Actuarial Risk Approach to the Insurance Protection Gap

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About the speaker

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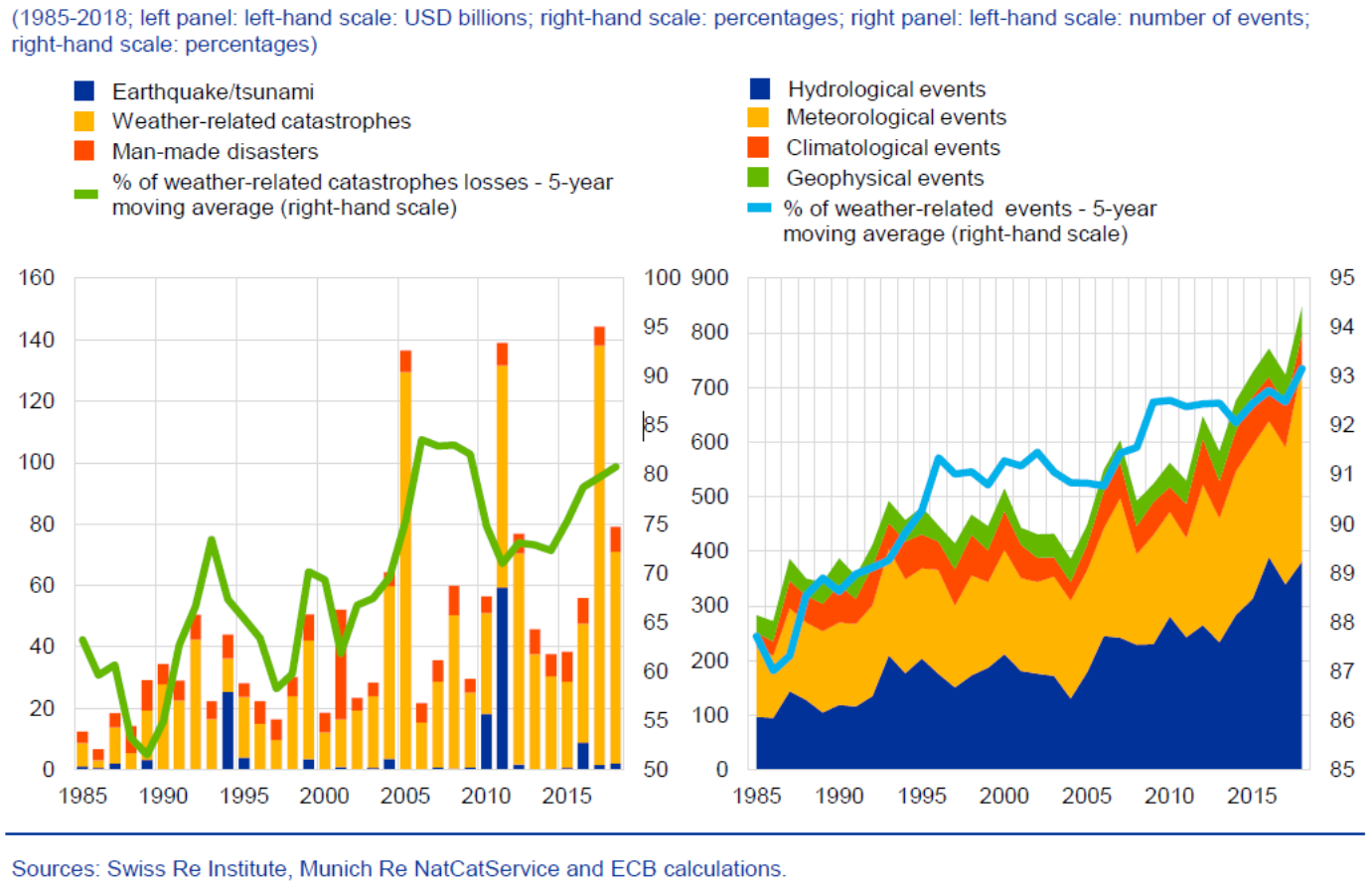
Disclaimer

- *The work presented hereafter is a theoretical approach developed independently by the author. The views and opinions expressed in this presentation are solely those of the author, and do not necessarily represent the views of Ageas or any of its subsidiaries*.

Executive Summary

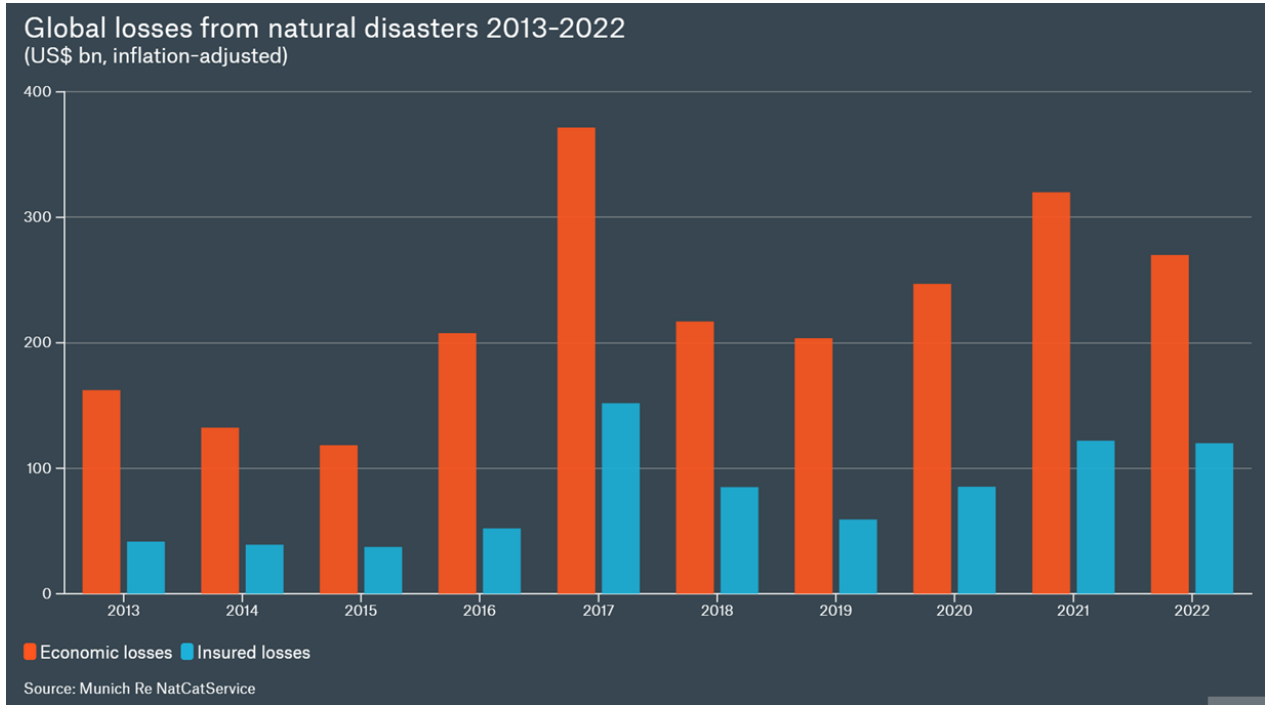
- The **Insurance Protection Gap** (**IPG**) describes the scale of uninsured losses in some country
  - Insurance protection gaps are costly to society
  - EIOPA's work on protection gaps aims to efficiently manage the European IPG
- Climate projections indicate that the **frequency & severity** of **extreme events** (heat waves, droughts, flood, storm, and wind speeds) is likely to increase in all main European regions [EEA No 1/2017]
  - There is evidence of increasing catastrophic losses due to natural disaster leading to global trends of:
    - Reducing reinsurance capacity
    - Expanding **CAT bond** and **insurance-linked security** (ILS) markets
- This paper introduces an Actuarial-Based model approach that:
  - Explicitly describes **the link between catastrophe risks and financial markets**
  - Provides a measure of actuarial-induced financial vulnerability contributing to efficiently managing the IPG

PART #1
Global Trend of Rising CAT Losses from Natural Disaster (1/2)

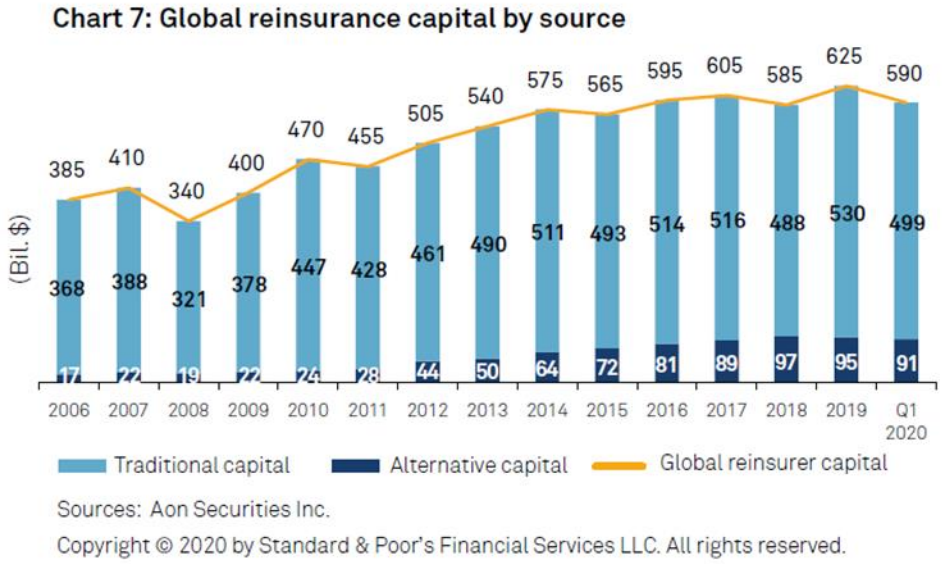


Global insured catastrophe losses (left panel) and number of relevant natural loss events worldwide (right panel).
Reproduced from: European Central Bank (2019). Financial Stability Review May 2019

Global Trend of Rising CAT Losses from Natural Disaster (2/2)



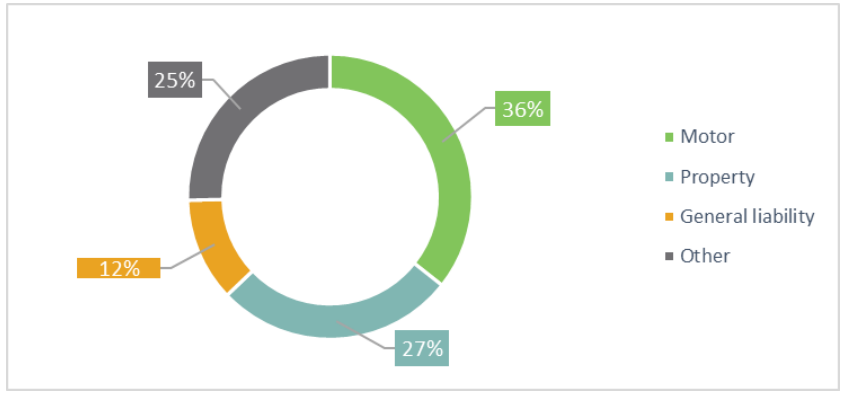
Raising trend in catastrophe losses. Losses from natural disasters in 2022 amount up to US$ 270bn. Roughly 55% was not insured.
Reproduced from: *Natural disaster risks*, Munich Re.
https://www.munichre.com/en/risks/natural-disasters.html

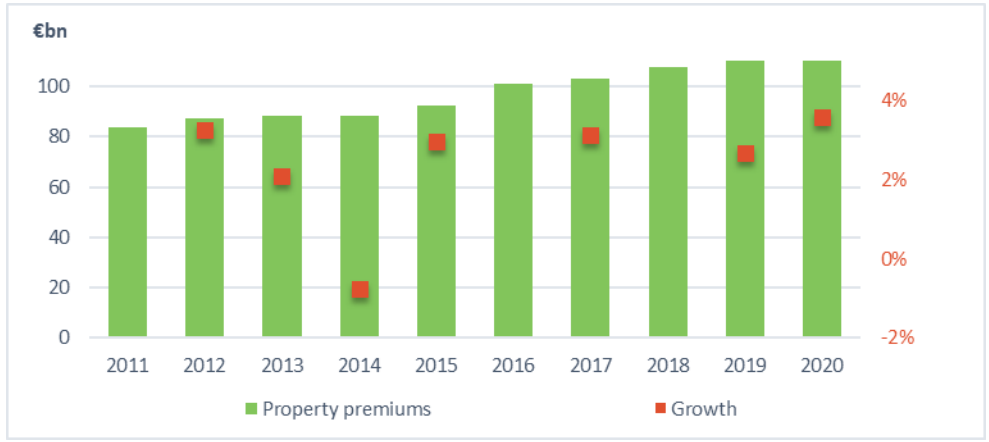


Global reinsurance capital (2006-2020Q1).
Reproduced from:
Standard & Poor's (2020). *Global Reinsurance Highlights 2020*.
New York City: Standard & Poor's Financial Services L.L.C.

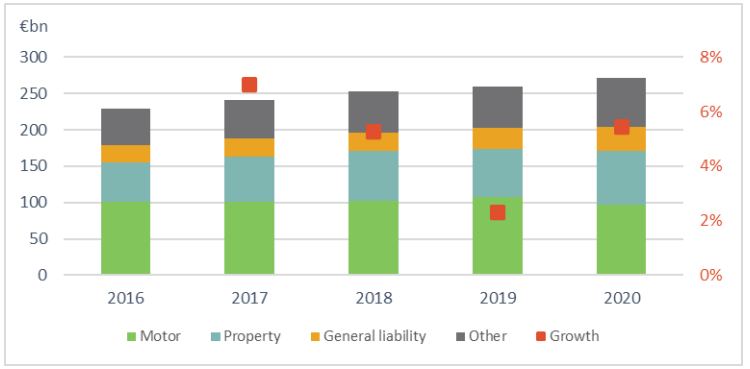
P&C Premiums and Claims Paid – Insurance Europe DB

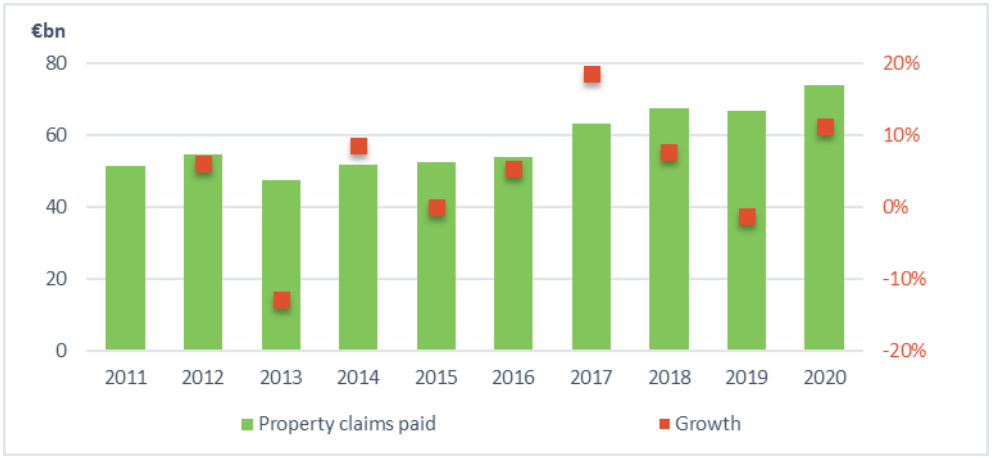
- P&C premiums - 2011-2020 (€bn)





- P&C claims paid - 2011-2020 (€bn)



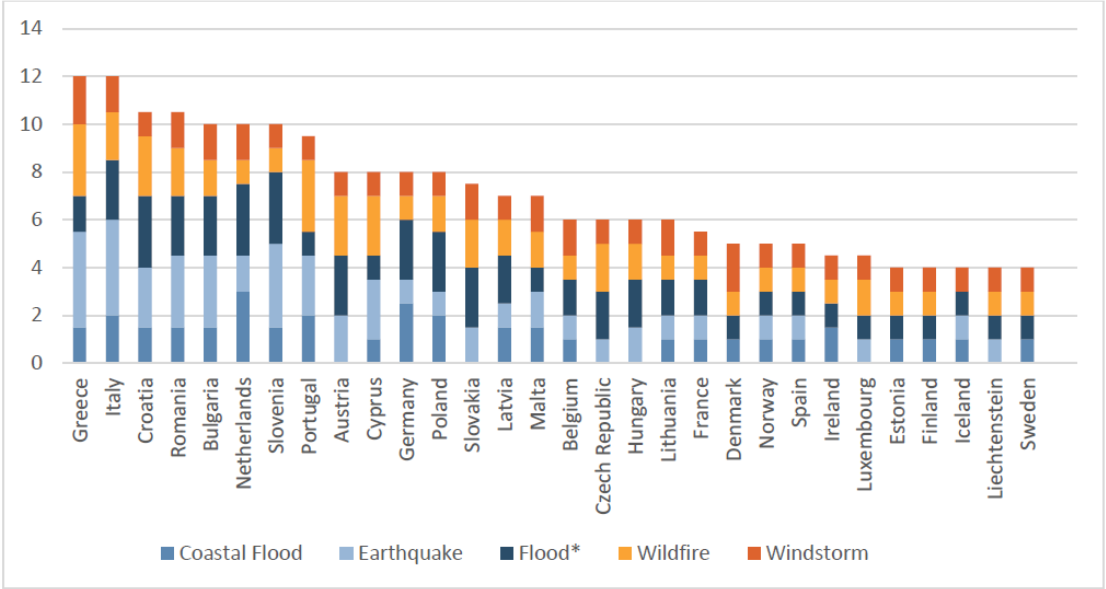


Source: Insurance Europe Database https: //www.insuranceeurope.eu/statistics

PART #2
Insurance Protection Gap in Europe (1/2)

- **Historical** insurance protection gap [EIOPA-22/507]
  - Only a quarter of the losses related to extreme weather events observed accross Europe during the period from 1980-2021 were actually insured
  - Italy-Earthquake, Germany-Flood and Italy-Flood are the peril regions that show the highest levels of uninsured losses, due to very low rates of insurance penetration (97%, 77% and 97% of these historical losses were uninsured)

Peril Region	% of total uninsured losses considering all perils in the EEA	Uninsured losses (1980-2022) in percentage of total economic losses
Italy Earthquake	24%	97%
Germany Flood	13%	77%
Italy Flood	11%	97%



- **Current** insurance protection gap 2023 [EIOPA-22/507]
  - Greece and Italy have the highest total current insurance protection gap score because of high hazard rates and very low insurance penetrations – particularly for earthquakes

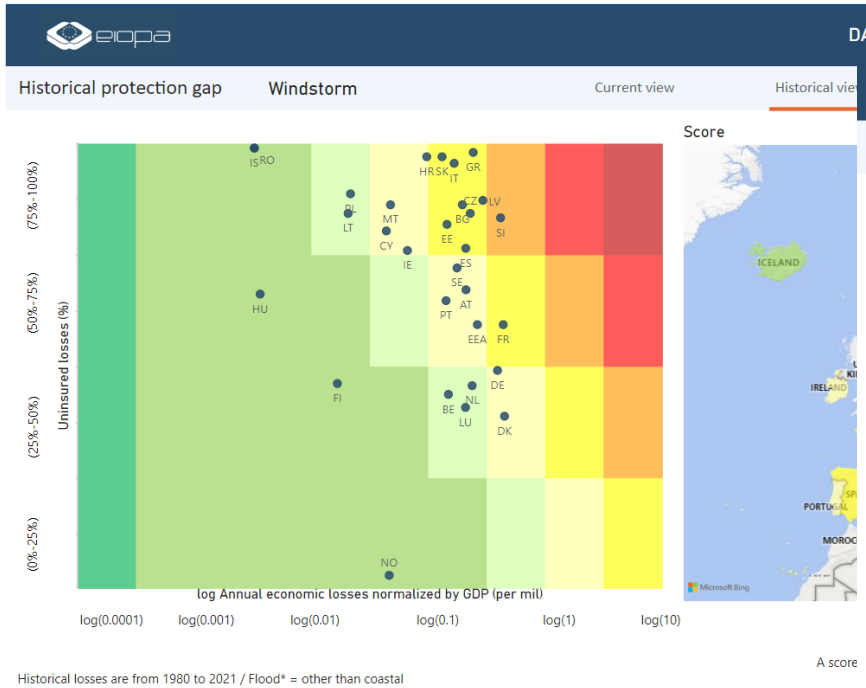
Insurance Protection Gap in Europe (2/2)

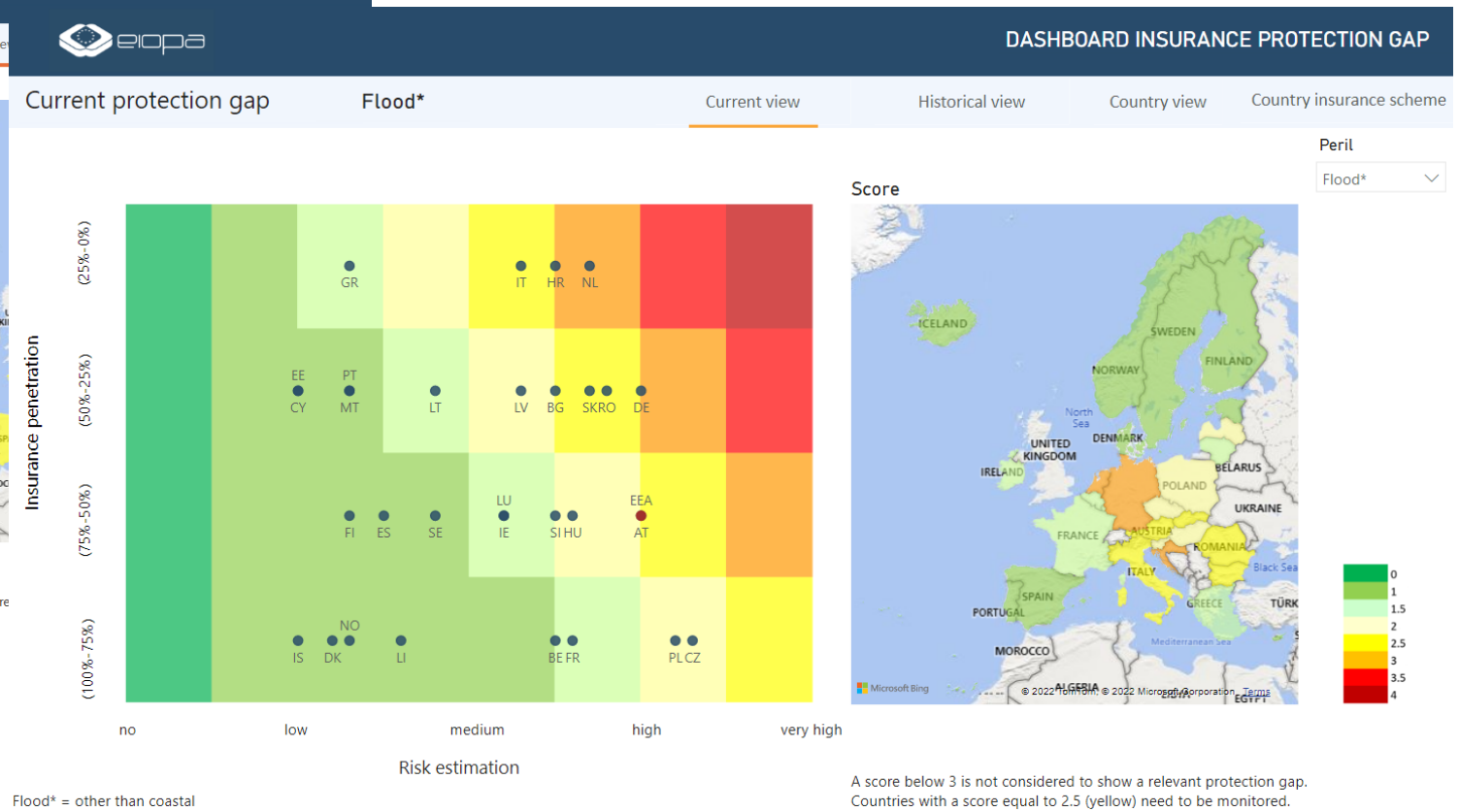
- The European IPG has become a main focus of EIOPA:
  - *EIOPA's work on protection gaps aims to raise risk awareness and inform, with technical analysis, the discussion on measures to improve risk assessment, risk prevention and adaptation measures, as well as incentives for appropriate product design and risk transfer for climate change and pandemic risks* (EIOPA: Sustainable Finance Activities 2022-2024)
- It is key to **understand and to describe** the IPG:
  - Estimation of the probability of NAT CAT events
  - Localisation of major exposures & vulnerabilities
  - Optimised insurance coverage
- Develop proactive prevention measures:
  - **Monitor the risks** related to the insurance protection gap for **Nat Cat in Europe**
  - Identify & **monitor vulnerabilities** both in physical infrastructures & (re)insurance markets

EIOPA Dashboard on the IPG (1/3)

- The EIOPA Dashboard measures the IPG by a current & historical view:
  - The **current protection gap** is described by means of a composite measure of insurance coverage and accepted risk
    - Latest information on hazards, exposures, vulnerabilities and insurance coverage
  - The **historical protection gap** is based on historical data on economic and insured losses
    - Past information on hazards, exposures, vulnerabilities and insurance coverage
- The current protection gap provides a more appropriate view of today's risk from a hazard perspective
  - Incorporates the latest available information
  - Incorporates plausible events that have not been yet observed historically
    - *Only because some event has not occurred in that past does not mean it cannot or would not in the near future* [EIOPA-22/507]

EIOPA Dashboard on the IPG (2/3)





Screenshots of the dashboard of the historical and current views of the European insurance gap for 2022 [EIOPA-22/507]

EIOPA Dashboard on the IPG (3/3)

- The **Current IPG** contributes to manage the protection gap by:
  - Monitoring the exposure impacted by the hazard
    - A main driver of the increase observed in **NAT CAT losses** is the growth in exposure
      - Get reliable data about exposures
      - Locate risk areas by using hazard maps
  - Optimising the **NAT CAT insurance schemes** within Europe
- Decreasing the **vulnerabilities** of physical infrastructure should be a clear goal when managing the IPG
  - Dynamics such as increasing value of assets, new growth regions, people concentrating in high-hazard areas may contribute strongly to potential high NAT CAT losses
  - **Resilience actions** are possible, e.g. build back better, developing building codes, etc.

PART #3
EIOPA Science-Based Approach

- EIOPA proposes to adopt a **science-based approach** to IPG management and decision-making, explicitly dependent on **risk drivers** and **regions at-risk**
- The IPG is measured in terms of:
  - Hazard
  - Exposure
  - Vulnerability
  - Insurance coverage

Elements of the protection gap and their descriptions [EIOPA-22/507].

Benchmark Actuarial Theoretical Setting (1/3)

- We next propose a science-based approach to the management of insurance risks within an actuarial risk theoretical framework
  - Based on estimations of the **Excess-Probability** defined as the probability that a random loss exceeds a certain amount during a predefined future period of time (hazard dimension)
- Theoretical model adopted in this presentation:
  - Provides insight into the determinant factors of the market prices of financial products contingent on catastrophe risks
  - Explicitly describes the **link between catastrophe risks and financial markets**
    - Undertakers must rely on short-term (wholesale) funding raised in financial markets to ensure they constantly hold enough capital to secure the losses derived from the risk they retain of their insurance portfolios (not ceded to reinsurance)

Benchmark Actuarial Theoretical Setting (2/3)

- The optimal contract minimises the **cost of issuing a stop-loss** (non-proportional) insurance policy covering financial losses for catastrophe perils:

$$\min_{\lambda} E_{\theta}\left[L \cdot \left(X_{(-)} - \lambda\right)_{+}\right] = L \cdot \int_{+\lambda}^{+\infty} T_{\theta, X_{(-)}}(x - \lambda) \cdot dx$$

$$s.t. \quad E_{\theta}\left[X_{(+)}\right] - (r_0 + \delta) \cdot \lambda > \frac{P}{L} - 1$$

- $T_{\theta,X}(x+\lambda) = T_X(x+\lambda)^{1/\theta}$: **distorted tail-probability** function
- $X_{(+)}$ & $X_{(-)}$: resp. random profit & loss of the asset pool
- P , L : resp. aggregate gross premium and claim loss level
- λ , θ : resp. retention level (**risk-sharing**) and information parameter
- r_0 , δ : resp. reference (risk-free) interest rate and **credit-default spread**

Benchmark Actuarial Theoretical Setting (3/3)

- Given any **target retention policy**, under the condition of equilibrium in liquidity markets, the optimal level of credit-default spreads is determined by the level of **Excess-Probability**:

$$r_0 + \delta^* = \left[P\{X_{(-)} > \alpha\}\right]^{1/\theta}$$

$B = \alpha \cdot M$

- α : **target retention policy** (optimal risk sharing)
- B : aggregate stock of capital consistent with the adopted target retention policy (**liquidity balance**)
- M: aggregate supply of liquidity

- The assumption of **Pareto** and **Exponential** loss tails leads resp. to **loglinear** and **semi-log linear** specifications:

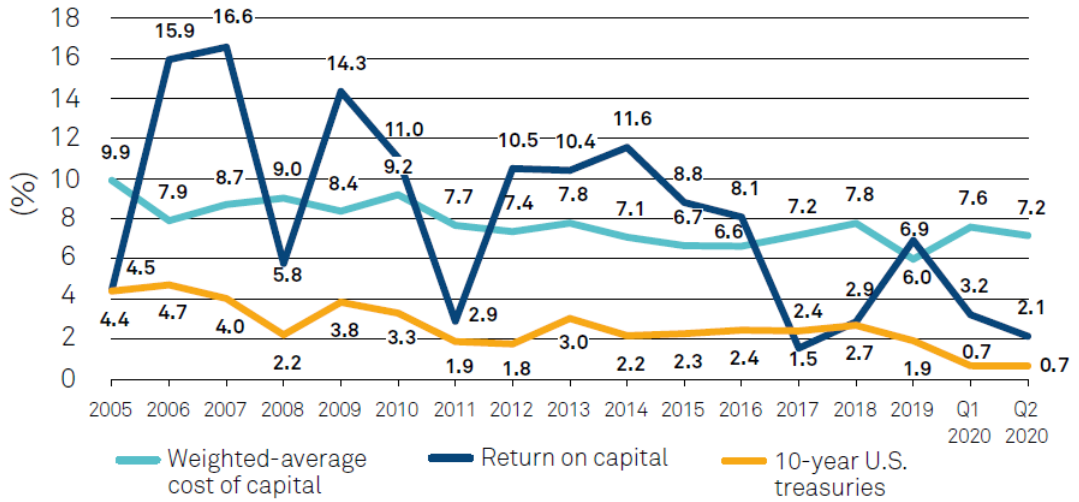
$$r_0 + \delta^* = \alpha^{-\gamma/\theta} \quad \wedge \quad \mu_{(-)} = \frac{\gamma}{\gamma - 1} \qquad r_0 + \delta^* = \left[exp\left(\frac{-\alpha}{\mu_{(-)}}\right)\right]^{1/\theta}$$

$$r_0 + \delta^* = \left[1 - \Phi\left(\frac{\mu_{(-)} - \alpha}{\sigma_{(-)}}\right)\right]^{1/\theta}$$

- $\mu_{(-)}$ & $\sigma_{(-)}$: resp. expected loss & expected loss deviation
- $\Phi(\cdot)$: **Gaussian(0,1)** cumulative probability function

PART #4
Implied Financial Vulnerability

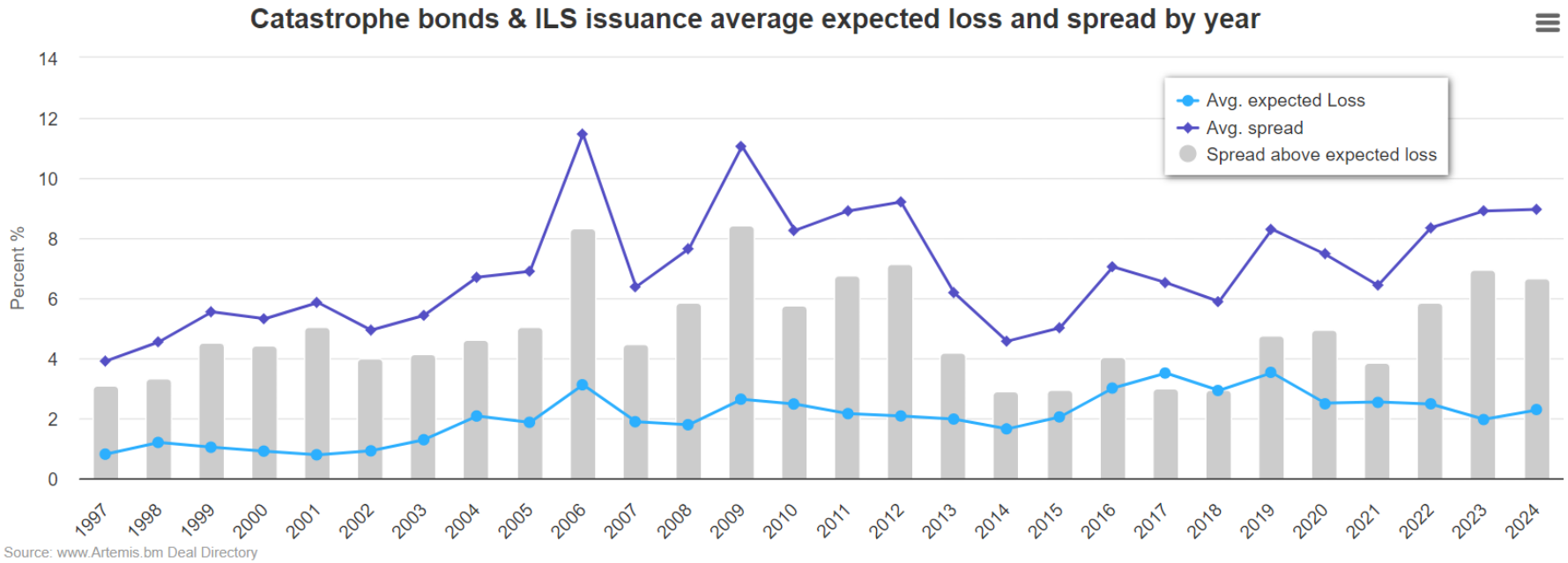
Chart 6: Reinsurers weighted-average cost of capital versus return on capital



Source: S&P Global Ratings, Bloomberg.

- *In 2019, alternative capital in the reinsurance market decreased for the first time since the 2008 financial crisis, and the trend has continued in 2020.*
- *The decrease in alternative capital was caused by dismal returns in the past few years, loss payments, and loss creep from earlier events, […]*
- *These factors […] have triggered redemptions by some investors while others paused to reassess their appetite for insurance risk.*
- Reproduced from: Standard & Poor's (2020). Global Reinsurance Highlights 2020. New York City: Standard & Poor's Financial Services L.L.C.

CAT Bond Expected Losses & Coupons (1997-2024)

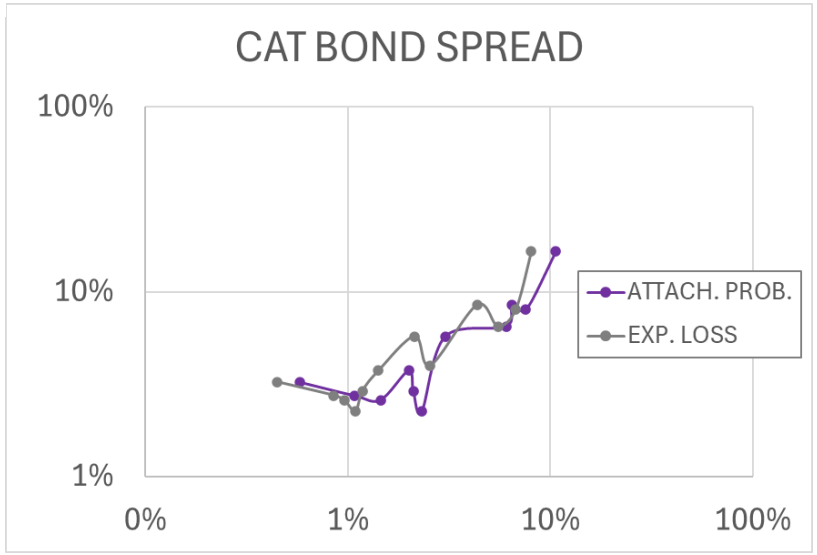


- *Yield spreads have tended to increase since 2013, with record insurance losses driven in part by Hurricanes Harvey, Irma, and Maria, as well as wildfires in the U.S. Additional years of losses for the insurance industry have continued setting a pressure for rising expected yield spreads*. Credit Suisse (2022). Paradigm shift in the catastrophe insurance market - What does it mean for Cat Bonds? November 16, 2022.
- *Self-insurance can save the coupon payment to investors, […] however, [cash] needs to be stored in a dedicated fund […] Therefore, for countries with large opportunity costs, self-insurance can be more expensive than catastrophe bonds*. Sovereign Climate Debt Instruments: An Overview of the Green and Catastrophe Bond Markets. IMF Staff Climate Note 2022/004.
- Source data: https://www.artemis.bm/dashboard/cat-bonds-ils-expected-loss-coupon/

CAT Bonds Issuance – Artemis DB

Alternative formula for the spread of catastrophe bonds as a function of the Expected Loss is derived by S. Christofides **[ASTIN 2004]**

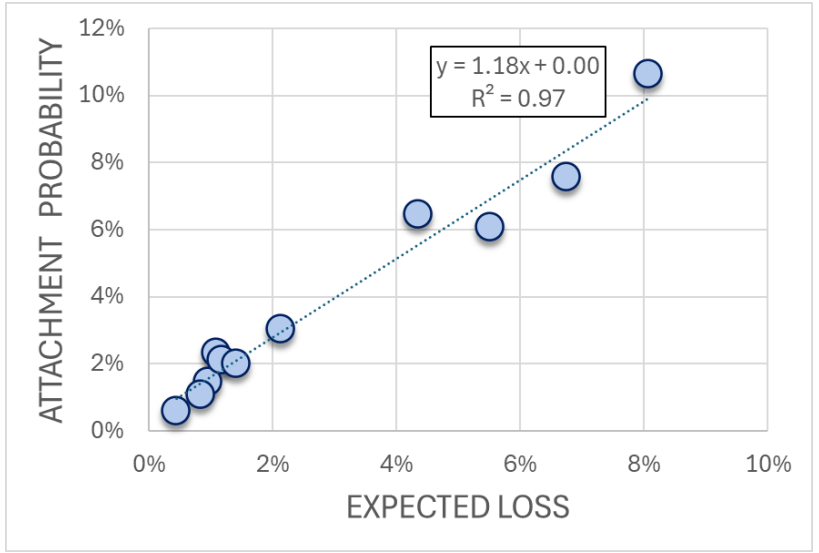
$$\text{Spread} = \text{EL}^{(1/\rho)}$$



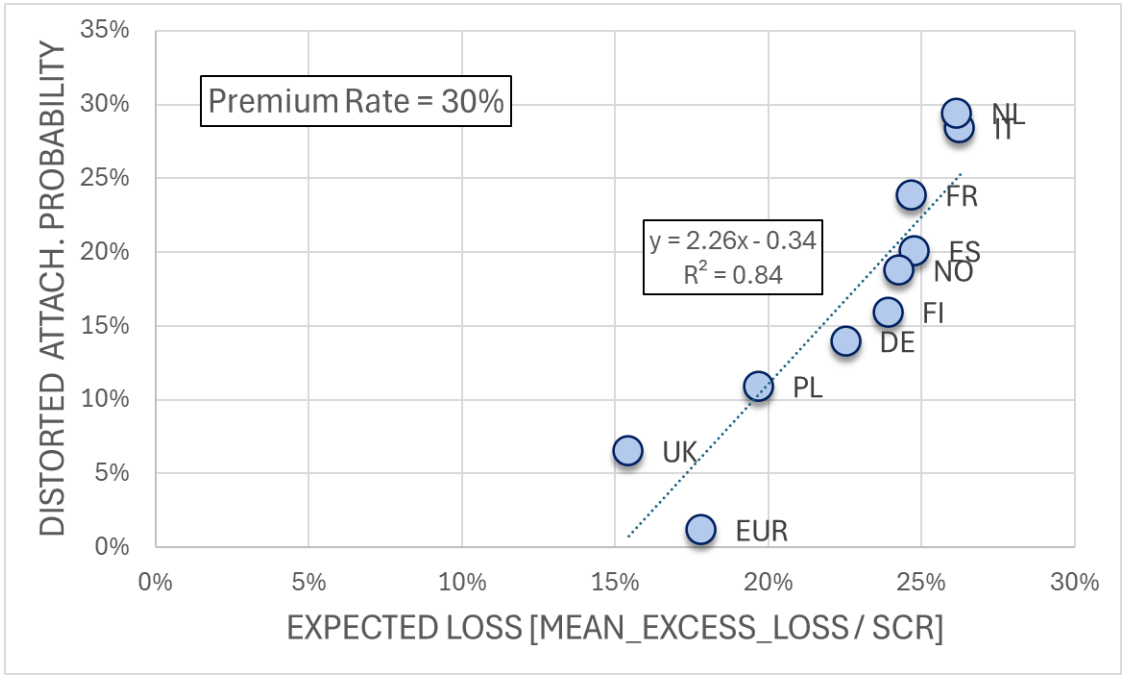
$$r_0 + \delta^* = \left[P\{X_{(-)} > \alpha\}\right]^{1/\theta}$$

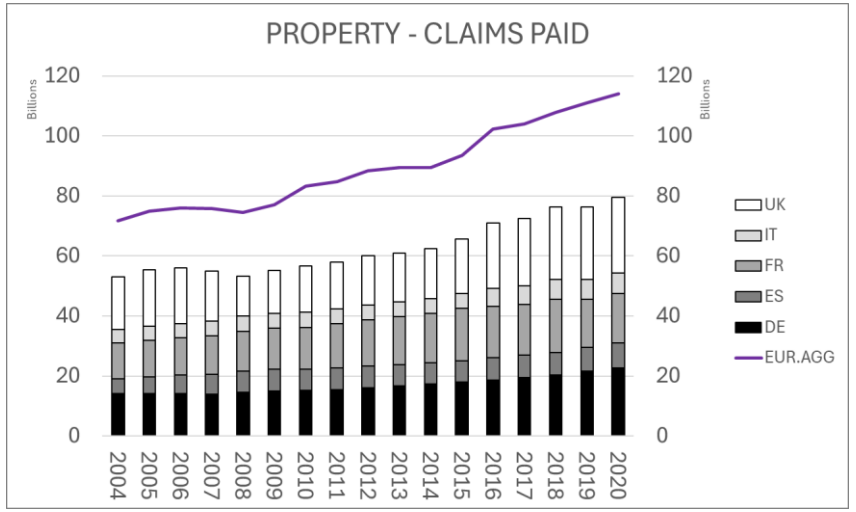
Source data: https://www.artemis.bm/dashboard/cat-bonds-ils-expected-loss-coupon/

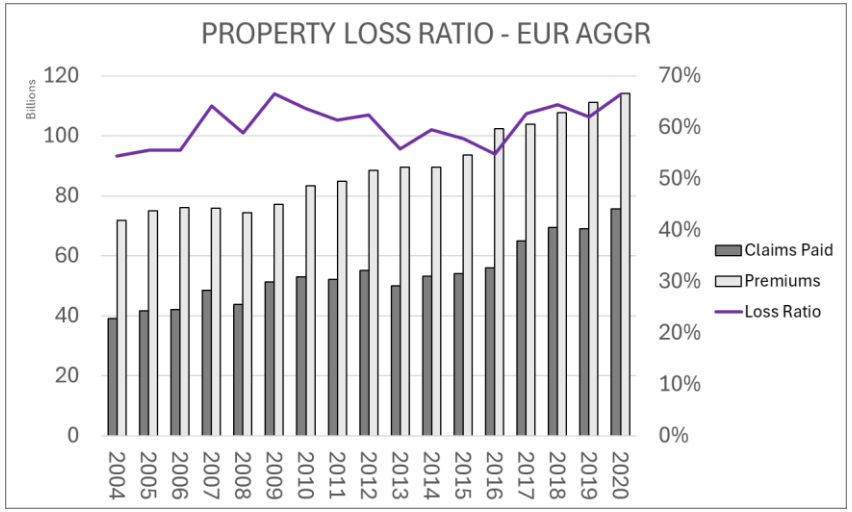
CAT BOND	ATTACHMENT PROBABILITY	EXPECTED LOSS	SPREAD
Blue Sky Re DAC (2023-1)	3.03%	2.14%	5.75%
Hexagon IV Re Ltd. (Series 2023-1) CLASS A	6.44%	4.35%	8.50%
Hexagon IV Re Ltd. (Series 2023-1) CLASS B	10.64%	8.08%	16.50%
Eiffel Re Ltd. (Series 2023-1)	0.58%	0.45%	3.25%
Windmill II Re DAC (2020)		2.56%	4.00%
Hexagon Reinsurance DAC (Series 2017-1) CLASS A	7.57%	6.75%	8.00%
Hexagon Reinsurance DAC (Series 2017-1) CLASS B	6.06%	5.52%	6.50%
Windmill I Re Ltd. (Series 2017-1)			
Lion I Re Ltd.	2.32%	1.09%	2.25%
Windmill I Re Ltd. (Series 2013-1)			3.25%
Calypso Capital II Ltd. (Series 2013-1) CLASS A	1.45%	0.96%	2.60%
Calypso Capital II Ltd. (Series 2013-1) CLASS B	2.11%	1.18%	2.90%
Green Fields II Capital Ltd. (Series 2013-1)	1.08%	0.85%	2.75%
Eurus III Ltd.	2.00%	1.42%	3.75%



Claims Paid – Insurance Europe DB (1/2)







Source: Insurance Europe Database https: //www.insuranceeurope.eu/statistics

Claims Paid – Insurance Europe DB (2/2)

- Actuarial-based benchmark approach:
  - The **financial costs** of managing the related-actuarial insurance-linked security are explicitly determined by the distorted probability of insurance losses
  - In other words, the financial costs of ILS are fully determined by the **actuarial costs** induced by the series of stochastic insurance losses
- Given any fixed premium rate, distorted attachment probabilities are **linearly related** to expected losses in log-log scale:
  - There is a **multiplicative effect** given by the slope of the line of expected losses and attachment probabilities
  - Higher expected losses thus implies higher attachment probabilities – which eventually lead to higher spreads
  - The multiplicative effect leads to **actuarial-implied financial vulnerability**

Conclusions

- Persistent **insurance protection gaps** (IPG) in Europe has raised the general concern about potential vulnerabilities in the European insurance industry
  - The European IPG has become a main **focus of EIOPA**
    - Monitor the risks related to the insurance protection gap for Nat Cat in Europe
    - Identify & monitor **vulnerabilities** both in **physical infrastructures** & **reinsurance** markets
- Under the actuarial-based model of the financial costs of ILS, CAT Bond and ILS spreads are fully described by the stochastic representation of insurance losses
  - Identify & monitor **financial vulnerabilities** due to the pure effect of variations in the stochastic representation of actuarial losses
  - Variations in the **frequency & severity of NAT CAT events** can thus become a source of financial vulnerability

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Thank you

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