each year is lower than a certain percentage (agreed upon with the company) of the reference portfolio value at the bond's issuance date.

The last characteristic to analyze is perhaps the most important: the bond's coupon. It represents the interest portion paid periodically to the bondholder. It is calculated annually on the residual principal. This calculation is done by multiplying the residual principal by the fixed coupon rate. The payment will be made 60 days after the end of each year.

The coupon rate will be specifically constructed to remunerate different components. The first component to remunerate is the *time* component. It will be calculated based on the EIOPA risk-free rate (RFR) at the issuance date for the maturity corresponding to the bond's maturity calculated at the time of issuance.

The second component will be the expected risk associated with the volatility of the Loss Ratio (see *risk premium*). This component will be calculated net of the expected excess profit, implicit in the standard deviation of the historical loss ratio (see *excess of profit*), and net of the portion of risk exceeding the residual capital of the bond (see *excess of loss*). This part corresponds to the derivative component (DC) described earlier

The last component will be an illiquidity premium (IP), also agreed upon with the company.

The coupon rate (CR) is obtained with the following formula.

$$CR = RFR + DC + IP \tag{3.8}$$

3.4 Calculation of the fair value of the derivative and the coupon.

In the following section, we will analyze how the fair value (FV) of the derivative component and, finally, the coupon rate were calculated. The fair value of a derivative is the price at which a interested party is willing to exchange the derivative at a specific point in time. It is determined using valuation models based on assumptions regarding interest rates, volatility, exchange rates, and other market factors. In the calculation tool used, it was computed using the Black-Scholes model. This was done because it involved calculating the FV of 3 options.

So, the following tables show how we arrived at the percentage value of the FV of the 3 options. It is noted that this concerns the sale of a put option and the sale and purchase of two call options. The calculation methodologies used are the same with one difference. In calculating the fair value of the put option, the equation 3.3 was used. In calculating the fair value of the call option, the equation 3.2 was used.

The calculation tool precisely computes the expected FV of the derivative calculated in t_0. Table 3.3 represents the calculation of the put option. This concerns the *EoP* component.

t	1	2	3	4	5	6	7	8	9
NV	20.769	18.692	14.538	12.461	10.384	8.308	6.646	3.738	831
Δ NV	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
St (FV)	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
K (Strike)	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
r	3,18%	3,30%	3,20%	3,15%	3,13%	3,11%	3,09%	3,09%	3,09%
σ	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%
$t - t_0$	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00
d1	0,37	0,54	0,64	0,73	0,81	0,89	0,95	1,02	1,08
d2	0,27	0,40	0,47	0,53	0,59	0,64	0,69	0,74	0,78
C (S,t)	52,82	117,52	61,60	61,90	60,58	46,98	79,20	75,43	20,38
C (S,t) / St (FV)	2,54%	2,83%	2,97%	2,98%	2,92%	2,83%	2,72%	2,59%	2,45%
C(S,t)/NV	0,254%	0,629%	0,424%	0,497%	0,583%	0,566%	1,192%	2,018%	2,453%
PV of NV	20.129,59	17.518,53	13.226,19	11.006,63	8.900,97	6.913,04	5.370,55	2.931,49	631,83
PV of the yearly EoP	51,19	110,14	56,04	54,67	51,93	39,10	64,00	59,15	15,50
$\sum$ PV of NV	86.628,81								
$\sum$ PV of the yearly EoP	501,71								
Yearly EoP %	0,579%								

Table 3.3

Firstly, the values of the *NV* calculated in table 3.3 are retrieved. Then, the variation of this value from one year to another is calculated. This variation represents the value of the underlying, i.e., the technical performance of the company. This value is then multiplied by a strike parameter equal to 1 to obtain the value of the strike. The interest rate r corresponds to the annual EIOPA free risk curve at T_0, while σ corresponds to the volatility of the loss ratio variation. The values of $d1$ and $d2$ are obtained using formulas 3.4 and 3.5. The cost $C(S,t)$ is calculated using formula 3.3. All data are extracted from the table in the previous entries. Then, the value of the cost on the underlying value (ΔNV) and on the NV is calculated. All these data are calculated for 9 years.

Continuing, the present value (PV) of NV and $C(S,t)$ are calculated, which correspond to the value of EoP. Then, the flows of the last two data points are summed up, resulting in two values. Finally, the ratio between the sum of the current values of EoP and the sum of the current values of the notional is calculated. This value corresponds to the annual percentage value of EoP, i.e., the derivative component of the put option that will constitute the coupon.

t	1	2	3	4	5	6	7	8	9
NV	20.769	18.692	14.538	12.461	10.384	8.308	6.646	3.738	831
Δ VN	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
St (FV)	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
K (Strike)	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
r	3,18%	3,30%	3,20%	3,15%	3,13%	3,11%	3,09%	3,09%	3,09%
σ	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%
$t - t_0$	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00
d1	0,37	0,54	0,64	0,73	0,81	0,89	0,95	1,02	1,08
d2	0,27	0,40	0,47	0,53	0,59	0,64	0,69	0,74	0,78
C (S,t)	117,74	382,43	251,88	307,92	361,55	329,81	644,92	711,53	221,95
C (S,t) / St (FV)	5,67%	9,21%	12,13%	14,83%	17,41%	19,85%	22,18%	24,47%	26,72%
C (S,t)/VN	0,567%	2,046%	1,733%	2,471%	3,482%	3,970%	9,704%	19,033%	26,717%
PV of VN	20.129,59	17.518,53	13.226,19	11.006,63	8.900,97	6.913,04	5.370,55	2.931,49	631,83
PV of the yearly RP	114,12	358,42	229,14	271,97	309,90	274,45	521,14	557,95	168,81
$\sum$ PV of NV	86.628,81								
$\sum$ PV of the yearly RP	2.805,90								
Yearly RP %	3,239%								

Table 3.4

The table 3.4 represents the calculation of the PV of purchasing the call option, referred to as *risk premium* (RP). Therefore, the calculation methods are the same as in table y with one difference. The cost of the call option is calculated using formula 3.2, which computes the value of a call option through the Black & Scholes model. The annual $RP\%$ corresponds to the percentage value of the risk premium that will constitute part of the coupon.

t	1	2	3	4	5	6	7	8	9
NV	20.769	18.692	14.538	12.461	10.384	8.308	6.646	3.738	831
Δ NV	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
St (FV)	2.076,89	4.153,78	2.076,89	2.076,89	2.076,89	1.661,51	2.907,65	2.907,65	830,76
K (Strike)	4.153,78	8.307,56	4.153,78	4.153,78	4.153,78	3.323,03	5.815,29	5.815,29	1.661,51
r	3,18%	3,30%	3,20%	3,15%	3,13%	3,11%	3,09%	3,09%	3,09%
σ	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%	9,96%
$t - t_0$	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00
d1	- 6,59	- 4,38	- 3,38	- 2,75	- 2,30	- 1,95	- 1,68	- 1,44	- 1,24
d2	- 6,69	- 4,52	- 3,55	- 2,95	- 2,52	- 2,20	- 1,94	- 1,73	- 1,54
C (S,t)	0,00	0,00	0,03	0,36	1,59	3,58	13,46	24,51	11,36
C (S,t) / St (FV)	0,00%	0,00%	0,00%	0,02%	0,08%	0,22%	0,46%	0,84%	1,37%
C (S,t)/ VN	0,000%	0,000%	0,000%	0,003%	0,015%	0,043%	0,203%	0,656%	1,368%
PV of VN	20.129,59	17.518,53	13.226,19	11.006,63	8.900,97	6.913,04	5.370,55	2.931,49	631,83
PV of the yearly EoL	0,00	0,00	0,03	0,31	1,36	2,98	10,88	19,22	8,64
∑ PV of NV	86.628,81								
∑ PV of the yearly EoL	43,43								
Yearly EoL %	0,049%								

Table 3.5

The table 3.5 represents the calculation of the PV of selling the call option, referred to as *excess of loss* (EoL). Therefore, the calculation methods are the same as in table y with one difference. This time, the strike parameter will be equal to 2. This is because the assumption underlying this model is that the value of loss that zeroes out the refund is exactly twice the expected loss ratio[7] . Consequently, the risk parameter will be equal to 2. This parameter will then be multiplied, as before, by $St(FV)$, obtaining the value of K. The cost of the call option is calculated using formula z, which computes the value of a call option through the Black & Scholes model. The annual $EoP\%$ corresponds to the percentage value of the excess of loss that will constitute part of the coupon.

The same calculations are then performed to calculate the FV of the derivative component expected and incurred in the future projection years. Consequently, there will be the three tables from t_1 to t_8.

As for the FV incurred, the tables will be updated year by year using the actual data obtained.

[7]LR expected = 69,23%
Strike parameter = 2
CAP Strike = 69,23% × 2 = 138,46%

Now with the data of the derivative components obtained respectively from tables 3.3,3.4 and 3.5, we can calculate the value of the coupon. Taking into account an illiquidity premium of 3% and a risk-free rate of 3,15%, the value of the coupon will be:

Excess of Profit (<LR)	-0,58%
Risk Premium (>LR)	3,24%
Excess of Loss (>x)	-0,05%
Derivative component	2,61%
EIOPA RFR	3,18%
Illiquidity premium	2,50%
Coupon	8,29%

Table 3.6

3.5 Classification and recognition under IFRS9

On July 24, 2014, the International Accounting Standards Board (IASB) published the International Financial Reporting Standard (IFRS) number 9, about financial instruments. The standard aims to enhance financial reporting on financial instruments by addressing issues that arose during the financial crisis. Specifically, IFRS 9 responds to the G20's call to transition to a more forward-looking model for recognizing expected credit losses on financial assets.

The purpose of this standard is to establish principles for the presentation in the financial statements of financial assets and financial liabilities that will enable users of the financial statements to assess the amounts, timing, and uncertainty of future cash flows[8].

According to paragraph 3.1 of this standard, an entity must recognize a financial asset or liability in its statement of financial position when, and only when, the entity becomes party to the contractual provisions of the instrument. When the entity initially recognizes a financial asset, it must classify it in accordance with paragraphs 4.1.1-4.1.5 based on its business model for managing financial assets and measure it at fair value (paragraphs 5.1.1-5.1.3). When the entity initially recognizes a financial liability, it must classify it at amortized cost (paragraphs 4.2.1-4.2.2)[9]. At initial recognition, the entity must measure the financial asset or liability at its fair value plus or minus, in the case of a financial asset or liability not measured at

[8] https://www.revisorionline.it/

[9] Except, according to paragraph 4.2.1, the following:

a) Financial liabilities at fair value through profit or loss. Such liabilities, including derivatives that are liabilities, must subsequently be measured at fair value. b) Financial liabilities arising when the transfer of a financial asset does not qualify for derecognition or when the continuing involvement approach applies. Paragraphs 3.2.15 and 3.2.17 apply to the measurement of such financial liabilities. c) Financial guarantee contracts. After initial recognition, the issuer of such contracts must (unless paragraph 4.2.1(a) or (b) applies) subsequently measure them at the higher of: i) The amount of the loss allowance determined in accordance with section 5.5, and ii) The amount initially recognized (see paragraph 5.1.1), adjusted where appropriate for the cumulative amount of revenue recognized in accordance with IFRS 15. d) Commitments to provide a loan at a below-market interest rate. The issuer of such a commitment must (unless paragraph 4.2.1(a) applies) subsequently measure it at the higher of: i) The amount of the loss allowance determined in accordance with section 5.5, and ii) The amount initially recognized (see paragraph 5.1.1), adjusted where appropriate for the cumulative amount of revenue recognized in accordance with IFRS 15. e) The potential consideration receivable by the acquirer in a business combination to which IFRS 3 applies. Such potential consideration must be subsequently measured at fair value with changes recognized in profit or loss.

Option to designate the financial liability at fair value through profit or loss.

fair value through profit or loss, the transaction costs directly.

3.5.1 Classification

The bond is a structured instrument. In fact it incorporates a derivative, correlated to the change in the loss ratio over time. Consequently, the accounting methods would seem to be of two types.

The first method involves the separation between the derivative component and the bond component. The derivative element, related to the movement of the loss ratio, must be recognized using the *fair value through profit and loss* methodology [10]. The bond component, the main contract, must be recognized using the amortized cost methodology [11].

The second methodology is used if it is impossible to separate the embedded derivative. In this case, the entire hybrid instrument must be recognized at FVTPL. The fair value change of the instrument must be recognized in the income statement. All of this is aimed at eliminating the effects of accounting mismatch [12]

The principle defines an embedded derivative as a component of a hybrid contract that also includes a primary non-derivative contract . The cash flows of the combined instrument vary similarly to those of the derivative taken on its own. An embedded derivative results in a change in some or all of the cash flows , with reference to a specified interest rate, the price of a specified financial instrument, the price of a specified commodity, a specified exchange rate, a specified price or rate index, credit rating or credit index, or other variable, provided that, in the case of a non-

[10] Financial assets held at fair value with impact on the Income Statement (Fair Value Through Profit and Loss). This classification refers: Primarily to financial instruments held for trading purposes; Financial instruments for which the fair value option has been elected, or those designated as FVTPL in an irrevocable manner, if such classification helps eliminate or reduce accounting asymmetries; Residually, all those financial instruments that do not meet the characteristics for classification as Amortized Cost (AC) and Fair Value Through Other Comprehensive Income (FVTOCI). These financial instruments are to be valued based on the fair value method, while the economic impacts will be recorded directly in the income statement.Cfr https://www.costanzoeassociati.it/glossario-economia-finanza/fvtpl/

[11] The value at which the financial asset or liability was measured at initial recognition, net of capital repayments, increased or decreased by the overall amortization using the effective interest rate method on any difference between the initial value and the maturity value, and reduced by any impairment losses (recognized directly or through the use of an allowance) resulting from a decrease in value or irrecoverability. Cfr IAS n.39 - IASB - Principio contabile internazionale (IAS) 3 novembre 2008

[12] IFRS 9, par. 4.2.1

financial variable, that variable is not specific to one of the contractual parties. A derivative associated with a financial instrument but contractually transferable independently of the instrument, or having a different counterparty does not qualify as an embedded derivative, but as a separate financial instrument. [13]

3.5.2 Initial recognition and subsequent evaluations

At the initial recognition, the Company evaluates the bond, regardless of its classification, at fair value [14]. As mentioned earlier, in case of classification of the entire instrument (including the derivative component) to FVTPL it must subsequently be measured at fair value with the imputations of changes in fair value to the income statement.[15]

If classified with a separate derivative, the derivative component is valued at FVTPL, while the bond is valued at amortized cost, following effective interest rate method[16].

The components of the bond subject to amortized cost valuation are the nominal value (or Fair Value of the principal to be repaid) and the coupon payment. If the issue value is not at par, the difference represented by the issue premium is recovered *pro-rata temporis* using the effective interest rate method. Additionally, in case of early redemptions, the residual value of the issue premium on the redeemed component must be released to the income statement.

Regarding the fair value delta of the derivative instrument, recognized in both classifications as FVTPL, this will be equal to the fair value delta generated by movements in the risk-free rate for discounting cash flows and the overall value of the derivative, recalculating its effect based on the pricing factors described above and the residual capital, updated at each valuation date.

[13] IFRS 9, par. 4.3.1

[14] IFRS 9, par. 5.1

[15] IFRS 9, par. 4.2.1, let.a)

[16] The effective interest rate method is a calculation method for amortized cost of a financial asset or liability (or group of financial assets or liabilities) and for apportioning interest income or expenses over the relevant period. The effective interest rate is the rate that exactly discounts estimated future cash payments or receipts over the expected life of the financial instrument or, when appropriate, a shorter period, to the net carrying amount of the financial asset or liability. Cfr OIC 19, Debiti

In simpler terms, the fair value delta of the derivative instrument, when classified as FVTPL, represents the change in value caused by fluctuations in the risk-free rate used to discount future cash flows and determine the overall value of the derivative. This change is recalculated periodically based on various pricing factors and the residual capital, which is updated at each valuation date.

The value of the derivative at initial recognition is not paid in cash. It is part of the coupon and is therefore settled annually on a deferred basis. The representation of it will see the recognition of the calculated fair value on the asset side and a liability of the same amount on the liability side.The annual recognition of coupons must subsequently record a reversal of the finance charge. This reversal corresponds to the portion of the coupon pertaining to the derivative component that has come due, against extinction of a portion of the debt. Simultaneously, the residual fair value of the asset must be recalculated, with recognition in the income statement of the differential component compared to the opening value.

3.5.3 Derecognition under IFRS 9

According to IFRS 9, derecognition involves removing from the balance sheet a previously recognized financial asset or liability.

A financial liability (or part of it) is extinguished when the debtor settles the debt (or part of it) by paying the creditor, usually in cash or through other financial assets, goods, or services, or when the debtor is legally released from the primary responsibility for the liability (or part of it) by law or by the creditor[17]. Throughout the life of the bond, could occur different derecognition events.The first event is obviously the natural maturity of the bond.

Then there may be early repayments of the underlying loans in the reference portfolio. These repayments will result in a partial cancellation of issued premiums and a consequent partial early redemption of the bond.

There could also be natural maturities of the underlying loans in the reference portfolio. These maturities will also result in a partial redemption of the bond.

[17] IFRS 9, par. B3.3.1

Finally, if the value of the remaining portfolio is less than a certain percentage of the value of the initial portfolio. This eventuality gives rise to a total early redemption of the bond.

3.6 Bond vs. reinsurance: analysis of convenience

The last part of the following chapter concerns the analysis of the convenience of issuing a reinsurance bond as an alternative risk mitigation technique compared to reinsurance (bond-reinsurance analysis). From the bond-reinsurance analysis, an advantage in terms of return on risk-adjusted capital (RORAC) of the reinsurance bond compared to reinsurance had emerged.

The RORAC (return on risk-adjusted capital) is an index commonly used to evaluate financial and banking activities that have different risk profiles or levels. It is obtained by relating the expected profitability to the bank's capital adjusted for potential losses.The RORAC is similar to return on equity (ROE), except the denominator is adjusted to account for the risk of a project. Therefore measures the expected profitability of an instrument in relation to the risk generated by the instrument. Specifically

$$RORAC = \frac{Net\ income}{Risk\text{-}wighted\ assets} \tag{3.9}$$

where *risk-weighted assets* can be interpreted as *allocated risk capital*[18], *economic capital*[19], or *value at risk*[20].

Therefore, the profitability of an instrument should be the higher the SCR[21] required by that instrument. To this end, the following should be considered: The effectiveness of the reinsurance strategy decreases as the loss ratio of the company improves. The advantage of the bond over reinsurance is proportional to the level of the risk-free curve value.

The analysis consists of comparing two RORACs: the RORAC of the company choosing reinsurance and the RORAC of the company choosing bond issuance. If the RORAC is negative, the company will incur a loss instead of a profit. This loss corresponds to the cost of average capital (COAC). That's why the convenience analysis will be relative to the RORAC if the impact on the SCR is positive or to

[18] amount of capital that a company sets aside to cover the risks it is exposed to.
[19] amount of capital that a company needs to survive any risks that it takes.
[20] a risk indicator that, for an investment, measures the loss that will not be exceeded with a certain level of confidence over a specific time horizon.
[21] Solvency capital requirement

the COAC if negative.

In the analysis mentioned above the company's proceeds for evaluating the RORAC/COAC consist of the reinsurance margin (or retrocession margin). This margin refers to the profit that an insurance company obtains from transferring a portion of the insurance risk to a reinsurance company. When an insurer transfers some of the risk to a reinsurer, it pays a reinsurance premium in return. The reinsurance margin is the difference between the reinsurance premium received and the cost of the indemnity paid by the reinsurer in the event of a claim. This margin represents the net gain of the insurance resulting from reinsurance of the risk.

In other words, it will be the difference between the technical result of the company[22] and the technical result of the reinsurance[23].

Of course, to calculate the RORAC/COAC resulting from the issuance of the bond, the retrocession margin resulting from the issuance of the bond will be used. Therefore, it will be the technical result of the company minus the technical result of the bond[24].

Therefore, the RORAC/COAC will be equivalent to the ratio between the retrocession margin (RM) and the benefit on the SCR of reinsurance[25] and the bond[26]
.

$$RORAC/COAC_{re} = \frac{RM}{SCR_{re}} \tag{3.10}$$

$$RORAC/COAC_{bond} = \frac{RM}{SCR_{bond}} \tag{3.11}$$

[22]Technical result= gross premiums - claims - recoveries - refunds - commissions

[23]Techincal result of reinsurance = reinsurance premiums - reinsured shares - reinsurance commissions

[24]Technical result of bond = other income (collateral return and retained premiums)+ interest expenses (coupons)+retained technical result+ fee for issuing the bond

[25]Benefit SCR reinsurance = SCR without reinsurnace - SCR with reinsurance

[26]Benefit SCR bond = SCR without bond - SCR with bond

The following tables show a summary of the results of the convenience analysis between the two instruments. For confidentiality reasons, the numbers in the tables do not match the values of the actual analysis conducted for the issuing company. They are illustrative values, but they lead to very similar results to those obtained from the real analysis.

t	1	2	3	4	5	6	7	8	9	Total
Earned premiums	50.000	-	-	-	-	-	-	-	-	50.000
Δ premium reserve	- 45.000	10.000	5.000	5.000	5.000	4.000	7.000	7.000	2.000	-
Gross premiums	5.000	10.000	5.000	5.000	5.000	4.000	7.000	7.000	2.000	50.000
Reinsurance premiums	- 2.209	- 4.542	- 4.615	- 4.189	- 5.277	- 3.745	- 2.024	- 1.860	- 1.540	- 30.000
Total earnings	2.791	5.458	385	811	- 277	255	4.976	5.140	460	20.000
Claims, recoveries and refunds	- 3.500	- 10.000	- 6.000	- 4.000	- 1.800	- 800	- 500	- 250	- 100	- 26.950
Reinsured shares	1.472	3.967	3.873	2.517	2.545	1.464	695	463	134	17.131
Commissions	-	-	-	-	-	-	-	-	-	-
Reinsurance commissions	8.747	- 294	- 337	- 285	- 1.104	1.121	72	- 39	- 14	7.867
Total costs	9.510	- 869	- 2.079	- 956	- 637	2.040	5.243	5.314	480	18.047
Profit before tax	17.301	14.589	3.306	4.855	4.086	6.296	17.219	17.455	2.941	88.048
Direct tec. result	1.500	-	- 1.000	1.000	3.200	3.200	6.500	6.750	1.900	23.050
Reinsurance tec. result	8.010	- 869	- 1.079	- 1.956	- 3.837	- 1.160	- 1.257	- 1.436	- 1.420	- 5.003
Total tec. result	9.510	- 869	- 2.079	- 956	- 637	2.040	5.243	5.314	480	18.047

Table 3.7

Table 3.7 shows the cumulative value of the reinsurance technical result over a 9-year horizon. This value is given by the sum of reinsurance premiums ceded, reinsured shares, and reinsurance commissions. The direct technical balance is given, instead, by the sum of gross premiums earned, claims, recoveries, refunds, and commissions. The total technical result of the company is the sum of the two.

t	1	2	3	4	5	6	7	8	9	Total
Earned premiums	50.000	-	-	-	-	-	-	-	-	50.000
Delta premium reserve	- 45.000	10.000	5.000	5.000	5.000	4.000	7.000	7.000	2.000	-
Gross premiums	5.000	10.000	5.000	5.000	5.000	4.000	7.000	7.000	2.000	50.000
Claims, recoveries and refunds	- 3.500	- 10.000	- 6.000	- 4.000	- 1.800	- 800	- 500	- 250	- 100	- 26.950
Other income	1.417	1.278	1.103	917	733	494	303	191	103	6.540
Interest expenses (coupons)	- 1.222	- 1.102	- 951	- 791	- 632	- 426	- 261	- 165	- 89	- 5.639
Retained technical result	-	-	-	-	-	-	-	-	-	-
Issuing fees	- 34	- 69	- 70	- 64	- 80	- 57	- 31	- 24	- 17	- 445
Direct technical result	1.500	-	- 1.000	1.000	3.200	3.200	6.500	6.750	1.900	23.050
Bond technical result	162	107	82	63	21	11	11	2	- 2	456
Total technical result	1.662	107	- 918	1.063	3.221	3.211	6.511	6.752	1.898	23.506

Table 3.8

Table 3.8 shows the cumulative value of the technical result of the bond issuance over a 9-year horizon. This value is equal to the sum of other income (collateral return and retained premiums), interest expenses (coupons), retained technical result, and issuing fees. The two values obtained constitute the numerator for the calculation of RORAC/COAC.

The denominator corresponds to the benefit on the SCR concerning reinsurance and the bond. The following table shows illustrative values of the company's SCR situation using reinsurance and the bond.

	Without reinsurance	With reinsurance	With bond
Own funds	88.000	86.000	87.000
SCR	85.000	40.000	45.000
Solvency ratio	104%	215,00%	193,33%
SCR benefit	-	45.000	40.000

Table 3.9

The solvency ratio is equal to the ratio between own funds (OF) and solvency capital requirement (SCR). The value of the benefit on SCR is the difference between the company's SCR without reinsurance and the one with reinsurance and the bond.

	WIth reinsurance	With bond
Direct result	23.050	23.050
Reinsurance/bond result	-5.003	456
Direct result net of einsurance/bond	18.047,48	23.506
Annualized reinsurance/bond result	- 1.429	130
OF	86.000	87.000
SCR	40.000	45.000
Solvency ratio	215,00%	193,33%
SCR benefit	45.000	40.000
RORAC / (COAC)	-3,18%	0,33%
IRR bond holder	na	8,29%

Table 3.10

The last table summarizes the calculation of RORAC/COAC. From the table, it is evident that the use of reinsurance results in a COAC of 3,18%. On the other hand, the issuance of the bond would lead to an RORAC of 0,33% for the company. This is due to a better technical result despite a higher benefit in terms of SCR.

The SCR benefit value (denominator) is an annualized value. Therefore, the reinsurance/bond result value must also be annualized. For this reason, the reinsurance/bond result has been divided by the duration of the expected premiums issued over a 9-year horizon. The duration value equals 3.5.

Thus, the value of RORAC/COAC will be:

$$RORAC/COAC = \frac{Annualized\ R/B\ result}{SCR\ benefit} \tag{3.12}$$

In summary, there would be an economic advantage because the net technical result of the bond is greater than the net technical result of reinsurance. There would be a greater absorption of capital, resulting in a worsening of the Solvency Ratio by 22 percentage points. Overall, the operation proves advantageous with an RORAC of 0,33% compared to a reinsurance COAC of 3,18%.

The last row shows the internal rate of return for the bondholder. Obviously, reinsurance generates no interest, while the bond will yield an interest for the bondholder equal to the value of the coupon.

Conclusions

The present thesis has explored deeply the evolution and application of alternative risk transfer (ART) techniques, with a particular focus on the issuance of reinsurance bonds as an innovative tool for risk management in non-life insurance companies. Through detailed analysis of the insurance context, the distinction between traditional and financial reinsurance, and the introduction of ART solutions, it was possible to outline a complex framework, in which market dynamics, coverage needs, and evolving regulations play a crucial role.

The case study presented allowed for a direct comparison of the effectiveness of issuing reinsurance bonds against traditional reinsurance strategies, highlighting how financial innovation can offer significant advantages in terms of capital management and cost optimization. In particular, the analysis illuminated how the use of reinsurance bonds can result in an improvement in the return on risk adjusted capital (RORAC) and a more efficient management of the solvency capital requirement (SCR), despite the challenges associated with capital absorption and operational complexities.

The approach adopted has facilitated reflection on the importance of integrating insurance coverage strategies with advanced financial solutions, taking into account the specificities of the insured risk and prevailing regulations. Thus, the thesis has contributed to enriching the academic and professional debate on the potential of ART, emphasizing the need for continuous evolution of risk management practices in the insurance sector.

In conclusion, this work has confirmed that the issuance of reinsurance bonds represents a promising technique for alternative risk transfer, capable of offering non-life insurance companies new opportunities for risk diversification and financial optimization. However, it is essential that such a tool is implemented with a deep understanding of risk dynamics, an accurate assessment of benefits and costs, and constant attention to regulatory and market evolution.

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