

sigma

More risk: the changing nature of P&C insurance opportunities to 2040

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Executive summary

Amid strong growth, the mix of P&C business will fundamentally change.

Property & Casualty (P&C) insurance will become riskier and more complex over the next 20 years. Our modelling indicates that the share of motor, the low-risk and high-volume mainstay segment of P&C for many decades, will shrink to 32% of global sector premiums by 2040 from 42% currently. The share of property, meanwhile, will rise to an estimated 29% of premiums from 25%, and liability to 13% from 12%. On average, property and liability carry more risk than motor. For example in property, natural catastrophes are main loss driver. Disasters are hard to predict and with climate change, weather-related catastrophes will likely become both more intense and frequent. Liability risks, meanwhile, involve human behaviour that evolve as socio-economic circumstances change: predicting associated long-term trends is at best an imprecise art. In the digital age, events such an outage of a major cloud service provider can quickly turn into a catastrophic event for liability insurers, and also present potential for huge loss accumulation.

We forecast global P&C premiums will more than double by 2040.

Yet, where there is risk is also opportunity. On this side of the risk-reward equation, we forecast that P&C market premiums will more than double to USD 4.3 trillion by 2040. Our forecasts are to be taken as best estimates, given the high uncertainties around predicting trends in climate, technology, and social and legal changes. Emerging markets will lead the growth, with their share of global P&C premiums rising to 33% from 20% in 2020. Economic development will remain the most important factor underpinning premium growth across all lines of business.

Motor will remain the largest line of business, but with a much smaller share of total P&C business than has hitherto been the case.

The biggest transformation will be in motor. With increasing wealth, car ownership continues to rise, particularly in emerging markets. In our scenario analysis, we model that global motor premiums will double to USD 1.3–1.4 trillion by 2040, and that the share of emerging markets will rise to 46% from 26% in 2020. However, as safety technology further permeates car fleets, accident frequency and claims cost per vehicle will decline, and premium growth will slow. In addition, with sustainability on the global agenda, shared economy models of mobility will gain traction. This will have a dampening effect on premium growth and within insurers' motor portfolios, likely leading to a shift from personal to commercial business.

Climate change effects will increase the property risk pool by around 33–41%, generating up to USD 183 billion in new premiums by 2040.

For property insurance, our model indicates that global premiums will grow by 5.3% annually from 2021 to USD 1.3 trillion by 2040. We estimate that climate risks will increase the property risk pool by 33–41%, generating USD 149–183 billion of new premiums. The share of catastrophe in all property premiums will rise from 20% in 2020 to 28–31% in 2040. We further forecast that in advanced markets, a rise in the frequency and severity of events on account of climate change will add 30%–63% to insured catastrophe losses. In some key markets like China, the UK, France and Germany, the increase could be as much as 90–120%. In emerging markets, urbanisation will be a main driver of exposure growth, yielding USD 24 billion, or around 10% of the additional global property premiums by 2040.

There will also be strong growth in liability lines due to technological, social and legal-system changes.

Liability premiums will rise by an estimated 4.7% annually, with technological, social and legal changes expanding the scope of tort liability. By 2040, global premiums will reach a forecast USD 583 billion, about 13% of total P&C. We see long-term growth potential in liability insurance from climate change effects, artificial intelligence, and social/legal changes. In the short- and mid-term, social inflation will drive up the frequency of large verdicts/settlements, especially in the US.

A more risky business means capital requirements and demand for reinsurance will rise.

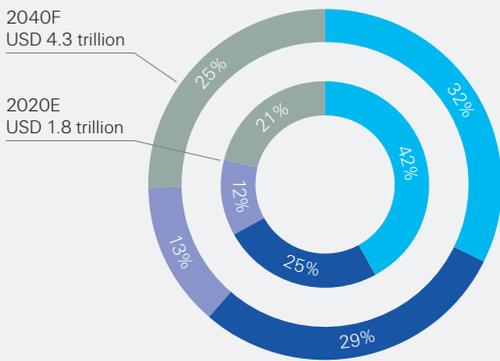
With P&C business becoming more risky and more complex, capital requirements and need for reinsurance will rise. Together, the industry and governments need to promote conditions for long-term sustainable growth, and collective action to mitigate and adapt to climate change is needed. Investment in green infrastructure, and upgrading zoning and building standards are important to ensure the insurability of property risks. And with fewer restrictions on allocating capital across jurisdictions, re/insurers can offer more risk transfer capacity globally. Evolving exposures call for innovation in data and related analytics tools to make risks more insurable and risk pricing more accurate. It is also important that regulation is flexible and accommodates the use of new data sources and modelling techniques.

Key takeaways

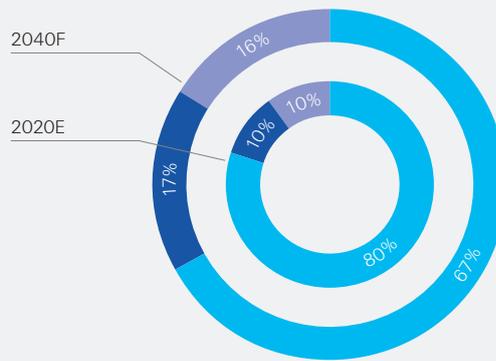
In premium terms, the global P&C risk pool will more than double by 2040

We forecast that global premiums will rise by USD 2.5 trillion over the next 20 years to USD 4.3 trillion by 2040. The share of property and liability in the global total will rise; motor will fall. The share of emerging economies of global premiums will rise.

P&C risk pool



P&C premiums by region, % of total



■ Motor ■ Property ■ Liability ■ Others

■ Advanced markets ■ Emerging markets, excluding China ■ China

E = estimate, F = forecast. Note: Motor and property risk pool 2040 projections shown are upper bound of forecast range (see motor and property chapters). Due to rounding, some percent totals do not add up to 100%.

Source: Swiss Re Institute

Growth rates

Property will be the fastest growing line of P&C business, followed by liability. Technological developments will cap growth in motor, partially offsetting the positive impact of other socio-economic forces.

	Motor	Property	Liability	Other	Total
Risk pool 2020E (USD billion)	766	450	214	378	1 808
% of total	42%	25%	12%	21%	100%
Risk pool 2040F (USD billion)	1 402*	1 273*	583	1 059	4 316
% of total	32%	29%	13%	25%	100%
Risk pool CAGR (2021–2040)	3.0%	5.3%	4.7%	5.0%	4.3%
Elasticities (average 2021–2040)**	0.58	1.24	1.12	1.05	0.94

Note: *Motor and property risk pool 2040 projections shown are the upper bound of forecast ranges (see motor and property chapters, respectively).

**Elasticities are calculated from regional elasticities weighted by average regional insurance premium volumes. CAGR = compound annual growth rate.

Due to rounding, some values do not add up to stated total.

Source: Swiss Re Institute

Main drivers

Economic development will remain the key driver of premium growth across all lines of business over the next 20 years. In property, climate risks will raise property claims and premiums.

	Motor	Property	Liability
Economic development	↑	↑	↑
Climate risk and associated policies	↓	↑	↑
Technology/digitalisation	↓	=	↑
Urbanisation	↓	↑	↑
Liability regimes, social inflation	↑	↑	↑

● Explicit quantitative analysis of impact

● Implicit quantitative analysis of impact

Source: Swiss Re Institute

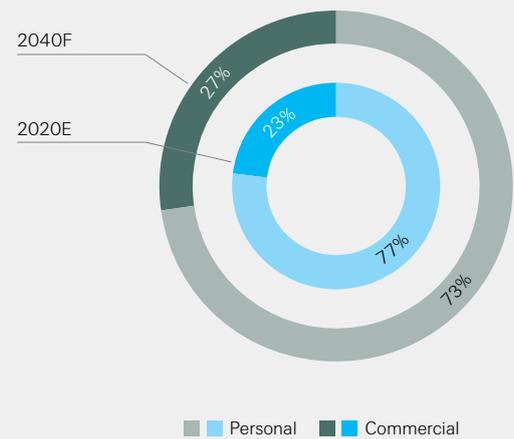
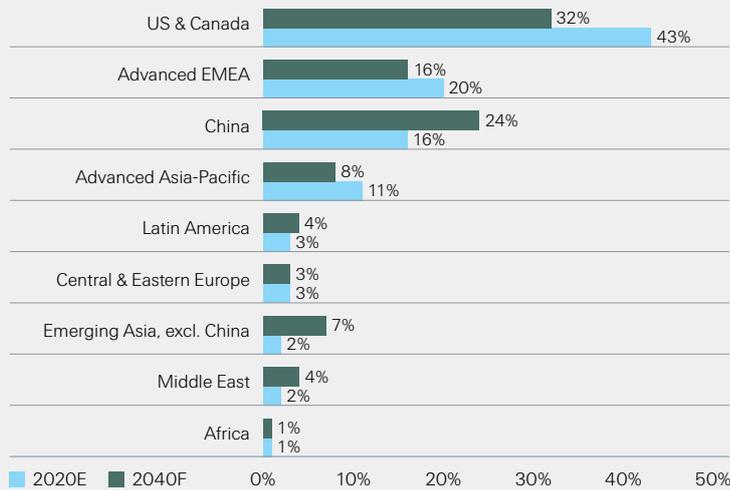
	Motor	Property	Liability	Other	Total
Additional premiums by 2040F (USD million)	635	823	369	681	2 508
Contribution by driver					
Economic development	194%	75%	100%	100%	116%
Urbanisation	na	3%	na	na	1%
Climate change	na	22%	na	na	7%
Technology & sustainability	-94%	na	na	na	-24%

na = implicit quantification only

Source: Swiss Re Institute

Rising importance of commercial motor

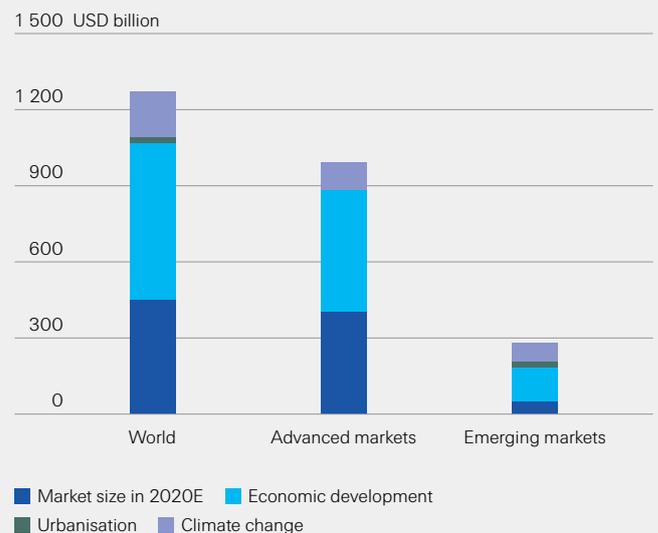
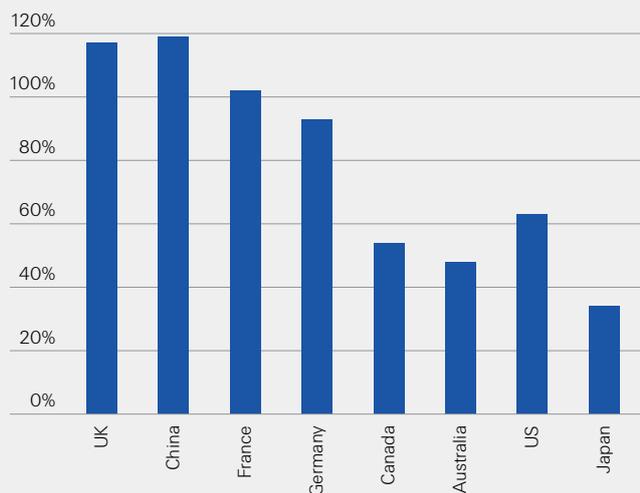
Slow adoption of claims-reducing safety features in emerging markets will accentuate the premium shift to these economies. Growth of shared economy models of transport and increasing use of mobility services will have a slowing effect on motor premium growth. Within insurers' motor portfolios, this will likely reflect in a shift from personal to commercial business.



Source: Swiss Re Institute

Climate risks could increase average weather-related property catastrophe losses in advanced markets by 30–63%

In China, the UK, France and Germany, the increase could be as much as 90–120%. The rising catastrophe losses translate into an estimated USD 149–183 billion of new global property premiums by 2040, increasing the property risk pool by 33–41%.



Note for left-hand side (LHS) chart: The values showing are the upper range of estimates for each country as yielded by our model. The perils considered in our model include tropical cyclones, winter storms, floods and wildfires. These are the biggest risks facing insurers and are most likely to be impacted by climate change effects. Natural catastrophe risks are calculated under the assumption that the global mean surface temperature will increase by 1.5°C by 2040 from pre-industrial times. With the high degree of uncertainty in climate change trends, our forecasts are by design intended as best estimates.

Source: Swiss Re Institute

P&C insurance: an evolving risk landscape

We forecast that global Property and Casualty (P&C) insurance premiums will grow by an annual average of 4.3% between 2021 and 2040 to USD 4.3 trillion. Economic development will remain the primary driver of premium growth across all lines of business. Technological advances and policy action to promote sustainability will slow growth in motor. The effects of climate change will boost property premiums in the advanced markets, while still-rapid urbanisation will drive increased demand for property covers in emerging economies. Motor will remain the largest line of business, but will be much smaller than today. The shift towards property and liability within the overall sector risk pool will make P&C business portfolios inherently more risky.

Long-term trends

Prevailing global trends will reshape the risk landscape.

Anticipating and understanding risks is at the core of any insurer's value proposition. Table 1 details the many prevailing long-term global trends that will change the risk landscape for P&C insurers over the next 20 years. This study seeks to quantify how economic growth, climate change effects, advances in technology, ongoing urbanisation and developments in liability regimes will re-shape P&C risk pools. Many of the trends are implicit in our long-term forecasts for economic development. This includes slowing economic growth due to climate change with a bias towards downside risks, especially for emerging economies. There is significant uncertainty around the magnitude of global warming and the associated implications for economic growth.¹ We model the latest trends in the largest lines of business and forecast premium outcomes by 2040. The quantitative analysis is complemented with qualitative discussion of emerging risks.

Table 1
Global trends set to re-shape future P&C risk pools

Socio-economic	The great pivot East ²	Asia to account for about 39% of global GDP in 2040 (2018: 26%)
	Trend towards urbanisation ³	Mega cities, additional property exposure growth, higher vulnerabilities
	Peak of globalisation ⁴	Supply-chain risks, protectionism, re-shoring, parallel supply chains
	Inequality	Political instability, income inequality and social activism, reduced macroeconomic resilience
Climate change	Climate change risks ⁵	Slower economic growth, accelerated cat loss trends, more volatility
	Resilient infrastructure investment ⁶	Need for insurance protection and need for sustainable infrastructure, investment opportunities
	ESG policies	Transition risks, changes to urban mobility, new liability exposures
Technology	Future of mobility	Safety technology, autonomous driving, shared mobility, micro-mobility
	Smart homes/cities	Potential to reduce property loss frequency and severity, new cyber exposures
	Network economy	Intangible assets, sharing economy, exponential growth of connectivity and digital data, state sponsored cyber-attacks, ransomware industry
Liability	Climate change liability ⁷	More commitment to ESG criteria, disclosure requirements, attribution science
	Expanding collective redress	EU directive expanding and standardising mass tort, growth of multi-district litigation in the US
	Social Inflation ⁸	Applied psychology-based strategies, litigation funding, data analytics, digital media advertising, jurors' attitudes towards large corporations

Source: Swiss Re Institute

¹ See *The economics of climate change: no action not an option*, Swiss Re Institute, April 2021, and *Global Warming of 1.5°C*, IPCC Special Report, 9 August 2021.

² *sigma 3/2019 – World insurance: the great pivot east continues*, Swiss Re Institute.

³ *sigma 5/2013 – Urbanisation in emerging markets: boon and bane for insurers*, Swiss Re, and *Mind the risk: A global ranking of cities under threat from natural disasters*, Swiss Re, 2014.

⁴ *sigma 6/2020 – De-risking global supply chains*, Swiss Re Institute.

⁵ *sigma 1/2021 – Natural catastrophes in 2020: secondary perils in the spotlight but don't forget primary peril risk*, Swiss Re Institute.

⁶ *Closing the Infrastructure Gap*, Swiss Re Institute and Global Infrastructure Facility, January 2021.

⁷ *Climate Change Litigation – Insights into the evolving global landscape*, Geneva Association, 2021.

⁸ *Social Inflation: Navigating the evolving claims environment*, Geneva Association, December 2020.

Our modelling of changing risk scenarios seeks to neither overestimate short-term trends nor underestimate longer-term impacts.

An issue in long-term forecasting is stated in Amara's Law: "We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run."⁹ Accurately forecasting long-term changes over two decades is nigh impossible and acknowledging the high uncertainty around predicting trends in climate change and technological advances, our forecasts are intended as best estimates. Nevertheless, we design our quantitative analysis to be wary of short-termism while not under-estimating the compounding impacts of long-term changes. We have narrowed our focus to the motor, property and liability lines of business, and model the impact of the factors showing in Figure 1 and a range of quantifiable trend variables on premium growth in each line. For example in motor, advances in safety technology and changes in mobility trends carry most influence. Climate change and urbanisation effects are main considerations for property risks.

Figure 1
Impact of key long-term factors on motor, property and liability insurance premium growth trends

	Motor	Property	Liability
Economic development	↑	↑	↑
Climate risk and associated policies	↓	↑	↑
Technology/digitalisation	↓	=	↑
Urbanisation	↓	↑	↑
Liability regimes, social inflation	↑	↑	↑

● Explicit quantitative analysis of impact
● Implicit quantitative analysis of impact
Source: Swiss Re Institute

The P&C risk pool will more than double in size by 2040.

Global P&C market growth by 2040

For the P&C sector, we model for the effects of economic development, climate risk, technology and urbanisation. On this basis, we forecast that global P&C premiums will grow by a compound annual growth rate (CAGR) of 4.3% between 2021 to 2040 to USD 4.3 trillion. Property premiums will grow fastest, by an estimated CAGR of 5.3%, followed by liability (4.7%). Growth in motor premiums will lag (3.0%, see Table 2). The share of motor in total P&C premiums will decline to 32% in 2040 from 42% in 2020, but it will remain the largest line of business.

Table 2
Global P&C risk pool size in 2020E and 2040F, by line of business

	Motor	Property	Liability	Other	Total
Risk pool 2020 (USD billion)	766	450	214	378	1 808
% of total	42%	25%	12%	21%	100%
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**Elasticities are calculated from regional elasticities weighted by average regional insurance premium volumes. Due to rounding, some values do not add up to stated total.

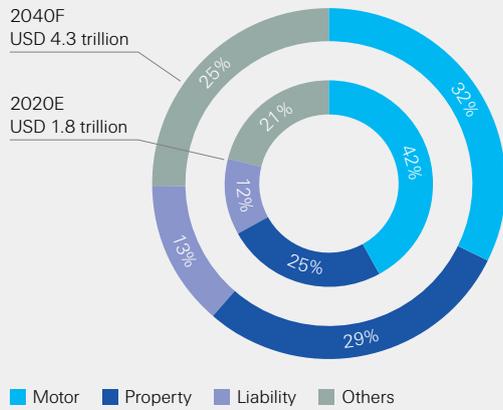
Source: Swiss Re Institute

⁹ S. Ratcliffe, ed. "Roy Amara 1925–2007, American futurologist", *Oxford Essential Quotations*, 2016.

¹⁰ For rationale on exclusions, see *sigma* 3/2021 – World insurance: the recovery gains pace, 14 July 2021, Swiss Re Institute.

P&C insurance: an evolving risk landscape

Figure 2
Global P&C risk pool size and composition

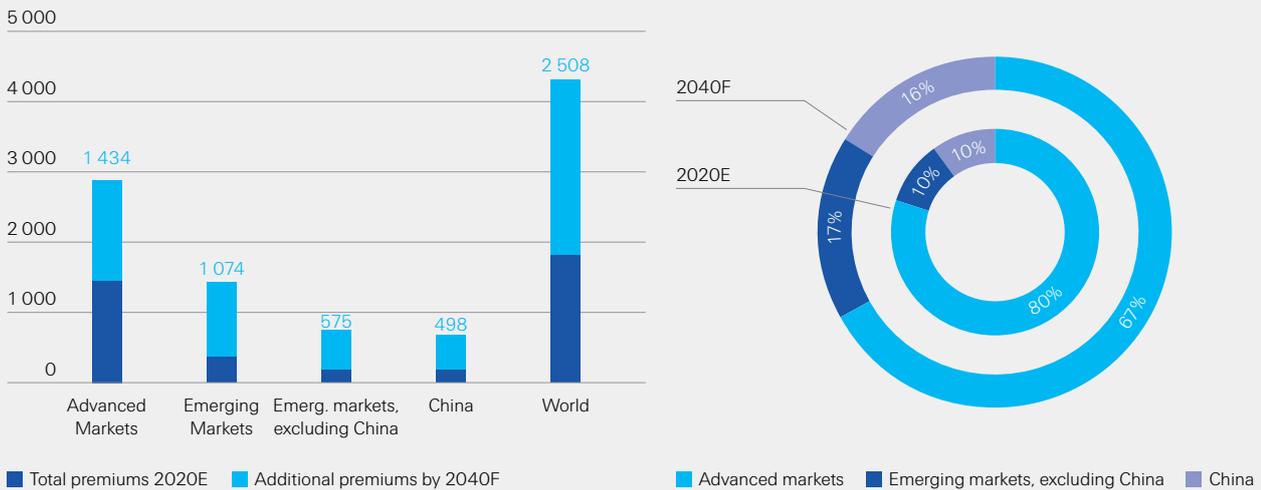


Note: Due to rounding, some percent totals do not add up to 100%.
Source: Swiss Re Institute

Emerging markets will grow fastest, but most new P&C premiums will come from advanced economies.

We expect that premium growth will be much stronger in the emerging (+7.1%) than in the advanced (+3.5%) markets, largely due to the strength of China (+6.8%). Nevertheless, most new global P&C premiums (USD 1.4 trillion, 57%) by 2040 will originate from the advanced markets (see Figure 3, left hand side (LHS)). China will be the source of 20% (USD 0.5 trillion) of the new additional premiums, with the remaining 23% (USD 0.6 trillion) coming from other emerging economies. We forecast that the emerging markets (including China) share of global P&C premiums will rise to 33% from 20% in 2020.

Figure 3
Regional split of additional P&C premiums, USD billions (LHS); Regional split of global P&C premiums, in % (RHS)

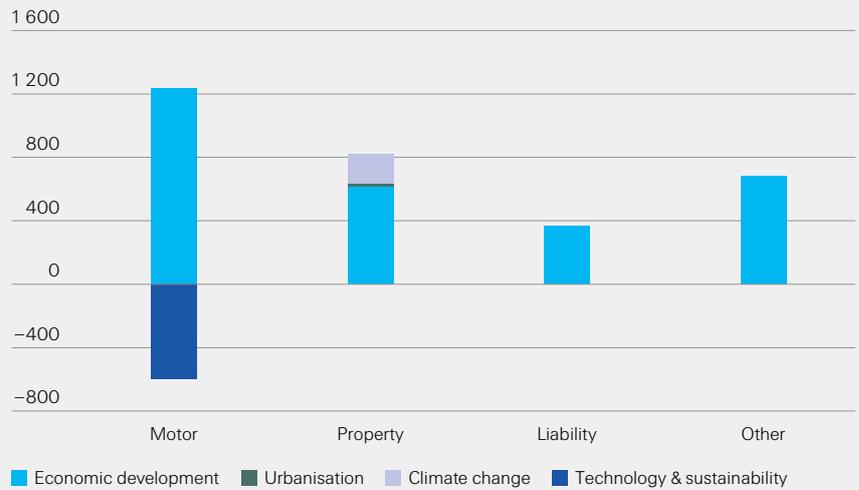


Source: Swiss Re Institute

Economic development will be the main growth driver of P&C premiums.

Economic development will remain the main driver of premium growth across all lines of business (see Figure 4). For motor, we expect that technological advances and policy action to promote sustainability will curb premium growth. Property premiums will grow the fastest. In addition to economic development, climate change risks will boost premiums, mostly in the advanced markets. In the emerging markets, urbanisation impacts will be more prominent in driving property premiums. For liability, the relative strong growth from a smaller base will be driven by an expanding scope of liability systems. The findings are further explained in the dedicated chapters on motor, property and liability insurance.

Figure 4
Contribution to additional premiums in 2040F by drivers, USD billion



Source: Swiss Re Institute

Future motor risk pools

Motor will likely see the biggest transformation of all lines of P&C business. We forecast that global motor premiums will double to around USD 1.3–1.4 trillion by 2040. Economic development will increase car ownership, especially in emerging economies, driving premiums higher. However, increasing automation and connectivity of vehicles should improve safety, reducing accident frequency and claims cost per insured vehicle. At the same time, promotion of the sustainability agenda will see greater use of shared mobility and public transport. These factors will dampen premium growth, particularly in advanced markets. With transport-sharing models of mobility gaining traction, we estimate that the share of commercial motor in the portfolio will rise to 27% from 23% over the next 20 years.

Key drivers re-shaping the mobility market

Even with still rising car ownership, longer term trends will likely slow motor premium growth.

Motor is the largest line of business in P&C insurance. In 2020, *sigma* data show that global motor premiums were USD 766 billion, accounting for 42% of the P&C total. We forecast that the share will fall to 32% by 2040. While we expect increasing levels of car ownership alongside strong economic growth in the emerging markets to continue to drive premium growth, a number of technological and societal factors are changing the fundamental nature of the motor industry. Advanced safety technologies, shared mobility models and sustainability policies are set to change driving patterns, reduce accident frequency, encourage use of more environmentally friendly forms of mobility, and increase demand for commercial motor coverage.

Table 3
Key factors affecting motor risk pools in the longer term

Factors	Implications for risk pools	Impact on premium trends
Economic development	Income elasticities, higher car ownership and demand for insurance cover, mostly in emerging economies	↑
Safety technology	Reduced accident frequency and falling repair costs	↓
Shared mobility	Shift from private to commercial ownership	=
Environmental & sustainability policies	Shift from car travel to public transport	↓
	Shift towards environmentally friendly mobility	=

Source: Swiss Re Institute

Car safety and automation technology will reduce accident frequency...

Safety technologies, increasing automation and connectivity

Technologies such as Advanced Driver Assistance Systems (ADAS) and, as a longer term prospect, the autonomous car, have the potential to reduce accident frequency. Increasing driving automation and communication between vehicles and their surroundings (vehicle-to-everything or V2X communication) will influence motor insurance on many fronts. For example, we expect claims frequency will reduce and that usage-based insurance products will proliferate. Over the long term, motor insurers will likely incur lower claims cost per insured vehicle, but also earn less premiums (see appendix on more background on our forecasting methodologies).

...but it will take time before all cars on the road will have these features.

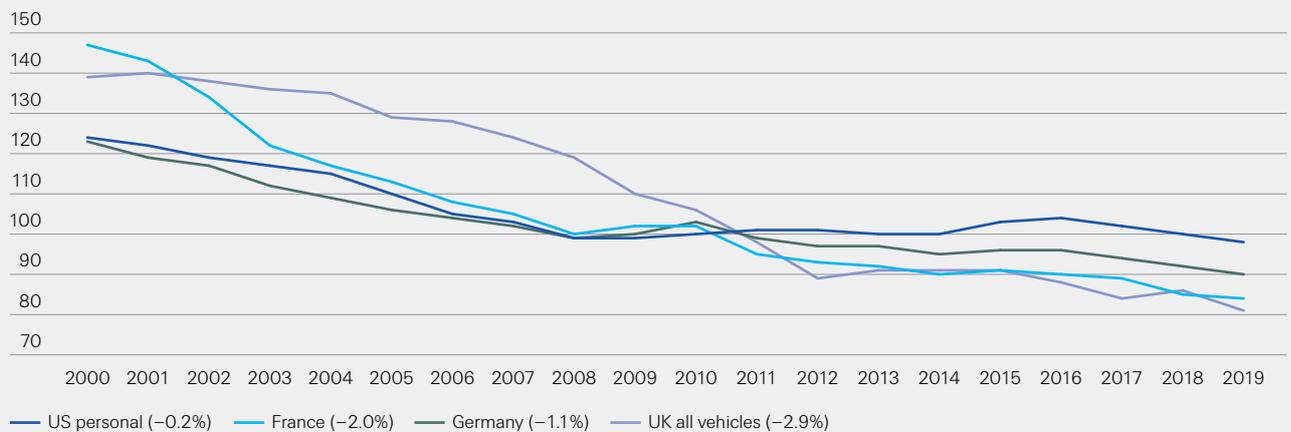
All told, adoption of new vehicle technology will be gradual. For instance in advanced economies, 44% of cars are more than 10 years old, and the share is much higher in emerging markets.¹¹ This indicates that for many, a car is a purchase for the long term, meaning it will take decades to replace existing fleets. Further, the transition will not be linear due to several factors: the performance of the same type of ADAS system varies greatly between different brands and generations of technology. Also, some technologies are focused on driving comfort and the repercussions for accident frequency are not clear. Taking such considerations into account, we believe the impact of vehicle technology on motor insurance will be evolutionary rather than disruptive.

¹¹ *Vehicles in use in Europe*, European Automobile Manufacturers' Association, 2021.

Also, accidents can still happen when drivers, taking comfort in safety features, let down their guard.

Numerous factors including advances in car safety technology, new and better enforcement of traffic laws, and improved driver education should lead to reduced accident frequency and claims cost per vehicle. Indeed, for a long time motor insurers benefited from falling claims frequency. However, the trend slowed across major economies in the middle of the last decade, and in the US loss frequency even rose temporarily. Reasons included heightened accident severity resulting from distracted driving, with drivers using mobile devices while driving, higher traffic density and a shortage of experienced commercial drivers (see Figure 5).

Figure 5
Motor claims frequencies (numbers of claims/number of insured vehicles) in key advanced markets (2010 = 100)



Note: Percents in the legend show CAGR of motor claims frequency over the last 10 years.
Source: Insurance associations, Verisk for US, Swiss Re Institute

More flexible forms of mobility will substitute some of the existing privately-owned car fleet.

Environmentally friendly, shared and mobility service consumption

Car ownership rates are still on the rise in most regions. This is more so in emerging markets, but a private car remains a necessity for many in the rural/suburban regions of advanced economies also.¹² Still, in response to technological advances, and social and environmental developments, we expect the privately-owned car will become a less dominant form of personal mobility over the longer term, particularly in densely populated urban areas. Competing modes of transport will likely proliferate: traditional or new taxi services (eg, ride-hailing, robotaxis), car rentals, shared car ownership, and multi-modal transport (combination of public transport, ride-hailing, micro mobility). Technology is the key enabler of new modes of travel, offering seamless and frictionless service delivery, and in some instances reduced cost. Rising traffic congestion and limited area for parking in densely populated urban areas also favour a shift to alternative mobility modes.

Sustainability goals will encourage more use of shared transport and mobility services.

There is no dedicated UN Sustainable Development Goal (SDG) for transport, but we believe the motor industry and insurance will be strongly influenced by the push towards sustainability on multiple fronts. For example, vehicles are a primary user of fossil fuels. The target of SDG 7 is transition to use of affordable and clean energy, which applies to transport also. Transport is also implicit in SDGs 9 (building resilient infrastructure) and 11 (sustainable cities and communities).¹³ We expect that the social and political push for sustainability will accelerate the roll out of technology and shared mobility concepts. We foresee:

¹² In the US, car ownership in city areas is still increasing more strongly than population. However, the share of car-lite households is also on the rise, see "Car-Rich Households Are Growing", *Bloomberg CityLab*, 7 January 2019.
¹³ *Sustainable Mobility for the 21st Century*, World Bank, 10 July 2017.

- improvements in road safety with accelerated implementation of associated technologies. This will also mean upgraded infrastructure to improve the environment for higher levels of automated driving;
- a push to shared mobility concepts to improve energy efficiency, reduce resource consumption, and encourage greater use of public transport;
- increased restrictions on vehicle access to city/urban centres to reduce air pollution and improve quality of life for residents; and
- an accelerated move towards low-carbon fuels and electric vehicles (battery or fuel-cell powered), away from the internal combustion engine.

Quantifying the future motor risk pool

A scenario approach to assess the potential future motor risk pool.

Methodology: a scenario approach

We have developed an in-house model to assess the potential outlook for the motor insurance risk pool to 2040. We project motor premium growth by taking into account a wide range of economic, technological and societal factors (see Table 4).

- *Economic growth and income effects*: The estimates of economic growth on global motor premiums are based on the historic relationship between the growth of motor premiums relative to growth in GDP per capita. The estimates capture the growth of the motor market due to the income effect.
- *Socio-technological factors and substitution effects* are set to change trends in motor premium growth. Automation, shared mobility models and the push for sustainable transport will likely have a dampening effect on premiums, more so in advanced countries. This is difficult to capture. Our analysis utilises judgement by Swiss Re experts and external reports to assess potential future trends on substitution of private vehicles. We consider the combined effect of three factors: safety-focused technology, sustainable mobility and shared mobility, and quantify the impact of these factors on motor insurance markets. With high uncertainty around the size and timeline of the technological impact, we consider two scenarios: a baseline, which assumes a more conservative effect of ADAS technology in new vehicles on claims reduction, and a disruptive scenario assuming a much larger claims reduction effect by 2040.

Table 4
A scenario approach and key assumptions

Key drivers	Assumptions / effects	
Income effect or GDP growth	Forecasts based on historic estimated elasticities of motor premium growth relative to GDP per capita growth	
Shared mobility	Gradual shift from personal to commercial lines, whereby 12% of travel is assumed to be substituted in advanced markets by 2040, 8% in China and 10% in other emerging markets	
Sustained mobility	Push for sustainable mobility leads to a gradual reduction in car-based travel by 2040 of 15% in advanced markets, by 8% in Central and Eastern Europe, and by 1% in other emerging markets	
Safety technology	Baseline scenario Introduction of ADAS technology in new vehicles assumed to reduce accident frequency by 35% by 2040 in new vehicles with ADAS technology compared to vehicles without	Disruptive scenario Introduction of ADAS technology in new vehicles assumed to reduce accident frequency by 60% by 2040 in new vehicles with ADAS technology compared to vehicles without

Sources: McKinsey, Swiss Re Advanced Driver Assistance Systems team, Swiss Re Institute

Economic growth will be the main driver of motor premium increases.

Our estimate of the economic or income-effect is based on the historical relationship of growth of motor premiums relative to GDP per capita. Using a panel regression of nominal motor premiums on GDP per capita, our estimate covers 72 countries over the period 1990–2020.¹⁴ Estimated elasticities of motor premiums relative to GDP per capita growth are statistically significant, and differ across regions. Elasticities are highest for the emerging markets, ranging from 1.2 to 1.8 for the Middle East, Latin America, China and rest of emerging Asia. For advanced economies where insurance markets are more saturated, the elasticities are lower, ranging from 1.0 to 1.1 for North America, Central and Eastern Europe, advanced EMEA and advanced Asia-Pacific.¹⁵

Once the growth trajectory due to the income effect is established for each region, we consider the impact of three technological and societal change drivers:

- **The impact of safety technology:** A reduction in claims frequency resulting from increasingly automated driving will be gradual and uneven. There will be a policy push for the introduction of safety-enhancing features to reduce economic and social costs from road accidents. Therefore we assume an ambitious adoption rate of ADAS technology in new vehicles to be mandatory from 2023 in advanced markets. Even so, we estimate that only slightly more than 50% of vehicles in advanced markets will be equipped with the technology by 2030, rising to more than 90% by 2040. To estimate the claims reduction potential of autonomous emergency braking (AEB) systems, the Swiss Re Automotive & Mobility Solutions team has performed several analyses of real-life portfolio data as well as track test data.¹⁶ Track test data of select vehicles showed accident frequency reductions of 27% (unweighted average) vs unequipped vehicles. The top performing high-end vehicles deliver frequency reductions of more than 70%, while mass market brands are below average. Based on this, we chose 35% frequency reduction for the average new car in 2040 as base scenario, up from 15% in 2020. For the less likely disruptive scenario, the end-point of 60% was chosen to be well above today's average and close to the performance of today's best in class systems.
- **The rise of shared mobility:** Over time, shared mobility services will replace some privately owned vehicles. Pressures for more efficient use of resources in urban areas, and also the convenience of new digital shared mobility services as opposed to having to maintain a car, will fuel the change. For insurance, the main effect of the substitution of private vehicle based mobility will be a shift in business mix, from personal to commercial lines. To calibrate the magnitude of the shift, we base our estimates on analysis by McKinsey. This indicates that the strongest effects will be in Europe, where 6% of travel will be substituted by 2030 and in the emerging markets (5%). In the US, the effect will be low (2%). The rise of shared mobility may also grow or decrease the risk pool relative to the income effect, but we abstain from modelling this as the direction and magnitude of the effect is not yet clear.
- **The push for sustainable mobility:** Rising environmental concerns and the costs of urban congestion will also lead to a push to reduce individual car travel. This will further pronounce the shift to public transport in urban areas in Europe and advanced Asia, but there will likely be limited impact elsewhere. Based on McKinsey assumptions, we assume that by 2040, there will be 15% less car-based travel in Europe and advanced Asia.

¹⁴ The panel regression also includes year fixed-effects (or time dummies) to control for any common variation across time.

¹⁵ Specifically, the estimated elasticities are 1.8 for Middle East; 1.4 for China; 1.2 for rest of Emerging Asia, Africa, and Latin America; 1.1 for North America and Advanced EMEA; and 1.0 for Central and Eastern Europe, Advanced EMEA and Advanced Asia-Pacific. All elasticities are significant at 1% significance level.

¹⁶ *The significance of progress. Implications of the diversity and complexity of ADAS for road safety and the insurance landscape*, Veoneer and Swiss Re, 2021.

Future motor risk pools

In our baseline scenario, global motor premiums will rise to USD 1.4 trillion by 2040.

The growth will derive mostly from emerging markets.

Market size by 2040

All effects accounted for, we forecast that global motor premiums will double by 2040. The difference between our baseline and disruptive scenarios appears marginal. This is on account of technological impacts being largely felt in the advanced markets. In the emerging markets, economic growth will continue to drive higher levels of car ownership and thus also solid growth in motor premiums.

In our baseline scenario where technology reduces claims by 35% in new vehicles with ADAS technology by 2040, motor will remain a growing risk pool. We forecast that global premiums will rise to USD 1.4 trillion, up from (USD 766 billion in 2020 (see Table 5). In nominal terms, there will be growth in both the advanced and emerging markets, although we forecast annual growth of just 1.5% in the former. On account of stronger levels of per capita GDP growth and also lesser reduction in claims due to a delayed adoption of safety technology, we estimate that nominal premiums in emerging markets will on average grow by 5.9% annually to 2040. In the more disruptive scenario in which technology rollout leads to a 60% reduction in claims in new vehicles in 2040, we forecast that global premiums will grow to USD 1.3 trillion by 2040.

Table 5
Motor premiums (nominal) by 2040F, in USD billion

	Advanced markets	Emerging markets	Emerging markets, excl. China	China	World
Motor premiums 2020E	565	201	82	119	766
Motor premiums 2040F (baseline scenario)	780	621	279	342	1402
motor premiums 2040F (disruptive scenario)	692	580	269	311	1272
CAGR motor (baseline scenario)*	1.5%	5.9%	6.2%	5.7%	3.0%
CAGR motor (disrupted scenario)*	0.8%	5.5%	6.0%	5.1%	2.5%
Elasticity motor premium to GDP (baseline scenario)**	0.38	0.93	0.99	0.87	0.58
Elasticity motor premium to GDP (disrupted scenario)**	0.21	0.86	0.96	0.78	0.46

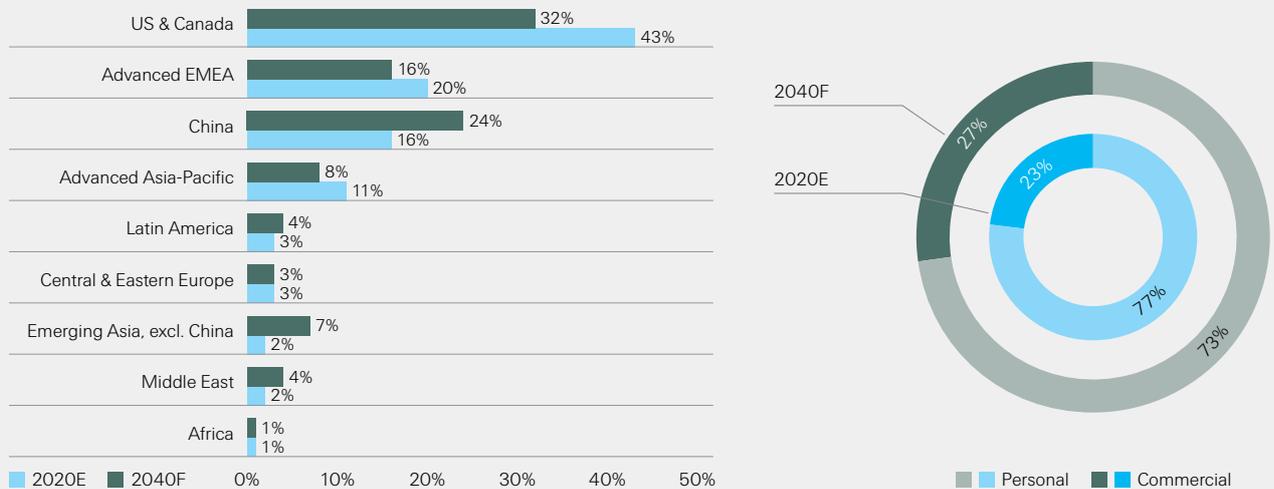
Note: Projections are based on assumptions outlined above.*The motor premium CAGR is for the period 2021–2040. **Elasticities are calculated over the period 2021–2040; world elasticity is weighted by average regional premium levels.
Source: Swiss Re Institute

We expect the share of emerging market premiums to increase, and that there will be a shift in the portfolio mix to commercial motor.

It will take more time for claims-reducing safety features to permeate existing fleets in emerging markets, where vehicles tend to be driven for longer. This will accentuate the premium shift to emerging markets. We forecast their share of global motor premiums rising to 46% in 2040 from 26% in 2020. Meanwhile, as shared economy transport models gain traction, the share of commercial motor business globally will increase to close to 27% in 2040 from 23% in 2020.

Figure 6

Motor premium projections, by region (LHS) and by line of business (RHS)



Note: The charts show shares according to our baseline forecast, in which global motor premiums reach USD 1.4 trillion by 2040.

Source: Swiss Re Institute

Implications for motor insurance markets

Motor insurance risks will become more complex.

Motor will still be the largest line of business in P&C insurance by 2040, but the nature of the risk pools will transform and become more complex. Technology will reduce accidents but until full autonomous driving is attained for a significant portion of the fleet, drivers will still need to remain alert. Over-reliance on technology and compensating driver behaviours may reduce some of the promise of new safety technologies. Motor insurers need to understand the differential impacts of various types of technologies on claims and also the differences in performance between brands, models and generations of technology. They will also need tools to effectively price and underwrite the evolving risks.

Data generated by cars will become increasingly important in risk selection and pricing.

Modern cars generate massive amounts of data about the car and the driver through telematic sensors that monitor driving performance. This information can help insurers price and underwrite risk, creating a nudge toward safer driving behaviours. Drivers can also be notified to change risky behaviour via smartphone apps. However, questions about privacy, data complexity and the potential for manufacturers to monetise the information are barriers that still need to be overcome. Manufacturers have better access to the data generated by modern cars, and are more knowledgeable about driving automation technology and its implications for accident frequency and severity. For insurers, this is an opportunity to partner with manufacturers to offer user-based insurance products.

Digital technology will make motor more exposed to accumulation risks.

For the foreseeable future, personal motor insurance will continue to bear most of the losses from motor accidents. However, the proliferation of advanced technologies in cars will subject manufacturers and their insurers to new risks, resulting in larger liability exposures and creating opportunities in other specialty lines. In particular, product liability and cyber risks will grow as cars promise additional safety features and are increasingly digitally connected. Product liability risks will arise from advances in safety technology, as personal liability exposure is replaced with commercial covers to the extent that the car or manufacturer, rather than the driver, assumes responsibility for safe driving. Cyber exposures will arise as part of the enhanced sophistication of autonomous driving technologies as well as the move to a shared economy model for mobility. As cars and the mobility business model become increasingly interconnected, the potential for less frequent but more severe events (ie, increasing correlation) will pose underwriting challenges.

Property risk pools

We forecast that global property premiums will almost triple to USD 1.3 trillion by 2040. Economic growth will be the main driver, contributing USD 616 billion (75–77%) of new premiums. About three quarters will originate from the advanced markets, where insurance penetration rates are higher. In emerging economies, urbanisation effects will generate an estimated 10% in new premiums, or 3% at the global level. According to our model, climate risks will increase the property risk pool by 33–41%, generating USD 149–183 billion of new premiums by 2040. The share of catastrophe in property premiums will rise to an estimated 28–31% in 2040.

Property is the second largest line of business in P&C insurance.

Key long-term trends for the property market

Property is the second largest line of business in P&C insurance. According to *sigma* data, global property premiums were USD 450 billion in 2020, accounting for 25% of the P&C total. Property insurance covers buildings and their contents in case of fire, natural hazards and damage from other perils. Globally, the business mix is evenly split between commercial and residential/private risk pools. Currently emerging markets account for just 11% of global premiums, of which 2 percentage points stem from the rapidly growing Chinese market. By 2040, we forecast that global property premiums will reach USD 1.3 billion (around 29% of the P&C total). The main drivers of the growth will be the effects of economic development, urbanisation and climate change. Table 6 highlights other possible drivers also.

Table 6
Key factors that affect long-term property risk pool

Long-term factors	Implications for risk pool	Impact on premium trends
Economic development	Income elasticities, stronger for emerging economies	↗
Climate change	Higher catastrophe losses, highest impact in advanced economies	↗
Urbanisation	Higher exposure growth, significant for emerging markets	↗
Smart homes, IOT, sensor technology	Reduced loss frequency, significant for high-income economies	↘
Green buildings, infrastructure	Higher exposure growth, significant for high-income economies	↗

Source: Swiss Re Institute

Quantifying the future property risk pool

We use a panel-data econometric to model estimate property premium growth.

Methodology and assumptions

To quantify the impacts of economic development, urbanisation and climate change on property premiums, we have developed an econometric model on a sample of 41 advanced and emerging economies, for which there is sufficient annual data for the period 2001 to 2019. The model uses real property premiums, real GDP and the insured losses from real weather-related catastrophes. It also includes the share of urban population to proxy levels of urbanisation, and controls for cyclicity using the world reinsurance price index for non-life business lines. To capture heterogeneity, advanced and emerging countries are analysed separately. The model estimates property premium growth using long-run elasticities of the relationship between the premium growth rate and the growth rates of the main drivers (see Table 7). The growth rates of the drivers are Swiss Re Institute projections for GDP and insured catastrophe losses, and UN projections for urban population growth by 2040.

Table 7
Long-run elasticities of property premiums

	Advanced markets		Emerging markets
	High cat exposure (Tier 1)	Low cat exposure (Tier 2)	
GDP captures elasticities of property premiums to GDP	0.96	1.03	1.08
Share of urban population captures elasticities of property premiums to the share of urban population	Statistically insignificant	Statistically insignificant	0.94
Weather-related catastrophe insured losses captures elasticities of property premiums to insured losses at a constant exposure (normalised by GDP)	0.14	Insufficient data*	Insufficient data*

*For smaller advanced (Tier 2) countries and emerging economies, there is not enough data to draw conclusions on long-run elasticities. Elasticities are significant at 5% confidence level.

Source: Swiss Re Institute

Climate change is a significant factor for property in advanced markets, given higher insurance penetration.

As the long-term elasticities in Table 7 indicate, economic development is a strong driver of premium growth in both advanced and emerging countries. Climate change is also an important factor (statistically significant) for a sample of larger advanced markets (Australia, Canada, France, Germany, Japan, the UK and the US). In the period 2001–2019, these Tier 1 markets accounted for 96% of the registered weather-related insured losses in Swiss Re Institute's disaster loss dataset. The elasticity of the weather-related catastrophe insured losses suggests that for these markets, the risks of increasing catastrophe losses have already been factored into historical premiums data. For smaller advanced (Tier 2) countries¹⁷ and emerging economies, there is not enough data to draw conclusions on the long-run elasticities. Hence, in our forecast for these countries we add a climate change impact proportionate to the total weather-related catastrophe premiums to be in line with estimates for Tier 1 countries. Urbanisation is an insignificant factor for premium growth in the advanced markets, but a significant factor for emerging markets.

Global property insurance premiums will triple to an estimated USD 1.3 trillion by 2040.

Market size by 2040

Through our model, we forecast that global property insurance premiums will almost triple to USD 1.3 trillion by 2040, from USD 450 billion in 2020. Of the USD 789–823 billion of new premiums, about three quarters will originate from advanced markets (see Table 8). Economic development, climate change and degree of urbanisation will be the main drivers of the increase.¹⁸

¹⁷ These countries include Austria, Belgium, Switzerland, Chile, Czech Republic, Denmark, Finland, Hong Kong, Israel, Italy, South Korea, Netherlands, Norway, New Zealand, Poland, Sweden, Singapore.

¹⁸ T. Holzheu, G. Turner, "The Natural Catastrophe Protection Gap: Measurement, Root Causes and Ways of Addressing Underinsurance for Extreme Events", *Geneva Papers Risk Insurance Issues Practice*, vol 4, 2018.

Table 8
Property insurance premiums by region

	Advanced markets	Emerging markets	Emerging markets, excl. China	China	World
Property premiums 2020E (USD billion)	402	48	40	8	450
Property premiums 2040F (USD billion)	967–993	272–280	219–226	53–54	1239–1273
CAGR property*	4.4–4.6%	8.9–9.0%	8.7–8.9%	9.8–9.9%	5.1–5.3%
Elasticity of property premiums to GDP**	1.15–1.19	1.40–1.42	1.40–1.43	1.50–1.52	1.20–1.24

Note: *The property premiums CAGR is for the period 2021–2040.

** Elasticities are calculated over the period 2021–2040 and world elasticity is weighted by average regional premium levels.

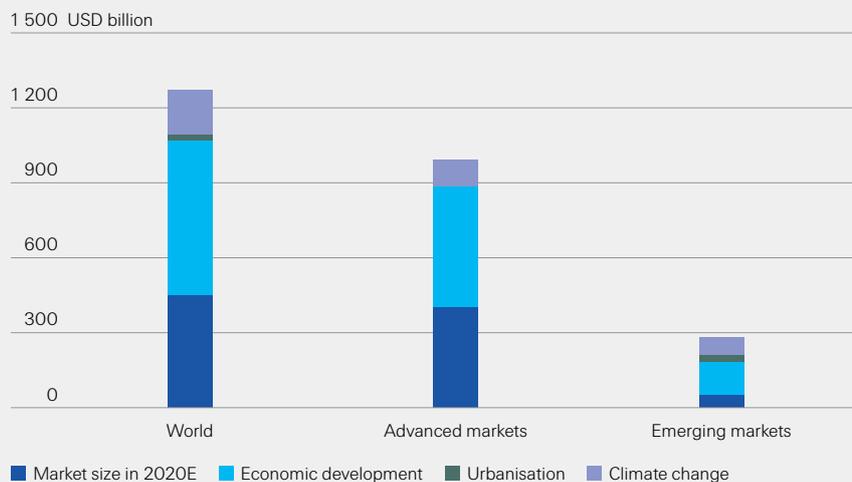
Source: Swiss Re Institute

Economic development effects will contribute 75–77% of the additional global property premiums.

Economic development

We estimate that USD 616 billion, or about 75–77% of the new global property premiums by 2040 will be generated by economic development (see Figure 7). Of that, USD 481 billion (about 78%) will come from the advanced, and USD 135 billion from emerging markets. Historically, the stage of development of an economy has been the most important factor in premium growth: higher GDP per capita translates to higher gross written premiums per capita. The results of our analysis show an income elasticity (the marginal effect of a 1% increase in GDP on property premiums) of between 0.96 and 1.03 for advanced markets, and 1.08 for the emerging economies (ie, 8 ppt higher premium growth than GDP growth).

Figure 7
Key drivers of additional global property premiums by 2040F



Note: The chart shows the upper bound estimates.

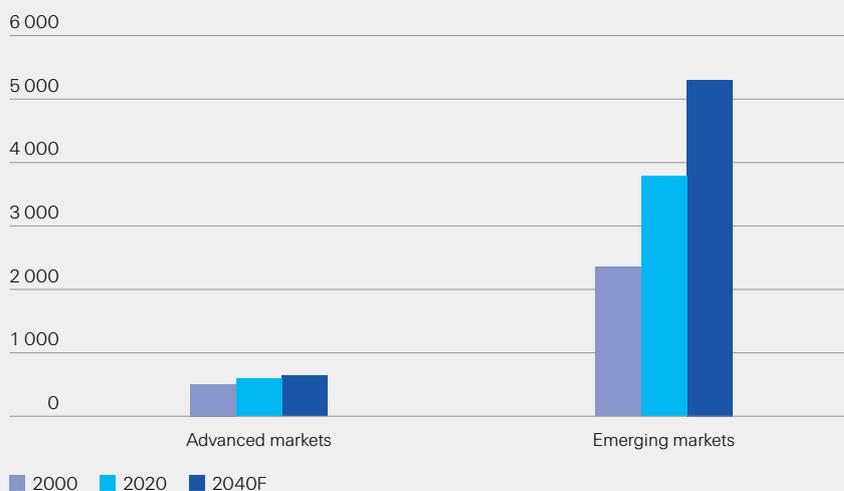
Source: Swiss Re Institute

Urbanisation will contribute 10% of the additional property premiums in emerging markets.

Urbanisation

Our analysis indicates that urbanisation will also increase global property premiums, most notably in emerging markets. There, urbanisation will contribute USD 24 billion, or around 10% of the additional property premiums by 2040, and 3% of global premiums. The share of the urban population in emerging markets is forecast to increase from 54% in 2020 to 63% in 2040, translating into an additional 1.5 billion urbanites (see Figure 8). The urban populations of India and China are forecast to rise to 261 million and 208 million, respectively. According to our model, in advanced markets, urbanisation will not be an important contributor to premium growth by 2040, reflecting the already-high levels of urbanisation in many of these countries.

Figure 8
Urban population
(in millions)



Source: United Nations Population Division

Expanding cities generate additional insurance demand from households and businesses.

The rising income levels and infrastructure investment typically associated with urbanisation contribute to increasing insurance demand from the household and commercial sectors. As urban populations in emerging markets grow, so do their infrastructure needs. These include big-ticket facilities such as airports, high-speed rail and other mass transit systems. Expanding cities also need investment in utilities like electricity, gas and fresh water distribution, sanitation and waste management. Infrastructure development in urban areas will create demand for engineering insurance. Industrialisation comes hand-in-hand with urbanisation in emerging markets, and leads to increasing need for insurance of production facilities. Urbanisation and the associated infrastructure investment also increases the amount of property that is exposed to natural disasters. As cities grow, municipal and state authorities will need focus on investments that enhance resilience in light of the increased frequency and severity of weather events due to climate change.

Property risk pools

Climate risk will add up to USD 183 billion in global property premiums by 2040.

Hazard intensification due to climate change effects will play an increasing role in the decades to come.

Most of the impacts to date show in increases in secondary-peril losses.

Confidence around the impact of climate change on tropical cyclones frequency remains low.

Climate change

With respect to climate change, we estimate that rising weather-related catastrophe losses will translate into USD 149–183 billion of premiums, increasing global property premiums by 33–41% between 2020 and 2040. Around USD 84–110 billion (56–60%) will come from advanced markets and USD 65–73 billion from the emerging economies.¹⁹ An escalation of climate risks such as floods and wildfires, will increase weather-related insured claims and premiums. We forecast that in advanced economies, weather-related insured losses could increase by 30–63% by 2040. The share of catastrophe risk in all property premiums will rise to around 28–31% from an estimated 20% in 2020.

Insured weather-related catastrophe losses projections

The effects of climate change already show: warmer temperatures, rising sea levels, greater weather extremes such as more frequent and prolonged heatwaves, extended wildfire seasons and erratic rainfall patterns. We expect warmer temperatures will lead to growing frequency of severe weather events, and that these will make an increasing contribution to rising insured losses over the next decades. The full extent of climate change impact on losses is difficult to predict, not least because many other factors such as economic development, urbanisation and land-use changes also play a big role and can even amplify climate-induced effects.²⁰ At the same time, risk-reduction and adaptation measures may reduce losses in the future. Here we make a first attempt to quantify the contribution of climate change to future losses from weather-related catastrophes.

So far climate change impacts manifest most notably in more intense secondary peril events, typically wildfires, or the secondary effects of a primary peril, such as precipitation during tropical cyclones (TCs). There has been a dramatic increase in insured losses from wildfires in recent years, from below 2% of total natural catastrophe insurance losses prior to 2016 to at least 12% since.²¹ Most climate models also project that extreme precipitation events will become more intense due to there being more moisture in the atmosphere and warming temperatures.²²

For primary perils like TCs, uncertainties remain high, especially when it comes to storms making landfall. This is in large part due to their infrequent occurrence, and also high natural inter-annual and even multi-decadal variability. Confidence is higher for TC intensity which, coupled with rises in sea levels also increases storm-surge risk for coastal areas. Both will have a substantial impact on future insured losses. There is also a high degree of confidence that TCs are producing greater amounts of rainfall.²³ Rain-driven flooding from storms such as Hurricane Harvey (2017) and Typhoon Hagibis (2019) is expected to become more severe, with a 1°C increase in temperatures projected to raise rainfall volumes by between 13% and 17%.²⁴

¹⁹ For the emerging economies (including China) total weather-related losses are not a significant driver, nevertheless, we added a climate change impact proportionate to the total natural catastrophe premiums.

²⁰ Tellman, B., Sullivan, J.A., Kuhn, C. *et al.* "Satellite imaging reveals increased proportion of population exposed to floods. *Nature* vol 596, 2021.

²¹ See *sigma* 1/2021, Swiss Re Institute, *op. cit.*

²² G. D. Madakumbura, C.W. Thackeray, J. Norris, *et al.* "Anthropogenic influence on extreme precipitation over global land areas seen in multiple observational datasets". *Nature Communications*, vol 12, 2021.

²³ T. R. Knutson, *et al.*, "Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming", *Bulletin of the American Meteorological Society*, vol 101, 2020.

²⁴ M. Liu, G. A. Vecchi, J. A. Smith, T. R. Knutson, "Causes of large projected increases in hurricane precipitation rates with global warming", *npj Climate and Atmospheric Science* 2, vol 38, 2019.

We have developed projections on how climate change will impact weather-related losses.

In Europe and China, most additional losses will likely result from flooding events. In the US and Japan, tropical cyclones will be the main drivers.

Based on latest findings from science and internal expertise, we estimate how expected losses from key perils may change between now and 2040. The perils considered include TCs, winter storms, floods and wildfires. These are the biggest risks facing insurers and the most likely to be impacted by climate change effects. The natural catastrophe risks are calculated under the assumption that the global mean surface temperature will increase by 1.5°C by 2040 from pre-industrial times. Given model uncertainty for TCs, we have used upper bound and median estimates for these perils. These represent the median and the top decile of outcomes from all possible model simulations.²⁵ There is great uncertainty around climate change trends. Swiss Re Institute's *Economics of climate change* report published earlier this year presents scenarios of severe climate change impacts on economic growth and the failure of policy actions to meet the Paris agreement.²⁶ Reflecting on those severe scenarios, we note that our modelling parameters in this current study are exposed to downside risk and may understate the negative impact of climate risks on economic growth. As economic growth is the main driver of premium growth, more extreme outcomes would also influence premium growth trends.

The following are the projections used to estimate how climate change will potentially impact weather-related catastrophe losses in major advanced economies and also in China (see Figure 9). Losses from floods (which include pluvial, fluvial and sea-level rise perils) will likely increase most; losses from TCs and winter storms will increase less. In Europe, floods will have most impact: in the UK, France and Germany, associated insured losses could increase by almost 200%.²⁷ Losses from winter storms, the biggest catastrophe risk in Europe, could increase by as much as 16%.²⁸ In China, most of the gains in estimated insured losses will be driven by flooding.²⁹ We estimate that by 2040, total losses from flood will increase by 235%, and for TC between 0.6% to 31.4%. In the US, most of the increase will come from TC, their resulting storm surges and, to a lesser degree, TC-driven precipitation.³⁰ But uncertainties are high and losses are expected to increase from anywhere from 6.8% to 49.2%. Wildfire insured losses in the US are projected to rise by 140%, although from the current low base.³¹ In Canada, losses from flood events are expected to rise by 145%.³² In Australia, losses from wildfires, which have historically contributed 17% of total insured losses from natural catastrophes, will increase by an estimated

²⁵ T. R. Knutson, et al., "Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming", *Bulletin of the American Meteorological Society*, vol. 101, 2020.

²⁶ *Economics of climate change*, Swiss Re Institute, 22 April 2021.

²⁷ L. Alfieri, et al., "Multi-Model Projections of River Flood Risk in Europe under Global Warming", *climate*, 2018. M. I. Vousdoukas et al., "Climatic and socioeconomic controls of future coastal flood risk in Europe", *Nature Climate Change*, vol 8, 2018; K. M. Nissen, et al., "Increasing frequencies and changing characteristics of heavy precipitation events threatening infrastructures in Europe under climate change", *Natural Hazards Earth System Sciences*, vol 17, 2017; J. Slingo, et al., *Technical Report. Chapter 1: Latest Scientific Evidence for Observed and Projected Climate Change*, UK Climate Risk Independent Assessment 2021; S. Jevrejeva et al., "Flood damage costs under the sea level rise with warming of 1.5°C and 2°C", *Environmental Research Letters*, vol 13, 2018.

²⁸ M. G. Donat et al., "Future changes in European winter storm losses and extreme wind speeds inferred from GCM and RCM multi-model simulations, *Natural Hazards Earth System*", *Sciences*, vol 11, 2011.

²⁹ F. Dottori, et al., "Increased human and economic losses from river flooding with anthropogenic warming", *Nature Climate Change*, vol 8, 2018; J. Fang, et al., "Coastal flood risks in China through the 21st century – An application of DIVA", *Science of The Total Environment*, vol 704, 2020; W. Zhang et al., "Increasing impacts from extreme precipitation on population over China with global warming", *Science Bulletin*, vol 65, 2020.

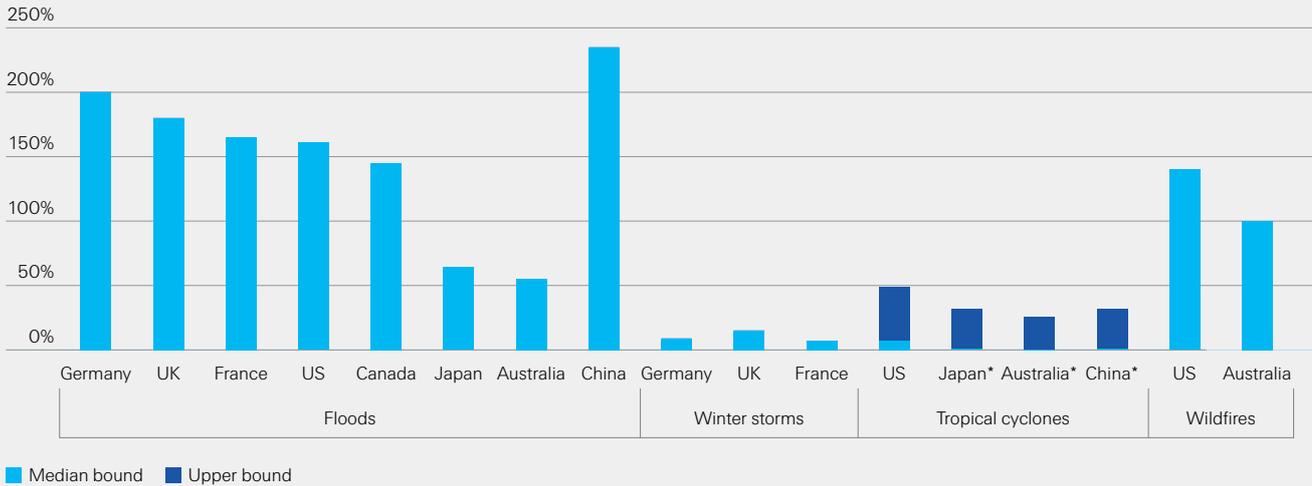
³⁰ O.E. Wing et al., "Estimates of present and future flood risk in the conterminous United States", *Environmental Research Letters*, vol 13, 2018; P. L. Bernard, et al., "Dynamic flood modeling essential to assess the coastal impacts of climate change", *Scientific Reports*, vol 9, 2019; A.F. Prein et al. "Increased rainfall volume from future convective storms in the US", *Nature Climate Change*, vol 7, 2017. T. R. Knutson, et al., "Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming", *Bulletin of the American Meteorological Society*, vol. 101, 2020.

³¹ Brown et al., "US wildfire potential: a historical view and future projection using high-resolution climate data", *Environmental Research Letters*, 16, 2021. Stambaugh et al., "Future southcentral US wildfire probability due to climate change", *Climatic change*, vol 147, 2018.

³² We do not have projections for storms and consider the impact comes from floods solely. See J. Thistlethwaite et al., "Application of re/insurance models to estimate increase in flood risk due to climate change", *Geo-environmental Disasters*, vol. 5, 2018; and also Jevrejeva et al., op.cit.

100%.³³ Losses from floods will potentially increase by 55%,³⁴ and from TCs by between 0.4% and 25.7%.³⁵ In Japan the estimated increase in losses range from 0.6% and 31.4%. These will be driven by TCs.³⁶

Figure 9
Expected change in weather-related catastrophe losses by perils for major advanced economies and China



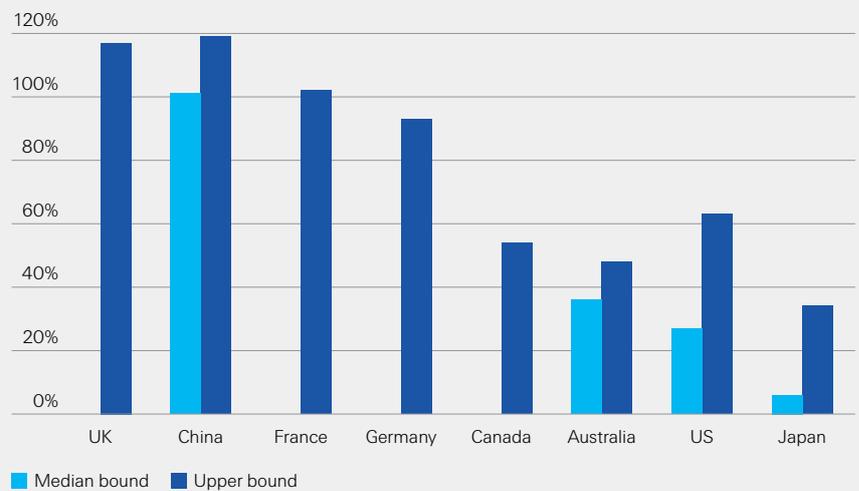
Note: * The median bounds for Japan, Australia and China are under 1%. The median and upper bounds reflect model uncertainty for TCs and present the median and the top decile of outcomes from all possible model simulations.
Source: Swiss Re Institute

Insured losses from weather-related catastrophes in advanced economies will rise by an estimated 30–63% because of climate change effects.

We aggregate the country's peril projections into an overall country-level change in expected weather-related losses due to climate effects by applying weights proportional to historical insured losses from weather-related events (see Figure 10). In aggregate, the increase for Tier 1 countries (Australia, Canada, France, Germany, Japan, the UK and the US) is projected to range between 30–63% by 2040. In some key markets like the UK, France and Germany, the increase could be as much as 90–120%. For the remaining advanced markets (Tier 2), we estimate a country-weighted increase of between 19% to 22%. For China, losses from all catastrophes are projected to increase by between 100% and 120%. We assume these same projections for other emerging markets.

³³ Lucas et al., *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts*, The Climate Institute of Australia, 2007; G. J. van Oldenborgh et al., "Attribution of the Australian bushfire risk to anthropogenic climate change", *Natural Hazards Earth System Sciences*, vol 21, 2021; A. J. Dowdy et al., "Future changes in extreme weather and pyroconvection risk factors for Australian wildfires", *Scientific Reports*, vol 9, 2019.
³⁴ Hirabayashi et al., "Global flood risk under climate change", *Nature climate change*, vol 3, 2013. Alexander et al., "Historical and projected trends in temperature and precipitation extremes in Australia in observations and CMIP5", *Weather and Climate Extremes*, vol 15, 2017.
³⁵ T. R. Knutson, et al., "Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming", *Bulletin of the American Meteorological Society*, vol 101, 2020.
³⁶ Ibid, and S. Tezuka, et al., "Estimation of the effects of climate change on flood-triggered economic losses in Japan", *International Journal of Disaster Risk Reduction*, vol 9, 2014; D. Hatsuzuka, T. Sato, "Future Changes in Monthly Extreme Precipitation in Japan Using Large-Ensemble Regional Climate Simulations", *Journal of Hydrometeorology*, vol 20, 2019; Jevrejeva, S. et al., op. cit.

Figure 10
Expected change in total weather-related catastrophe losses for major advanced economies and China



Note: The perils considered include tropical cyclones, winter storms, floods and wildfires. These are the biggest risks facing insurers and the most likely to be impacted by climate change effects. The natural catastrophe risks are calculated under the assumption that the global mean surface temperature will increase by 1.5°C by 2040 from pre-industrial times. The median and upper bounds reflect model uncertainty for tropical cyclones. Our forecasts are intended as best estimates given the large uncertainties around changes in climate trends.
Source: Swiss Re Institute

Smart and sustainable infrastructure

Massive investment in green infrastructure...

Climate change mitigation requires significant investments in green infrastructure.. There also needs to be promotion of renewable energy generation, building energy codes, emission standards and carbon pricing.

...of close to USD 7 trillion annually is needed to cut global greenhouse emissions to target levels.

Investment in green infrastructure

With the focus on sustainability, ever-growing populations and mega cities, global investment in green infrastructure is on the rise. Current energy, transport, building and water infrastructure make up more than 60% of global greenhouse gas emissions.³⁷ To achieve the 2030 agenda for global sustainable development, to the tune of USD 6.9 trillion a year, existing infrastructure needs fundamental transformation.³⁸ The EU Green Deal and The American Jobs Plan emphasise the importance of sustainability, supporting green investments from the public sector. China's new infrastructure plan is geared towards digital investments (5G, industrial Internet of Things and cloud computing), ultra-high voltage networks, and railway infrastructure (intercity high-speed railways (HSR), rail transit). (see Table 9).

The investments will give rise to new underwriting opportunities.

In addition to supporting the sustainability agenda, insurers can benefit from these opportunities to underwrite risks inherent in the construction and operational phases of green infrastructure projects. Using *sigma* data on associated lines of business, we estimate that global premiums from insuring green or renewable infrastructure projects will grow to USD 24–38 billion by 2040, from USD 12.6 billion in 2019.³⁹ The infrastructure upgrades could generate additional economic growth leading to a further growth in property premiums.⁴⁰

³⁷ *Financing Climate Futures: Rethinking Infrastructure Policy Highlights*, OECD/The World Bank/UN Environment, 2018.

³⁸ Ibid. The UN estimates USD 5–7 trillion, see *UN Alliance for SDG Finance*, UN Global Compact.

³⁹ The scope of the estimate includes electricity generation with renewable energy technologies and covers hydro, wind, photovoltaic solar, concentrated solar power, geothermal, bioenergy and marine). Grid extensions are excluded.

⁴⁰ Swiss Re Institute estimates, based on International Energy Agency (IEA), International Renewable Energy Agency (IRENA) data. Electricity generation capacity data and forecasts based on IEA analysis. There are two scenarios: stated policies (the baseline case) and the optimistic (sustainable development) scenario. The estimate covers traditional insurance products only, which include marine cargo, engineering (project, operation), property and liability. Non-traditional insurance products such as weather, plant yield and revenue insurance are not included.

Table 9
Infrastructure initiatives in the EU, the US and China

	EU Green Deal ³⁹	The US Senate Infrastructure Proposal	China's New Infrastructure plan
Objectives ⁴⁰	Making Europe climate-neutral	Rebuilding infrastructure	Enhance the foundation of digital infrastructure
Budget	At least EUR 1 trillion over 2020 – 2030	About USD 1 trillion over eight years ⁴¹	USD 1.8 trillion by 2030 ⁴²
Property focus	Build energy-efficient and climate-proof buildings and enforce rules on building quality; increase property digitalisation.	Build and retrofit more than 2 million homes and commercial buildings for energy efficiency, resilience and affordability.	New digital infrastructure, including Ultra High Voltage network, intercity high-speed railways and rail transit, and electric vehicle charging stations.

Source: Swiss Re Institute

Building codes help reduce losses from weather-related calamities.

Building codes and other preventive measures

In mature markets such as the US, Japan, Canada and Australia, building codes have reduced risks and improved insurability. Effective building codes may require elevating buildings in flood risk zones or bracing home frames to foundations.⁴⁵ In wildfire-prone areas, effective early warning systems, landscape management and other fire prevention measures minimise the effect on lives and property, and also avoid conditions that may lead to very damaging fires. In addition, changes in land use such as discouraging development of high-risk areas through zoning or providing incentives to relocate from high-risk areas can reduce the losses wrought by the power of nature. A research paper by Deryugina found that stricter building codes reduce the amount of money spent by the federal government following a hurricane.⁴⁶ Simmons et al (2017) estimate that the Florida Building Code reduced windstorm losses by up to 72%, and the cost-benefit analysis showed that USD 1 of costs in building safer houses resulted in USD 6 of reduced losses.⁴⁷

Digital technology will also shape the future of property risks...

Smart home and city technology can mitigate risks

The increasing importance of digital technology will also shape the property insurance market over the next two decades. Smart manufacturing (Industry 4.0), smart homes and “smart cities” combine data and technology to create digital tools that offer more efficient solutions to households, corporations and urban governments. A parallel trend is the emergence of broader “smart infrastructure” for cities, where physical infrastructure is embedded with sensors.⁴⁸ The data can be used to mitigate various risks, including from climate change. For example, Da Nang in Vietnam is exposed to typhoons and flooding. There, the Climate Change Coordination Office (CCCO) has developed an early-warning system to project water levels and identify areas that could be affected.⁴⁹

⁴¹ *The European Green Deal Investment Plan and Just Transition Mechanism explained*, European Commission, 2020.

⁴² We highlight only the objectives relevant to the discussion in this chapter.

⁴³ Scope of the Senate bill, House approval is pending.

⁴⁴ *New Infrastructure Opportunities Handbook*, Morgan Stanley, 2020.

⁴⁵ For a review of cost – benefit analyses on disaster mitigation measures see C.M. Shreve, I. Kelman, “Does mitigation save? Reviewing cost-benefit analyses of disaster risk reduction”, *International Journal of Disaster Risk Reduction*, vol 10, 2014.

⁴⁶ T. Deryugina, “Reducing the Cost of Ex Post Bailouts with Ex Ante Regulation: Evidence from Building Codes”, *SSRN*, 2013.

⁴⁷ K. Simmons, J. Czajkowski, J. Done, “Economic Effectiveness of Implementing a State-wide Building Code: The Case of Florida”, *Land Economics*, vol 94, 2018.

⁴⁸ *Smart Infrastructure: Getting More from Strategic Assets*, Cambridge Centre for Smart Infrastructure and Construction, 2020.

⁴⁹ *Smart cities in Southeast Asia*, McKinsey Global Institute, 2018.

...and help foster the design of new types of insurance product.

Digitalisation can provide insurers with a vast amount of risk-relevant data. This can, enable them to develop more dynamic underwriting tools, and also provide a digital end-to-end journey for customers.⁵⁰ Another possible consequence of the IoT and digitalisation in insurance could be that the average size and volume of claims decreases, as insurers develop better understanding of the risks. Empirical evidence from BNP Paribas Cardif, which launched a home telematics product in the Italian market in 2013 alongside its traditional offering, suggested that telematic claims are up to 20% lower than non-telematic claims.⁵¹

⁵⁰ "Smart Home Insurance", *IoT Insurance Observatory*, 2019.

⁵¹ "Connected Insurance Report", *Insurance Nexus*, 2019.

Reshaping liability risk pools

Demand for liability insurance will increase in excess of economic growth, driven by technological, social and legal changes. We forecast that economic development alone will add USD 369 billion to global liability premiums, bringing the total to USD 583 billion by 2040, representing 13% of the total P&C market. The estimates are conservative and may understate the full potential, as our model does not capture some trends that are hard to quantify. We see areas of long-term potential for liability from climate change effects, artificial intelligence, as well as social and legal changes. In the medium term, social inflation will drive up the frequency of large verdicts and settlements, especially in the US.

Liability insurance will account for an estimated 13% of global P&C business by 2040, up from 12% in 2020.

Liability claims growth has exceeded economic growth in major countries recently, and this trend is likely to continue in the near-term.

Rising medical costs, wages and increasing propensity to sue will impact the severity and frequency of claims.

Liability insurance is a dynamic market: what is deemed insurable can change over time.

The liability market will likely grow faster than the economy in the long term.

The primary market for liability risks is the third largest line of business in P&C insurance. According to *sigma* data, in 2020 global liability premiums were USD 214 billion, accounting for 12% of the P&C sector total. Commercial liability lines comprise a variety of covers: commercial general liability (premises liability), product liability, professional liability (including directors & officers (D&O)), financial liability (or errors and omission (E&O)), and medical malpractice insurance. Other miscellaneous liability covers include environmental impairment liability and employment practices liability. We forecast that by 2040, global liability insurance premiums will reach USD 583 billion in nominal terms, or 13% of the P&C total.

Liability claims have been rising faster than economic growth in most major countries recently, increasing claims costs for insurers. COVID-19 litigation, social inflation, opioid litigation and sexual harassment claims among others will shape the near-term future of liability insurance. Climate change litigation, cyber risk and the liability from emerging technologies such as artificial intelligence, hydrofracking and autonomous cars, may expand tort liability and liability claims in the period to 2040. The potential for risk accumulation in the increasingly interconnected world could further escalate claims.

The long-term growth in liability claims is influenced by economic factors such as medical expenses, wages, inflation and asset values; by societal and demographic trends (eg, longer life spans); by developments within the legal system; and also the scope of liability insurance cover. Rising medical costs and wages will affect the severity or average value of bodily injury claims. Societal trends with respect to propensity to sue and of the value of fair compensation can impact both the severity and the frequency of claims filed each year. The scope of tort liability grows through legislation and the evolution of case law. Many countries are experiencing an expansion of litigation, collective redress and litigation funding.

The evolution of the liability insurance market does not follow a linear path. Rapid expansion of the scope of liability has often triggered legislative action (tort reform) to curb costs and uncertainty for business and society. The insurance industry is also reacting to claims trends. What is insurable in the market can change over time. For example, the application of advanced data analytics may increase insurability of new emerging risks such as cyber. On the other hand, a risk once deemed insurable can become challenging to insure or uninsurable, as has happened with asbestos, pharmaceutical products and professional liability for financial institutions.

We thus do not attempt to predict and quantify specific legal trends. Economic activity will be the main long-term influence on claims growth. Based on past experience, we expect that liability claims – and thus the demand for liability insurance cover – will increase at a faster pace than economic growth.

Table 10**Key factors that affect long-term liability risk pools**

Long-term factors	Implications for risk pool	Impact on premium trends
Economic development	GDP elasticities larger than one, stronger for emerging economies	↗
Climate change	Climate change litigation	↗
Technology, digitisation	Cyber risk exposure, litigation	↗
Expansion of legal liability	Social inflation	↗

Source: Swiss Re Institute

Economic development is the strongest driver of liability premiums.

Countries with common law systems tend to have larger liability insurance markets relative to economic output.

Countries with common law systems also display stronger cycles of social inflation.

Economic development as the main driver of liability sector growth

To assess how liability markets will likely evolve over the next two decades, we have analysed the historic relationships between liability premiums and various economic variables. We find that economic development tends to be the strongest driver of liability premiums, though this relationship has not always been linear. More developed economies tend to have bigger volumes of liability premiums not only due to larger economic output, but also because liability penetration rates tend to be higher for more advanced economies. There is a positive and significant correlation between penetration rates and GDP per capita, suggesting that countries with larger GDP have larger liability markets not only because they have larger economic output, but also because a larger share of their economic activity is insured.

Countries with common law legal systems such as the US, Canada, the UK and Australia tend to have stronger liability markets than others with comparable levels of economic output.⁵² Common law legal systems resolve conflicts through private legal disputes, which increases liability claims and consequently demand for liability insurance. In continental Europe, national legal systems are shaped more by public regulation.⁵³

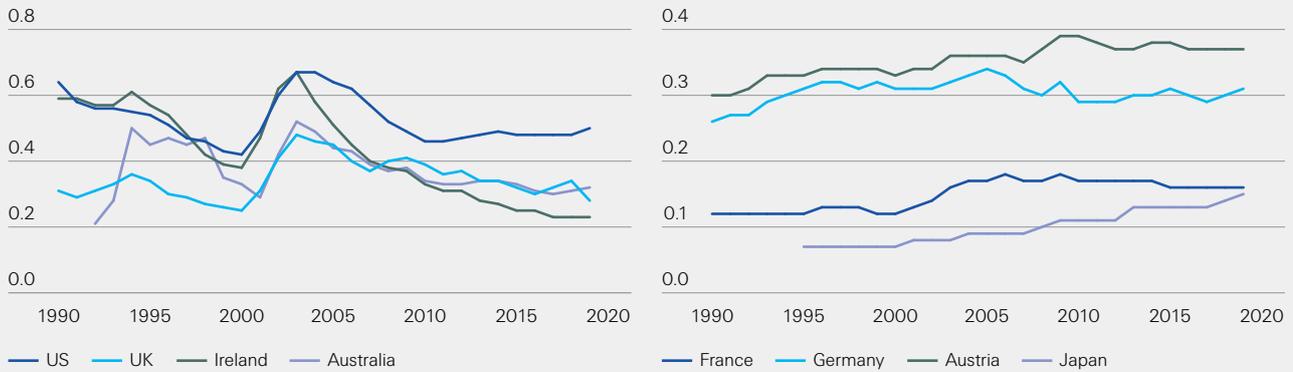
Social inflation and underwriting cycles

Liability claims are highly exposed to economic, social and legal dynamics, which can result in large variability in claims costs and risk premiums. They are influenced by social inflation, that is upward pressure on liability claims beyond that deriving from economically-driven inflation. Due to social inflation, liability markets are strongly cyclical, especially in Anglo-Saxon countries with common law legal systems (see Figure 11). Trials gain relevance quickly through the evolution of case law and the adaptive behaviour of plaintiffs and their trial lawyers. Insurers respond to an increasing claims burden by charging higher risk premiums and driving liability premiums upwards. Due to episodes of social inflation and underwriting cyclicity, the growth of liability premiums tends to fluctuate in a cyclical pattern around a long-term, steady-state growth trend. We adjust for the premium rate cycle in our model.

⁵² For instance, in terms of size, the UK liability market is double that of France, a country with similar GDP. Similarly, Australia's liability market is twice as large as that of Spain, though both countries have comparable economic output.

⁵³ Examples are the larger roles of mass tort, product liability, medical malpractice and securities fraud. Legal expenses are also driven higher in common law regimes by the attorneys' role in fact finding. In civil law regimes, inquiry lies more within the purview of the court system.

Figure 11
Liability premium trends in countries with strong cycles (LHS) vs no cycles (RHS)



Note: Figure shows the difference in liability premium growth patterns between a set of countries with strong cyclicalities (the US, UK, Ireland and Australia), and a set of countries with no or with low patterns of cyclicalities (France, Germany, Austria, and Japan). Liability penetration, calculated as liability premiums as a share of GDP, are given on the y-axis (in %).

Source: Swiss Re Institute

Modelling the liability insurance risk pool in 2040

We analysed the relationship between economic development and liability premium growth for 60 countries.

GDP elasticities of liability premium growth are higher for emerging economies.

Methodology

To assess how the liability insurance market can evolve with global economic developments in the future, we carried out a regression analysis on a sample of advanced and emerging markets on annual data for the period 1990–2020.⁵⁴ We included a Lloyd's premium rate price index as a proxy to control for the cyclicalities in liability premiums. Based on the observed differences in past developments, we allowed for the estimated elasticities of liability premiums in relation to GDP growth to vary by the country income group, and for China separately.

As a result, we estimate that at 1.15, the elasticity of liability premiums with respect to economic growth is slightly higher in emerging than in advanced markets (1.11) (see Table 11 for regression results). This implies that for every USD 100 of GDP per capita growth, liability insurance markets expand by USD 115 in emerging markets, and by USD 111 in advanced economies. That insurance premiums in emerging markets react more strongly to economic development is not surprising. The so called “S-curve” model in insurance implies that the growth of insurance markets relative to GDP is fastest for countries in the middle-income range, and tapers off for those at the highest income level.⁵⁵

Table 11
Summary of model results

Elasticity of liability premiums with respect to:	
GDP, advanced markets only	1.11
GDP, emerging markets (excl China) only	1.15
GDP, China only	1.23
Lloyd's Price Index	0.60

Note: Regression output is based on a panel regression using nominal liability premiums, nominal GDP, a global Lloyd's Price Index and country fixed-effects. Regression includes 36 advanced economies and 24 emerging economies for which sufficient annual data for the period 1990–2020 is available. All variables are in logs so that the estimated coefficients represent elasticities. All elasticities are significant at 1% confidence level.

Source: Swiss Re Institute

⁵⁴ To control for underlying, unobserved cross-sectional heterogeneity across countries, the regression also includes country fixed-effects.

⁵⁵ R. Enz, “The S-Curve Relation Between Per-Capita Income and Insurance Penetration”, *The Geneva Papers on Risk and Insurance*, vol 25, 2000.

GDP elasticities are higher than 1 due to structural changes in the economy.

While our forecasts are based primarily on economic (GDP per capita) growth, to a certain extent they also implicitly account for underlying trends and structural changes in the economy. For instance, the valuation of corporations is increasingly driven by intangible rather than physical assets (see *Corporate sector's exposure increasingly lies in intangible assets*). Intangible assets include goodwill, legally protected intellectual property, software, databases, customer relationships, workforce, websites and many more. These assets expose corporates to liability and cyber risks (see *Cyber risks*). For instance, there is huge reputational risk from not properly looking after customer records and from loss of data. Such transformations are driving liability market growth faster than economic growth, resulting in estimates of GDP elasticities higher than 1.

Liability premiums will grow fastest in emerging markets.

Market size by 2040

Based on our in-house model, we forecast that economic development alone will yield an additional USD 369 billion in global liability premiums, bringing the total to USD 583 billion by 2040, up from USD 214 billion in 2020. Much of the growth will come from the emerging markets, where the liability market is expected to grow two times faster than in advanced economies (see Table 12). The faster growth in emerging markets is due both to their faster expected GDP per capita growth over the next two decades, and also the higher elasticities of liability markets to GDP per capita growth in these markets. We expect emerging markets to represent 18% of the global liability market by 2040, up from 10% in 2020.

Table 12
Global liability premiums forecast up to 2040 (smoothed)

	Advanced markets	Emerging markets	Emerging markets, excl China	China	World
Liability premiums 2020E (USD billion)	193	21	8	13	214
Liability premiums 2040F (USD billion)	480	103	34	69	583
CAGR liability*	4.3%	7.7%	7.1%	8.0%	4.7%
Elasticity liability to GDP**	1.11	1.22	1.15	1.23	1.12

Note: Forecasts are based on our estimates of liability premium elasticities to GDP per capita growth, shown in Table 10, and in-house forecasts of GDP per capita growth, for 36 advanced and 24 emerging markets. Forecasts are based on a smoothed trend growth, netting out of any possible future cyclicalities such as those due to social inflation. *The liability premium CAGR is calculated for the period 2021–2040. **Elasticities are calculated over the period 2021–2040 and world elasticity is weighted by average regional premium levels.

Source: Swiss Re Institute

Evolving economic and social trends have the potential to expand the scope of liability beyond our quantitative outlook.

The estimates are conservative and may understate full potential, as our model does not capture some trends that are hard to quantify. Liability risk evolves with economic growth, social conditions and changes on the product and technological front. More so than natural catastrophe or mortality risks, liability risks involve human behaviour and complex societal relationships that are difficult to quantify. This evolution of liability risk is not new and is part of the reason why liability insurance premium growth exceeded economic activity in the past. There have been significant episodes of expansion of liability regimes in the observation period and hence we do not assume an acceleration of these trends for the 20-year forecast period, even though we face an episode of social inflation in the short-term.⁵⁶ Nevertheless, we flag some larger trends with the potential to expand the scope of liability exposures. These trends are impossible to quantify as of now and add risk to our quantitative outlook.

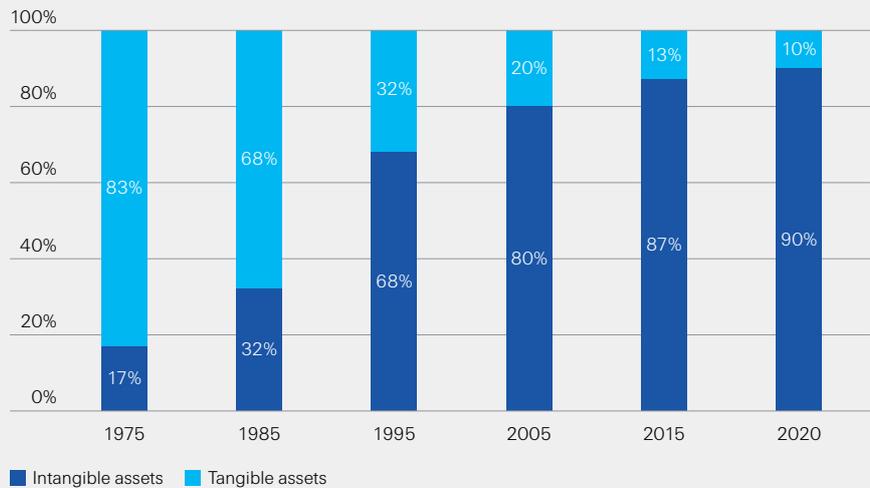
⁵⁶ See *Economic Insights - Social inflation: a building pain point in US liability insurance*, Swiss Re Institute, 14 November 2019.

Corporate exposures are shifting from physical towards intangible assets.

Corporate sector's exposure increasingly lies in intangible assets

Over the past few decades, the corporate sector has undergone a number of changes. First, a gradual transformation from firms being rich in tangible assets to firms where intangible assets have become the main source of value. In 1975, tangible assets (ie, mostly physical assets such as plant, property, equipment and inventory) constituted 83% of the total market value of the S&P 500 (see Figure 12). By 2020, the share of tangible assets had fallen to just 10%.⁵⁷ Conversely, intangible assets such as intellectual property, networks, platforms, data and customer relationships accounted for the other 90% of the S&P 500's market value.

Figure 12
Tangible vs intangible assets as share of S&P 500 market value



Source: Ocean Tomo

This shift is also reflected in the composition of the world's largest corporations from being manufacturing-based (eg, Exxon Mobil and General Electric) in 1980 to technology and service companies in 2020 (Apple, Alphabet, Microsoft, Amazon etc). With the shift, concerns around risks related to physical property have given way to a risk management process for intangibles.⁵⁸ With these changes, insurance demand has moved increasingly toward covers for supply-chain risks, cyber, product recall and liability exposures. Our forecasts are in line with these trends: we expect the liability insurance market to grow as a share of total P&C risk pool (from 12% in 2020 to 13% in 2040), and that liability premiums will grow faster than the economy (4.9% projected CAGR in liability premiums over next two decades, vs 4.4% CAGR in global economic growth).

⁵⁷ *Intangible Asset Market Value*, Ocean Tomo, 2020.

⁵⁸ B. Libert, M. Beck, S. Cracknell, "Why Leaders Are Still So Hesitant to Invest in New Business Models," *Harvard Business Review*, 21 December 2016.

Evolving liability risk trends

A new EU directive will expand and standardise collective redress for consumers.

US-style litigation and awards are unlikely, but we expect an upward trend in claims nonetheless.

Climate change litigation has gained momentum.

ESG criteria are increasingly part of corporate pledges and disclosure requirements.

Collective redress in Europe

There has been a long trend in the European Union (EU) to protect and empower consumers through expanding liability rules and facilitating collective action, although implementation has been more limited than in the US or Australia. In November 2020, the European Parliament and Council adopted directive 2020/1828⁵⁹ with the goal of standardising mass torts across the EU. The directive is part of the “New Deal for Consumers” and requires EU member states to provide for at least one representative action procedure for consumers in national law by June 2023. Under the new procedures, only Qualified Entities (QEs) like public authorities or non-profit consumer organisations can bring representative actions on behalf of groups of consumers and file for collective action. Member states need to ensure that third party-funded actions do not include conflicts of interest or divert from the goal of consumer protection. To that end, third-party funding needs to be disclosed.

The Directive aims at harmonising mass tort rules and will likely lead to an increase in claims activity, even if not to the level of US-style outcomes. Key drivers of headline-grabbing awards in the US are not present in Europe. The EU favours opt-in rather than opt-out class action rules (reducing the size of the prospective class), awards do not allow for punitive damages, and trials are decided by judges rather than a jury.⁶⁰ The Directive also includes additional safeguards against abusive lawsuits, including the “loser pays” principle. This prevents punitive damages and also enables courts to “dismiss manifestly unfounded” cases. Nevertheless, we expect the establishment of a collective redress mechanism alongside other activity, such as the expansion of litigation funding firms, will increase liability costs.

Climate change litigation

Climate change litigation has gained momentum since the adoption of the Paris Agreement in 2015, increasing in volume, scope and geographical coverage. Of the 1727 cases documented worldwide between 1986 and 2020, more than half have been brought since 2015.⁶¹ Increased awareness of climate risks and the growing perception that courts can be a forum to advance climate goals are two main drivers of climate change litigation. New developments in attribution science, where the relationship between emissions and climate change-related impacts is quantified, have also encouraged efforts to attribute emissions to specific companies.⁶²

Sustainability issues are becoming core considerations in business. ESG criteria are increasingly valued by shareholders, employees and customers.⁶³ 2020 saw a record number of corporate pledges on mitigating climate change: on average one new company joined the Science Based Targets initiative each day and committed to emission reduction goals. This momentum raises the bar for corporate governance. The growing focus on climate change also extends to corporate disclosure, and there has been significant progress on this front. Europe is taking the lead on climate-related financial disclosures, and other jurisdictions are following suit.⁶⁴

⁵⁹ Directive (EU) 2020/1828 of the European Parliament and of the Council of 25 November 2020.

⁶⁰ *The Future of Disputes: Class Actions and Consumer Claims*, Baker McKenzie (webcast), 19 November 2020.

⁶¹ *Climate Change Litigation – Insights into the evolving global landscape*, Geneva Association, April 2021.

⁶² M. Burger, J. Wentz and R. Horton, “The Law and Science of Climate Change Attribution”, *Columbia Journal of Environmental Law*, vol 45, 2020.

⁶³ For an example on investors see: N. Holmes et al., *Insurance ESG Big Picture. Exiting coal – At the heart of insurance ESG*, Societe Generale Cross Asset Research,

⁶⁴ *2020 Status Report: Task Force on Climate-related Financial Disclosures*, Financial Stability Board, 29 October 2020.

Reshaping liability risk pools

Firms and states are at increasing risk to be found negligent in causing harmful climate change effects.

Transition impacts have already started to expand professional liability/D&O exposure to claims.

The rise of AI will raise ethical and legal questions on how liability is apportioned.

AI-specific policies will emerge, as coverage of existing policies will likely lag behind technological progress.

Standards of care are also evolving, increasing the risk that states and corporations can be found negligent in their duty to protect the public from the harmful effects of climate change. Attribution science is central to the recent litigation, as it informs discussions of responsibility. As an example of these changes, in a significant decision in May 2021, the District Court in The Hague ruled that Shell must reduce its global net carbon emissions by 45% by 2030 from 2019 levels.⁶⁵ The decision is under appeal.⁶⁶ This was the first time a judge has held a corporation liable for causing climate change. The ruling could set a precedent for similar lawsuits.

In addition to general and product liability exposures based on the physical impacts of climate change, transition impacts pose significant risks to professional liability/D&O lines.⁶⁷ Transition impacts include changes in policy, law, markets, technology and public attitudes toward business activities.⁶⁸ For example, in June 2021 the G7 finance ministers announced their support for a mandatory climate reporting standard based on the current voluntary Task Force on Climate-Related Financial Disclosures (TCFD) recommendations. The potential for mis-representation of climate-related risks will increase if disclosure is mandatory, but the transition impacts have already begun to expand D&O exposures to claims brought by customers, shareholders or the community. In an attempt to mitigate exposure to climate-related litigation, D&O insurers are likely to rely on pollution-related exclusionary language, defence cost carve-outs and the claims-made basis of the coverage.

Liability for Artificial Intelligence

Artificial intelligence (AI) is a transformative technology that will have a profound impact on manufacturing, transportation, modelling and forecasting, healthcare and many other fields. But AI also involves risks, as AI systems can make mistakes. These can lead to tort liability and discrimination claims. This raises the question of how liability is allocated among the parties involved – the developers, manufacturers, sellers and users. While developers are likely targets, AI learns by doing, and the AI that caused an injury may have evolved significantly from that of the original design.⁶⁹ These are complex issues relating to product liability, where the focus is on attributing responsibility for products that cause harm. What is the role of the data that was used to “teach” the AI algorithm, and who is responsible for unintended consequences: the user, the data provider or the developer? Within the broad umbrellas of tort and contract law, multiple theories of liability can potentially arise in the context of AI.⁷⁰

The issues and challenges presented by AI do not fall neatly within current liability products. General liability policies cover bodily injuries and property damage from products, but exclude coverage for losses arising from professional services, or cyber and tech losses. Professional liability policies provide coverage for wrongful acts, so they may not respond to situations where the AI worked as intended, but a loss occurred because the data was flawed. Cyber and tech E&O policies do not cover bodily injuries or property damage, and may only cover cyber-attacks. While emerging, there is likely a significant coverage gap when it comes to AI losses. This gap will likely widen first since advances in technology will outpace any changes to insurance industry policy language. Since existing policies may not provide the necessary coverage, we expect to see the emergence of AI-specific policies, or bespoke language addressing certain AI risks in the long-run. Similar to other

⁶⁵ “Court orders Royal Dutch Shell to cut carbon emissions by 45% by 2030”, *The Guardian*, 26 May 2021.

⁶⁶ *Shell confirms decision to appeal court ruling in Netherlands climate case*, Shell, 20 July 2021.

⁶⁷ *Climate change litigation threats to directors and officers*, Willis Towers Watson, 27 November 2019.

⁶⁸ See *Climate change litigation update*, Norton Rose Fulbright, 2019.

⁶⁹ *Is the insurance industry ready for Artificial Intelligence losses?* Swiss Re, Trend Spotlight, 2021.

⁷⁰ See J. Villasenor, *Products liability law as a way to address AI harms*, Brookings, 31 October 2019.

technology-triggered areas of emerging liability risks, insurers will not have a rich loss experience or modelling capability on which to draw to assess these risks.

Climate change litigation is likely to exacerbate the current episode of social inflation...

Social inflation in the medium term

Climate change litigation, among other emerging liability risks, has the potential to exacerbate the current spell of social inflation and make it similar to earlier episodes. The last two periods in the US occurred in the mid-1980s and early 2000s, with loose parallels to today. In the mid-1980s, the scope of tort liability was widened through changes to legislation and case law, with a rapid development of claims centred around asbestos and environmental liability. In the early 2000s, the scope of liability was widened by easing access to mass tort claims through case law. As a result, there was a wave of class actions that drove claims costs higher.

...which is already being amplified by the use of litigation funding and new psychology and data-based strategies in trial bar.

The current episode of social inflation started in 2015. Adverse reserve development was first observed in commercial auto liability claims and then spread to general liability, D&O and medical malpractice lines. This trend is driven by factors such as the trial bar increasingly using psychology-based strategies, data analytics, digital media advertising and litigation funding. Other factors relate to jurors' attitudes to issues like social injustice, rising inequality and negative sentiment toward corporations. We expect the experience of liability claims growth in excess of inflation to continue over the next couple of years. The COVID-19 crisis is likely to amplify rather than alleviate the societal factors in play, exacerbating factors such as economic, educational and health inequality.

Table 13
Long-term outlook for the non-economic factors contributing to social inflation

Plaintiff/defendant bar tactics	<ul style="list-style-type: none"> ■ The plaintiff bar's applied psychology tactics (focus on emotions rather than facts) will spread as more law firms adopt them. ■ Defence lawyers are only slowly adapting/reacting effectively to the tactics of the plaintiff bar. The defence bar may regain some control, but catching up will be challenging and take time.
Litigation funding	<ul style="list-style-type: none"> ■ Litigation funding is expected to continue to grow as the market for legal assets matures and awareness among lawyers increases. ■ Regulation could be a counterforce (eg, requiring disclosure of litigation funding or capping usury rates of funders).
Social attitudes	<ul style="list-style-type: none"> ■ Trust in large corporations is low, trending down and trails other institutions; strengthening support for social activism through the tort liability system. ■ (Social) media continues to broadcast negative news, driving outrage and polarisation. ■ Mid- to long-term changes are less clear and will depend on whether society and politics are further divided or manage to come closer together and adopt inclusive policy changes.
Inequality	<ul style="list-style-type: none"> ■ COVID-19 has deepened economic, educational and health inequality. ■ Without a major policy reset, there is no indication that the long-term trend of rising inequality would change.
Tort reform	<ul style="list-style-type: none"> ■ Tort reform has curbed prior episodes of social inflation. No significant legislative developments on tort reform are expected in the next few years. It is not considered a pressing issue by either major political party and a divided Congress makes reforms unlikely at federal level. ■ There is no clear trend at state level.

Source: Swiss Re Institute

Despite efforts to secure networks, cyber exposures are growing.

Costs of cybercrime is rising fast, reaching USD 1 trillion in 2020.

The global cyber insurance market is projected to triple in size by 2025.

Systemic impacts of cyber risks are beyond the risk transfer capabilities of the private re/insurance industry.

Cyber risks

Digitisation is contributing increasingly more to wealth creation. On the flipside, cyber risk is rising rapidly too. Since 2016, cyber exposure has constantly ranked among the top 3 business risks. In the 2021 *Allianz Risk Barometer* report, 40% of respondents mentioned cyber incidents as one of the Top 3 risks, at par with pandemics outbreaks (41%) and business interruption risks (40%) in 2021.⁷¹ “The threat of business interruption, whether from ransomware attacks, technical failure or via the supply chain, more severe consequences from data breaches and risks emerging from the acceleration of digitalisation post-Covid-19, loom large.”⁷² Risk perception varies by sector: cyber is the top risk for telecoms, professional and financial services and public services (including healthcare). The Barometer report shows it is also deemed highly relevant in manufacturing and transportation sectors, less so in agriculture and consumer goods.

A recent report said that cybercrime costs the world economy more than USD 1 trillion (just more than 1% of global GDP, and up more than 50% from 2018).⁷³ This encompasses direct losses due to cyber-crime, the cost of securing networks, reputational damage and liability risk for a hacked company and its brand, opportunity costs, and the cost of associated insurance. Among others, major cyber risks events can include a large data breach, outage of a major cloud service provider, and/or a global malware event.

With a growing catalogue of cyber incidents and increasing exposures, demand for associated insurance solutions is rising. The global cyber insurance market size is projected to grow from around USD 7 billion today to USD 20 billion by 2025, a CAGR of 20%.⁷⁴ Assuming a 10% growth rate thereafter, which is about double the growth of property insurance, the cyber market could amount to USD 80 billion in premiums by 2040. The major factors driving the market include the increasing number of sophisticated cyber-attacks, which in turn amplify the fear of financial losses, and the growing need for compliance with various regulations. While a significant share of cyber risk is currently insured via D&O/E&O liability insurance, we expect most of the longer-term growth will come from dedicated standalone products. We also expect that these will increasingly include first-party protection against business interruption, ransom, and reputational risk.

We believe there needs to be a thorough exploration of pool or government-backed solutions. This is so as to provide some level of support for systemic impacts, such as major infrastructure attacks that can cripple an entire region, or virulent malware that can take down entire networks. Such an attack could result in a large loss from risk accumulation and propagation, exceeding the risk transfer capability of the private re/insurance industry. As has been seen in terrorism risk, pools and government backstops can allow insurance companies to provide a layer of coverage without taking inordinate risks. This can help protect the economy and society from severe impacts following a large-scale event.

⁷¹ *Allianz Risk Barometer: Identifying The Major Business Risk for 2021*, Allianz, 2021.

⁷² Ibid.

⁷³ Z. Malekos Smith, E. Lostri E., A. J. Lewis, *The Hidden Costs of Cybercrime*, McAfee Report, 2020.

⁷⁴ *Cybersecurity Insurance Market*, Markets and Markets, October 2020.

Call for action

Insurance can facilitate the transformational changes taking place in the economy, society and in technology, but only with collective action by the private and public sectors. For instance, climate change is the main risk to the global economy. Insurance can provide compensation for damage to property resulting from extreme weather events, but an institutional framework to encourage investment in green infrastructure, and upgrading zoning and building standards, are equally important to ensure insurability of property risks. Likewise, with expanding liability regimes, unsustainable social inflation needs to be curbed through legislation and regulation. Further, the value of re/insurance needs to be protected against a trend of fragmentation via local capital and collateral requirements.

Insurance and governments need to work together

More policy action is needed to reduce emissions...

Climate change will have significant negative impact on economic growth and catastrophe losses, even if the Paris Agreement goals are met.⁷⁵ Current policy actions, however, appear to be working against the Paris Agreement targets being met. For instance in June this year, Germany amended its Climate Protection Act after the Constitutional Court ruled the act unconstitutional in parts for not going far enough to ensure climate policy goals are met.⁷⁶

...and it needs to be globally coordinated.

To get back on track to the Paris goals will require global policy action. To this end, there needs to be more policy action on carbon pricing coupled with incentivising nature-based and carbon-offsetting solutions. International convergence on the definition of what counts as green and sustainable investments is also needed. As part of corporate reporting, institutions should disclose their roadmaps on how they intend to reach the Paris and 2050 net-zero targets.⁷⁷

There needs to be more promotion of pre-disaster loss mitigation.

The impacts of climate change on property insurance emphasise the importance of risk-mitigation measures as a pre-condition to keeping some property risks insurable. Insurers play a key role in encouraging investment in loss mitigation. Actuarial and underwriting expertise can help measure the relative costs and benefits of mitigation decisions. Premium rates can provide ex ante incentives for investments in loss mitigation of physical structures.⁷⁸ Long-term contract features relating to premium discounts could strengthen the incentives to invest in safety features.⁷⁹ Industry standards on premium discounts would enable homeowners to capture the payback via lower premiums even after changing carriers. Transparency about safety investments could be increased by including this information in data collected and analysed by realtors, appraisers and mortgage banks.⁸⁰

More green infrastructure is needed to reduce carbon emissions and mitigate the impact of disasters.

Green infrastructure is central to adapting to climate change. Examples of how it can help include using scarce water resources more efficiently; restoring natural flood defences; using tree species and forestry practices that are less vulnerable to storms and fires; implementing natural water retention measures; reducing heat islands in urban areas; and setting aside land corridors to help species migrate. In addition, resilient and sustainable infrastructure incorporating renewable energy technologies helps mitigate climate change through carbon capture and storage.⁸¹ Infrastructure investments also increase the capacity of communities to withstand the physical impact of large disasters and minimise economic disruption.

⁷⁵ IPCC Special Report, 9 August 2021, op. cit.

⁷⁶ "How a court ruling changed Germany's climate protection act", *Pinsent Mason*, 20 July 2021.

⁷⁷ Swiss Re Institute, April 2021, op. cit.

⁷⁸ C. Kousky "The Role of Natural Disaster Insurance in Recovery and Risk Reduction" *Annual Review of Resource Economics*, vol 11, 2019.

⁷⁹ P. Kleindorfer, H. Kunreuther, C. Ou-Yang "Single-year and multi-year insurance policies in a competitive market," *Journal of Risk and Uncertainty*, vol 45, 2012.

⁸⁰ This could include information about location within flood zones, building elevation, structural storm reinforcements, etc. See for example T. Holzheu, G. Turner, *The Geneva Papers on Risk and Insurance - Issues and Practice*. 2018, op. cit.

⁸¹ *The insurance rationale for carbon removal solutions*, Swiss Re Institute, July 2021.

Call for action

A transparent and harmonised infrastructure asset is needed to catalyse investments.

Insurance can support the much-needed overhaul of existing, and facilitate investment into new sustainable infrastructure to cut emissions and achieve the 2030 Agenda for Sustainable Development targets.⁸² To attract private sector investment, including from insurers, it is important to turn infrastructure into a tradeable investment class and improve the consistency, comparability and reliability of sustainability reporting.⁸³ Moreover, insurers can contribute by underwriting the risks inherent in the construction and operational phases of green infrastructure projects. In the construction phase, specialty lines such as engineering, credit & surety, contractors' all risk, marine and energy-related insurance products can provide financial protection against loss-making events; when operational, property and business interruption covers will keep projects running.

Incorporate state-of-the-art costing and risk management models.

The re/insurance industry needs to actively track and embed the effects of temperate warming and adapt models to a changing risk landscape. There is a large degree of uncertainty about the future pathways of climate-relevant emissions and their translation into rising temperatures. Consequently, there is a significant risk that temperatures rise more than 1.5°C by 2040, causing higher property losses than predicted in our baseline scenario of this study.⁸⁴ More global warming would also lead to slower GDP growth rates, especially in emerging economies.⁸⁵ Therefore, updating the risk modelling of exposures to primary peril risks remains critical, but so too is strengthening modelling of secondary peril risks. Given the rise of their associated losses, secondary perils need to be better understood for the purpose of more complete risk assessment of the full range of natural catastrophe exposures that society and the global economy faces.⁸⁶

Facilitate and strengthen public-private partnerships.

Public-private partnerships can facilitate insurability of hard-to-insure risks. These types of partnerships can go both ways: on the one hand, there is a need for government backstops as insurer of last resort for risks that exceed the capacity for insurability in the private markets. This could be cyber catastrophe risks from large coordinated attacks, future pandemics, or solutions for affordable natural catastrophe insurance in peak risk zones. On the other hand, there is a need for insurance of public (infrastructure) assets for countries or public entities under fiscal stress, where risk transfer through the global re/insurance market comes at a lower cost of capital. There is also a strong case for transforming international disaster assistance from post-event grants to ex ante solutions via insurance or cat bonds.

Curb unsustainable social inflation through legislation and regulation.

Liability insurers are exposed to expanding concepts of liability and rising compensation awards. Social inflation has emerged as a key factor pushing up loss costs in the US. There are several areas where government action is needed to keep the tort liability system and commercial liability sustainable. This includes mandatory transparency about litigation funding to all parties involved in a lawsuit, tort reforms on state and federal level in areas where claims developments turn unsustainable, and regulation about terms and conditions of litigation funding agreements to protect plaintiffs from predatory lending conditions and to reduce conflicts of interest.

Promote global capital efficiency and flexibility in solvency regulations.

The global P&C risk pool will become riskier. We estimate that the share of catastrophe in all property premiums will increase from 20% in 2020 to 28–31% in 2040. Catastrophe losses are volatile given the potential for huge risk accumulation, and capital requirements and need for reinsurance will increase. Global flexibility in allocation of capital and risk enables re/insurers to use scarce risk capital efficiently

⁸² *Transforming our world: the 2030 Agenda for Sustainable Development*, United Nations, 2015

⁸³ Swiss Re Institute and Global Infrastructure Facility, January 2021, op. cit.; *Facilitating European Infrastructure Investment*, European Financial Services Round Table, 2018; *Infrastructure investing. It matters*, Swiss Re and the Institute of International Finance, 2014.

⁸⁴ IPCC Special Report, 9 August 2021, op. cit.

⁸⁵ Swiss Re Institute, April 2021, op. cit.

⁸⁶ M. Gloor, T. Holzheu, K. Tamm, "Modelling Climate Change for the Insurance Industry", in Network for Greening the Financial System: *Case Studies of Environmental Risk Analysis Methodologies*, 2010.

and provide a maximum of risk transfer capacity to the global economy. It is therefore important to protect the value of re/insurance against fragmentation via local capital and collateral requirements and challenges to intragroup transactions. We also advocate for the use of internal models in capital standards, which are necessary for the full recognition of risk mitigation and diversification.

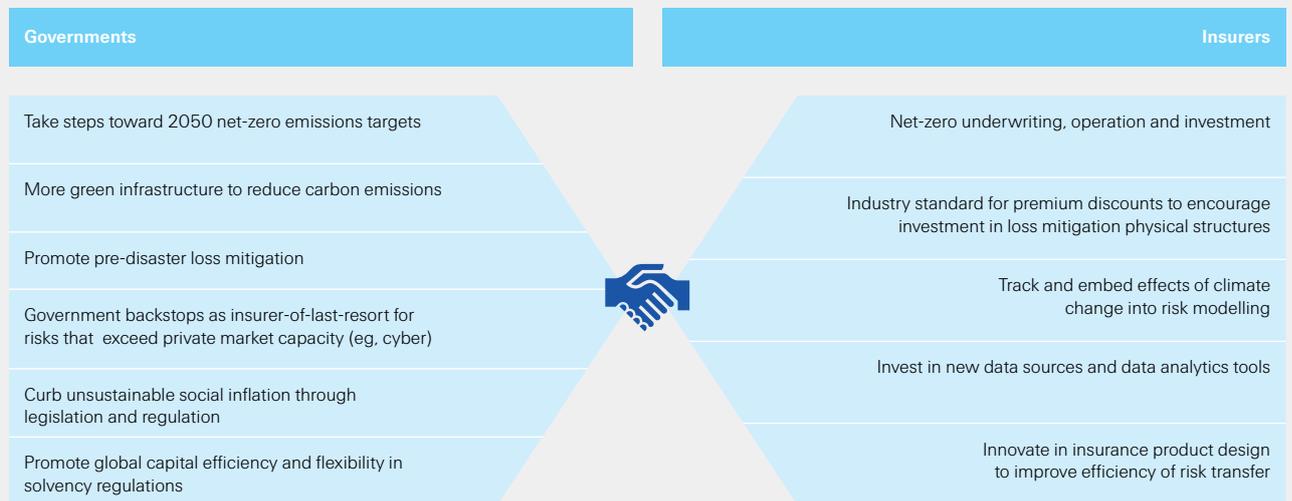
Invest in new data sources and data analytics tools.

Evolving risks call for innovation in data, data curation and state-of-the-art analytics tools to make risks more insurable and more accurately priced. New data sources can enhance models, giving insurers information on trends outside traditionally available data sets. Insurers can now combine client data, in-house and third-party data from sources such as internet browsing histories, submission data, e-mail and meeting minutes, claims files, usage-based insurance devices and social media. Model analytics can also improve fraud detection.

Innovate in insurance product design to improve efficiency of risk transfer.

With advanced modelling, insurers can analyse and better understand key risk drivers. Product developments and innovation around data and analytics are needed to expand the scope of insurance in order to respond to the evolving risk landscape. Holistic covers, for example, combining multiple risks and/or interdependent triggers, can facilitate better alignment to the specific risk transfer needs of an insurance buyer. Parametric solutions are based on indices rather than actual losses. Both concepts are used to improve the efficiency of risk transfer and to enhance insurability of difficult-to-insure exposures. It is important that insurance regulation is flexible and accommodates the use of new data sources for underwriting and modelling, as well as the application of innovative risk transfer concepts such as parametric products and risk-linked derivatives.

Figure 13
Call for action: governments and insurers to work together



Source: Swiss Re Institute

Data sources and forecasting methodology

To model the P&C insurance risk pool, we construct a country-level annual panel dataset. The models for each business line use corresponding premium volumes and GDP or GDP per capita as the main explanatory variable, as well as other drivers specific to each market.

Premiums for each of the business lines are collected by Swiss Re Institute, primarily from national supervisory authorities and in some cases from insurance associations. Premiums are based on the direct premium volumes of insurance companies. Using the average exchange rate for the financial year, premium volumes are converted into USD dollars to facilitate comparisons between countries and regions.

Macroeconomic data such as GDP, population, share of urban population etc is sourced from the World Bank and the United Nations. The weather-related catastrophe insured losses come from Swiss Re Institute's disaster loss dataset.

The property and the liability models use a price index to control for cyclicity in premiums. The property model uses the world reinsurance price index for non-life business lines, the liability model uses the Lloyd's Price Index.

The designation of the economies in this report as "advanced" or "emerging" is generally in keeping with the conventions of the International Monetary Fund.

To project premium growth rates to 2040, we use Swiss Re Institute's internally developed projections of weather-related insured losses and of GDP. The shorter term GDP growth forecasts are estimated as a result of business cycle dynamics. Our longer-term GDP growth projections are anchored by the estimated growth potential of the various economies. We also benchmark our long-term forecast with institutions, such as the OECD.⁸⁷ For the share of urban population, we use the UN's projections up to 2040. The price indices are not included in the projections, since they only control for cyclicity.

⁸⁷ Y. Guillemette, D. Turner, *The long view: scenarios for the world economy to 2060*, OECD Economic Policy Paper, July 2018

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Published by

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for their contributions to this report.

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Explore and visualise *sigma* data on natural catastrophes and the world insurance markets at www.sigma-explorer.com

The editorial deadline for this study was 30 July 2021.

sigma is available in English (original language) and Chinese.

sigma is available on Swiss Re's website: www.swissre.com/sigma

The internet version may contain slightly updated information.

Graphic design and production:
Corporate Real Estate & Logistics / Media Production, Zurich



Printing: Multicolor Print AG, Baar

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Order no: 270_0421_EN

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