Ca' Foscari University of Venice

Master's Degree in Management

Final Thesis

The effect of climate change on the insurance industry: how planning and control functions affect the natural claims monitoring process

Supervisor
Ch. Prof. Daria Arkhipova

Supervisor
Ch. Prof. Antonio Constantini

Graduand
Marco Borsato
Matriculation Number 856522

Academic Year
2021 / 2022

Ca' Foscari University of Venice

Master's Degree in Management

Final Thesis

The effect of climate change on the insurance industry: how planning and control functions affect the natural claims monitoring process

Supervisor
Ch. Prof. Daria Arkhipova

Supervisor
Ch. Prof. Antonio Constantini

Graduand
Marco Borsato
Matriculation Number 856522

Academic Year
2021 / 2022

Ever tried.

Ever failed.

No matter.

Try Again.

Fail again.

Fail better.

Ringraziamenti

I ringraziamenti più importanti vanno alla mia famiglia. Mamma e papà la mia più grande sicurezza. Ringrazio mio fratello Gianni che nel momento del bisogno ha sempre saputo esserci. Ringrazio mio zio Enrico, per i consigli e come sa trasmettere le sue conoscenze. Ringrazio i miei nonni, mia nonna Edda per avermi insegnato che un silenzio vale più di mille parole e Alderico e Elvia per esserci sempre.

Grazie a Michela, per come è entrata nella mia vita e ancora di più per come mi è stata accanto. Per le parole di conforto e motivazione che ha saputo darmi. Per la pazienza (tanta) che ha dovuto usare con me. Per i consigli, i diversi punti di vista e la complicità.

Ringrazio i miei amici. È proprio vero che sono le persone che danno sapore alla nostra vita. Impossibile nominarli tutti. Voglio dedicare un grande ringraziamento ad Andrea che per me è diventato come un fratello, potermi confrontare con lui ha rappresentato sempre un valore inestimabile.

Un sentito ringraziamento alla mia relatrice Professoressa Arkhipova per l'aiuto e il supporto che ha saputo fornirmi in questi mesi. Per me è stato un piacere poter scrivere la mia tesi con i suoi consigli. Inoltre, ringrazio l'intero ateneo di Ca' Foscari, per le occasioni che mi ha dato. L'Università deve essere un trampolino di lancio. Spero nella mia vita di dimostrare di aver preso bene la rincorsa.

Per ultimo voglio ringraziare me stesso. Per non averci creduto all'inizio ma per non averne dubitato mai durante.

Treviso, settembre 2022

Marco Borsato

Acknowledgements

The most important thanks go to my family. Mom and dad my greatest security. I thank my brother Gianni who always knew how to be there in times of need. I thank my uncle Enrico for the advice and how he knows how to pass on his knowledge of him. I thank my grandparents, my grandmother Edda for always teaching me that silence is worth a thousand words and Alderico and Elvia for being there.

Thanks to Michela, for how she entered my life and even more for how she stood by me. For the words of help and the motivation she gave me. For the patience (a lot) that she had to use with me. For advice, different points of view and complicity.

I thank my friends. It is really true that it is people who give our life flavour. Impossible to name them all. I want to dedicate a big thank you to Andrea who has become like a brother to me, dialogues with him are always an inestimable value.

A sincere thanks to my supervisor Professor Arkhipova for the help and support she has been able to provide me in these months. It was a pleasure to write my thesis with her advice. Furthermore, I thank the entire Ca 'Foscari University for the opportunities it has given me. The University must be a steppingstone. I hope in my life to show that I have taken a good run.

Lastly, I want to thank myself. For not having believed it in the beginning but for never having doubted it during.

Treviso, September 2022

Marco Borsato

Table of contents

Abstract

The consequences of natural events devastate most economies and industries with their pervasive effects. The insurance industry is heavily affected by this phenomenon. This research will introduce the main features of the Non-Life insurance company business. To do that, this thesis will consider industry-specific key performance indicators that summarize the technical aspects of the operating performance, for example the underwriting policy, the claims management, and the reinsurance policy. Moreover, the thesis will illustrate the role of the entire industry in order to limit the effect of climate change. For this reason, mitigation and adaptation measures will be treated.

The planning and control functions of insurance companies support management decisions. The operating profitability has a high priority in the monitoring process and its deeply influenced by the trend of claims. This last figure will be analyzed in the research. While the research and the available literature have been focused mainly on the global effect of climate change on the insurance industry, there has been less focus on translating this phenomenon into management control system terms. Therefore, the thesis will investigate what kind of influence weather-related losses have on the claims and operating profitability.

Finally, together with the findings and conclusions, the research will focus on the future challenges that the planning and control function will face due to climate change.

Introduction

The consequences of natural events devastate most economies and industries with their pervasive effects and this phenomenon will increase in the following years. In this landscape, the insurance sector due to its risk coverage function and its mission to assist its customers is at the forefront of the economic impacts caused by natural disasters, especially major ones.

To deal with this problem, insurance companies are adopting measures to limit the effects on their economic and financial performance. Insurers are developing predictive models thanks to artificial intelligence and big data contributions in order to adapt their business, and moreover the business of their customers, and mitigate climate change effects.

The business control functions are committed to including this relatively recent variable in the control and forecasting models in order to make their strategy more effective.

This research will investigate the effective development of these strategies considering the economic impact on the core business of the insurers. To do so, the annual reports of the main European companies will be analyzed and compared to firstly understand the relationships between claims caused by natural disasters and the operating profitability of the insurance companies. Therefore, the companies of the sample will be divided into two different groups depending on the disclosure of the Natural Catastrophes claims. Although all companies are subject to this particular type of claim, only a few have decided to disclose this information.

CHAPTER 1

Introduction to insurance and climate change

SECTION 1.1: History and functioning of the insurance business

The early methods of insurance date back to the 3^{rd} millennia BC in the Babylonian, Chinese and Indian civilizations according to the studies of Trenerry (1926). Initially, the insurance consisted of a mechanism to share and distribute losses due to vessels capsizing. Furthermore, the Codex Hammurabi Law (c. 1755–1750 BC) remarked this mechanism but with different rules.

Italy had a primary role in the formation of the modern concept of insurance. After the roman empire collapsed, Genova and Venice acquired financial and commercial predominance in Europe. During the 11^{th} century, when the basis for the modern economy was created, municipalities in the north of Italy had a fundamental position thanks to their weak influence from the main Empires. The governments of these cities met the need to establish regulatory structures to ensure commercial exchanges. In fact, the first marine republic is the birthplace of the first signed insurance contract dated back to July 12^{nd} 1370 according to Swiss Re studies. But standardization of modern insurance had its first appearance due to the Great Fire of London in 1666 after the fire devoured 13,000 houses. Thanks to the work of the economist Nicholas Barbon, in 1681 the first fire insurance company, the "Insurance Office for Houses", was established. Initially, 5,000 houses were insured. Therefore, it is possible to affirm the first modern insurance was property insurance. To understand the economic relevance and translate the disaster in nowadays prices of an extensive man-made claim as the Great Fire of London, it is possible to compare it to the disaster of September 11th, 2001. Although it is clear the two dynamics differ in their causes - the former was an incident caused in a bakery in London the latter a terrorist attack - both catastrophes were man-made and both hit the property and casualty coverages of the insurance. According to the Insurance Information Institute report, the impact of the New York disaster was 32.5B$ including 11B$ for the business interruption. Always in 17th century, Italy had a minor role due to internal local contrast among different municipalities, the small dimensions that a few centuries before enhanced the commerce development at this time represented a limit to economic growth.

The following modern insurance policy created was insurance for business ventures. In the seventeenth century, the main center of growth for the insurance market was London because of its level of international commerce which pushed the demand for marine insurance. The first structured market for insurance was born in a coffee house opened by Edward Lloyd, it was founded as a place where those who had cargo or ships could meet other people interested in sharing the risk for a price. Thus, it was born the Lloyd's of London, the first marine insurance organized market. Following the first property and casualty insurance policies, life insurance was adopted for the first time in 1706 by the Amicable Society for a Perpetual Assurance Office. In the following century, society developed rudimental forms of the welfare state. In this field, insurance has played a primary role in the well-being of society, in this period there has been an acceleration in the insurance products development. In fact, in the 19th century, the first accident insurance was launched against the rising number of victims on the railway system. Moreover, in Germany, Chancellor Otto von Bismarck established insurance against sickness and old age. Consequently, developed a real pension program that together with the medical care system formed the welfare state of Prussia and Saxony. Meanwhile in Britain, the government founded the first contributory system against illness and unemployment.

Like all the other industries, also insurance sector has its distinctive features. A distinguishing and unique characteristic is the “raw material” used by the insurance industry to do their business. In the insurance industry, the primary element is the *risk* the insurers are willing to accept from their customers (policyholders) to carry on their business. Insurance can be identified in a form of protection from financial loss. This solution represents a risk management measure structured as an insurance contract (insurance policy). Modern insurance began when individuals became able to define risks and consequently created a method to price them the insurable risk. Not all risks can be defined as “insurable”. Generally, the risk involves interests where the insured has an interest established by ownership, possession, or pre-existing relationship. Schmit (1986) summed up the prerequisites of an insurable risk. These are requisites for ideal risks. In reality, the complexity of risks and their holistic implications generally do not permit the match of all these requirements together. In order to identify which of them are necessary to underwrite a risk, Schimt identified seven requirements. These elements include technicalities such as the number of exposure units. Exposure units refer to the potential for accident or loss due to the risk covered by the insurance company for an individual. In other words, the number of exposure units indicates how likely is the insurer to pay, given the number and the quality of the risk underwritten. The following categories synthesize which are the requisites of the Schmit list and their related criticisms:

A. A large number of homogeneous exposure units. Certain phenomena in real life do not respect this requisite of numerosity, the insurance of a space program for example. On the other hand, it is possible to resort to judgment rates based on similar particular cases. This is true for small samples but also with larger phenomena, think about the technological progress and the insurance of self-driving cars. Furthermore, the Bayesian techniques to assess the pricing are effective for both large and small samples. Therefore, a situation with no large number of observations does not preclude the insurability of the risk.

B. Independence among exposure units. Although big data analysis and artificial intelligence could lead to substantial improvement in this area, in reality, is difficult to identify insured clients exposed to dependent risks. The independence among exposures permits the sale of coverages at lower costs because in case of the occurrence of one claim the others will not be related or caused as a consequence one each other. In other words, is the independence of different claims that permits the approximation of the expected loss more precisely.

C. The calculable expected loss in monetary values. This point is closely related to the previous one. In fact, if the insurer cannot assess the independency of different exposures, the expected loss could not be calculable because these are not identified ex-ante due to the relationships among different insured risks. The determinant difference with respect to the previous point lies precisely in the possibility of calculating the expected loss. Although the previous assumption stated the difficulty to identify dependent risks, this did not preclude the possibility to assess the expected loss. Instead, the current assumption is more restrictive and closer to reality leaving the loss indefinite.

D. Definite loss as to time, place, amount, and cause. Following the problem of calculability of a risk on the one side, we find the dependent risks that could obstacle the assessment of their insurability. On the other hand, the insurability of some risks could be in doubt if the value of the loss is nebulous, not due to the relationships among different risks but due to the definition itself of the risk. Therefore, the insurable risk must be well identified in all its aspects: time, place, amount, and cause. In other words, this requirement of insurable risk states that the probability of the expected loss can be problematic to assess, meanwhile the measurement of loss is still possible.

E. Fortuitous loss is necessary to make a risk insurable, otherwise, it would be a certain event. It means that the insurer decides to cover its customers only from accidental events. The requirement objective is to contrast the moral hazard. Moral hazard has a wide literature that describes this fact, Grubel (1971) defined it as the propension to produce a loss by the insured individual. In other words, it can be seen as a fraud until the insurer has limited control over the losses. Moral hazard studies have evolved in the last years thanks to the behavioural finance implications. Meanwhile, it has not been investigated as much on the insurability side.

F. Economic feasibility is an important requirement. Its absence poses substantial problems on the insurability of risks.

G. Avoidance of catastrophe potential. Insurance companies generally look for large numbers of homogeneous risk units in order to pool the potential loss. Although insurers try to minimize the large catastrophes risks, defined as exposures with low occurrence but high severity, they are able to cover also heterogeneous exposures assuming these have an approximated estimation of the loss distribution. Therefore, is not necessary to calculate the distribution of each exposure, while is fundamental to assess the distribution of the portfolio.

Therefore, Schmit stated that the only mandatory requirement mentioned above is the predictability of the distribution of the insurer's loss portfolio. Furthermore, the large number of units is not necessary but remains a desirable characteristic. Also, independence is not mandatory if either the company adopts reinsurance measures or unless the dependence is unmeasurable. Loss definition is not mandatory until the distribution of the loss portfolio is sufficiently defined to allow predictability. Also, the economic feasibility and the avoidance of catastrophe potential do not represent a strict requirement unless the loss distribution is not predictable. It is relevant to consider the behavioural phenomenon of the moral hazard that could influence the unpredictability losses requirement, then this requirement of ideal risk is not mandatory if the moral hazard is adequately calculated, and the insurance company puts in place incentives to minimize this behaviour.

The contribution by Schmit explained the main component of the insurance contract, the risk. The scholar did not make a clear in-depth analysis of the heterogeneity of risks covered by the insurance companies. Due to these diversities, the insurance industry is divided into the Life segment and the Non-Life segment, these two terms will be analyzed in section 1.3 where there will be also an analysis of the management control systems used for these two different branches. After the risk, the other components of the insurance policy are:

- The premium is the price the policyholder pays for the risk coverage by the insurance company.
- The deductible is the threshold below which the insurance company is not required to pay for a claim.
- The policy limits represent the cap above which the policy does not cover the risk.
- The exclusions, namely types of risks that are not included in those covered or conditions under which the policy does not cover a risk.
- The parties, generally the parties are two. The first is the insurance company, the firm whose core business consists of issuing insurance or annuity contracts, or the reinsuring of risks underwritten by other insurance companies. The second is the

policyholder, namely the customer of the insurance company who pays the premium. In the Life insurance branch generally is possible to find other 2 actors in the insurance contract. The first is the insured party which could differ from the policyholder, while the second is the beneficiary who receives the payment if an event involving the human life of the former actor occurs.

The insurable risk plays a central role in the operating principles of the insurers. While the majority of industries present the typical production cycle where costs are held before collecting revenues for the sales of finished products, the insurance companies instead present an inverted production cycle. Namely, insurance companies first receive the premiums for the insured risk, and subsequently, the insurer could face the cost of the claim that remains uncertain. To understand the functioning of this particular procedure it has to consider the production cycle as all the activities related to the conversion of raw material into finished goods. The “raw material” for an insurer is the insured risk. For this reason, it can be stated that the production cycle begins when the insurer starts to cover the insured risk. While production cycle ends when the contract finishes its coverage period. The limits to a first inaccurate interpretation of the production cycle of the insurer could be to switch the beginning of the cycle with the payment of the policy and the end with the claim payment. The former is wrong due to the fact the payment of the premium could be postponed after the coverage period begins, while the latter shows its limits in the randomness of the claim incurrence.

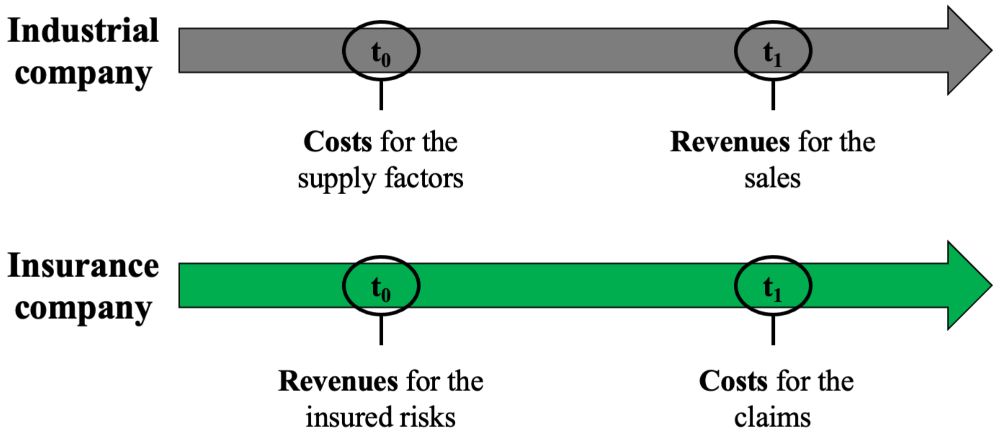


Figure 1. Representation of the inverted production cycle of the insurance companies (source: personal elaboration)

SECTION 1.2: Insurance industry overview and market outlooks

In 2021, the OECD published sales figures for the insurance sector. Gross Premiums stood at 7,6 T$, a figure that represents the 9% of the Global GDP estimated by the World Bank for the same period at 84,9 T$. Considering the top line of the insurance industry, the sector states among the 5 biggest industries. In 2021, sales volumes surpass the revenue level of other primary importance industries such as food and beverage, oil and gas, automotive and information technology. Always in 2021, the Swiss Re Institute declared a rise in demand for insurance worldwide, expecting a rebound in revenues after the pandemic in 2021 (+3,3%) and 2022 (+3,9%). Breaking down the industry growth, Life insurance was expected to reach +3,8% in 2021 and +4,0% in 2022 while the developments in the Non-Life business were forecasted to bring lower growth rates for the same periods, respectively 2,8% and 3,7%. Also, profitability was expected to rise contextually. In fact, Fitch Ratings in 2021 expected a raise in profits linked to the non-recurring expenses due to Covid-19 that amounted to 6.1B$ spent during 2020. Looking at the bottom line, while the international context shows several threats and challenges at the macroeconomic level the growth and the increasing demand for insurance is likely to enhance the profitability of the companies. In this challenging context, the leading companies by revenue level and divided by area are the following.

	GLOBAL (data in B€)			
	Company	**YE21**	**Country**	**Segments**
1	UnitedHealth Group	287,6	United States	Life and Health
2	Ping An Insurance Group	199,7	China	Life and Non-Life
3	Allianz	175,6	Germany	Life and Non-Life
4	Cigna	174,1	United States	Life and Health
5	AXA Group	118,1	France	Life and Non-Life
6	China Life Insurance	95,9	China	Life and Health
7	Generali Group	89,6	Italy	Life and Non-Life
8	Dai-ichi Life Insurance	79,7	Japan	Life
9	MetLife	71,1	United States	Life and Non-Life
10	Munich Re	70,5	Germany	Life and Non-Life
11	Zurich Insurance Group	69,9	Switzerland	Life and Non-Life
12	Allstate	50,6	United States	Life and Non-Life
13	American International Group	49,3	United States	Life and Non-Life
14	AIA Group	47,5	Hong Kong	Life and Health
15	Chubb	41,0	Switzerland	Non-Life
16	Travelers	32,0	United States	Non-Life
17	China Pacific Insurance	31,5	China	Life and Non-Life
18	Manulife	31,2	Canada	Life and Health
19	ING Group	25,0	Netherlands	Life and Non-Life
20	Tokio Marine Holdings	22,9	Japan	Life and Non-Life

Table 1. Global ranking of insurance companies by revenues (source: www.atlas-mag.net; figures elaborated using the annual reports in the websites of the companies)

	EUROPE (data in B€)			
	Company	**YE21**	**Country**	**Segments**
1	Allianz	148,5	Germany	Life and Non-Life
2	AXA Group	99,9	France	Life and Non-Life
3	Generali Group	75,8	Italy	Life and Non-Life
4	Munich Re	50,4	Germany	Life and Non-Life
5	Talanx	45,5	Germany	Life and Non-Life
6	Credit Agricole Assurance	36,5	France	Life and Non-Life
7	BNP Paribas Cardif	32,6	France	Life
8	CNP	31,8	France	Life and Non-Life
9	Mapfre	22,2	Spain	Life and Non-Life
10	R+V	19,2	Germany	Life and Non-Life
11	Covéa	19,1	France	Life and Health
12	Aviva	18,5	United Kingdom	Life and Non-Life
13	Ergo	18,2	Germany	Life and Health
14	Poste Vita	17,9	Italy	Life and Health
15	Sogecap	15,7	France	Life and Health

Table 2. European ranking of insurance companies by revenues (source: Mapfre publication of "2021 Ranking of the largest European insurance group"; figures elaborated using the annual reports on the websites of the companies)

	ITALY (data in B€)			
	Company	YE21	∆% YoY	Segments
1	Generali	29,8	-1,7%	Life and Non-Life
2	Intesa SanPaolo Vita	20,1	-8,7%	Life and Non-Life
3	Allianz	18,0	6,0%	Life and Non-Life
4	Poste Vita	17,9	5,9%	Life and Non-Life
5	Unipol	13,2	9,2%	Life and Non-Life
6	AXA	6,8	-3,5%	Life and Non-Life
7	Mediolanum	6,4	67,6%	Life and Non-Life
8	BNP Paribas Cardif	4,6	22,0%	Life and Non-Life
9	Credit Agricole Assurance	4,3	28,5%	Life and Non-Life
10	Reale Group	4,2	2,2%	Life and Non-Life
11	CNP Vita Assicura	3,9	78,8%	Life
12	CNP Unicredit Vita	3,2	-2,2%	Life
13	Gruppo Zurich Italia	2,5	-6,0%	Life and Non-Life
14	CNP Vita Assicurazione	2,1	127,8%	Life
15	HDI Assicurazioni	2,1	6,7%	Life and Non-Life
16	Eurovita	1,7	-6,6%	Life
17	Vittoria Assicurazioni	1,6	10,2%	Life and Non-Life
18	Credemvita	1,3	34,4%	Life and Non-Life
19	Zurich Insurance	1,3	5,3%	Life and Non-Life
20	Groupama	1,2	-2,9%	Life and Non-Life

Table 3. Italian ranking of insurance companies by revenues, for the international groups are considered only the Italian revenues (source: ANIA)

Comparing the tables with the different rankings depending on the geographical area the main highlights are:

- The countries represented by the leading companies at the global level are the richest countries. In fact, 6 countries out of the 7 components of the G7 Summit are on the list. Although the United Kingdom is not present in the Global ranking, Aviva is among the main insurers.
- The presence at both local and global levels of the same leading companies could suggest that the geographical expansions of these companies are led by economies of scale. This phenomenon has been studied by Fecher et al. (1993) and Doherty (1981). While the first article states that the top line is not a sufficient driver to understand the impacts of the economies of scale, indeed there is a pool of characteristics to consider; the latter research explains that the economies of scale

were not completely realized due to a non-optimal dimension of the companies considered in the sample. It is important also to remark that the insurance market is considered to have a high level of fragmentation according to a McKinsey report. In addition, the report stated that the dichotomy between leaders and the other players of the market created by the Covid-19 pandemic has reinforced the economic success of the formers at the expense of the latter. This feature is likely to create a favourable landscape for mergers and acquisitions operations. Bain&Co study published in 2022 shows a peak in the value of extraordinary finance operations attesting 2021 at 5,9 T$ reaching the peak since 2000.

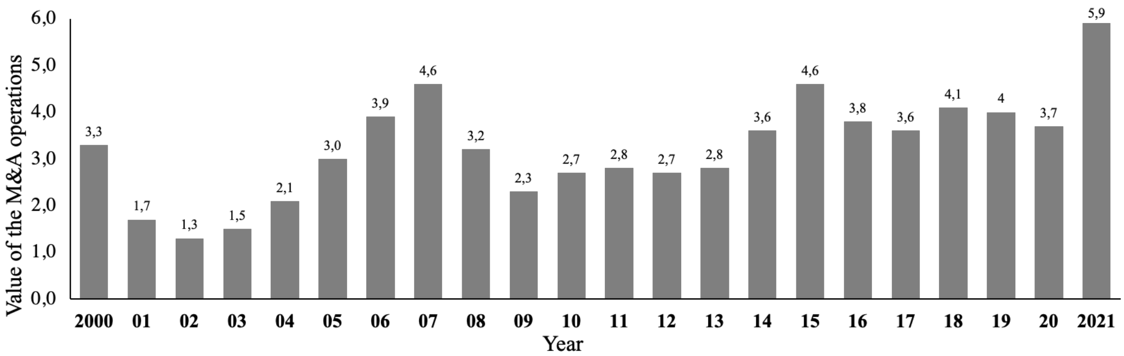


Figure 2. Value in trillions of dollars of the global M&A operations in the last 21 years (source: Bain&Co)

- A large majority of the companies presented in the rankings operate in both Life and Non-Life businesses. As will be presented in the following section, the main categorization of the insurance industry consists of the Life and Non-Life segments of the business due to their specific peculiarities. The reason can be probably found in operational economies of scale and strategic advantages with regard to bundling opportunities in sales operations. Indeed, an important key performance indicator monitored by the distribution functions of the insurance companies is the percentage of customers holding a number of policies with the same insurer.

Moreover, the distribution channels are better suited to the sale of Life insurance policies.

	EUROPE (data in B€)				
	Company	**YE21**	**Country**	**Life %**	**Non-Life %**
1	Allianz	148,5	Germany	58,1%	41,9%
2	AXA Group	99,9	France	35,4%	64,6%
3	Generali Group	75,8	Italy	68,2%	31,8%
4	Munich Re	50,4	Germany	17,3%	82,7%
5	Talanx	45,5	Germany	32,3%	67,7%
6	Credit Agricole Assurance	36,5	France	86,0%	14,0%
7	BNP Paribas Cardif	32,6	France	100,0%	0,0%
8	CNP	31,8	France	97,8%	2,2%
9	Mapfre	22,2	Spain	22,1%	77,9%
10	R+V	19,2	Germany	21,2%	78,8%
11	Covéa	19,1	France	17,0%	83,0%
12	Aviva	18,5	United Kingdom	42,1%	57,9%
13	Ergo	18,2	Germany	54,4%	45,6%
14	Poste Vita	17,9	Italy	98,2%	1,8%
15	Sogecap	15,7	France	7,5%	92,5%

Table 4. European ranking of insurance companies shares of Life and Non-Life revenues (source: Mapfre publication of "2021 Ranking of the largest European insurance group"; figures elaborated using the annual reports on the websites of the companies)

	ITALY (data in B€)				
	Company	**YE21**	**Δ% YoY**	**Life %**	**Non-Life %**
1	Generali	29,8	-1,7%	72,8%	27,2%
2	Intesa SanPaolo Vita	20,1	-8,7%	93,0%	7,0%
3	Allianz	18,0	6,0%	73,0%	27,0%
4	Poste Vita	17,9	5,9%	98,2%	1,8%
5	Unipol	13,2	9,2%	40,6%	59,4%
6	AXA	6,8	-3,5%	70,8%	29,2%
7	Mediolanum	6,4	67,6%	98,2%	1,8%
8	BNP Paribas Cardif	4,6	22,0%	99,8%	0,2%
9	Credit Agricole Assurance	4,3	28,5%	97,6%	2,4%
10	Reale Group	4,2	2,2%	42,5%	57,5%
11	CNP Vita Assicura	3,9	78,8%	100,0%	0,0%
12	CNP Unicredit Vita	3,2	-2,2%	100,0%	0,0%
13	Gruppo Zurich Italia	2,5	-6,0%	94,1%	5,9%
14	CNP Vita Assicurazione	2,1	127,8%	100,0%	0,0%
15	HDI Assicurazioni	2,1	6,7%	65,9%	34,1%
16	Eurovita	1,7	-6,6%	100,0%	0,0%
17	Vittoria Assicurazioni	1,6	10,2%	20,6%	79,4%
18	Credemvita	1,3	34,4%	100,0%	0,0%
19	Zurich Insurance	1,3	5,3%	1,9%	98,1%
20	Groupama	1,2	-2,9%	24,1%	75,9%

Table 5. Italian ranking of insurance companies shares of Life and Non-Life revenues, only revenues from the Italian perimeters of the international groups are considered (source: ANIA)

The high percentage of Life insurance sales are generally combined with the presence of banks – retail banks in particular – in the same group of insurer. Otherwise, it is common that the insurer has signed partnership deals with other external banks.

Rather, by comparing the tables of European and Italian rankings it is possible to appreciate how the distribution between Life and Non-Life premiums changes. In Italy, the average Life share in revenues of the first 15 insurance companies is 83%, while in Europe is 51%. This higher incidence in the Italian companies revenues could be caused by the level of financial education of the Italian people. Since 2019 OECD has been investigating the financial literacy of individuals, in this special ranking Italians were below of the OECD average value. The other European countries were all above the Italian level except for France which was only partially involved in the research.

An important watershed in the insurance industry is represented by the Covid-19 advent. Insurers have demonstrated their ability to make large-scale changes faster than expected. This adaptability is not caused just by their capacity to rethink their way to distribute and commerce their products but more importantly due to the different needs and necessities arising from the pandemic. Nowadays the insurance sector is a rapidly changing industry where the players have to adapt to many different challenges in order to evolve and maintain their competitive advantage. In the last few years, the insurance industry has shown a clear trend in both Life and Non-Life branches.

In the 2021 report drawn up by one of the most important consulting and audit firms EY, the first emerging trend characterizing the insurance industry is the presence of ecosystems and open insurance. Since 2020 open finance emerged thanks to technology and collaboration among finance incumbents with tech industry start-ups in response to a change in customers preferences. Similarly, the insurance industry shows a sudden increase in demand with new needs for transparent, adaptable, and affordable products. Therefore, the competition has moved toward offering holistic and personalized solutions, reaching a wider target of customers, increasing their engagement level, and using data more effectively. The action plan to make ecosystems as effective as possible should include a top-down commitment starting from the top management. The first variable to identify is the target customer to serve and consequently the use cases and the products. Finally, another lever to success in the ecosystems will be data management skills. The presence of numerous bank branches throughout the territory and the similarities between insurance and investment products that the customers of the bank look for enable an efficient meeting between offer and supply. In Italy, the fourth insurer Poste Vita presents a percentage of 98% sales in the Life branch, it is not a surprising fact considering the almost 12,8 thousand post offices located in the country.

Secondly, insurers face an important human resources challenge. Workforce transformation before the pandemic was addressed on employee reskilling, and dynamic and agile work instilling. Covid-19 with the "Great Resignation" phenomenon has exacerbated this trend. Very linked to the last factor there is the globalization of the labour market due to the growing adoption of remote and smart working solutions. In the McKinsey report, this topic is flanked by the enhancement of diversity and inclusion policies.

Competition is aggravated by the forces of the market that limit the companies operations. The first of these factors is the cost and capital allocation due to the low-interest rates, thin margins, weak premium growth, and the need to make big investments. The estimation by Deloitte agrees with the McKinsey report, arguing that this will be the most important obstacle for the players in the insurance industry. The direct consequence of the eroded profit margins of the insurance companies leads the competition dynamics to a sort of "fight for the customer" according to McKinsey. The competition is worsened by the bargain of insurers with the owners of distribution channels, such as brokers. The situation is critical considering the study published by the consulting firm, where 54% of listed insurers, representing 52% of the global industry's equity, had an ROE below their cost of equity over the past five years. Secondly, companies have undertaken organizational changes rapidly during the pandemic to serve the new needs of customers.

The last main issue of the competitive landscape in the insurance market consists of the high level of fragmentation and the new non-traditional entrants. This problem can be overcome by inserting collaborations with the same players with which until now they have always competed in the strategy and business models of the companies. In fact, fragmentation can be an opportunity to consolidate the strategic positioning of insurers at a local level leveraging economy of scale.

An additional point of attention raised by Deloitte is cyber risk. In 2021 the cyber-attacks showed a 25,5% year increase. Also, the pandemic has influenced (but not changed) the trend of internet fraud due to the increased use of digital channels and more home-based workers during the lockdowns. The current scenario sees the war in Ukraine as a catalyst for new ransomware attacks.

Given the current situation characterized by a multitude of forces influencing the competition and the internal operations of the actors of the sector, in line with the already mentioned studies by the consulting firms, the future developments of the insurance industry are summed up as follows.

The Covid-19 pandemic and the consequent change in customers needs have created completely new trends. In particular, two are likely to shape and influence the path of the players in the next years. The first is the rethinking of mobility after two years of sharp fall for transport industries such as aviation and other forms of travel. The second is the focus on health and well-being because the pandemic has raised the level of need for assistance and health attention of customers.

Apart from the new trends, the tendencies existing before the pandemic are still a priority. Deloitte studies show a deep value chain reshaping due to artificial intelligence (AI) and advanced analytics used to perform tasks historically difficult. Moreover, the use of chatbots and AI should bolster the interactions with stakeholders with particular regard to customers and their experience personalization. Furthermore, the extensive use of artificial intelligence is an important step in the saving actions that industry players should undertake in order to restate the historical profitability of the insurance sector by acting on both the loss and the expense indicators. In fact, AI can identify misrepresentation or fraud while improving speed and accuracy. This issue is caused also by limited productivity, according to a McKinsey report explaining that although several saving programs have been undertaken by the main players of the industry the aggregate results are unsuccessful. On the other hand, the first main negative consequence is brought by the regulatory barriers and customer groups opposition. Another issue could be represented by the emerging threat to the company reputation.

According to McKinsey reports, the pandemic has reinforced the dichotomy between the world largest insurers and the rest, with the top 10% capturing the 80% of the industry economic profit.

All the trends and forces described will have a certain relevance in the future of insurance. On the other hand, the most impactful priority in the industry is probably climate change. Covid-19 has restored the business priorities of the insurers, putting ahead sustainability and climate change. Leading players in the industry were already working on metrics measuring the full impact of environmental, social and governance (ESG) issues and opportunities. It is likely that among these three listed areas the most impacting for insurers will be environmental sustainability. Perhaps, this is due to the immediate impact that climate change is having on the performance of the companies. In fact, climate-related losses continue to grow. Although only less than half of climate-related losses are insured, the Swiss Re Institute estimated global insured natural disaster property losses of 40 B$ through June 2021. According to these factors, insurers are elaborating on new solutions by collaborating with other companies and the government because the climate risk can not be addressed by the industry itself. A good example of how the industry can collaborate with the government and individuals to share risks caused by climate change is described in the article by Keskitalo et al. (2013). In their paper, the scholars stated that the UK, Germany, and the Netherlands have already adopted different systems to integrate adaptation programs.

Moreover, beyond the massive impact of climate change on the insurance industry, there are other reasons for insurers to increase their efforts on climate change. The first is given by the regulatory pressures on the requirement of increasing detailed disclosure. Consequently, the political agenda is likely to enhance this change. The second reason is always to be traced back to economic performance on the bottom lines of the insurers. Indeed, underwriting policies should consider the uncertainty and indirect implications of climate change. A worse economic performance by the insurers can be seen as an increased risk by the institutional investors. Therefore, climate risk could result in restricted access to capital for those players not adapting their business models. The last reason insurers should pay more attention to climate change is the role they play as institutional investors. Insurance companies should change their investment strategies to accelerate the green transition of the economy and other industries. According to an estimate by the consulting and auditing firm EY, this change in investment strategies could cover up to 30 T€. While as risk underwriters they can increase the relevance of risk transfer in order to address risk mitigation. As reported by McKinsey, the five actions that allow this change are: stress-test total exposure against projected climate hazards; build resilience and rebalance portfolios; help organizations mitigate climate risk; create innovative products to address climate-related risk; revise investment strategies.

Climate change is also impacting the organizational level of companies. Many insurers are appointing a new professional at the C-suite executive level. The chief sustainability officer is the key figure whose objective is to quantify and illustrate the ESG elements in financial disclosure. An interesting contribution about this new professional comes from the article by Whelan et al. (2021), although sustainability is becoming an increasingly relevant issue for insurers, many CFOs still consider this factor as a cost instead of a valuable asset. Scholars explain the causes of these diametrically opposed views. The first motivation is the separate reporting between sustainability and financial performance that leads to different and unbridgeable metrics and language used. Moreover, the return on sustainability investments is not sufficiently monitored and assessed due to poor communications among different functions of the company, difficulty in measuring intangible benefits and limited data available to measure sustainability together with unsuitable accounting systems.

SECTION 1.3: Planning and control function of the insurance business

The management control function aims to support management decisions and address organizational behaviours. Information is essential for its implementation, both qualitative and quantitative information is used by the business control. As stated by Simons (2014) the amount and quality of the information is a good proxy to understand organizational health. The system has to provide insights for the head of the organization to address the strategic direction of the company and tackle the issues that obstacle the effective achievement of the strategy milestones. This is not a compulsory function requested by regulators, but the advantages provided usually encourage companies to install a management control system. In the end, insurance companies are particularly incentivized to adopt it because of the regulator pressures necessary for the pervasive impact of this business on society and high competition levels in the market. Moreover, the insurance sector attracts the interest of a lot of institutional investors, such as rating agencies and investment funds. Thus, the demand for information is continuously increasing and the management control, thanks to its view of the entire operation of the company, can play a role of primary importance in providing the information requested.

In order to understand the most efficient management control system and the different variables to be monitored is necessary to first explain the divisions in the insurance industry. As mentioned in the previous section, not all insurance products are homogenously comparable. In addition, the different needs of customers led the market developments toward the specialization of the products. Therefore, the market is divided into two main branches: Life business and Non-Life business. The former consists of a policy between the insurance company and the policy owner. In this case, there is a third party named beneficiary who will be guaranteed the payment of the sum of money in case of the death of the insured. There are many types of Life insurance products to meet the specific needs of the customers, but these can be summarized into two main types of Life insurance. The first is the protection class, it responds to the necessity of the customers to protect their heirs in case of death of the policyholder. Always among the protection products, the Long Term Care Insurance (LTCI or LTC) is a policy which protects the income of the policyholder in case of severe illness or disability. The second need covered by the Life insurance policies is the requirement of savings management, this function is similar to the proposal that banks and asset management companies offer to their customers. As a matter of fact, this second function of the Life segment is the reason why this insurance is also known as Life & Saving insurance. The Non-Life business (or General Insurance) consists of protection from financial losses that could occur in case of certain events. Also, for Non-Life insurance as well as for Life insurance there are classes that identify the different products, the main distinction is designed between Motor and Non-Motor products. While the first represents very standardized products due to the high regulation, the latter is comprehensive of a multitude of different products to respond to the several needs of customers. According to EIOPA, the main Non-Motor products are classified as follows:

- Accident insurance covers the incurrence of injury of the insured.
- Sickness insurance includes the accidental events or sickness that forces a worker to stop working.
- Property products provide coverage for economic losses regarding the policyholder properties. The main examples are home insurance, flood insurance and earthquake insurance. In other words, its function is to guarantee the replacement of the good.
- Liability insurance covers the third-party claims caused by the policyholder.

The first step of the planning and control function in order to fulfil its main tasks is to align its view of the required data with the strictly accounting data that represent the source for the elaborations and analyses. For the Non-Life segment, the accounting structure is similar to the framework adopted for the analyses. On the contrary, for the Life business the accounting support must be modified because it does not allow controlling activity. While the former has clearly stated how generated the profitability of the operations, the latter fails to bring out the margins. Indeed, the representation for the two segments is very similar, the exposed operating profit results from the difference between premiums and operating expenses, where the claims are the main figure. While Non-Life insurance emerges clearly pictured in its nature using this framework, this is not quite true for the Life segment. In reality, Life insurance is very linked to financial investments and the asset management world. This peculiarity makes the income statement representation more complicated, there is not a proper correspondence between claims and operating cost items despite the financial accounting rules.

The economic performance of the insurance company is monitored in the dedicated income statement. For example, Allianz 2021 published the following prospect:

data in M€	YE21
Gross premiums written	86.063
Ceded premiums written	-7.567
Change in unearned premiums (net)	-840
Premiums earned (net)	**77.656**
Interest and similar income	23.137
Income from financial assets and liabilities carried at fair value through income (net)	-2.008
Realized gains/losses (net)	9.423
Fee and commission income	13.998
Other income	24
Total income	**122.230**
Claims and insurance benefits incurred (gross)	-62.926
Claims and insurance benefits incurred (ceded)	5.804
Claims and insurance incurred (net)	**-57.122**
Change in reserves for insurance and investment contracts (net)	-13.716
Interest expenses	-1.159
Loan loss provisions	-11
Impairements of investments (net)	-1.331
Investments expenses	-1.962
Acquisition and administrative expenses (net)	-31.422
Fee and commission expenses	-5.000
Amortization of intangible assets	-307
Restructuring and integration expenses	-666
Other expenses	-15
Total Expenses	**-112.711**
Net income before income taxes	9.519
Income taxes	-2.415
Net income before income taxes	**7.104**

Table 6. Allianz Group final year 2021 income statement (source: www.allianz.com)

Due to the introduction of the IFRS 17 principle, according to the PwC report, the income statement is likely to switch its focus and will be more illustrative permitting a higher degree of disclosure on the insurance contracts for the external investors and analysts. In particular, the new income statement composition will allow a higher particular on the marginality formation and nature. The impacts estimated for 2023 by Deloitte could cost between 15 B$ and 20 B$ globally. Another important aspect is the implementation of the new accounting standard that will completely change the systems of insurance companies, due to this wide change in the same report Deloitte stated that in 2021 only the 37% of the insurers declared the complete preparation and adoption of IFRS 17.

data in M€	YE21
Insurance revenue	114.845
Insurance service expenses	-101.256
Net expenses from reinsurance contracts held	-5.849
Insurance service result	**7.740**
Interest revenue from financial assets not measured at FVTPL	2.696
Net gains on FVTPL investments	11.129
Net gains on investments in debt securities measured at FVOCI reclassified to profit or loss on disposal	78
Net change in investment contract liabilities	-756
Net gains from the derecognition of financial assets measured at AC	22
Net gains from fair value adjustments to investment properties	157
Net credit impairment losses	-40
Net investment income	**13.286**
Finance expenses from insurance contracts issued	-7.228
Finance income from reinsurance contracts held	1.610
Net insurance finance expenses	**-5.618**
Net insurance and investment result	**15.408**
Asset management services revenue	1.133
Other finance costs	-2.283
Other operating expenses	-3.949
Share of profit of associaciates and joint ventures accounted for using equity method	463
Profit before income tax	**10.772**
Income tax expense	3.155
Profit of the year	**7.617**

Table 7. Example of income statement after the adoption of the IFRS17 principles elaborated by PriceWaterhouseCooper (source: www.pwc.com)

The insurance industry is capital intensive and claims sensitive, its peculiarities and its impacts on society require a particular management control system to monitor the business performance adequately and respond to changes in profitability in a timely manner. The needs for information of these stakeholders are not completely aligned with the business necessities of the management. In order to comply with this need of the business lines, the planning and control function developed a different statement that allows monitoring all the key performance indicators of the business. For example, the business control function seeks to identify the different types of claims, while this specification is not requested by the general financial accounting rules.

In order to limit the different effects that influence the net income of the insurance company, this research will analyze only the technical part of the income statement from a managerial control function point of view. In other words, by analyzing the technical income statement it is possible to identify the very operative part of the business although it includes the effects of many underlying actions (i.e. underwriting, reinsurance, pricing, and claims management) the insurer is carrying on. Both Life and Non-Life businesses present different and specific KPIs that explain the performance of insurers and allow comparisons among peers or benchmarks. Although this research will consider only the Non-Life branch for its higher impact caused by the direct consequences of climate change and its related claims, in the following paragraphs will be exposed both Life and Non-Life planning and control frameworks. For the Non-Life branch, the technical income statement is the following:

data in M€	YE21
Gross Written Premiums	62.272
Reserve IN*	5.000
Reserve OUT*	-14.218
Gross Earned Premiums	53.054
Claims	-35.565
Attritional*	-31.636
Large Claims (man-made)*	-2.292
Natural Catastrophes	-1.637
Expenses	-14.186
Commissions and incentives	-2.011
Administrative Expenses	-12.175
Technical Result	3.303

Table 8. Re-elaborated income statement with focus on the technical part of the Non-Life insurance business (personal elaboration, items with "*" are personal hypotheses)

The technical income statement shows at the top line the Gross Written Premiums and ends with the Technical Result. Gross Written Premiums are the premiums received by the insurer from the customer (or policyholder) for the coverage of the risk. It is independent of the reinsurance costs. Moreover, it does not consider the duration of the policy and the risk coverage. The policy could last for many years and could exceed the exercise period. Given the fact, the risk could last for the following years of the policy, the insurer has to create an outgoing reserve represented by a fraction of the premiums in order to reserve part of the income for the unexpired elements of the policy and the following years the risk will have its corresponding premium. The outgoing reserve of the year will become the incoming reserve of the following exercise. Summing up the gross written premiums, the incoming reserve, and subtracting the outgoing reserve it is obtained the Gross Earned Premium. Namely, the Gross Earned Premiums are the share of premium pertaining to the period. The technical results are determined principally by the costs of incurred claims. While the premiums are calculated in function to the underwriting policy of the company and its risk appetite, the cost of claims depends on the liquidation policy. Although the global outcome of these policies is clearly stated in the financial statements, the single actions that lead to the overall result are difficult to identify and generally kept secret by the companies. Even if this information is not published generally, it is not unpopular for insurers to publish specific information about the quality of claims and their nature. In this case, the need for information from investors and external stakeholders coincides with the information necessity of the business control function. Claims are divided by the drivers and the complexity they depend on, their severity and frequency. For this reason, the control function divides the claims into different categories:

1. Attritional claims are the part of claims characterized by a high number and low severity. An example of an attritional claim for an individual could be represented in a rear-end collision or a small accident between two cars. It is determined by its limited amount and the standardized process that leads to the settlement management of the claim by the insurer.
2. Natural Catastrophes (Cat) claims are caused by natural events and environmental perils. In this case, there can be a large accumulation of claims from a single event because Cat generally hits the vast event by territorial extension, it has a low number but high severity. Examples of this kind of claim are floods, storms, and

earthquakes. This kind of claim can impact the overall economic performance with a single event; therefore, insurers subscribe to reinsurance treaties in order to control the potential impact

3. Large claims are the part of the claims man-made with a low number but high severity. This kind of claim can impact remarkably the economic performance; therefore, insurers usually employ reinsurance treaties in order to control the potential impact of large claims.

While in financial accounting the claims result all in the same figure, the management accounting system classifies them. The advantage of claims classification is the subdivision of uncertainties deriving from the heterogeneity of claims that derive from their different nature. This permits to separate the effects underlying the technical results, identifying the different behaviours of different types of claims.

After the claims section, the technical income statement presents the expenses section. Here there are two kinds of expenses: the first consists of those expenses from the sales activity and represented by the commissions and incentives; while the second consists in the part of costs the company faces for the functioning of the business and all the costs not directly linked to the claims.

The Technical Result is represented by the difference between the Gross Earned Premiums and the costs pertaining to the year. Starting from these items, fundamental feedback on economic performance comes from some specific key performance indicators. These are industry specific due to the particular productive cycle set for the insurance companies as previously mentioned.

The most relevant indicators are:

- The Loss Ratio, this ratio explains the incidence of claims on the Gross Earned Premiums. The limit of this ratio is that can be conditioned by big claims, such as Large claims and Natural Catastrophes and these two classes of claims are likely to create distortion in the indicator values because are discontinuous year by year. This drawback can be easily resolved by drilling down the ratio separating the Attritional claims from the Large claims and the Natural Catastrophes claims. The value added by the Loss Ratio is the comparability of the single ratio, allowing a deep comprehension of the behaviour of claims independently from sales volumes. This indicator is useful to understand the ability of the company to assume the right and appropriate risks and moreover to understand the capacity of the insurer of pooling exposures in order to mitigate the risk of claims incurrence.
- The Expense Ratio highlights the relationship between the expenses held by the company and its Gross Earned Premiums. It allows isolating the effect of the claims cost from the other expenses and includes the administrative and acquisition costs. On the other hand, this ratio remains very linked to the above-mentioned indicator because they depict the complete cost structure of the very core business of the insurance company.
- The Combined Ratio measures the overall profitability by dividing the incurred loss and expenses by the Gross Earned Premiums. It is important to remark that this indicator investigates not the total profitability of the insurance company but only the technical profitability. Therefore, not including the income coming from investment management a Combined Ratio above 100% does not mean the company has a comprehensive loss. On the contrary, the other components of the overall income could provide a positive effect in compensating for the loss of the

operating income. Anyway, a Combined Ratio above 100% means the company for its very core business is paying more money than those it collects.

Indicator	Formula	Main European players (YE21)
Loss Ratio	$\frac{Net\,Claims}{Net\,Earned\,Premiums}\%$	Allianz: 67,0% AXA: 68,0% Generali: 62,6%
Expense Ratio	$\frac{Net\,Operating\,Expenses}{Net\,Earned\,Premiums}\%$	Allianz: 26,8% AXA: 26,6% Generali: 28,2%
Combined Ratio	$1 - \frac{Net\,Technical\,Result}{Net\,Earned\,Premium}$ OR $Loss\,Ratio + Expense\,Ratio$	Allianz: 93,8% AXA: 94,6% Generali: 90,8%

Table 9. Summary of key operating performance indicators (source: personal elaboration and annual reports of the main European players Allianz Group, AXA Group, Assicurazioni Generali Group)

The situation and analyses are different for the management control system of the Life segment. Starting from the financial accounting data, the main priority is to distinguish the margins that create the operating profitability of the Life insurance. There are two categories of margins:

- Technical margin includes a classification of figures that are not exposed in the income statement. This margin includes all the inflows inherent to upfront commissions and entrance fees, the costs for the distribution network, and the penalties paid in case of withdrawal by the policyholder. Moreover, the technical margin includes the release of reserves for the ceased risks, for example in the event that the policy expires and the reserve that was set aside for the underwritten risk is consequently released.
- Financial margin, represented by the insurers share of the return obtained on the assets under management entrusted by the policyholders of Life products.

SECTION 1.4: Climate change and the insurance industry

Climate change is a pervasive issue that the whole society faces and is part of the social development process. This complex problem falls under many fields of study and presents criticalities at different levels concerning regulation and embedment in national programs. To deal with this issue in her article Vlassopoulos (2012) splits the problem into two main questions: firstly, which are the causes of the problem; secondly, the consequences of the problem and the motivation why it represents an issue itself. From the perspective of the author, the answers to these questions lead to an evolving definition of climate change. In the beginning, it was considered a degradation problem that has changed more and more thanks to public debate. Then this phenomenon has been presented as a development issue, but many authors continue to think that this is not a completely accomplished definition.

Nowadays, widespread use of the term "climate change" leads to confusion and misunderstanding of the phenomenon. For Werndl (2015) the choice of an appropriate definition is essential to obtain effective results. An important starting point to determine the process comes from the United Nations Framework Convention on Climate Change (UNFCCC) definition of climate change as *"change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability over comparable time periods"*. The UNFCCC is the ad hoc entity created in 1992 by the United Nations with the objective to combat dangerous human interference with the climate system. When the Kyoto Protocol was signed in 1997 its implementation was under the management of the UNFCCC. Given this definition of the UNFCCC and its view on the phenomenon of climate change, a remarkable feature to point out is the attribution to human activity. This position is in stark contrast to the Intergovernmental Panel on Climate Change (IPCC). IPCC is the United

Nations body for assessing the science related to climate change, its role is to mediate between the climate research community and the entities appointed for the development of environmental policies and strategies. The Intergovernmental Panel considers a broader list of causes not exclusively human-related. In fact, IPCC identifies the climate change phenomenon as the changes in the average and variability of its properties. Moreover, a determinant aspect of the definition by IPCC is that this change must persist in the long run. This definition has a broader list of climate change causes comprehensive of human activity but not exclusively related to persistent anthropogenic changes.

Which is the most reliable and adaptable for the research question? The inconsistency of the UN FCCC definition is stated in the research by Pielke (2005) who affirms that not all the climate change effects are attributable to human emissions of greenhouse gasses. Therefore, even if human activity has been demonstrated also by the IPCC as one of the determinant variables of climate change according to Mills (2009), it is difficult for insurers to identify and extract the effects. For this reason, insurance companies are likely to cover all the risks related to atmospheric events, independently from the influence of human activity. Why IPCC definition fits better the objectives of the research? Firstly, as it is mentioned above, insurance companies will cover risks caused by climate change independently of the human activity influence. Secondly, defining climate change as a phenomenon only caused by human activity could lead to a concept of climate completely untied with the actual properties of climate systems with important consequences on climate policy. Moreover, defining climate change as only a human-related phenomenon implicates that all the exogenous variables are excluded from the group of climate change causes. An example of an exogenous variable that leads to change in climate is exemplified by Pielke (2005) as an increase in the intensity of the Sun. A good insight to clarify how a climate system can be defined comes from the research of Werndl (2016) who reviewed the most relevant definitions of climate change. In her work, she provides a conceptual analysis of the several definitions of climate change in order to identify the most accurate. The presence of many different definitions is explained by Todorov (1986) who noted that there are no strict criteria to define climatic change. This lack of clarity summed up with the approximative use of the term “climate change” creates confusion about the issues related to climate change, for example, global warming. To improve the definition Werndl summarizes and discusses 5 main desirable requirements that every definition should respect and comply with these desiderata:

1. Empirical applicability of definition is necessary. It means that given time series on climate variables is possible to estimate the present climate and approximate the future values. Otherwise, the definition is empirically void.
2. Correct classification of different climates accordingly to the time period because climate systems should be contextualized coherently with the time horizon. Therefore, it could be stated that different climates belong to different time periods.
3. Independence from knowledge level. While the prediction and forecasting systems of climate change depend on knowledge and research, it is important to keep unrelated from the level of research the definition itself of climate change.
4. Applicability to the independently from the time horizon.
5. Precisely define in mathematical terms.

The definitions identified by Werndl in the literature are 5 and each contains some limits and criticisms:

1. Climate is defined as the distribution over time of constant external conditions. In reality, external conditions are not constant. In fact, different distributions of the conditions over time correspond to different climates. These changes can be

triggered by external conditions or by the values assumed by the variables given stable external conditions. It is possible to affirm this definition is not compliant with the first requirement, therefore is empirically void. Although it is possible to find similar results in the distribution of the conditions for several climate models, there is a fundamental difference between the changes in the distribution of the variables that create a climate system and the changes in their average values. In fact, similar results could come from completely different climate systems. Therefore, it is not possible to approximate either the present or the future values of the climate variables.

2. Climate is defined as the distribution over a limited time period when the external conditions vary as in reality. In this way, the climate is defined as the evolution of the climate variables and the direct consequence is that climate change happens when variables assume different distributions for succeeding time periods. But this is based on the actual properties of the climate system. In reality, the set of variables considered can change, therefore there could be summed up in simple observation of the values assumed by the variables. The problem is that we consider only a limited number of variables to identify a climate system. Therefore, although the measured variables do not change from a time period to another it can be possible that the excluded variables will change influencing the system itself. This problem is similar to the former point, except for the fact that in this case are considered the distribution of both external variables and internal variables instead of their average values as mentioned above.
3. Climate is defined as the distribution over time of regimes of varying external conditions. In this case, the definition permits the settlement of both internal and external variables and the time horizon. This definition is not radically different

from the previous definition. In fact, this interpretation defines climate as a unique set of variables distribution and time period, meanwhile in the previous point the external variables were excluded in order to distinguish separate climate systems. In other words, the improvement of this definition from the previous is that until the conditions not included in the system are stable the climate can change, contrary the change in the external conditions could lead to a different climate system but not a proper climate change. Again, it is possible to assist in both internal and external climate change, but it is caused only if in two consecutive time periods the distribution of values is different for both internal and external variables.

4. The fourth definition states that climate is a distribution of constant external conditions. This is a determinant difference from the previous three due to the interpretation of the time horizon. In fact, the others stated that different distributions in different time periods determine different climates. This interpretation, on the contrary, determines different climates when any variable changes, no one excluded. Therefore, this interpretation states that external variables are neither excludable nor can be kept constant in order to determine differences in climate systems. In practice, this interpretation explains that in case any variable changes its distribution the climate system varies and therefore there is climate change. Also, this definition shows substantial criticisms again. Given the fact that every minimum change in any variable leads to a radically different climate system, it could be stated that there are unlimited climates. A direct consequence of this latter consideration of the fourth interpretation is that in this case is not appliable the first desirable requirement which affirms that a climate system must be consistent, and its future development must be predictable. This is in stark contrast with the latter definition because in the fourth case any change in a system leads to

a completely new system. For this reason, possible developments or forecasts are a representation of a different system and not the old one.

5. The fifth and last version states that climate is the actual ensemble distribution of climate variables when the external conditions vary as in reality. The focus of this interpretation lies in how the external conditions vary. In fact, although this is a widely endorsed interpretation by scholars, there are some criticisms that in this review of the literature can not be omitted. The problems with this interpretation are the uncertainty of the initial values from the previous time period and the definition of future climate, which is the focus of this point omitting the lens on the current climate definition. Moreover, also this version develops infinite climate systems like in the previous one. Therefore, it is possible to affirm the fifth definition does not respect the first desired requirement and the empirical applicability of the definition because although is possible to define future climate systems with already mentioned limits, it is not possible to identify the current one.

All the five definitions reviewed above but the third have shown limits and criticisms. The third interpretation permits a flexible and comprehensive understanding of climate change.

In reality, the external conditions are not constant and their different distributions over time result in different climates, thus systems can have either external climate change or internal climate change depending on the observed variables. Thus, the important aspect is not the specific values and the climate variables included because these depend on the purpose of the research. On the contrary, distribution is fundamental for those variables selected.

Therefore, climate change constitutes a disruptive change for the insurance industry due to its emerging environmental uncertainties shown in the distribution of the variables. Climate change affects human activity as a whole but there are actions that can be undertaken in order to ease this phenomenon. According to Klein et al. (2005) research, all the processes assisting human activities to reduce emissions of greenhouse gasses fall into the definition of mitigation. While adaptation refers to adjustment that takes place in response to impacts of climate change, with the objective of moderating expected losses or enhancing opportunities raised by climate change. This second type of action has been investigated by Pagano et al. (2018) considering all the disparate initiatives by the insurance companies. The scholars have identified 5 categories putting together the work of Dlugolecki and Mills already mentioned above. The different types of actions are:

- Insurers promote culture and knowledge about climate change issues in order to enhance research and literature that can expand the data collection about this phenomenon.
- Insurance companies stimulate the protection of private property building awareness and participating in public policy.
- Insurance companies are renewing their products with terms and conditions aligned with risk-reducing behaviours in order to nudge customers to actively reduce risks.
- Insurers are developing new products adapted to the new climate conditions, the main example is the parametric product whose claim is automatically recognized by artificial intelligence without the need for communication by the policyholder hit by the event and consequently automatically paid to the customer.
- Insurance companies are choosing to invest directly in new adaptation solutions with operations of portfolio rebalancing. As mentioned above, insurers also perform the role of institutional investors.
- Insurance companies in order to promote adaptation measures are financing customers investments. Anyway, this measure remains a marginal action according to the authors.

Moreover, climate change affects insurance companies with direct and indirect effects. The former is defined by Hertin et al. (2003) as the "*physical impacts associated with changing climatic conditions (temperature, precipitation, storminess, etc.)*" while the latter is the changes in regulation, economy, society, and culture originated by climate change in order to contain emissions. The insurance industry can play a fundamental role in both directions. In fact, adaptation measures directly affect insurance companies' property and casualty business while mitigation can fit better with Life insurance. The first is because of the resilience of the coverages underwritten by the insurer, the latter because more severe climate conditions affect in a negative way the life quality of individuals. According to Herweijer (2009), adaptation measures undertaken by insurance companies will have relevant effects on underwriting and investment operations. The final aim of adaptation measures is to change the behaviour of an organization by taking advantage of the effects of any climate-related phenomena. Thus, it enables insurance companies to transform the threat represented by climate change into an opportunity and a competitive advantage. For this reason, it is not intended to be a short-run change in the organization. On the contrary, to be effective and embedded in the business, it should be enabled by the dynamic capabilities of the company. Anyway, it remains a necessary process for the sustainability of the industry.

SECTION 1.5: Climate change impacts on planning and control function

After the review seen in the previous section of the climate change impacts on human activity as a whole and on the insurance business at a theoretical level, this research aims to investigate and quantify these impacts. Furthermore, this study will analyse the involvement of the planning and control function in the monitoring and forecasting activities referred to Natural Catastrophes claims. The evaluation of the climate change impacts on the insurance industry as a whole and the explanation of the planning and control function aims, and objectives are important to understand how the two topics are linked. In other words, what the management control function can do in order to assist the business of a so deeply impacted industry? How are the impacts assessed? In their article, Stechemesser et al. (2015) stated that climate change has different financial impacts on the insurance sector. On one side it increases the claims expenses endangering the capital reserves, on the other side it assisted in a decrease in the revenues. As a consequence of these two factors, the reduced profitability could lead to increased capital costs due to higher expectations by debt and equity holders. While the research and the available literature have been focused mainly on the global effect of climate change on the insurance industry, there has been less focus on translating this phenomenon into management control system terms. The planning and control function of the insurance company can play a primary role to avoid this eventuality. Indeed, one of the duties of the planning and control function is to monitor the current operating performance and identify the underlying causes of any overperformance or underperformance. While for the ex-post results, the construction is quite straightforward using the financial accounting data, this is not true for the forecasting process. In the forecasting activity the planning and control function has to create a model that faces a key tradeoff: represent in a summarized framework all the items that contribute to the technical profit creation or consider the several underlying variables that determine the figures of the technical income statement. Probably the answer to this problem lies within the continuum that unites the two variables. Therefore, an efficient number of underlying variables must be considered to allow the evaluation of the technical income statement elements. Thus, the key step in order to realize an effective provisional technical income statement is the choice of the right set of variables that will determine the assessment of the stated figures.

Generally, forecasts for the topline are made in accordance with the business function itself, the same office assisted by the management control function with its activities. This procedure allows a higher fit of the estimates with strategic planning. On the contrary, the profitability part – which includes the claims, commissions and fees, administrative and other expenses – is built on variables that describe the historical trend of the business but at the same time allow easy steering operations in order to present strategic outlooks, such as planned improvements or possible future deteriorations. The most characteristic items of the technical cost structure in the Non-Life segment are the claims. This figure has a high incidence among the operating costs and is typical of the only insurance industry. The different types of claims are individually analyzed and appraised, this method allows to dedicate the model to better describe the specific behaviour of each precise class of claims. Moreover, this procedure limits the variability of the forecasts.

The classification of claims has been already mentioned in the previous section. Following the same classification will be re-analyzed exposing their peculiarities and arguments for a reliable forecast of each item. The definition and classification of different claims are particularly meaningful for the Property branch of Non-Life insurance. Indeed, Property insurance consists of the classes that cover fire and natural forces, other damage to property and miscellaneous financial loss.

Attritional claims can be relatively easily forecasted due to their high and predictable frequency with a quite standardized cost; therefore, it is possible to forecast their evolution in the short term with a restricted set of variables. The estimation of the Attritional claims cost can be assessed as a result of frequency and the average cost of the claims. The number of the claims multiplied by the average cost gives the total amount of expected cost for Attritional claims. On the other hand, the other two classes of claims do not present the same characteristics as the Attritional claims. In fact, the Large Claims and the Natural Catastrophes claims are less frequent and have higher variability. The reasons for this different trend in these types of costs are due to multiple reasons, also different from one category to another. The Large Claims trend can be at least partially explained considering the risk appetite of the company. The larger the amount (and obviously the probability of incurrence also) of a possible claim for the insured risk, the larger will be the premium paid by the policyholder. Risk appetite is defined as the risk an insurer is willing to cover as a result of the premium payment. The risk aptitude of the insurer depends on its ability to create a pool of underwritten risks in order to be sufficiently diversified in its exposures. Moreover, the insurer attraction for risk could be influenced also by the shareholders requirement for profitability, level of expertise and experience of the professionals, competition, and reinsurance coverage strategies. After all these risk appetite factors, the counterparty and the fortuitous events can heavily affect the trend of the Large Claims. The last category considered, the Natural Catastrophes claims strongly depends on the climate and the weather events in particular. The uncertainty and variability linked to this figure of the forecasts should not exempt the controlling function from the assessment of this particular item. On the contrary, as suggested by the research of Reichert et al. (2005) the forecast provided a relevant added value contribution even just by estimating the variability.

The forecasting process for the planning and control function is aimed to represent the evolution of the business in the short term. Generally, the projections are based on 12 months in order to target the year-end results. Due to the multiple landscape changes and macroeconomic variability, the companies perform the forecasting process multiple times during the year in order to update the benchmark between the actual performance and the ambition. To assess multiple forecasts during the year the planning and control function creates models that use internal variables to predict the reasonable and probable evolution of the business performance. Although it could be thought as a stochastic elaboration with the use of complex variables and large samples, there are some drawbacks in using so complex systems. Indeed, using these methods takes longer than is available for the planning and control function to provide a reliable estimate. Secondly, the use of past data could provide biased insights that do not fit with the shared vision of the management and thus could not permit an analysis of the expected future performance. Furthermore, the use of external variables to be correlated with the monitored indicators in order to create forecasts, could create path dependence and not respond suddenly to changes in corporate information needs. Therefore, it is important to create a reliable model with the used and monitored internal key performance indicators that stand for the base of computation of the economic performance.

CHAPTER 2

Analysis of the operating profitability

SECTION 2.1: Data selection, sampling, and methodologies

The first step of the analysis consisted of the data finding and collection. This passage presented the first issue, although climate change is a primary concern for the insurance industry as a whole there still be a scarcity of disclosure in the data related to the effects on the core business of the companies, in other words, the disclosure of the Natural Catastrophes claims by the insurers remains a rare case. Therefore, a proper public database with all the data and companies collected was not available for consultation. For this reason, the creation of a database has assumed even more relevance and the step has been split into two sub-processes. Namely, the identification of the formation of a pool of companies followed by the analyses of their publications.

For the first sub-process, the insurance companies grouping, the research has focused on the European context. The aim was to compare companies operating in a homogeneous context, as suggested by Dlugolecki (2007) in his contribution focused on Europe, because of the comprehensive insurance system and the data availability of this specific area. Here has been included the United Kingdom despite Brexit in 2020. The indicators and the figures presented in the reports continue to be aligned with the same regulations in order to ensure continuity to the external stakeholders.

In order to select the companies operating in the described context, various data sources have been used:

- Investing.com website was used to collect all the insurance companies listed in European markets and based in a European country.
- Insurance companies that are included in stress tests by EIOPA.
- The other companies present in the rankings of the previous chapter are a selection of Atlas Magazine's global ranking of insurance companies, the Mapfre Foundation European ranking and the ANIA (Associazione Nazionale fra le Imprese Assicuratrici, the Italian insurers association) Italian ranking.

The total number of companies grouped from these sources was 164. The first exclusion criterion has been the residence of the company, in other words, non-European companies have been excluded. This selection has deleted 41 insurers from the list. The following criteria for the company exclusion relate to the completeness and availability of information and reports published by the companies. These criteria consist of:

- From the analysis of the reports, the company had to present the characteristics of the insurance business. 17 companies have been excluded from the selection process, of these 3 were excluded because not direct insurers but reinsurance companies, 3 were brokers and 4 were banks or asset management companies.
- 44 companies were excluded due to missing information in their annual reports and relations or for the lack of all the years since 2010. The only 2 companies presenting data from 2011 until 2021 were included anyway because there were no missing data in the remaining 11 years observed.
- Then, not all the companies presenting all the documents for the period considered have been included. 17 insurers have been deleted because although these companies perform insurance activity, they attain the Life and Saving segments.

- The last criterion was the language of the reports. Only the Italian or English reports have been considered valid sources of information. 12 companies have been excluded for this reason. 3 of the published documents were in French, 2 in German, 2 in Serbian, 2 in Polish, 1 company was Greek, 1 company was from Sweden and 1 company was from Cyprus.

In order to collect the data, the annual reports and presentations published on the official websites of the insurers were read and analyzed. The remaining 33 companies were divided depending on the availability of the Natural Catastrophe claims publication. 13 companies disclosed the data on their claims caused by weather-related causes, while the other 20 did not. The aim is to identify possible discriminatory variables that can identify the companies with the best awareness about the impact of climate on claims.

Of the 33 companies the following variables were collected:

- Written Premiums, representing the revenue volumes of the companies.
- Earned Premiums, in order to complete the revenue data where the Written Premiums were missing. Although these two variables do not present the same figures, the changes in the Written and Earned Premiums have the same trend generally.
- Claims, all the claims incurred in the period.
- Nat Cat, the Natural Catastrophes claims incurred in the period. This variable is a component of the total claims.
- Operating profit represents the profitability of the company.
- The Loss Ratio, as mentioned in the previous chapter is a profitability index that relates the claims that occurred to the earned premiums.

- The Combined Ratio, already mentioned in the previous chapter, this index considers all the costs deriving from the operating activities of the insurance company.
- Premiums Growth is the yearly variation of the revenues of the company.

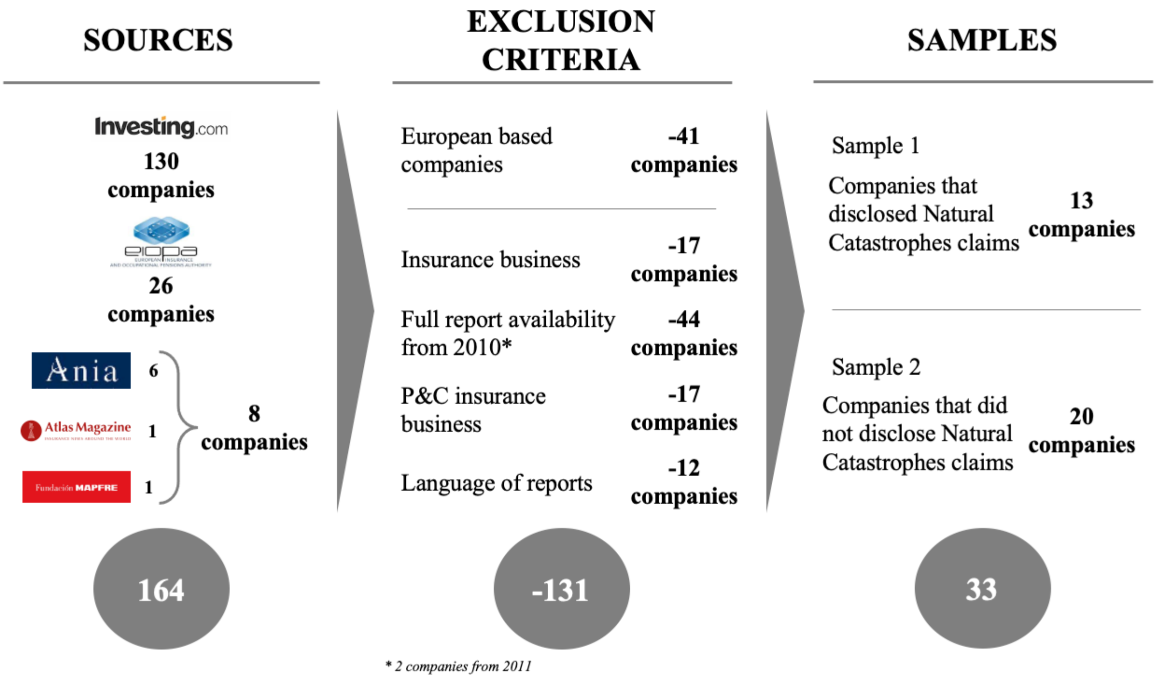


Figure 3. The procedure of data selection and rules of exclusion led to the final sample

This research analysis aims to identify the possible relationships between the companies operating profitability indexes and the macroeconomic environment. Moreover, a second step was the investigation of the relationships between the operating performance of the company and the weather-related losses caused by weather and climatic events.

A contribution for the first analysis comes from the research by Dorofti et al. (2015). In the paper developed for the elaboration of the stress testing framework, the authors analyzed a very similar context because their dataset contained 30 European countries and considered "over 8 years long time series with annual frequency". On the other hand, the main difference between this research and the mentioned article is the concept of profitability. In this analysis, only the operating profitability concerning core business will be considered. On the contrary, the paper by Dorofti et al. (2015) took into account the profitability of the insurance companies as a whole (e.g. considering also the results from the assets under management). The literature has mainly focused on the comprehensive profitability of the companies. Given this fact, the analysis will be focused on the most characteristic indicator that could affect the operating performance. Moreover, while this research is exclusively focused on the Non-Life business of the companies, the other research is comprehensive of both Life and Non-Life figures. Therefore, the authors identified:

- Gross Domestic Product, which has been considered in this research.
- Long Term Interest Rates, which are more related to the savings business and to financial management performance and not to the operating performance, thus have not been included in the thesis.
- Inflation, the rise of prices has been largely mentioned by the available literature as a determining macro variable that affects the profitability of insurers. Moreover, in the operating management of the P&C segment insurance has a wide impact on the cost of claims. This variable has been considered in the analysis.
- The Unemployment Rate, which refers to the availability of income and saving capacity of the individuals. Saving business is part of Life insurance, therefore has not been included in the analysis.
- The stock market index has not been included in the research while was considered by Dorofti et al. (2015).

While for the macroeconomic variables a wide literature exists, there is little analysis on the behaviour of the operating profitability of insurance companies related to environmental and climate change phenomena. Therefore, in this research, a publication by AON that quantified the weather-related losses for the period analyzed has been selected. Moreover, Eurostat provided a database of the losses decomposed by the cause: meteorological events (e.g. storms), hydrological events (e.g. floods), and climatological events (e.g. heatwaves, cold waves, droughts).

The tools used for the analysis of the data were both Stata software and an Excel worksheet. Further, only the non-monetary figures of the data collected by the reports of the companies were used in the analysis due to different currencies.

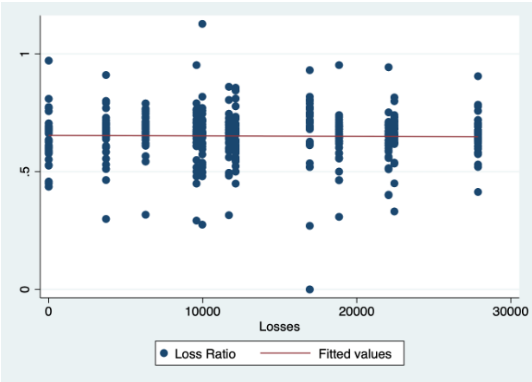
SECTION 2: Analysis

The aim of this research was the analysis of the relationships between the operating profitability ratios of the Non-Life insurance companies operating in the European context and the weather-related losses. In order to investigate these relationships, the first part consisted of the correlation analysis of all the variables collected. The correlation matrix on the entire sample elaborated using Stata software has provided the following evidence:

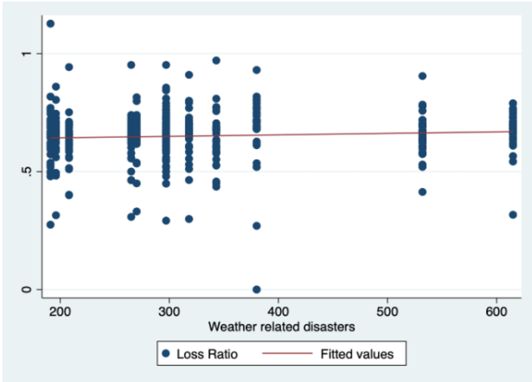
	LossRa~o	Combin~o	Premiu~h	Inflat~n	Weathe~s	GDPgro~h	Losses
LossRatio	1.0000						
CombinedRa~o	0.6019	1.0000					
PremiumGro~h	0.1088	-0.0061	1.0000				
Inflation	0.0290	0.0100	0.1212	1.0000			
Weatherrel~s	0.0696	0.0683	0.0454	0.5835	1.0000		
GDPgrowth	-0.0208	-0.0345	0.1210	0.3570	0.1629	1.0000	
Losses	-0.0141	-0.0123	-0.1108	-0.2632	-0.0053	-0.0940	1.0000

Table 10. Correlation matrix showing the correlation coefficients of the variables collected

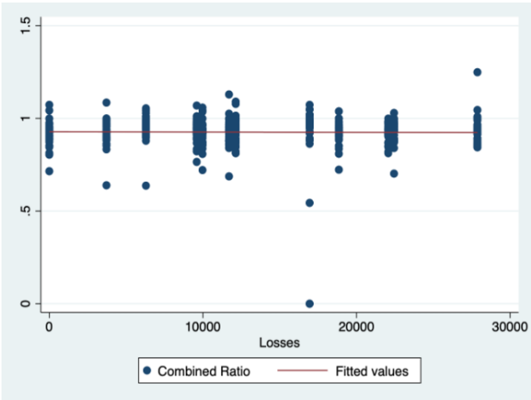
The Loss Ratio seems to be positively related to the Combined Ratio, while the other correlations seem to have weak significance. For the aims of the research, the correlations between these two ratios (Loss Ratio and Combined Ratio) and the two measures of weather-related losses (Weather-related losses by AON and Losses by Eurostat) have been also graphically analyzed using a scatterplot elaborated with Stata.



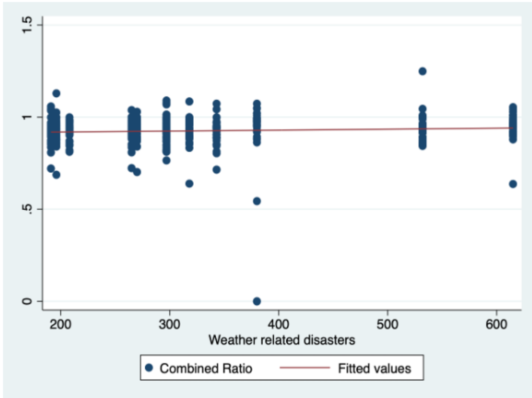
4A. Loss Ratio correlation with weather-related losses by Eurostat



4B. Loss Ratio correlation with weather-related losses by AON



4C. Combined Ratio correlation with weather-related losses by Eurostat



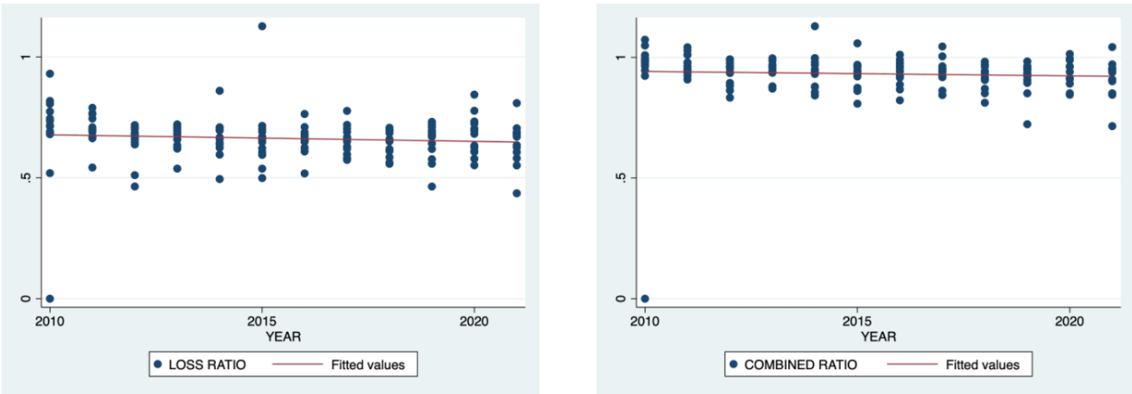
4D. Combined Ratio correlation with weather-related losses by AON

Figure 4. Scatterplot for the graphical analysis of the correlations between operating profitability indexes and the variables measuring the weather-related losses

Also, the graphical analysis confirms the weak correlation between the profitability indexes and the weather-related losses. The non-correlation of the operating profitability of the companies in the sample with the selected variables describing the weather-related losses could mean that Non-Life insurers are sufficiently diversified in the accepted coverages. In other words, their underwriting and reinsurance policies could be efficient because the profitability is not heavily affected by the losses caused by weather events.

As mentioned in the previous section, the sample has been divided into 2 sub-samples depending on the companies disclosure of the Natural Catastrophes claims. The analysis continues considering these 2 sub-samples separately to understand if these show different trends and correlations of the considered variables in order to investigate the underlying effects of both the sub-samples.

The first sub-sample (Sample 1), which includes companies who disclosed the Natural Catastrophes claims, is composed of 13 insurers. The time series of the two profitability indicators show a slight decrease over the years that suggests a better performance mainly for the Loss Ratio, while the Combined Ratio has a flatter trend over the years although it remains negative, meaning that the ratio is generally improving for the companies of the sample.



5A. Historical Series of Loss Ratio for the companies of Sample 1

5B. Historical Series of Combined Ratio for the companies of Sample 1

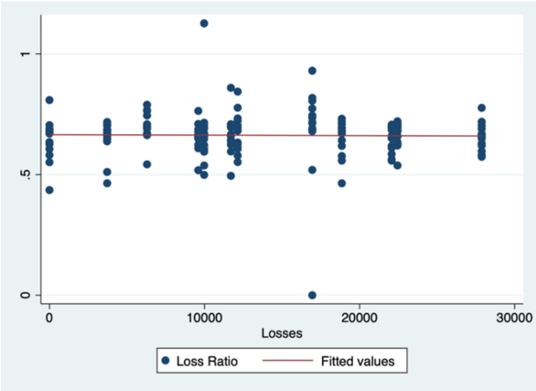
Figure 5. Historical series of the profitability indicators of Sample 1 companies

The correlations between the observed variables for Sample 2 have been calculated using Stata, the software has provided the following correlation matrix:

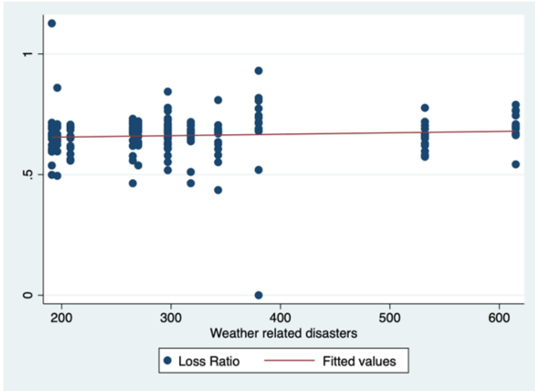
	LOSSRA~O	COMBIN~O	PREMIU~H	INFLAT~N	WEATHE~N	GDPGRO~H	Losses
LOSSRATIO	1.0000						
COMBINEDRA~O	0.7049	1.0000					
PREMIUMGRO~H	-0.0429	-0.0146	1.0000				
INFLATION	-0.0095	0.0058	0.0714	1.0000			
WEATHERREL~N	0.0738	0.0790	0.0288	0.5835	1.0000		
GDPGROWTH	-0.0495	-0.0690	0.2053	0.3570	0.1629	1.0000	
Losses	-0.0161	-0.0373	-0.0945	-0.2632	-0.0053	-0.0940	1.0000

Table 11. Correlation matrix showing the correlation coefficients of the variables collected for Sample 1

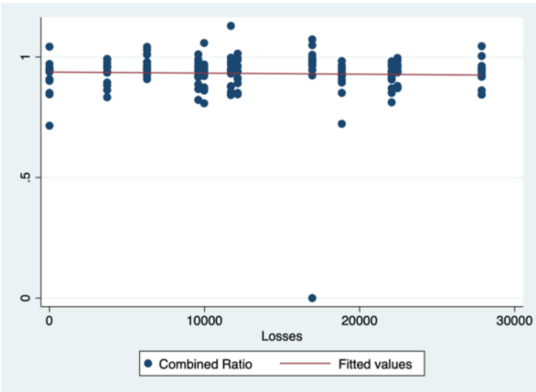
The results show a weak correlation of both the Loss Ratio and the Combined Ratio with the weather-related losses variables. While the Loss Ratio has a positive correlation with the Combined Ratio.



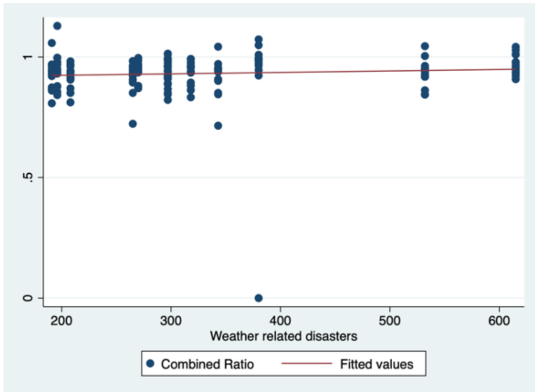
6A. Loss Ratio correlation with weather-related losses by Eurostat



6B. Loss Ratio correlation with weather-related losses by AON



6C. Combined Ratio correlation with weather-related losses by Eurostat



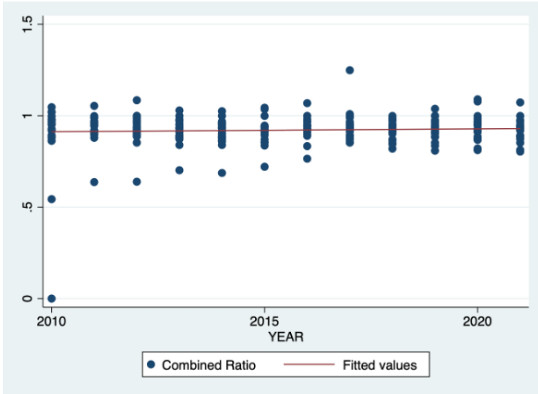
6D. Combined Ratio correlation with weather-related losses by AON

Figure 6. Scatterplot for the graphical analysis of the correlations between operating profitability indexes and the variables measuring the weather-related losses of Sample 1

Again, like for the sample comprehensive of both sub-samples, the graphical analysis of the scatter plots confirms the weak correlations of the variables observed.

The other companies which did not disclose the values of Natural Catastrophes claims constitute the second sub-sample (Sample 2). The time series of the Loss Ratio shows a slight decrease that suggests a better performance, while the Combined ratio has a completely flat trend although data seems more concentrated with a lower variance in recent years than at the beginning of the considered period

7A. Historical Series of Loss Ratio for the companies of Sample 2



7B. Historical Series of Combined Ratio for the companies of Sample 2

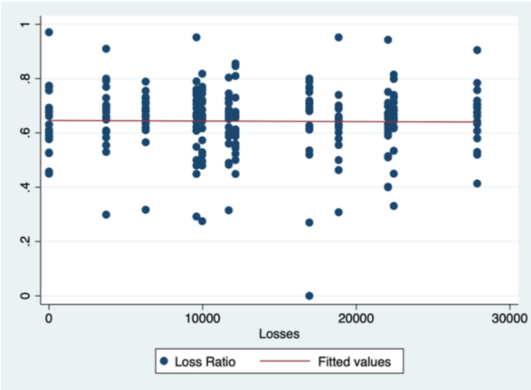
Figure 7. Historical series of the profitability indicators of Sample 1 companies

The correlations between the observed variables for Sample 2 have been calculated using Stata, the software has provided the following correlations matrix:

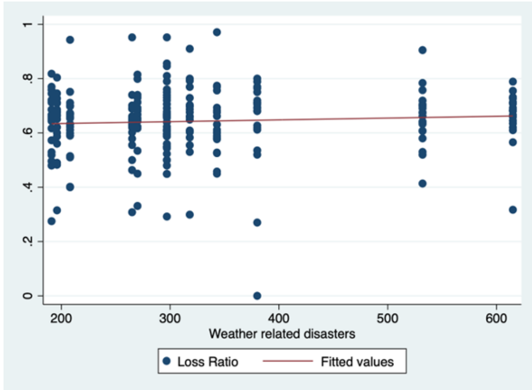
	LossRa~o	Combin~o	Premiu~h	Inflat~n	Weathe~s	GDPgro~h	Losses
LossRatio	1.0000						
CombinedRa~o	0.5515	1.0000					
PremiumGro~h	0.1819	0.0048	1.0000				
Inflation	0.0494	0.0128	0.1485	1.0000			
Weatherrel~s	0.0684	0.0614	0.0545	0.5835	1.0000		
GDPgrowth	-0.0063	-0.0119	0.0794	0.3570	0.1629	1.0000	
Losses	-0.0132	0.0042	-0.1208	-0.2632	-0.0053	-0.0940	1.0000

Table 12. Correlation matrix showing the correlation coefficients of the variables collected for Sample 2

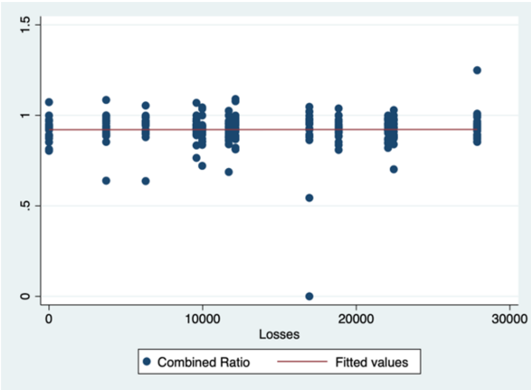
The graphical inspection confirms the quantitative analysis, as there are no significant correlations between the operating profitability indexes and the weather-related losses variables. Compared to Sample 1, the correlation between Loss Ratio and Combined Ratio seems to be always positive but weaker compared to Sample 1.



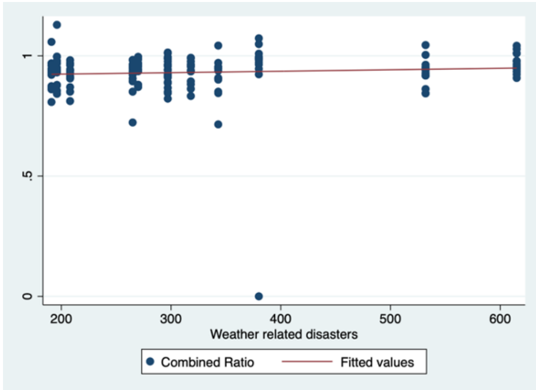
8A. Loss Ratio correlation with weather-related losses by Eurostat



8B. Loss Ratio correlation with weather-related losses by AON



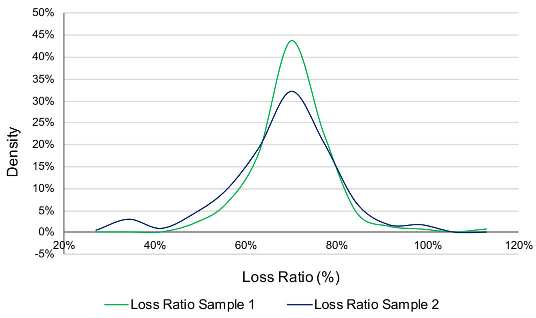
8C. Combined Ratio correlation with weather-related losses by Eurostat



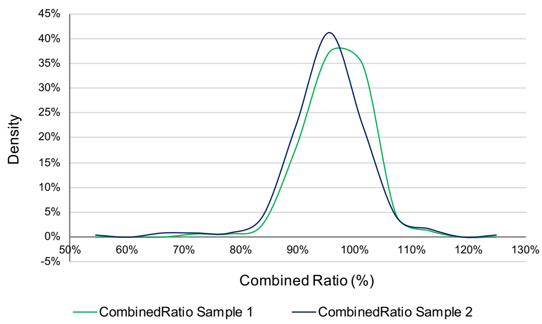
8D. Combined Ratio correlation with weather-related losses by AON

Figure 8. Scatterplot for the graphical analysis of the correlations between operating profitability indexes and the variables measuring the weather-related losses of Sample 2

By comparing the analysis between Sample 1 and Sample 2, it is possible to affirm that the two sub-samples have similar trends and correlations for the variables selected. In fact, both correlation matrices show significant values only for the correlations between Loss Ratio and Combined Ratio. The statistical significance is confirmed by the logical relationship that links these two factors. As mentioned in the previous chapter, the Loss Ratio is one of the two components of the Combined Ratio. Another significant coefficient present in each correlation matrix is the correlation between weather-related losses by AON and the Inflation data by Eurostat, but this relationship is not among the objectives of the research. The two sub-samples seem to have a similar distribution of the key performance indicators analyzed in relation to weather-related losses.



9A. Frequency distribution of Sample 1 and Sample 2 Loss Ratio



9B. Frequency distribution of Sample 1 and Sample 2 Combined Ratio

Figure 9. Comparison of the frequency distribution for the operating profitability ratios for Sample 1 and Sample 2

The Loss Ratio distributions of Sample 1 and Sample 2 have similar distributions. The two distributions differ for the larger number of observations for Sample 1 in the middle of the curve meaning tails contain a lower number of observations. A remarkable difference could be highlighted for the Combined Ratio of Sample 1 which shows a distribution shifted to the right compared to Sample 2 distribution. This difference in the Combined Ratio can be explained by the analysis of the yearly average value of the Combined Ratios for the two sub-samples.

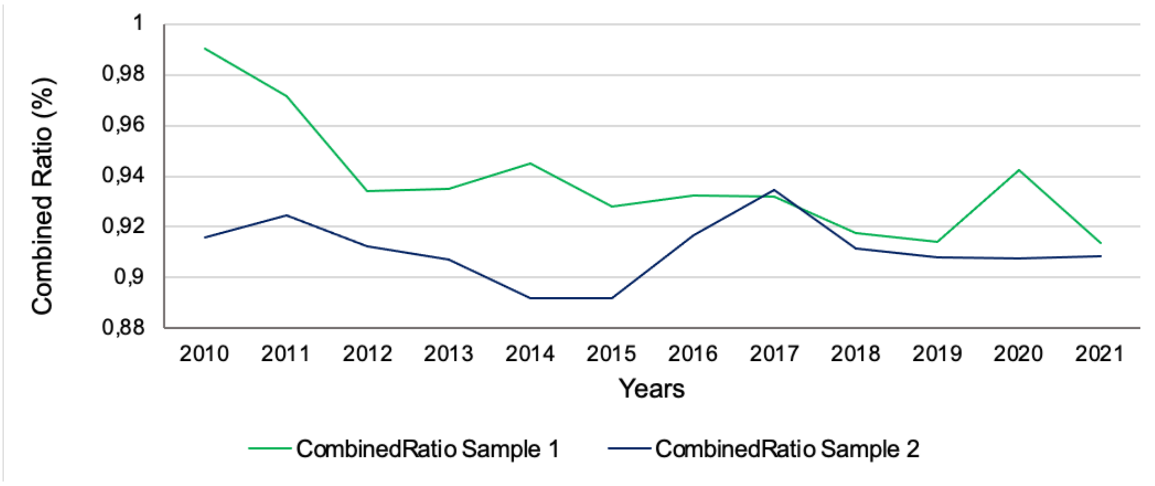


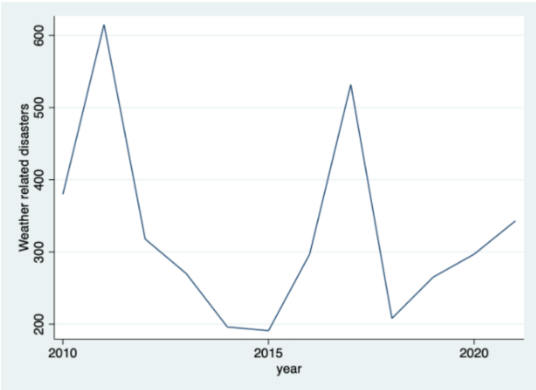
Figure 10. Historical trend of the yearly average of Combined Ratio of Sample 1 and Sample 2 compared

A first graphical analysis could suggest that Sample 1 companies presented a higher Combined Ratio at the beginning of the time period considered, meaning a poorer performance. The profitability has improved over the years and Sample 1 has closed the initial gap. This trend could be the result of increased awareness of the companies about weather-related losses and climate risk.

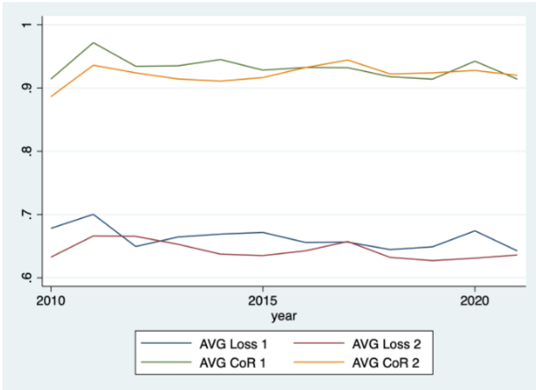
Finally, the analysis of the correlations has not suggested any significant correlation between the profitability ratios of the companies and the weather-related losses. This topic has not been largely investigated by the available literature. On the contrary, the main findings are concentrated on the whole profitability and not exclusively on the operating performance. Moreover, a large majority of the contributions by the scholars consider Life and Non-Life segments together this could be misleading due to the different peculiarities of the two businesses. Furthermore, another difference between this research and the main available articles lies in the selected variables. In fact, scholars have deeply investigated the relationships between insurers profitability and macroeconomic variables, but the literature has not addressed its focus on weather-related losses.

Therefore, this research has continued trying to represent the general trend of the observed variables in relation to weather-related losses the trend with simplifications in order to identify possible trends. While in the previous analysis each year considered individually all the observations of the companies, now the next one will be focused on the yearly average of the considered sample. In other words, the number of observations will reduce because the yearly average will eliminate a dimension of the sample (the number of companies in the sample). The resulting analysis will take into consideration only the correlations between the profitability ratios and the weather-related losses variables in order to expand the lack of research on this topic.

The first analysis of these data has been done considering the weather-related losses by AON and the two profitability indexes by both samples. The first graphical analysis highlights the considerable variance of the weather-related losses (figure 11A). While the comparative analysis of the ratios of the two sub-samples (figure 11B) shows that the companies of Sample 1 had higher values of Combined Ratio and Loss Ratio at the beginning of the considered period, but the gap with Sample 2 has been closed over the years.



11A. Time series decribing the evolution of weather-related losses from AON



11B. Time series describing the evolution of the profitability ratios observed for both sub-samples (Sample 1 and Sample 2)

Figure 11. Time series of the considered variables

After the graphical analysis, the correlation matrix has been elaborated using Stata and the results are the following:

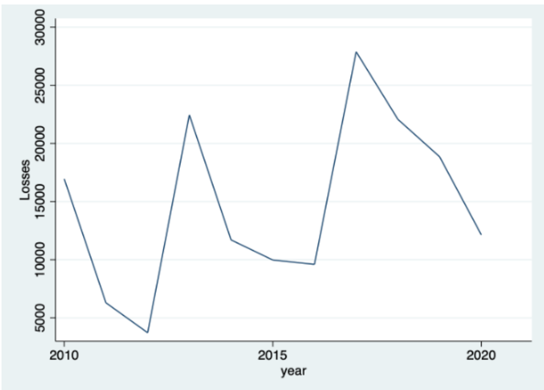
	Weathe~s	AVGLoss1	AVGCoR1	AVGLoss2	AVGCoR2
Weatherrel~s	1.0000				
AVGLoss1	0.4517	1.0000			
AVGCoR1	0.4735	0.7246	1.0000		
AVGLoss2	0.6359	0.2544	0.6248	1.0000	
AVGCoR2	0.4160	-0.1168	0.4192	0.4493	1.0000

Table 13. Correlation matrix showing the correlation coefficients of the weather-related losses variable with the profitability ratios of the two sub-samples

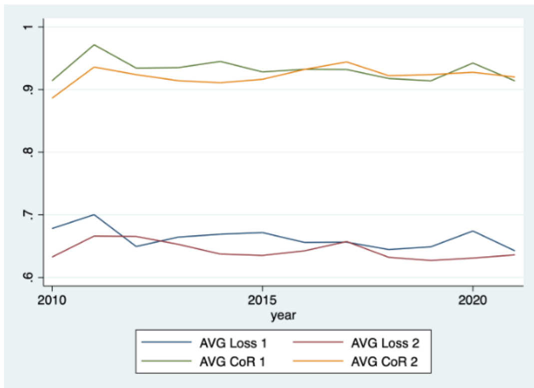
All the profitability variables show a significant level of correlation with the weather-related losses variables. The average Loss Ratio of Sample 1 has a lower correlation coefficient than the average Loss Ratio of Sample 2. While it is true the opposite for the Combined Ratio.

AON information are global data and not exclusively dedicated to the European context. Therefore, it is important to enhance the focus on the European area using the Eurostat dataset. On the other hand, the drawback of these data is the length of the time series. In fact, the series provided by Eurostat ends in 2020. The analysis has been performed anyway, in order to understand the general trend of the observed variables and their evolution over time.

Although the Eurostat dataset is referred to a different geographical area, the trend is similar to the AON global data. For example, the top right peak incurred in 2017 in the graph (figure 12A) is the same registered in the AON graph (figure 11A).



12A. Time series decribing the evolution of weather-related losses from Eurostat



12B. Time series describing the evolution of the profitability ratios observed for both sub-samples (Sample 1 and Sample 2)

Figure 12. Time series of the considered variables

The correlation matrix has been calculated on Stata; the results are the following:

	Losses	AVGLoss1	AVGCoR1	AVGLoss2	AVGCoR2
Losses	1.0000				
AVGLoss1	-0.3702	1.0000			
AVGCoR1	-0.4881	0.6844	1.0000		
AVGLoss2	-0.2389	0.2128	0.6151	1.0000	
AVGCoR2	0.0134	-0.1403	0.4339	0.4500	1.0000

Table 14. Correlation matrix showing the correlation coefficients of the weather-related losses variable with the profitability ratios of the two sub-samples

The results here show lower correlation coefficients. On the other hand, there are still significant coefficients. This is the case of the Combined Ratio of Sample 1 which is negatively correlated to the weather-related losses variable. Moreover, it is interesting to note that the Combined Ratio of Sample 2 does not show significant correlation with weather-related losses. Both Loss Ratios show a weak correlation with the weather-related losses but it is important to notice the negative sign of the coefficients.

Finally, it is not possible to affirm that the correlations assume significant values with the exception of the analysis performed on the yearly averages of the variables. These correlations refer to a more punctual data source, focused only on the European territory. After the correlation analysis, the focus has been shifted towards the regression analysis of the variables collected, in order to estimate the significance of the relationship among the variables collected. The regression analysis has been divided into 2 steps: firstly, the investigation of the entire sample considering both the Loss Ratio and the Combined Ratio; then the comparative analysis of the two sub-sample for the profitability ratio with the most significant results.

The data have been organized and analyzed as panel data so that Stata could identify the companies (defined as ID variable) and the time variable from 2010 until 2021 (defined as YEAR variable) with a change of 1 year (described by Delta). The same analysis has been performed for both the entire sample and the two sub-samples. Before running the regression, a series of stationary tests (e.g. Levin-Lin-Chu test) have been performed on the dataset to verify the stationarity of the latter. The analysis of the panel data includes two types of estimates: fixed effect and random effect. The former assists to limit the heterogeneity of data and it is used for the analysis of impacts of variables that vary over time, for example subtracting the average value of the investigated variables for each company. While the latter considers individual-specific effects. In order to understand which of the two effects was more efficient for the analysis, the Hausman test has been performed on the two kinds of regression to test the consistency of the estimators. The null hypothesis of this test is that the model can be run with the random effect, while the alternative hypothesis states that the preferred model is the one with the fixed effect.

As anticipated above, the first analysis has been done on the entire sample. The first analysis used the Loss Ratio as the dependent variable, while adopted the independent variables were Premiums Growth, Inflation, Weather-related disasters (by AON), and Gross Domestic Product growth with the fixed effect. The Levin-Lin-Chu test confirms the stationarity of the dataset. The parameters estimated by the regression are depicted in table 15:

	Loss Ratio
Premiums Growth	0.0873 * (0.0443)
Inflation	-0.1642 (0.5682)
Weather-related disasters	0.0001 * (0.0001)
Gross Domestic Product growth	-0.1664 (0.1674)
Number of observations	396
F	2.11 *
R^2	0.0229

*p<0.1,p<0.05,***p<0.01 (standard errors in parentheses)**

Table 15. Results of the regression considering the entire sample and Loss Ratio as the dependent variable, fixed effect

The result of the regression showed a marginal significance for the Premium Growth with a p-value equal to 0,050 and the estimated coefficient is positive. This result confirms the academic literature findings which stated that the premiums growth of the insurance companies is likely to be detrimental to their operating profitability. The Weather-related disasters estimated parameter is significant at a 10% level and the coefficient direction is positive meaning that is positively related to the Loss Ratio although it is not strongly supported. For the aim of this research, it is not possible to affirm there is significant evidence of the relationship between Loss Ratio and Weather-related disasters. The Random Effect version of the same test has provided the following parameters:

	Loss Ratio
Premiums Growth	0.0907 ** (0.0439)
Inflation	-0.1683 (0.5677)
Weather-related disasters	0.0001 * (0.0001)
Gross Domestic Product growth	-0.1676 (0.1673)
Number of observations	396
Wald chi^2	8.82 *
R^2	0.0229

$*p<0.1, **p<0.05, ***p<0.01$ (standard errors in parentheses)

Table 16. Results of the regression considering the entire sample and Loss Ratio as the dependent variable, random effect

The results are similar to the previous regression. In fact, the effect of Premiums Growth on Loss Ratio is positive and significant with a confidence level of 5% and Weather-related disasters are positively related and significant with a confidence level of 10%. With the aim of understanding which one of the two versions of the regression analysis is the most efficient, the Hausman test has been performed. The test has identified the random effect as the most efficient for the observed variables.

To complete the analysis of the profitability indexes considered in the research, the second analysis used the Combined Ratio as the dependent variable, while the independent variables adopted were Premiums Growth, Inflation, Weather-related disasters (by AON), and Gross Domestic Product growth. But, before running the regression, the Levin-Lin-Chu test does not confirm the stationarity of the dataset. Therefore, the regression has not been performed. This result could be attributed to the influence of the other cost components of the operating activity of the Non-Life insurers, with a relevant effect of the Expense Ratio – the other Combined Ratio component.

The regressions on the entire sample have not given particular insights into the considered independent variables. The scarcity of management accounting information (e.g., frequency or average costs of claims) does not allow for expansion of the analysis. On the other hand, other available variables collected in the dataset have been included in the model as independent variables (e.g., claims and operating profit). Although the models were statistically significant, they were not logically worthy because the new added independent variables were underlying components of the Loss Ratio.

As mentioned above, after the analysis of the entire sample the focus has moved to the two subsamples. The analysis of Sample 1 used Loss Ratio as the dependent variable, as it was done for the previous analysis, while the independent variables adopted were Premiums Growth, Inflation, Weather-related disasters (by AON), and Gross Domestic Product growth with the fixed effect. The Levin-Lin-Chu test confirms the stationarity of the dataset. The parameters estimated by the regression are depicted in table 17:

	Loss Ratio
Premiums Growth	0.0714 (0.0899)
Inflation	-0.6323 (0.9647)
Weather-related disasters	0.0001 (0.0001)
Gross Domestic Product growth	-0.2220 (0.2910)
Number of observations	156
F	0.72
R^2	0.0203

p<0.1,**p<0.05,p<0.01 (standard errors in parentheses)**

Table 17. Results of the regression considering Sample 1 and Loss Ratio as the dependent variable, fixed effect

The result of the regression has not provided any significant result neither at a 5% confidence level nor 10%. Again, the same test has been run using the Random Effect version:

	Loss Ratio
Premiums Growth	0.0407 (0.0877)
Inflation	-0.6320 (0.9683)
Weather-related disasters	0.0001 (0.0001)
Gross Domestic Product growth	-0.2008 (0.2917)
Number of observations	156
Wald chi^2	2.44
R^2	0.0195

p<0.1,**p<0.05,p<0.01 (standard errors in parentheses)**

Table 18.Results of the regression considering the Sample 1 and Loss Ratio as the dependent variable, random effect

The results with the second version of the test are similar to the Fixed Effect, and do not provide any significant evidence. After having both the results of the two types of regression, the Hausman test has been performed. The test has identified the random effect as the most efficient for the observed variable. Finally, the Loss Ratio of Sample 2 has been analyzed as for the previous. Again, the independent variables included in the model were Premiums Growth, Inflation, Weather-related disasters (by AON), and Gross Domestic

Product growth. Running the Levin-Lin-Chu test there is no evidence if stationarity of the dataset. Therefore, the regression has not been performed.

CHAPTER 3

Conclusions

SECTION 3.1: Summary of the analysis results and suggestions for future research

The correlation analysis has highlighted a strong relationship between Loss Ratio and Combined Ratio. This finding is all but insignificant, the relationship between the two ratios has been explained in the previous chapters and is not the only component which can determine the whole operating performance of the companies. The other types of operating expenses different from the claims have a considerable effect on the cost structure. Moreover, this relationship is confirmed by the existing literature.

On the other hand, an interesting finding has been highlighted by the trend of the two ratios. The trend of the yearly average of the two operating profitability ratios is decreasing, in particular for Sample 1. Furthermore, the correlation analysis of these variables has confirmed the results of the graphical analysis, highlighting a strong and positive correlation of the ratios with the weather-related losses. The trend of Sample 1 shows a more sustained decrease over time in the Combined Ratio compared to Sample 2. This result is supported by the correlation matrix calculated with Eurostat data which indicates a negative correlation concerning the indicator of the former, while a positive correlation for the latter. This finding could be further investigated to understand if the companies of the first sample have made their business management more efficient and the motivations. Moreover, the density distributions of the two samples together appear similar. Therefore, the distinction based on the disclosure of the Natural Catastrophes claims data could be the object of further studies to understand if it represents a real clusterization variable.

The regression analysis has provided evidence of the relationship between Loss Ratio, Premiums Growth and Weather-related disasters considering the entire sample. The result of this analysis differs from the mainstream literature findings so far. The large majority of the scholars that studied the profitability of insurance companies have focused on the relationship of the latter mainly with macroeconomic indicators. Moreover, in the available research, the profitability indexes were neither industry-specific nor exclusively focused on the operating performance of the Non-Life insurance companies.

SECTION 3.2: Planning and control function challenges

As Whelan et al. (2021) stated in their article, the Chief Financial Officer (CFO) of organizations can play a primary role in company sustainability given his impact on the development of awareness of climate change effects in monetary terms. While a large majority of the analyzed companies consider their environmental sustainability as the carbon footprint of their organizations and their compliance with the Sustainable Development Goals of the 2030 Agenda by the UN, the social role of the insurance companies should enhance their awareness, leading them to include the economic impacts of climate change in their reports. The finance function of the insurance company can enhance awareness of climate change impacts in monetary terms thanks to its involvement in sustainability reporting. Although few companies keep track of sustainability as an investment rather than a cost, the scholars stated that the CFO is the most qualified figure to become the Chief Sustainability Officer.

The planning and control function monitors profitability and its developments. It provides reports on the causes of the current performance to the CFO. Moreover, it carries out a feedback role with the business lines. Therefore, the planning and control function represents the link between the Chief Sustainability Officer of the future and the business line responsible for the P&C insurance. This situation together with the recent developments in climate change is likely to bring increased attention to the Natural Catastrophes claims caused by weather-related events.

A probable future challenge of the planning and control function will consist in providing reliable reports and forecasts for both the C-suite management and the business lines to continue the constant improvement of the operating performance as demonstrated in the analysis of this research.

Appendix 1

Code

In the following pages the code developed for the analysis on Stata.

```
*IMPORT TABLES
. import excel "/Users/marcoborsato/Desktop/Thesis/5_SAMPLE & ANALYSIS/0_DB/20220925 - db for stata.xlsx", sheet("DB new template") fir

*BROWSE DATASETS after the import
bro

*CORRELATION ANALYSIS

* specifying the variables to calculate correlation
correlate LossRatio CombinedRatio PremiumGrowth InflationWeatherrelateddisasters GDPgrowth Losses

*plotting the scatterplot with regression line. The dependentvariable
*is the Loss Ratio, the Independent variable is Losses
*(weather-related losses by Eurostat)
twoway (scatter LossRatio Losses) (lfit LossRatio Losses)

*GRAPHS

*plot time series of data
* step 1: specify only the time variable
tsset year
* step 2: specify the variable to plot, it is possible tospecify more
*than a single variable
```

```
tsline Losses

*plot density distribution of the 2 sub-samples but was notparametric
*so I decided to plot it with excel
kdensity LossRatio


*REGRESSIONS

*setting the dataset imported from Excel so that
*Stata sets the table as a Panel data
xtset ID YEAR

*Levin-Lin-Chu test for the dataset stationarity
xtunitroot llc LossRatio

*regression. The first variable specified is the dependentvariable,
*in this case the Loss Ratio. "fe" states the type of regressiondone,
*in this case is Fixed Effect
xtreg LossRatio PremiumGrowth Inflation WeatherrelateddisastersGDPgrowth , fe
estimates store fixed

*regression. The first variable specified is the dependentvariable,
*in this case the Loss Ratio. "re" states the type of regressiondone,
*in this case is Random Effect
xtreg LossRatio PremiumGrowth Inflation WeatherrelateddisastersGDPgrowth , re
estimates store random

*Hausman test. This test was used to decide the most efficienttype of test
*between Random and Fixed effects
hausman fixed random

```

Appendix 2

Stata output

In the following pages the outputs provided by Stata software are depicted to show the complete results of the analysis of the sample.

```
  ___  ____  ____  ____  ____ ©
 /__    /   ____/   /   ____/      17.0
___/   /   /___/   /   /___/       BE—Basic Edition

 Statistics and Data Science       Copyright 1985-2021 StataCorp LLC
                                   StataCorp
                                   4905 Lakeway Drive
                                   College Station, Texas 77845 USA
                                   800-STATA-PC        https://www.stata.com
                                   979-696-4600        stata@stata.com

Stata license: Unlimited-user network, expiring  6 Oct 2022
Serial number: 501709347316
  Licensed to: Marco Borsato
               Università Ca' Foscari di Venezia

Notes:
      1. Unicode is supported; see help unicode_advice.
      2. New update available; type -update all-

  1 .
  2 . import excel "/Users/marcoborsato/Desktop/Thesis/5_SAMPLE & ANALYSIS/0_DB/20220925 - db for stata.xlsx", sheet("DB
> new template") firstrow
(18 vars, 396 obs)

  3 . xtset ID YEAR

Panel variable: ID (strongly balanced)
 Time variable: YEAR, 2010 to 2021
         Delta: 1 unit

  4 . xtunitroot llc LossRatio

Levin–Lin–Chu unit-root test for LossRatio
──────────────────────────────────────────
H0: Panels contain unit roots                Number of panels  =     33
Ha: Panels are stationary                    Number of periods =     12

AR parameter: Common                         Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 7.00 lags average (chosen by LLC)
──────────────────────────────────────────────────────────────────────────────
                    Statistic      p-value
──────────────────────────────────────────────────────────────────────────────
 Unadjusted t        -12.5319
 Adjusted t*          -5.2647       0.0000
──────────────────────────────────────────────────────────────────────────────

  5 . xtreg LossRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , fe

Fixed-effects (within) regression               Number of obs     =        396
Group variable: ID                              Number of groups  =         33

R-squared:                                      Obs per group:
     Within  = 0.0229                                         min =         12
     Between = 0.0227                                         avg =       12.0
     Overall = 0.0177                                         max =         12

                                                F(4,359)          =       2.11
corr(u_i, Xb) = 0.0321                          Prob > F          =     0.0796

─────────────────────────────────────────────────────────────────────────────────────────
              LossRatio │ Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
────────────────────────┼────────────────────────────────────────────────────────────────
          PremiumGrowth │   .0873216   .0443267     1.97   0.050     .0001489    .1744942
              Inflation │  -.1642493    .568272    -0.29   0.773     -1.28181     .953311
Weatherrelateddisasters │   .0000736   .0000409     1.80   0.073    -6.77e-06     .000154
              GDPgrowth │  -.1664634   .1674443    -0.99   0.321    -.4957584    .1628316
```

```
                   _cons |   .6304057    .011877    53.08   0.000     .6070486    .6537629
-------------------------+----------------------------------------------------------------
                 sigma_u |  .08341213
                 sigma_e |  .08221641
                     rho |  .50721887   (fraction of variance due to u_i)
------------------------------------------------------------------------------------------
F test that all u_i=0: F(32, 359) = 12.33                    Prob > F = 0.0000

 6 . estimates store fixed

 7 . xtreg LossRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , re

Random-effects GLS regression                   Number of obs     =        396
Group variable: ID                              Number of groups  =         33

R-squared:                                      Obs per group:
     Within  = 0.0229                                         min =         12
     Between = 0.0227                                         avg =       12.0
     Overall = 0.0178                                         max =         12

                                                Wald chi2(4)      =       8.82
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0657

------------------------------------------------------------------------------------------
               LossRatio | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------------------+----------------------------------------------------------------
           PremiumGrowth |   .0907305   .0438959     2.07   0.039      .004696    .1767649
               Inflation |  -.1683225   .5677448    -0.30   0.767    -1.281082    .9444368
Weatherrelateddisasters  |   .0000737   .0000408     1.80   0.071    -6.34e-06    .0001537
               GDPgrowth |  -.1676345   .1672896    -1.00   0.316     -.495516    .1602471
                   _cons |   .6303333    .018403    34.25   0.000      .594264    .6664025
-------------------------+----------------------------------------------------------------
                 sigma_u |  .08087428
                 sigma_e |  .08221641
                     rho |   .4917712   (fraction of variance due to u_i)
------------------------------------------------------------------------------------------

 8 . estimates store random

 9 . hausman fixed random

Note: the rank of the differenced variance matrix (3) does not equal the number of coefficients being tested
        (4); be sure this is what you expect, or there may be problems computing the test.  Examine the output
        of your estimators for anything unexpected and possibly consider scaling your variables so that the
        coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference       Std. err.
-------------+----------------------------------------------------------------
PremiumGro~h |    .0873216     .0907305       -.0034089        .0061648
   Inflation |   -.1642493    -.1683225        .0040732        .0244741
Weatherrel~s |    .0000736     .0000737       -9.25e-08        1.69e-06
   GDPgrowth |   -.1664634    -.1676345        .0011711        .0071971
------------------------------------------------------------------------------
                          b = Consistent under H0 and Ha; obtained from xtreg.
           B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   0.31
Prob > chi2 = 0.9589

10 . clear all

11 .
12 . import excel "/Users/marcoborsato/Desktop/Thesis/5_SAMPLE & ANALYSIS/0_DB/20220925 - db for stata.xlsx", shee
> t("DB new template") firstrow
(18 vars, 396 obs)

13 . xtset ID YEAR
```

```
Panel variable: ID (strongly balanced)
 Time variable: YEAR, 2010 to 2021
         Delta: 1 unit
```

```
14 . xtunitroot llc CombinedRatio
```

Levin–Lin–Chu unit-root test for **CombinedRatio**

```
H0: Panels contain unit roots            Number of panels  =     33
Ha: Panels are stationary                Number of periods =     12

AR parameter: Common                     Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 7.00 lags average (chosen by LLC)
```

	Statistic	p-value
Unadjusted t	-13.6517	
Adjusted t*	3.5604	0.9998

```
15 . xtreg CombinedRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , fe
```

```
Fixed-effects (within) regression               Number of obs     =        396
Group variable: ID                              Number of groups  =         33

R-squared:                                      Obs per group:
     Within  = 0.0167                                         min =         12
     Between = 0.1101                                         avg =       12.0
     Overall = 0.0037                                         max =         12

                                                F(4,359)          =       1.52
corr(u_i, Xb) = -0.1173                         Prob > F          =     0.1954
```

CombinedRatio	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
PremiumGrowth	.0752627	.0466716	1.61	0.108	-.0165214	.1670467
Inflation	-.387628	.5983336	-0.65	0.517	-1.564307	.7890513
Weatherrelateddisasters	.000072	.000043	1.67	0.095	-.0000126	.0001566
GDPgrowth	-.1644679	.1763021	-0.93	0.352	-.5111826	.1822468
_cons	.909212	.0125053	72.71	0.000	.8846192	.9338047
sigma_u	.04761633					
sigma_e	.08656566					
rho	.2322848	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(32, 359) = 3.53                    Prob > F = 0.0000
```

```
16 . estimates store fixed

17 . xtreg CombinedRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , re
```

```
Random-effects GLS regression                   Number of obs     =        396
Group variable: ID                              Number of groups  =         33

R-squared:                                      Obs per group:
     Within  = 0.0159                                         min =         12
     Between = 0.1101                                         avg =       12.0
     Overall = 0.0052                                         max =         12

                                                Wald chi2(4)      =       4.54
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.3379
```

CombinedRatio	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
PremiumGrowth	.0473894	.0453326	1.05	0.296	-.0414609	.1362398

Inflation	**-.3543227**	**.6014642**	**-0.59**	**0.556**	**-1.533171**	**.8245255**
Weatherrelateddisasters	**.0000713**	**.0000433**	**1.65**	**0.099**	**-.0000135**	**.0001561**
GDPgrowth	**-.1548922**	**.177227**	**-0.87**	**0.382**	**-.5022508**	**.1924664**
_cons	**.9098045**	**.0141231**	**64.42**	**0.000**	**.8821237**	**.9374853**
sigma_u	**.03676568**					
sigma_e	**.08656566**					
rho	**.15281683**	(fraction of variance due to u_i)				

```
18 . estimates store random

19 . hausman fixed random
```

Note: the rank of the differenced variance matrix (**3**) does not equal the number of coefficients being tested (**4**); be sure this is what you expect, or there may be problems computing the test. Examine the output of your estimators for anything unexpected and possibly consider scaling your variables so that the coefficients are on a similar scale.

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
PremiumGro~h	**.0752627**	**.0473894**	**.0278732**	**.011099**
Inflation	**-.387628**	**-.3543227**	**-.0333053**	**.**
Weatherrel~s	**.000072**	**.0000713**	**7.56e-07**	**.**
GDPgrowth	**-.1644679**	**-.1548922**	**-.0095758**	**.**

b = Consistent under H0 and Ha; obtained from **xtreg**.
B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**.

Test of H0: Difference in coefficients not systematic

```
    chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   6.31
Prob > chi2 = 0.0976
(V_b-V_B is not positive definite)

20 .
```

```
  ___  ____  ____  ____  ____ ©
 /__    /   ____/   /   ____/      17.0
___/   /   /___/   /   /___/       BE—Basic Edition

 Statistics and Data Science       Copyright 1985-2021 StataCorp LLC
                                   StataCorp
                                   4905 Lakeway Drive
                                   College Station, Texas 77845 USA
                                   800-STATA-PC        https://www.stata.com
                                   979-696-4600        stata@stata.com

Stata license: Unlimited-user network, expiring  6 Oct 2022
Serial number: 501709347316
  Licensed to: Marco Borsato
               Università Ca' Foscari di Venezia

Notes:
      1. Unicode is supported; see help unicode_advice.
      2. New update available; type -update all-

1 .
2 . import excel "/Users/marcoborsato/Desktop/Thesis/5_SAMPLE & ANALYSIS/0_DB/20220925 - db for stata.xlsx", sheet(
  > "sample 1") firstrow
  (18 vars, 156 obs)

3 . xtset ID YEAR

  Panel variable: ID (strongly balanced)
   Time variable: YEAR, 2010 to 2021
           Delta: 1 unit

4 . xtunitroot llc LossRatio

  Levin–Lin–Chu unit-root test for LossRatio
  ───────────────────────────────────────────
  H0: Panels contain unit roots              Number of panels  =     13
  Ha: Panels are stationary                  Number of periods =     12

  AR parameter: Common                       Asymptotics: N/T -> 0
  Panel means:  Included
  Time trend:   Not included

  ADF regressions: 1 lag
  LR variance:     Bartlett kernel, 7.00 lags average (chosen by LLC)
  ──────────────────────────────────────────────────────────────────────────────
                       Statistic      p-value
  ──────────────────────────────────────────────────────────────────────────────
   Unadjusted t        -11.7641
   Adjusted t*          -6.4154        0.0000
  ──────────────────────────────────────────────────────────────────────────────

5 . xtreg LossRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , fe

  Fixed-effects (within) regression               Number of obs     =        156
  Group variable: ID                              Number of groups  =         13

  R-squared:                                      Obs per group:
       Within  = 0.0203                                         min =         12
       Between = 0.1342                                         avg =       12.0
       Overall = 0.0057                                         max =         12

                                                  F(4,139)          =       0.72
  corr(u_i, Xb) = -0.0923                         Prob > F          =     0.5804

  ─────────────────────────────────────────────────────────────────────────────────────────
                LossRatio │ Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
  ────────────────────────┼────────────────────────────────────────────────────────────────
            PremiumGrowth │   .0714086   .0899138     0.79   0.428    -.1063668    .2491841
                Inflation │  -.6323039   .9647469    -0.66   0.513     -2.53978    1.275172
  Weatherrelateddisasters │   .0000925   .0000696     1.33   0.186    -.0000452    .0002302
                GDPgrowth │  -.2220441   .2910355    -0.76   0.447    -.7974729    .3533848
                    _cons │   .6461116   .0202132    31.96   0.000     .6061465    .6860767
  ────────────────────────┼────────────────────────────────────────────────────────────────
                  sigma_u │  .05434022
```

```
             sigma_e    .08798827
                 rho    .27610249   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(12, 139) = 4.43                    Prob > F = 0.0000

 6 . estimates store fixed

 7 . xtreg LossRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , re

Random-effects GLS regression                   Number of obs     =        156
Group variable: ID                              Number of groups  =         13

R-squared:                                      Obs per group:
     Within  = 0.0195                                         min =         12
     Between = 0.1342                                         avg =       12.0
     Overall = 0.0083                                         max =         12

                                                Wald chi2(4)      =       2.44
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.6548

------------------------------------------------------------------------------------------
              LossRatio  Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
------------------------------------------------------------------------------------------
          PremiumGrowth    .0407099   .0877276     0.46   0.643    -.1312331    .2126529
              Inflation   -.6320124   .9683124    -0.65   0.514     -2.52987    1.265845
Weatherrelateddisasters    .0000924   .0000699     1.32   0.186    -.0000446    .0002294
              GDPgrowth   -.2008327   .2917446    -0.69   0.491    -.7726416    .3709761
                  _cons    .6464584    .023852    27.10   0.000     .5997094    .6932074
------------------------------------------------------------------------------------------
                sigma_u    .04506479
                sigma_e    .08798827
                    rho    .20780548   (fraction of variance due to u_i)
------------------------------------------------------------------------------------------

 8 . estimates store random

 9 . hausman fixed random

Note: the rank of the differenced variance matrix (3) does not equal the number of coefficients being tested (4); be
        sure this is what you expect, or there may be problems computing the test.  Examine the output of your
        estimators for anything unexpected and possibly consider scaling your variables so that the coefficients are
        on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference       Std. err.
-------------+----------------------------------------------------------------
PremiumGro~h |    .0714086     .0407099        .0306987        .0197064
   Inflation |   -.6323039    -.6320124       -.0002915               .
Weatherrel~s |    .0000925     .0000924        1.17e-07               .
   GDPgrowth |   -.2220441    -.2008327       -.0212114               .
------------------------------------------------------------------------------
                          b = Consistent under H0 and Ha; obtained from xtreg.
           B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   2.43
Prob > chi2 = 0.4887
(V_b-V_B is not positive definite)

10 .
```

```
  ___  ____  ____  ____  ____ ©
 /__    /   ____/   /   ____/      17.0
___/   /   /___/   /   /___/       BE—Basic Edition

 Statistics and Data Science       Copyright 1985-2021 StataCorp LLC
                                   StataCorp
                                   4905 Lakeway Drive
                                   College Station, Texas 77845 USA
                                   800-STATA-PC        https://www.stata.com
                                   979-696-4600        stata@stata.com

Stata license: Unlimited-user network, expiring  6 Oct 2022
Serial number: 501709347316
  Licensed to: Marco Borsato
               Università Ca' Foscari di Venezia

Notes:
      1. Unicode is supported; see help unicode_advice.
      2. New update available; type -update all-
```

```
1 .
2 . import excel "/Users/marcoborsato/Desktop/Thesis/5_SAMPLE & ANALYSIS/0_DB/20220925 - db for stata.xlsx", sheet("sam
> ple 2") firstrow
(18 vars, 240 obs)

3 . xtset ID YEAR

Panel variable: ID (strongly balanced)
 Time variable: YEAR, 2010 to 2021
         Delta: 1 unit

4 . xtunitroot llc LossRatio

Levin—Lin—Chu unit-root test for LossRatio
──────────────────────────────────────────

H0: Panels contain unit roots              Number of panels  =     20
Ha: Panels are stationary                  Number of periods =     12

AR parameter: Common                       Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 7.00 lags average (chosen by LLC)
──────────────────────────────────────────────────────────────────────────────
                    Statistic      p-value
──────────────────────────────────────────────────────────────────────────────
 Unadjusted t        -6.2605
 Adjusted t*         -1.1149        0.1324
──────────────────────────────────────────────────────────────────────────────

5 . xtreg LossRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , fe

Fixed-effects (within) regression               Number of obs     =        240
Group variable: ID                              Number of groups  =         20

R-squared:                                      Obs per group:
     Within  = 0.0291                                         min =         12
     Between = 0.1126                                         avg =       12.0
     Overall = 0.0335                                         max =         12

                                                F(4,216)          =       1.62
corr(u_i, Xb) = 0.0930                          Prob > F          =     0.1713
```

LossRatio	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
PremiumGrowth	.09219	.0503878	1.83	0.069	-.0071248	.1915048
Inflation	.1305161	.7045408	0.19	0.853	-1.258139	1.519171
Weatherrelateddisasters	.0000615	.0000504	1.22	0.224	-.0000379	.0001608
GDPgrowth	-.1237623	.2056643	-0.60	0.548	-.5291281	.2816036
_cons	.6201788	.0146631	42.30	0.000	.5912776	.6490799
sigma_u	.09813272					

```
             sigma_e |  .07890922
                 rho |  .60731636   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(19, 216) = 18.28                    Prob > F = 0.0000

6 . estimates store fixed

7 . xtreg LossRatio PremiumGrowth Inflation Weatherrelateddisasters GDPgrowth , re

Random-effects GLS regression                   Number of obs     =        240
Group variable: ID                              Number of groups  =         20

R-squared:                                      Obs per group:
     Within  = 0.0290                                         min =         12
     Between = 0.1126                                         avg =       12.0
     Overall = 0.0343                                         max =         12

                                                Wald chi2(4)      =       7.03
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.1345

------------------------------------------------------------------------------
           LossRatio | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
---------------------+--------------------------------------------------------
       PremiumGrowth |   .0993086   .0501659     1.98   0.048     .0009854    .1976319
           Inflation |   .1165252   .7055083     0.17   0.869    -1.266246    1.499296
Weatherrelateddisasters |   .0000618   .0000505     1.22   0.221    -.0000372    .0001607
           GDPgrowth |  -.1246004   .2059696    -0.60   0.545    -.5282933    .2790926
               _cons |   .6199813   .0255908    24.23   0.000     .5698242    .6701385
---------------------+--------------------------------------------------------
             sigma_u |  .09359067
             sigma_e |  .07890922
                 rho |  .58449783   (fraction of variance due to u_i)
------------------------------------------------------------------------------

8 . estimates store random

9 . hausman fixed random

Note: the rank of the differenced variance matrix (3) does not equal the number of coefficients being tested (4); be
        sure this is what you expect, or there may be problems computing the test.  Examine the output of your
        estimators for anything unexpected and possibly consider scaling your variables so that the coefficients are
        on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference       Std. err.
-------------+----------------------------------------------------------------
PremiumGro~h |      .09219     .0993086       -.0071187        .0047245
   Inflation |    .1305161     .1165252         .013991               .
Weatherrel~s |    .0000615     .0000618       -3.01e-07               .
   GDPgrowth |   -.1237623    -.1246004        .0008381               .
------------------------------------------------------------------------------
                          b = Consistent under H0 and Ha; obtained from xtreg.
           B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   2.27
Prob > chi2 = 0.5182
(V_b-V_B is not positive definite)

10 .
```

References

Bleda, M. and Shackley, S., 2008. The dynamics of belief in climate change and its risks in business organisations. *Ecological Economics*, 66(2-3), pp.517-532.

Busch, T. and Hoffmann, V., 2009. Ecology-Driven Real Options: An Investment Framework for Incorporating Uncertainties in the Context of the Natural Environment. *Journal of Business Ethics*, 90(2), pp.295-310.

Dlugolecki, A., 2007. Climate Change and the Insurance Sector. *The Geneva Papers on Risk and Insurance - Issues and Practice*, 33(1), pp.71-90.

Doherty, N., 1981. The Measurement of Output and Economies of Scale in Property-Liability Insurance. *The Journal of Risk and Insurance*, 48(3), p.390.

Dorofti, C. and Jakubik, P., 2015. [online] Available at: <https://www.semanticscholar.org/paper/Insurance-Sector-Profitability-and-the-Environment-Dorofti-Jakubik/0e2c57cc6bcd7409eb5ca4c23bb09c148bcfb6fb> [Accessed 18 August 2022].

Eiopa - European Commission. 2022. *Classes of Non-Life Insurance - Eiopa European Commission*. [online] Available at: <https://www.eiopa.europa.eu/rulebook/solvency-ii/article-2548_en> [Accessed 18 July 2022]

European Commission - European Commission. 2022. *Financial literacy*. [online] Available at: <https://ec.europa.eu/info/business-economy-euro/banking-and-finance/consumer-finance-and-payments/financial-literacy_en> [Accessed 24 July 2022].

Fecher, F., Perelman, S. and Pestieau, P., 1993. Scale economies and performance in the French insurance industry. *Insurance: Mathematics and Economics*, 12(1), pp.87-88.

Gibson, L., 2008. The Contemporary Treatment of Risk, Uncertainty and Complexity in Decisionmaking in Selected Disciplines. *The OMEGA 1 Project*, pp.53-71.

Grubel, H., 1971. Risk, Uncertainty and Moral Hazard. *The Journal of Risk and Insurance*, 38(1), p.99.

Hertin, J., Berkhout, F., Gann, D. and Barlow, J., 2003. Climate change and the UK house building sector: perceptions, impacts and adaptive capacity. *Building Research & Information*, 31(3-4), pp.278-290.

Herweijer, C., Ranger, N. and Ward, R., 2009. Adaptation to Climate Change: Threats and Opportunities for the Insurance Industry. *The Geneva Papers on Risk and Insurance - Issues and Practice*, 34(3), pp.360-380.

Insurance Information Institute, 2010. *TERRORISM RISK: A REEMERGENT THREAT*. [online] Insurance Information Institute. Available at: <https://www.iii.org> [Accessed 4 July 2022].

Investing.com. 2022. *Investing.com - Stock Market Quotes & Financial News*. [online] Available at: <https://www.investing.com/> [Accessed multiple times].

Keskitalo, E., Vulturius, G. and Scholten, P., 2013. Adaptation to climate change in the insurance sector: examples from the UK, Germany and the Netherlands. *Natural Hazards*, 71(1), pp.315-334.

Klein, R., Schipper, E. and Dessai, S., 2005. Integrating mitigation and adaptation into climate and development policy: three research questions. *Environmental Science & Policy*, 8(6), pp.579-588.

Mills, E., 2009. A Global Review of Insurance Industry Responses to Climate Change. *The Geneva Papers on Risk and Insurance - Issues and Practice*, 34(3), pp.323-359.

Pagano, A., Feofilovs, M. and Romagnoli, F., 2018. The relationship between insurance companies and natural disaster risk reduction: overview of the key characteristics and mechanisms dealing with climate change. *Energy Procedia*, 147, pp.566-572.

Pielke, R., 2005. Misdefining “climate change”: consequences for science and action. *Environmental Science & Policy*, 8(6), pp.548-561.

Price Waterhouse Cooper, 2019. IFRS 17, Insurance Contracts: An illustration. [online] pp.1-144. Available at: <https://www.pwc.com/id/en/publications/assurance/ifrs-17-insurance-contracts.pdf> [Accessed 17 July 2022].

Reichert, P. and Borsuk, M., 2005. Does high forecast uncertainty preclude effective decision support?. *Environmental Modelling & Software*, 20(8), pp.991-1001.

Schmit, J., 1986. A New View of the Requisites of Insurability. *The Journal of Risk and Insurance*, 53(2), p.320.

Sg-reinsurers.org.sg. 2022. *Glossary of Reinsurance Terms | Singapore Reinsurers Association*. [online] Available at: <https://sg-reinsurers.org.sg/glossary-reinsurance-terms> [Accessed 10 July 2022].

Simons, R., 2014. *Performance measurement and control systems for implementing strategy*. 1st ed. Harlow: Pearson Education Limited, pp.70-75.

Stechemesser, K., Endrikat, J., Grasshoff, N. and Guenther, E., 2015. Insurance Companies' Responses to Climate Change: Adaptation, Dynamic Capabilities and Competitive Advantage. *The Geneva Papers on Risk and Insurance - Issues and Practice*, 40(4), pp.557-584.

Swiss Re Corporate History, 2017. La storia delle assicurazioni in Italia.

Todorov, A., 1986. Reply. *Journal of Climate and Applied Meteorology*, 25(2), pp.258-259.

Trenerry, C., 1926. *The origin and early history of insurance*. London: P.S. King & Son.

Vlassopoulos, C. A., 2012. Competing definition of climate change and the post-Kyoto negotiations. *International Journal of Climate Change Strategies and Management*, 4(1), pp.104-118.

Whelan, T. and Douglas, E., 2021. How to Talk to Your CFO About Sustainability. *Harvard Business Review*, January–February 2021.

Werndl, C., 2016. On Defining Climate and Climate Change. *The British Journal for the Philosophy of Science*, 67(2), pp.337-364.

2022. World insurance outlook post-covid-19. [online] Available at: <https://www.swissre.com/institute/> [Accessed 4 July 2022].

Zillman, 1997. The IPCC: A View from the Inside. *Australian APEC Study Centre*,.

A papà e mamma. A Gianni. A Michi.