

IAIS Global Insurance Market Report (GIMAR) 2017

27 February 2018

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Executive Summary

This 2017 edition of the Global Insurance Market Report (GIMAR) discusses the global (re)insurance sector from a supervisory perspective, focusing on recent sector performance and key risks.

Throughout 2017, the (re)insurance sector remained stable with clear signs of growth, as evidenced by high capital levels, positive profitability, and a persistent inflow of additional reinsurance capital. Nonetheless, the (re)insurance sector operates in a macroeconomic and financial environment characterised by weak global demand, low inflation rates, very low and partially negative yields, and occasional bursts of financial market volatility. This environment is challenging long-established business models of various insurance companies, mainly life insurers.

Non-life (re)insurance continues to be subject to soft market conditions. Premiums charged by non-life (re)insurers in the commercial lines, property and catastrophe markets remain under pressure, partly due to increasing competition, while investment yields are declining gradually. Competition has been especially strong in the reinsurance market – a market still operating in benign catastrophe times heading into 2017. The market is expecting an upturn in pricing following numerous natural catastrophic events in the second half (H2) of 2017.

The prolonged low interest rate environment is a source of vulnerability for life insurers especially in advanced economies. Low interest rates are putting pressure on life insurers' capital positions, particularly those offering products with long-term guaranteed rates and having large maturity mismatches between assets and liabilities. The longer these low rates persist, the more maturing higher coupon investments will have to be reinvested at prevailing low interest rates. Insurers may respond by repricing or redesigning products to reflect these lower rates.

These issues are developed and further discussed in the four chapters that make up the 2017 GIMAR. Chapter 1 analyses the overall macroeconomic and financial environment. Chapter 2 focuses specifically on global re/insurance market developments, while Chapter 3 covers a variety of special topics focusing on regulatory, financial and economic developments and risks. One special topic looks at the investment markets and insurance investments, while others discuss public disclosure under Solvency II and the catastrophe risk modelling practices in Bermuda. Lastly, emerging market topics explore the importance of financial education and inclusion for emerging insurance markets, and the digital innovations in the insurance market in India. Chapter 4 summarises the IAIS survey of the global reinsurance market. It documents a unique global data set made possible by the participation of 47 reinsurers in nine jurisdictions in North America, Europe and Asia, and links the financial position of reinsurers to the broader financial economy.

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Background

This is the fifth issue of the GIMAR.

The GIMAR assesses developments relevant to the (re)insurance industry and identifies and documents some main risks and vulnerabilities for the industry. It does so to promote awareness of these developments and risks among IAIS Members, stakeholders and interested parties more generally. By providing a financial system-wide assessment of developments and risks, the GIMAR also plays an important role in the macroprudential policy and surveillance framework of the IAIS. A global system-wide dimension is an important complement to microprudential insurance supervision, which is more focused on the soundness of individual financial institutions.

This report is data-driven and has been prepared by the IAIS Macroprudential Policy and Surveillance Working Group (MPSWG). It is neither standard-setting nor supervisory supporting material, and is not intended to reflect the views of IAIS Members. Part of the report draws from an IAIS data pool on reinsurers. The GIMAR report benefitted from contributions from several jurisdictions.

Chapter 1 - Macroeconomic and Financial Environment

Internationally, the insurance industry operates in a macroeconomic and financial environment that is increasingly difficult for (re)insurers because of weak global demand; low inflation rates; low, and in many advanced economies negative, short- and long-term interest rates; and occasional bursts of financial market volatility. This environment challenges long established business models of (re)insurers¹ and other financial sector participants. To date, insurance companies have been able to weather such developments; however, the pressure is increasing as is the incentive to engage in a search for yield.²

1.1 International economic growth and inflation

Nine years after the global financial crisis, the world economy is still trying to recover the momentum gained during the mid-2000s. Amidst an overall concern about the rapidly gathering piles of global debt, which stood at a record of 327% of GDP in 2017,³ the IMF stated that governments should be cognisant of the fact that debt financing should be offset by sustainable fiscal policy and growth.⁴ Even in a challenging environment, global trade is actually expected to grow. The World Trade Organisation (WTO) estimates that world merchandise trade is forecasted to grow by 2.4% in 2017. Nonetheless, the WTO emphasised that this can only be achieved if “governments pursue the right policy mix”.⁵

Globally, yields on 10-year break-even bonds⁶ have risen, particularly due to an anticipation of the end of an accommodative monetary policy. Prospects of a tighter monetary policy (among other reasons) have helped stock markets reach new heights. However, higher inflation has yet to materialise in a number of countries, while high levels of unemployment have put downward pressure on wages. The headline inflation in July 2017 was just 1.7% and 1.3% in the United States (US) and the Euro area, respectively. In a number of economies, not only was the inflation rate low, but also the inflation expectations decreased.⁷

Japan’s inflation remained close to zero with no change in expectations as the Bank of Japan (BoJ) has delayed reaching its inflation target.⁸ The 10-year break-even rate in Japan since the BoJ started issuing such financial instruments in October 2013 has averaged less than 0.8%. The average expected inflation for some developing countries, such as Brazil and South Africa, was somewhat higher at 6.3% and 6.4%, respectively, in September 2017.

¹ Henceforth, the term “insurer” is used synonymously for all types of insurers, when appropriate.

² The Deutsche Bundesbank’s Financial Stability Review 2016, Press release, 11 November 2016.

³ IIF (2017): Global Debt Monitor – June 2017, Institute of International Finance, 27 June 2017.

⁴ Fiscal Monitor: Achieving More with Less, International Monetary Fund, Washington, D.C., April 2017.

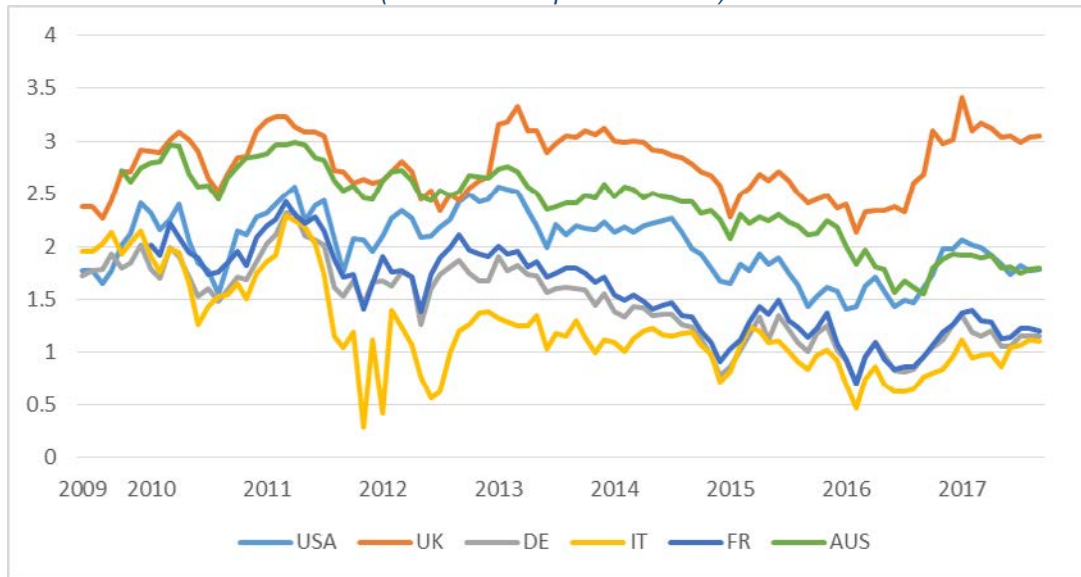
⁵ “Trade recovery expected in 2017 and 2018, amid policy uncertainty”, World Trade Organization, 12 April 2017.

⁶ 10-year break-even bonds are used as a market-based proxy for expected inflation and their yield is computed as the difference between the yield of a nominal bond and an inflation-linked bond of the same maturity.

⁷ International Monetary Fund – World Economic Outlook: Subdued Demand – Symptoms and Remedies (2016), “Global Disinflation in an Era of Constrained Monetary Policy”, Washington, D.C., October 2016.

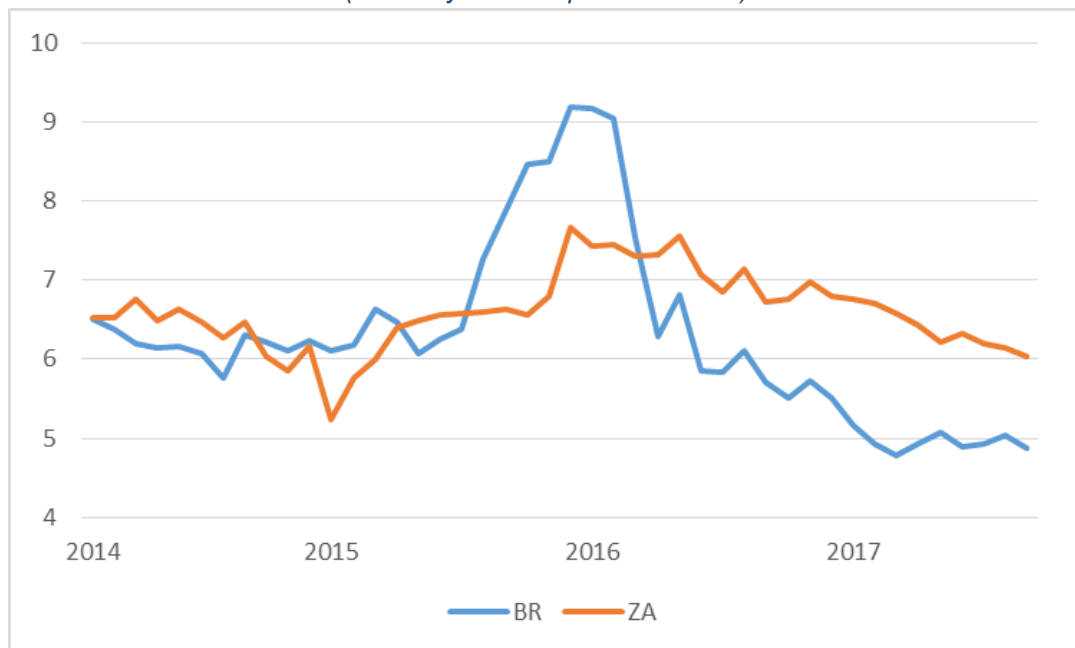
⁸ Bank for International Settlements, Quarterly Review (2017), “Strong outlook with low inflation spurs risk-taking”, BIS, 17 September 2017.

Figure 1.1a: Market-based inflation expectations, break-even rates of 10-year bonds, in % (June 2009-September 2017)



Source: Bloomberg

Figure 1.1b: Market-based inflation expectations, break-even rates of 10-year bonds, in % (February 2014-September 2017)



Source: Bloomberg (Data unavailable for other BRICS⁹ economies)

In 2017, growth remained solid in many countries, including the US, the Euro area economies and Japan. In China, GDP growth in 2017 (through the first three quarters) was slightly higher than in 2016, but still below the pre-2016 levels.

⁹ Brazil, Russia, India, China and South Africa

1.2 Financial markets

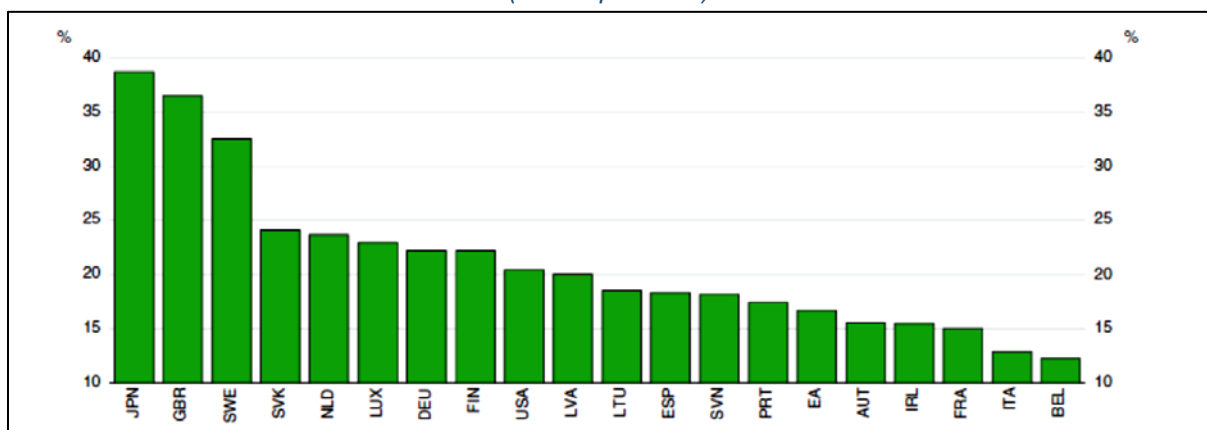
The decline in long-term interest rates in many countries around the world since the financial crisis has been driven almost entirely by a fall in term premiums (ie the excess yield that investors require to commit to holding a long-term bond instead of a series of shorter-term bonds).¹⁰ An important factor behind the eroding term premiums were the sizable bond purchases of central banks as part of their asset purchase programmes.

Figure 1.2a: Long-term interest rates (January 2007-August 2017)



Source: Organisation for Economic Co-operation and Development (OECD)

Figure 1.2b: Government bonds held by central banks as a percentage of government debt securities (as of April 2017)



Source: OECD

As stated in the 2016 GIMAR, insurers and pension funds operating for a long time in a low interest rate environment are exposed to lower return on their future investments and increasing present values of future liabilities due to a decrease in their discount rate. This might induce them to reconsider asset allocation strategies to meet the market expectations.¹¹

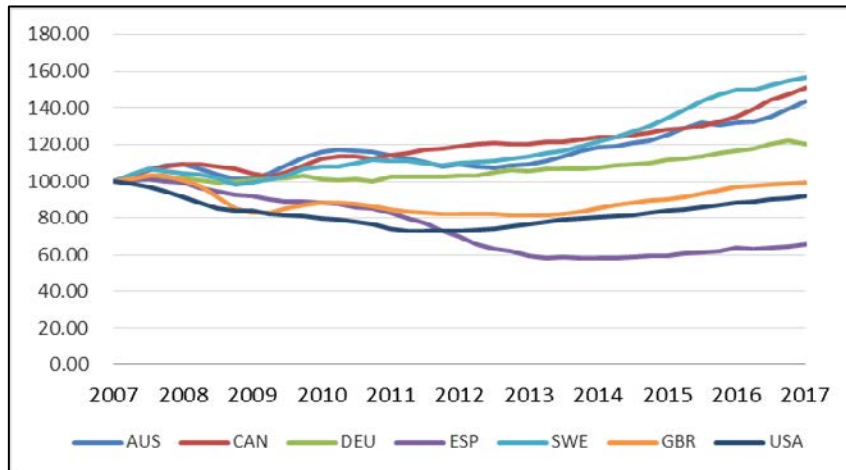
During the low-rate environment, investments in riskier asset classes, like equities and real estate, have increased significantly. Equity prices have risen significantly in recent years, with further gains in 2017 in advanced economies, notably in the US and Germany. In addition,

¹⁰ Peter Hördaahl, J.Sobrun, P.Turner (2016): Low long-term interest rates as a global phenomenon, BIS Working Paper No. 574.

¹¹ European Central Bank (2015), "Financial Stability Review: Special Features – B. Euro area insurers and the low interest environment", November 2015.

house prices have started to increase in most countries as shown in Figure 1.2c, perhaps in part due to the low interest rates.

Figure 1.2c: Real house price indices in selected advanced economies, (2007 Q1-2017 Q1, Index 2007:Q1=100)



Source: OECD

While low interest rates can pose a challenge to insurers, the current financial market environment is potentially vulnerable to sudden upward shifts in interest rates. An increase in rates might place a strain on valuations of riskier asset classes. Increasing interest rates could well decrease investor appetite to hold riskier assets, which could increase demand for the limited pool of safe assets. One unknown in this is the potential effects of changes in central bank bond purchase programs. In recent years, central banks including the European Central Bank (ECB), the US Federal Reserve (Fed), and the BoJ have purchased significant amounts of safe assets such as government bonds. In late 2017, the Fed announced that it was going to scale back its bond ownership. It is believed the ECB may follow suit in the near future. This would increase the availability of safe assets for investors.

Chapter 2 - Global Insurance Market Developments

As an integral part of the international financial environment, the global insurance industry follows the global macroeconomic trend and is, therefore, exposed to weak economic growth, low inflation rates, volatile financial markets and the persistent low interest rate environment. Since the global financial crisis, premium growth has generally remained below pre-crisis levels. In Q2 2017, on average, insurance prices declined across the globe for the seventeenth consecutive quarter.¹² Underwriting is under pressure, but remains profitable.

The 2016 IAIS GIMAR found the protracted low-yield environment was pressuring the capital positions of life insurance companies, particularly those companies offering products with long-term guaranteed rates and big maturity mismatches between assets and liabilities. News of possible rate increases in advanced economies is very closely monitored by market participants since they could result in an asset reallocation. Non-life (re)insurance was subject to soft market conditions in the first half of 2017, after which the market started hardening, mainly as a consequence of the major natural catastrophic events occurring in the Caribbean and the US.

2.1 Non-life insurance

The Q1 2017 survey conducted by the Council of Insurance Agents & Brokers indicated an overall softening of rates in US commercial lines, although to a lesser extent than in Q4 2016. Rates decreased across all sizes of accounts, by an average of 2.5% (compared to decreases of 3.7% in same quarter in 2016 and 3.3% in the previous quarter). In their “Global Insurance Market Index: Second Quarter 2017” outlook, Marsh reports commercial rate declines across regions and lines of business. In Q2 2017, global commercial insurance rates fell for the seventeenth consecutive quarter (-2.2%) albeit at a slower pace than in previous quarters (-3.6% in Q2 2016 and -2.3% in Q1 2017) marking the sixth consecutive quarter of moderating renewal rate decreases. This continued decline in global insurance rates may be mainly driven by increased global underwriting competition together with significant excess capacity.

Throughout 2017, global non-life insurance premium growth was expected to be driven by economic strengthening of the emerging markets, particularly Asia. This is backed up by the increasing demand for saving channels.¹³

In the first half (H1) of 2017, natural catastrophe losses remained below historic average levels, with the main losses in the US produced by hailstorms and tornadoes and in Peru from floods. According to Swiss Re, losses from natural catastrophes in H1 2017 amounted to USD 41 billion out of which half of the losses were uninsured. The costliest event in this period has been estimated at USD 3.1 billion in losses from the floods in Peru.¹⁴

¹² Marsh (2017), “Global Insurance Market Index: Second Quarter 2017”.

¹³ Swiss Re (2016), “Global insurance review 2016 and outlook 2017/18”, Zurich, 22 November 2016.

¹⁴ Munich Re (2017), “Press Release: Natural catastrophe review for the first half of 2017: A series of powerful thunderstorms in the USA causes large losses”, 18 July 2017.

However, in the second half (H2) of 2017, there was an increasing occurrence of severe natural catastrophes in North and Central America (these included Hurricanes Harvey, Irma, Jose and Maria, and several earthquakes in Mexico, including one in Mexico City). RMS estimates of the insured losses resulting from Hurricane Harvey might be between USD 25 and 35 billion,¹⁵ while the insured losses from Hurricane Irma might accrue to anywhere from USD 35 to 55 billion.¹⁶ AIR Worldwide¹⁷ estimates that the 19 September 2017 earthquake that occurred near Mexico City might produce insured losses between USD 0.7 and 2 billion. Swiss Re estimates that the total insured market losses from Hurricanes Harvey, Irma and Maria and the Mexico earthquakes stood at USD 95 billion at the end of October 2017.¹⁸ Munich Re is expecting the insured losses to amount to a record level of USD 135 billion.¹⁹

As discussed above, the global non-life insurance markets have been characterised by a period of softness. However, in H2 2017, renewal rates might be driven up again as observed in the motor insurance market. The OECD has postulated that motor vehicle insurance growth or decline can stand as a proxy for the entire non-life insurance trend. The OECD claims that this business line is a driver of performance and is closely linked to the economic performance of non-life insurers.²⁰ As a consequence, the industry is expecting extensive pay-outs mainly because of the increased number of natural catastrophic events. In other parts of the world, low penetration of non-life insurance persists in Latin America and Asia and thus represents long-term growth potential.

¹⁵ RMS (2017), "RMS Estimates Hurricane Harvey Insured Losses from Wind, Storm Surge and Inland Flood Damage will be Between USD 25 and 35 billion", 9 September 2017, www.rms.com, accessed on 25 September 2017.

¹⁶ Bermuda:Re+ILS (2017), "RMS releases latest Irma loss estimate", 21 September 2017, <http://www.bermudareinsurancemagazine.com/news/rms-releases-latest-irma-loss-estimate-3505>, accessed on 25 September 2017.

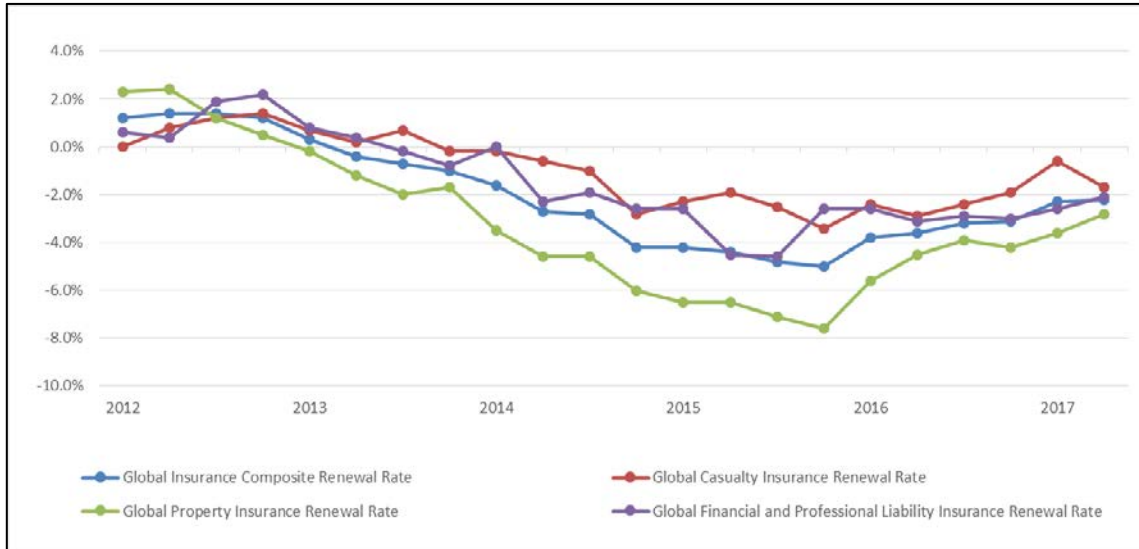
¹⁷ AIR Worldwide (2017), "AIR Worldwide Estimates Insured Losses from September 19, Central Mexico, M7.1 Earthquake", Boston, 22 September 2017, www.air-worldwide.com/press-releases/, accessed on 25 September 2017.

¹⁸ Swiss Re (2017), "Swiss Re estimates its claims burden from hurricanes Harvey, Irma and Maria and the Mexico earthquakes at USD 3.6 billion", 20 October 2017, http://www.swissre.com/media/news_releases/nr_20171020_swissre_harvey_irma_maria_losses.html, accessed on 31 October 2017.

¹⁹ Munich Re (2018), Press Release, "Natural catastrophe review: Series of hurricanes makes 2017 year of highest insured losses ever", 4 January 2018.

²⁰ OECD (2016), "Global Insurance Market Trends", 2016.

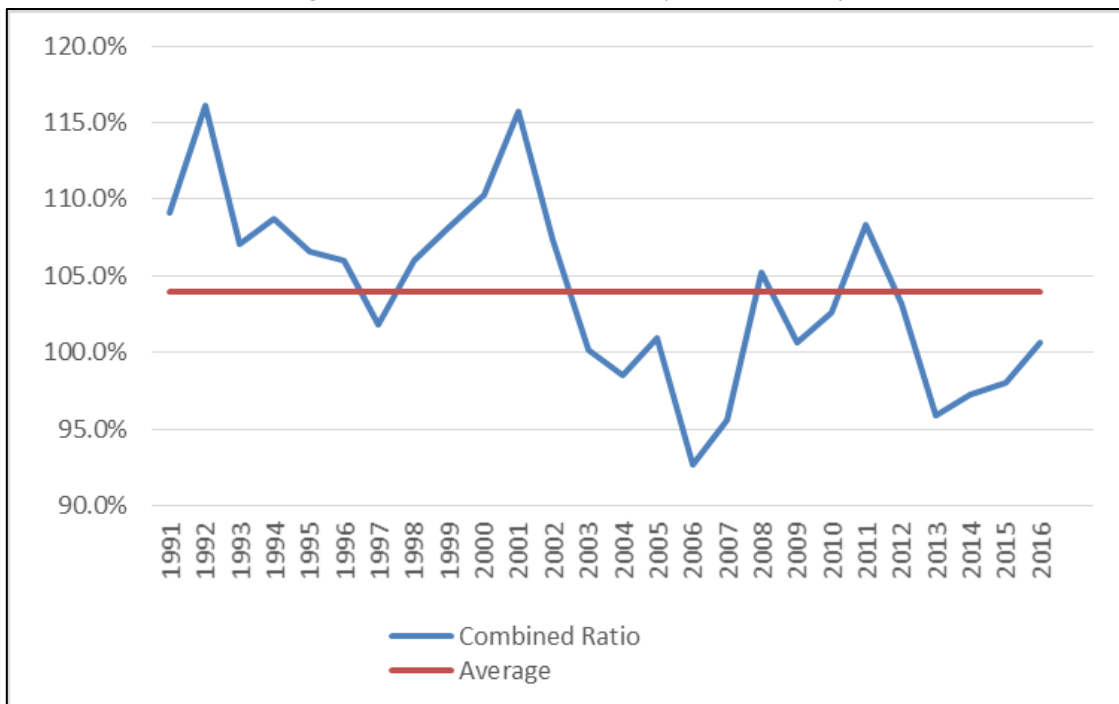
Figure 2.1a: Global insurance market renewal rates (2012 Q1-2017 Q2)



Source: Marsh Global insurance market index – 2017 Q2

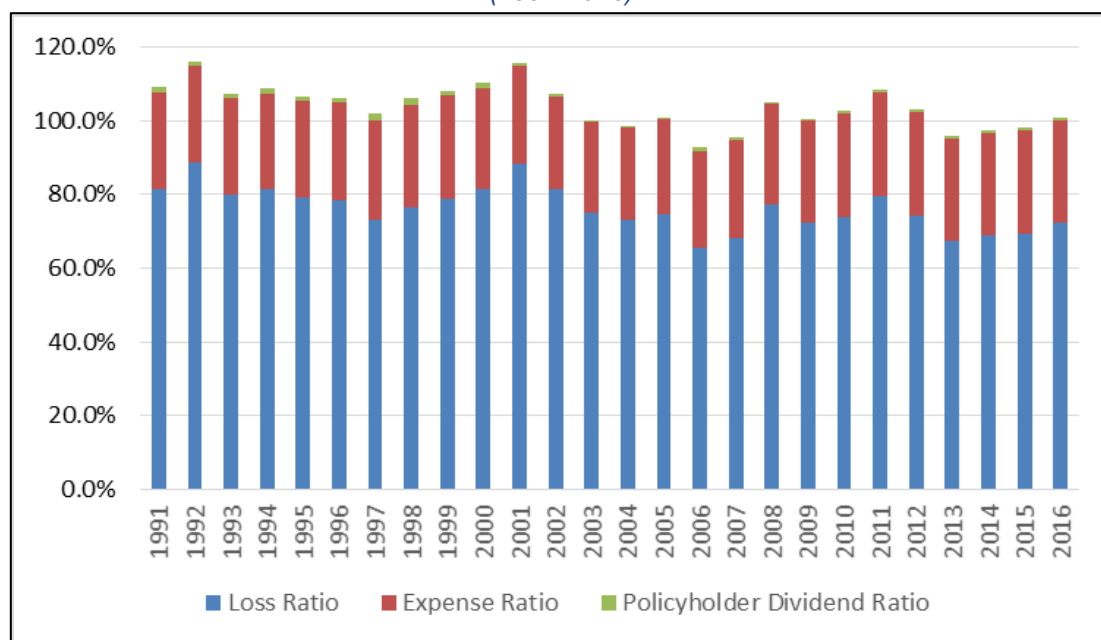
The reported profitability remains generally positive. Between 2013 and Q3 2016, the US Property & Casualty (P&C) insurance industry reported combined ratios (ie incurred losses and expenses as a proportion of premiums earned) below 100%. After barely exceeding 100% in Q4 2016, in particular due to higher natural catastrophes losses, the combined ratio decreased to 99.7% in Q1 2017. The long-run (1991-2016) average combined ratio of the US P&C industry is 103.9% (not taking into account the Q1 2017 data).

Figure 2.1b: US combined ratio (1991-2017 Q1)



Source: National Association of Insurance Commissioners (NAIC)

Figure 2.1c: US property & casualty loss ratio, expense ratio and policyholder dividend ratio (1991-2016)



Source: NAIC data

In Europe, the combined ratio remained broadly unchanged. At the end of 2016, the average combined ratio was close to 95%, similar to the one at year-end 2015 and slightly lower than the ratio at H1 2016.²¹ The main competitive pressures stem from motor insurance and medical expenses.²² The United Kingdom observed a combined ratio at year-end 2016 of 99.29%, which followed an upward trend from previous years.²³ Regarding the German market, as well as that of several other European markets, the combined ratio (which is the sum of the expense ratio and the loss ratio²⁴) has been quite stable over the years.

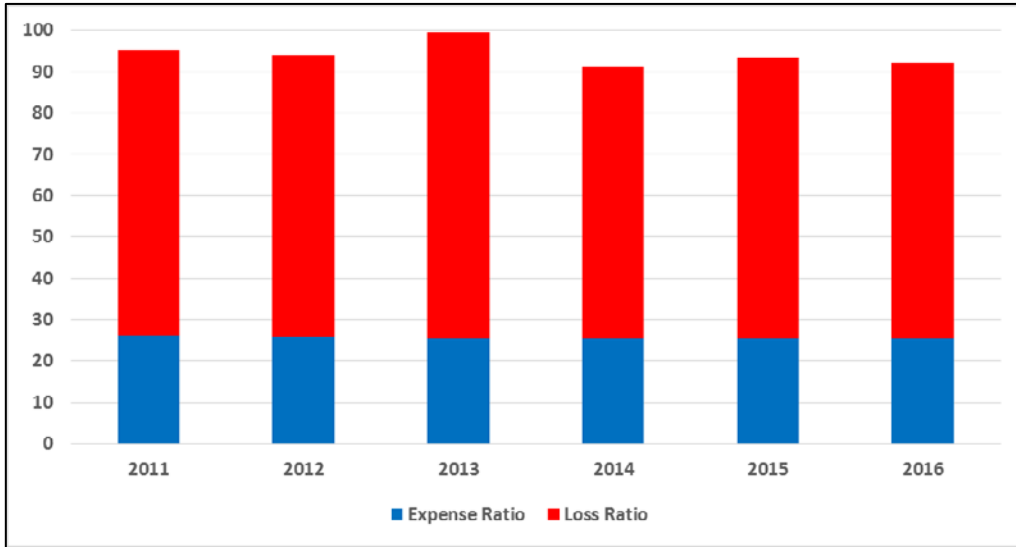
²¹ European Central Bank (2017), "Financial Stability Review", Frankfurt am Main, May 2017.

²² EIOPA (European Insurance and Occupational Pensions Authority) (2017), "Financial Stability Report", June 2017.

²³ Bank of England, Prudential Regulatory Authority data.

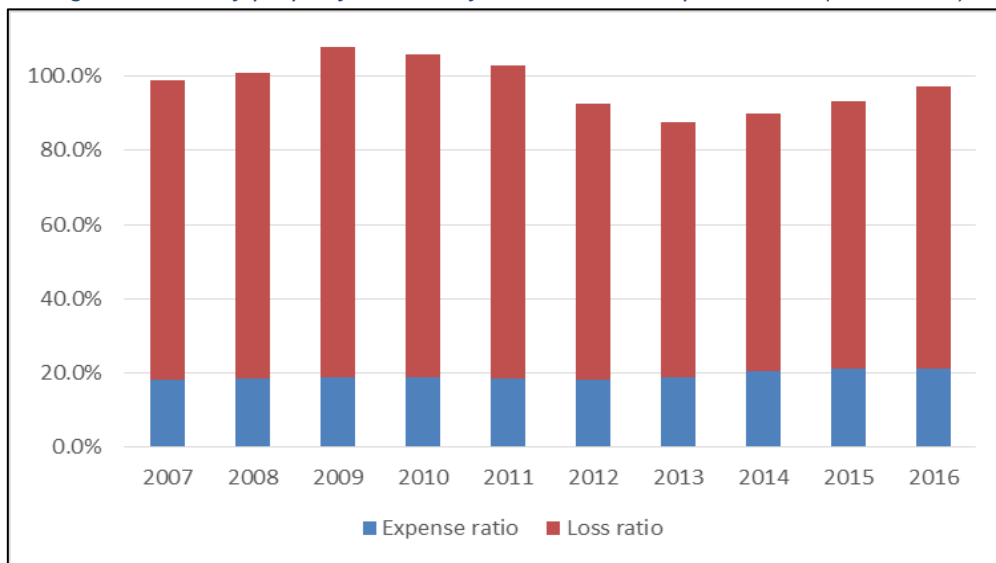
²⁴ The expense ratio describes the relation of the costs/expenses vs. the gross premiums, and the loss ratio is the ratio of claims vs. gross premiums. These data take into account the full settlement of the technical provisions (ie the ratios are taken after the technical provisions have been fully settled).

Figure 2.1d: Germany property & casualty loss ratio and expense ratio (2011-2016)



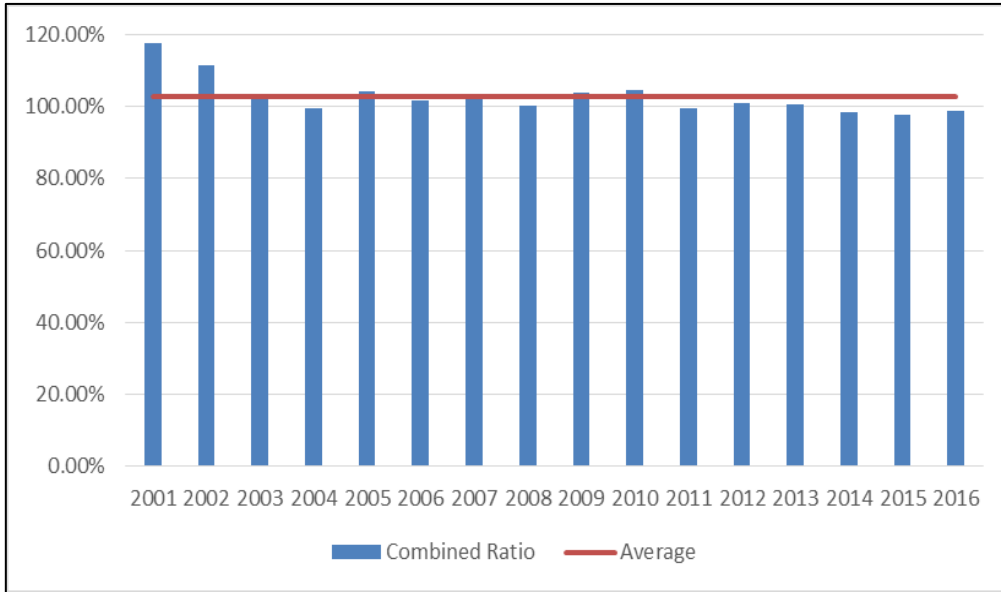
Source: Federal Financial Supervisory Authority (BaFin)

Figure 2.1e: Italy property & casualty loss ratio and expense ratio (2007-2016)



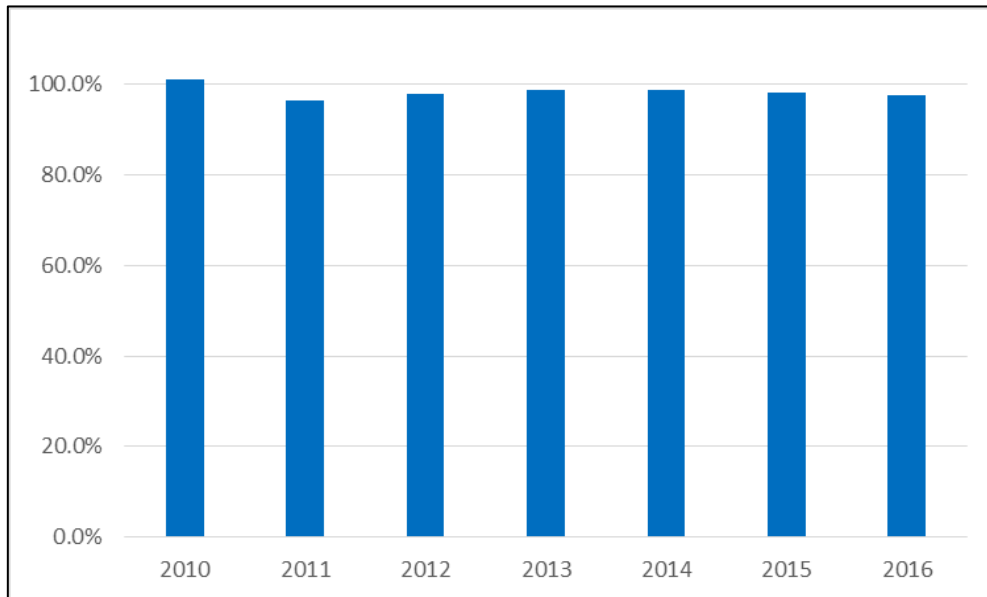
Source: Italian Institute for the Supervision of Insurance (IVASS)

Figure 2.1f: Belgium property & casualty combined ratio (2001-2016)



Source: National Bank of Belgium

Figure 2.1g: France property & casualty combined ratio (2010-2016)

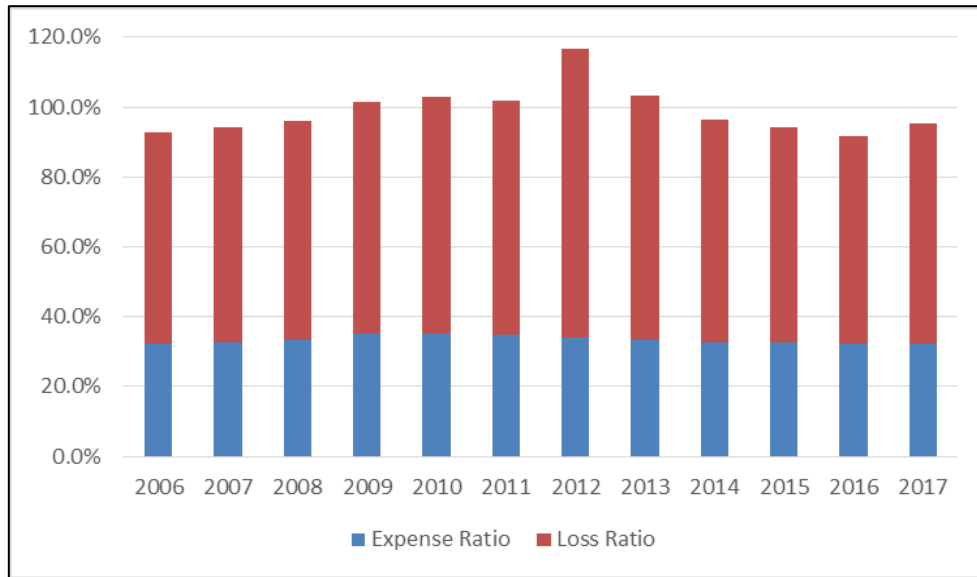


Source: French Prudential Supervision and Resolution Authority (ACPR)

In Australia, the profitability of property insurers improved in H1 2017, with a net underwriting combined ratio of direct insurers of 88% at the end of June 2017 compared to 92% at the end of the same period in 2016.²⁵ Although the Japanese P&C market observed a slight upturn in its combined ratio in 2017 following a period of decline, mainly due to the natural catastrophes with substantive pay-outs, the ratio has remained stable over recent years.

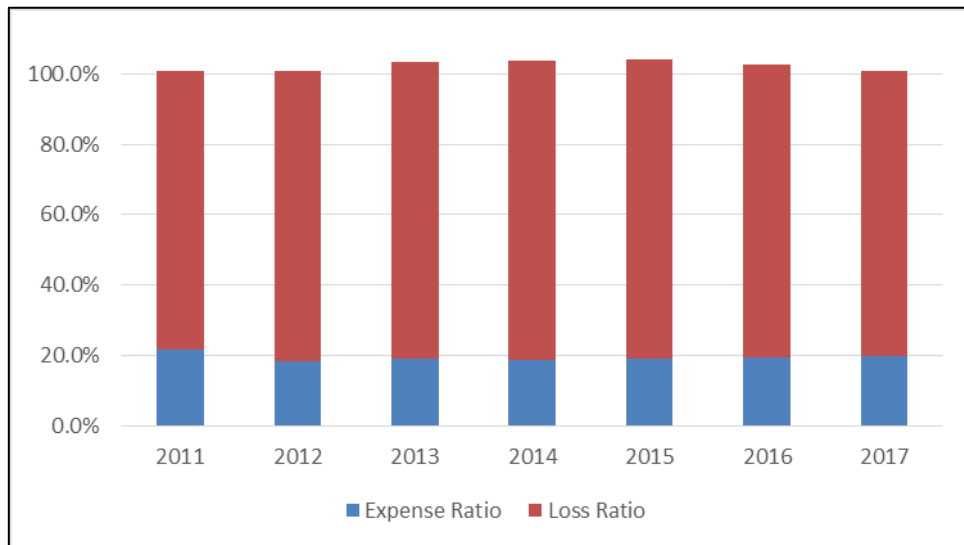
²⁵ Information from the Australian Prudential Regulation Authority (APRA).

Figure 2.1h: Japan property & casualty loss ratio and expense ratio
(March 2006-March 2017)



Source: Published data from non-life insurers in Japan

Figure 2.1i: South Korea property & casualty loss ratio and expense ratio
(March 2011-March 2017)



Source: Republic of Korea Financial Supervisory Service

2.2 Life insurance

Overall, in 2016, life insurance premiums grew and are expected to continue to grow through 2017 and 2018. This growth is driven in part by an increasing demand for savings products in Asia and other emerging markets. Global life insurance premiums in real terms are forecasted to grow by 4.8% and 4.2% in 2017 and 2018, respectively, compared to a previously estimated

increase of 5.4%. The projected decline in growth rates has been attributed to lower expected growth rates in emerging Asia.²⁶

Even though the overall global financial market is showing signs of recovery, life insurers are still under the threat of low-yields. These might weigh on insurer profitability. Though stable for now, the life insurance market might turn more volatile in the medium-to-long term under a “low-for-long” scenario.

This specific market environment can be seen as a vulnerability to many life insurers. A life insurer makes a profit from the spread between its investments and (guaranteed) pay-outs (benefits to policyholders). A mismatch between initial interest rates to present much lower ones considerably increases the present value of life insurers’ future liabilities compared to the present value of their assets.

As a result, life insurers’ books of business are under strain, especially on the traditional life products side. Companies are under pressure to offer efficient savings products to customers, taking into account a long-term low-rate environment. The asset-liability matching process comes into the spotlight when a life insurer needs to match high-yield-guarantees in such a market. Thus, the life insurance market can be easily exposed to low liquidity levels, increased reserves, and search for riskier investments in the short-term to offset the effects of low-yielding products.²⁷

Insurers have also started to offer unit-linked products, tying the pay-out of the insurance policy to the performance of the capital market. This in turn limits insurer exposure to interest rate risk. However, the demand for these products has been hit by the very same low-yield financial markets.²⁸ In this respect, life insurer business models are starting to resemble those of asset managers by lowering or even removing guarantees on returns.²⁹

In the US, the NAIC continues to track the differential between net investment yields and guaranteed crediting rates for the US life industry. In 2016, the margin stabilised modestly, increasing from 110 basis points in 2015 to 118 basis points in 2016. The main reason for this was a decline in crediting rates, as net investment yield continued to decrease. The percentage of fixed income assets represented by higher coupon legacy assets has contracted. Therefore, while some further declines in that component are probable, the impact is not likely to be significant. On the other hand, an increasing portion of investment income is coming from non-fixed income assets. This could result in greater variability.

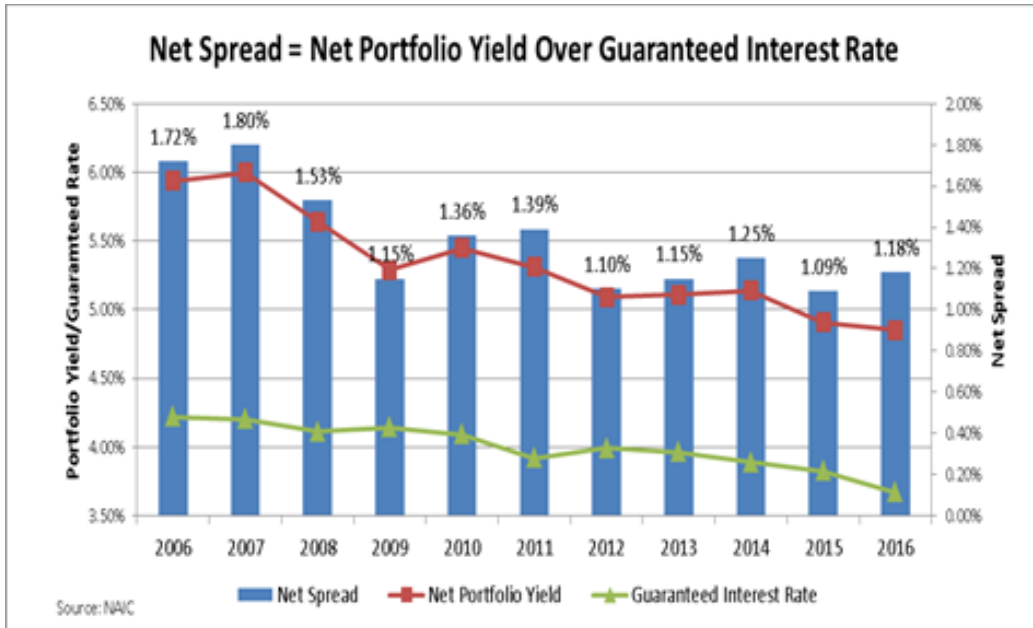
²⁶ Swiss Re (2016), “Global Insurance Review 2016 and Outlook 2017/18”, 22 November 2016.

²⁷ European Central Bank (2017), “Financial Stability Review May 2017”, Frankfurt am Main, May 2017.

²⁸ European Systemic Risk Board (ESRB) (2017), “Annual Report 2016”, Frankfurt am Main, 2017.

²⁹ ESRB (2016), “Macroprudential policy issues arising from low interest rates and structural changes in the EU financial system”, November 2016.

Figure 2.2a: US Life Insurance market net spreads (2006-2016)

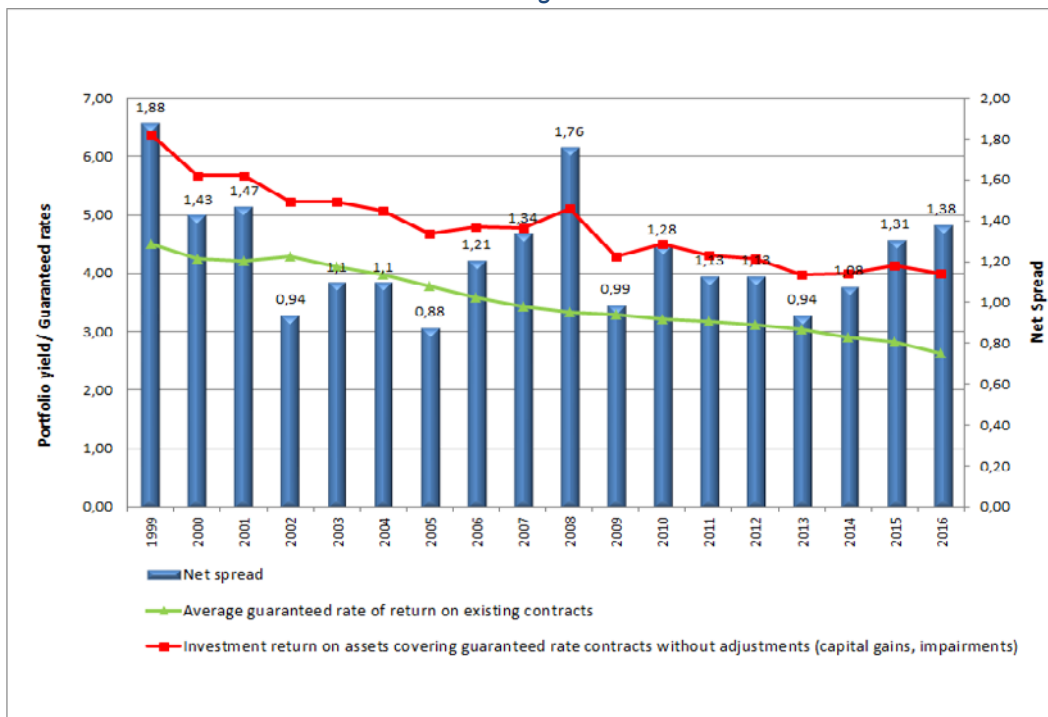


Source: NAIC

Similar trends can be observed in other economies as well, especially throughout Europe.

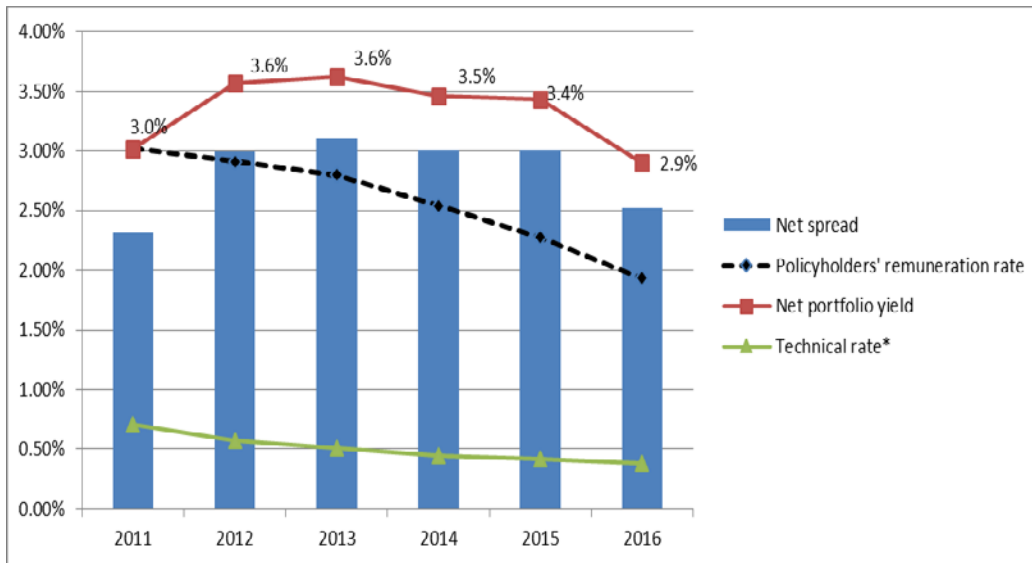
Figure 2.2b: Selected European life insurance market net spreads (2006-2016)

A. Belgium



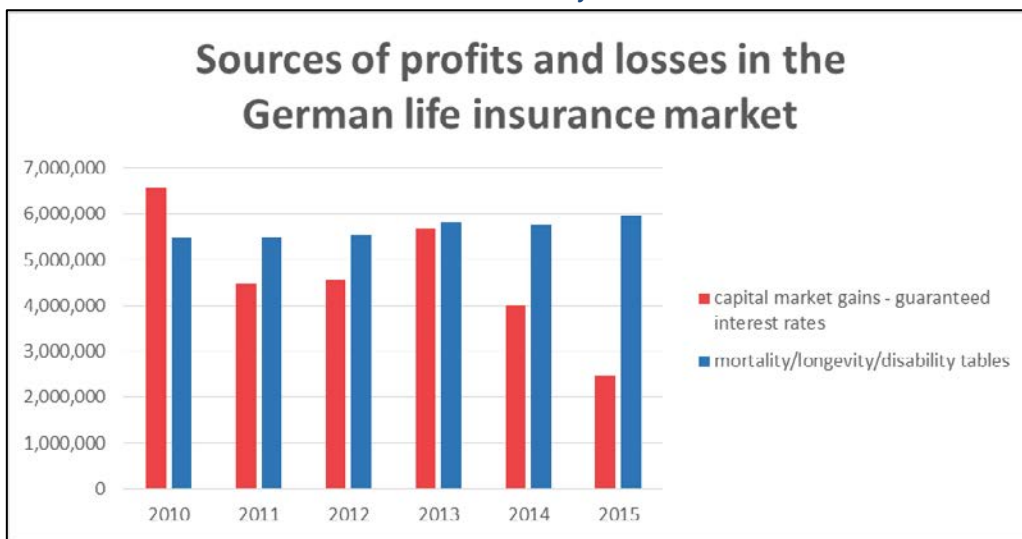
Source: National Bank of Belgium

B. France³⁰



Source: ACPR

C. Germany



Source: BaFin

Such a low-interest rate environment might push life insurers (especially those with a mismatch between assets and liabilities) to reinvest maturing investments at these low rates. Companies will need to respond quickly to such a strategic shift in the way of doing business, mainly by repricing and redesigning their products to reflect and fully take into account these low rates. Usually liabilities of life insurers mature in the distant future. This in turn obliges insurers to make carefully considered assumptions of future rates so they can meet policyholder

³⁰ The “technical rate” is the guaranteed rate of return for policyholders over the coverage period of the contract. According to French law, insurers have to distribute to policyholders at least 75% of their financial result within eight years. This is not taken into account in the calculation of this technical rate.

expectations. The continuous development of risk management frameworks will be key in achieving carefully considered assumptions of future rates.³¹

2.3 Reinsurance³²

The global reinsurance market has remained largely unchanged compared to 2016, especially throughout H1 2017. Market conditions in the reinsurance industry remain challenging, being marked by competitive pressures, excess capacity, modest premium growth, softening premium rates, low investment yields and industry consolidation.³³ Gross P&C reinsurance premiums grew by 1% after similar growth over the same time period in 2016.

In H1 2017, the reinsurance market experienced a return of just 1.2% above its cost of capital. This is one of the lowest excess returns in more than ten years. While at the end of 2016 the return on equity averaged 8.6%, it is expected that this will drop to the 5-7% range by the end of 2017. The cost of capital is expected to increase marginally from its 2016 level of 6.5%. Given that, first, the Ogden discount rate was reduced during Q1 2017 and, second, insured losses due to natural catastrophes remain below the historical average, reinsurer profitability faces heavy pressure not to dip below the cost of capital in the future.³⁴

One trend observed again in the reinsurance market over the past year is an increase in merger and acquisition (M&A) deals. This can be seen as one way of strengthening reinsurer market position and capital position, as well as trying to counteract the current soft market in which these companies operate. Even though softer than in 2015 and 2016 (in principle due to the preparations for the UK's exit from the European Union and temporary monetary controls in China), 2017 is still expected to be marked by several consolidations such as Sampo Holdings Inc's purchase of Endurance Specialty Holdings Ltd (purchase price USD 6.3 billion), Liberty Mutual Group Inc's acquisition of Ironshore Inc (purchase price of USD 3 billion), and Fairfax Financial Holdings Ltd's purchase of Allied World Assurance Co Holdings AG (purchase price of USD 4.9 billion).³⁵

Following an increased supply of reinsurance capital to a peak level in 2016 of USD 595 billion, H1 2017 saw another rise in this level by almost 2%, reaching USD 605 billion at 30 June 2017. Interestingly, alternative capital has been rising at a faster rate (10%) than traditional capital (0.5%).³⁶

Driven by investor appetite for insurance risk, the average growth between 2006 and H1 2017 has been 40% for traditional capital and more than 400% for alternative risk transfer capital (as % of total capital). This build up has occurred on the back of a benign period of catastrophic losses in previous years, as well as the presence of a low-yield environment and strong retained earnings reported by reinsurers. The staggering increase of alternative asset classes

³¹ IMF (2014), "The impact on the insurance sector of a low interest rate environment – Technical Note: IMF Country Report No. 14/68, 2014.

³² The topic of reinsurance is also covered elsewhere in this GIMAR. Chapter 3 discusses recent developments in risk transfer to the capital markets. Chapter 4 introduces findings from empirical research conducted by the IAIS on a sample of global reinsurers.

³³ EIOPA (2017), "Financial Stability Report: June 2017", June 2017.

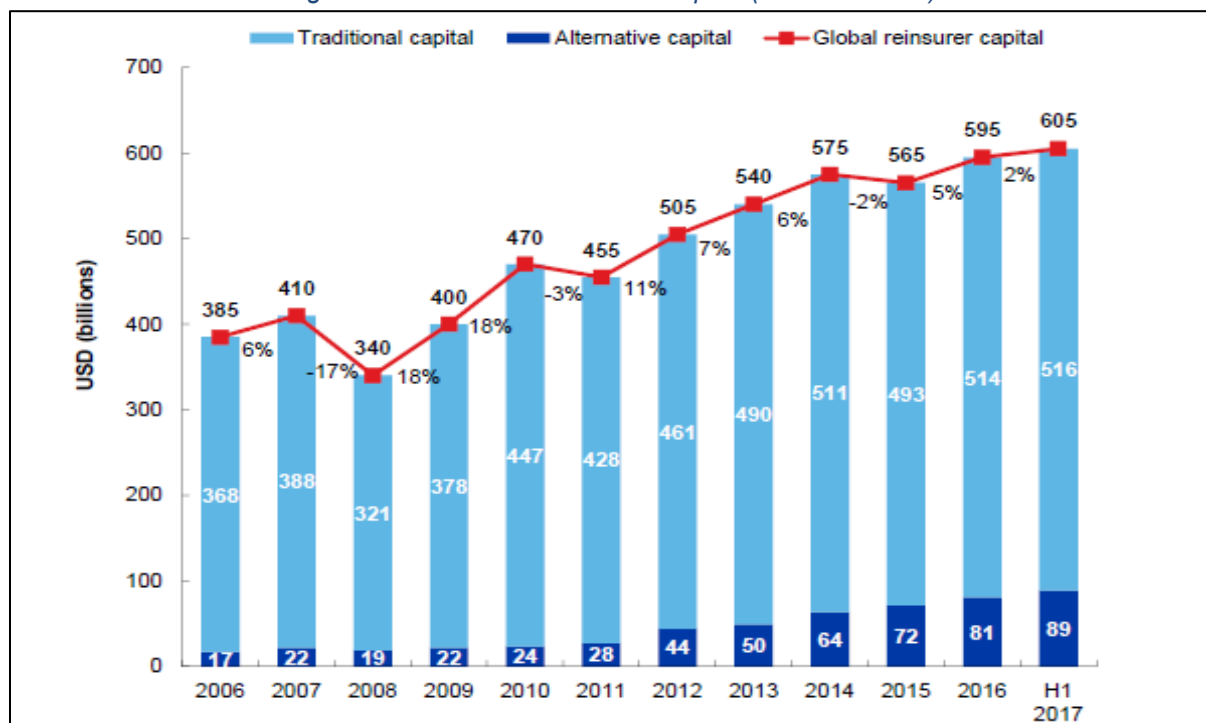
³⁴ S&P Global (2017), "Global Reinsurance Highlights 2017 Edition".

³⁵ S&P Global (2017), "Global Reinsurance Highlights 2017 Edition".

³⁶ Aon Benfield (2017), "Reinsurance Market Outlook: Hurricane Harvey Highlights Protection Gap", September 2017.

is mainly due to the low interest rate environment, which has pushed investors to search for other sources of returns, preferably within instruments not tied to the capital markets.

Figure 2.3a: Global reinsurance capital (2006-2017 H1)



Source: Aon Benfield Analytics

The use of Insurance-Linked Securities (ILS) is at an all-time high. At the end of H1 2017 the largest half-year issuance of ILS had been surpassed by more than USD 8 billion (over 40% more than any other previous half-year issuance) and a mere USD 230 million short of a full-year record. The market has now reached its highest outstanding amount of USD 25.5 billion. Yet, it appears there is room for more innovation. Instruments covering pandemic risks have been issued and, while this is an innovation in itself, for the first time ever such a product aims at mitigating a risk rather than covering the losses ex-post.³⁷

In addition to an increase in the deployment of capital towards cat bonds, a massive increase has been observed in collateralised reinsurance, the limits for which have tripled since 2008. This is a clear sign of investor demand for a broader risk exposure and desire for more efficient diversification.

The 21 largest reinsurance groups reported an average 94.7% combined ratio at the end of H1 2017, compared with an average over the past decade of 93.7%. Reinsurers appear to still be profitable, but this profitability is under significant stress. Aon Benfield Analytics reports a total investment return of 3.6% for the first half of 2017, 6% higher than at year-end 2016. Compared to H1 2016 (8.7%) the return on equity (RoE) of the largest reinsurers dropped to 8.4% at the end of H1 2017. These levels continue a decreasing trend since 2012.³⁸

³⁷ Swiss Re (2017), "Insurance-Linked Securities: market update", August 2017.

³⁸ AON Benfield (2017), "Reinsurance Market Outlook: Hurricane Harvey Highlights Protection Gap", September 2017.

Commentators have flagged that reinsurers will need to observe the market with care and adjust properly to its challenges, otherwise their RoE might face additional pressure in the future.³⁹

The reinsurance market's profitability is closely tied to how the direct insurance market evolves and operates. As shown by numerous natural catastrophic events around the world, there are significant growth opportunities. For example, in South East Asia, less than 5% of economic losses (due to natural catastrophes) are insured.⁴⁰ This points to clear opportunities for (re)insurers to deploy their capital and to grow over the long-term while alleviating the pressure on governments when catastrophes occur.

³⁹ Willis Re (2017), "Reinsurance Market Report: Results for Half-Year 2017", London, September 2017.

⁴⁰ AON Benfield (2017), "Reinsurance Market Outlook: Hurricane Harvey Highlights Protection Gap", September 2017.

Chapter 3 – Special Topics

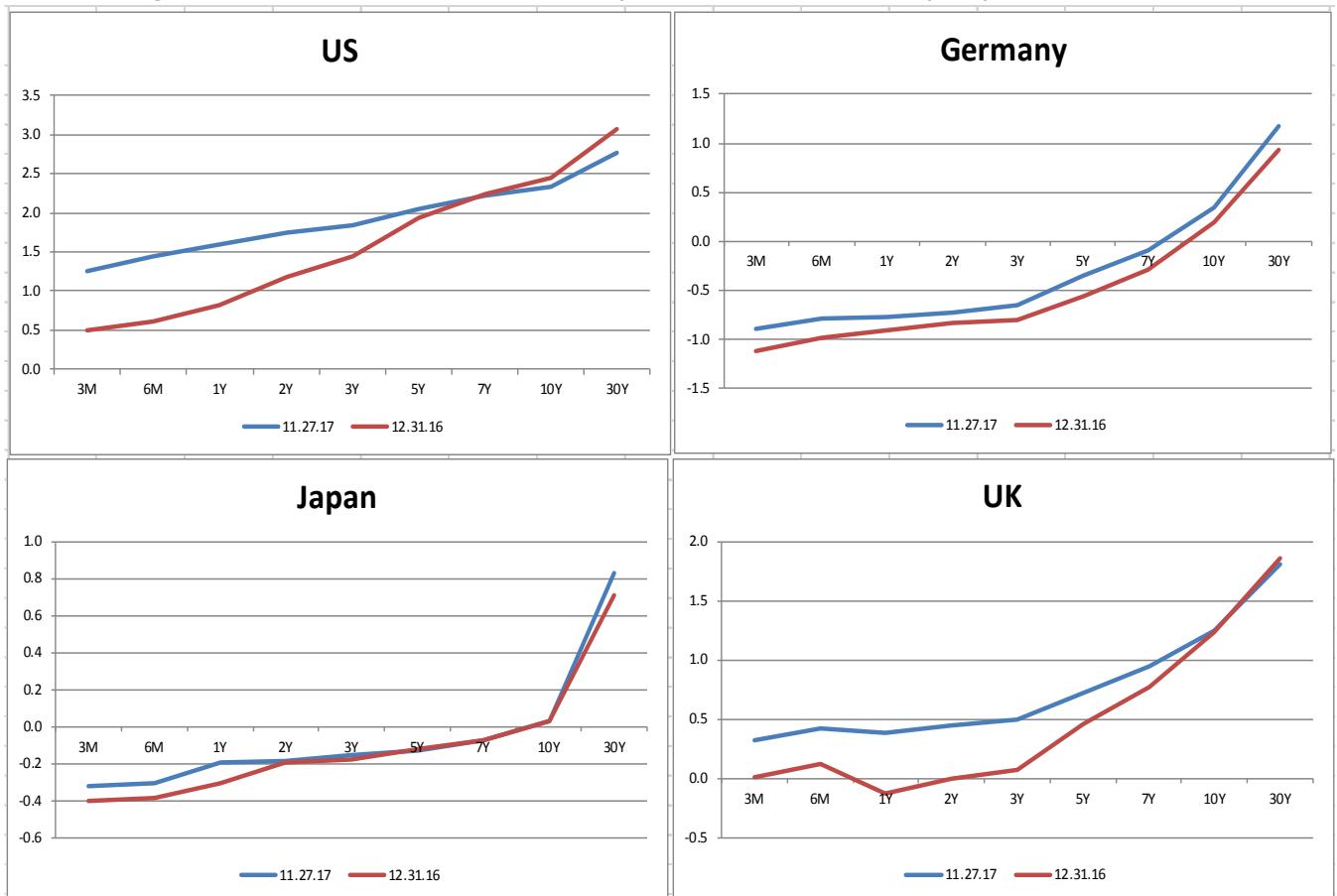
The special topics in the GIMAR vary every year and cover a wide array of areas of interest to IAIS Members. They focus on regulatory, financial and economic developments and risks. The global topics section in 3.1 covers investment markets and insurance investments, first experience with public disclosure under Solvency II, and an overview of catastrophe risk modelling practices in Bermuda. This year, the IAIS also started a specific focus on emerging market topics, covered in section 3.4. This includes financial education and financial inclusion as well as digital innovation in the insurance sector in India.

3.1 Global topics

3.1.1 Investment markets

Insurers depend upon investment income as well as premiums for their incomes, and the return on investment opportunities are determined in the wider financial markets. Changes in these markets also affect the market value of insurer portfolios.

Figure 3.1.1a: Yield curves for four developed markets: US, Germany, Japan, UK



Insurers are major investors in fixed income markets. The long-term nature of many life insurance products drive life insurers to invest in long term assets in the fixed income market. Higher yields at the longer end of the yield curve are especially important to life insurers. The industry's competitiveness relative to other investment vehicles also varies depending on the

steepness of the yield curve (as well as other factors such as tax treatment or management fees). Asset managers that offer investment vehicles with greater liquidity will invest primarily in shorter term instruments that avoid the interest rate risk of longer term assets. When the curve is flat, there is less of an advantage to invest in longer term assets, making it more difficult for insurers to differentiate their products from a yield perspective. Other asset managers offer investment vehicles that tend to emphasise liquidity and the ability to take advantage of near term market opportunities; whereas insurers focus on less liquid, longer term products and more stable income.

Table 3.1.1a shows 10-year maturity government bond yields for the six countries with the largest amount of life and non-life direct premiums written in 2016.⁴¹ Between 2015 and 2016, government bond yields continued to decrease for European countries and Japan. Yields in Japan, UK, France, and Germany decreased by 23, 71, 33 and 30 basis points, respectively. The outside change in the UK can largely be explained by the result of the UK referendum. In China and US, yields increased somewhat, but remained lower than in 2013 and earlier. Overall, government bond yields remained very low compared to historical averages.

Table 3.1.1a: 10-year government bond yields for US, Japan, China, UK, France and Germany⁴²

Country	2013	2014	2015	2016
US	2.90	2.21	2.24	2.49
Japan	0.69	0.32	0.27	0.04
China	4.63	3.68	2.90	3.22
UK	3.16	1.82	2.01	1.30
France	2.50	0.86	1.01	0.68
Germany	1.80	0.59	0.55	0.25
Italy	4.31	2.89	1.71	1.49

Sources: FRED, Federal Reserve Bank of St. Louis, MarketWatch.com, Bank of England, Banque de France, Bank of Italy.

Longer term government bond yields moved up at the end of 2016 and in early 2017, with markets expecting the trend would continue. However, since the spring of 2017, yields on ten-year government bonds have traded within a relatively narrow range.

There has also been no significant change in the steepness of the yield curve since year-end 2016 for major benchmarks: US, UK, Germany and Japan. Yield curves remain relatively flat going out to the seven or eight year point in the curve.

In the US, the Federal Reserve Board began increasing rates on the short end by raising the Fed Funds target. Market expectations for interest rate actions by the Federal Reserve's Open Market Committee (FOMC) have varied considerably over the last several years, beginning each year with forecasts of significant increases and scaling back those forecasts as the FOMC has taken a more circumspect approach.

⁴¹ Source: Swiss Re, *sigma*, No. 3/2017.

⁴² The table includes the six countries with the largest insurance activity in 2016. Insurance activity is measured as direct premiums underwritten during the calendar year.

Also important to investors such as insurers is the potential for central bank activity with respect to their holdings of longer term paper. The balance sheets of European central banks, the US Federal Reserve Banks and the BoJ have reached relative high points as part of their respective economic stimulus programs. However, authorities are very conscious of the potential market implications of a change in the bond-buying policy. Rather than selling holdings, a more gradual shift would take the form of reducing purchases. The sale of longer term assets would put pressure on prices in the market place. This would improve investment yields on the longer end of the market, but may also have a negative impact on the existing portfolios. As insurers have invested on the longer end of the curve, especially when interest rates are low, this has added to the marked to market risk given the longer duration.

Figure 3.1.1b: Central bank assets (2003-2017)

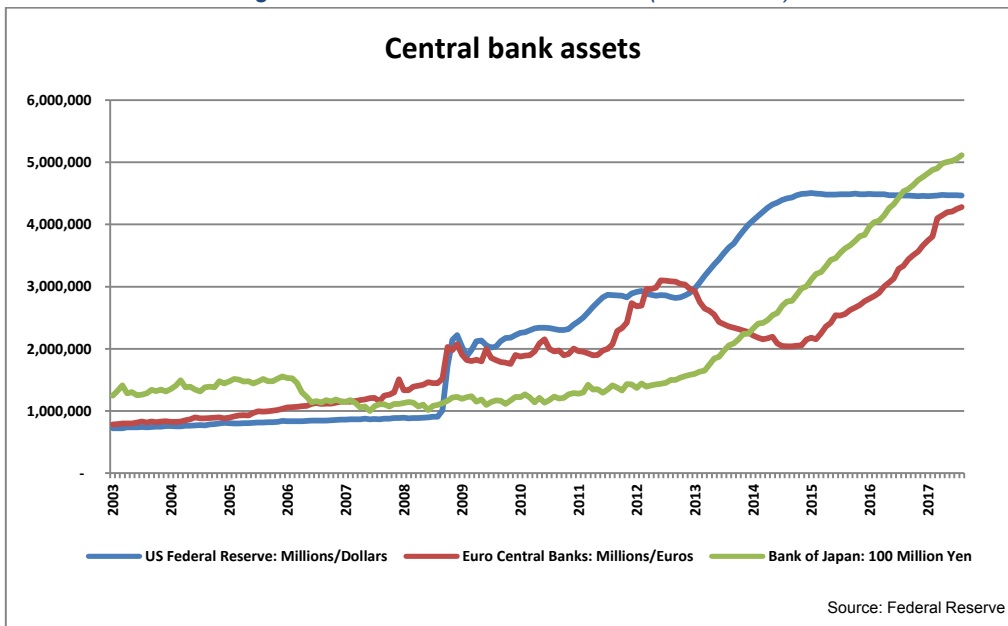
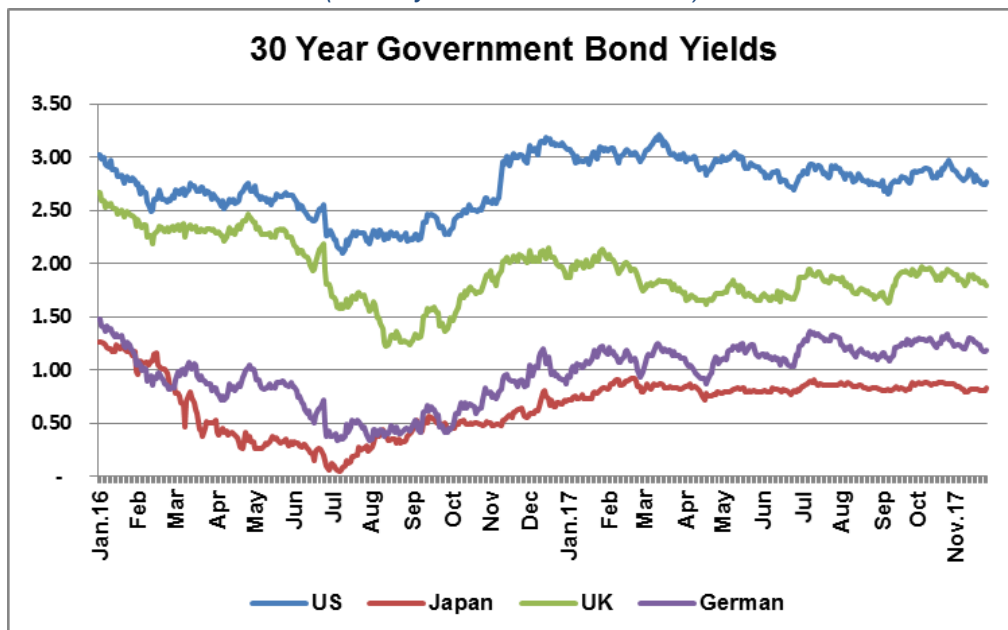


Figure 3.1.1c: Interest rates in developed markets (January 2016-November 2017)



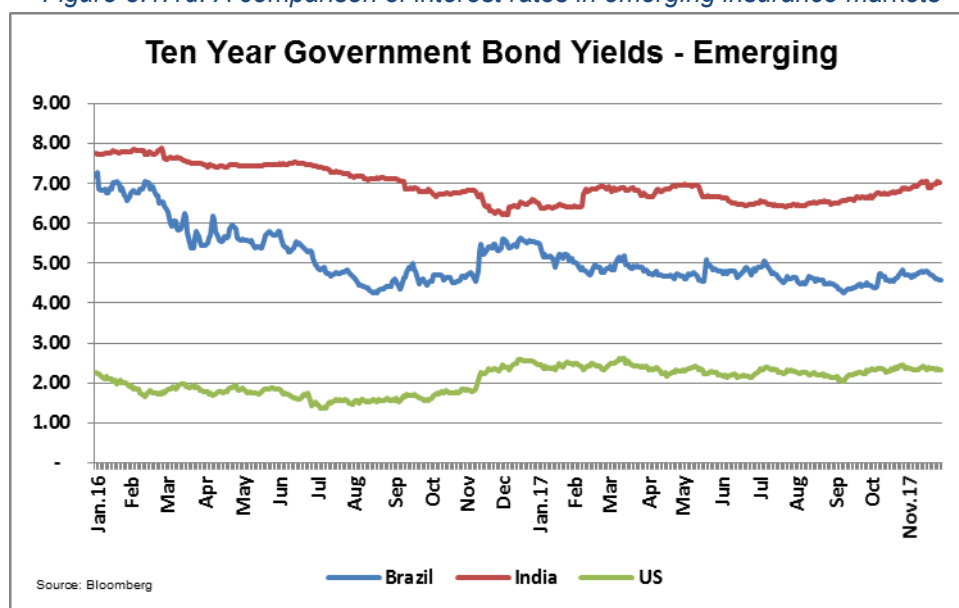
Long term rates in Japan have changed little over the two year time period. However, the 10-year yield did move into positive territory at the end of 2016.

In the US, 10-year yields increased significantly at the tail end of 2016 and first few weeks of 2017.

The UK Bank of England injected significant liquidity into the market following the result of the UK referendum on June 2016. Investors also shifted their investment profiles to government bonds, driving the yield on the 10-year gilt to a low of 50 basis points. Since then, UK markets have calmed, recognizing that any real impact will not be known until there is clarity about the outcome of the negotiations between the UK and the European Union. As a result, the 10-year yield has recovered and has been trading within a narrow range as separation negotiations proceed.

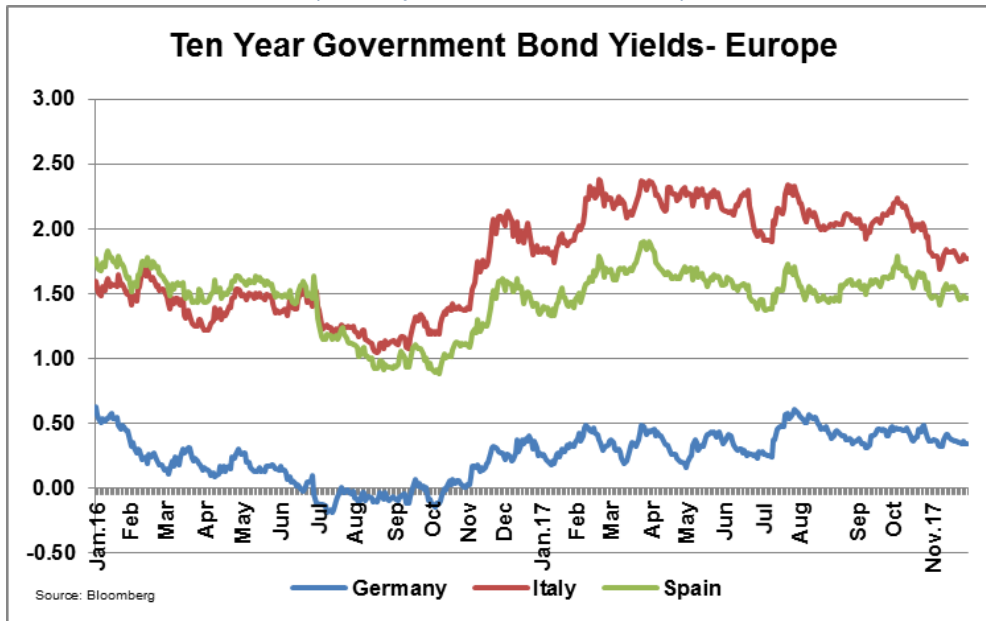
Continued low investment yields add to the investment challenge for insurers. For the industry as a whole, this maintains the pressure on earnings. For selected insurers and jurisdictions, this can present solvency issues. As the last remaining assets from the days of higher interest rates mature and must be reinvested at the current lower rates, the margin between net investment yields and crediting rates continues to narrow.

Figure 3.1.1d: A comparison of interest rates in emerging insurance markets



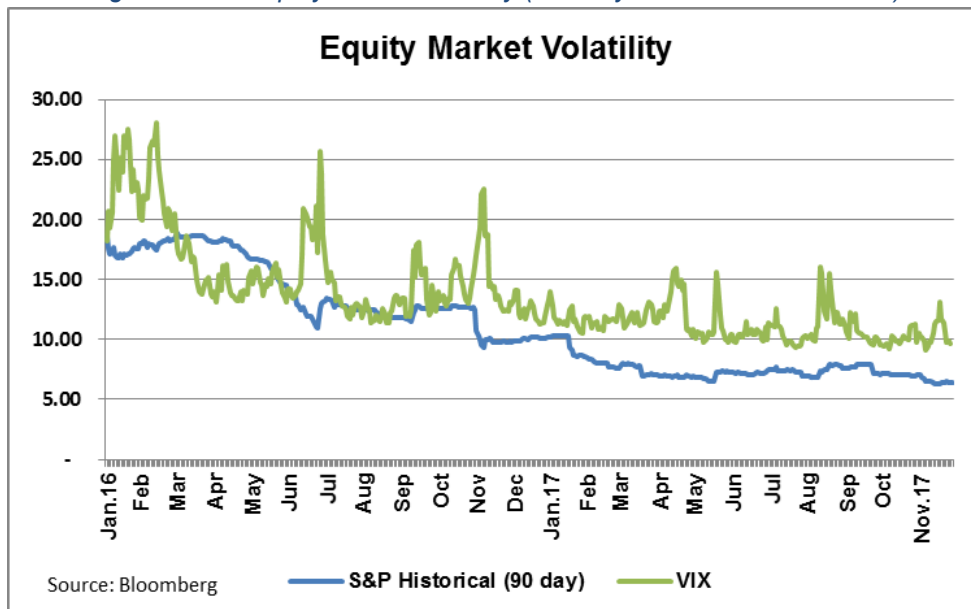
Unlike in the US and other major developed countries, interest rates have generally not been low in emerging insurance markets. While there has been some drift downwards in the last two years, India and Brazil, as two examples, have yields on their 10-year government bonds at substantially higher levels than the US. Thus the investment dynamic for insurers in those jurisdictions is different.

Figure 3.1.1e: Interest rate differentials in the European Union
(January 2016-November 2017)



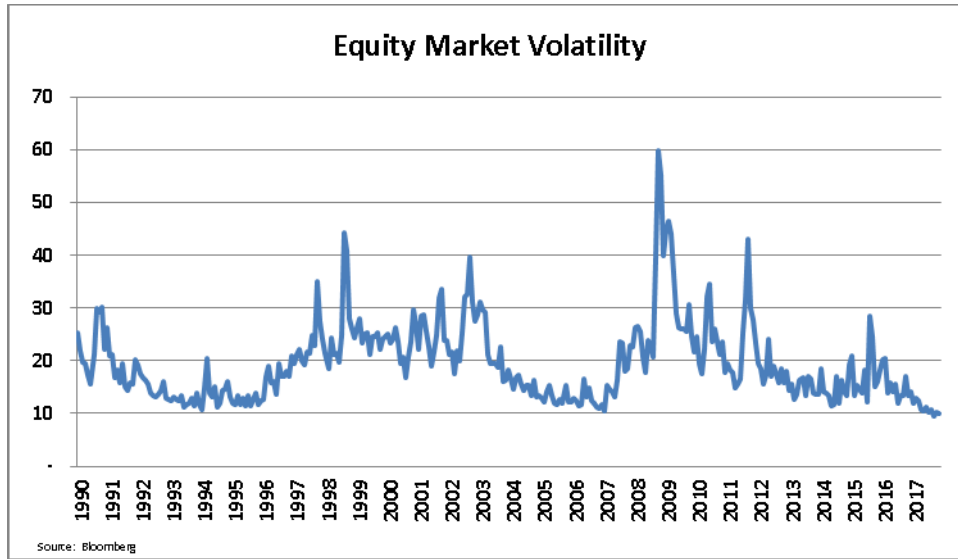
Within Europe, the differential in government bond yields is also striking. Yields on the 10-year German bund are very low, and played in negative territory briefly at the end of 2016. Yields in Italy and Spain are significantly higher, though still substantially lower than their peaks in 2011. The differential between Italy and Spain versus Germany widened significantly in first half of the year, but has declined somewhat since then.

Figure 3.1.1f: Equity market volatility (January 2016-November 2017)



Equity market volatility continued its general decline in 2017, and also did not experience the brief event-driven spikes to the same degree as in 2015 and 2016. Taking a longer term view, equity market volatility has reached its lowest point in the last 30 years, matching previous low points in the early 1990's and in 2007. This trend is particularly notable given the uncertainty that exists in some areas.

Figure 3.1.1g: Equity market volatility



While high volatility is often seen a positive by active traders, it presents challenges to longer term investors such as insurers, which generally buy and hold rather than shift investment strategies quickly.

Figure 3.1.1h: Equity market performance indexed at year-end 2015

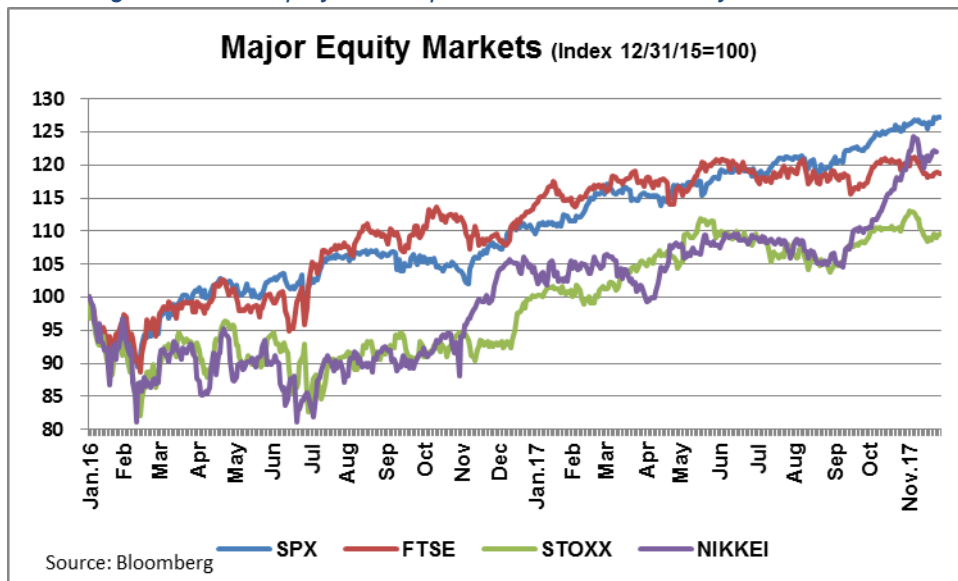
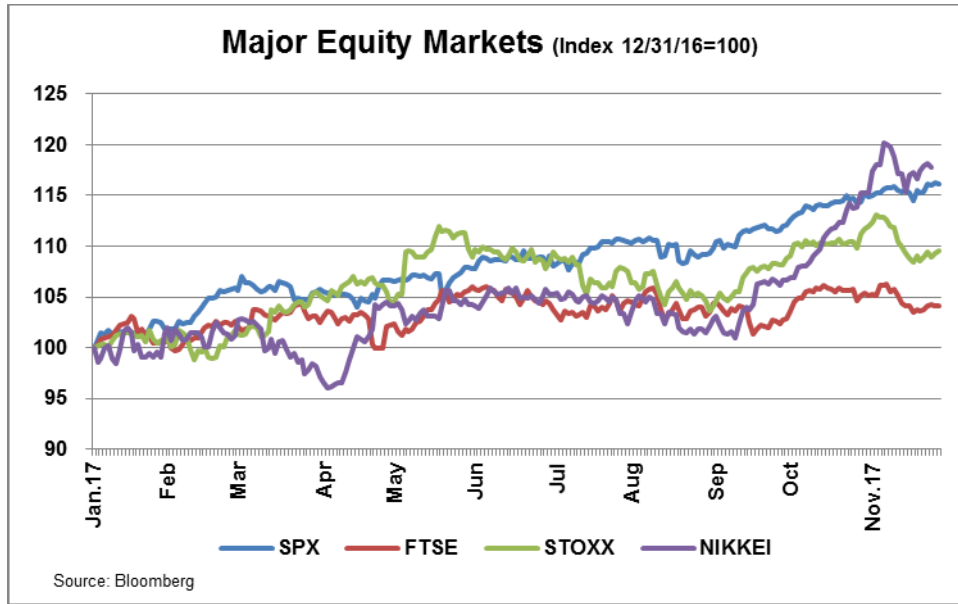
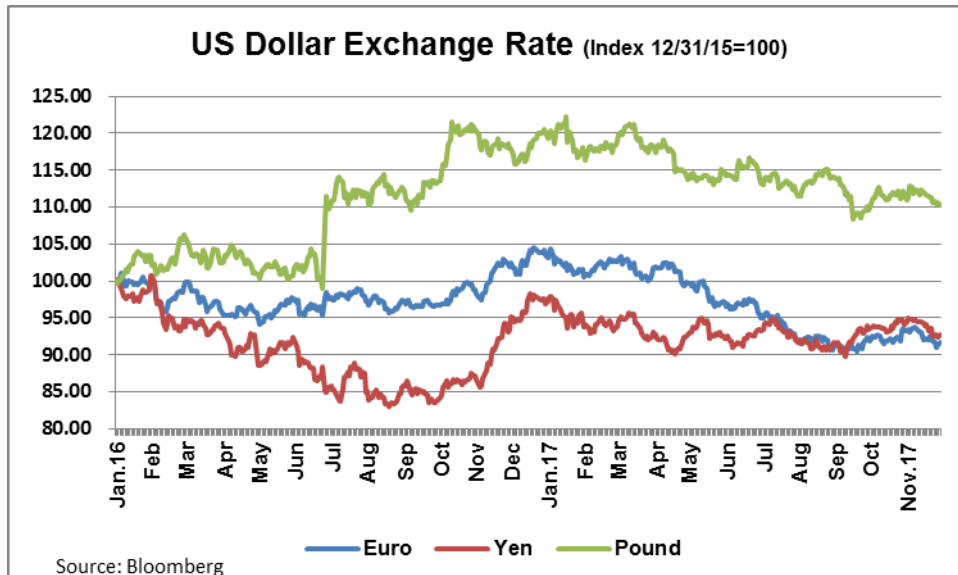


Figure 3.1.1i: Equity market performance indexed at year-end 2016



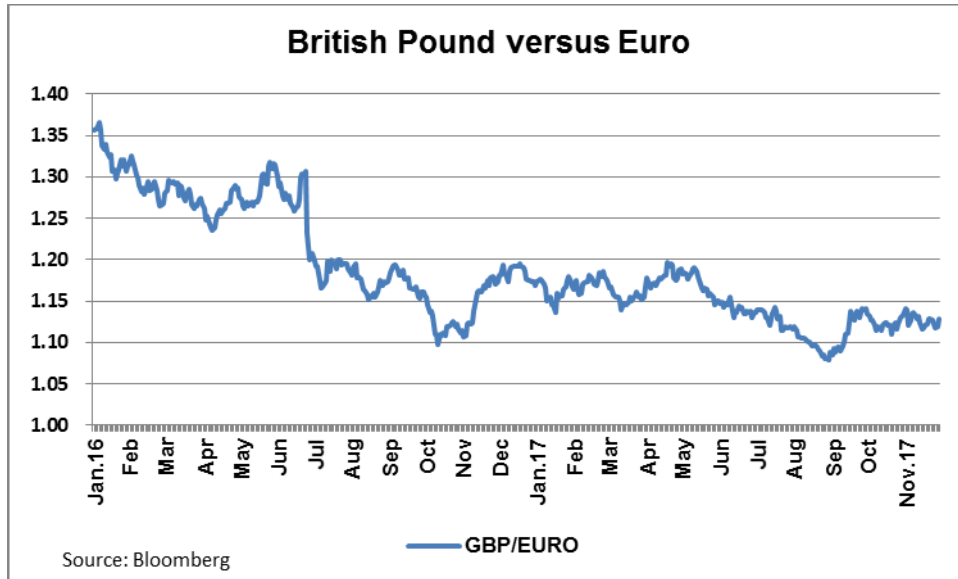
Both the US and UK equity markets have been doing well through most of 2016 and 2017. Europe and Japan struggled in 2016 and the early part of 2017, but have recovered since then. As insurers have sought to offset low investment yields on fixed income instruments, they have increased their exposure to equity and equity-like investments. This has been a successful strategy thus far for insurers that have increased and/or maintained significant exposures to common stock, providing realised and unrealised capital gains to bolster investment income. The strategy does entail additional market risk if equities were to correct significantly.

Figure 3.1.1j: Exchange rate US Dollar (January 2016-November 2017)



The US dollar appreciated against most currencies at the end of 2016, but has drifted downward since the beginning of 2017. The assets of US insurers are predominantly denominated in US dollars.

Figure 3.1.1k: Exchange rate GBP – EUR (January 2016–November 2017)



With the result of the UK referendum, the British Pound declined substantially versus other currencies. The pound traded within a range from the date of referendum to when British Prime Minister Theresa May invoked Article 50 of the European Union’s Lisbon Treaty which outlines the steps to be taken by a country seeking to leave the bloc. Since then, the British Pound has declined further versus the Euro.

Figure 3.1.1l: Bond market volatility (January 2016-November 2017)

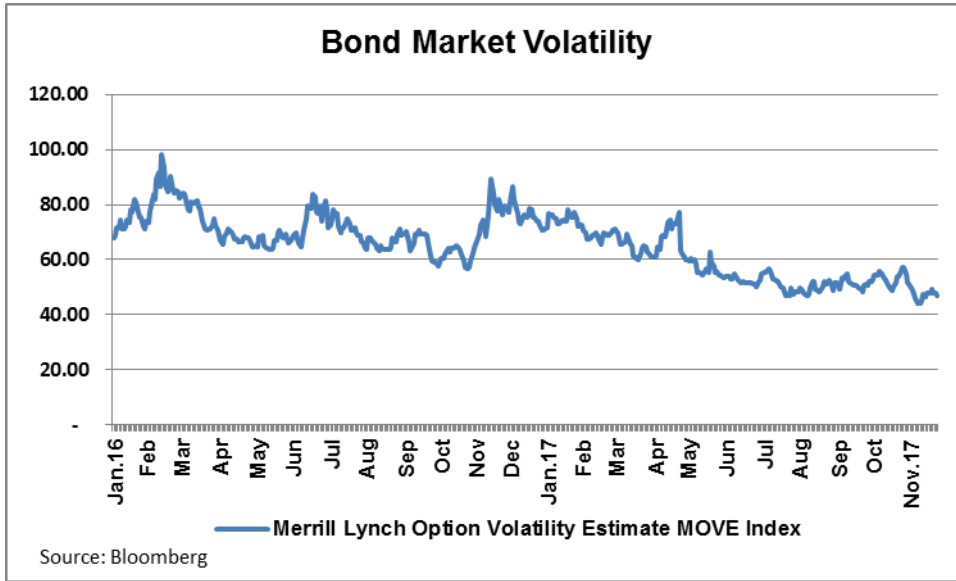
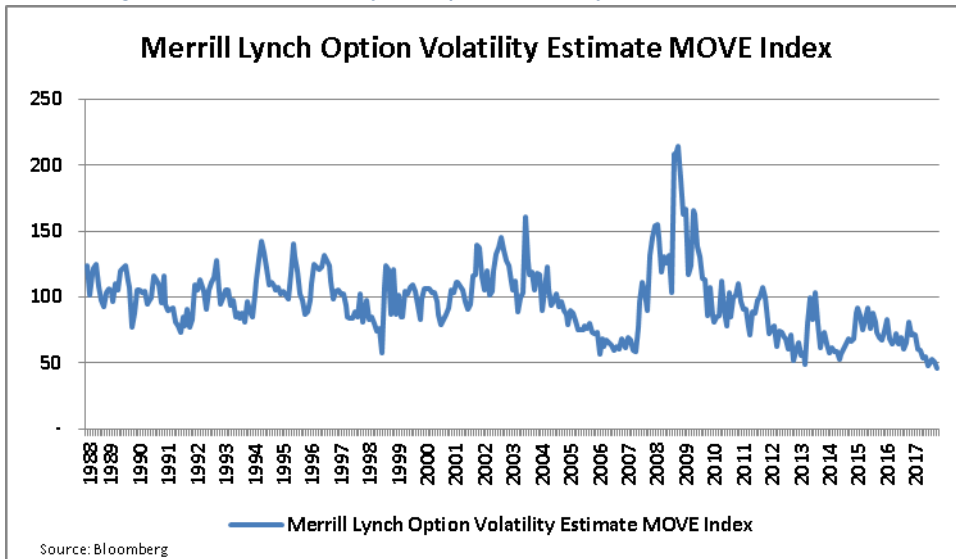
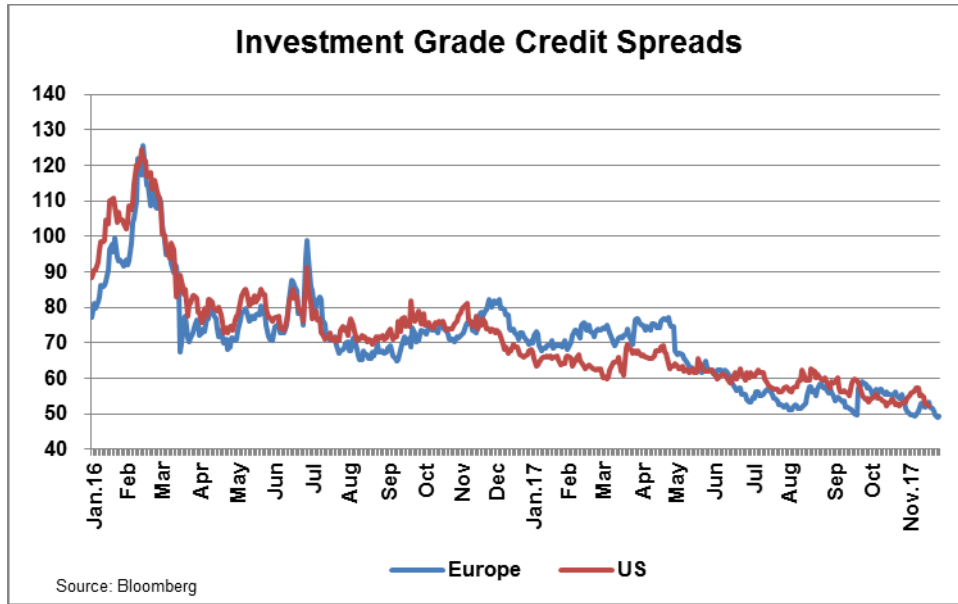


Figure 3.1.1m: Merrill Lynch option volatility estimate MOVE Index



Similar to equity market volatility, bond market volatility also declined significantly in 2017, reaching its lowest point in the last thirty years.

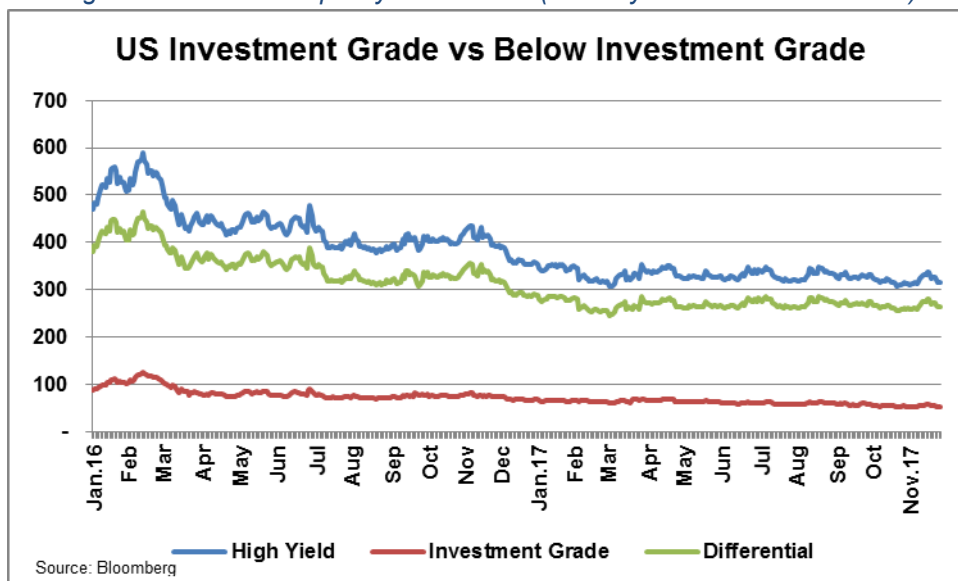
Figure 3.1.1n: Credit spreads (January 2016-November 2017)



With interest rates generally low among the more developed economies, investors have sought to improve investment yields, in part, by shifting away from sovereign debt to corporate issues. This along with a relatively benign atmosphere as far as credit concerns, has caused credit spreads to decline since the middle of 2016. This is the case in both the US and Europe.

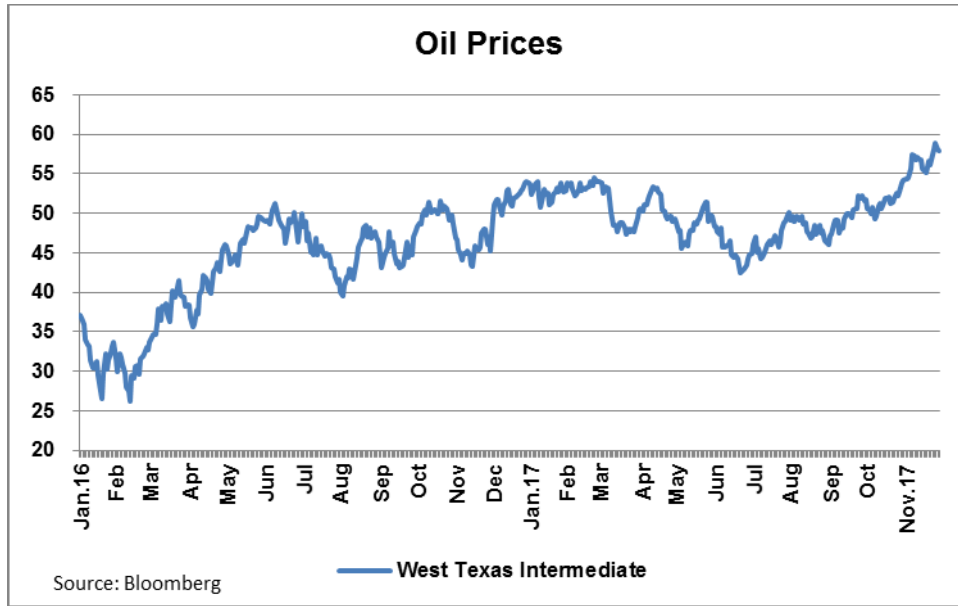
Default rates among corporate issuers globally remain below historic averages, though there was a modest increase sparked by the drop in oil prices and the resulting impact on below investment grade oil and gas companies. The retail sector has also experienced additional concerns, with traditional brick-and-mortar retailers suffering.

Figure 3.1.1o: Credit quality differentials (January 2016-November 2017)



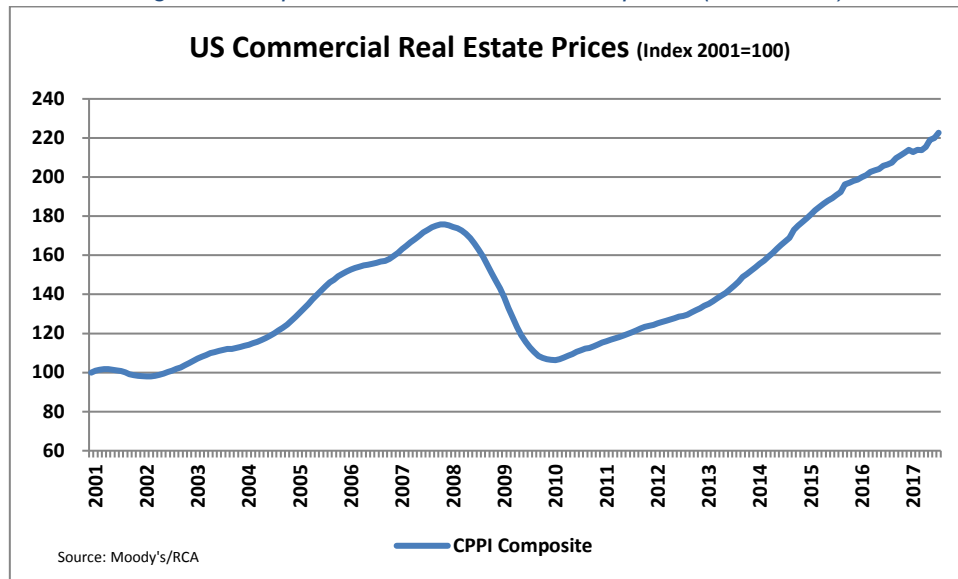
As investors have sought additional yield by investing in the lower quality spectrum, prices on below investment grade bonds have risen, driving yields and spreads down. This has raised questions about whether or not investors are being adequately compensated for the additional default risk, market value volatility and lower liquidity.

Figure 3.1.1p: Oil prices (January 2016-November 2017)



Oil prices have recovered from their low point in early 2016, but have not recovered anywhere close to their 2013 highs.

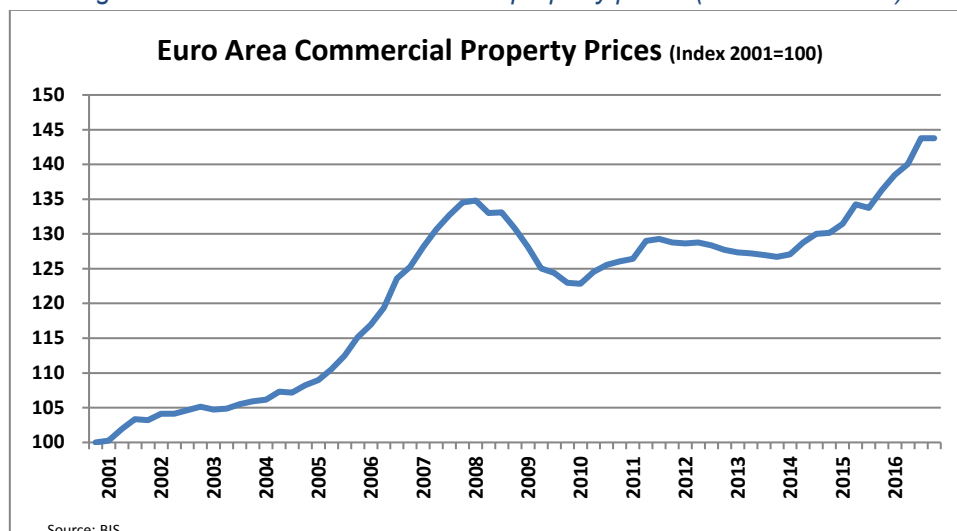
Figure 3.1.1q: US commercial real estate prices (2001-2017)



The financial crisis resulted in substantial declines in commercial real estate values. The resulting defaults on commercial mortgage loans caused a downward spiral in many cases among financial institutions globally. Since the trough in 2010, commercial real estate prices in the US have not only recovered, but now significantly exceed their pre-crisis peak. With this, there has been additional focus on valuations. Thus far, vacancy rates and rental rates remain relatively stable among most property types. Significant concerns exist, however, over the retail sector. This warrants careful monitoring of underwriting standards among insurers for investing in this and related asset classes.

Commercial Property Prices within the Euro area have shown a profile similar to that in the US. The significant drop in 2008 and 2009 has completely recovered.

Figure 3.1.1r: Euro Area commercial property prices (Index 2011=100)



However, it should be noted that commercial real estate values are idiosyncratic to specific markets. Within the US, different regions can display different characteristics. In Europe, trends can differ markedly from country to country.

3.1.2 Insurance investments

The persistence of historically low interest rates in advanced economies appears to have led insurance companies to shift investments, although in modest amounts, towards riskier assets.

For five of the six countries with the largest insurance activity,⁴³ government bond yields experienced only moderate changes between 2015 and 2016. In general, this was accompanied by a decrease in the spread of corporate bond yields over treasury yields.

The yields on corporate bonds decreased more than those for government bonds (as seen in Table 3.1.1a). Figures 3.1.2a and 3.1.2b show the evolution of the corporate bond spreads for bonds of different risk ratings within the last seven years. Figure 3.1.2a shows the corporate bond spreads for US companies, while Figure 3.1.2b shows the corporate bond spreads for European and Asian companies. During 2016, corporate bond spreads decreased substantially. For example, the spread of US high yield bonds over US Treasury bonds decreased by more than 400 basis points over the year.

⁴³ Insurance activity measured as direct premiums issued in 2016.

Figure 3.1.2a: US corporate bond spreads
(January 2010-16 November 2017)

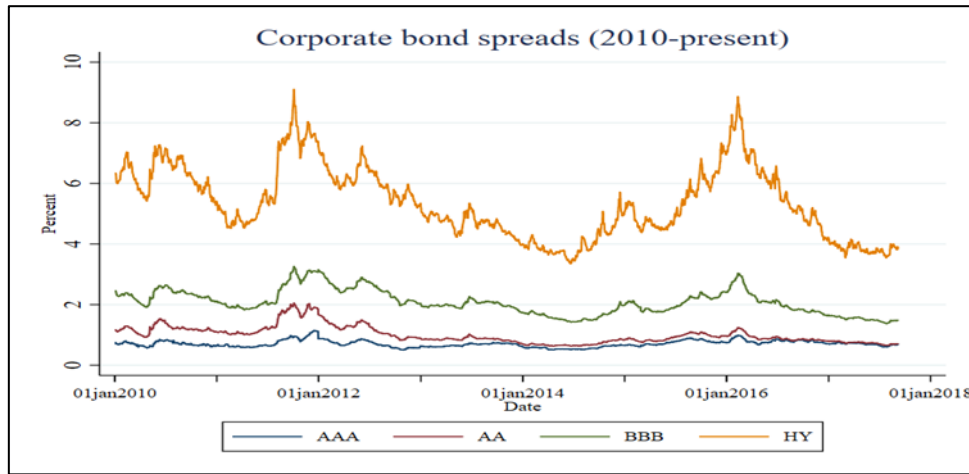
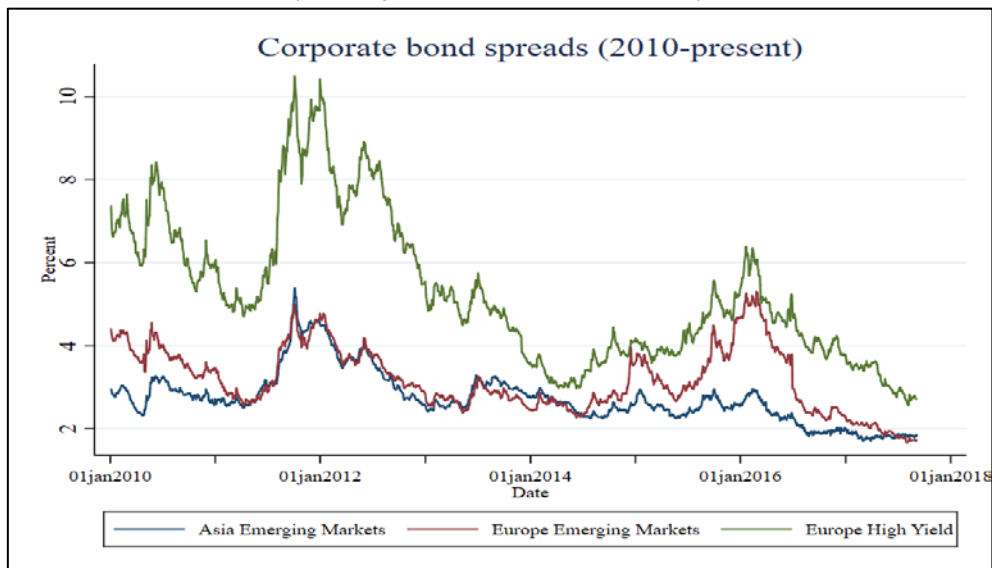


Figure 3.1.2b: Europe and Asia corporate bond spreads
(January 2010-16 November 2017)



Note: Spreads of BofA Merrill Lynch bond indices over comparable maturity sovereign bonds. The data were obtained from FRED, Federal Reserve Bank of St. Louis (US).

In this low bond yield environment, some insurers seek yield through slow changes in the riskiness of their asset portfolios. The specific changes in investment asset class and risk rating composition by geographic region are described in the Tables that follow.⁴⁴

⁴⁴ This analysis includes investment in the general account with affiliated and unaffiliated entities.

Table 3.1.2a Panel a: US life insurance industry investment asset allocation

Invested assets	2013	2014	2015	2016
Government (incl. Agency)	18.2	17.8	17.6	17.5
Non-Agency Structured	7.0	6.8	6.5	6.3
Hybrid Securities	0.7	0.7	0.6	0.5
Corporate Bonds	51.7	51.6	52.1	52.2
Preferred Stock	0.2	0.3	0.3	0.3
Common Stock	1.0	1.1	0.9	0.9
Commercial Mortgage	10.5	10.6	11.2	11.6
Mezzanine Loans	0.2	0.2	0.2	0.3
Real Estate	0.7	0.7	0.7	0.7
Other	9.8	10.4	9.9	9.9

Source: SNL Financial. Table 3.1.2a excludes cash and short term investments

For the years 2013 to 2016, Table 3.1.2a Panel a, presents the general account asset holdings of US life insurers, and Panel b presents the rating composition of corporate bond holdings of US life insurers. Both panels are constructed excluding affiliated investments. As shown in Panel a, US life insurers had little change to their asset portfolios in the last year. Continuing a trend, commercial mortgages increased by 0.4 percentage points from 2015 to 2016. In part, the mortgages replaced non-agency structured securities, an asset class that has been largely in runoff since the financial crisis. There has also been a gradual reduction in government bond holdings, but the change from 2015 to 2016 was minimal. In recent years, and specifically during 2016, US life insurers made little change to the rating composition of their corporate bond portfolios.

Table 3.1.2a Panel b: US life insurance industry bond investment ratings⁴⁵

Rating	Percentage of all corporate bonds			
	2013	2014	2015	2016
A-AAA	64.5	64.7	63.6	63.2
BBB	26.8	26.5	27.6	27.7
BB and below	8.8	8.8	8.8	9.1

For the years 2013 to 2016, Table 3.1.2b Panel a, presents the general account asset holdings of US P&C insurers and Panel b presents the rating composition of corporate bond holdings of US P&C insurers. Both panels are constructed excluding affiliated investments. As shown in Panel a, US P&C insurers changed their asset composition somewhat in 2016. From the end of 2015 to the end of 2016, the proportion of government bond holdings decreased 0.9 percentage points, from 39 to 38.1 percent of total assets. This was about the same rate of decline as for the prior two years. The reduction in government bonds has been offset by small increases in other asset classes, with the largest increase in 2016 being for common stocks. Increasing the holdings of common stocks is consistent with an effort by insurers to obtain higher expected returns by taking on more risk. In 2016, P&C insurers continued their gradual move toward replacing a small share of their corporate bonds rated A-AAA with bonds rated

⁴⁵ Bond ratings correspond to NAIC designation; A- and above are bonds with NAIC designation of 1, BBB are bonds with NAIC designation of 2, and BB+ and below are bonds with NAIC designation of 3 to 6.

BB or lower, consistent with seeking higher expected returns. As a proportion of total assets, bonds rated A-AAA decreased from 79.4 to 79.1 percent while bonds rated BB or lower increased from 6.8 to 7.1 percent as a proportion of total assets.

*Table 3.1.2b Panel a: US property & casualty insurance
Industry investment asset allocation*

Invested assets	2013	2014	2015	2016
Government (incl. Agency)	41.2	39.2	39.0	38.1
Non-Agency Structured	3.9	4.2	4.2	4.0
Hybrid Securities	0.1	0.2	0.2	0.2
Corporate Bonds	24.4	24.9	25.9	25.9
Preferred Stock	0.8	1.0	1.0	0.7
Common Stock	18.8	19.3	18.6	19.3
Commercial Mortgage	0.6	0.7	0.9	1.0
Real Estate	0.8	0.7	0.8	0.9
Other	9.5	9.8	9.4	9.8

Data from SNL Financial. Table 3.1.2b excludes cash and short term investments.

Table 3.1.2b Panel b: US property & casualty industry bond investment ratings⁴⁶

Rating	Percentage of all corporate bonds			
	2013	2014	2015	2016
A-AAA	81.8	81.4	79.4	79.1
BBB	12.4	12.1	13.8	13.8
BB and below	5.8	6.4	6.8	7.1

Table 3.1.2c shows an asset breakdown for a selection of large European Life and P&C insurers (Panel a) and the ratings of their corporate bonds (Panel b). As with US life insurers, there have been only marginal changes across the asset classes over the past few years, although there may have been changes within asset classes such as government bonds. The largest change over the last four years has been to equity ownership. This increased from 5.5 percent to 6.0 percent; however, the change in 2016 was only 0.1 percentage points.

⁴⁶ Bond ratings correspond to NAIC designation; A and above are bonds with NAIC designation of 1; BBB are bonds with NAIC designation of 2; and BB and below are bonds with NAIC designation of 3 to 6.

Table 3.1.2c Panel a: European life and property & casualty insurance industry investment asset allocation

Invested assets	2013	2014	2015	2016
Government Bonds	26.4	28.6	27.1	26.8
Corporate Bonds	24.3	23.4	23.4	23.8
Equity	5.5	5.4	5.9	6.0
Real Estate	2.8	2.9	2.7	2.7
Other	41.0	39.7	40.9	40.6

Data from SNL Financial. Tables are constructed using data from the 30 largest insurers in Europe (in terms of total assets)⁴⁷

Between 2015 and 2016, the proportion of bonds rated A or better decreased from 72.6 percent to 70.8 percent as a proportion of total bonds, the proportion of bonds rated below BBB increased from 23.4 percent to 25.3 percent, and the percent of non-investment grade decreased from 4.0 percent to 3.9 percent. The decrease in the proportion of highly rated bonds was already observed between 2014 and 2015.

Table 3.1.2c Panel b: European life and property & casualty insurance Industry bond investment ratings⁴⁸

Rating	Percentage of all corporate bonds			
	2013	2014	2015	2016
A-AAA	74.7	75.2	72.6	70.8
BBB	22.3	21.9	23.4	25.3
BB and below	3.0	3.0	4.0	3.9

Table 3.1.2d shows the cumulative investment portfolio for a group of large Asian insurers over 2013 to 2016. During 2016, these insurers reduced the proportion of corporate bonds in their investment portfolio from 38.8 percent to 37.7 percent and their equity holdings from 12.6 percent to 11.7 percent. Continuing a trend, the proportion of other assets increased from 33.2 to 34.6 percent in 2016. The increase in other assets was driven by a wave of large acquisitions of international real estate and international insurance companies by Chinese insurers.

⁴⁷ Companies with missing information or not covered by SNL Financial are excluded from the sample. Companies included in Table 3.1.2c Panel A: AXA; Allianz Group; Assicurazioni Generali SpA; Zurich Insurance Group AG; AEGON N.V.; Prudential Plc; Aviva Plc; Münchener Rückversicherungs-Gesellschaft AG; Swiss Re AG; Standard Life Aberdeen Plc; Swiss Life Holding AG; NN Group NV; Talanx AG; Gjensidige Forsikring ASA; Ageas SA/NV; Unipol Gruppo SpA; MAPFRE SA; Hannover Rück SE; St. James's Place Plc.

⁴⁸ Companies included in Table 3.1.2c Panel b: AXA; Allianz Group; Storebrand ASA; Assicurazioni Generali SpA; Zurich Insurance Group AG; Legal & General Group Plc; CNP Assurances SA; Aviva Plc; Standard Life Aberdeen Plc; Swiss Life Holding AG; NN Group NV; Gjensidige Forsikring ASA; Ageas SA/NV; Wüstenrot & Württembergische AG; Phoenix Group Holdings; Powszechny Zakład Ubezpieczeń SA; Unipol Gruppo SpA; St. James's Place Plc; MAPFRE SA.

Table 3.1.2d: Asian life and property & casualty insurance industry investment asset allocation

Invested assets	2013	2014	2015	2016
Government Bonds	7.5	14.0	14.0	14.5
Corporate Bonds	42.2	41.8	38.8	37.7
Equity	9.8	10.7	12.6	11.7
Real Estate	1.6	1.5	1.4	1.4
Other	31.2	32.0	33.2	34.6

Data from SNL Financial⁴⁹

Table 3.1.2e shows the cumulative investment portfolio for the India life insurance industry over 2014 to 2016. During 2016, these insurers decreased the proportion of central government securities from 41.7 percent to 41 percent, and increased the proportion of state government and other approved securities from 22 to 22.2 percent. Infrastructure investments decreased from 11.7 percent to 11.0 percent, approved investments increased from 22.9 percent to 23.8 percent, and other than approved investments increased from 1.8 percent to 2.0 percent.⁵⁰

Table 3.1.2e: India life insurance industry investment asset allocation:

Invested assets	2014	2015	2016
Central Government - Securities	40.3	41.7	41.0
State Government & Other Approved Securities	19.8	22.0	22.2
Infrastructure Investments	12.0	11.7	11.0
Approved Investments	25.6	22.9	23.8
Other than Approved Investments	2.3	1.8	2.0

Table 3.1.2f shows the total investment portfolio for the India P&C insurance industry over 2014 to 2016. During 2016, these insurers increased the proportion of central government securities from 26.7 percent to 26.9 percent, and increased the proportion of state government and other approved securities from 10.7 to 11.5 percent. Infrastructure investments increased from 17 percent to 17.2 percent, approved investments decreased from 33.4 percent to 30.7 percent, and other than approved investments increased from 3 percent to 3.4 percent.

⁴⁹ Tables are constructed using data from the 30 largest insurers in Asia (in terms of total assets). Companies with missing information or not covered by SNL Financial are excluded from the sample. Companies included: Ping An Insurance (Group) Company of China, Ltd.; China Life Insurance Company Ltd.; ICICI Prudential Life Insurance Company Ltd.; China Pacific Insurance (Group) Company Ltd.; Mercuries Life Insurance Co., Ltd.; People's Insurance Company (Group) of China Ltd.; China Taiping Insurance Holdings Company Ltd.; Farglory Life Insurance Co., Ltd.; Bangkok Life Assurance PCL; Samsung Life Insurance Co., Ltd.; China Reinsurance (Group) Corporation; AIA Group Ltd.; Hanwha Life Insurance Co., Ltd.; Japan Post Insurance Co., Ltd.; Bao Viet Holdings; Samsung Fire & Marine Insurance Co., Ltd.; Bangkok Insurance PCL; Dhipaya Insurance PCL; Dai-ichi Life Holdings, Inc.; Central Reinsurance Corporation; Dongbu Insurance Co., Ltd.; Thai Reinsurance PCL.

⁵⁰ Approved investments in India include securities fully guaranteed by the government. Approved investments in India include equity shares, preferred shares, bonds issued by financial institutions or by non-financial institutions rated AA or better, secured and collateralised debentures, immovable property, loan on policies, asset backed securities, and money market instruments. For a comprehensive list and description of these securities, see India Insurance Act 1938, and IRDAI Investment Regulation.

Table 3.1.2f: India property & casualty insurance industry investment asset allocation

Invested assets	2014	2015	2016
Central Government - Securities	25.7	26.7	26.9
State Government & Other Approved Securities	10.2	10.7	11.5
Housing/Loans to Housing/Fire Equipment	9.1	9.2	10.3
Infrastructure Investments	17.6	17.0	17.2
Approved Investments	35.2	33.4	30.7
Other than Approved Investments	2.2	3.0	3.4

3.2 Public disclosure in Europe under Solvency II – the Solvency and Financial Conditions Report

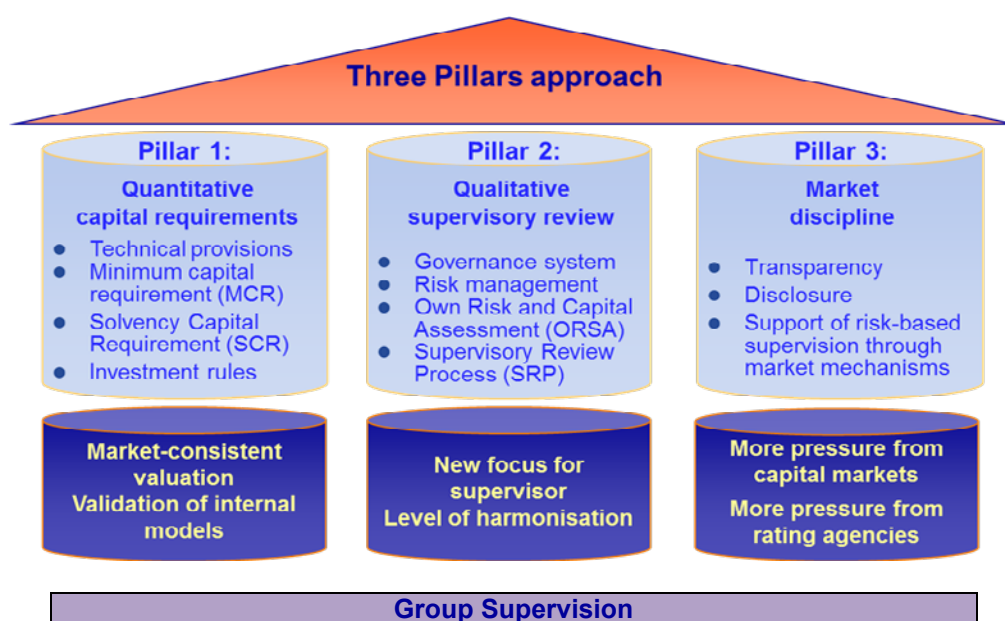
3.2.1 Legislative framework

On 1 January 2016, the Solvency II regulatory framework (Solvency II) entered into force and became fully applicable to European insurers and reinsurers.

The key objectives of this framework are to increase the level of harmonisation of solvency regulation across Europe, to introduce quantitative capital requirements that are more sensitive to the levels of risk being undertaken (risk based – market consistent), and to strengthen the requirements for appropriate risk management.

The Solvency II framework covers three main areas, known as pillars, related to: 1) capital requirements, 2) supervisory review (ie governance, internal control and risk management), and 3) market discipline (ie transparency, disclosure and supervisory reporting requirements).

Figure 3.2.1a: Three Pillar Approach of Solvency II



Bearing in mind the risk-based perspective, the three pillars are closely interlinked.

Undertakings have to consider all of the risks to which they are exposed, taking into account those on the asset side and the interrelationships between all risks for the undertaking (total balance sheet approach), managing them effectively and efficiently.

The capital requirements set in Pillar 1 are intended to reflect the risk profile of insurance undertakings on a quantitative basis. However, since some specific risk categories may not be quantifiable or can be only partially quantified in the solvency calculation and the capital adequacy valuation, these risks may be properly addressed through governance requirements. To this purpose, complementary measures and governance tools are applied. Nevertheless, and beyond the capital requirements calculation, a stronger management awareness of the entity risks along with risk management criteria should always be in place as key tools ensuring that the overall risk profile is evidenced, managed and monitored, and that the overall solvency needs are properly assessed (Pillar 2). To complete the risk-based picture, transparent information to investors and policyholders (Pillar 3) is essential both to increase the market's ability to assess the solvency position of insurance undertakings and to incentivise good market conduct.

3.2.2 Overview

The Solvency II directive enables supervisors to review and evaluate whether or not insurance entities comply with the rules and requires these entities to report to supervisory authorities (Regular Supervisory Report – RSR) and disclose information publicly (Solvency and Financial Conditions Report – SFCR).

The regulatory framework envisions a reporting system, identifying a minimum content of information to be addressed to the public audience described in the SFCR.⁵¹

As the SFCR Solvency Report was produced for the first time in 2017, caution needs to be applied when making comparisons or when attempting to draw conclusions from the findings. Indeed it is too early to elaborate an accurate analysis due to the lack of experience and the differences in the way information is reported. In this respect, a dedicated working group within the European Insurance and Occupational Pensions Authority (EIOPA) is carefully assessing the information, quality, completeness and level of detail of this report to consider potential areas for improvement.

3.2.3 Content

The SFCR is a full-year report containing narrative information in quantitative and qualitative form supplemented, where appropriate, with quantitative templates. The report is subject to

⁵¹ The SFCR-specific content is defined by the primary legislation of Solvency II Directive and Delegated Regulation (in particular article 256 of the Solvency II Directive, articles 359-371 and articles 290-298 of the Delegated Regulation, its implementing measures - which provide detailed information on the essential aspects of the undertaking's business and relevant EIOPA Guidelines; in particular the "Guidelines on reporting and public disclosure" (EIOPA-BoS-15/109) as issued by EIOPA. The latter provides further clarification on an undertaking's process for public disclosure and supervisory reporting to insurers regardless the methods used to calculate the solvency capital requirement (SCR).

<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0138&from=EN>
<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0035&from=en>

approval by the administrative, management or supervisory body (AMSB) and is published on the website, where it shall remain available for at least five years after the disclosure date.

The key objective of the SFCR is to collect information in pre-defined sections on the soundness and solvency of insurers to increase transparency in the insurance market. It requires insurance and reinsurance undertakings to disclose publicly at least on an annual basis, a report on their solvency and financial condition. July 2017 was the deadline for publishing the first SFCR for the European insurance groups.⁵²

Insurance and reinsurance entities should provide at least detailed information regarding their business and performance, their governance, risk profile, valuation for solvency purposes and capital management.

The information to be disclosed is considered material if its omission or misstatement could influence the decision-making or the judgment of the users of the document, including the supervisory authorities.

The following paragraphs briefly describe the structure of the SFCR and inform on some comparisons on key topics as reported by the major European insurance groups identified as G-SIIs, resulting from the 2016 G-SII assessment exercise.

Section A: Business and performance

This section provides information on the group and its organisational structure with a focus on major shareholders and related undertakings. A business overview reports information on the underwriting performance at an aggregated level by lines of business and geographical area, investment income and expenses, gains and losses recognised directly in equity as well as major changes compared to the previous financial year.

Section B: System of governance

This section sets out general information on the governance structure in place, on roles and responsibilities of the board and on the remuneration policy. This section is narrative and also includes a description of fit and proper policies of the risk management system, including the Own Risk and Solvency Assessment (ORSA). It informs on strategies, processes and reporting procedures, and explains how the undertaking has determined its own solvency needs - given its risk profile - and how its capital management activities and risk management system interact with each other. To complete this topic, this section covers the internal control system, the implementation of key functions (ie internal audit, actuarial, compliance), and outsourcing policies.

⁵² For insurance companies, the publication of the SFCR was due by 22 May 2017.

Section C: Risk profile

The content of this section gives an in-depth overview of the risks that insurance groups are exposed to, and on how risks are grouped within the same category. It includes details on the exposure arising from off-balance sheet positions and the transfer of risk to special purpose vehicles.

The section is complemented by information on the assessment, measurement and monitoring of each risk category, as well as the risk concentration and techniques applied to mitigate the risk exposures, including the processes for monitoring the continued effectiveness of these risk mitigation techniques.

It concludes with a description of the methods used, the assumptions made and the outcome of stress testing and sensitivity analysis for material risks and events.

Section D: Valuation for solvency purposes

This section describes the bases, methods and assumptions used in the valuation of assets, technical provisions and other liabilities.

The valuation criteria adopted by Solvency II are largely similar to the International Financial Reporting Standards (IFRS) principles adopted by the European Commission. However, there are cases where IFRS valuation methods are not fully aligned with the Solvency II requirements. In these cases, reclassification and revaluation adjustments need to be made. The differences between Solvency II valuations and accounting valuations are included in the reconciliation reserve to allow for comparison of figures.

Section E: Capital management

This section covers the management and monitoring of the capital adequacy level of the entity along with the maintenance of adequate liquidity to ensure that the group is able to meet its obligations. Capital and liquidity adequacy should be on an ongoing basis, in line with the risk policy, which sets out the risk tolerance, and the capital management policy. This will lead to an efficient allocation of financial resources and the maintenance of the predefined target capital ratio. Specific information is also reported on internal models and regarding any non-compliance with the capital requirements.

3.2.4 Sample and metrics of the analysis

The SFCR publication is required from all European undertakings and groups. For purposes of this analysis, the sample is limited to the four largest European insurance groups (ie AEGON N.V, Allianz SE, Aviva plc, Axa S.A.), for the life and non-life segments, based on the G-SII list published by the Financial Stability Board in November 2016. In this instance, the classification is supplemented by the inclusion of an Italian group (Assicurazioni Generali SpA), which was on the G-SII list until 2014. The weight of these insurance groups on the overall global and European insurance market is significant. Nevertheless, the analysis is only meant to consider the solvency and capital adequacy and the sensitivity analysis performed by these groups.

The cross-analysis of these reports aims to investigate the main risks that European groups following a global business model are facing, and to what extent these have been disclosed. It

is also intended to provide basic information on the various components of their Solvency II capital, which in some cases differs widely from insurer to insurer.

3.2.5 Solvency capital requirement (SCR) and solvency ratio

According to the Solvency II risk-based approach, insurers need to hold capital to absorb losses they may incur on their investments or liabilities. The main indicator reflecting the overall risk exposure is the SCR, which corresponds to the economic capital needed to limit the probability of falling into financial failure once every 200 years, calculated with the Value-at-Risk method.⁵³

Solvency II provides a range of methods to calculate the SCR. This allows undertakings to choose a method that is proportionate to the nature, scale and complexity of the risks of the undertaking.

The SCR may be calculated using:

- A standard formula (which may be calculated with or without simplifications or undertaking-specific parameters-USP)
- The combination of the standard formula for some risk factors and a partial internal model for the remaining risk factors
- A full internal model, which is subject to prior supervisory approval.

The majority of groups under observation applies the Partial Internal Model (PIM) for the calculation of the group capital requirement as of 31 December 2016.

The PIM provides an accurate representation of the main risks to which the groups are exposed, measuring both the impact of each individual risk and their combined impact on the groups' own funds.

The capital adequacy-to-risk exposures may also be represented in terms of the solvency ratio, that is, the ratio of eligible own funds to solvency capital requirements. The ratio is indeed a synthetic indicator of the capital held in relation to the risk profile to guarantee that insurers have enough financial resources to withstand financial difficulties. Insurers have to maintain a solvency ratio of 100% or higher to comply with regulatory requirements.

In Table 3.2.5a, all groups show a solvency ratio well above the regulatory solvency ratio (100%).

⁵³ The solvency capital requirement is calculated by combining a number of separate risk charges, allowing for diversification credits by means of correlation matrices or other methodologies. The SCR is calibrated to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of approximately 99.5% over a one year time horizon. The SCR for each individual risk is then determined as the difference between the net asset value (for practical purposes this can be taken as assets less best estimate liabilities) in the unstressed balance sheet and the net asset value in the stressed balance sheet. These individual risk capital amounts are then combined across the risks within the module, using a specified correlation matrix and matrix multiplication.

Table 3.2.5a: Solvency ratio of selected European insurance groups

Groups	Country	Solvency ratio
Aegon	Netherlands	157%
Allianz	Germany	218%
Aviva	United Kingdom	172%
Axa	France	197%
Generali	Italy	178%

Source: SFCRs publicly available on the group websites.

3.2.6 Breakdown of risks

The analysis presented within this section is mainly focused on the most significant risks affecting the selected insurance groups, which are primarily reflected in the calculation and figures of the SCR.

The breakdown of risks grouped by risk types as reported by the selected European Union insurance groups shows that the weight of financial risks (market and credit) on the SCR is significant and ranges between 37% and 71%.

Underwriting risk is also a material risk, which impacts the total SCR pre-diversification⁵⁴ and is between 27% and 45%. Information provided seems to indicate that the underwriting risk is mainly driven by the life business, but there is evidence that, at least for a couple of groups, a higher risk exposure also stems from non-life insurance, specifically due to premium risk and reserve risk.

Figures for the health underwriting risk are in some cases reported separately and represent an insignificant amount (<2%).

Operational risk is also indicated as material and has a weighting in the total undiversified SCR components of 7% on average.

An additional category is reported as significant for the calculation of the SCR, which relates to the combination of the group consolidation methods according to Solvency II (Accounting Consolidation and Deduction & Aggregation Based Methods) and local requirements used for entities based in equivalent third-country jurisdictions.

Policies to manage and mitigate risks are clearly reported to be in place by all groups.

3.2.7 Sensitivity analysis of the Solvency II ratio

Sensitivity analysis and stress testing are key tools for testing the resilience and the financial robustness of the insurance group, as they allow for the quantification of the potential impact of changes in market conditions on the capital position and helps groups to adequately manage their risk exposures. These analyses are carried out on the basis of plausible and non-standardised assumptions defined considering the group's expectation of future events.

⁵⁴ Diversification takes into account the combination of risks which may or may not be correlated by nature and is deducted from the SCR.

The underlying assumptions cover both financial and insurance factors. Methods and assumptions used rely primarily on the Internal Model, where applicable, and the Standard Formula. The reference date is 31 December 2016.

All groups perform scenario analysis or sensitivity analysis for almost all risks included in their risk profile to evaluate the impact on capitalisation and the sensitivity to certain market fluctuations. The impact of the shocks is quantified in terms of the Solvency II ratio.

As shown in the Table 3.2.7a, stresses and sensitivity analyses are mainly applied to financial variables; in particular, to market and credit risks (eg risk free rate, ultimate forward rate, credit spread for corporate bonds, government bonds, equity values).

Table 3.2.7a: Financial shocks and impact on the solvency ratio⁵⁵

Solvency ratio: 157%	Financial risks	Shock applied	Solvency ratio after the shock
Aegon	Interest rate	-100 bps	132%
	Interest rate	+100bps	159%
	Equity markets	-20%	151%
	Equity markets	20%	156%
	Credit spreads (non-gov bonds)	+100bps	159%
	US credit defaults	+200bps	140%
	Dutch mortgage spreads	+50bps	160%
Solvency ratio: 218%	Financial risks	Shock applied	Solvency ratio after the shock
Allianz	Interest rate	-50bps	207%
	Equity markets	-30%	216%
	Credit spreads	+50bps	206%
	Currency	weakening 10%	215%
Solvency ratio: 172%	Financial risks	Shock applied	Solvency ratio after the shock
Aviva	Interest rate	-25bps	168%
	Interest rate	+25bps	175%
	Interest rate	-50bps	164%
	Interest rate	+100bps	185%
	Corporate bond spreads	-50bps	172%
	Corporate bond spreads	+50bps	171%
	Corporate bond spreads	+100bps	171%
	Credit downgrade on annuity portfolio		169%
	Equity markets	-10bps	171%
	Equity markets	+10bps	174%
	Equity markets	-25bps	169%
Solvency ratio: 197%	Financial risks	Shock applied	Solvency ratio after the shock
Axa	Interest rate	-50 bps ¹	188%
	Interest rate	+50bps	200%
	Equity markets	-25%	190%
	Equity markets	25%	203%
	Corporate spreads	+75bps	196%
Solvency ratio: 178%	Financial risks	Shock applied	Solvency ratio after the shock
Generali	Interest rate	-50bps	169%
	Interest rate	+50bps	184%
	Government bond spreads	+100bps	167%
	Corporate bond spreads	+100bps	175%

⁵⁵ Source: Solvency and Financial Condition Reports publicly available on the website of each group:
<https://www.aegon.com/contentassets/8d62f2b2a6c14a9b81f3577fa61301f4/aegon-group-2016-solvency-and-financial-condition-report.pdf>
https://www.allianz.com/v_1498485156000/media/investor_relations/en/results_reports/SFCR/en-Allianz-Group-SFCR.pdf
https://www.aviva.com/content/dam/aviva-corporate/documents/investors/pdfs/regulatoryreturns/2016/Aviva_plc_Group_SFCR_31_December_2016.pdf
https://www.axa.com.cdn.axa-contento-118412.eu/www-axa-com%2F8609ef94-0ab0-44ee-9399-d7fd055796bb_axa_sfcr_va.pdf
<https://www.generali.com/investors/reports-and-presentations/report-archive#2016>

For adequately managing the risk exposure, sensitivity or selected stress scenario analyses are also applied to other material and technical risks to test the impact on the Solvency II ratio of a reasonably possible change in the selected factors.

Underwriting sensitivity to various scenarios refers to premium risk, reserve risk and longevity risk, as well as to changes in lapse, mortality and morbidity rates.

Other material risks are changes in investment expenses, in the Ultimate Forward Rate - (UFR-) following European proposals for changing the methodology to derive the UFR-, and in the loss-absorbing capacity of deferred taxes (LAC-DT). Although the underlying assumptions adopted⁵⁶ by individual groups are not fully comparable, the overall results demonstrate that under these assumptions the capital position of each group seems to be solid.

The sensitivity analyses in most cases do not take into account management actions that might be taken to mitigate the effects of the defined shocks.

In some cases, historical stress has been applied to financial events (eg 2008/2009 and 2011 financial crises) and to technical risks (eg 1918 Spanish flu and 1999 Lothar and Martin storm) to measure potential market movements during a pre-defined period and their impact on capitalisation.

Reverse stress tests are carried out to measure the level of severity of a particular kind of stress and the capability to meet a certain capitalisation ratio as well as to test the resilience of the business plan and strategic projects to make sure that the risks are understood by the senior management and can inform decision-making.

3.2.8 Asset composition

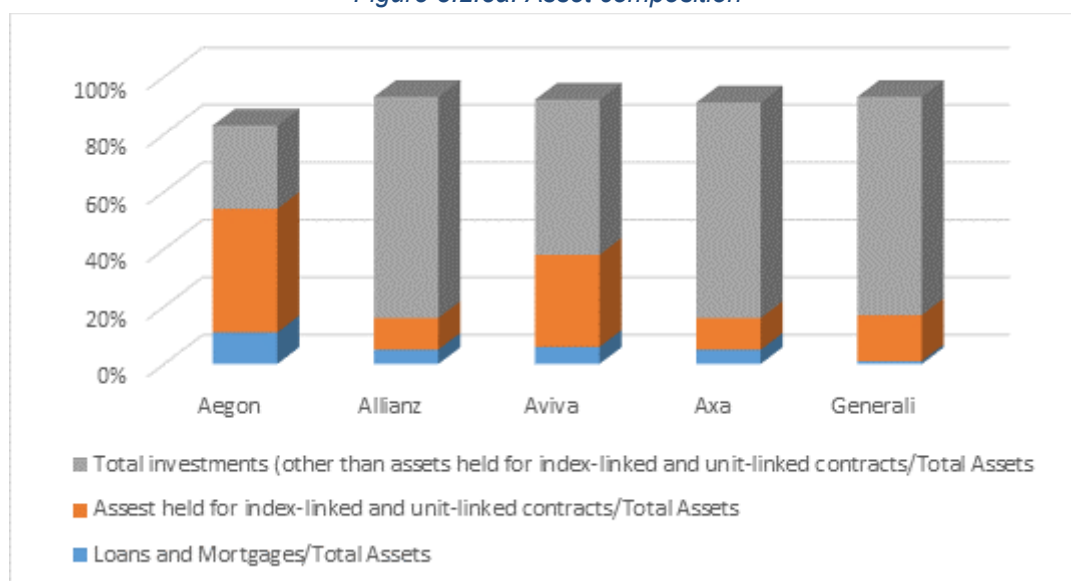
The breakdown of investment portfolios for the selected European insurance groups shows that their portfolio is predominantly invested in corporate and government bonds. These vary from 46% to 82% of total investments (other than assets held for index-linked and unit-linked contracts) within the selected sample.

The Italian, French and German groups show a higher exposure to government bonds.

The exposure to equities is not homogeneous but in general it accounts for no more than 7% of total investments (other than assets held for index-linked and unit-linked contracts), while the investment in loans and mortgage asset class varies between entities (from 1% to 11% of total investments) with higher levels for the Dutch group.

⁵⁶ In principle, the assumptions used have some limitations: they are supposed to remain unchanged and no correlation with other factors is considered in the analysis.

Figure 3.2.8a: Asset composition



Source: SFCRs publicly available on the website for the group.

3.2.9 Capital structure of own funds (Tiering)

Own funds are classified into three different tiers according to the quality of the own funds elements depending on their immediate availability to absorb losses.⁵⁷

The information reported in the groups SFCR show that the bulk of own funds consist of Tier 1 capital, amounting on average to 80% within the sample of insurers. The capital elements classified in Tier 1 are mainly ordinary share capital, share premium and future profits, and the surplus funds and the reconciliation reserve, where differences between IFRS balance sheet items and Solvency II Market Value balance sheet are recognised. Grandfathered debt⁵⁸ is also a relevant component of Tier 1 capital.

The weighted average share of Tier 2 capital amounts on average to 16% and consists of dated subordinated capital instruments (subordinated notes and bonds), while net deferred tax assets are the components of Tier 3 capital (See Table 3.2.9a).

⁵⁷ Restrictions apply to the eligibility of tiers to cover the SCR. No limits are set to Tier 1 elements which are the capital components of highest quality. Tier 1 items must be at least 50 % of the SCR, and the sub category of restricted Tier 1 may not exceed 20% of total Tier 1 own funds. Tier 2 cannot exceed 50% of the SCR whilst Tier 3 items are limited to 15%. The sum of eligible amount of Tier 2 and Tier 3 cannot exceed 50% of the SCR.

⁵⁸ According to art. 82, 3(d) of the Delegated Regulation (EU) 2015/35, the grandfathered debt refers to Items that are included in Tier 1 basic own funds under the transitional arrangement set out in article 308b(9) of the Directive 2009/138/EC (ie items issued before 1 January 2016 or prior to the date of entry into force of the delegated act; items that on 31 December 2015 could be used to meet the available solvency margin up to 50% of the solvency margin according to the Solvency I legislation; items that would not otherwise be classified in Tier 1 or Tier 2 in accordance with Article 94 of the Solvency II directive.

Table 3.2.9a: Breakdown by tier of Solvency II-eligible own funds to meet SCR (in %)

Groups	Tier 1	Tier 2	Tier 3
Aegon	73	18	19
Allianz	84	14	2
Aviva	76	22	2
Axa	79	15	6
Generali	87	13	0.3

Source: SFCR publicly available on the website for each group.

Significant developments of own funds throughout 2016 are also reported to provide information about the capital movement or group’s transactions and operations that determine the capital level and composition.

3.3 Catastrophe risk modelling practices in Bermuda

3.3.1 Introduction

Natural catastrophe reinsurers heavily utilise catastrophe risk models in their pricing and capital management. Catastrophe modelling has advanced into a full-fledged scientific field where meteorologists, seismologists, engineers and actuaries combine skills and expertise to provide forecasts of the impact of natural hazards to insured property. In its most basic form, a catastrophe model provides the distribution of losses across return periods and measurements based on the distribution of losses such as expectation or upper percentiles. These measurements can be used for pricing, capital management as well as risk management and risk mitigation.

This section explores the history and the basic theory behind catastrophe risk modelling. It also includes some results from the catastrophe risk practices in Bermuda. The Bermuda Monetary Authority (BMA) collects and compiles data on catastrophe modelling practices from the prudential annual filings of supervised entities. There are tabs – or in BMA jargon, schedules – within the so-called CSR⁵⁹ filing template - where companies are asked to answer a set of questions. These questions and their results are aggregated and presented in an annual catastrophe risk report published on the BMA website.

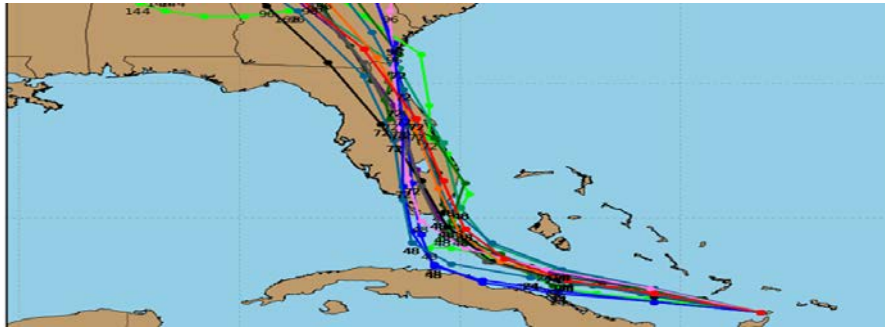
3.3.2 Structure of a catastrophe risk model

Catastrophe modelling is a multidisciplinary field utilising knowledge and expertise from natural catastrophe experts, engineers and actuaries. Each discipline provides input into a catastrophe model.

Natural catastrophe experts provide scenarios about the development of natural perils such as hurricanes, floods and earthquakes. As an example, a meteorologist or climate expert builds models of weather patterns to produce plausible scenarios for the areas where a weather phenomenon is expected to occur. For example, see Figure 3.3.2a. It shows a weather model output of probable hurricane paths hitting Florida (US).

⁵⁹ CSR stands for Capital and Solvency Return.

Figure 3.3.2a: Probable hurricane paths hitting Florida

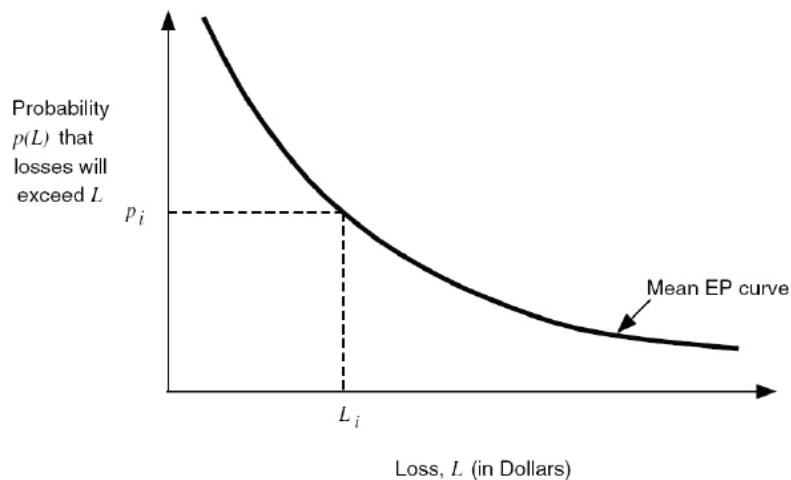


Source: Spaghettimodels.com

Engineers estimate the impact of a specific weather scenario on insured structures such as houses, commercial buildings and infrastructure. Engineers study the type of structure and its resilience to specific perils. They then estimate the damage each weather scenario will cause to an insured structure. Engineers make extensive use of geographic information systems (GIS) to identify the regions where the weather scenario is expected to hit. Then, for each region, they can make estimates based on the type of insured units that exist in a particular region. For example, in a region dominated by agricultural land, the damage will be different than in a region with high urban density because the structures built in each region are different.

Actuaries combine the information from engineers and natural catastrophe experts to evaluate the financial impact of a natural peril. The main tool they use is the so-called “exceedance probability (EP) curve” illustrated in Figure 3.3.2b

Figure 3.3.2b: Sample EP Curves



The EP curve is a graphical representation of the probabilities that a loss will exceed a specific amount shown in the horizontal axis. As the loss becomes larger the probability of exceeding that loss declines. This indicates that higher losses are associated with more extreme loss events which rarely occur.

The probabilities of exceedance are expressed not in usual percentages, but in return periods measured in years. For example, if the probability of exceedance for a particular loss is 1%,

then it is called a 1-in-100 year event and expressed as 1/100. Similarly a probability of 0.5% is called 1-in-200 year event.

Box 3.3.2a Return Periods

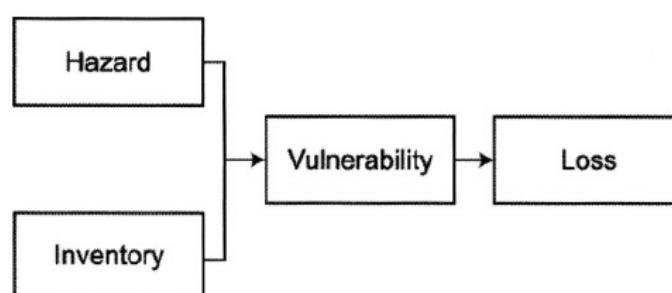
Some may assume that a 1-in-100 year event occurs only once in 100 years, but it is wrong to assume that. Multiple 1-in-100 year events can happen even within one calendar year but the probability of that is very low. The term 100 years is a convenient way to express the probability 1/100. In addition, these return periods are estimated upon limited data. These events can occur more frequently than assumed.

Once the EP curve has been produced, actuaries calculate the average annual loss (AAL).⁶⁰ This is the expected loss given this distribution of probabilities. The AAL is the technical basis on which the premium for this risk is calculated. It represents the actuarially fair premium for the pure risk excluding expenses, profits and other costs. Another important measure is the probable maximum loss (PML). The PML is usually defined as an upper percentile of the loss distribution such as the 99% Value at Risk (VaR).⁶¹

The PML provides information on how much the insurer is expected to lose if a rather unlikely event were to occur with specified probability. It is called probable maximum loss since the assumption is that the insurer has to be covered for a high percentile of potential losses.

Figure 3.3.2c presents the process of catastrophe risk modelling schematically.

Figure 3.3.2c: Catastrophe risk modelling process



Source: Grossi and Kunreuther (2005): Catastrophe Modeling: A New Approach to Managing Risk

The model uses as input the estimations of potential hazard scenarios and the inventory of insured units. The blend of hazards and inventories produces the vulnerability. The vulnerability is the estimated damage to a structure.

⁶⁰ AAL is the expected loss within one year and it is derived from the EP curve. The expectation is in the statistical sense and it means that loss outcomes are multiplied by their respective probability to occur and then the products of outcomes and probabilities are summed up. The AAL summarises the loss that the insurer will occur on average over all possible loss outcomes without any profit and underwriting expenses.

⁶¹ PML is the potential loss derived from the EP curve and it corresponds to upper percentiles of the loss distribution. In other words, the PML is either the VaR or the TVaR of the loss distribution.

The vulnerability is based on the resolution of the GIS or, in other words, the granularity of the loss estimation used by the modeller. On the one hand, a higher resolution, for example street by street, generally provides a better estimate of the vulnerability since different streets carry properties with different values. On the other hand, if the nature of the insurance contract is such that there is no need for such high GIS resolution, the modeller can adjust the resolution accordingly.

In all cases, the end result is a loss estimate stemming from the EP curve which is one of the outputs of the catastrophe model.

3.3.3 Brief History of Catastrophe Modelling⁶²

In the 1800's, residential insurers managed their risk by mapping the structures that they covered. Without access to GIS software, they used tacks on a map to indicate their exposure. This technique served insurers well as long as the risks were simple enough to be mapped manually. Widespread usage of mapping ended in the 1960's when it became too cumbersome and time consuming to execute.⁶³

Up to 1950s, scientific measures of natural hazards advanced rapidly. By the 1970s, studies theorising on the source and frequency of events were published. Significant analyses included the US Water Resources Council publication on flood hazard,⁶⁴ the Algermissen study on earthquake risk⁶⁵ and the National Oceanic and Atmospheric Administration (NOAA) hurricane forecasts.⁶⁶ These developments led US researchers to compile hazard and loss studies, estimating the impact of earthquakes, hurricanes, floods, and other natural disasters.

These two separate developments – mapping risk and measuring hazard – came together in a definitive way in the late 1980s and early 1990s, through catastrophe modelling. Computer-based models for measuring catastrophe loss potential were developed by linking natural hazards measurements and historical occurrences with GIS. The models provided estimates of catastrophe losses by overlaying the insured units at risk with the potential natural hazard sources in a geographic area.

Around the same time, several new modelling firms developed computer software for analysing the implications of natural hazard risk. Three major firms emerged: AIR Worldwide, Risk Management Solutions (RMS) and EQECAT. When introduced, the use of catastrophe models was not widespread. In 1989, two large-scale disasters occurred that instigated a flurry of activity in the advancement and use of these models. On September 21, 1989, Hurricane Hugo hit the coast of South Carolina (US), devastating the towns of Charleston and Myrtle Beach. Insured loss estimates totalled USD 4 billion before the storm moved through North Carolina (US) the next day. Less than a month later, on October 17, 1989, the Loma Prieta Earthquake occurred at the southern end of the San Francisco (CA/US) peninsula. Property damage to the surrounding Bay Area was estimated at USD 6 billion.

⁶² This chapter draws from the book *Catastrophe Modelling: A New Approach to Managing Risk* (Huebner International Series on Risk, Insurance and Economic Security) by Grossi and Kunreuther (2005).

⁶³ Kozlowski and Mathewson, 1995.

⁶⁴ USWRC, 1967.

⁶⁵ Algermissen, 1969.

⁶⁶ Neumann, 1972.

These two disasters sent a warning signal to the insurance industry. Then, on the heels of these two events, Hurricane Andrew made landfall in South Florida (US) in August 1992. Within hours of landfall, AIR Worldwide issued a fax to its clients estimating the losses in real time by the AIR Worldwide hurricane model. The estimate by AIR reached the astonishing amount of USD 13 billion. It was not until months later that the final amount of USD 15.5 billion was issued by the Property Claim Services Office.

Nine insurers became insolvent as a result of losses from Hurricane Andrew. To remain in business, insurers and reinsurers realised that they needed to estimate and manage their natural hazard risk more precisely. Many companies turned to the modellers of catastrophe risk for decision support. The modelling companies grew and catastrophe models increased in number, availability, and capability. By 2001, other organisations joined these front-runners in developing catastrophe models for assisting insurers and reinsurers in pricing their insurance policies and determining how much coverage to offer in hazard-prone areas of the country.

Box 3.3.3a. Cat Modelling and Insurance Linked Securities

One recent development has been spurred by the use of catastrophe modelling. ILS such as catastrophe bonds (cat bonds) are priced and structured with the help of catastrophe models sold by vendors. These models allow insurers to set up an insurance protection scheme that allows players other than traditional insurance companies to enter the insurance space and price catastrophe bonds without the need of actuaries.

3.3.4 Catastrophe Modelling Practices in Bermuda

The aggregated results from the 2016 statutory filings of (re)insurers are presented in this section. Bermuda class 3B and 467 (re)insurers are required to file the catastrophe risk schedule. This is a questionnaire about modelling practices. It also includes quantitative information about catastrophe exposures. The catastrophe modelling process is dubbed as “accumulation” and stands for accumulation of risks. Considering quantitative factors, Bermuda (re)insurers report metrics such as the AAL, PML and factor loadings.⁶⁸ The latest data is provided in the following two tables.

⁶⁷ Class 3B are commercial insurers whose percentage of unrelated business represents 50% or more of net premiums written or net loss and loss expense provisions and where the unrelated business net premiums are more than \$50 million. Class 3B insurers are required to maintain capital and surplus of \$1 million. Class 4 (re)insurers underwrite direct excess liability insurance and/or property catastrophe reinsurance risks. Class 4 insurers are required to maintain minimum capital and surplus of \$100 million. Moreover these companies must hold sufficient capital to withstand an aggregate expected loss beyond the 99.0% percentile.

⁶⁸ In the context of the Bermuda supervisory environment, factor loadings correspond to an add-on over estimated figures from the catastrophe models. In particular, the add-on corresponds to the AAL to compensate for additional conservatism in the estimates. Loadings also compensate for model error and data quality.

Table 3.3.4a: PML ratios (in %)

	2016	2015	2014	2013	2012
Industry Average Gross PML to Capital & Surplus	48	46	45	41	39
Industry Average Net PML to Capital & Surplus	25	28	29	29	29

Source: BMA

Table 3.3.4a presents ratios on the gross and net PML to capital and surplus. The PML is defined as the 99% TVaR (Tail Value at Risk). All PMLs refer to aggregate exposures and not to per-occurrence exposure. This ratio expresses whether or not the available capital and surplus can withstand a loss equal to 99% TVaR. On a gross basis, a 99% TVaR loss is expected to consume 48% of available capital and surplus. This ratio has been steadily increasing over the past years. However, on a net basis, after reinsurance, the ratio dropped to 25% in 2016 down from 29% in 2012, indicating a more pronounced use of reinsurance.

Table 3.3.4b presents the loading factors used as add-ons to the output of catastrophe modelling. These factors compensate for model error, lower resolution, data quality as well as increased conservatism in the modelling process. They are applied on the PML. For example if the catastrophe model yields a PML of USD 100, a 5% factor would raise the PML to USD 105.

Table 3.3.4b: Loading factors (in %)

	2016	2015	2014	2013	2012
Average Loading Factor	5.4	5.9	8.3	8.4	9.2

Source: BMA

In 2016, the average loading factor reached 5.4% - a steady decline since 2012. One should be cautious in interpreting the loading factor since models become more accurate and more conservative, thus reducing the need for higher safety buffers. In addition, there are now models for perils and regions not previously covered by models and higher quality data which has improved the modelling and reduced the need for higher loading factors.

Another interesting modelling practice is the usage of the Atlantic Multi-decadal Oscillation (AMO).⁶⁹ The AMO refers to the alteration of Sea Surface Temperatures (SST) in the Northern Atlantic from cool to warm phases. These phases last for several years. Since the mid-1990s, a warm phase has existed. A correlation has been observed between warm SSTs and more frequent severe hurricanes and other destructive weather phenomena. Bermuda (re)insurers responded as to whether they consider loadings for this risk factor on near-term or long-term views.

Table 3.3.4c: AMO factor consideration (in % of respondents)

	2016	2015	2014	2013	2012
Near-term Frequency	74	89	89	89	86
Long-term Frequency	26	11	11	11	14

Source: BMA

In 2016, 74% of (re)insurers considered the AMO for their near term modelling of Atlantic hurricane exposures, while 26% were also considering this factor for long term modelling. The

⁶⁹ For more information, see Appendix 1.

AMO factor has to do with trends that should be taken into account in modelling Atlantic hurricane exposures and the financial losses that stem from hurricane activity. Near-term frequency and long-term frequency estimations have been converging. This explains the fact that more (re)insurers are using the long term view.

Part of a questionnaire asks about the models that (re)insurers use. This gives an indication on whether or not (re)insurers are forming their modelling opinions based on one or multiple models. One can see which vendors are more prevalent in the market as well as how frequently (re)insurers are developing their own models. Responses are summarised in the following five tables.

Table 3.3.4d: Vendor model usage (in % of respondents)

	2016	2015	2014	2013	2012
AIR only	13	9	17	11	9
EQECAT only	0	0	0	0	0
RMS only	41	39	31	29	26
AIR and RMS	44	45	39	46	44
AIR and EQECAT	0	0	0	0	0
EQECAT and RMS	0	0	0	0	3
AIR, EQECAT and RMS	3	6	14	14	18

Source: BMA

The RMS seems to be the most commonly used model with an increasing share either as a standalone or in combination with other vendors.

Table 3.3.4e: Model frequency usage (in % of respondents)

	2016	2015	2014	2013	2012
Ad-hoc	0	0	0	0	0
Annual	0	0	0	0	0
Semi-annual	0	0	3	3	6
Quarterly	53	44	35	38	39
Monthly	26	24	25	21	22
Weekly	3	2	5	5	3
Daily	13	22	20	21	14
Real time	5	7	13	13	17

Source: BMA

(Re)insurers use catastrophe modelling in fixed periods – usually quarterly and monthly. Each quarter either renewals or supervisory reporting are the most common reasons (re)insurers run the catastrophe models, with 53% of (re)insurers reporting quarterly use in 2016 up from 39% in 2012. Real time use declined to 5% of (re)insurers in 2016 compared to 17% in 2012.

Table 3.3.4f: Business units performing accumulations at different frequencies (in % of respondents)

	2016	2015	2014	2013	2012
Yes	39	37	33	35	29
No	61	63	68	65	71

Source: BMA

(Re)insurers were asked whether different business units perform accumulations at different frequencies. In 2016, 61% of respondents said that they do not perform accumulations at different frequencies, a decrease of ten percentage points since 2012.

Table 3.3.4g: (Re)insurers that have developed their own Internal model (in % of respondents)

	2016	2015	2014	2013	2012
Yes	34	39	43	44	39
No	66	61	58	56	61

Source: BMA

In 2016, 34% of (re)insurers developed their own stochastic model, while 66% have not developed such a model. (Re)insurers with very specialised lines of business outside the cover of traditional vendors and major property catastrophe writers, are more likely to develop such in-house models to capture their unique risks. In this sense, the same (re)insurers seem to be in lines of business requiring bespoke modelling.

(Re)insurers were also asked how catastrophic risk modelling accounts for reinsurance and retrocessions. The results are shown in Table 3.3.4h.

Table 3.3.4h: External reinsurance model usage (in % of respondents)

	2016	2015	2014	2013	2012
The company has minimal catastrophe exposure protection and as such gross is effectively net.	11	12	15	13	8
The accumulations are calculated on a gross basis with reinsurance protections calculated approximately outside the system.	3	0	0	0	3
The accumulations are calculated on a gross basis with reinsurance protections calculated explicitly outside the system.	5	7	8	8	6
The accumulations are calculated on a gross basis with the effect of reinsurance protections calculated explicitly for some types of protection within the system.	32	27	25	21	33
The accumulations are calculated on a gross basis with the effect of reinsurance protections calculated explicitly for each type of protection within the system.	50	54	53	59	50

Source: BMA

Few (re)insurers have minimal catastrophe exposure; namely, 11% of respondents in 2016 compared to 8% in 2012. The majority of (re)insurers model catastrophic risk by taking into account explicitly external reinsurance either for some types or for each treaty separately.

In 2016, 82% of respondents considered either some external reinsurance or all reinsurance treaties in their catastrophe modelling. In 2012, this percentage was 83%. In 2016, 8% of respondents did not model external reinsurance directly within their models, compared to 9% in 2012. Overall, there is stability in the responses, indicating that companies have fixed modelling practices with respect to external reinsurance.

3.3.5 Exceedance Probabilities Curves for Bermuda

This section presents some outputs from the catastrophe models in Bermuda on an aggregated basis. (Re)insurers were asked to produce EP curves for named perils. These perils are Atlantic hurricane, North American earthquake, European windstorm, Japanese earthquake and Japanese typhoon. The EP curves cannot be aggregated by summing individual EP curves since an event for one firm can be completely unrelated to the event of another company even for the same peril and the same return period.

For example, a 1-in-250 year event in North America earthquake means something different for a company with exposures to San Francisco versus to a company with exposures to Northern California outside large urban centres. Moreover, the simple addition of EP curves does not recognise diversification benefits since it assumes that all events for all perils and for all return periods can occur at the same time even if some events may be mutually exclusive.

Therefore, the data from the EP curves has been compiled by drawing the distribution of EP curves in the cross section for firms for named perils across return periods. A box plot including the mean, median, 10th, 25th, 75th and 90th percentiles of the EP curves is then plotted for

each peril and for each return period . As expected, the higher the return period in years, the rarer the event and the EP curve is increasing in value. Or, to put it another way, the rarer the event, the higher the impact if realised.

The largest exposure for Bermuda (re)insurers is North Atlantic hurricane with average gross exposure between USD 693 million for a 1-in-50 year event up to almost USD 1.3 billion for a 1-in-1000 year event. Notice that this is an average with significant variation within firms. For example, at the 90th percentile of losses, there are firms with 1-in-50 year exposures north of USD 1.6 billion, while there are firms who exceed USD 2.8 billion of exposures for a 1-in-1000 year event for the same peril. Net exposure is lower since it includes the purchase of reinsurance. The net to gross exposure ratio is then calculated for Atlantic hurricane. Some descriptive statistics are presented in the Table 3.3.5a.

Table 3.3.5a: Net to gross exposure for Atlantic hurricane (in %)

Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1000
Mean	56	58	61	63	65
Median	46	49	54	58	61

Source: BMA

An interesting pattern that emerges is that the purchase of reinsurance becomes less pronounced at higher risk layers. The median (re)insurer retains 46% of the gross exposure for a 1-in-50 year event, while the median (re)insurer retains 61% of the gross exposure for a 1-in-1000 year event. The average exposure per peril, per return period both gross and net are shown in the following tables.

Table 3.3.5b: Average gross exposure (in USD millions)

Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1000
Atlantic hurricane	693	833	1012	1152	1296
NA. earthquake	449	586	761	889	1021
European windstorm	213	270	338	381	422
Japanese earthquake	172	229	300	343	375
Japanese typhoon	125	157	177	194	213

Source: BMA

Table 3.3.5c: Average net exposure (in USD millions)

Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1000
Atlantic hurricane	333	415	540	650	763
NA. earthquake	205	272	378	470	575
European windstorm	117	148	186	213	241
Japanese earthquake	87	111	142	162	179
Japanese typhoon	68	84	96	107	118

Source: BMA

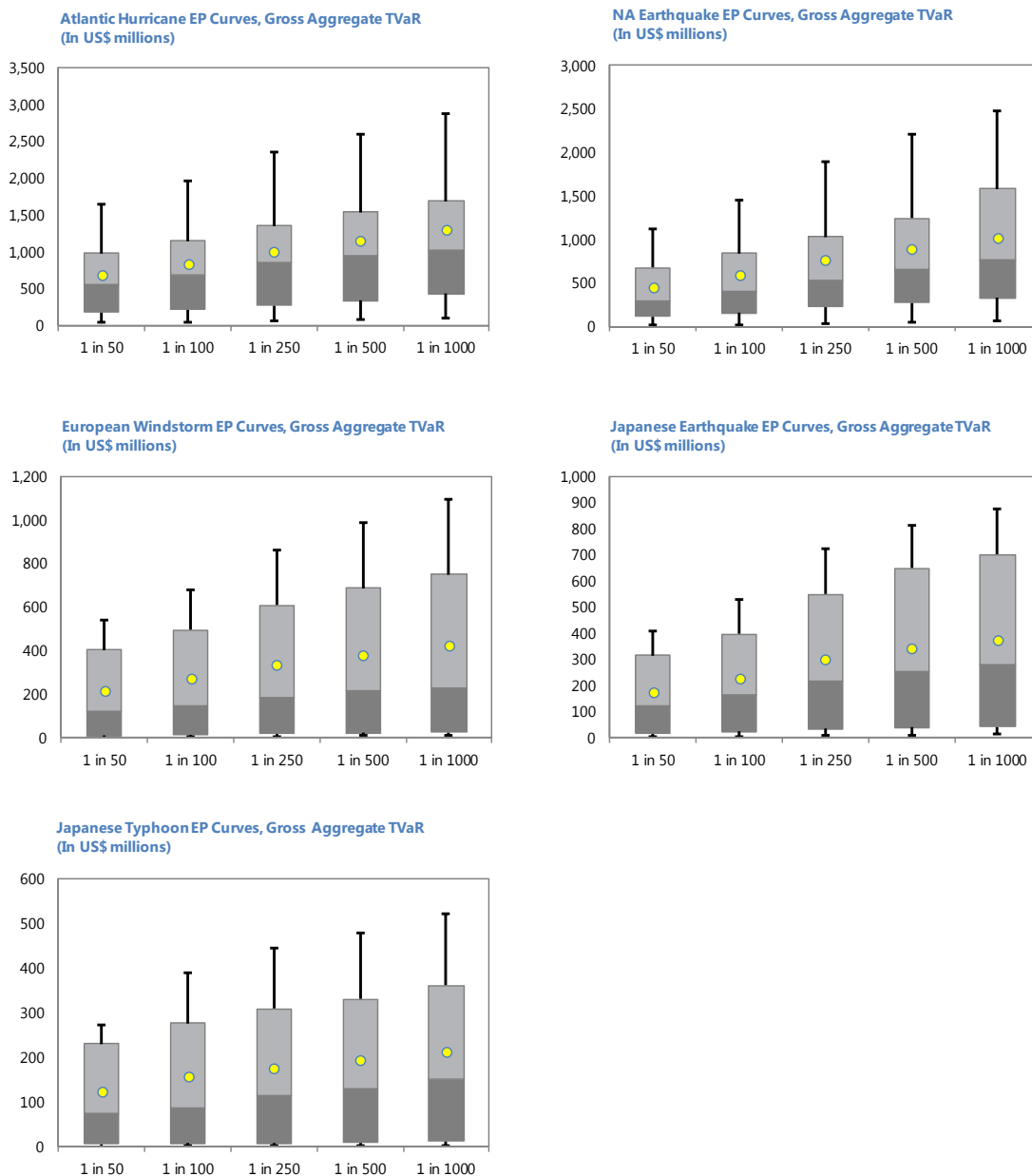
Table 3.3.5d: Average exposure for all perils (in USD millions)

Return Period	1-in-50	1-in-100	1-in-250	1-in-500	1-in-1000
Gross	944	1105	1315	1476	1645
Net	469	569	723	856	998

Source: BMA

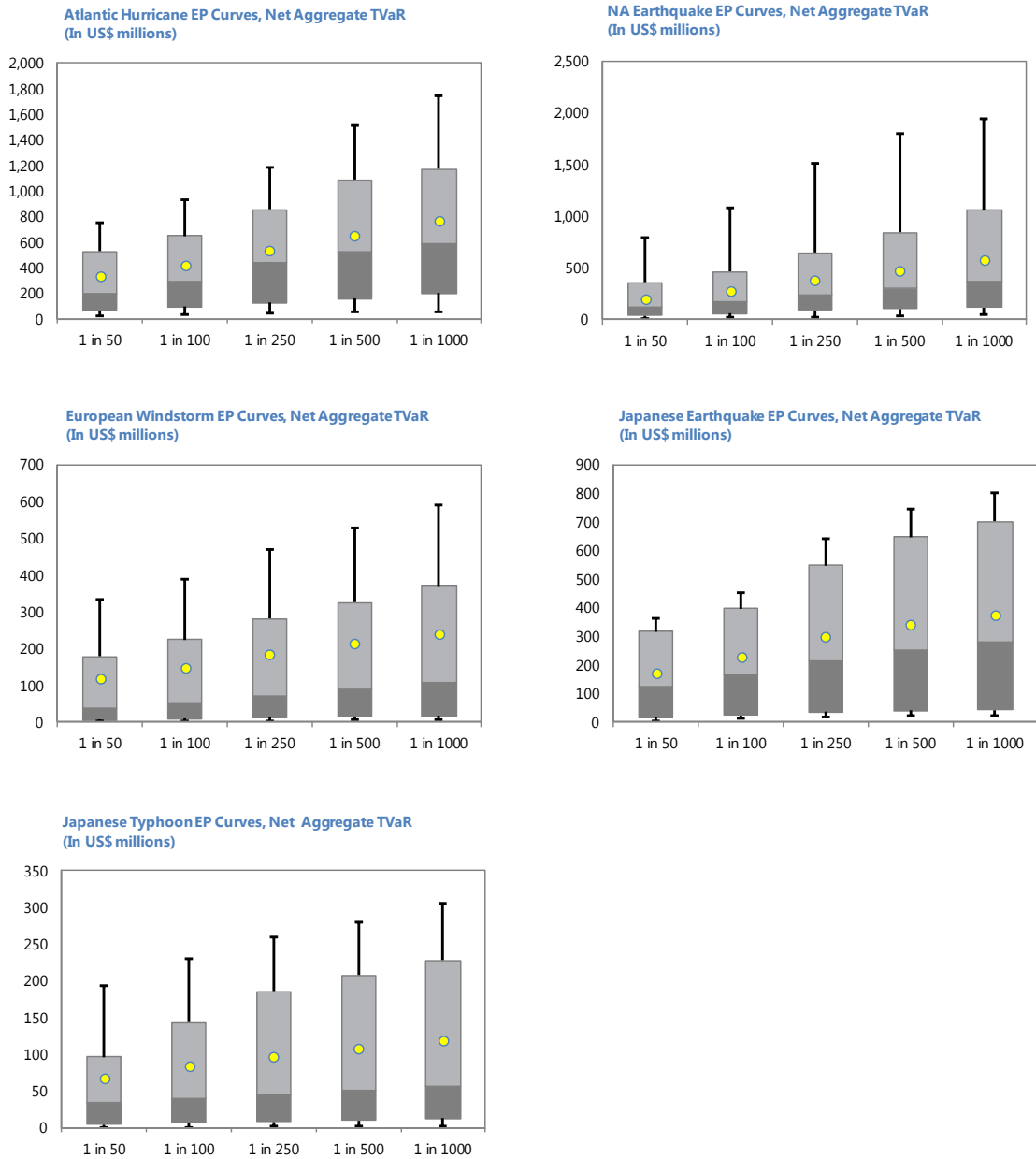
As noted before, the largest exposure across all return periods is Atlantic Hurricane followed by North American Earthquake. Also plotted are the aggregate gross and net EP curves which include all the catastrophic risks in a (re)insurer's portfolio.

Figure 3.3.5a: Gross EP curves for named perils



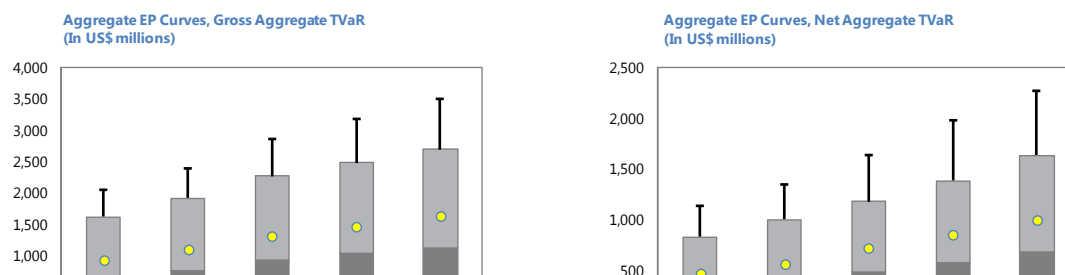
Source: BMA staff calculations. Note: Boxplots include the mean (dot), the 25th and 75th percentiles (grey box, with the change of shade indicating the median), and the 10th and 90th percentiles ("whiskers").

Figure 3.3.5b: Net EP curves for named perils



Source: BMA staff calculations. 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 3.3.5c: Gross and net aggregate EP curves for all perils



Source: BMA staff calculations. 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”).

3.3.6 Discussion

This paper has discussed some of the catastrophe modelling practices in Bermuda. For macroprudential policy and supervision, (re)insurers appear to be concentrated in terms of modelling practices. (Re)insurers place a degree of reliance upon specific vendors for their risk calculations. Appreciating this risk and ensuring they both own (and have their own view of) risk, (re)insurers develop internal models to confirm the calculations yielded by vendor models or when the risks cannot be covered by existing vendors. In the absence of (re)insurers having their own view of risk, the concentration of risk modelling into a handful of vendors potentially can increase the risk that most (re)insurers will “get it wrong” at the same time if the vendor models also “get it wrong”.

To mitigate vendor model risk, the market to some extent exhibits self-regulation by recognising that the models have limitations. Either (re)insurers develop bespoke models or they apply factor loadings as more conservative estimates of the AAL and the PML. We have also seen the extensive use of reinsurance as a way to pass risk to better suited market participants, while capital markets are taking more insurance risk than ever, especially risks at very high layers. As of 2016, the volume of catastrophe bonds stood close to USD 29 billion, more than double the 2006 volume.

Despite the fact that the industry has a vested interest in measuring risks appropriately, it is the supervisory framework that further enhances the management of catastrophe risk. The BMA has a multifaceted approach to catastrophe risk supervision which includes capital charges for catastrophe risk, stress testing, evaluation of the catastrophe risk practices of each (re)insurer and public dissemination of aggregated data to inform market participants about the market. The supervisory framework eventually rests on the ability of (re)insurers to absorb catastrophe risk. Bermuda has also aligned its supervision regime with established jurisdictions to enhance its credibility. As of 2016, Bermuda is fully equivalent to Solvency II, while as of 2015 Bermuda was a qualified non-US jurisdiction from the NAIC.

Box 3.3.6a: The Bermuda Framework for Catastrophe Risk Supervision

As one of the largest property catastrophe reinsurance centres in the world, Bermuda has a comprehensive framework of catastrophe risk supervision. The supervisory framework rests on an assessment of the ability of insurers to withstand severe catastrophic shocks and also public dissemination of catastrophe risk data on an aggregated basis. The capital requirements include a catastrophe risk charge which comprises aggregate probable maximum loss at 99% TVaR over a one year time horizon. To further evaluate the ability to withstand catastrophic shocks and the reasonableness of catastrophe model outputs, additional information is collected in a catastrophe risk return.

The catastrophe risk return contains both qualitative and quantitative information. This includes qualitative information on the process of catastrophe risk modelling such as the type of models, the frequency of the modelling process, data quality, whether or not certain switches are turned on (eg secondary uncertainty, storm surge, demand surge, fire following and sprinkler et al, long-term versus medium term hurricane frequency). In addition to the qualitative information, the insurer provides quantifications of loadings to account for unmodeled risks, model error and other deficiencies. The insurer also provides quantitative information such as AALs, PMLs and EP curves for major perils and for the entire portfolio from a 1-in-50 to 1-in-1,000 TVaR, (occurrence and in the aggregate). Percentage-of-limits modelled and un-modelled within the accumulation framework are also provided.

The supervisory process validates and assesses the prudential filings. Since part of the calibration of the catastrophe risk capital charge hinges on the assumptions of the insurer, the BMA validates the results with a set of tools. Industry peer comparisons on selected metrics and consistency between pricing and accumulations are checked to give a picture of the insurer's solvency and the market's solvency.

The catastrophe risk return is one source of cross validation. Another source of validation is the stochastic scenario generator developed in-house by the BMA. This model performs Monte Carlo simulations on the balance sheets of individual insurers by shocking assets and liabilities and producing income statements used to estimate probabilities of future insolvency and financial results based on different return periods.

Finally, the BMA prescribes a set of stress tests based both in BMA-designed scenarios and the Lloyd's Realistic Disaster Scenarios (RDS) and they are reported in the prudential filings. The insurer has to show the capital position before and after the relevant RDS while also providing its own scenario RDS quantifying a worst case scenario. The insurer is also obligated to provide a reverse stress test rendering its business non-viable.

When weather stations show that a hurricane is make landfall, or shortly after catastrophic events (eg earthquakes) occur, the BMA uses its exposure data to conduct preliminary capital adequacy assessments on insurers to estimate likely impact. To verify preliminary results, industry surveys are conducted. Usually a data call is used and insurers are asked to gauge their exposures. Based on the catastrophe risk submissions, insurers are reassessed regarding their ability to withstand the losses. The BMA publicly publishes aggregated data of the catastrophe risk returns for information purposes of the market and for its macroprudential surveillance framework for the insurance sector.

3.4 Emerging market topics

3.4.1 Financial education

Financial education has fast emerged as a key policy tool to help individuals and households navigate the increasingly complex financial decisions they have to make in both the short- and long-term. With the unprecedented pace of technological change and the proliferation of digital financial services around the world, there is a need to strengthen financial and digital literacy. This is an important component of the international policy agenda as highlighted by G20 leaders in 2016 when they endorsed the High-level Principles for Digital Financial Inclusion. Financial education, financial consumer protection and financial inclusion are globally recognised as essential ingredients for the financial empowerment of individuals and the overall stability of the financial system, as enshrined in a series of high-level principles approved by G20 leaders.⁷⁰

In May 2017, the OECD published its PISA⁷¹ 2015 Results (Volume IV) including the assessment of Students' Financial Literacy.⁷² For instance, Russia established the Russia Trust Fund for Financial Literacy and Education, to support the advancement of financial literacy and capability programmes in low and middle-income countries. With funding provided by the Ministry of Finance of the Russian Federation, the World Bank and the OECD conducted methodological, analytical and policy work on financial literacy, capability and education.⁷³

The OECD survey also shows that Students in Beijing-Shanghai-Jiangsu-Guangdong (China) score at the highest level among the countries and economies assessed in financial literacy. In China, some personal money-management topics have been included in the national curriculum in primary and secondary education since the 1990s, in subjects related to ethics, society and history, as part of the popularisation of knowledge about the market economy.

In India, the National Centre for Financial Education, comprising representatives from all financial sector regulators, has been set up to implement the National Strategy for Financial Education, under the guidance of a Technical Group on Financial Inclusion and Financial Literacy of the Financial Stability and Development Council, which caters to all sections of the population. A National Financial Literacy Assessment Test was implemented as a means to encourage the school students to obtain basic financial skills that are essential for their full participation in society and a lifetime of well-being.⁷⁴

In Brazil, financial education initiatives carried out by the Superintendence of Private Insurance (SUSEP) have shown significant growth in recent years, mainly through the establishment of partnerships in most of the projects. Such initiatives are in line with the Strategic Institutional Planning, and are in accordance with the objectives and guidelines of the National Strategy for Financial Education. Among the main initiatives, the production of two theatre plays staged in public squares and in secondary and elementary schools; product orientation lectures on supervised markets. Other examples to support financial education are SUSEP's 1st Seminar

⁷⁰ OECD (2017), G20/OECD INFE Report on ensuring financial education and consumer protection for all in the digital age.

⁷¹ Programme for International Student Assessment.

⁷² <http://www.oecd.org/finance/financial-education/pisa-2015-results-volume-iv-9789264270282-en.htm>

⁷³ <http://www.oecd.org/daf/fin/financial-education/russia-oecd-world-bank-financial-literacy.htm>

⁷⁴ <http://www.ncfeindia.org/>

on Financial Education; the publication of the “Consumer Guidance and Defence Guide”, in digital format and of the “Basic Manual for the Guidance and Protection of the Consumer” on Car Insurance, Life and Personal Accident Insurance, DPVAT Insurance, Extended Warranty Insurance, Open Supplementary Pension Plans and Capitalisation, in print version; in addition to the creation of the SUSEP Financial Education Portal “My Safe Future” (Meu Futuro Seguro): www.meufuturoseguro.gov.br.

South Africa has put in place the National Consumer Financial Education Strategy. The National Treasury of South Africa summarises its mission for comprehensively empowering consumers to engage with financial services. The aim of the strategy is to guarantee that “all South Africans, particularly those that are vulnerable and marginalised, are empowered to participate knowledgeably and confidently in the financial marketplace and to manage their financial affairs, deal with their day-to-day financial decisions and make good choices about allocating their incomes from school-going age, during working age and through to retirement”.⁷⁵

3.4.2 Financial inclusion

Microinsurance is helping to address the needs of emerging market consumers. It is recognised as an important tool for low-income households to be able to mitigate risk and recover from financial shocks. Today, according to the Microinsurance Network’s World Map of Microinsurance, over 280 million people worldwide are covered by at least one insurance policy.

Microinsurance has been showing steady growth in emerging economies in recent years. The growth has been driven in part by increasing the use of the mobile channels and the diversification of microinsurance products beyond life cover.⁷⁶

In Africa, insurers have capitalised on the enormous penetration of mobile phones in the region to offer microinsurance policies through their partner mobile network operators. In Latin America, a diverse range of intermediaries has brought about dynamic change in the market, with products distributed through utility bills, supermarkets and other less conventional players

According to the World Map of Microinsurance programme, total written microinsurance premiums in the Africa region now amount to almost USD 756 million, up from USD 387 million in 2011. Microinsurance currently covers 61.8 million lives compared with 44.4 million lives in 2011. The region has also experienced an evolution in products and associated benefits offered on the market, and an increase in providers entering the market.

In Latin America and the Caribbean, where a diverse range of intermediaries has also brought about dynamic change in the market, with products distributed through utility bills, supermarkets and other less conventional players, almost 8% of the population is covered by a microinsurance policy with more than 200 products identified equating to USD 828 million in written policies.

⁷⁵ Roberts, B., Struwig, J., and Gordon, S. (2016). Financial Literacy in South Africa: Results from the 2015 South African Social Attitudes Survey round. Report prepared by the Human Sciences Research Council on behalf of the Financial Services Board. Pretoria: Financial Services Board.

⁷⁶ <https://www.cover.co.za/massive-opportunity-in-emerging-consumer-market/>

In this context, Brazil has been committed to promoting financial inclusion for the low-income population through implementation of simple and low-cost insurance products more adapted to the needs of the low-income population and to the formal and informal micro-entrepreneurs.

Overall, the emerging markets should be the main driver of premium growth in both the non-life and life sectors with emerging Asia likely to have the strongest growth in non-life premiums, forecast to be nearly 8% in 2017 and 9% in 2018.⁷⁷

However, many products classified as microinsurance are still not adequate for the low-income markets. Sometimes the products that are sold to them are actually mass products with lower prices that are pushed to the most vulnerable population. Microinsurance products and their distribution processes need to be adapted to meet the characteristics and preferences of the low-income market and fulfil their needs. It is important to develop appropriate arrangements that are viable and provide value to the poor

Therefore, when evaluating the success of microinsurance, it is important to not only consider premium growth but also verify if the products and their distribution are in fact meeting the expectations of the target customers and creating value for them.

3.4.3 Digital innovation in the insurance sector in India

Insurance repository system

On 20 April 2011, the Insurance Regulatory and Development of India (IRDA) launched the insurance repository system. Under the provisions of these guidelines, five entities have been granted certificates of registration to function as insurance repositories.

The objective in creating an insurance repository is to provide policyholders with a facility to keep insurance policies in electronic form and to undertake changes, modifications and revisions in the insurance policy with speed and accuracy to bring about efficiency, transparency and cost reduction in the issuance and maintenance of insurance policies.

To leverage this electronic platform to the benefit of all stakeholders, and more particularly to the Inclusive segments, the participation of multiple regulated entities was considered necessary. At the same time, it was felt that the platform should lend itself to bringing in efficiencies and avoiding duplication of efforts. The guidelines were therefore revised on 29th May, 2015.

Benefits of the insurance repository system

The insurance repository system is expected to provide significant benefits to all stakeholders. The policyholder will have ease of access to view all his insurance policies in one place and also receive periodic statements on the status of their policies. The cost for storage and maintenance of the policy is expected to be reduced significantly. The proposed system will provide a boost for inclusive growth and reach remote corners of the market in a cost effective manner. The increased use of this system will enhance the role of the insurance repositories beyond just storing electronic policies. Under the proposed system, multiple Know Your

⁷⁷ http://www.swissre.com/media/news_releases/Sustained_insurance_sector_growth_in_2017_largely_based_on_demand_from_emerging_markets.html

Customer (KYC) checks can be avoided. As KYC originators and consumers, the costs for insurers of doing KYC will be greatly reduced.

To implement the Insurance Repository System, the Authority also issued Extensible Mark-up Language standards for various insurance lines such as life, motor and other than motor. This facilitated issuance of electronic insurance policies.

Important features of the insurance repository guidelines

- i. Classification of services under e-Insurance Accounts: The various services offered under the e-Insurance Accounts have been categorized into the following:
 - a. Portfolio services – Where the policyholders will have the ability to create a portfolio of their policies.
 - b. Basic services – These are standard minimum services that will be offered by the insurance repositories (eg status, printing options, periodic reports, and mini statements). The IRDA will review the list of services on a regular basis.
 - c. Premier services – These are services over and above the portfolio and basic services (eg premium and transaction history, premium reminders, notifications of various claims, portfolio analysis tools and rendering of certain policy services).
- ii. Sharing of KYC information: To enable the re-use of KYC information, it is proposed to set up a KYC repository database in the Central Index Server (iTrex) currently supporting the insurance repository system. The entities who perform KYC validation would be identified as “KYC originators” and the entities using this information would be identified as “KYC consumers”. Sharing of KYC information is expected to ease the sales process and enable faster issuance of both electronic and physical insurance policies. A suitable revenue model is proposed to be built to support the KYC sharing.
- iii. Electronic issuance in certain cases: In the following categories of policies, insurers must also issue electronic policies.
 - a. All Insurance policies sold online or through Web-Aggregators or Common Service Centres.
 - b. Policies falling within the criteria stipulated below in Figure 3.4.3b.
- iv. Business benefit for insurance repositories: The revenue for insurance repositories under the revised guidelines shall be from the following sources:
 - a. From insurers for holding of electronic policies.
 - b. From policyholder for premier services.
 - c. From insurers for performing outsourcing activities.
 - d. “KYC- originator” revenue.

- v. Business benefit for insurers: The reason why this might benefit insurers include:
 - a. “KYC-originator” revenue.
 - b. Faster issuance of policies owing to KYC sharing.
 - c. Reduced cost of storage/maintenance of electronic policies.
 - d. Increased coverage through the electronic commerce route.
 - e. Reach to inclusive segments.

- vi. Standard operating procedures: To facilitate easier conduct of the operations in the IR system, Standard Operating Procedures on the following areas are included as a part of these guidelines:
 - a. Opening of electronic insurance account.
 - b. Issuance/conversion of e-policies.
 - c. Sharing of KYC data.
 - d. Turnaround times defined for major processes.
 - e. Sharing electronic insurance account details and modus operandi.
 - f. Appointment, renewal of approved people’s applications.
 - g. Inter-insurance repository transfers.
 - h. Security framework.

The following insurance repository companies are operating in the Indian insurance market:

- NSDL Database Management Limited
- Central Insurance Repository Limited
- Karvy Insurance Repository Limited
- CAMS Insurance Repository Services Limited

The number of e-insurance accounts and shell-insurance accounts for life-only insurers opened as of 8 September 2017 stand at a level of 1,052,393 accounts while the total number of e-insurance policies issued reached 704,933.

Insurance web aggregator regulations

The Authority caught early trends in the distribution of insurance products in the online space. It observed that price comparison websites were being established to offer a comparison of prices across various insurers for different insurance products.

The Authority issued insurance web aggregator regulations in 2013 which recognised them as an insurance intermediary that generated leads and passed them on to insurers for conversion into policies. The insurance web aggregators were remunerated based on the successful conversion of these leads.

The regulations laid down the procedures and processes for the sale of insurance online, through tele-calling and through distance marketing. As of 31 March 2017, the Authority had issued 17 web aggregator licences. Web aggregator statistics for the 2015-16 financial year are shown in Table 3.4.3a.

Table 3.4.3a: Web aggregator statistics (2015-2016).

Web aggregator statistic	Millions
Total number of visitors	16.0
Total number of lead converted	4.8
Total number of visitors not selected any option	2.6
Total premium collected (INR)	4500.0
Total remuneration earned (INR)	725.0
Total sum assured (INR)	1100000.0

Guidelines on insurance e-commerce

As part of the IRDA's developmental mandate, the Authority is facilitating the promotion of e-commerce in the insurance space. This will lower the cost of transacting insurance business and bring higher efficiencies and greater reach. E-commerce is seen by IRDA as an effective medium to increase insurance penetration and bring financial inclusion in a cost-efficient manner. As a result, the Authority has issued guidelines on insurance e-commerce.

The guidelines define the Insurance Self-Network Platform which is a technology platform. It allows only entities granted a certificate of registration by IRDA, such as insurers and insurance intermediaries.

The Insurance Self-Network Platform will undertake insurance e-commerce activities in India such as selling and servicing of insurance products.

The guidelines lay down the procedure for granting permission to establish an Insurance Self-Network Platform. This includes filing an application, furnishing information and clarifications and the conditions thereof.

The guidelines also stipulate internal monitoring and the review and evaluation of systems and controls.

The scope of an external audit shall be as prescribed by the Authority from time to time.

In addition, the participant shall ensure compliance with the information security management system standard of the International Organisation for Standardisation or the International Electro-technical Commission or its equivalent at all times by having an annual review of the systems.

The participant shall place the report of the CISA (Certified Information Systems Auditor) and the information security management system before the board or its sub-committee for their observations.

The guidelines propose a code of conduct for the Insurance Self-Network Platform and its obligations.

The guidelines also cover the operational issues for the Insurance Self-Network Platform available on regular internet web-site (desktop and mobile) or as a mobile app or both. It allows for differential pricing when sold through the Insurance Self-Network Platform.

A proposal form for insurance business transacted on the Insurance Self-Network Platform shall not carry physical signature and instead an electronic signature or digital signature or single factor authentication such as one time password, personal account number and date of birth authentication shall suffice. Creation of an e-insurance account is made mandatory before selling insurance policies on the Insurance Self-Network Platform.

Issuance of electronic insurance policy regulations, 2016

Consequent upon promulgation of Insurance Laws (Amendment) Act, 2015, a new section in the Insurance Laws (Amendment) Act, 2015 has been incorporated which states that every insurer shall, in respect of all business transacted by it, endeavour to issue policies above a specified threshold in terms of sum assured and premium in electronic form, in the manner and form to be specified by the regulations made under this Act.

The Authority issued regulations on the issuance of electronic insurance policies and threshold limits.

The regulations define such terms as e-proposal, e-insurance policy, solicitation of insurance business through electronic mode, opening of e-insurance account, e-signature, one-time password-based validation and mandatory issuance of electronic policies above a certain minimum threshold limit in terms of sum insured and premium.

Figure 3.4.3b: Threshold limits on the issuance of electronic insurance policies per lines of business

Line of Business		Sum Insured* (equal to or exceeding) (in INR)	Single/Annual Premium (equal to or exceeding)
Pure term (excluding term with ROP)		1,000,000	10,000
Other than Pure term (including term with ROP)**		100,000	10,000
Pension policies		NA	10,000
Immediate Annuities (Pension p.a.)		NA	10,000
All retail General Insurance policies except Motor		1,000,000	5,000
Individual Health		500,000	10,000
Motor Retail		All policies	All policies
Miscellaneous	Individual Personal Accident & Domestic Travel	1,000,000	5,000
	Individual Travel Insurance (Overseas)		All Policies

Guidelines on Information and cyber security for insurers

The Authority issued guidelines on information and cyber security for insurers in April 2017 which will be effective from 1 April 2018.

These guidelines are applicable to all insurers. In the case of intermediaries and other regulated entities with whom the policyholder information is being shared, it is the responsibility of the insurer to ensure that adequate mechanisms are put in place to ensure that the issues related to information and cyber security are addressed

Insurers who have not completed three years from the date of commencement of business are exempted from the requirement of a full-time person appointed as Chief Information Security Officer. However, that responsibility may be taken care of by any of the functionaries reporting to the governing board. All other requirements stipulated in the guidelines document are applicable to these insurers.

Figure 3.4.3c: Information and cybersecurity for insurer implementation timeline

1	Appointment/ designation of a suitably qualified and experienced Senior Level Officer exclusively as Chief Information Security Officer to be responsible for articulating and enforcing the policies to protect their information assets and formation of Information Security Committee (ISC)	30 April 2017
2	Preparation of Gap Analysis report (AS-IS Vs requirements stated in the guidelines document)	30 June 2017
3	Formulation of Cyber Crisis Management Plan	30 June 2017
4	Finalisation of Board approved Information and Cyber Security Policy	31 July 2017
5	Formulation of Information and Cyber Security assurance programme (implementation plan / guidelines) in line with Board approved Information and Cyber security policy	30 September 2017
6	Completion of first comprehensive Information and Cyber Security assurance audit	31 March 2018

Insurers are expected to take suitable steps to become fully compliant by 31 March 2018 as per the above timelines.

Creation of a database

The creation of the database⁷⁸ started with the issuance of point of sales person guidelines. The purpose was to check de-duplication of point of sales enrolled by insurers and insurance intermediaries. Therefore, the Aadhaar number⁷⁹ was taken as the unique identifying filed to check de-duplication.

Going forward, it was viewed by the IRDA that the same logic could be extended to insurance agents and marketing persons of insurance intermediaries that would include broker qualified persons, specified persons of corporate agents and authorised verifiers for web aggregators. Again, the unique identifying field would be the Aadhaar number.

Therefore, a roadmap for creation of the centralised database of insurance agents and insurance intermediaries was decided by the IRDA in two phases:

- Phase I: database for broker qualified person, authorised verifiers and specified persons of corporate agents.
- Phase II: database for individual insurance agents and all others involved in soliciting and procurement of insurance policies.

⁷⁸ Covers all insurance agents, broker qualified persons, specified persons of corporate agents, authorised verifiers for web aggregator, point of sales person, etc.

⁷⁹ This is the Indian social security number.

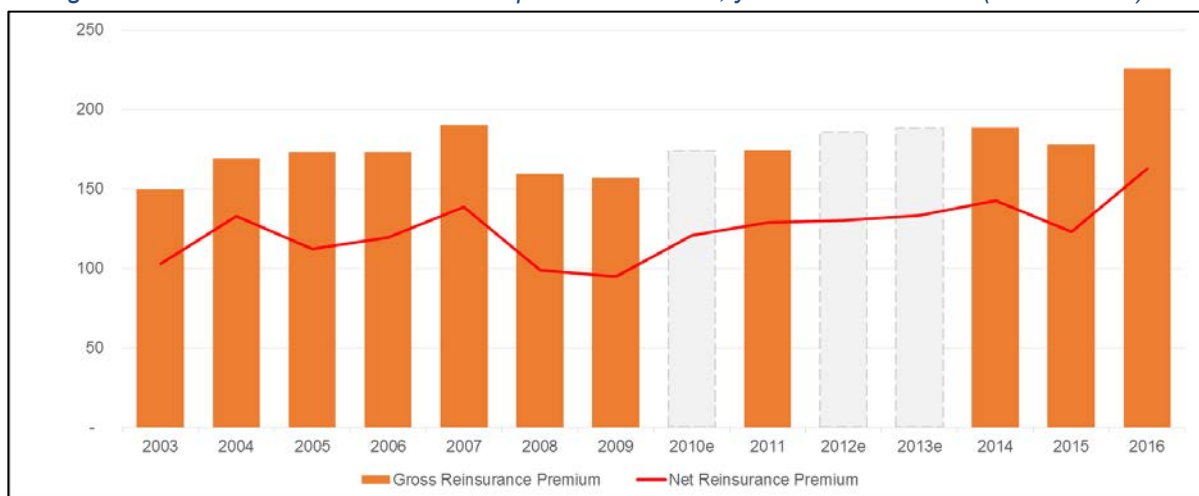
Chapter 4 - Global Reinsurance Market Survey

The IAIS has gathered international reinsurance data on the insurance sector through the Global Reinsurance Market Statistics (GRMS) survey, a yearly exercise for which the IAIS collects data via its Member jurisdictions.⁸⁰ This survey was first conducted in 2003. This iteration covers 47 reinsurers based in nine different jurisdictions. The participating list of reinsurers has remained largely consistent throughout the years. The GRMS survey captures data from reinsurers with gross unaffiliated reinsurance premiums in excess of USD 800 million. Data captured from the survey mainly covers gross and net premiums written, claims paid and provisions, investments by asset class, business profitability, shareholders equity and available and minimum capital requirements. This section of the report discusses the analysis completed on the data ascertained from the 2017 GRMS survey.

4.1 Reinsurance premiums⁸¹

Overall, at the end of 2016, the global reinsurance industry experienced an increase in gross premiums written. Reported premiums in life reinsurance increased from USD 44 billion to USD 78 billion, while non-life reinsurance premiums increased slightly (10%). Within non-life reinsurance, liability reinsurance exhibited the greatest change, increasing 20% (USD 10 billion) in the period. Property and financial lines of business moved upward similarly (10%) to general premium growth.

Figure 4.1a: Gross and net reinsurance premiums written, year-end 2003-2016 (USD billions)



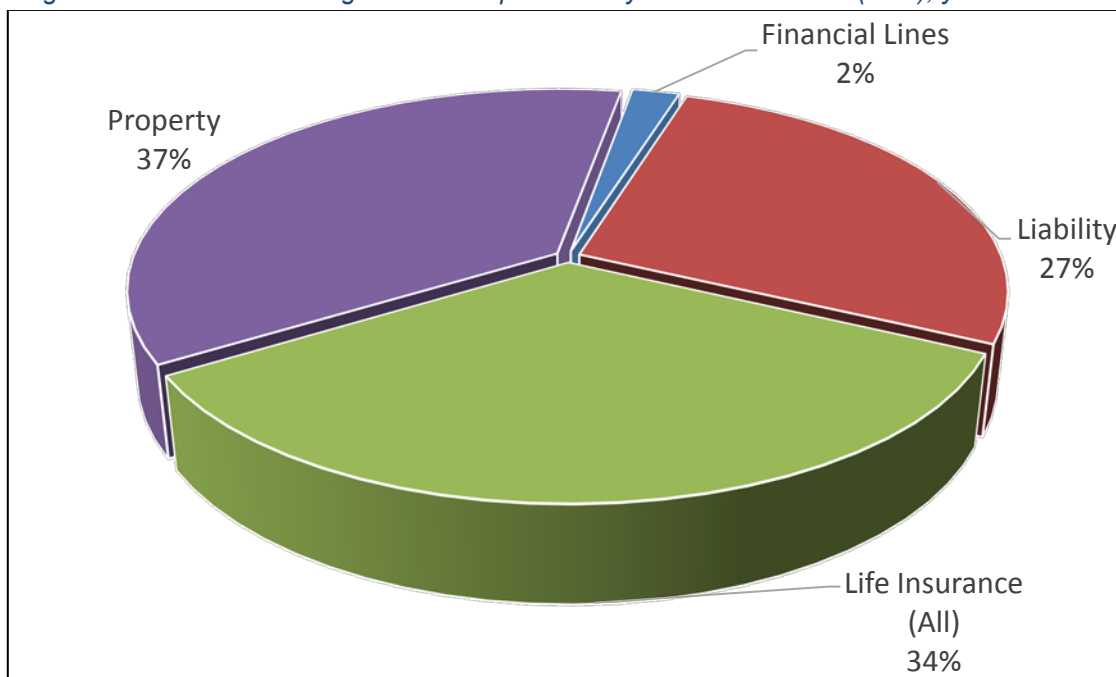
Source: 2017 IAIS survey

As shown in Figure 4.1a, the increase in gross premium written (GPW) in 2016 was accompanied by a comparable increase in net reinsurance premiums written (NPW). NPW is derived from GPW less retrocession. Overall, reporting entities for 2016 retroceded 28% (USD 63 billion) of GPW. The majority of the retrocession was for non-life risks, which accounted for 64% (USD 40 billion) of the total recession at the end of the period. Hence, the 28% change in retrocession from 2015 to 2016 was driven by life risks.

⁸⁰ Subject to survey bias.

⁸¹ The charts within this section of the report reflect an analysis performed on the data gathered from the IAIS global reinsurance market statistics surveys conducted from 2003-2016. The 2010, 2012 and 2013 periods of the charts were forecast using historical and current reinsurance data of the sample of large reinsurers surveyed.

Figure 4.1b: Distribution of gross written premium by class of business (in %), year-end 2016



Source: 2017 IAIS survey

The relative share of lines of business by gross written premium has remained static. In 2016, life insurance accounted for one-third and non-life insurance lines of business represented two-thirds. Within non-life reinsurance lines of business, property reinsurance represented the majority of gross written premium, accounting for 37% of total premiums. Liability coverage amounted to 27%, and financial lines reflected 2%.

4.2 Risk transfer between regions

Data in Table 4.2a shows gross reinsurance premiums grouped and assumed by region of domicile of reporting entities and ceding region. The data has been grouped by the region in which the reporting entities are domiciled. For example, USD 299.85 million of African and Middle East insurance business in the sample is ceded to companies based in North America. Europe accounted for the majority of the risks assumed and ceded by Africa and Middle East and Latin America regions.

Table 4.2a: Risk transfers between regions, ceding and assumed amounts, year-end 2016 (in USD millions)

Ceding region	Assuming region		
	North America	Europe	Asia
Africa, Near and Middle East	299.85	3,066.23	32.43
Asia and Australia	5,575.88	19,474.25	2,164.04
Europe	3,439.41	45,496.33	818.91
Latin America	1,536.99	6,257.08	29.60
North America	99,323.37	35,171.83	629.14
Grand Total	110,175.50	109,465.72	3,674.12

Source: 2017 IAIS survey

As the data in Table 4.2a shows, it is common for reinsurers to assume risks from ceding insurers located across borders. These risk transfers are driven, among other things, by the nature of reinsurance business; in particular, by the kind of insurance risks involved (eg catastrophe risk). Geographical diversification of risk is a key element of reinsurer risk management strategies. By ceding insurance risk across borders, jurisdictions exposed to catastrophe may benefit from a reduced concentration of insurance risk exposures within the borders of the jurisdiction. This can positively contribute to the financial stability of the jurisdiction.

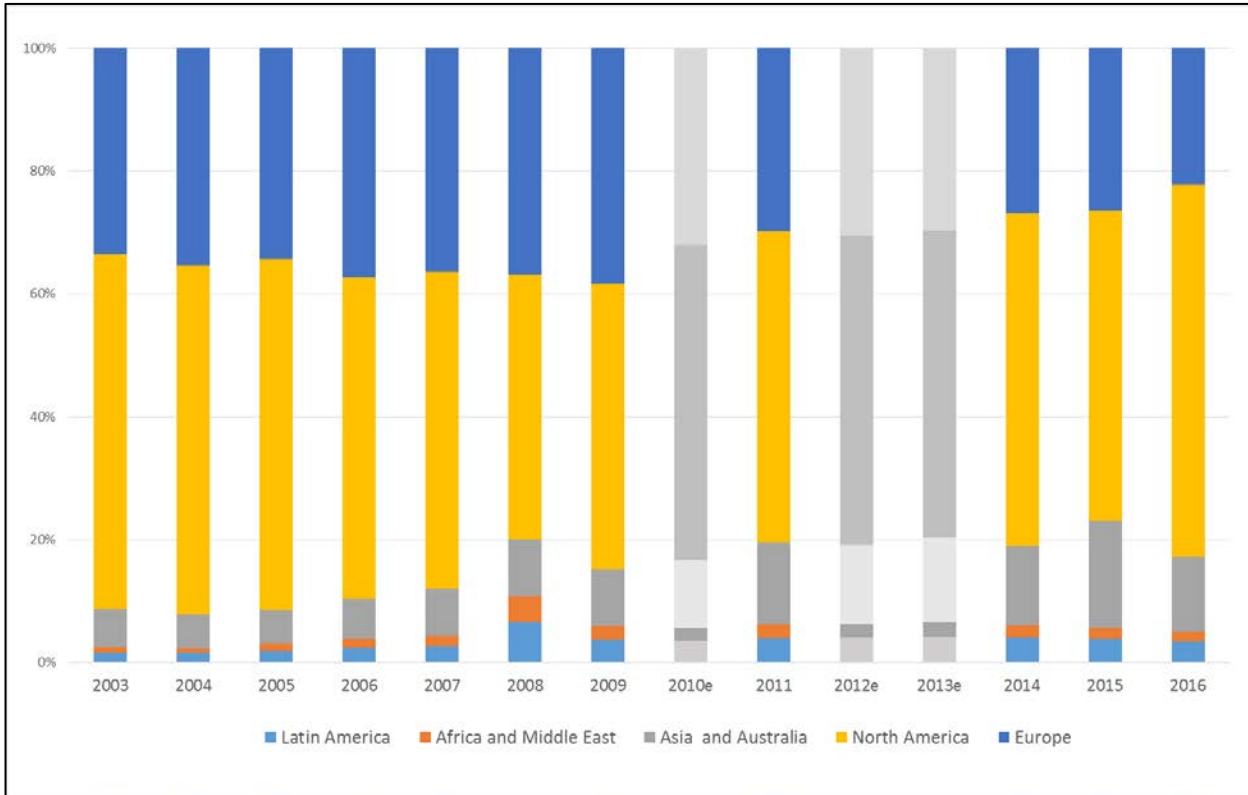
Table 4.2b: Risk transfers between regions and net positions, year-end 2016

Risk transfer by reporting entities between regions in 2016			
Company	Gross assumed	Gross ceded	Net position
Asia and Australia	7,348	27,214	-19,866
Europe	218,931	49,755	169,177
North America	222,647	135,124	87,523

Source: 2017 IAIS survey

As Table 4.2b shows for the sample firms, the net position of the European and North American regions is strongly positive. Net position means difference between the gross amounts of premiums assumed by reporting entities less gross amounts ceded to other reporting entities. A negative position means that sample firms from a particular region (eg Asia and Australia) ceded to other reporting entities within the sample more than they assumed from these reporting entities.

Figure 4.2a Gross premiums assumed by region, year-end 2003-2016



Source: 2017 IAIS survey

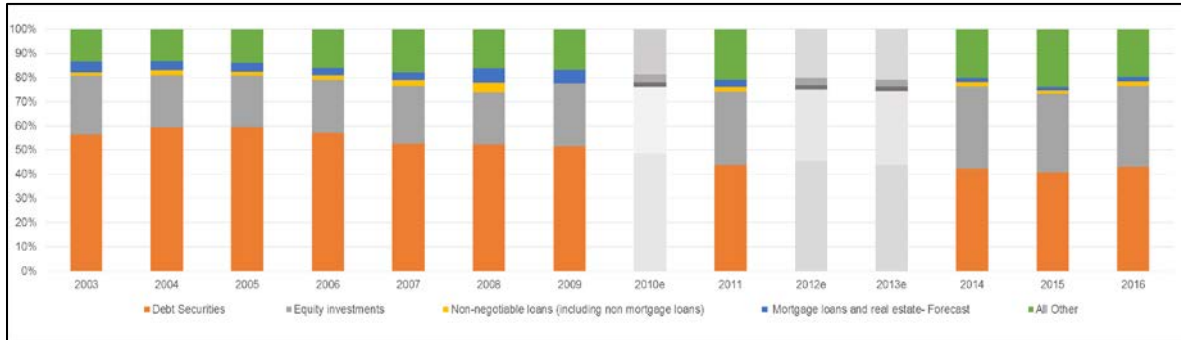
Figure 4.2a provides an analysis on gross reinsurance premiums assumed according to the region of the ceding insurer. In 2015, North America accounted for 60% (up from 50% in 2015) of the global reinsurance market, followed by 22% in Europe (5% decrease in comparison to 2015) and 12% in Asia and Australia (versus 17% in 2014). The risks assumed in Latin America and Africa remained stable, accounting for 3% and 2% respectively of global risks.

4.3 Assets

The GRMS survey captures data on financial instruments held by reinsurers at balance sheet value and market value. An analysis of this data shows that total book value of invested assets held by reinsurers had increased by 10% (USD 67 billion) in 2016. Reinsurers held invested assets totalling USD 769 billion in 2016 compared to total assets of USD 702 billion in 2015.

In recent years, the asset composition of reinsurers (excluding cash) has exhibited marginal shifts. However, fixed income debt securities have remained the largest assets class held by reinsurers. In 2016, debt securities comprised a 43% proportional share of total assets. This reflects a 1% point increase over the prior year.

Figure 4.3a: Asset composition (in %), year-end 2003-2016



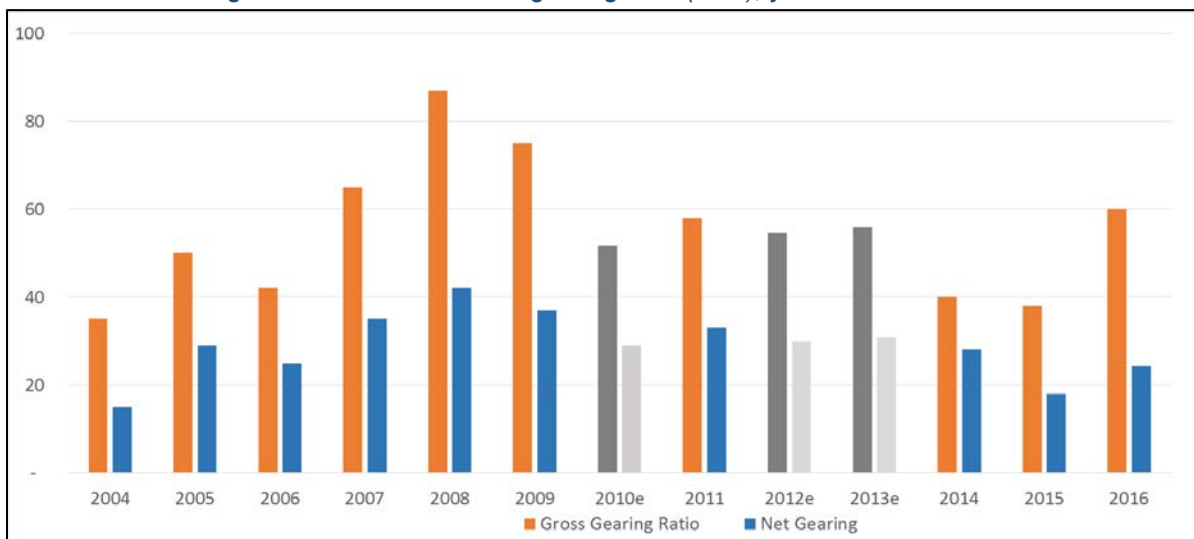
Source: 2017 IAIS survey

4.4 Profitability

The financial performance of the reinsurance industry can be assessed using financial indicators such as gearing and net gearing ratios. As shown in Figure 4.4a, gearing ratios reflect on overall capital improvement of reinsurers in the year and measure reinsurer dependency on reinsurance (for direct business) and retrocession (for assumed reinsurance business), by comparing recoverables to total available capital.

In 2016, reinsurers reported a gearing ratio⁸² of 60% and a gearing ratio net of collateral and offsetting items of 24%. As shown in Figure 4.4a, the analysis shows that gearing ratios have trended downward since 2009 through 2015. The movement has been driven mainly by an increase in the capital base of reinsurers. This has led to a decrease on the impact of recoverables to reinsurance and retrocessions. In 2016, the downward trend stopped with ratios increasing substantially and returning to a 12-year average. This finding can be related to an increasing recoverable values (as the capital base also improved this year).

Figure 4.4a: Gross and net gearing ratio (in %), year-end 2003-2016

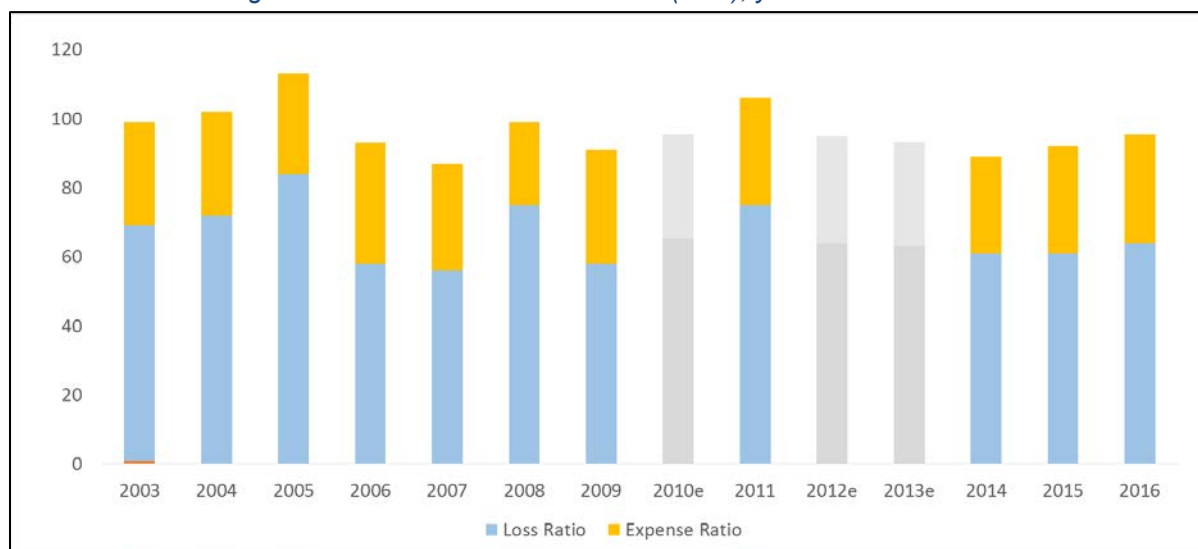


Source: 2017 IAIS survey

⁸² The gearing ratio is defined as the ratio between recoverables from reinsurance and retrocessions and total capital available.

The combined ratio is a metric used to assess profitability and financial performance. It is a commonly used benchmark for non-life insurers (expenses plus incurred insurance losses relative to earned premiums) for underwriting performance and measures the amount of earned premiums that an insurance company must pay to cover the claims and expenses generated by the business.

Figure 4.4b: Combined and loss ratio (in %), year-end 2003-2016



Source: 2017 IAIS survey

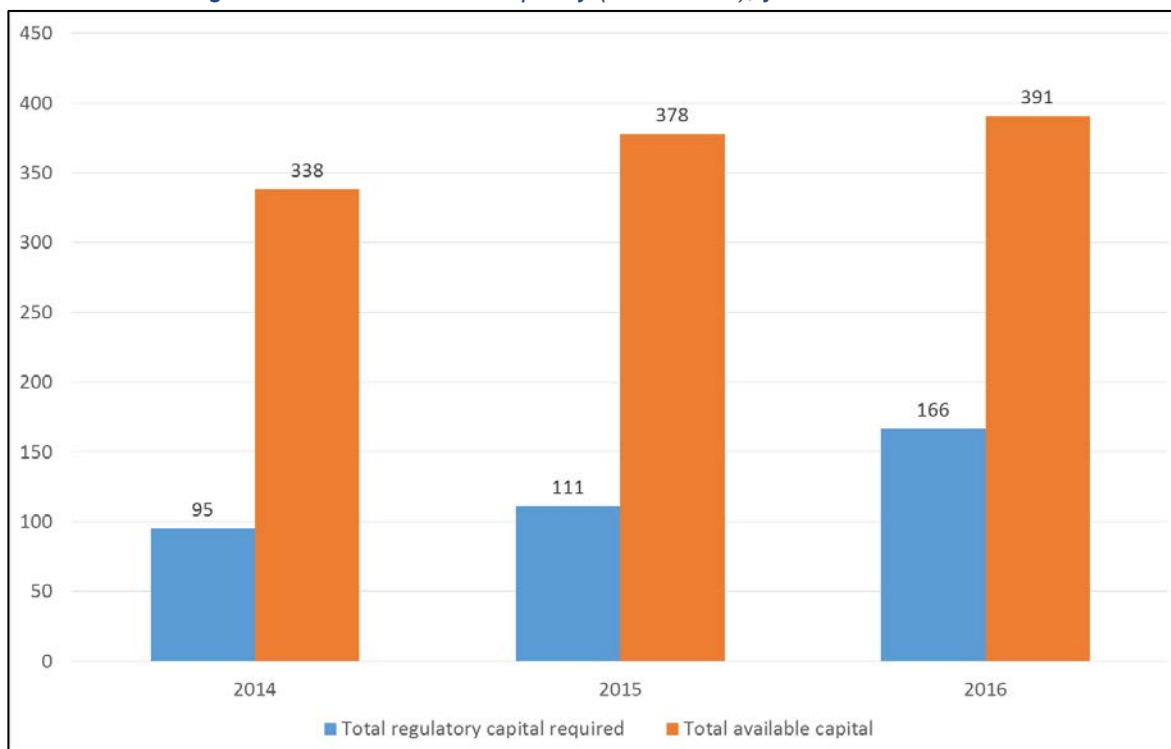
Figure 4.4b shows the average combined ratio of reinsurers surveyed over a 13-year period. From 2003 to 2016, the average combined ratio was 96%, with 2005 reflecting the highest period (113%) and 2007 reporting the lowest (87%) over the 13-year period. The constant oscillation in the combined ratio is indicative of the volatility in profitability of the reinsurance sector.

In 2016, the average combined ratio grew four percentage points from 92% in 2014 to 96%. The expense ratio (net operating expenses to net premiums earned) provides insight on the performance of reinsurers from an operational point of view. The loss ratio, which measures the flow of money from a reinsurance company, remained unchanged at 61% over the same period. The rise in the combined ratio was driven by a slight increase of the average expense ratio of reinsurers, from 31% in 2015 to 32% in 2016 and especially a 3% increase in the loss ratio.

4.5 Capital adequacy

In terms of traditional reinsurance, reinsurers maintained a strong capital base for the period. Global reinsurance capital increased to USD 391 billion in 2016, a small increase of 3% over the prior year. In the same period, total regulatory capital required grew even more than available capital, but the sector's capital base was well in excess of its regulatory capital requirement by 235% (up USD 225 billion). For 2016, regulatory capital required amounted to USD 166 billion, and increased massively by 50% over the prior year.

Figure 4.5a: Reinsurance capacity (USD billion), year-end 2014-2016



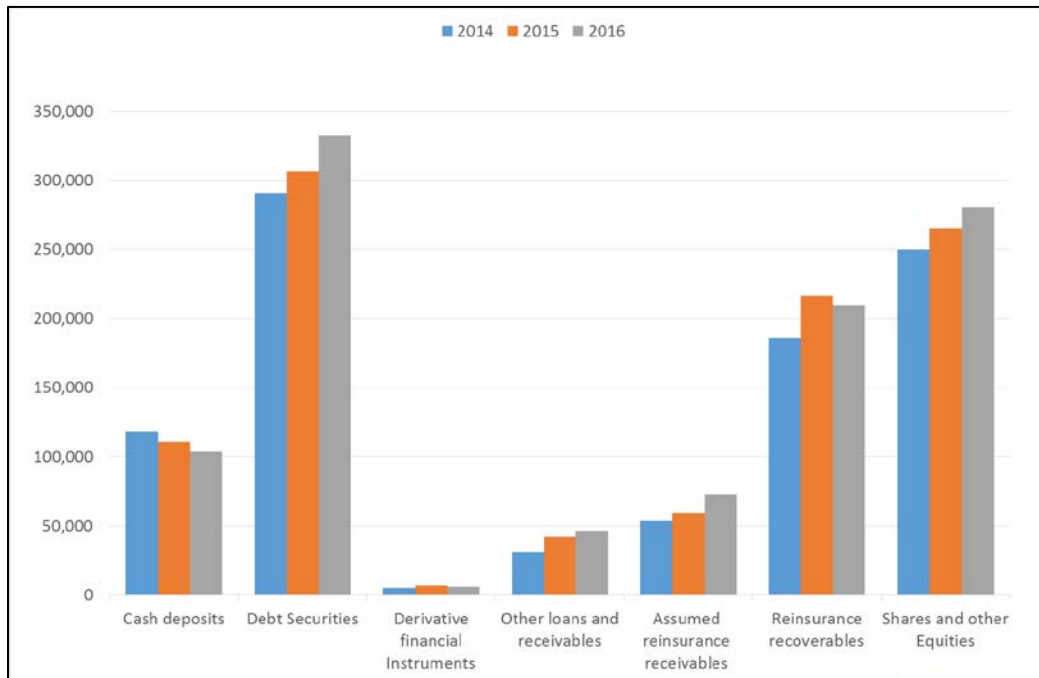
Source: 2017 IAIS survey

4.6 Counterparty linkages and exposures

In 2016, total selected assets held with counterparties increased slightly. Nevertheless, the general development is rather stable. This growth was driven by an increase in debt securities (which constitute 32% of all counterparty exposures) and also shares and other equity investments (which constitute 27% of all counterparty exposures).

Cash deposits, constituting 10% of all counterparty exposures and reinsurance recoverables, constituting 20% of all counterparty exposures, decreased slightly.

Figure 4.6a: Counterparty exposure, year-end 2014-2016



Source: 2017 IAIS survey

Technical Appendix – Global Reinsurance Market Survey

Figure TA.1: Gross reinsurance premiums

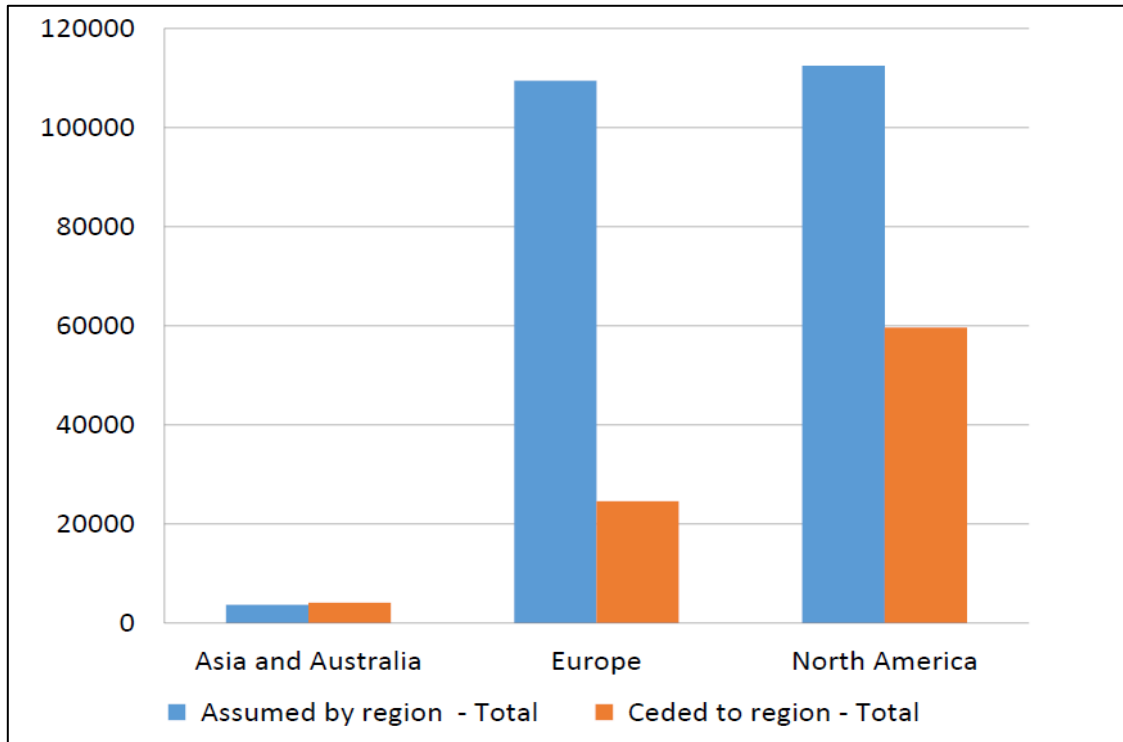


Figure TA.2: Gross reinsurance premiums assumed by regions

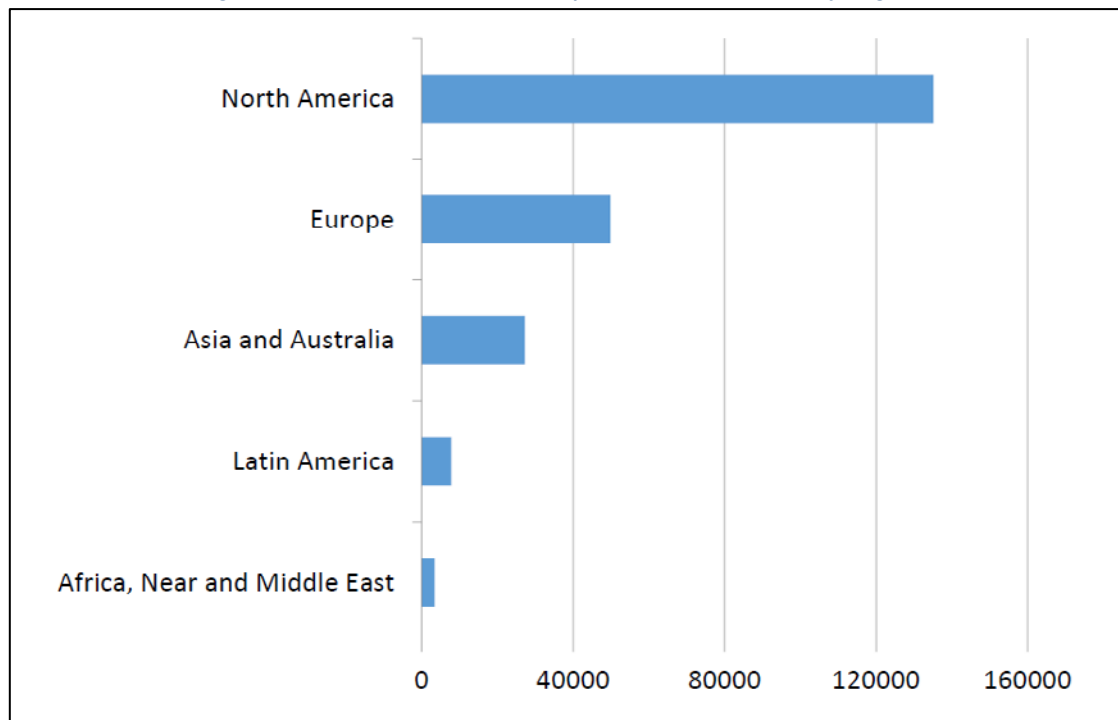


Figure TA.3: Technical performance 1

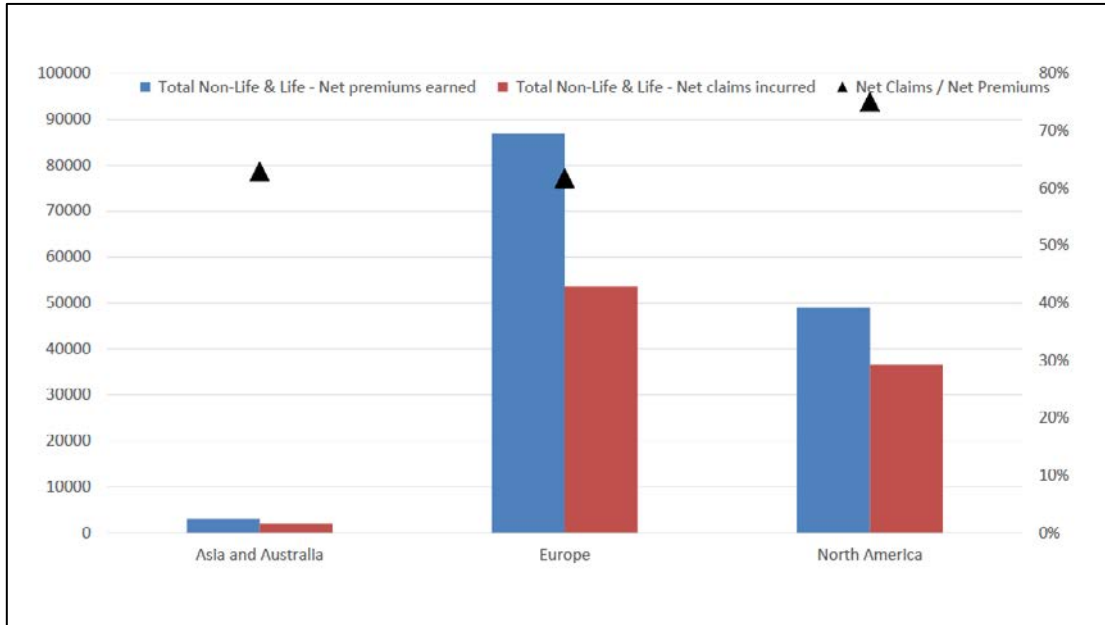


Figure TA.4: Technical performance 2

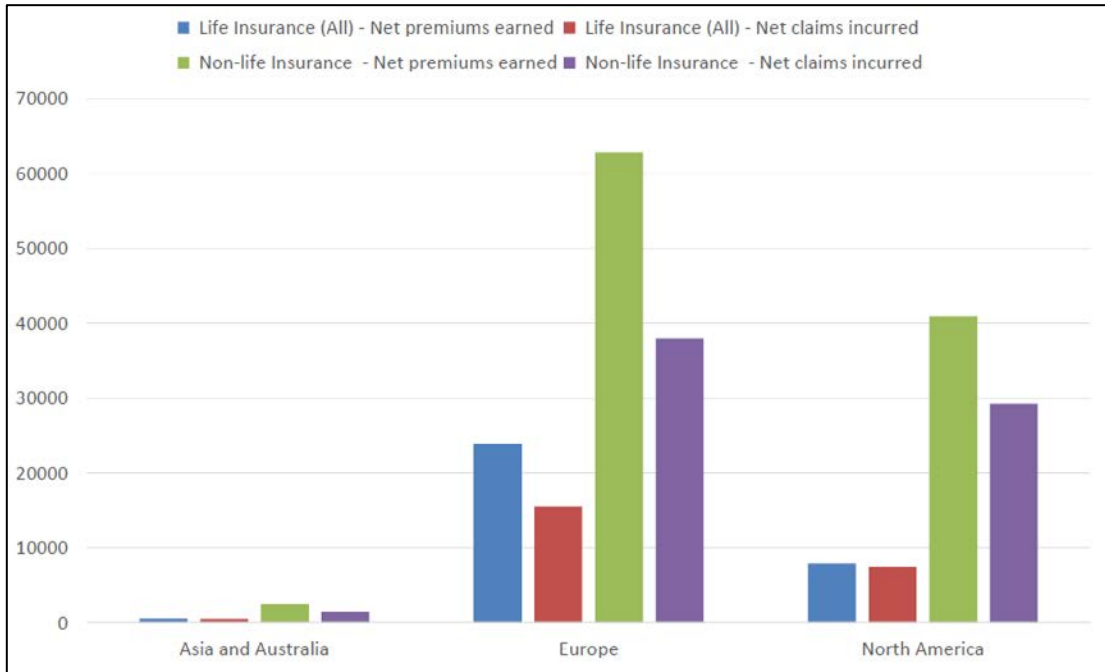


Figure TA.5: Claims provisions 1

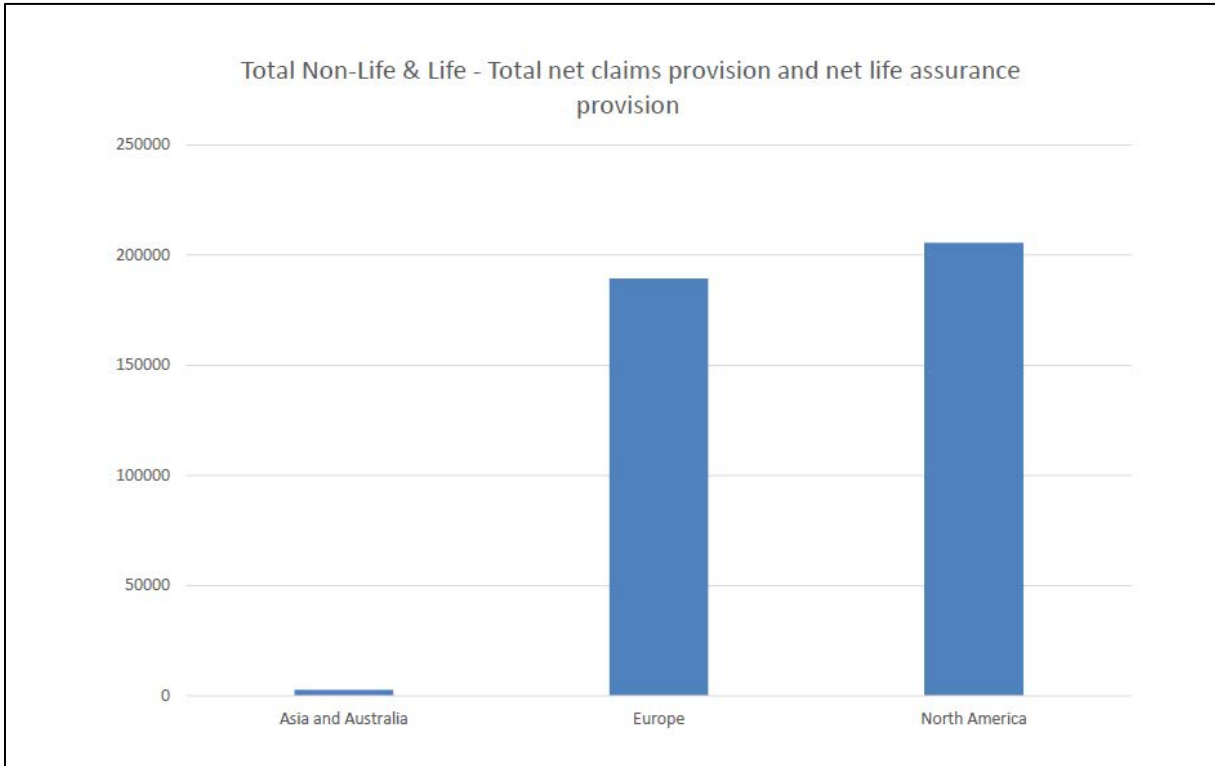


Figure TA.6: Claims provisions 2

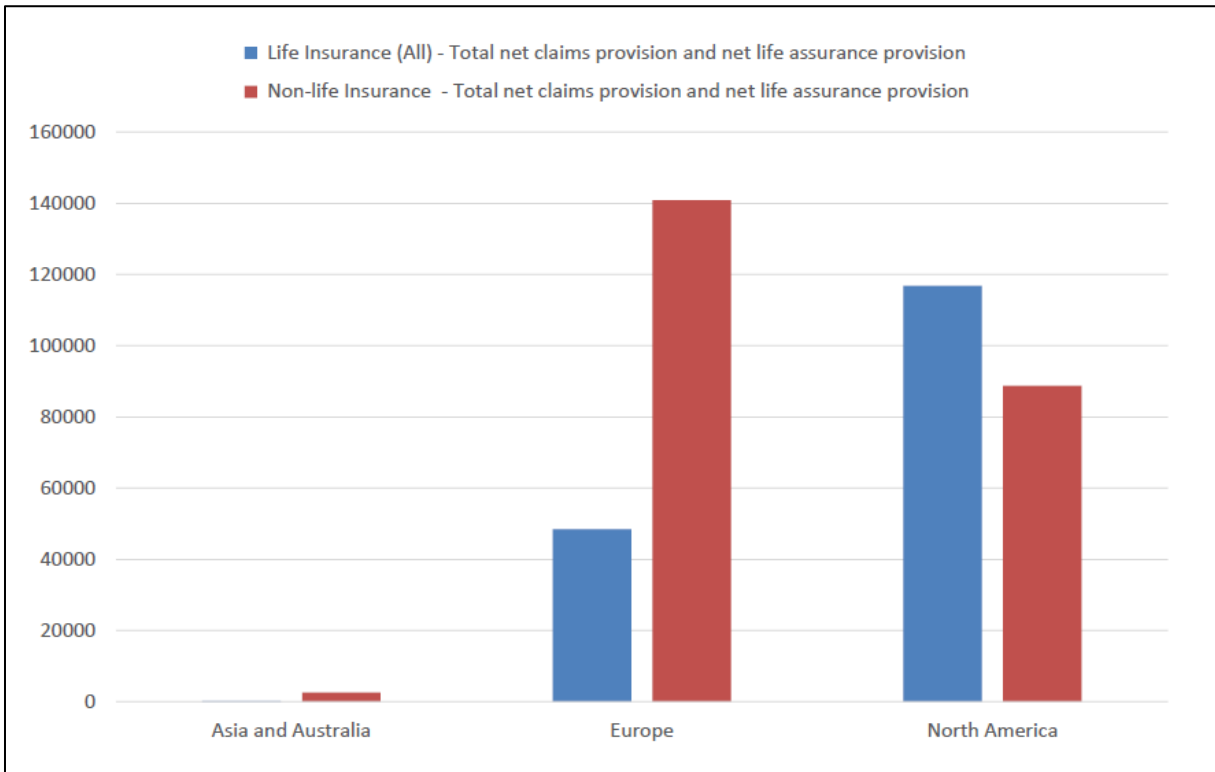


Figure TA.7: Claims provisions 3

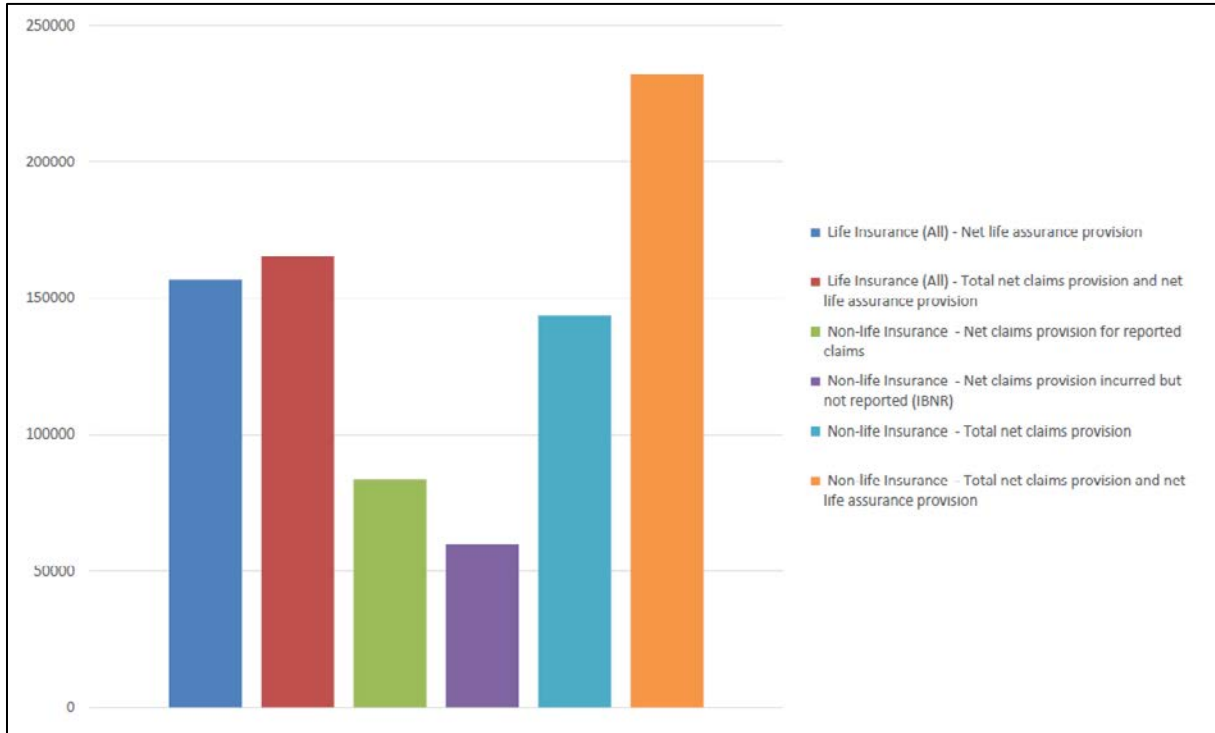


Figure TA.8: Derivatives

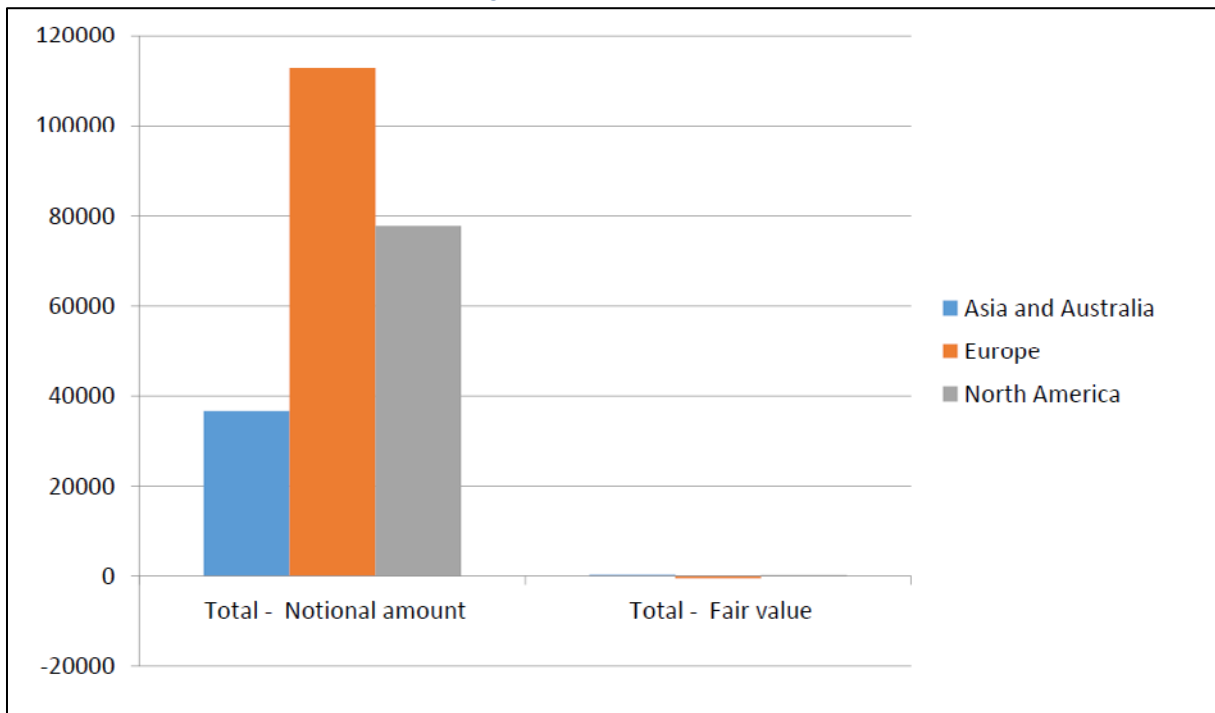


Figure TA.9: Derivatives – hedging

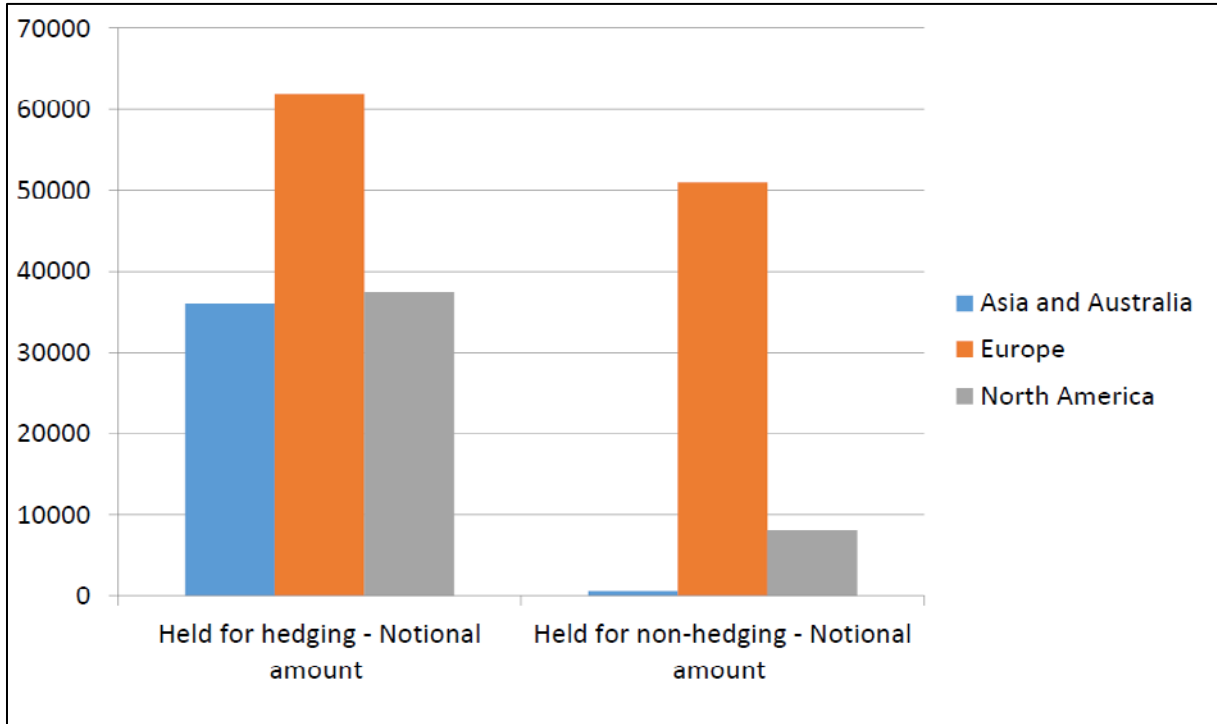


Figure TA.10: Derivatives – fair value

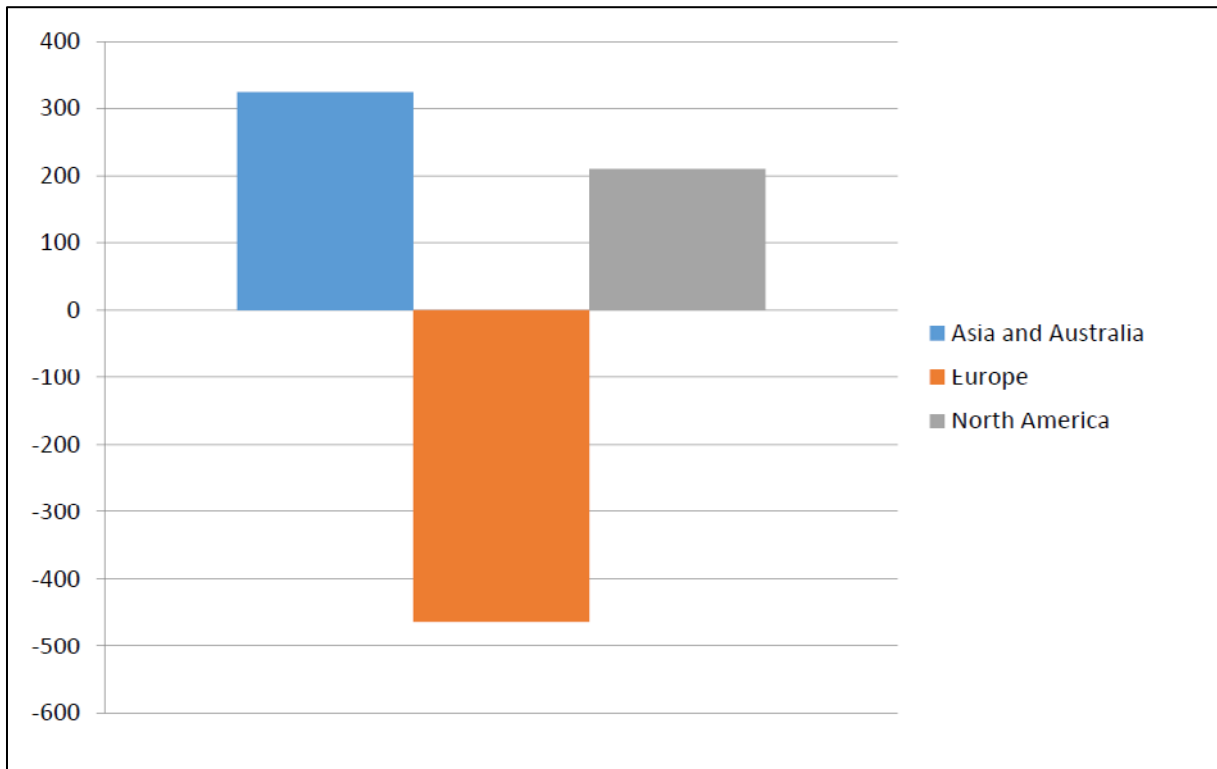


Figure TA.11: Investments

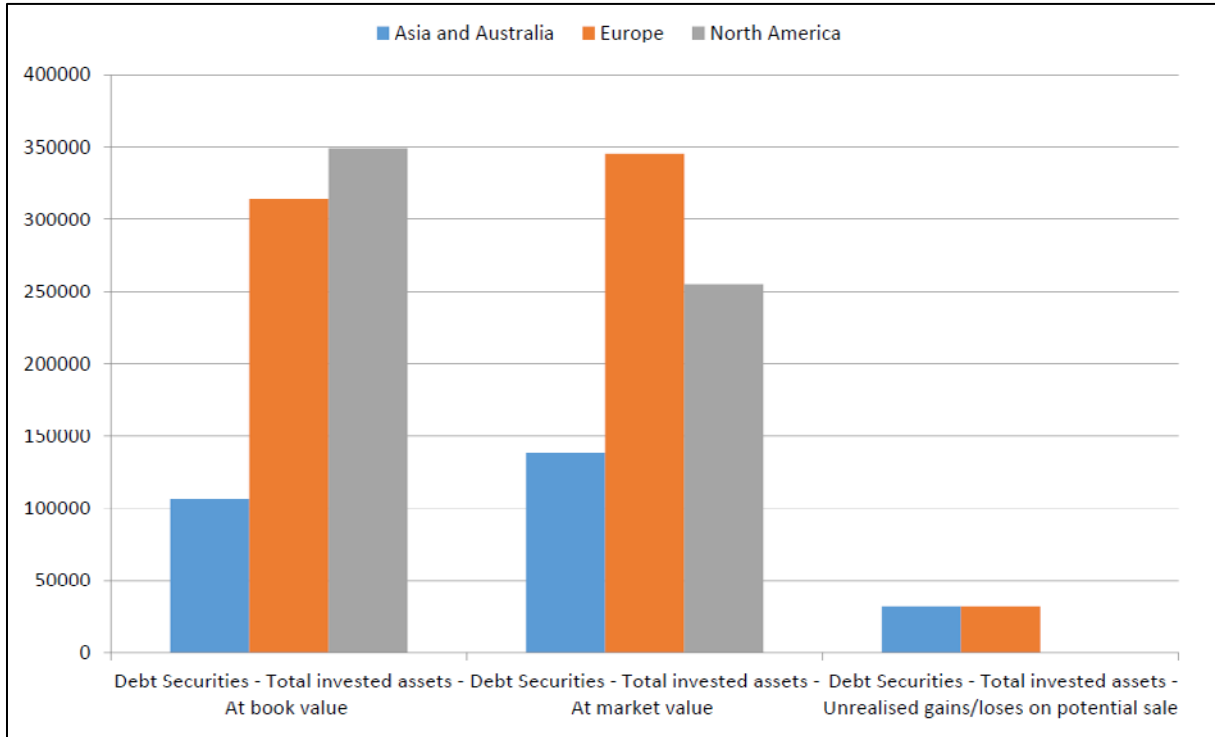


Figure TA.12: Investments – at book value



Figure TA.13: Investments – at market value

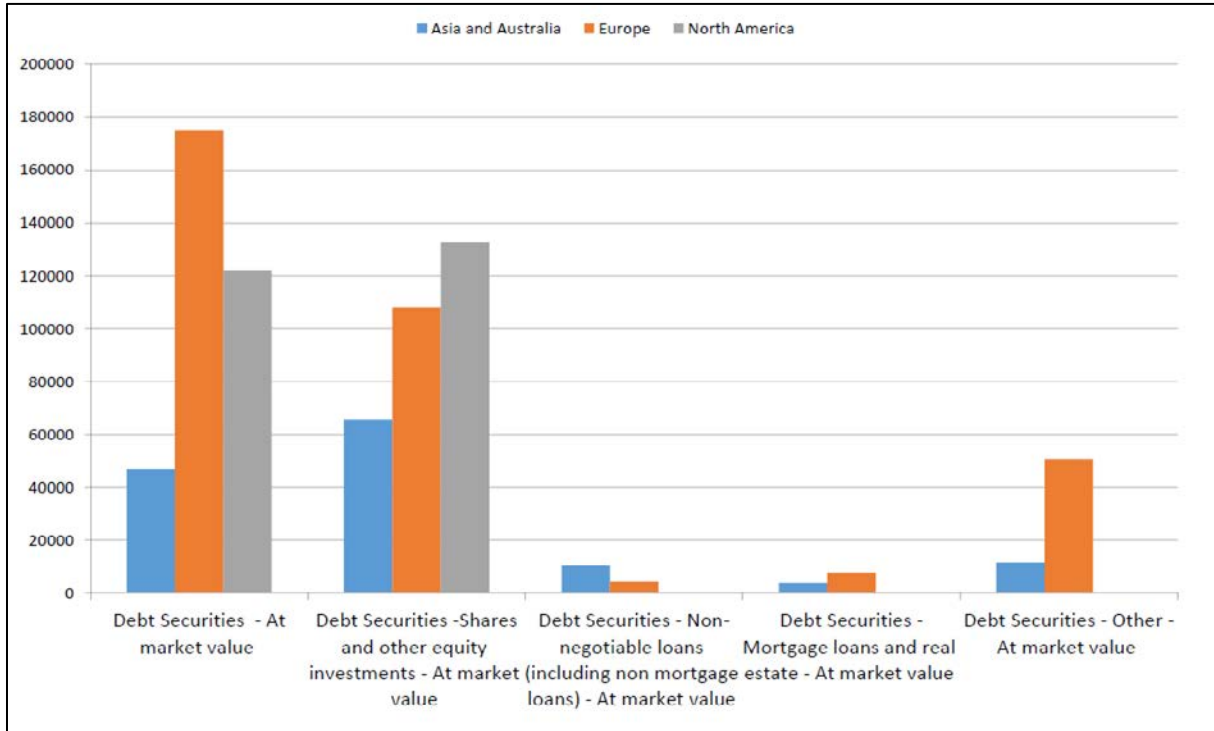


Figure TA.14: Profitability 1

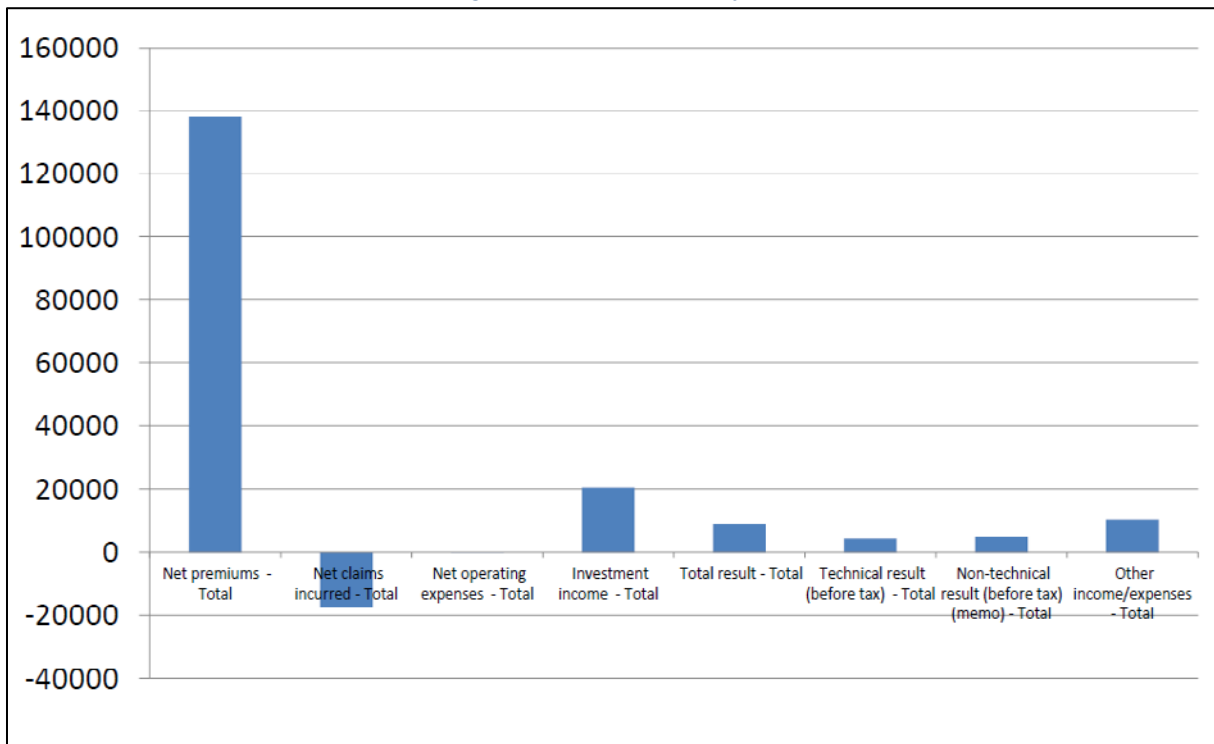


Figure TA.15: Profitability 2

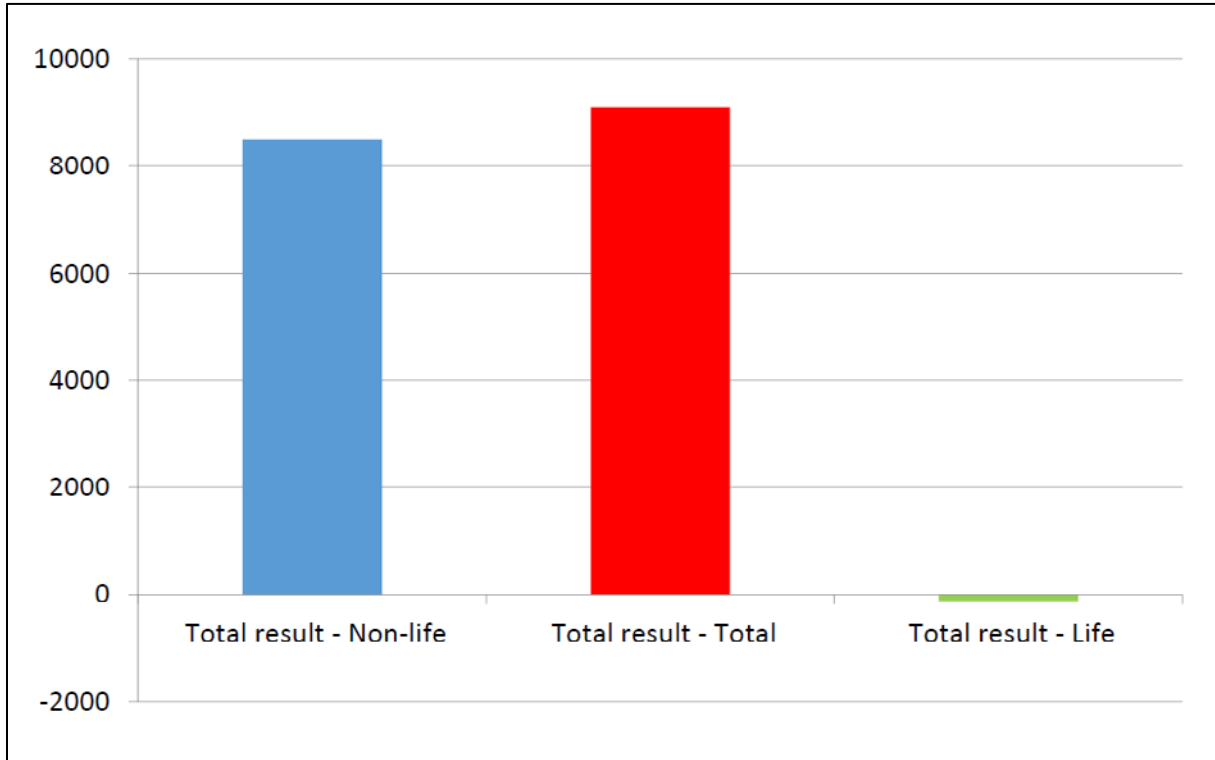


Figure TA.16: Profitability 3

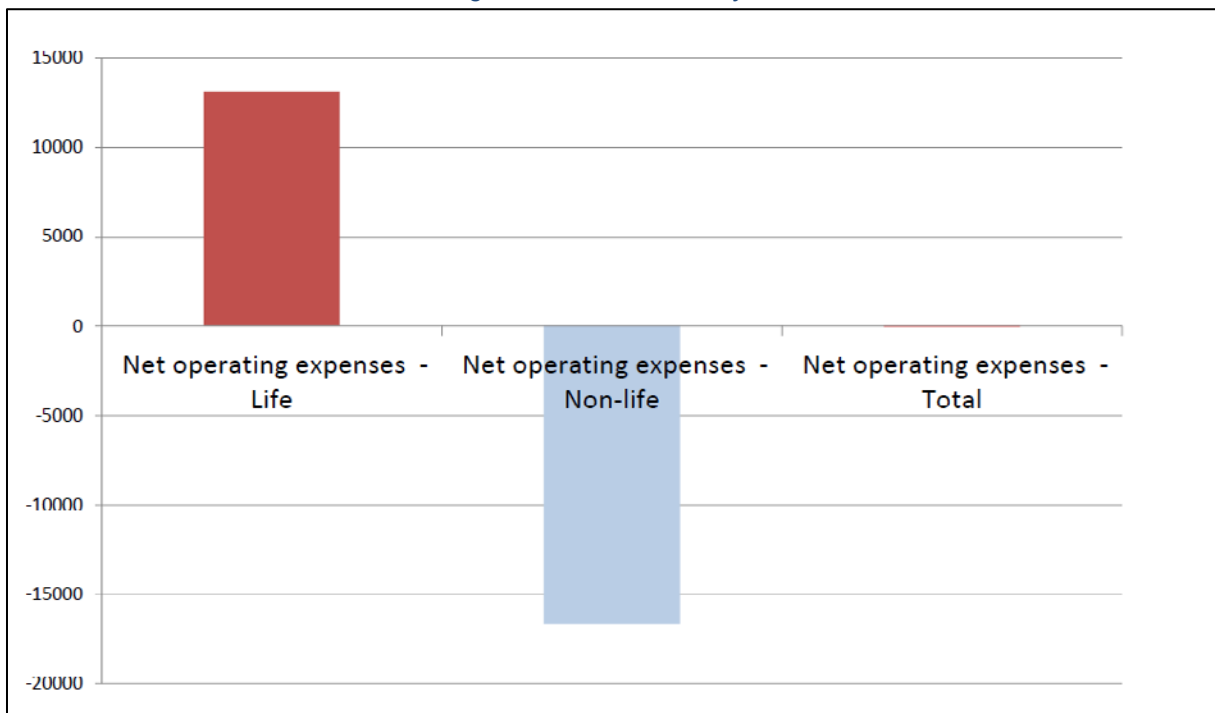


Figure TA.17: Profitability 4

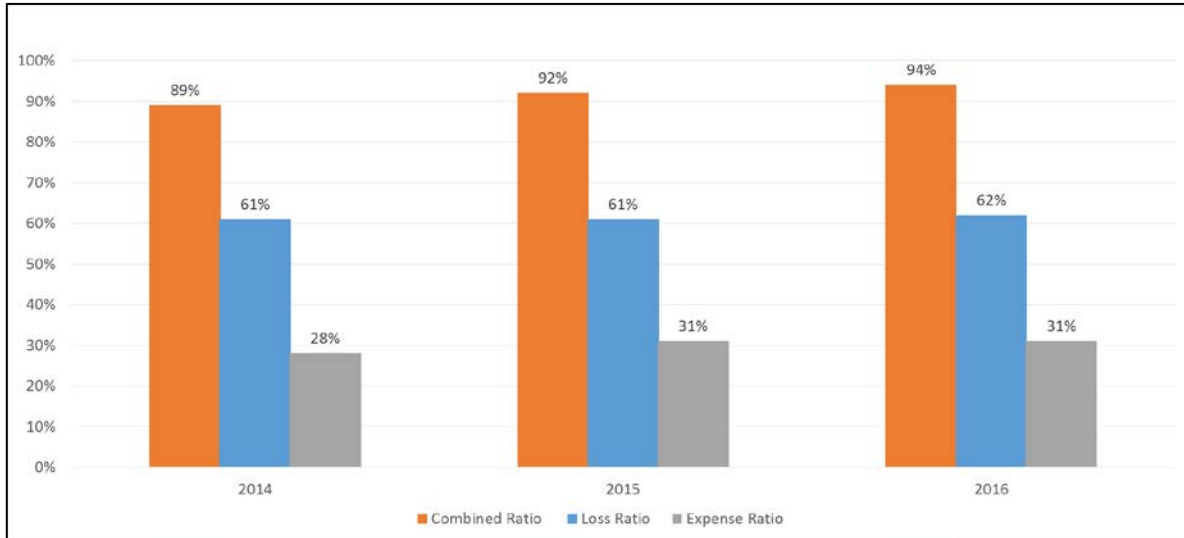


Figure TA.18: Reinsurance and retrocession dependency

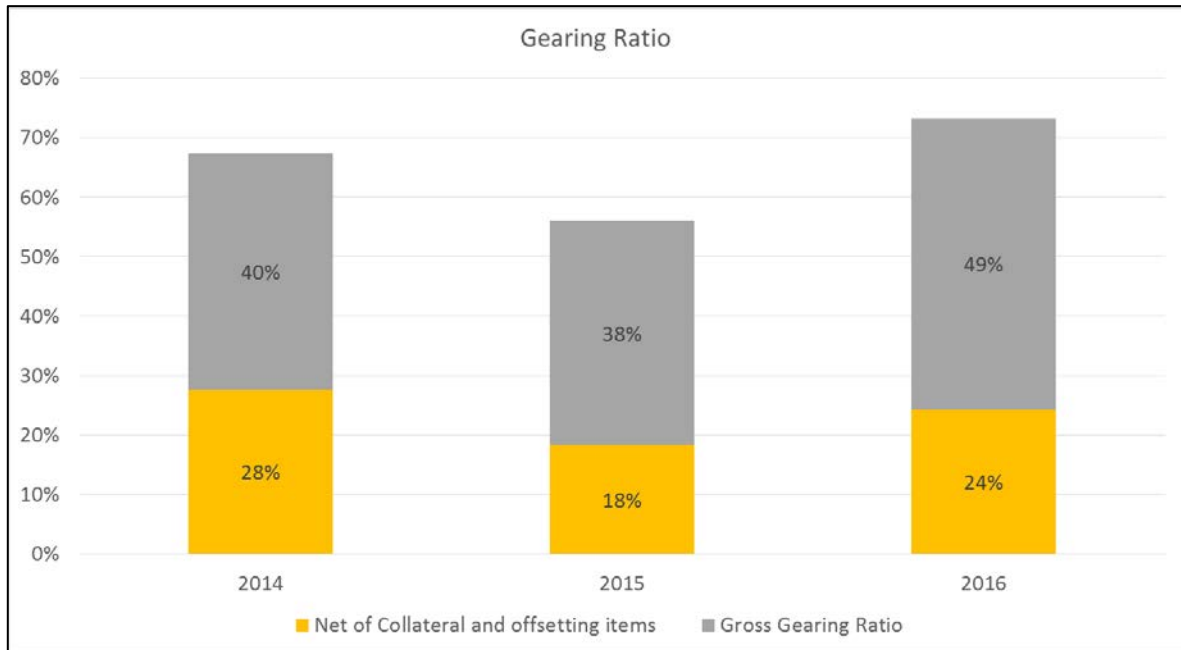


Figure TA.19: Capital adequacy 1

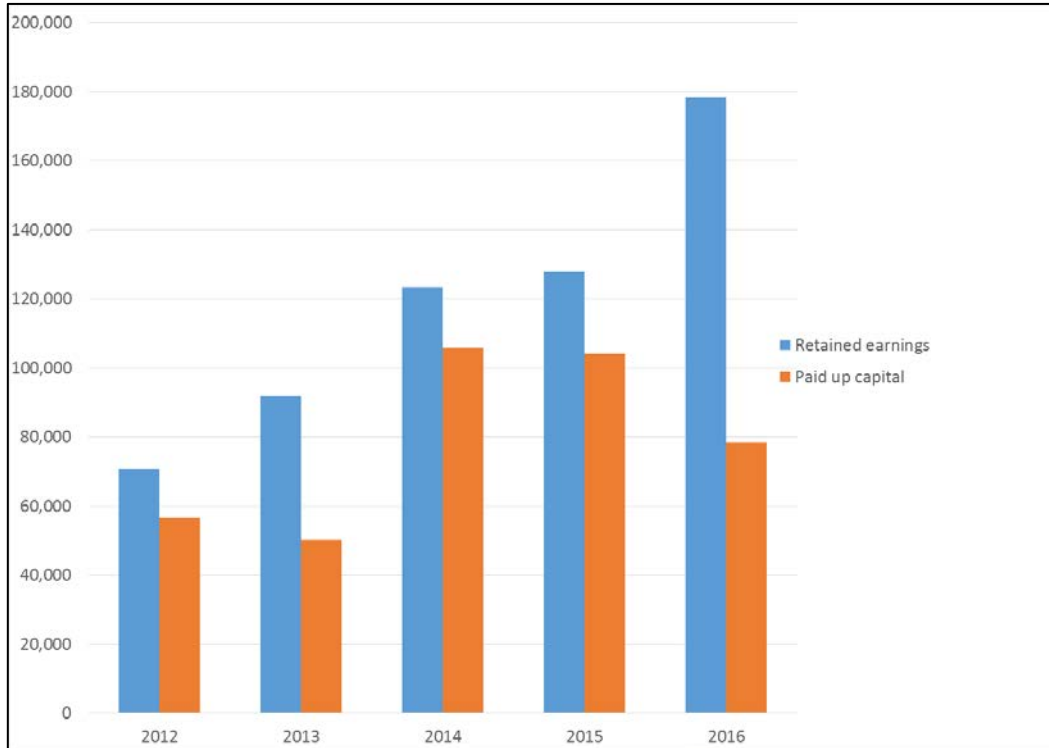


Figure TA.20: Capital adequacy 2

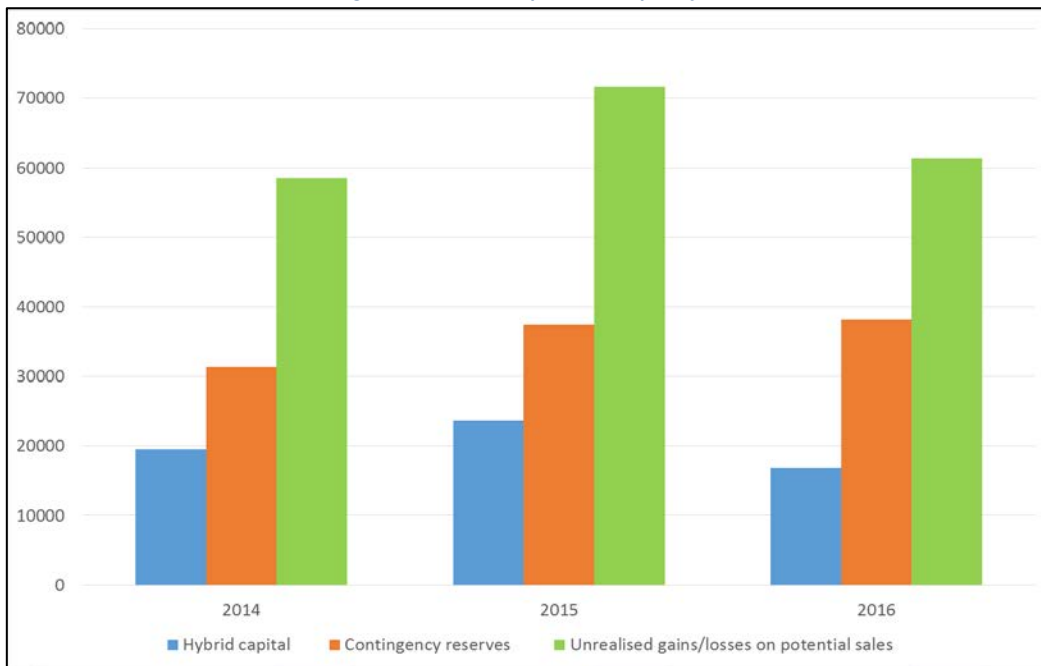


Figure TA.21: Capital adequacy 3

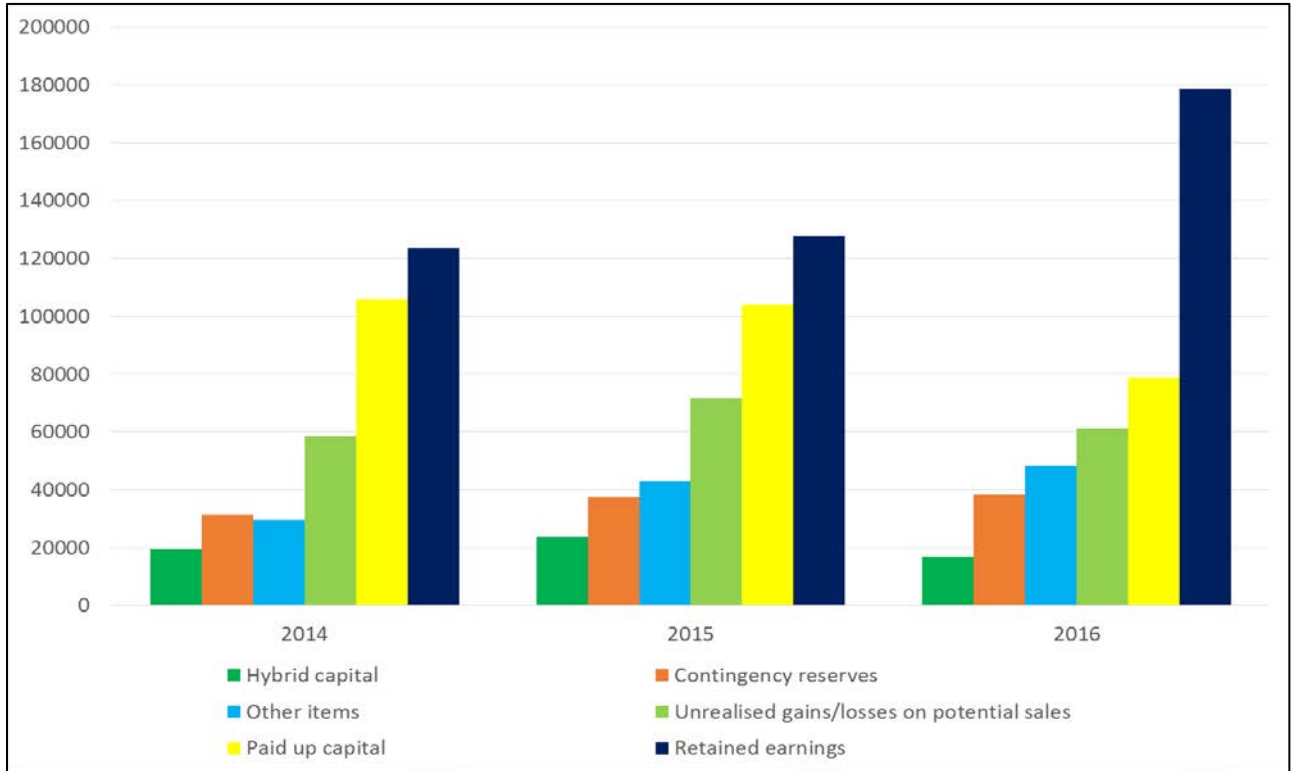
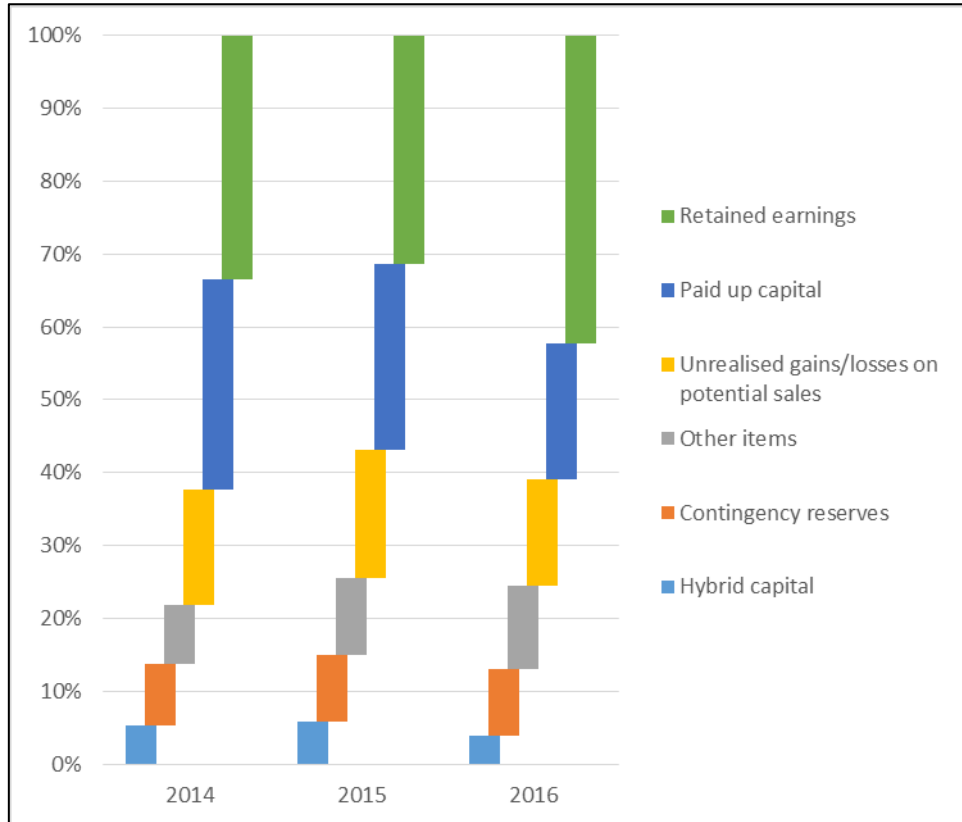


Figure TA.22: Capital adequacy 4

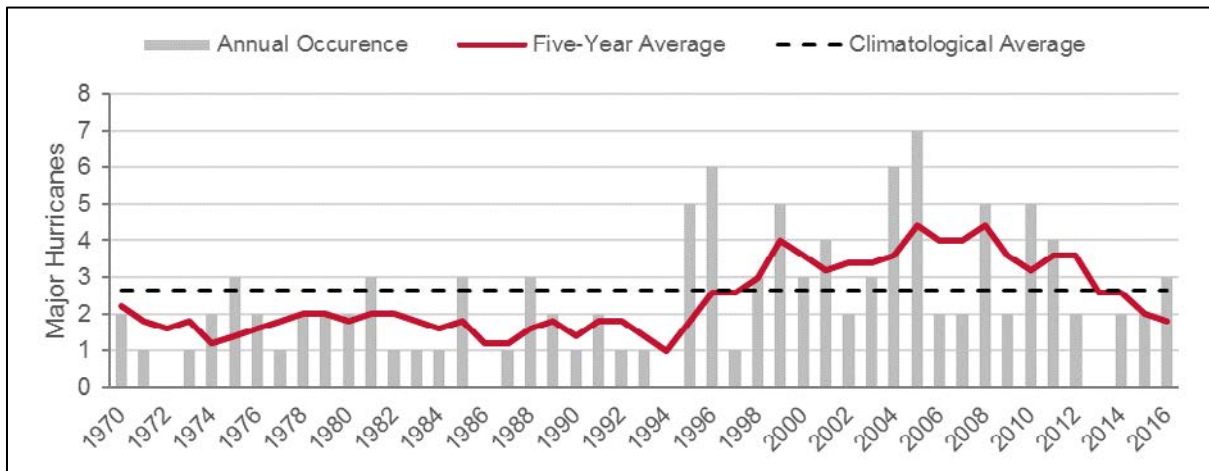


Appendix 1

Atlantic multi-decadal oscillation (AMO)

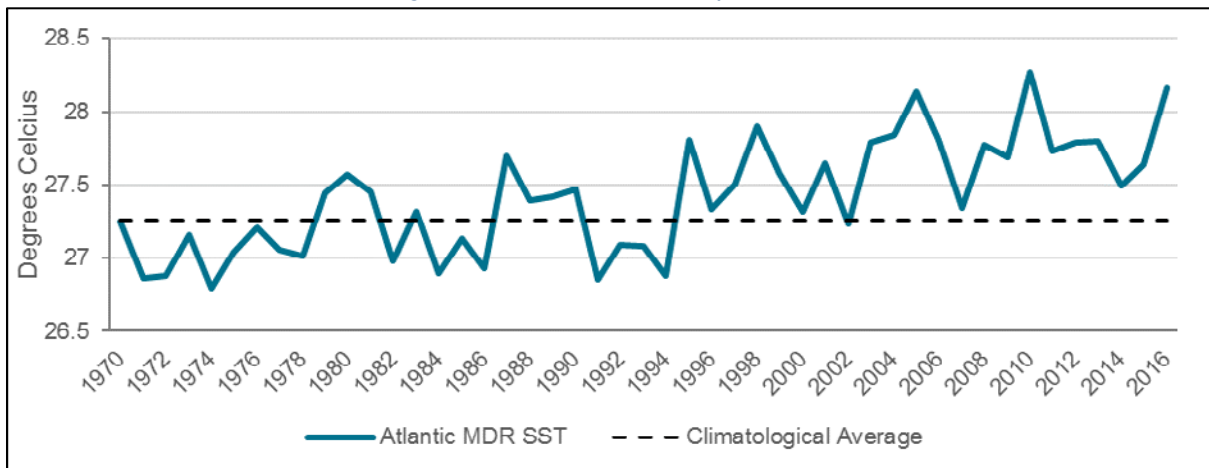
The AMO is a switch in many catastrophe risk models and is used as a predictor of future hurricane activity. As a predictor, it uses sea surface temperatures (SST) in order to estimate hurricane activities since warm water is one of the fuels of a hurricane. The SSTs have been rising; however, the last four year trend shows that hurricanes declining in number. This is shown in Figures A.1 and A.2.

Figure A.1: Number of hurricanes



Source: RMS

Figure A.2: Sea surface temperatures



Source: RMS

Assuming a four-to-five year near-term trend, catastrophe models would show that the number of hurricanes is expected to decline, while a longer term view over the past twenty years could indicate that this is a temporary phenomenon. According to RMS, for the first time since its introduction, the RMS medium-term rate forecast (MTRof) has dipped slightly below the long-term rate. For the US as a whole, the new 2017-2021 medium-term rate forecast MTRof hurricane landfall frequency is now one percent below the long-term rate for Category 1-5

storms, and six percent for major hurricanes (Category 3–5 storms). Therefore, to be conservative, more companies are switching to the long-term view.