BMA
BERMUDA MONETARY AUTHORITY

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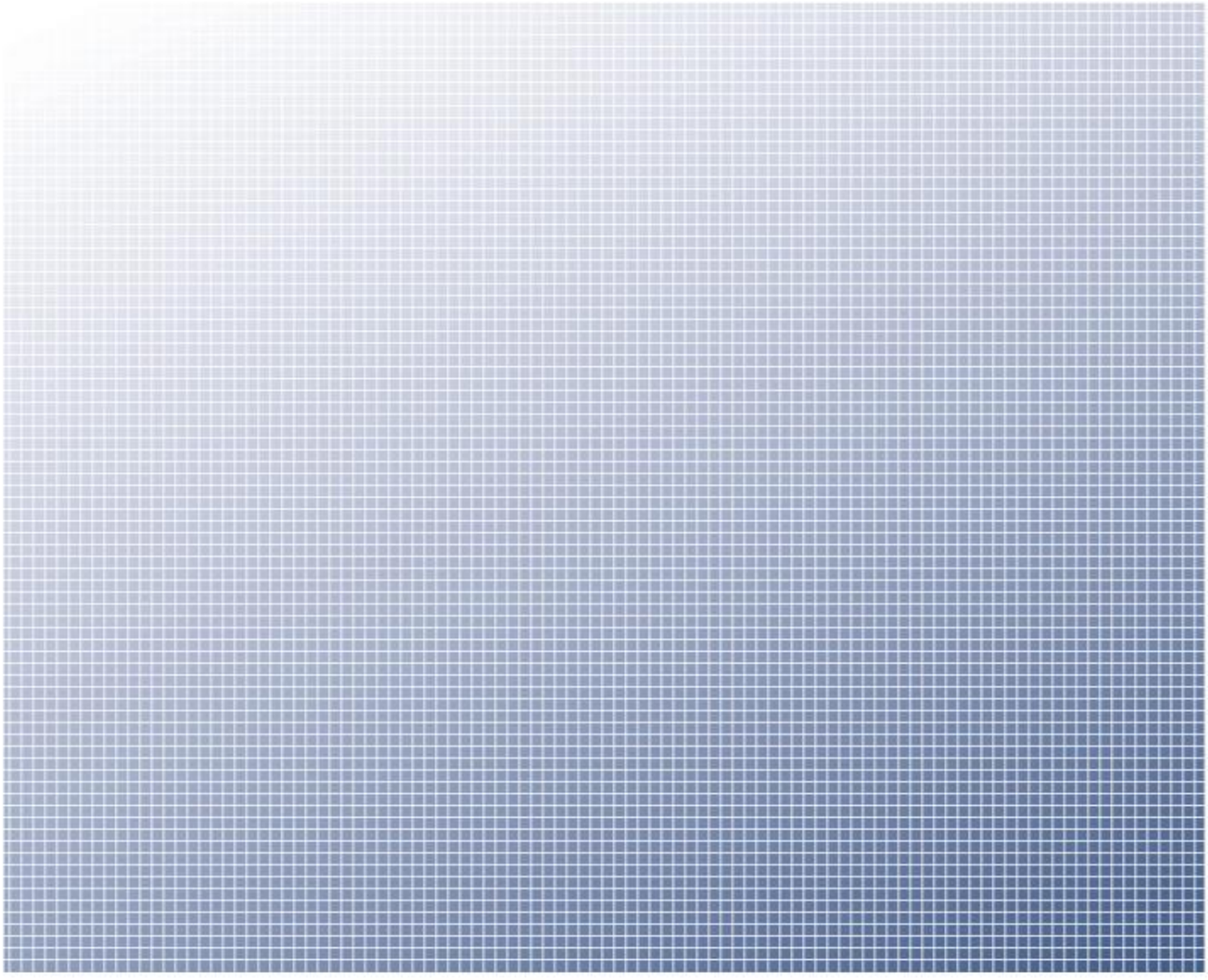
Bermuda Monetary Authority

Bermuda Insurance Property and Casualty Market

Catastrophe Risk and Stress Testing Analysis

Report on 2023 Year-end Data



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Acronyms

AAL	Average Annual Loss
A&E	Asbestos and Environmental
Authority	Bermuda Monetary Authority
BMA	Bermuda Monetary Authority
C&S	Capital and Surplus
Cat	Catastrophe
Cat Return	Catastrophe Risk Return and Schedule of Risk Management
CSR	Capital and Solvency Return
CPR	Constant Prepayment Rate
EP	Exceedance Probability
MBS	Mortgage-backed Security
PML	Probable Maximum Loss
RDS	Realistic Disaster Scenarios
SPI	Special Purpose Insurer
TVaR	Tail Value at Risk

Foreword

In 2023, Bermuda's international (re)insurance sector saw a much-improved combined ratio and net income due to several factors such as continued price improvements, terms and conditions tightening, limit and aggregation management and favourable investment returns. However, uncertainty persists in the global economic environment with less-than-expected reductions in headline inflation leading to fewer expected interest rate cuts, particularly in the USA, and continued pressure on claims inflation. In addition, whilst expectations of recessions in the largest economies have abated, growth momentum has also slowed increasing the probability of stagnated growth – globally and locally insurers must navigate these uncertainties.

In Bermuda, predominantly a reinsurance market, (re)insurers saw significant improvements to profitability in 2023, largely driven by lower levels of high-severity catastrophes despite catastrophe losses globally estimated to exceed US$100 billion. The precise impact of climate change on the frequency and severity of catastrophic events is still uncertain although data indicates that secondary perils, such as floods and wildfires, drove catastrophe losses in recent years. Bermuda (re)insurers benefited from increased retentions, restricted coverage, and restructured programmes to control premium budgets.

The Bermuda Monetary Authority (Authority and BMA) continually monitors trends and market developments, including evolving risks and business models. As part of its macroprudential mandate and given the Bermuda market's relatively high concentration of Catastrophe (Cat) risk, the Authority prioritises maintaining a broad understanding of Bermuda insurers' Cat exposure, including the stress testing analysis and monitoring concentration of risk in Bermuda.

The assessment of Cat risk exposure and stress testing at the micro and macro levels are fundamental elements of the Authority's overall supervisory framework. These elements allow the Authority to evaluate insurers' capital adequacy under adverse financial markets and underwriting conditions. The results of the assessment provide a comprehensive understanding of the sector's general vulnerability to shocks and as shown in this report, Bermuda insurers remain well capitalised to absorb any unlikely and potentially significant losses.

Ricardo Garcia
Managing Director, Supervision

Bermuda Insurance Market Stress Testing Report

This is the Authority's fifth standalone, annual *Catastrophe Risk and Stress Testing Analysis Report* and is the result of an analysis conducted by the BMA's staff.

About the BMA

The BMA was established by statute in 1969. Its role has evolved over the years to meet the changing needs of Bermuda's financial services sector. Today, the Authority supervises, regulates and inspects financial institutions operating in the jurisdiction. It also issues Bermuda's national currency, manages exchange control transactions, assists other authorities with detecting and preventing financial crime and advises the Government on banking and other financial and monetary matters.

The Authority develops risk-based financial regulations that apply to the supervision of Bermuda's banks, trust companies, investment businesses, investment funds, fund administrators, money service businesses, corporate service providers, insurance companies, digital asset businesses and digital asset issuances. It also regulates the Bermuda Stock Exchange and the Bermuda Credit Union.

BMA Contact Information

Bermuda Monetary Authority
BMA House
43 Victoria Street
Hamilton

P.O. Box 2447
Hamilton HMJX
Bermuda

Tel: +1 441.295.5278
Fax: +1 441.292.7471

E-mail: FSRD@bma.bm

This publication is available on the BMA website: www.bma.bm

1. Executive Summary

Overall, the 2023 Cat Risk Return and Schedule of Risk Management (together 'Cat Return') results show that the gross loss exposure assumed by Bermuda insurers increased by 2.69%, from $199.11 billion in 2022 to $204.51 billion in 2023. Furthermore, the value of global gross estimated potential loss assumed by Bermuda insurers from the major Cat perils (combined) has increased from $180.14 billion in 2022 to $184.75 billion in 2023; the Bermuda market maintained 23% of the global market share year-over-year. After a hardening of the market in 2022, the Cat exposure assumed by the Bermuda market remained steady in 2023.

An analysis of the Exceedance Probability (EP) curves demonstrates that Bermuda insurers are more exposed to the Atlantic Hurricane peril than any other peril, with gross average modelled losses over all companies ranging from $930 million for 1-in-50-year events to up to $1.76 billion for 1-in-1,000-year events. Other perils show lower modelled losses for the 1-in-50 and 1-in-1,000-year events, with some variation between firms. The use of reinsurance is widespread and is generally more pronounced for lower frequency return periods for the Atlantic Hurricane and North American Earthquake perils.

The stress test results demonstrated that the Bermuda insurance market is resilient to potential adverse impacts, including the financial market, Cat and other underwriting loss scenarios. These results highlight the industry's overall resilience and establish Bermuda insurers' ability to absorb these unlikely and potentially large losses while still having capital remaining to settle policyholder obligations and meet regulatory capital requirements.

Table 1.1 – Key Findings

Description	*US$ or Per Cent*	*Notes*
Gross Loss Exposure	$204.51 billion	2.69% increase year-on-year
Ceded Loss	$118.49 billion	-2.64% decrease year-on-year
Net Loss Exposure	$86.02 billion	11.08% increase year-on-year
Global Share of Gross Estimated Exposure on the Major Cat Perils	$184.75 billion	23% of global share
Total Pre-stress Capital and Surplus	$147.34 billion	Participating insurers only
Total Post Cat Stress (Aggregate of Largest Three Cat Scenarios) Capital and Surplus - Net	$109.26 billion	Participating insurers only
Average Capital and Surplus Post Aggregate of Three Largest Cat Underwriting Scenarios - Net	70.81%	0.41% increase year-on-year
Average Capital and Surplus Post 'Insurer's Own Worst Case' Scenario	69.93%	4.25% increase year-on-year
Average Capital and Surplus Post Aggregate of 'Largest Three Terrorism Stress' Scenarios	83.66% / 89.15%	Gross and net respectively
Average Capital and Surplus Post 'Cyber Stress' Scenario	92.03% / 94%	Gross and net respectively
Average Capital and Surplus Post 'Mortgage Insurance Loss' Scenario	82.78%	Shock 1
Average Capital and Surplus Post 'New Latent Liability' Scenario	93.44%	-0.68% decrease year-on-year
Average Capital and Surplus Post 'Deterioration in Existing US A&E and UK Asbestos' Scenario	96.16%	1.78% increase year-on-year
Average Capital and Surplus Post a Combination of Four Financial Market Scenarios	80.01%	Most severe scenerio
Average Ceded Exposure	58%	-3.16% decrease year-on-year

Source: BMA

2. Introduction

Bermuda's insurance sector is regulated and supervised by the BMA. As part of its regulatory and supervisory measures, the Authority requires all Class 3B and Class 4 insurers to submit a Capital and Solvency Return (CSR), which includes a Cat Return detailing the insurers' Cat risk management practices.[1]

Within the Cat Return, insurers report their Cat exposures, their EP curves (for various return periods), their Average Annual Losses (AAL) and their Probable Maximum Losses (PML). In addition, insurers are required to carry out rigorous forward-looking stress tests to measure the sensitivity of their statutory capital and surplus in various adverse financial markets and underwriting conditions. The Cat Return also serves as a point of reference in the prudential filings for the quantification of Cat risk assumed in Bermuda.

Drawing from the information in the Cat Returns, this report gives an overview of the Cat risk exposure assumed by Bermuda's insurance sector. It also assesses the sector's capacity to absorb shocks from various adverse financial markets and underwriting conditions. The report analyses whether Bermuda insurers are adequately capitalised to withstand severe but remote losses from various possible events that might adversely impact their economic balance sheets (i.e., economic assets, economic liabilities and capital and surplus). This report also reviews Bermuda insurers' levels of reliance on reinsurance, including identifying risk concentrations.

Stress testing is a valuable supervisory tool for the BMA as it provides supervisors with a forward-looking perspective of the resilience of individual insurance entities and the whole sector. The main objective of stress testing is to assess the capacity of individual insurers and the entire sector to absorb the impact of various extreme, but not inconceivable, adverse events. Stress testing can also be used to assess the effect of tail events beyond the measured level of confidence. Furthermore, the stress and scenario testing results help the Authority identify any concentration of risk and new and/or emerging risks and assess how insurers respond to such risks.

The BMA does not use the stress testing exercise to determine required capital levels. Nonetheless, the results help the Authority assess whether the risk assumed by Bermuda insurers is commensurate with each insurer's risk appetite. This information ultimately informs

[1] For the purpose of this report, insurers also include reinsurers.

the Authority's risk-based supervisory approach, addressing any capital adequacy concerns identified during this exercise as part of the Authority's regular supervisory routine.

Information Box

Class 3B and Class 4 insurers are the largest property and casualty commercial insurers in Bermuda's market and are required to maintain statutory capital and surplus of at least 99% Tail Value at Risk (TVaR) over a one-year time horizon.

Aggregate Statistics for Classes 3B and 4, 2023 (In US$ billions)

Net Written Premiums	68.9
Net Income	25.2
Total Claims	35.5
Total Assets	315.2

Source: **BMA**

3. Methodology

The report was produced using aggregated and non-aggregated data from the Bermuda CSR filings of Class 3B and Class 4 legal entities for the period ending 31 December 2023[2]. Specifically, the following schedules from the CSR were used as data sources:

- Schedule V(e) – Schedule of Risk Management: Stress/Scenario Test
- Schedule X(a) – Catastrophe Risk Return: EP Curve Total
- Schedule X(c) – Catastrophe Risk Return: EP Curve for Regions-Perils
- Schedule X(e) – Catastrophe Risk Return: Accumulations Overview
- Schedule X(g) – Catastrophe Risk Return: Reinsurance Disclosures

The BMA only aggregated data when it was possible to do so. For example, the Authority did not use aggregated EP curve data, while it did use aggregated AAL data. Furthermore, EP curves were not aggregated as they represent upper quantiles of distributions, and quantiles are not additive functions. On the other hand, AALs represent averages over distributions and can be aggregated without logical inconsistencies. When data could not be aggregated, an augmented boxplot, presenting percentiles and averages, was used to describe the distribution of the variable within the industry. Care was taken not to identify individual insurers to preserve the confidentiality of the CSR filings.

The exclusion of all other classes, such as Special Purpose Insurers (SPI), limits the conclusions that could be drawn from the results of this survey. Therefore, the results should be viewed as reflecting a segment of the industry and not the exposure of the entire Bermuda insurance market, which is larger than what is presented in this report.[3] It should also be noted that the report does not consider mortality Cat risk because it excluded the long-term (life) insurers.

The stress/scenario impact and effects reported here are those that were observed immediately upon the occurrence of the event (stress/scenario) as determined by the insurer's internal or vendor model(s), both with and without the effect of reinsurance and/or other loss mitigation instruments. The stress/scenarios were run against the insurers' balance sheet positions and aggregated in-force exposures as of 1 January 2024[4].

[2] Not all insurers have 31 December year-ends. Therefore, the data used in the report may not fully reconcile with other BMA reports that may include fall-end underwriting data.
[3] The Bermuda insurance market includes the Bermuda reinsurance market and SPIs.
[4] Where the fiscal year does not correspond to the calendar year, in-force exposures on the day following the fiscal year-end were used rather than 1 January 2024.

To assist the Authority with comparability, insurers were required to provide a description of the vendor model(s) used to perform the stress/scenario tests, including the model and the version used for each stress/scenario. As the acquisition of a vendor package is not an obligation, insurers sometimes use internal models. Where an internal model was utilised, the insurer was required to include information on the internal model's key assumptions and parameters.

The analysis in this report was based only on the original CSR data input. No reference was made to the other supporting documents that are required separately as part of the CSR filing. These additional documents were also reviewed by the Authority's supervisory team at the micro level in the context of individual insurers. As such, this report does not reflect subtle nuances provided by an insurer's full return that might otherwise impact these results.

Bermuda Stress Testing Guidelines

This report only provides an overview of insurers' stress/scenario analyses. Each year, the BMA publishes a detailed description along with guidelines for each analysis, including any assumptions made. This guide and the '2023 Capital and Solvency Return: stress/scenario analysis Class 4, Class 3B and Insurance Groups' can be found on the Authority's website.[5]

[5] https://www.bma.bm/document-centre/reporting-forms-and-guidelines-insurance

4. Bermuda's Cat Risk Exposure

For 2023, the year-on-year gross loss exposure assumed by Bermuda insurers increased 2.69%, from $199.11 billion in 2022 to $204.46 billion in 2023. The amount of ceded loss decreased by 2.63%, from $121.67 billion in 2022 to $118.47 billion in 2023. As such, the net loss exposure assumed by Bermuda insurers increased by 11.04%, from $77.44 billion in 2022 to $85.99 billion in 2023. These results are detailed in Table 4.1 below. With a gross loss impact of $28.78 billion and a net loss impact of almost $11.29 billion, the Gulf Windstorm peril had the highest gross and net loss exposure, followed by the Northeast Hurricane peril ($25.74 billion gross and $11.15 billion net) and San Francisco Earthquake peril ($24.06 billion gross and $9.54 billion net).

Table 4.1 - Cat Risk Exposure – Impact of Named Perils (In US$)

Standardised Cat Peril	Gross Loss Impact	Ceded Loss Impact	Net Loss Impact	Gross Loss Impact Ceded (In per cent)
Gulf Windstorm (Onshore)	28,780,945,168	17,495,113,901	11,285,831,268	61
Northeast Hurricane	25,739,149,409	14,589,352,811	11,149,796,597	57
San Francisco Earthquake	24,056,301,655	14,519,112,802	9,537,188,853	60
Pinellas Hurricane	20,694,696,990	13,453,025,457	7,241,671,533	65
Los Angeles Earthquake	19,803,238,144	11,094,117,674	8,709,120,469	56
Miami-Dade Hurricane	19,484,437,735	13,010,470,694	6,473,967,041	67
Carolinas Hurricane	14,002,804,089	8,205,314,218	5,797,489,872	59
European Windstorm	12,164,460,110	6,487,539,693	5,676,920,417	53
Japanese Earthquake	10,821,482,794	5,210,712,005	5,610,770,789	48
Aviation Collision	5,818,991,111	3,219,183,461	2,599,807,650	55
New Madrid Earthquake	4,729,385,905	1,928,897,056	2,800,488,850	41
Japanese Typhoon	4,476,743,999	1,907,844,818	2,568,899,181	43
Major Cruise Vessel Incident	3,718,574,587	2,231,373,024	1,487,201,563	60
US Oil Spill	3,463,977,854	2,041,955,392	1,422,022,462	59
Marine Collision in Prince William	2,950,675,361	1,826,264,146	1,124,411,215	62
US Tornadoes	1,520,208,688	440,996,971	1,079,211,717	29
Australian Flooding	1,396,142,080	450,728,516	945,413,563	32
Australian Wildfires	845,383,699	363,124,796	482,258,903	43
Total	**204,467,599,378**	**118,475,127,435**	**85,992,471,943**	**57.9**

Source: BMA

Using the Lloyd's-developed Realistic Disaster Scenarios' (RDS) ultimate industry settlement estimated values ($793.33 billion as shown in Table 4.2), the global share of gross estimated potential loss assumed by Bermuda insurers from the major Cat perils (combined) increased by about 1.03 %.[6] The estimated total industry losses by event, as specified in the RDS event description, did not change. Still, when the European Windstorm and Japanese Typhoon and Earthquake losses are converted to US dollars, they decrease slightly compared to 2022. The

[6] Insurers are required to run the Lloyd's-developed realistic disaster scenarios as specified in Lloyd's Handbook on *Realistic Disaster Scenarios – Scenario Specification 2024* using aggregates in force at 1 January 2024.

Bermuda share increase was driven by the rise in gross exposure offset by the US dollar (US$) strengthening against the Euro and the Japanese Yen. The total industry loss for these events is estimated in local currencies and converted[7] to US$.

Table 4.2 - Bermuda Loss to Industry Loss Using Lloyd's Developed RDS (In US$)

Standardised Cat Peril	Estimated Total Industry Loss	Estimated Bermuda Share (Gross)	Bermuda Share (In per cent)
Gulf Windstorm (Onshore)	111,000,000,000	28,780,945,168	26
Northeast Hurricane	81,000,000,000	25,739,149,409	32
San Francisco Earthquake	80,000,000,000	24,056,301,655	30
Pinellas Hurricane	134,000,000,000	20,694,696,990	15
Los Angeles Earthquake	78,000,000,000	19,803,238,144	25
Miami-Dade Hurricane	131,000,000,000	19,484,437,735	15
Carolinas Hurricane	39,000,000,000	14,002,804,089	36
Japanese Earthquake	56,720,000,000	10,821,482,794	19
European Windstorm	26,552,160,000	12,164,460,110	46
New Madrid Earthquake	44,000,000,000	4,729,385,905	11
Japanese Typhoon	12,053,000,000	4,476,743,999	37
Total	**793,325,160,000**	**184,753,645,999**	**23**

Source: BMA

The Bermuda share of global Cat exposure, as determined by Lloyd's RDS events, was on-level year-over-year. This was after a reduction of gross exposure in 2022, which saw primary insurers increasing retentions, restricting coverage and/or restructuring programmes to manage reinsurance premium budgets.

[7] The Authority uses the Oanda exchange rate as of 1 January 2024 to convert the non-US$ values into US$ values

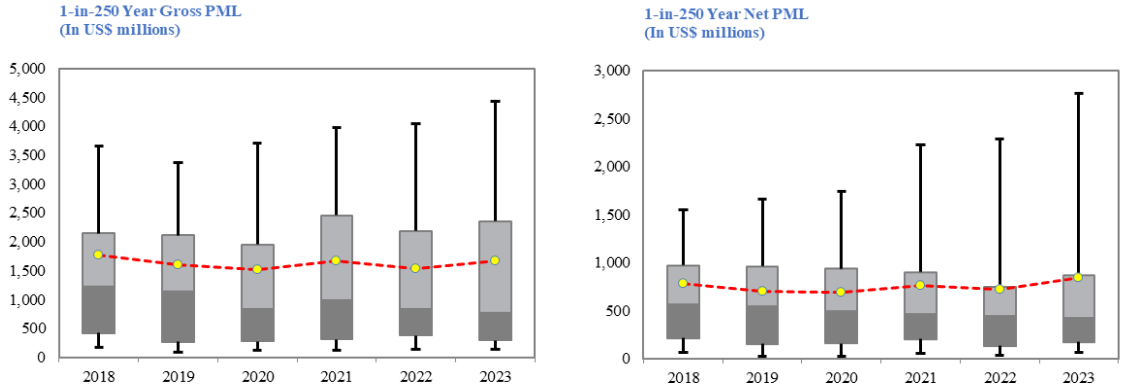
5. Exceedance Probability Curves

This section presents some outputs from the Cat models in Bermuda on an aggregated basis. Insurers were asked to produce EP curves for the following named perils: Atlantic Hurricane, North American Earthquake, European Windstorm, Japanese Earthquake and Japanese Typhoon perils.

Data was compiled from the EP curves by drawing their distribution from a cross-section of firms for named perils across return periods. EP curves reflect the unique risk profile and modelling practices of individual firms, and as such, they cannot be aggregated[8] across firms. The Authority, however, uses summary statistics and boxplots to provide insight into the distribution of losses for peril and return period combinations. The following exhibits include the mean, median and 10th, 25th, 75th and 90th percentiles of the EP curves.

Historical trends for the gross and net 1-in-250-year PML for aggregate exposures for the past five years were evaluated. For the purposes of the BMA's analysis, the 1-in-250-year event is the most extreme risk to which an insurer can be exposed. The following panel presents the distribution of the PML for this return period.

Panel 5.1 - Gross and Net 1-in-250 PML



Source: BMA

Note: Boxplots include the mean (yellow dot), the 25th and 75th percentiles (grey box, with the change of shade indicating the median) and the 10th and 90th percentiles (whiskers).

[8] EP curves cannot be aggregated by summing individual EP curves since an event for one company can be completely unrelated to the event of another company, even for the same peril and the same return period.

Insurers increased their average gross 1-in-250-year exposure between 2022 and 2023 by 9.15%. The variation within the sample in 2023 increased for gross exposures, with some companies having large changes in their exposures and many smaller firms having smaller changes in exposures. The 90th percentile gross 1-in-250-year exposure was $4.42 billion, with a similar increase to the mean of 9.30% compared to 2022.

Average net 1-in-250-year exposure increased by 16.28% between 2022 and 2023; similarly, the variation of exposures within samples increased. The 90th percentile 1-in-250-year net exposure reached $2.76 billion.

The largest exposure for Bermuda insurers is the Atlantic Hurricane peril, with the average gross exposure between $930.30 million for a 1-in-50-year event and up to $1.76 billion for a 1-in-1,000-year event. This is an average figure with variation among firms. For example, at the 90th percentile of losses, there are firms with 1-in-50-year exposures of $2.58 billion, while there are firms that exceeded $4.26 billion in exposures for a 1-in-1,000-year event for the same peril. The BMA's net-to-gross exposure ratio and corresponding descriptive statistics are presented in a table on the next page.

Table 5.1 – Net-to-Gross Exposure for Atlantic Hurricane (In per cent)

Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1000
Mean	51.9	52.9	55.3	57.4	59.5
Median	46.8	47.4	49.9	52.1	55.3

Source: BMA

The data shows that reinsurance purchases become less pronounced at higher-risk layers. The median insurer retains 46.8% of the gross exposure for 1-in-50-year events, while the median insurer retains 55.3% of the gross exposure for 1-in-1,000-year events. Average exposure per peril is also shown per return period for both gross and net in the tables below.

Table 5.2 - Average Gross Exposure (In US$ millions)

Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1000
Atlantic Hurricane	930.3	1,124.9	1,376.2	1,574.3	1,764.3
NA. Earthquake	577.0	776.5	1,020.9	1,190.7	1,333.3
European Windstorm	287.0	368.3	462.2	520.8	574.6
Japanese Earthquake	158.8	221.2	291.3	328.9	357.6
Japanese Typhoon	182.3	221.4	255.8	282.0	311.5

Source: BMA

Table 5.3 - Average Net Exposure (In US$ millions)

Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1000
Atlantic Hurricane	404.1	505.0	662.5	801.1	943.1
NA. Earthquake	254.5	337.7	468.5	578.7	695.5
European Windstorm	155.2	194.0	241.8	275.7	310.1
Japanese Earthquake	94.1	125.9	163.6	185.9	204.5
Japanese Typhoon	104.7	123.1	142.7	159.1	176.3

Source: BMA

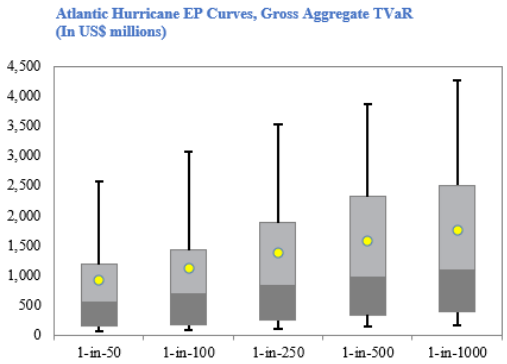
The largest exposure across all return periods is the Atlantic Hurricane peril, followed by the North American Earthquake peril. The aggregate gross and net EP curves are also plotted by return period in Panel 5.4, approximating all Cat risk within an insurer's portfolio.

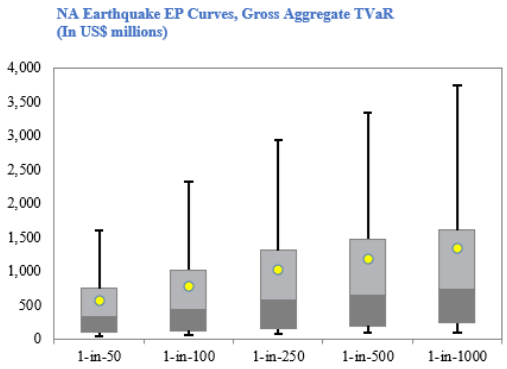
Table 5.4 - Average Exposure for All Perils (In US$ millions)

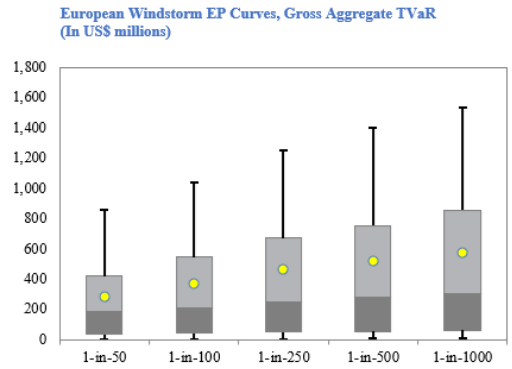
Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1,000
Gross	1,202.5	1,406.2	1,666.6	1,862.5	2,063.4
Net	568.4	673.7	839.8	981.8	1,138.7

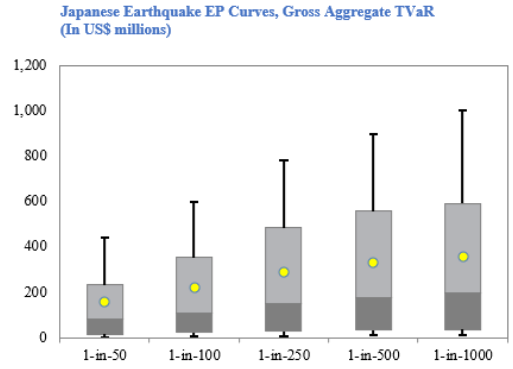
Source: BMA

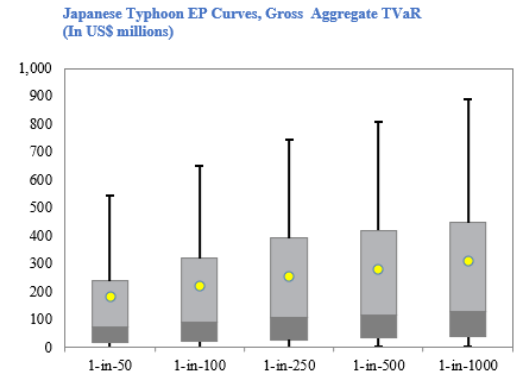
Panel 5.2 - Gross EP Curves for Named Perils







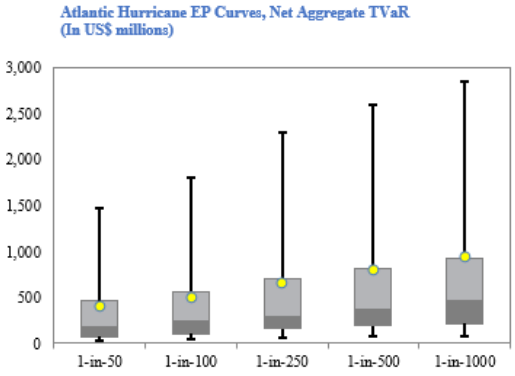


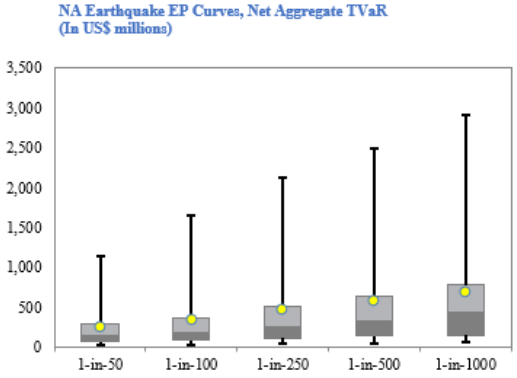


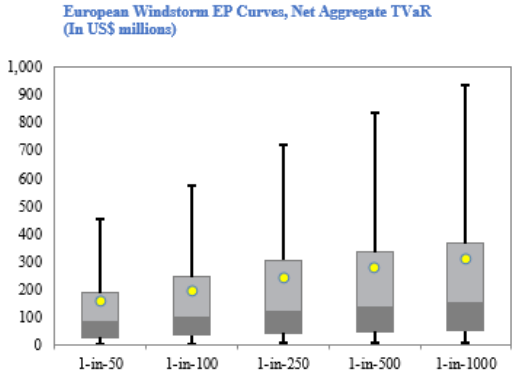
Source: BMA

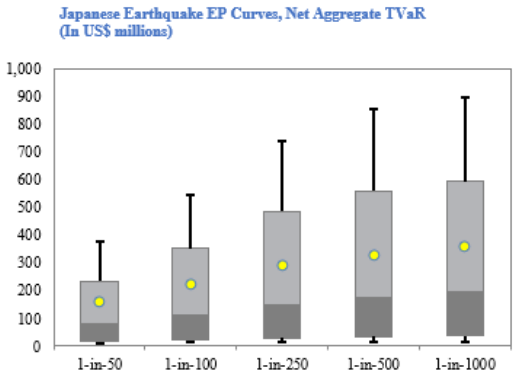
Note: Boxplots include the mean (yellow dot), the 25th and 75th percentiles (grey box, with the change of shade indicating the median) and the 10th and 90th percentiles (whiskers).

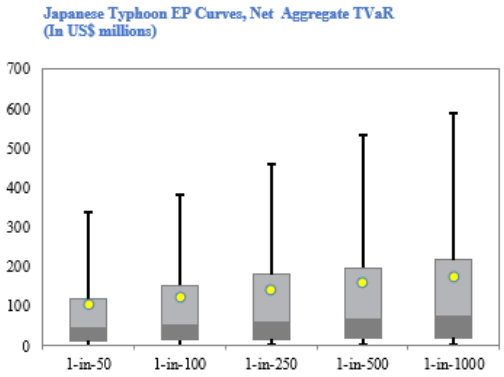
Panel 5.3 - Net EP Curves for Named Perils







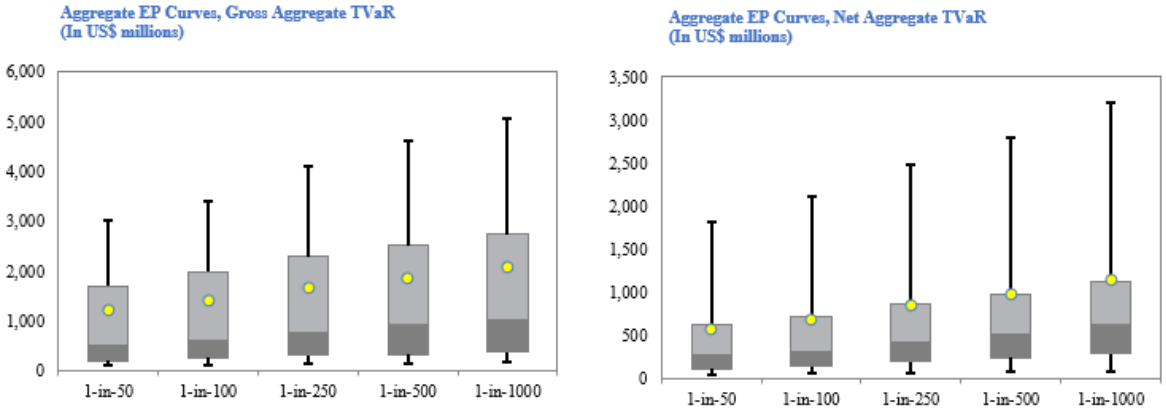




Source*:* BMA

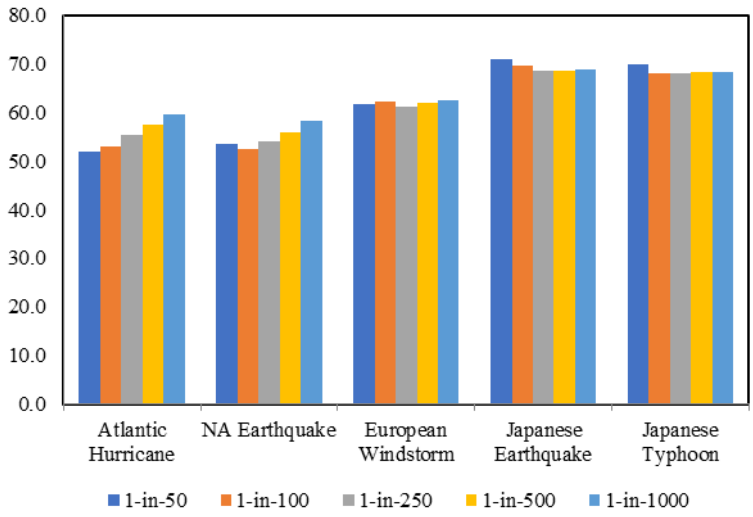
Note: Boxplots include the mean (yellow dot), the 25th and 75th percentiles (grey box, with the change of shade indicating the median) and the 10th and 90th percentiles (whiskers).

Panel 5.4 - Gross and Net Aggregate EP Curves for All Perils



Source: BMA
Note: Boxplots include the mean (yellow dot), the 25th and 75th percentiles (grey box, with the change of shade indicating the median), and the 10th and 90th percentiles (whiskers).

Figure 5.1 - Average Net-to-Gross EP Exposure per Peril and Return Period (Aggregate EP curves, in per cent)



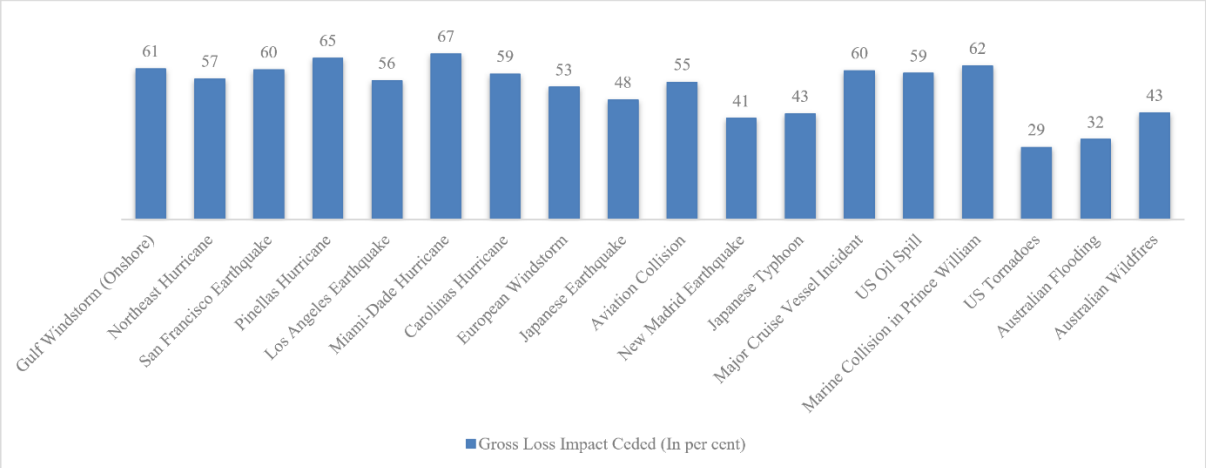
Source: BMA

For the Atlantic Hurricane and North American (NA) Earthquake perils, the ratio of net-to-gross exposure increased as the return period increased. The rarer the event, the more the insurer retained risk on average. In comparison, the average proportion of exposure retained for the other perils shown was level across return periods.

6. Reliance on Reinsurance

The BMA also assesses the level of insurers' reliance on reinsurance and/or other loss mitigation instruments for each peril [9]. Overall, the aggregate loss impact results show that the level of reinsurance reliance (gross loss ceded) decreased by about 2.63% compared to last year and varied across each peril (see Figure 6.1 below). This is in comparison to the slight increase in the aggregate loss impact and indicates that insurers, on balance, retained more in 2023. Typically, the risks that could lead to the largest financial losses are often heavily reinsured. These included the Gulf Windstorm, Miami-Dade Hurricane, Pinellas Hurricane and San Francisco Earthquake.

Figure 6.1 - Gross Loss Impact Ceded (In per cent)

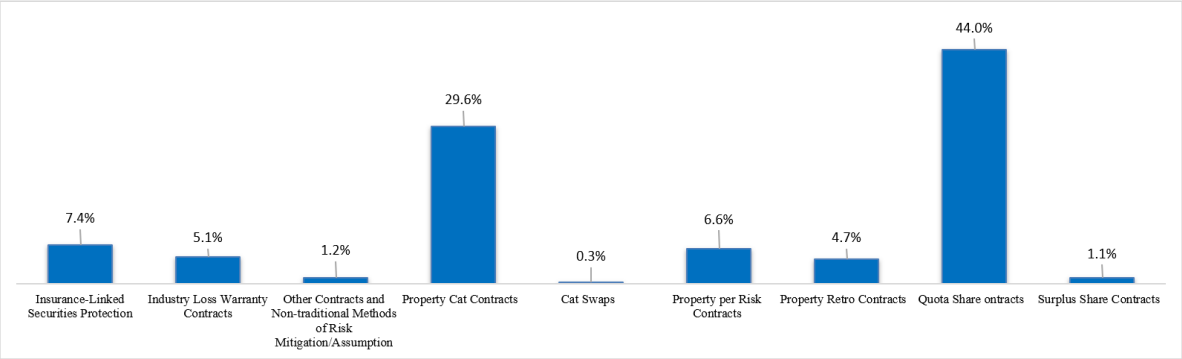


Source: BMA

On average, insurers ceded about 57.9% of gross losses in 2023, compared to 61.1% in 2022. Bermuda insurers use various reinsurance methods to cede some of their catastrophe exposure, which can include traditional property catastrophe contracts, quota share contracts, insurance-linked securities protection and industry loss warranties contracts. Compared to last year, purchases of property catastrophe contracts dropped by 25%, whereas quota share contracts increased by 26%. This indicates a shift in how losses are ceded, potentially with the aim of bringing risk profiles into closer alignment.

[9] Bermuda is predominantly a reinsurance-based international financial centre; thus, 'insurers' reliance on reinsurance' for the purpose of this section includes insurance and reinsurance undertakings that reinsure their risks with other reinsurance undertakings, i.e., retrocession.

Figure 6.3 - Reinsurance Strategy - Aggregate Occurrence Limit (In per cent)



Source: BMA

7. Cat Risk Underwriting Scenarios

The BMA assesses Cat risk stress tests at three different levels. The first level uses Lloyd's RDS and other scenarios designed internally by the Authority, with each insurer required to estimate its loss impact for 18 standardised Cat underwriting loss scenarios. The details on each underwriting loss scenario and the key assumptions that insurers used as a guide to estimate their market share can be found on the BMA website (see "Section 3 - Methodology" above). At the second level, insurers are required to submit three of their own highest underwriting loss scenarios in addition to the 18 standardised RDS underwriting loss scenarios provided by the Authority. At the third level, insurers are required to consider and provide estimates for their worst-case underwriting loss scenario based on their own independent underlying assumptions.

Cat risk scenarios

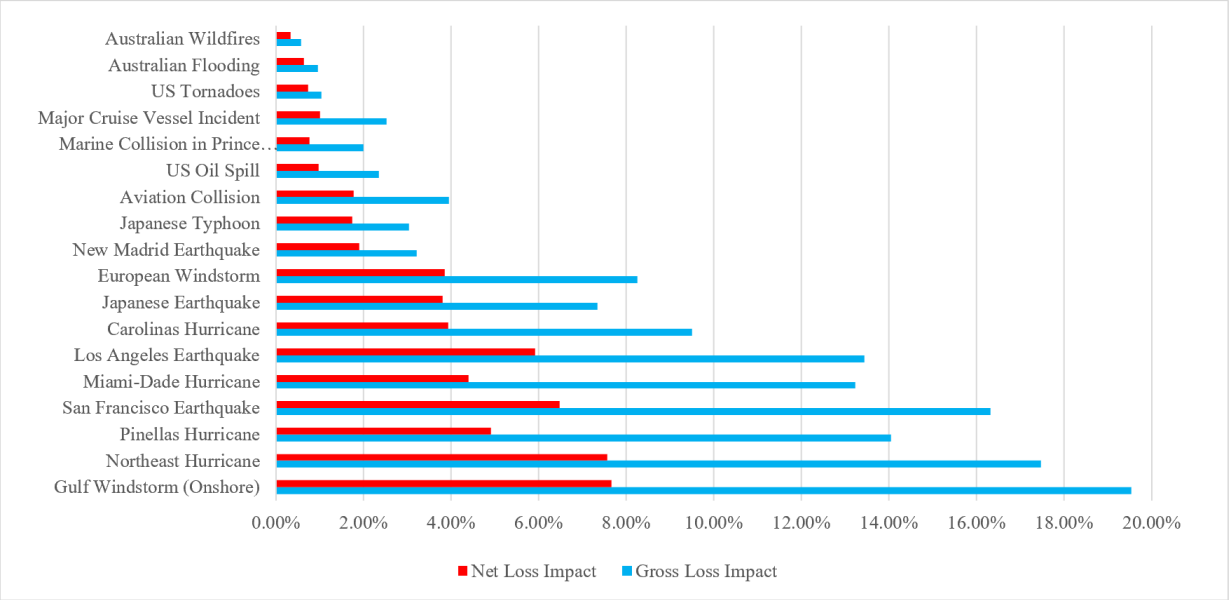
In general, the 2023 Cat underwriting loss scenario results show that the Bermuda insurance market continues to be resilient to potential underwriting loss impacts arising from all major catastrophe perils underwritten and that insurers are meeting regulatory capital requirements by holding satisfactory capital to settle policyholder obligations.[10] Out of the 18 standardised underwriting loss scenarios, the Gulf Windstorm (onshore) peril had the largest potential adverse effect with an estimated gross loss impact to statutory capital and surplus of 19.53% (and 7.66% net loss impact), followed by the Northeast Hurricane peril, which had the potential to deplete 17.47% (and 7.57% net loss impact) of the market's total statutory capital and

[10]The underwriting loss impact and associated assumptions reported by insurers are probabilistic estimates. Actual losses may differ significantly from these estimates.

surplus.[11,12] The Australian Wildfire peril had the least impact, with only 0.57% gross and 0.33% net impact on the statutory capital and surplus. The gross impact from each of the other perils ranges from 0.95% to 14.05%, with many (12) of the perils incurring a gross loss impact of less than 10% (see Figure 7.1 below).

Figure 7.1 - Stress Testing - Cat Loss Scenarios

(As a Percentage of Total Capital and Surplus)

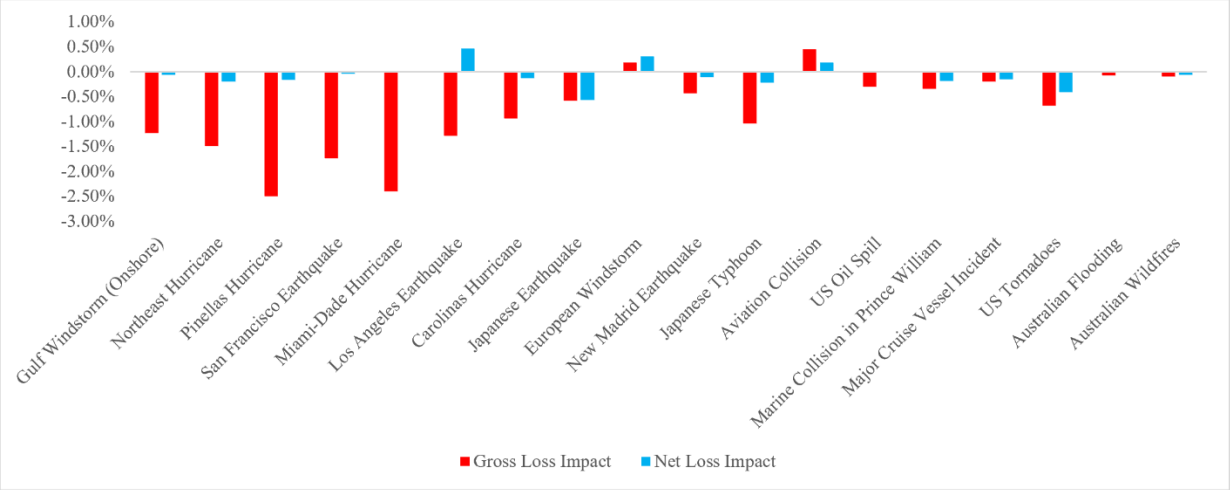


Source: BMA

While the year-on-year ceded loss exposure decreased overall, insurers took on a marginally higher level of gross exposure, resulting in an increase in net loss exposure compared to 2022, similar to the level of net loss impact in 2021. On the other hand, the insurers' year-on-year aggregate statutory capital and surplus increased by 13.55%.[13] On the whole, as a proportion of capital and surplus, the impact of the gross Cat loss scenarios is decreasing year-over-year given the increasing level of capital. For example, the Pinellas Hurricane peril had the highest year-on-year decrease of 2.49% gross, followed by the Miami-Dade Hurricane peril and the San Francisco Earthquake peril, which had decreases of 2.40% and 1.74%, respectively. All the other perils' gross loss impact decreased by an average of 0.54%. On a net loss basis, all decreases were less than 0.56% year-on-year (see Figure 7.2 below).

[11]Gross loss impact is calculated before any reinsurance and/or other loss mitigation instruments.
[12]Total capital and surplus include only capital and surplus for insurers that underwrite Cat risk (i.e., capital and surplus for insurers that do not underwrite Cat risk is not included).
[13] The increase in capital and surplus is driven primarily by the increase in the level of capital held by several insurers.

Figure 7.2 – Year-on-Year (2020 and 2021) Gross and Net Loss Impact Change (In per cent)



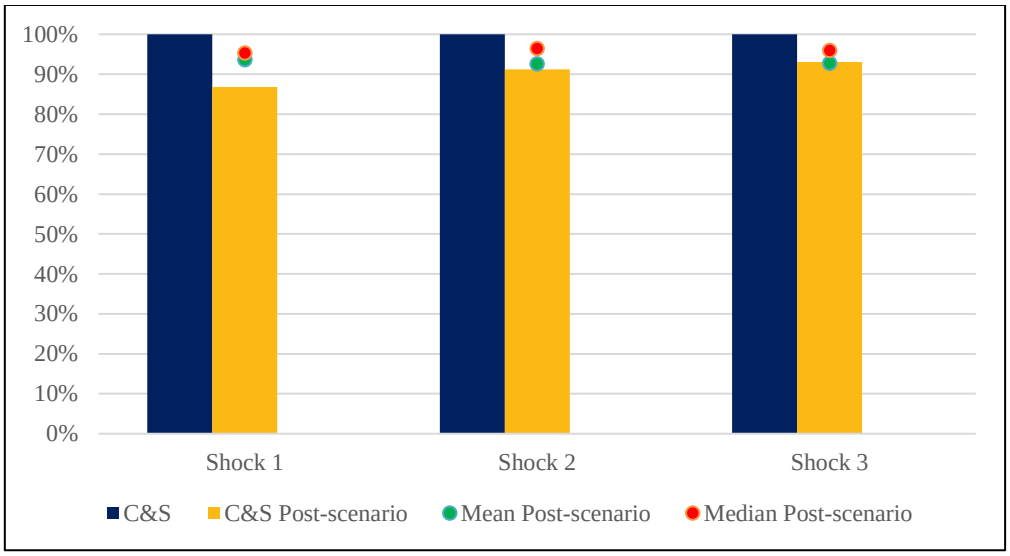
Source: BMA

Other underwriting loss scenarios

Sometimes, the underwriting scenarios under the Cat risk scenarios above either do not apply, or partially apply to the insurer, resulting in de minimis loss projections. In this case, the insurer was required to submit three of its own underwriting loss scenarios. Typically, insurers that underwrite a significant amount of casualty business (where the potential arising from casualty losses exceeds that from property) fall under this category.

For each of the three scenarios, insurers were required to include a detailed description of each scenario, including related key assumptions. In addition, the insurer was required to include the post-stress positions on aggregate statutory assets and statutory liabilities that would be observed immediately upon the occurrence of the event, both with and without the effect of reinsurance and/or other loss-mitigation instruments. Figure 7.3 shows the results from these scenarios.

Figure 7.3 - Capital and Surplus (C&S) Post Other Underwriting Loss Scenarios



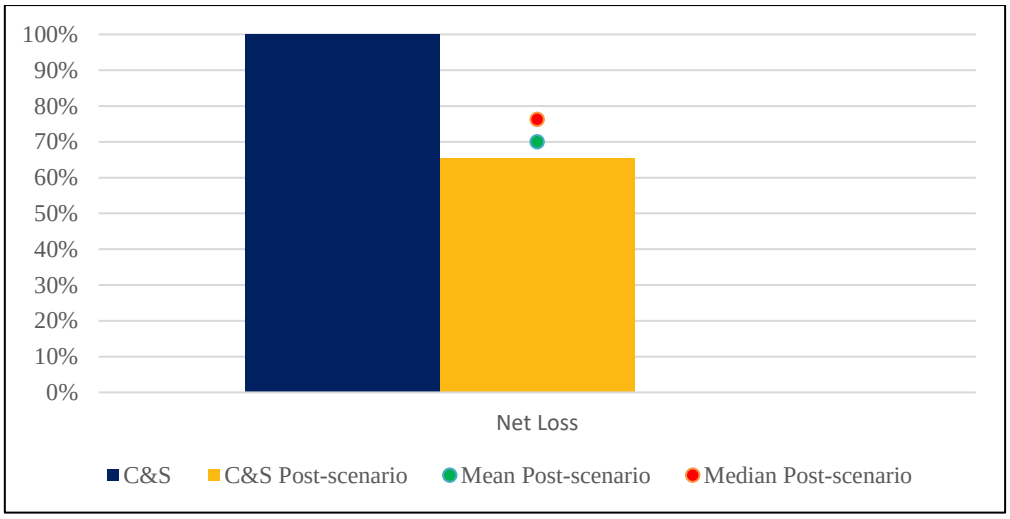
Source: BMA

As shown in Figure 7.3, insurers could comfortably withstand these scenarios, with most insurers retaining a high percentage of their statutory capital and surplus for each. Across these scenarios, the average mean and median post-stress capital and surplus returned by Bermuda insurers were 92.99% and 95.87%, respectively.

Insurer's own worst-case scenario

An insurer's own worst-case scenario presents a more severe impact and is generally the insurer's most remote and extreme test. The net mean and median post-stress capital and surplus returned by Bermuda insurers for this scenario were 69.93% and 76.22%, respectively (see Figure 7.4).

Figure 7.4 - Capital and Surplus Post Insurer's Own Worst-Case Scenario



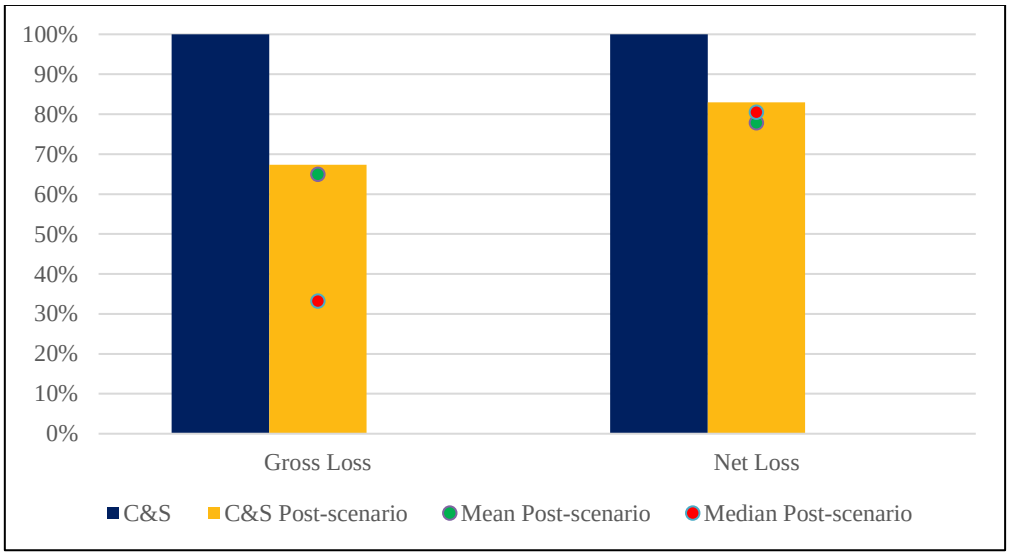
Source: BMA

Loss simulations scenario

Insurers were required to run a series of loss simulations or other analyses related to extreme tail events that included all policies at the beginning of the year. These scenarios were substantiated by the relevant underlying assumptions.

The result of a series of loss simulations or other analyses related to extreme tail events scenarios shows that the mean and median capital and surplus post-gross loss impact will be medium/low (e.g., 64.94% and 33.21%, respectively). Nevertheless, after factoring in the exposure ceded, the post-stress capital and surplus for the majority of insurers is significantly higher (i.e., mean of 77.82% and median of 80.50% - see Figure 7.5).

Figure 7.5 - Capital and Surplus Post Loss Simulations – Tail Events



Source: BMA

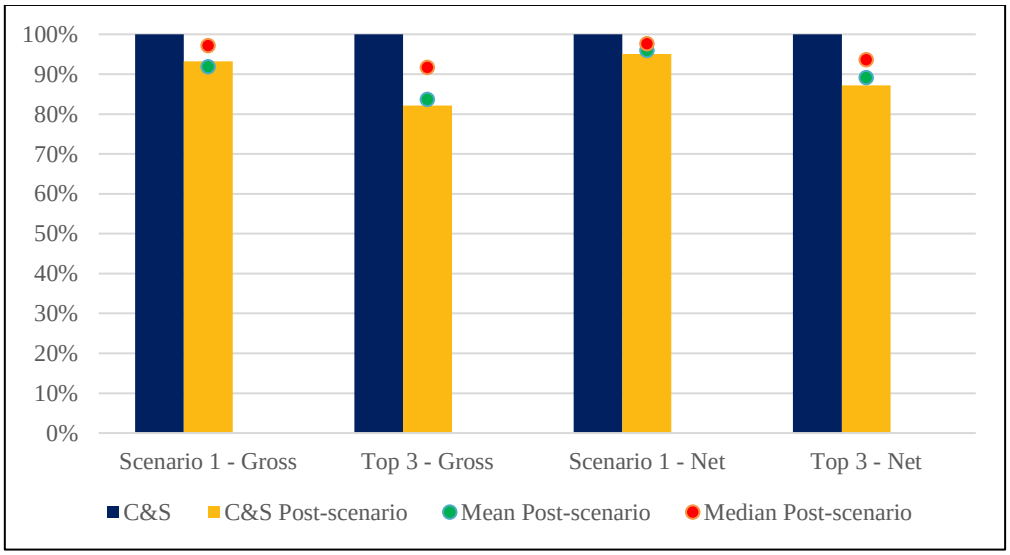
8. Terrorism, Cyber Risk and Mortgage Insurance Scenarios

Terrorism stress scenario

It is appropriate to consider terrorism exposure in absolute terms and for realistic loss scenarios. The BMA requires insurers to carry out a separate stress test for terrorism coverage by estimating the potential loss impact using a standardised scenario of an explosion of a two-tonne bomb.[14] Firms, on average, retained 91.86% of the statutory capital and surplus on a gross basis and 95.97% on a net basis. The cohort of firms for the top three most significant terrorism exposures remained stable year over year. Moreover, the results illustrate that all the insurers' balance sheets comfortably withstood the impact from three of their most extensive terrorism exposures combined (i.e., insurers will retain, on average, 83.66% of the statutory capital and surplus on a gross basis and 89.15% on a net basis – see Figure 8.1).

[14] For a detailed description of this scenario, please refer to the BMA's Cat Risk Return Guidelines.

Figure 8.1 – Capital and Surplus Terrorism Stress Scenario



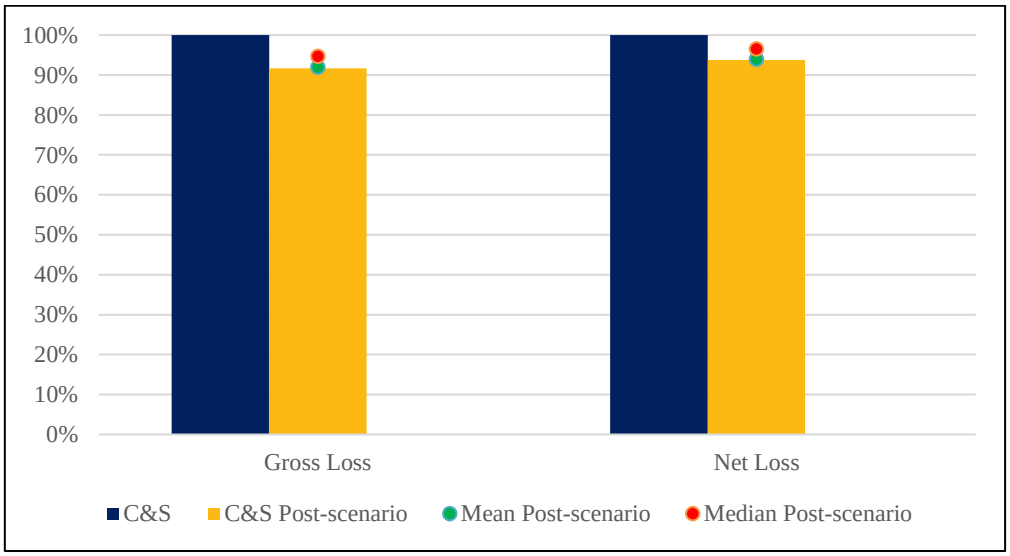
Source: BMA.

Cyber stress scenario

Insurers were required to provide cyber risk data, including their estimated aggregate exposure, their own cyber risk worst-case annual aggregate loss scenarios and the associated underlying assumptions. The insurance-specific cyber stress scenario data shows that the insurers' own worst impacts from cyber risk have had a minor effect on their statutory capital and surplus, both on a gross basis and net basis. It also shows the mean and median statutory capital post the cyber risk stress was at 92.03% (94.00% net) and 94.71% (96.59% net), respectively (see Figure 8.2).[15]

[15] The BMA publishes a separate annual Bermuda Cyber Underwriting Report and can be found on the BMA's website: https://www.bma.bm/pdfview/9656

Figure 8.2 - Capital and Surplus Cyber Stress Scenario



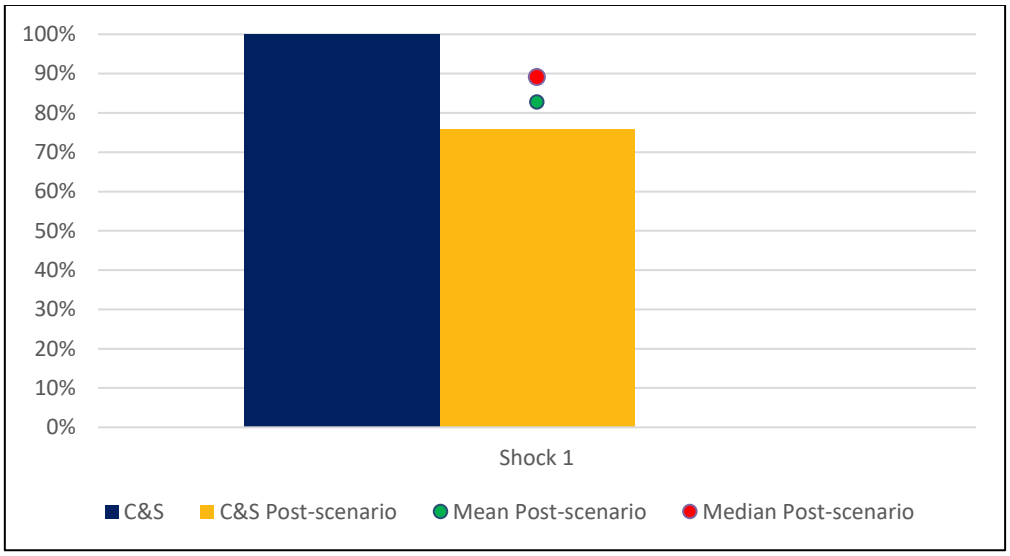
Source: BMA.

Mortgage insurance scenario

For year-end 2023, insurers that wrote mortgage business were required to shock their exposure by instantly increasing the default rate to 9.47% (equivalent to approximately 99.5% TVaR) for their mortgage book.

In addition to the increased default rate, insurers that held agency Mortgage-Backed Security (MBS) and securities as investment assets subject to prepayment risk were required to shock these investments by assuming that the MBS prepay at an annual Constant Prepayment Rate (CPR) of 40% instantaneously. If the 40% CPR produced capital gains, the insurer had to stress the CPR at 0%, 5% and 10%. The expectation is that if using a CPR of 40% produces a gain, then applying a substantially lower MBS prepayment shock rate of 10% or less will likely produce capital losses. Figure 8.3 illustrates the results from this scenario.

Figure 8.3 - Capital and Surplus Mortgage Insurance Loss Scenario



Source: BMA.

The results of these scenarios show the mean and median post-stress capital and surplus returned by Bermuda insurers were 82.78% and 89.14%, respectively.

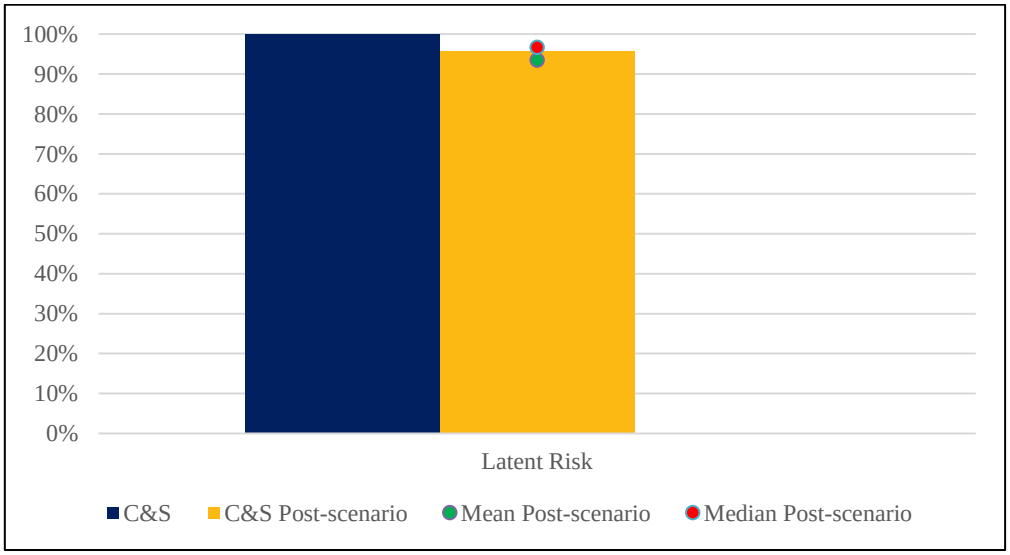
9. Liability Loss Accumulation Scenarios

Insurers were also required to run stress tests on scenarios that estimate potential insurance loss accumulations relating to liability exposures. The scenarios aim to capture risk on liability exposures generally not adequately reflected by historical claims experience. Such risks tend to materialise slowly and impact many years of exposure. Specifically, insurers had to stress their balance sheets under two separate scenarios: a new latent liability scenario and an Asbestos and Environmental (A&E) scenario that assumes deterioration in existing US A&E and UK asbestos reserves.

The new latent liability test aims to cover a 'mass tort' event. For example, a general and potentially legally enforceable opinion could emerge after a court decision characterising a specific product or substance as causing observed or potential future adverse effects, such as bodily injury, property damage or environmental damage. This is expected during that year and the following years to lead to claims on the product liability insurance of the producers, followed by mass litigation against companies that are distributing or using or have distributed or used the product or substance. These developments are expected to accumulate potentially worldwide claims on general commercial liability and worker compensation/employer liability

insurance policies. The scenario considers that the amount recognised at the end of the one-year time horizon is smaller than the maximum possible ultimate loss from the scenario due to the incompleteness of available information and uncertainty of the subsequent development. Figure 9.1 below shows the results of this scenario with the mean and median post-stress capital and surplus returned by the Bermuda insurer at 93.44% and 96.68%, respectively).

Figure 9.1 - Capital and Surplus New Latent Liability

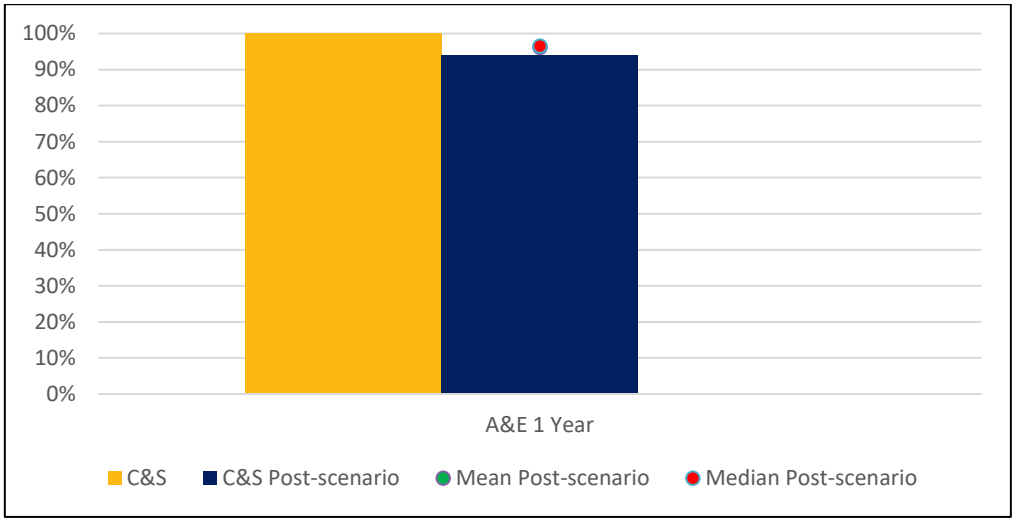


Source: BMA

The A&E scenario aims to reflect potential deterioration in existing US Asbestos, US Environmental and UK Asbestos reserves.[16] For the US A&E stress, the scenario considers potential under-reserving by referencing survival ratio market benchmarks, an increase in projected claims inflation and an increase in projected asbestos claims due to medical advances.[17] For the UK asbestos stress, the scenario considers new claims arising beyond 2050, a deterioration in the projected number of claims up to 2050, an increase in the projected claims due to medical advances and an increase in projected claims inflation. Figure 9.2 below shows the results of this scenario with the mean and median post-stress capital and surplus returned by Bermuda insurers at 96.16% and 96.55%, respectively).

[16] Insurers with total US A&E and UK Asbestos net reserves of less than $50 million do not need to calculate this scenario.
[17] A survival ratio is a common market benchmark for assessing the reserve strength of A&E reserves. It is defined as the number of years that current reserves will suffice (survive) if average future payments equal average current payments.

Figure 9.2 - Capital and Surplus the Deterioration in Existing US A&E and UK Asbestos



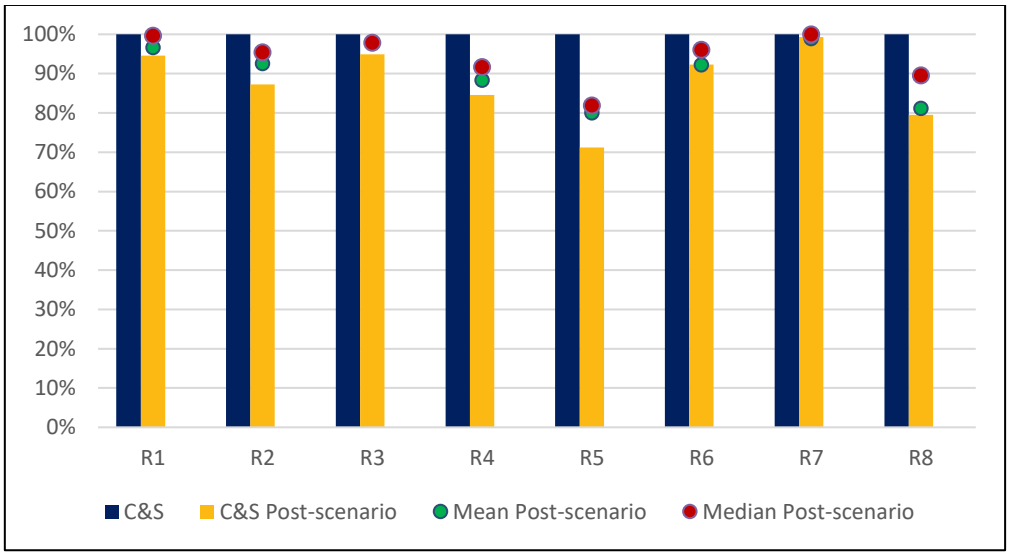
Source: BMA

10. Financial Market Scenarios

The financial market scenarios comprise capital market-related single-factor shocks triggered by specific risk factors (i.e., equity returns, credit spreads and defaults). These shocks were calibrated based on historical data about the evolution of interest rates, exchange rates and equity markets. Furthermore, considering the continued sovereign risk concerns and their implications on the investment performance of insurers, the financial market scenarios included haircuts on sovereign bonds. The ongoing volatility due to political risk and the volatility of capital flows also warrants shocks on foreign currency positions.

Specifically, the insurer (depending on the insurer's exposure to capital market-related factors) was required to quantify the impact on its statutory balance sheet from eight different financial market scenarios. Figure 10.1 shows the capital and surplus after these various scenario impacts.

Figure 10.1 - Capital and Surplus - Financial Market Scenarios



Source: BMA

R1 (Severe decline in equity prices) – assumes a decrease of 40% of the value of equities in a portfolio. This stress scenario is consistent with the 'Black Monday' crash of 1987. The result of this scenario shows that the mean and median post-stress capital and surplus returned by the Bermuda insurance market were 96.59% and 99.67%, respectively.

R2 (Alternative investment and real estate) – focuses on assets that have a low correlation with financial markets and less liquidity compared to typical financial assets. Such assets include investment holdings in hedge funds, real estate, private placements and venture capital, among others. R2 requires those assets to be decreased in value by 40%. For assets such as hedge funds with lockup periods, venture capital, and real estate in illiquid markets, the (re)insurer reported whether sudden decreases in their value could entail an inability to make rapid sales and whether this effect had material consequences. The result of this scenario shows that the mean and median post-stress capital and surplus returned by the Bermuda insurance market were 92.53% and 95.43%, respectively.

R3 (Yield curve stress) – assumes moderate and severe movements in global yields. The insurer is required to stress its balance sheet for this scenario using the following yield curve scenarios.

Table 1 – Yield Curve Scenarios	
Scenario	**Stress**
Moderate Widening	1% increase in yields across all maturities
Moderate Tightening	1% decrease in yields across all maturities
Severe Widening	2% increase in yields across all maturities
Severe Tightening	2% decrease in yields across all maturities

The result of this scenario shows that the mean and median post-stress capital and surplus returned by the Bermuda insurance market were 98.12% and 97.83%, respectively.

R4 (General widening of credit spreads) – assumes that credit spreads widen across different rating classes. The widening reflects the increase of the perceived credit risk in the market. The insurer was required to stress all positions, including those available for sale and held to maturity. Structured finance products, asset-backed securities and agency and non-agency MBSs also had to be included. If there was no rating for an asset, the insurer needed to assume that the rating was below BB. The result of this scenario shows that the mean and median post-stress capital and surplus retained by the Bermuda insurance market were 88.34% and 91.64%, respectively.

R5 (R1 to R4 combined) – is the most severe financial market scenario as it assumes a combination of a decrease of 40% of the value of equities in a portfolio (R1), a decrease in the value of alternative investment and real estate (R2) by 40%, US yield curve stress (R3) and credit widening across different rating classes (R4). The results showed that most insurers can withstand this scenario, with the mean and median post-stress capital and surplus returned by the Bermuda insurance market being 80.01% and 81.88%, respectively.

R6 (Foreign currency shocks) - assumes an equal percentage, provided by the Authority, of depreciation and/or appreciation of foreign exchange positions in both assets and liabilities. The result of this scenario shows that the mean and median post-stress capital and surplus returned by the Bermuda insurance market were 92.20% and 96.01%, respectively.

R7 (Escalation of sovereign risk) – assumes certain sovereigns will have to undergo a haircut in the face value of their debt. Both available-for-sale and held-to-maturity bonds were stressed. The haircuts were based on the realisation of a prolonged pan-European banking crisis in Europe that caused sovereign defaults. Only a handful of Bermuda insurers are exposed to this scenario. The result of this scenario shows that the mean and median post-stress capital and surplus returned by the Bermuda insurance market were 98.92% and 100.00%, respectively.

R8 (Inflation and monetary policy risk) – insurers have to apply a moderate (+5%), severe (+10%) and deflation (-1%) scenario for three years that assumed no initial action was taken to curb inflation from central banks. In year four, the central bank changed its stance and increased rates to restore the current real interest rate. From year five onwards, inflation and interest rates returned to current levels. Higher-than-expected inflation decreased the real yield on loans and debts while it may increase the value of indemnities, claims and expenses. This scenario is similar to the 2022 inflationary scenario. The mean and median post-stress capital and surplus after the severe inflationary scenario returned by the Bermuda insurance market were 81.17% and 89.55%, respectively.

In addition, insurers were required to submit a detailed qualitative disclosure of the impact upon both their statutory statement of income and liquidity positions of a rating downgrade of their Bermuda legal entities or groups by two notches or below A-, whichever was lower. The disclosure needed to cover and indicate the relative impact/severity of collateral requirements, loss payment triggers on in-force policy contracts, clawbacks and/or other adverse financial and liquidity implications of the downgrade.

Appendix I - The Bermuda Framework for Cat Risk Supervision

As it is one of the world's largest property Cat reinsurance centres, Bermuda has a comprehensive framework of Cat risk supervision. The supervisory framework rests on three pillars:

1) Cat capital charge in prudential filings;
2) Supervisory assessment of prudential filings; and
3) Public dissemination of Cat risk data on an aggregated basis.

The first pillar includes the capital charge for Cat risk that the insurer must uphold as part of its solvency capital requirement. The capital charge is a combination of a BMA in-house factor plus an insurer-specific factor provided by the insurer. Once the capital charge for Cat risk was calculated, it had to be further blended into the overall capital charge to allow for diversification.

Within the prudential filings, some schedules comprise the Cat risk-return. The Cat risk-return questionnaire contains qualitative information on the process of Cat risk modelling, such as the type of models and the frequency of the modelling process. In addition to the qualitative information, the insurer provides quantitative information such as AALs, PMLs and EP curves for major perils.

In the second pillar, the supervisory process validates the prudential filings. Since part of the Cat risk capital charge calibration hinges on the insurer’s assumptions, the BMA validates the results with a set of tools. The Cat risk return is one source of cross-validation.

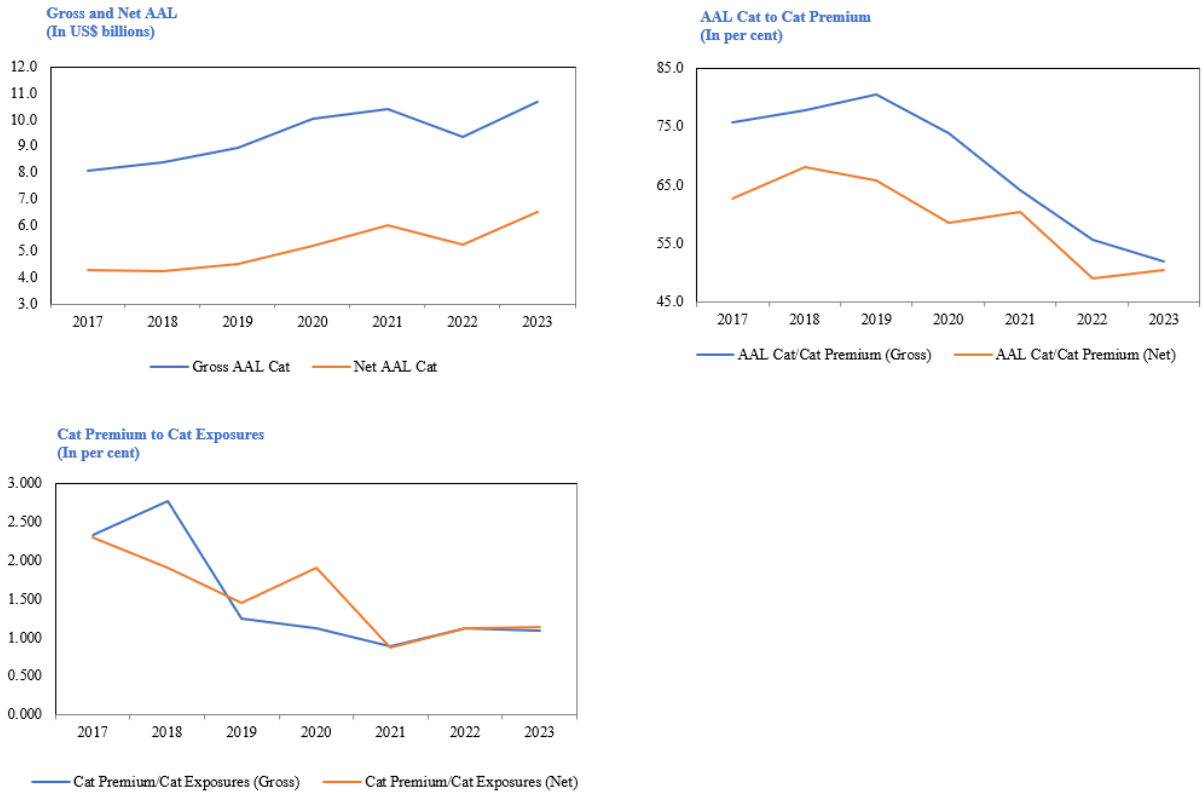
Finally, the BMA prescribes a set of stress tests based on Lloyd’s RDS, which are reported on in the prudential filings. The insurer must show its capital position before and after the relevant RDS and is required to provide several scenarios should the RDS be insufficient for the type of exposures in its portfolio. The insurer is also obligated to provide a reverse stress test that will render its business non-viable.

Regarding the third pillar, the BMA publicly publishes aggregated data of the Bermuda Cat risk returns for the market and its macro-prudential surveillance framework for the insurance sector.

Appendix II - Pricing Dynamics

The following panel shows the pricing dynamics of the Bermuda Cat market over time based on aggregated data only.

Panel 1. AAL, Risk and Pricing Ratios[18]



Year-over-year, the gross Cat AAL increased to $10.70 billion in 2023 from $9.36 billion in 2022. Similarly, the net AAL increased to $6.49 billion in 2023 compared to $5.28 billion in 2022.

Panel 1 plots the risk and pricing dynamics to show the ratios of the Cat AAL to Cat premium on both a gross and net premium basis. The AAL represents the modelled estimation of the expected Cat losses, and the gross premium includes provisions for profit and expenses. The relationship between these gross and net ratios indicates the amount of expenses, profit and other loadings charged to insured entities. The BMA observes that, on average, the gross and net ratios have steadily decreased over the last three years. For 2023, the gross ratio is 51.98%, while the net ratio is 50.54%. The decrease in these ratios is consistent with the hardening of the insurance market and the reduction of Cat exposure by Bermuda insurers.

[18] The BMA only uses modelled exposures and premium.

The BMA also plots the ratio of modelled Cat premium to Cat exposures, which can be seen in the second row of Panel 1. For 2023, the ratio decreased slightly on a gross basis to 1.09% from 1.12% in 2022, while on a net basis, it stood at 1.13%, which was stable y/y.