



ANNUAL MEETING

November 9-12, 2020 • Online Event

GREY SWANS AND BLACK ELEPHANTS: WHY WE KEEP GETTING SURPRISED AND WHAT WE CAN LEARN FROM THEM

Rade Musulin

Principal, Finity Consulting, Sydney, Australia

Leigh Wolfrom

Policy Analyst, Directorate for Financial and Enterprise Affairs, OECD, Paris, France



**Rade Musulin,
Finity
Consulting**



Agenda

- Catastrophic complexity, swans, elephants, and butterflies
- Big mistakes and examples of catastrophic complexity
- Grey swans
- Evolving the risk management paradigm



**Catastrophic
complexity,
swans,
elephants,
and
butterflies**

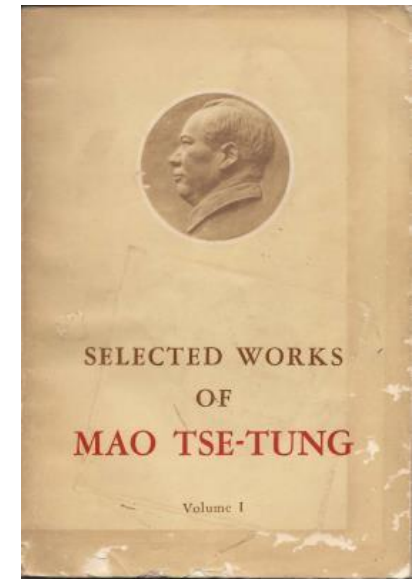
“A Black Swan has three attributes: unpredictability, consequences, and retrospective explainability.”

- Nassim Taleb



“Everything under heaven is in utter chaos; the situation is excellent.”

- Mao Tse-tung



David Brooks

The New York Times

Opinion

Drilling for Certainty



By David Brooks

May 27, 2010



In the weeks since the Deepwater Horizon explosion, the political debate has fallen into predictably partisan and often puerile categories. Conservatives say this is Obama's Katrina. Liberals say the spill is proof the government should have more control over industry.

But the real issue has to do with risk assessment. It has to do with the bloody crossroads where complex technical systems meet human psychology.

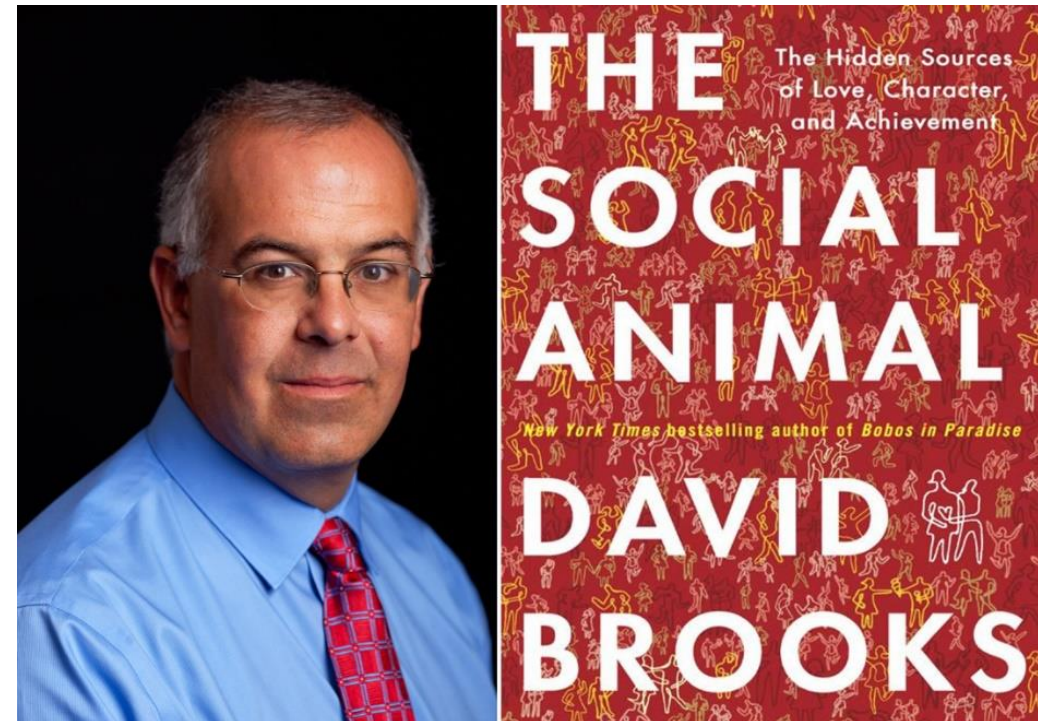
Over the past decades, we've come to depend on an ever-expanding array of intricate high-tech systems. These hardware and software systems are the guts of financial markets, energy exploration, space exploration, air travel, defense programs and modern production plants.

These systems, which allow us to live as well as we do, are too complex for any single person to understand. Yet every day, individuals are asked to monitor the health of these networks, weigh the risks of a system failure and take appropriate measures to reduce those risks.

If there is one thing we've learned, it is that humans are not great at measuring and responding to risk when placed in situations too complicated to understand.

In the first place, people have trouble imagining how small failings can combine to lead to catastrophic disasters. At the Three Mile Island nuclear facility, a series of small systems happened to fail at the same time. It was the interplay between these seemingly minor events that led to an unanticipated systemic crash.

<https://www.nytimes.com/2010/05/28/opinion/28brooks.html>



The New York Times

Drilling for certainty – The Deepwater Horizon

- On the Deepwater Horizon debacle, “...the bloody crossroads where complex technical systems meet human psychology”
- Humans often design systems which:
 - let small failings lead to catastrophic disasters
 - allow ourselves get acclimated to risk
 - place too much faith in elaborate backup devices
 - match complicated systems with complicated governance
 - spread good news and hide bad news
 - are overcome by “Groupthink”
- “We have constructed a world in which the potential for high-tech catastrophe is embedded in day to day life”; he referred to this as “**catastrophic complexity**”



CBS News

Nassim Taleb and Gregory F. Treverton



January/February 2015
ESSAY

The Calm Before the Storm

Why Volatility Signals Stability, and Vice Versa

Nassim Nicholas Taleb and Gregory F. Treverton

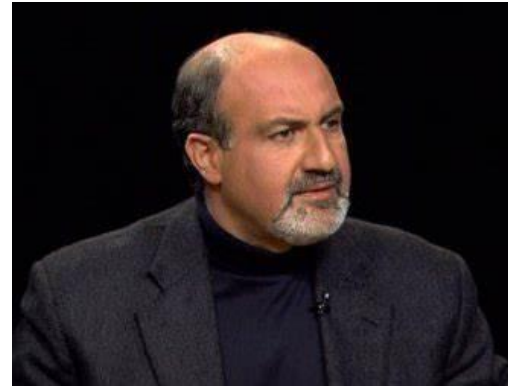
NASSIM NICHOLAS TALEB is Distinguished Professor of Risk Engineering at New York University's Polytechnic School of Engineering and the author of *Antifragile: Things That Gain From Disorder* [1]. GREGORY F. TREVERTON is Chair of the U.S. National Intelligence Council. From 2009 to 2014, he was Director of the RAND Corporation's Center for Global Risk and Security (where he wrote this article). This essay is adapted from a RAND risk-methodology report funded by the U.S. government.

Even as protests spread across the Middle East in early 2011, the regime of Bashar al-Assad in Syria appeared immune from the upheaval. Assad had ruled comfortably for over a decade, having replaced his father, Hafez, who himself had held power for the previous three decades. Many pundits argued that Syria's sturdy police state, which exercised tight control over the country's people and economy, would survive the Arab Spring undisturbed. Compared with its neighbor Lebanon, Syria looked positively stable. Civil war had torn through Lebanon throughout much of the 1970s and 1980s, and the assassination of former Prime Minister Rafiq Hariri in 2005 had plunged the country into yet more chaos.

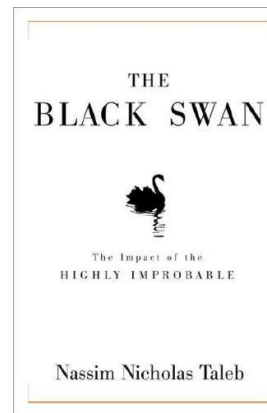
But appearances were deceiving: today, Syria is in a shambles, with the regime fighting for its very survival, whereas Lebanon has withstood the influx of Syrian refugees and the other considerable pressures of the civil war next door. Surprising as it may seem, the per capita death rate from violence in Lebanon in 2013 was lower than that in Washington, D.C. That same year, the body count of the Syrian conflict surpassed 100,000.

Why has seemingly stable Syria turned out to be the fragile regime, whereas always-in-turmoil Lebanon has so far proved robust? The answer is that prior to its civil war, Syria was exhibiting only pseudo-stability, its calm façade concealing deep structural vulnerabilities. Lebanon's chaos, paradoxically, signaled strength. Fifteen years of civil war had served to decentralize the state and bring about a more balanced sectarian power-sharing structure. Along with Lebanon's small size as an administrative unit, these factors added to its durability. So did the country's free-market economy. In Syria, the ruling Baath Party sought to control economic variability, replacing the lively chaos of the ancestral souk with the top-down, Soviet-style structure of the office building. This rigidity made Syria (and the other Baathist state, Iraq) much more vulnerable to disruption than Lebanon.

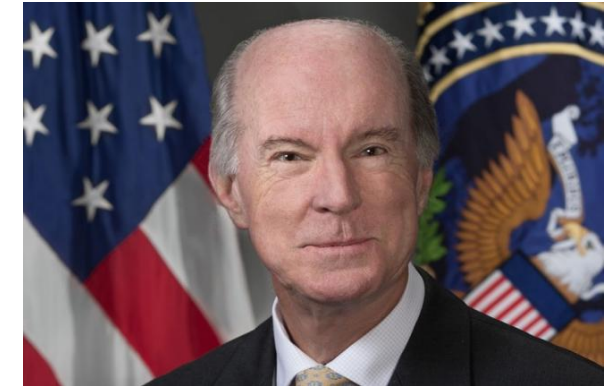
<https://www.foreignaffairs.com/articles/africa/calm-storm>



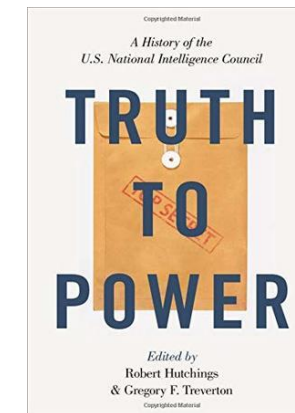
Business Insider



Nassim Taleb is Distinguished Professor of Risk Engineering at New York University's Tandon School of Engineering and author of "The Black Swan"



Leading Authorities



Gregory Treverton is the former Chair of the U.S. National Intelligence Council

The Calm Before the Storm

- Why volatility signals stability, and vice versa
- Past experience is a good indicator of “normal” risk, but a bad bellweather of tail risk
- Instead of trying to predict “black swan” events, it is more fruitful to focus on how systems can handle disorder
- Generally, systems which experience periodic and moderate amounts of change and disorder become more resilient, while ones which suppress change and natural cycles become fragile (e.g. periodic disorder is a vaccine against massive upheaval)
- **Do efforts to create stability sow the seeds for “black swan” events?**



From top: NASA, Foreign Policy, CNN

Black elephants

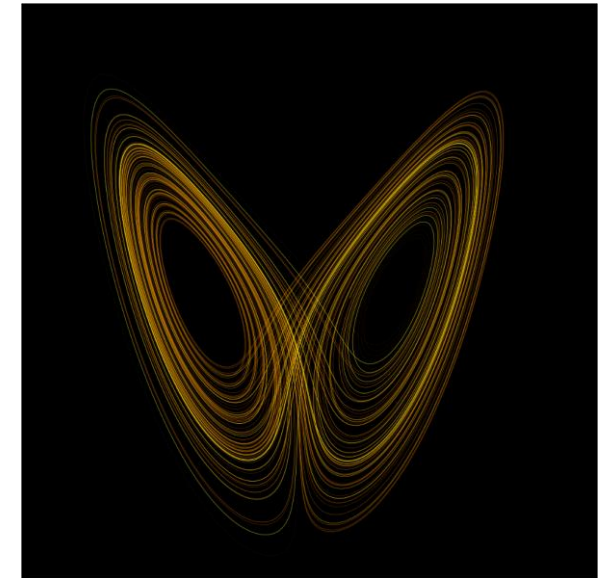
- A black elephant is a cross between “a black swan” (an unlikely, unexpected event with enormous ramifications) and the “elephant in the room” (a problem that is visible to everyone), something no one wants to address even though we know that one day it will have vast, black-swan-like consequences
- **“There are a herd of black elephants around**, such as global warming, deforestation, ocean acidification, mass extinction and massive fresh water pollution” (Adam Sweidan, 2014)
- Is COVID-19 an example of a black elephant?



<https://www.centerforhealthsecurity.org/event201/>

Butterflies

- The “butterfly effect” per Cambridge Dictionary:
 - Refers to a situation in which an action or change that does not seem important has a very large effect
 - Chaos theory relies on the idea of the "butterfly effect," that even slight imbalances in starting conditions lead to huge final variations in outcome because of the fundamental instability of the system
- Important to understand that **small, random events can have enormous consequences**
- Examples:
 - Gore vs. Bush
 - Archduke Ferdinand’s driver made a wrong turn in 1914
 - Lt. Col. Petrov chose not to report false missiles in 1983



A plot of Lorenz's strange attractor for values $\rho=28$, $\sigma = 10$, $\beta = 8/3$

Wikipedia

Big mistakes and examples of catastrophic complexity

“I’ve always believed that America’s government was a unique political system — one designed by geniuses so that it could be run by idiots. I was wrong. No system can be smart enough to survive this level of incompetence and recklessness by the people charged to run it.”

- Thomas Friedman, New York Times

2008



Carrington Event – it happened before (technology) (I)

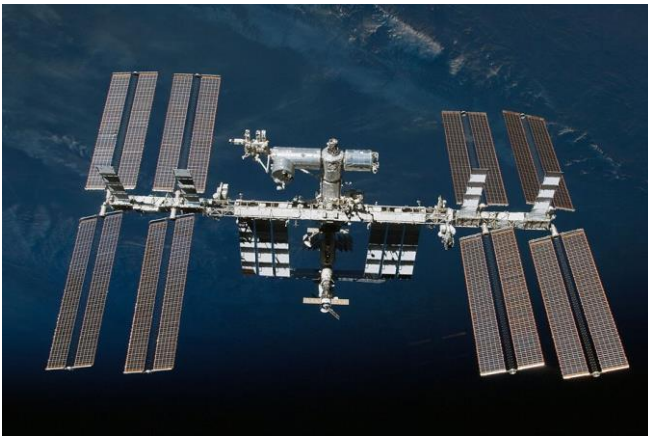


A STORM OF ELECTRICITY

TELEGRAPH WIRES USELESS FOR SEVERAL HOURS.

ONE OF THE MOST SEVERE DISTURBANCES FOR MANY YEARS, EXTENDING EVEN TO EUROPE—TELEPHONE WIRES ALSO OBSTRUCTED—BUSINESS DELAYED A GOOD PART OF THE DAY.

Yesterday's storm was accompanied by a more serious electrical disturbance than has been known for years. It very seriously affected the workings of the telegraph lines both on the land and in the sea, and for three hours—from 9 A. M. until noon—telegraph business east of the Mississippi and north of Washington was at a stand-still.



DAILY COURIER

WEDNESDAY, SEPTEMBER 14, 1859.

Northern Lights in the Tropics.

All our exchanges from the northern coast of the Island of Cuba—from the southern side we have none so late—come to us with glowing descriptions of the recent Aurora Borealis, which appears to have been as bright in the tropics as in the Northern zones, and far more interesting. At Havana it made its appearance a few minutes after nine o'clock, and in the most approved style, not as here, gradually crimsoning over the sky, but quick as thought it shot up, and in a moment spread over the whole Northern zone, from the horizon to the zenith. At first it was very brilliant, but at half-past nine it began to lose somewhat of its coloring, as it did of its length, and at ten it disappeared altogether. The sky was as clear as before.

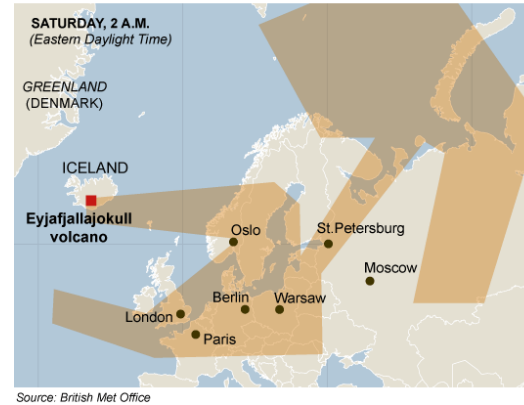
In 1859 a severe solar storm caused auroras visible as far south as the Caribbean and knocked out telegraph communications. A similar event today would cause massive damage to electrical grids, and satellite communications. Losses would be in the trillions and services might be disrupted for years.

Clockwise from upper left: NASA, Australian Broadcasting Corporation, Daily Courier, NASA

European air crisis – it happened before (technology) (II)



Estimated Spread of Volcanic Ash Cloud



Volcanoes have been affecting Iceland for thousands of years; why did no one think about the risk they posed to jet airplanes?

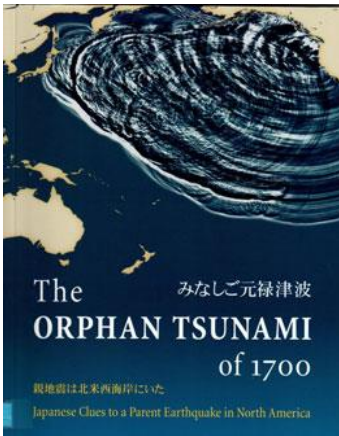
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TCX652K	TENERIFE	08:10	CANCELLED
TCX152K	DALAMAN	19:40	CANCELLED
KL1540	AMSTERDAM	06:00	CANCELLED
FR2332	KRAKOW	06:30	CANCELLED
LS257	PALMA	07:00	CANCELLED
TCX279K	FUERTEVENTURA	07:00	NEXT INFO AT 1500
BE350	GATWICK	07:55	CANCELLED
FR2501	PISA	09:10	CANCELLED
FR2484	VENICE TREVISO/SAN ANGELO	CANCELLED	
SZ481	BRISTOL	09:55	CANCELLED
BE172	SOUTHAMPTON	10:25	CANCELLED
KL1546	AMSTERDAM	10:30	CANCELLED
LS241	NICE	10:30	CANCELLED
FR153	DUBLIN	10:40	CANCELLED
BE730	BELFAST CITY	11:35	CANCELLED
NM327	ISLE OF MAN	12:05	CANCELLED
FR2334	KNOCK	13:20	CANCELLED

For information on liquids please refer to security notices. NO SMOKING It is against t



Clockwise from upper left: Royal Society, UK Met Office, Wikimedia, RT

Tohoku – it happened before (technology) (III)



Japan built a nuclear power plant in a known tsunami zone with a six-foot sea wall and failed to waterproof the backup generators.

Clockwise from upper left: Amazon, Blogspot, Wordpress, Blogspot

Thailand floods – unmodeled and unaware



From top: BBC, CNN

Many failed to anticipate the effect of the Thai floods because there were no flood models, **but just because a risk is not modelled does not mean it does not exist.**

Australian floods – managing one risk creates another

Water **2011**, 3, 1149-1173; doi:10.3390/w3041149

OPEN ACCESS

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Article

The 2011 Brisbane Floods: Causes, Impacts and Implications

Robin C. van den Honert * and John McAneney

Risk Frontiers, Macquarie University, NSW 2109, Australia; E-Mail: john.mcaneney@mq.edu.au

* Author to whom correspondence should be addressed; E-Mail: rob.vandenhonert@mq.edu.au;
Tel.: +61-2-9850-4421; Fax: +61-2-9850-9394.

<https://research-management.mq.edu.au/ws/portalfiles/portal/16832889/mq-19234-Publisher+version+%28open+access%29.pdf>



Courier Mail

12-November-2020

A dam built in the 1970s to manage flood risk was allowed to reach full capacity following a prolonged drought; a strong La Niña developed, several large rain events occurred, the dam overflowed, and billions of dollars of losses occurred where they were not supposed to. **This illustrates the human factor in risk – how do you model the behavior of dam operators?**

Grey Swans and Black Elephants: Why we keep getting surprised and what we can learn from them

16



We were warned and we ignored it



Hurricane Pam Exercise Concludes

Release Date: July 23, 2004
Release Number: R6-04-093

BATON ROUGE, La. -- Hurricane Pam brought sustained winds of 120 mph, up to 20 inches of rain in parts of southeast Louisiana and storm surge that topped levees in the New Orleans area. More than one million residents evacuated and Hurricane Pam destroyed 500,000-600,000 buildings. Emergency officials from 50 parish, state, federal and volunteer organizations faced this scenario during a five-day exercise held this week at the State Emergency Operations Center in Baton Rouge.

The exercise used realistic weather and damage information developed by the National Weather Service, the U.S. Army Corps of Engineers, the LSU Hurricane Center and other state and federal agencies to help officials develop joint response plans for a catastrophic hurricane in Louisiana.

"We made great progress this week in our preparedness efforts," said Ron Castleman, FEMA Regional Director. "Disaster response teams developed action plans in critical areas such as search and rescue, medical care, sheltering, temporary housing, school restoration and debris management. These plans are essential for quick response to a hurricane but will also help in other emergencies."

"Hurricane planning in Louisiana will continue," said Colonel Michael L. Brown, Deputy Director for Emergency Preparedness, Louisiana Office of Homeland Security and Emergency Preparedness. "Over the next 60 days, we will polish the action plans developed during the Hurricane Pam exercise. We have also determined where to focus our efforts in the future."



Res ipsa loquitur (Latin: "the thing speaks for itself")

Beirut blast - becoming acclimated to risk



From top: Irish Sun, News 18

Authorities allowed a huge amount of ammonium nitrate to be stored in a poorly ventilated warehouse for years. Despite risks being well known to authorities, no action was taken to reduce exposure. The resulting explosion leveled much of Beirut's port district.

Risk management observations

- These events (and many others like them) illustrate several important things about risk management (or the lack of it) in many situations:
 - Our world has become complex, interdependent, and subject to risks which are difficult to extrapolate from past events
 - A key issue is the collision of natural hazards and modern society
 - We often become too comfortable with our modeling and ignore risk that falls outside our models
 - Human factors are important and hard to model
- However, as we will see in the next section, we have a remarkable capacity to adjust to risk and mitigate it



Grey Swans



“Study the past if
you would define
the future”

- Confucius

The gold standard and free-floating exchange rates

- Gold standard widely used until 1971
 - Each country's paper currency is based on some fixed quantity of gold, exchange rates stable
 - In 1971 US abandoned standard and countries adopted floating exchange rates
- Significant disruptions occurred
 - Many firms caught (example Laker Airways)
 - Widespread disruption
- New tools
 - Foreign exchange hedging
 - Enterprise Risk Management (ERM)
 - Currency options, derivative markets



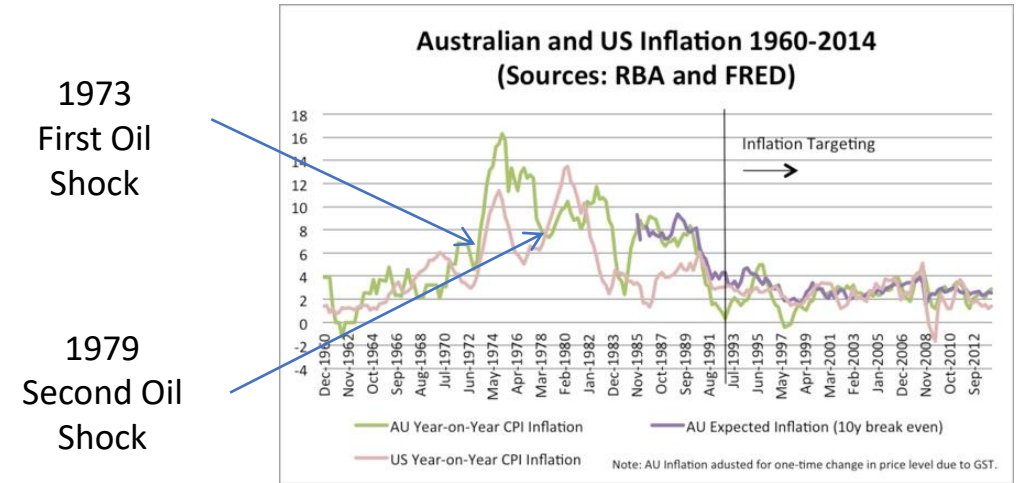
Source: <https://steemit.com/bitcoin/@bobgillvan/gold-volatility-vs-bitcoin-after-usd-left-the-gold-standard>



Airlinepictures.net

1970s oil crises and inflation

- Two oil shocks led to huge increases in oil prices and a large bout of inflation
- Many financial firms had mismatched assets and liabilities
- New techniques developed
 - Contractionary monetary policy
 - High interest rates
 - Use of inflation linked bonds
 - Asset/Liability matching (ALM)
 - Enterprise risk management (ERM)
- Have lessons of this era been forgotten?



Source: <https://theconversation.com/look-at-the-data-to-understand-the-risks-for-the-australian-economy-28311>



Hurricane Andrew - catastrophe risk management

- Andrew decimated insurers:
 - Destroyed 63,500 homes and damaged 124,000 others
 - 11 insurers became insolvent
 - 900,000 policyholders lost coverage
 - Massive rate increases
- Andrew demonstrated risk control failures:
 - Inadequate pricing techniques, previously based on “excess loss (wind) procedure”
 - Poor understanding of large loss potential
 - Cheap insurance = overdevelopment, poor building practices



NOAA, Wikimedia



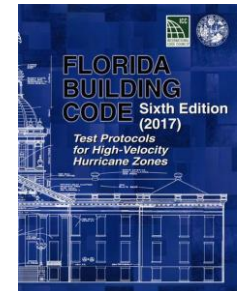
Source: Sigma (No 1 / 2018), Swiss Re Institute

After Andrew

- Government actions:
 - New regulatory structures for solvency and price regulation
 - Formation of government reinsurer, insurer, and stronger insolvency fund
 - Stronger building codes
- Insurer risk management improvements:
 - Sophisticated catastrophe models
 - Exposure management
 - New insurers and reinsurers
 - New pricing techniques
- Led to a recovery of the insurance market



Florida Hurricane Catastrophe Fund



World Trade Center – 9/11

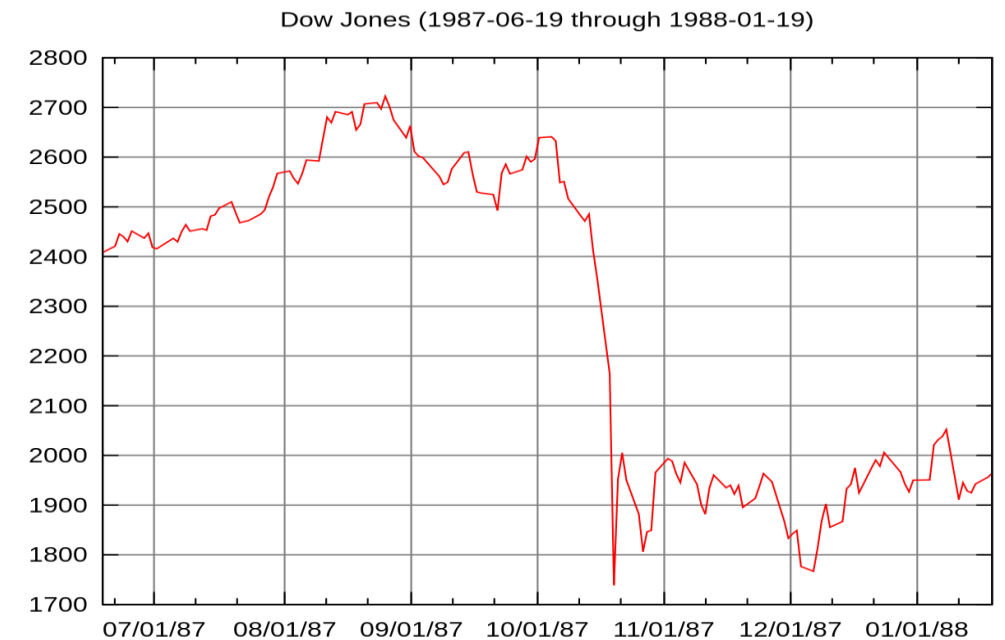
- Government response:
 - “War on terror”
 - Airport security screenings
 - Hardening of infrastructure
 - Huge investment in security
 - Risk pools (ARPC, Pool Re, TRIA)
- Insurer risk management improvements:
 - Terrorism models
 - Policy wordings
 - New pricing techniques
- Led to a partial recovery of the terrorism reinsurance market



*From Top: New York Daily News,
National September 11 Memorial*

Global Financial Crisis of 2007-2008

- Causes:
 - Exotic financial instruments (CDOs)
 - Banks taking excessive risk
 - US housing bubble
 - Relaxed regulation
- Response – stronger capital requirements:
 - Overhaul of financial regulation
 - Introduction of Basel III in 2010
 - Contingent capital requirements
 - Higher capital quality and larger buffers
 - Capital maintenance and reporting requirements
- Are similar issues lurking (google “CLO”)?



Source: https://favpng.com/png_view/stock-market-black-monday-wall-street-crash-of-1929-stock-market-crash-dow-jones-industrial-average-png/BGigWUhV

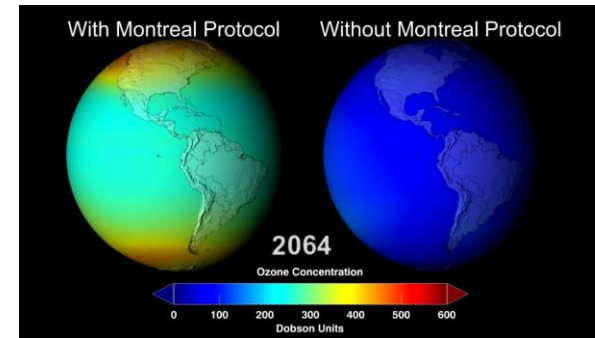
Lessons from the past – surprise, surprise

- There are many other examples of events like this
- Most or all these examples contain elements of black swans, black elephants, and butterflies; they also illustrate concepts of fragility and catastrophic complexity
- In each case the situation looked dire in the moment, but new institutions and tools emerged to manage risk
- There are lessons in these events for the current COVID-19 pandemic:
 - Risk is best understood through a combination of models and mindset
 - Complex systems are rife with interconnected risks
 - Human psychology is a key factor, and something very difficult to model
 - Risk mitigation and adaptation can transform seemingly impossible problems
 - Many risks are global; neither viruses nor carbon, for example, respect borders



A final thought...calamities can be avoided

- Y2K
- Montreal Protocol on Substances that Deplete the Ozone Layer
- Tylenol poisoning (1982) and tamper-resistant packaging
- “Nutrition Facts” labeling
- Depletion of fish stocks – cod recovery
- Lead paint phaseout
- 4 Florida hurricanes 2005
- Center for Near Earth Objects



From Top: Weekly World, NASA, NASA

Evolving the risk management paradigm

“Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. **But there are also unknown unknowns—the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tend to be the difficult ones.**”

- Donald Rumsfeld



McKinsey: Six problem-solving mindsets

September 2020
McKinsey
Quarterly

Six problem-solving mindsets for very uncertain times

Even the most inscrutable problems have solutions—or better outcomes than have been reached so far. Here's how the best problem solvers crack the code.

by Charles Conn and Robert McLean

Great problem solvers are made, not born. That's what we've found after decades of problem solving with leaders across business, nonprofit, and policy sectors. Those leaders learn to adopt a particularly open and curious mindset, and adhere to a systematic process for cracking even the most inscrutable problems. They're terrific problem solvers under any conditions. And when conditions of uncertainty are at their peak, they're at their brilliant best.

Six mutually reinforcing approaches underlie their success: (1) being *ever-curious* about every element of a problem; (2) being *imperfectionists*, with a high tolerance for ambiguity; (3) having a *"dragonfly eye"* view of the world, to see through multiple lenses; (4) pursuing *occurent behavior* and experimenting relentlessly; (5) tapping into the *collective intelligence*, acknowledging that the smartest people are not in the room; and (6) practicing *"show and tell,"* because storytelling begets action (exhibit).

Here's how they do it.

1. Be ever-curious

As any parent knows, four-year-olds are unceasing askers. Think of the never-ending "whys" that make little children so delightful—and relentless. For the very young, everything is new and wildly uncertain. But they're on a mission of discovery, and they're determined to figure things out. And they're good at it! That high-energy inquisitiveness is why we have high shelves and childproof bottles.

When you face radical uncertainty, remember your four-year-old or channel the four-year-old within you. Relentlessly ask, "Why is this so?" Unfortunately, somewhere

Faced with an inscrutable problem? Try a more creative approach.



McKinsey
& Company

<https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/six-problem-solving-mindsets-for-very-uncertain-times>

A better crystal ball



<https://www.foreignaffairs.com/articles/united-states/2020-10-13/better-crystal-ball>

A Better Crystal Ball

The Right Way to Think About the Future

J. Peter Scoblic and Philip E. Tetlock

Every policy is a prediction. Tax cuts will boost the economy. Sanctions will slow Iran's nuclear program. Travel bans will limit the spread of COVID-19. These claims all posit a causal relationship between means and ends. Regardless of party, ideology, or motive, no policymaker wants his or her recommended course of action to produce unanticipated consequences. This makes every policymaker a forecaster. But forecasting is difficult, particularly when it comes to geopolitics—a domain in which the rules of the game are poorly understood, information is invariably incomplete, and expertise often confers surprisingly little advantage in predicting future events.

These challenges present practical problems for decision-makers in the U.S. government. On the one hand, the limits of imagination create blind spots that policymakers tend to fill in with

J. PETER SCOBLIC is Co-Founder of Event Horizon Strategies, a Senior Fellow in the International Security Program at New America, and a Fellow at Harvard's Kennedy School.

PHILIP E. TETLOCK is Leonore Annenberg University Professor at the University of Pennsylvania. Co-Founder of Good Judgment, and a co-author of *Superforecasting: The Art and Science of Prediction*.



J. Peter Scoblic



Philip E. Tetlock

From Top: New America, Wharton Press

“When it comes to anticipating the future, then, the United States is getting the worst of both worlds. It spends untold sums of money preparing yet still finds itself the victim of surprise—fundamentally ill equipped for defining events, such as the emergence of COVID-19.”

Improving forecasts

- Tetlock published a study in 2005 demonstrating experts had trouble outperforming “dart-tossing chimpanzees” when it came to predicting global events
- Hedgehogs vs. foxes: those who are surest often fare the worst
- Instead of asking experts to evaluate long-term scenarios as a whole:
 - Develop questions which pass the clairvoyance test (sharply defined)
 - Break down future states into a series of clear and forecastable signposts
 - Use “question clusters” which are diverse
 - Draw upon a group of experts instead of individuals
 - Regularly update scenarios and forecasts reflecting if events follow signposts
- Blend scenario analysis and probabilistic forecasts, “A scenario planner’s conviction that the future is uncertain need not clash with a forecaster’s quest to translate uncertainty into risk.”

Closing thoughts on managing risk

- There is no way we can anticipate what exposures may face us decades in the future, so we need to **design systems for resilience and adaptability**
- **Focus on building resilience:**
 - Opposability (be able to hold conflicting ideas in one's mind, be open to new ideas)
 - Adaptability (do not fear saying "I was wrong" or "I have changed my mind")
- **Study history** and see how new technology is affecting old perils
- **Think stochastically** – embrace uncertainty!
- Brooks – **develop new skills** to deal with catastrophic complexity
- Taleb and Traverton – **understand why volatility signals stability, and vice versa**
- McKinsey – **adopt a problem-solving mindset** based on their six approaches
- Scoblic and Tetlock – use **clusters of sharply defined questions**



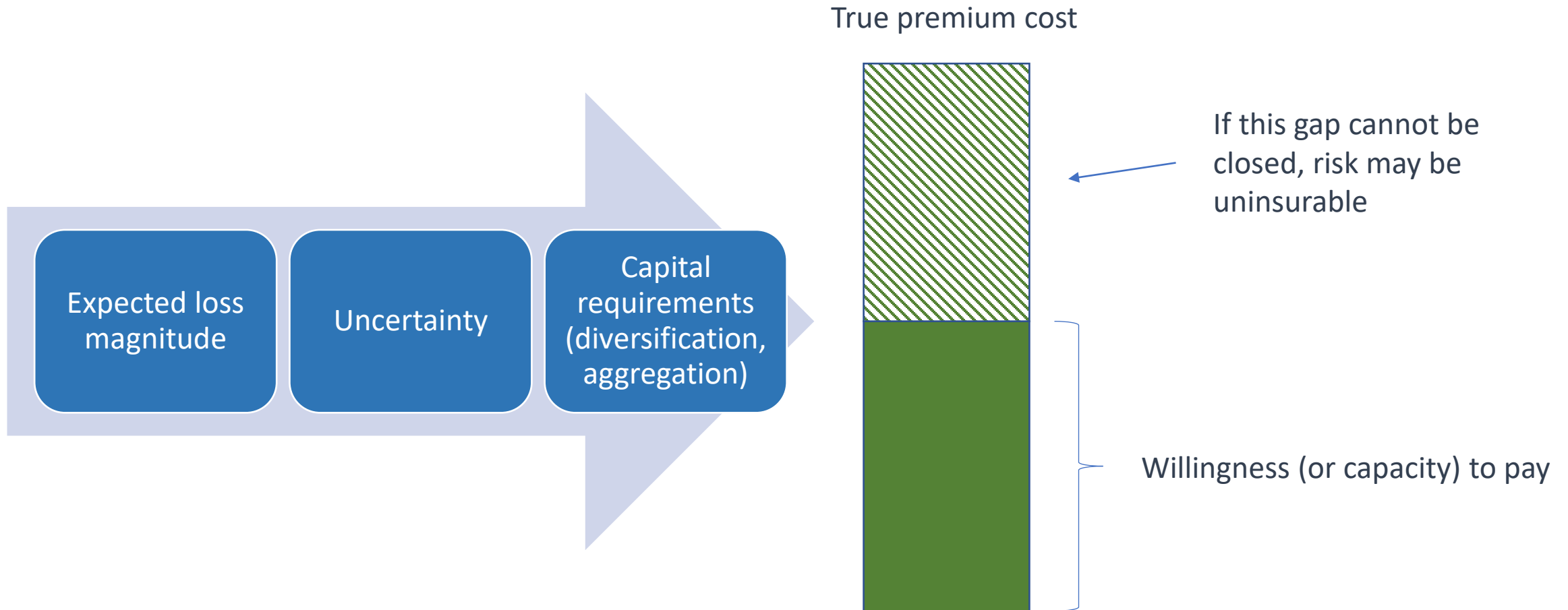
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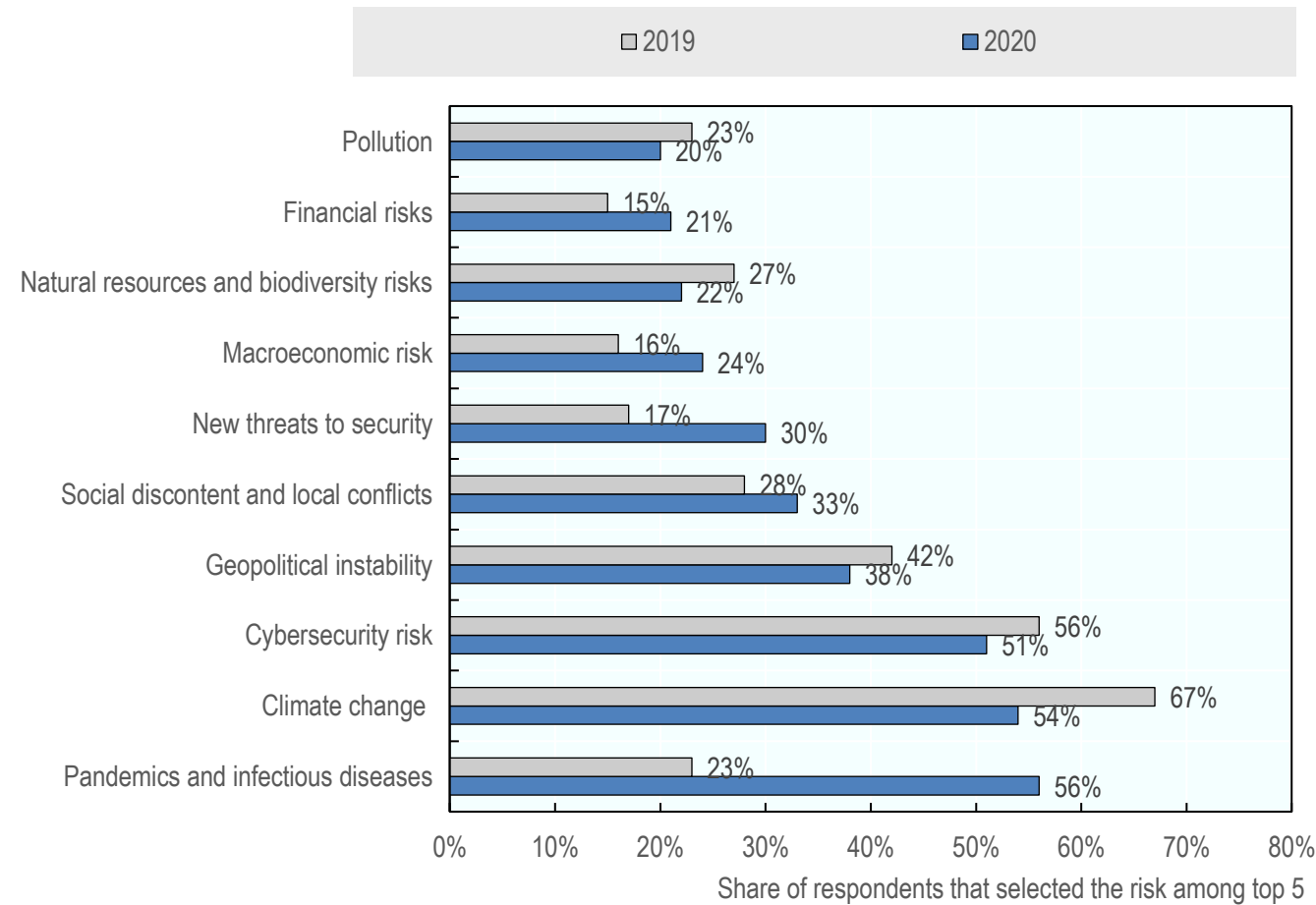
Poll

- Are these insurable? (yes or no):
 - Infectious disease outbreaks
 - Social instability
 - Inter-state conflict
 - Terrorist attacks
 - Cyber attacks
 - Critical infrastructure disruption
 - Climate change

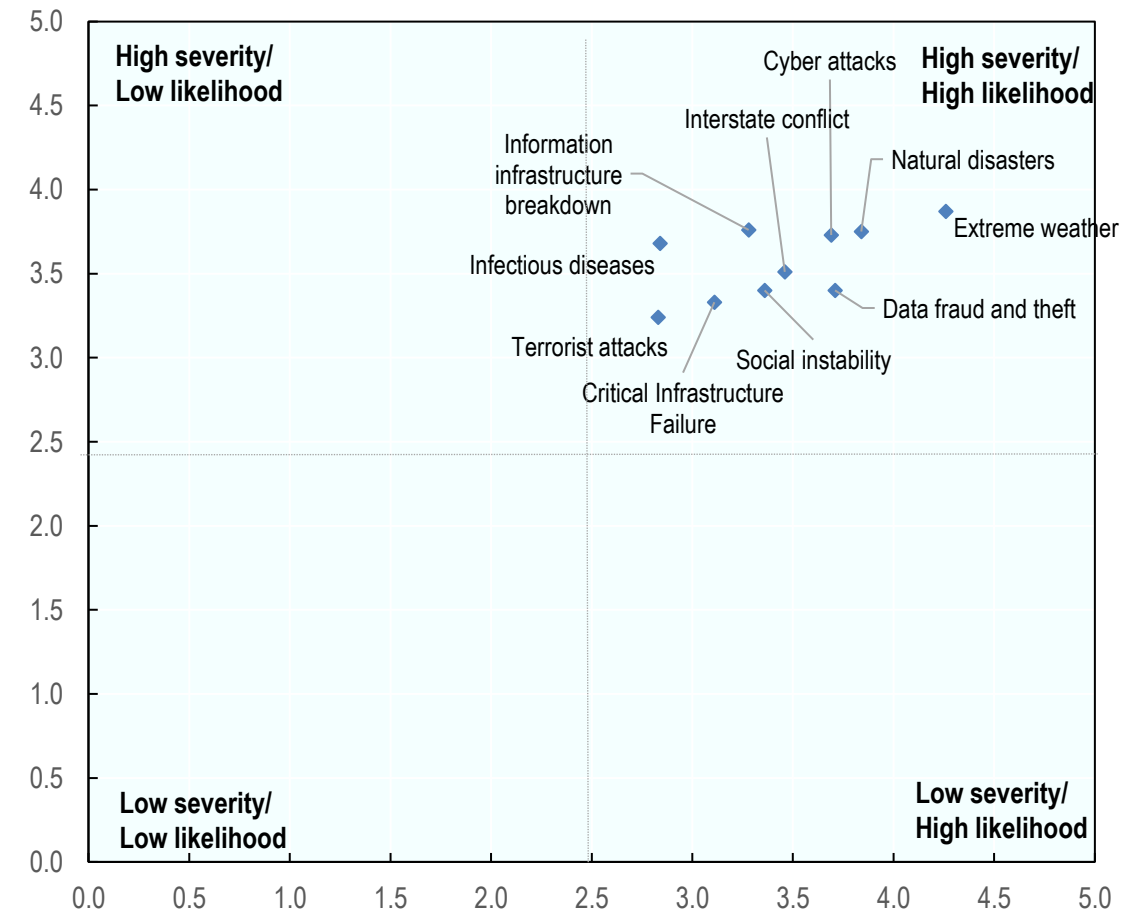
Uninsured, Underinsured and Uninsurable Risk



Future uninsurable risks? Ask the experts



Source: AXA, "Future Risks Report 2020"



Source: WEF, "The Global Risks Report 2020"

Climate change is expected to increase losses

Human influence has intensified extreme precipitation in North America
Megan C. Kirchmeier-Young^{a,1} and Xuebin Zhang^a
^aClimate Research Division, Environment and Climate Change Canada, Toronto, ONT M3H 5T4, Canada
Edited by Susan Solomon, Massachusetts Institute of Technology, Cambridge, MA, and approved April 20, 2020 (received for review December 9, 2019)

ARTICLE

<https://doi.org/10.1038/s41467-020-18339-2>

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Check for updates

Compounding impact of severe weather events fuels marine heatwave in the coastal ocean

B. Dzwonkowski^{1,2}, J. Coogan^{1,2,5}, S. Fournier³, G. Lockridge², K. Park⁴ & T. Lee³

Frequency of severe thunderstorms across Europe expected to increase in the 21st century due to rising instability
Anja T. Rädler^{1,2}, Pieter H. Groenemeijer², Eberhard Faust¹, Robert Sausen³ and Tomáš Púčik²

Published: 14 May 2014

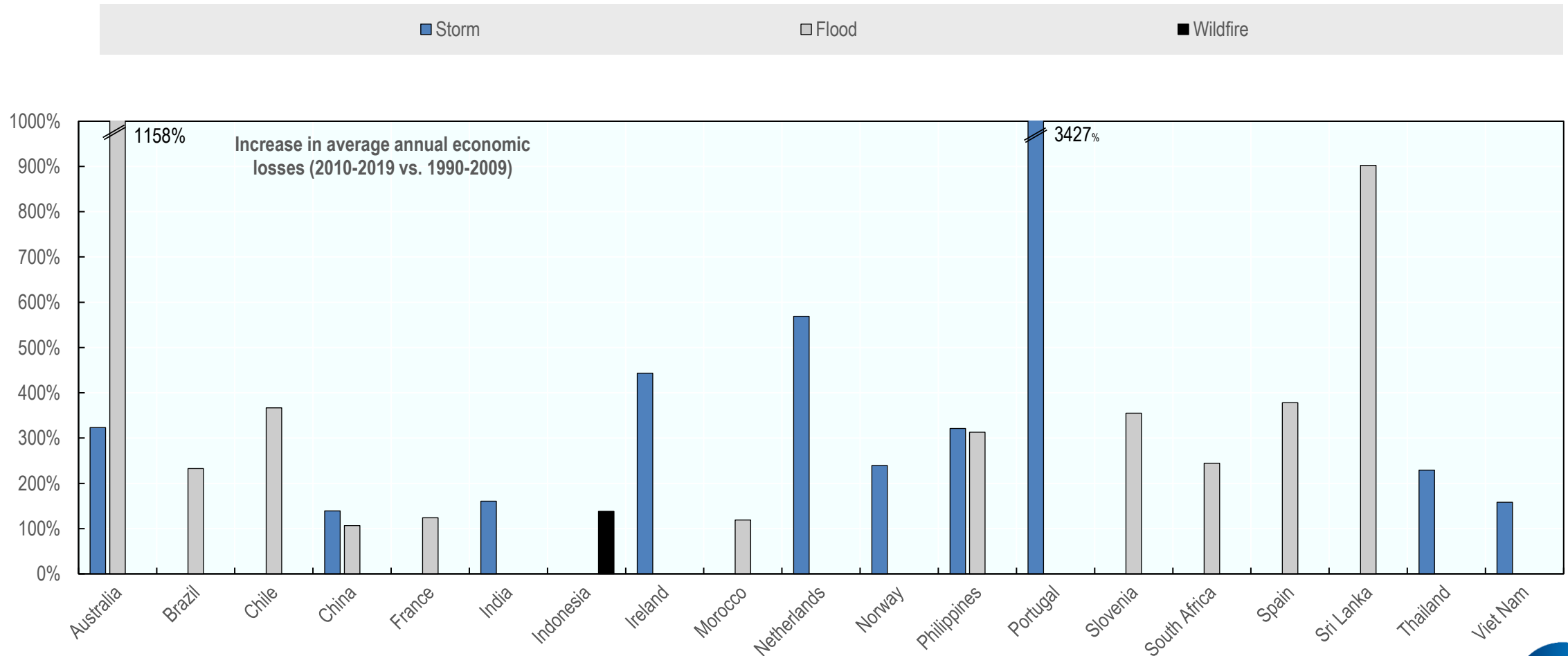
The poleward migration of the location of tropical cyclone maximum intensity

James P. Kossin[✉], Kerry A. Emanuel & Gabriel A. Vecchi

Nature 509, 349–352(2014) | [Cite this article](#)

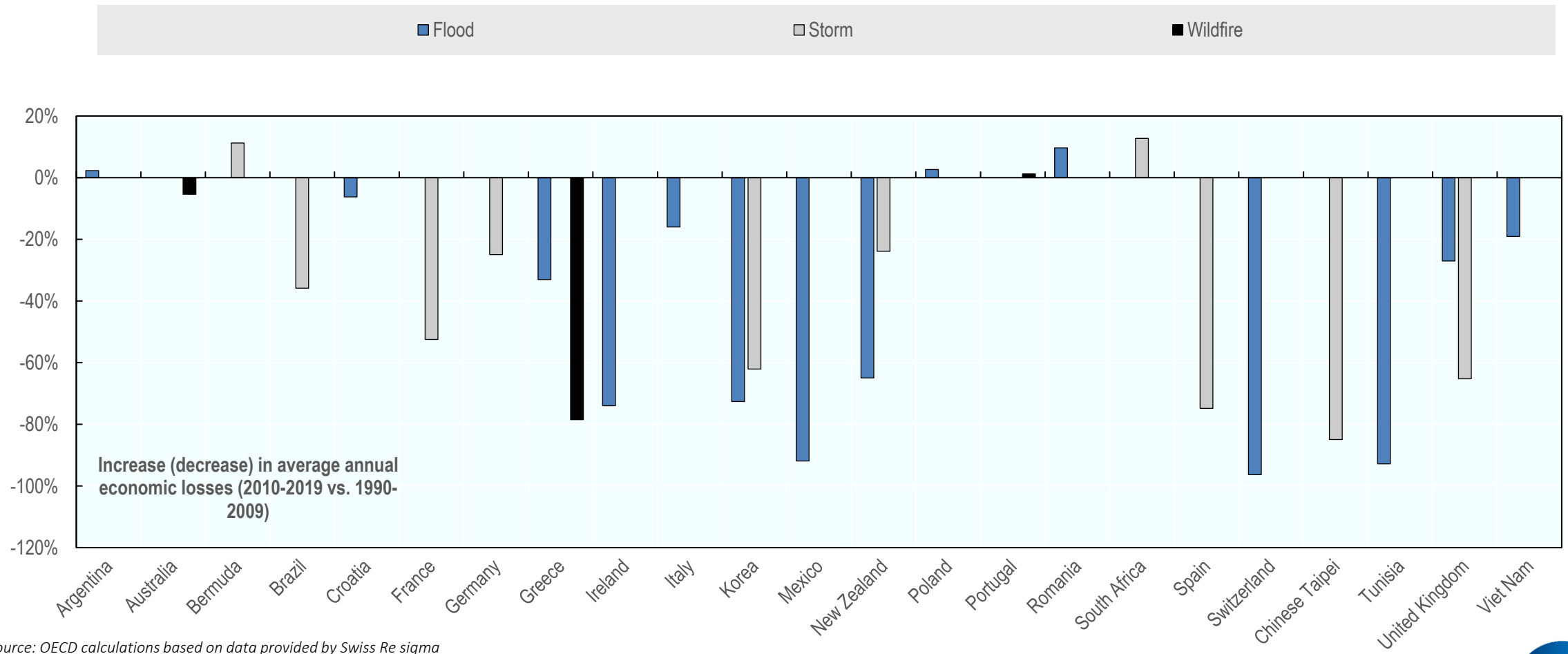
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Climate-related losses are already increasing in many countries..



Source: OECD calculations based on data provided by Swiss Re sigma

....but not everywhere



Source: OECD calculations based on data provided by Swiss Re sigma

Higher losses could lead to future insurability challenges

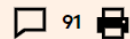
The Big Read Insurance

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Climate change: can the insurance industry afford the rising flood risk?

Floods were once considered too irregular to insure against. But global warming has changed the calculation

Robert Armstrong in New York and Oliver Ralph in London FEBRUARY 18 2020



Financial Times



BIZ & TECH // NET WORTH - KATHLEEN PENDER

As California wildfire risk increases, insurance nonrenewals surge



Kathleen Pender | Oct. 20, 2020 | Updated: Oct. 23, 2020 10:27 p.m.

San Francisco Chronicle

How climate change is contributing to soaring insurance costs

Dr Karl Mallon

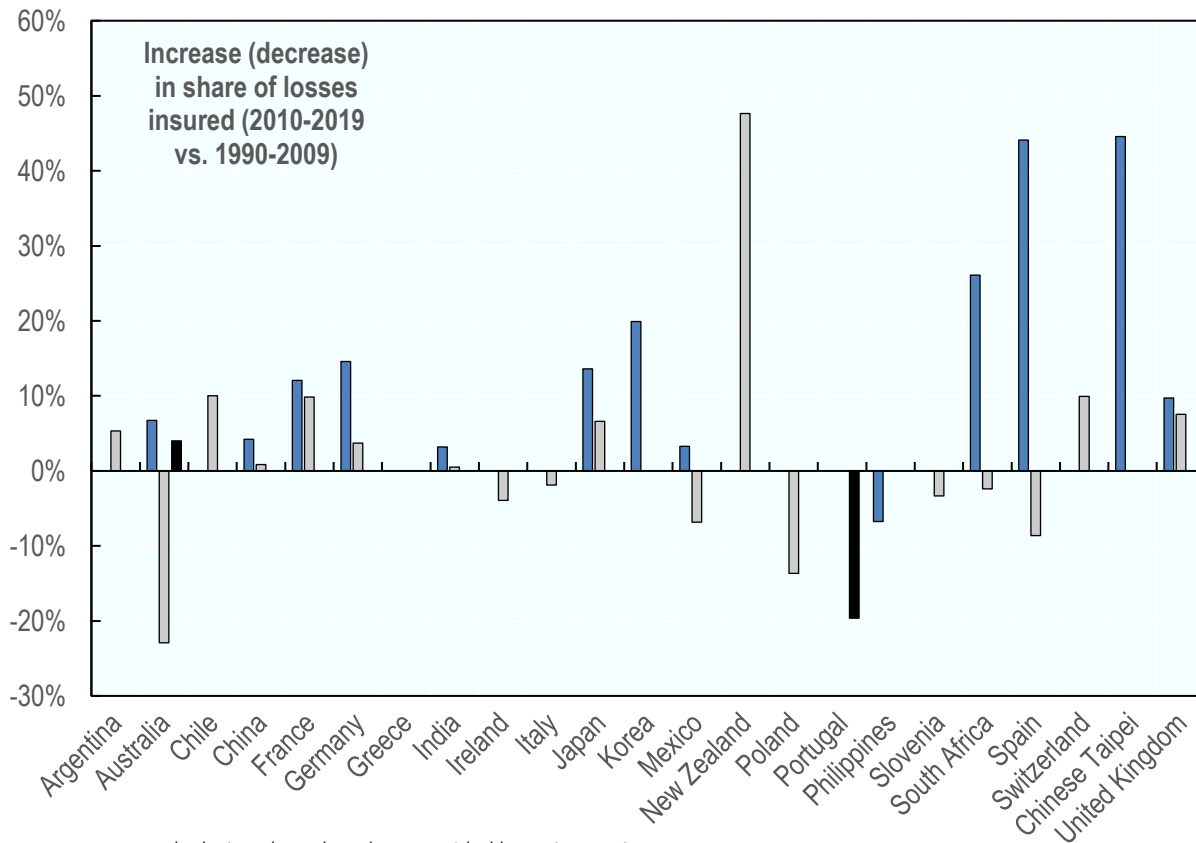
Latest News

The Canberra Times

A 2°C world might be insurable, a 4°C world certainly would not be -
Henri de Castries, Chairman & CEO, AXA (2000-2016) in May 2015

General improvements in insurance coverage (so far)

■ Storm □ Flood ■ Wildfire

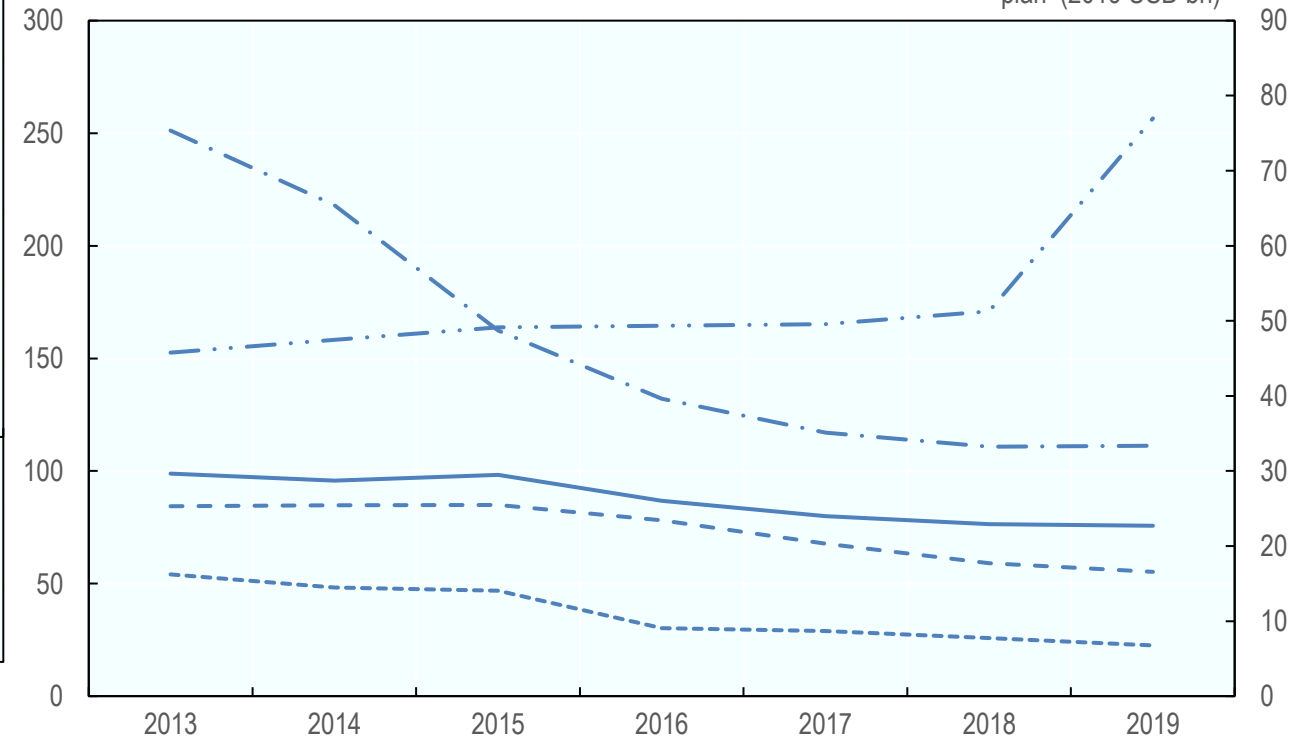


Source: OECD calculations based on data provided by Swiss Re sigma

— North Carolina - - - Texas - . - Florida - - - Others (wind) - . . California

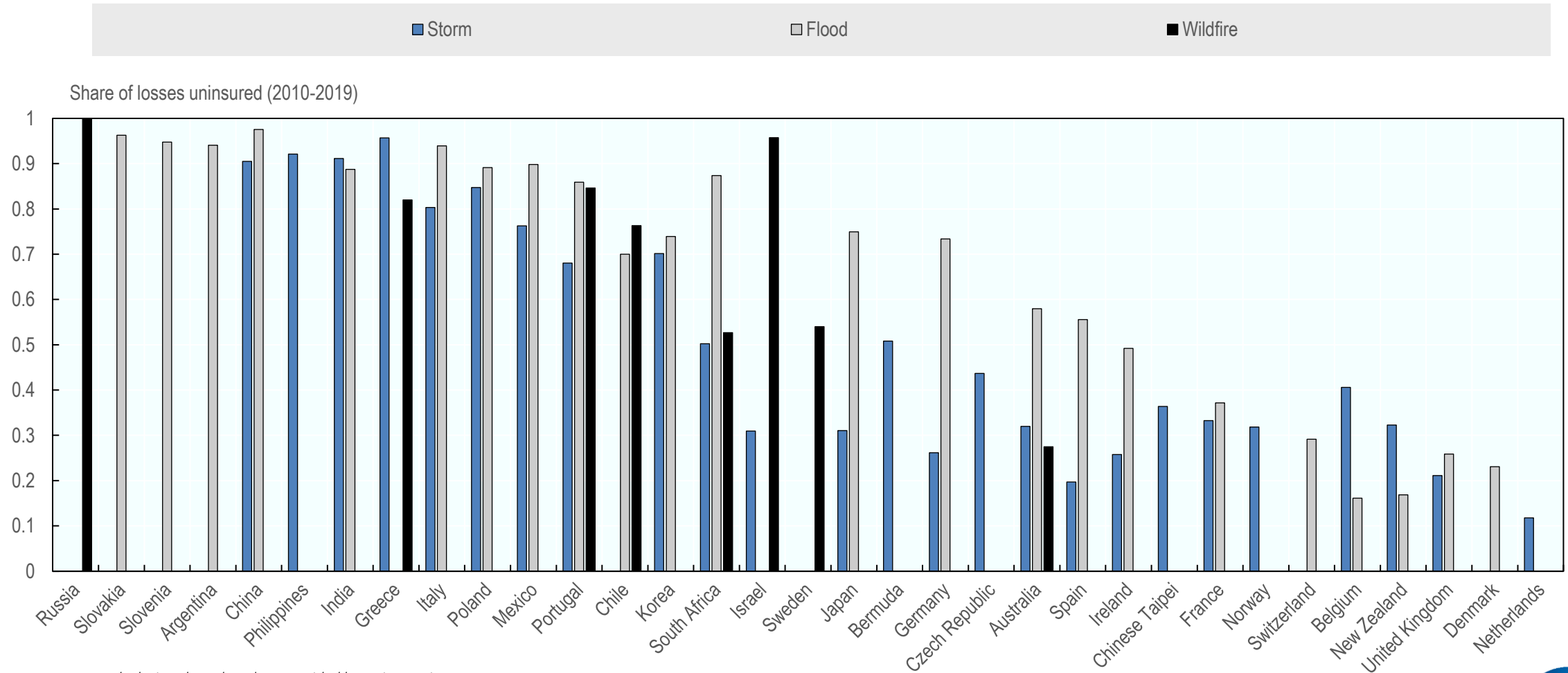
Sum insured by state residual plans in wind states (2019 USD bn)

Sum insured by California residual plan (2019 USD bn)



Source: OECD calculations based on data published by Insurance Information Institute

Real challenge remains widespread underinsurance



Source: OECD calculations based on data provided by Swiss Re sigma

Plenty of warnings of pending cyber catastrophe

\$19 Billion in Potential Losses from Cloud Services Failure Mostly Uninsured: Lloyd's, AIR

By Suzanne Barlyn | January 23, 2018

Insurance Journal

Modeling Fundamentals: Systemic Ransomware Cyber Risk

Oct 20, 2020

A single systemic ransomware event has the potential to trigger multiple claims from domino-like disruption that can generate widespread, aggregate losses across otherwise independent insureds. Economic loss from a major systemic ransomware attack could exceed USD 15 billion, inflicting significant damage to the global economy, and significant losses to re/insurers' portfolios without well-managed cyber risk.

AIR Worldwide



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Global Agenda Insurance Cybercrime Cybersecurity

Cyber insurance is only a few claims away from disaster. This is why it matters

How insurable are cyber risks?

Cyber risks constitute a big challenge for the insurance industry, not just because of the risk of change and the accumulation risk but also due to hidden exposure in policies from different lines of business - silent cyber. What is Munich Re's approach?

24.07.2018
Stefan Golling

News > Risk Management

07 Oct 2020

Cyber insurance growth may require PPP support



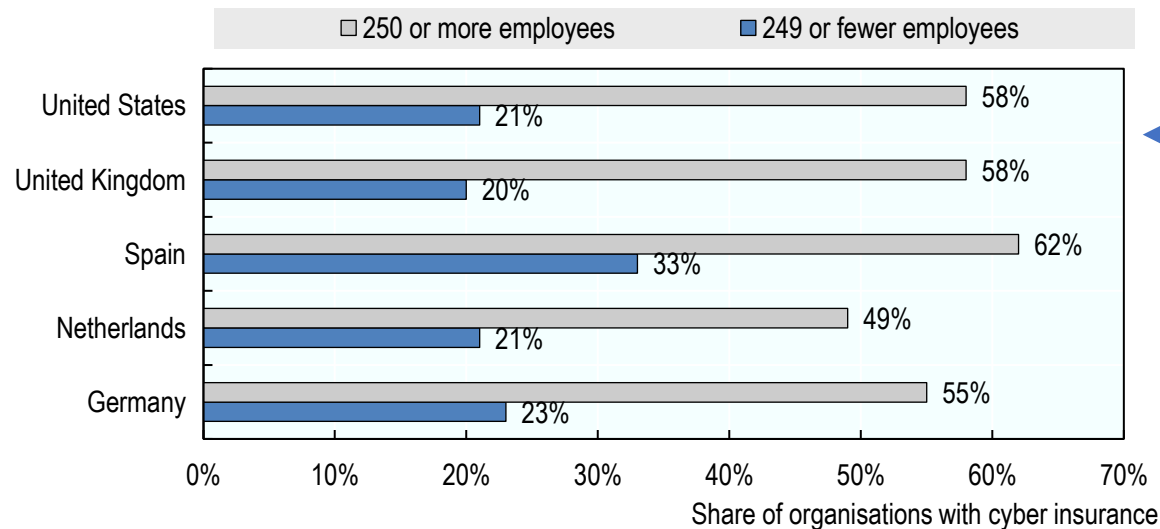
By Anoop Khanna | 07 Oct 2020

Asian Insurance Review



Cyber insurance doesn't provide much protection (overall)

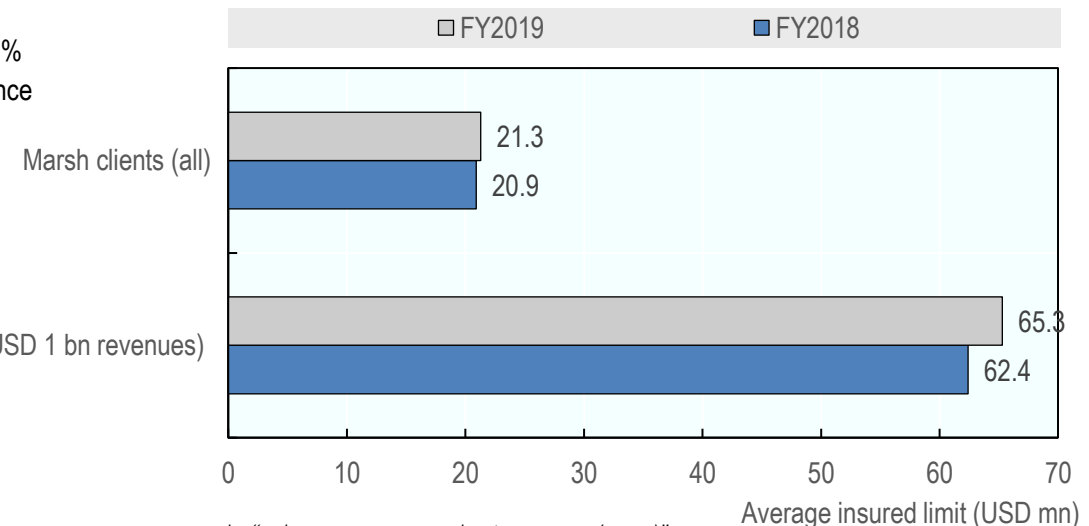
Businesses with cyber insurance coverage



Source: Hiscox, "2018 Cyber Readiness Report"

Cyber insurance penetration – while growing quickly – remains well below other commercial lines

Cyber insurance policy limits



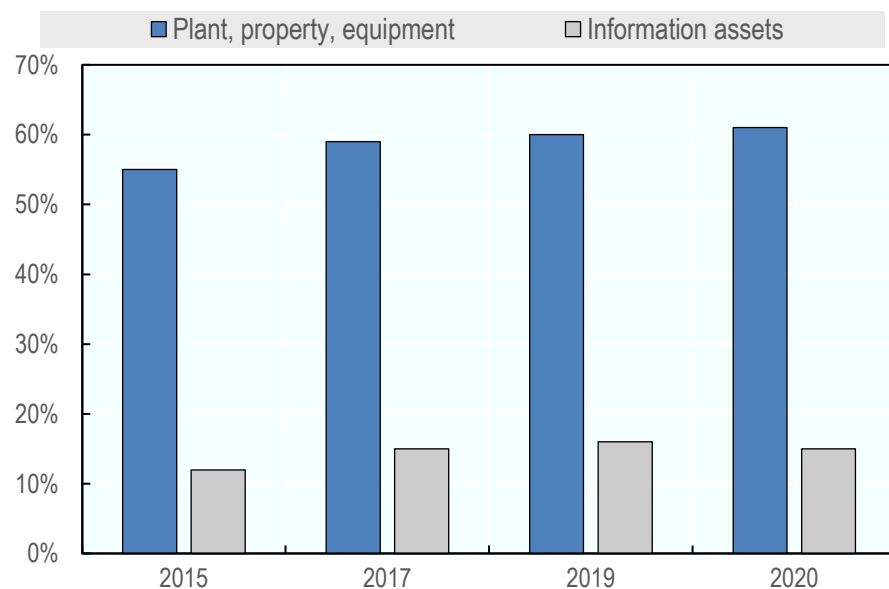
Source: Marsh, "Cyber Insurance Purchasing Report (2020)"

Policy limits purchased remain low relative to potential loss

Marsh clients (>USD 1 bn revenues)

Low share of information assets and cyber losses insured

Share of potential losses insured



Source: Aon & Ponemon Institute, "Financial Impact of Intellectual Property & Cyber Assets Report"

As a result, some estimates suggest that share of potential losses insured is significantly lower for information assets

Insured	Insured Loss	Economic Loss
Equifax	US\$125 mn	> US\$1 bn
Merck	US\$275 mn	> US\$1.5 bn
FedEx	US\$0	> US\$300 mn
Maersk	US\$0	US\$300 mn
Nuance Comms	US\$30 mn	UNK
Others	US\$0	US\$600 mn

Source: PCS, based on data from PCS Global Cyber, Capsicum Re and PCS internal research

Large cyber events in 2017 resulted in most losses being absorbed by businesses (not insurers)

A number of types of cyber attacks are likely to be uninsured

Physical damage



Image source: PBS

State-backed cyber attacks



Image source: wallhere.com



No internet

Try:

- Checking the network cables, modem, and router
- Reconnecting to Wi-Fi
- [Running Windows Network Diagnostics](#)

DNS_PROBE_FINISHED_NO_INTERNET

Internet outage



Image source: TechGenez

Cyber attack on critical infrastructure

Infectious diseases – devastating and more frequent?

5 reasons why pandemics like COVID-19 are becoming more likely

SARS, Ebola, Zika and now COVID-19. Disease epidemics and even pandemics are becoming increasingly common occurrences. Here are five reasons why.

28 April 2020 – updated 10 June

GaviL The vaccine alliance

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English

[Global Agenda](#) [COVID-19](#) [Future of Economic Progress](#) [Global Economic Imbalances](#)

\$82 trillion over 5 years? Cambridge study counts the cost of coronavirus

"Pandemics are fundamentally uninsurable events"

by Lyle Adriano
19 May 2020



Free e-newsletter – get the latest news!

Insurance Business America

"Foolish" & "lazy" to say pandemic risk is completely uninsurable: Chubb's Keogh

⚡ 30th September 2020 - Author: [Luke Gallin](#)

Reinsurance News

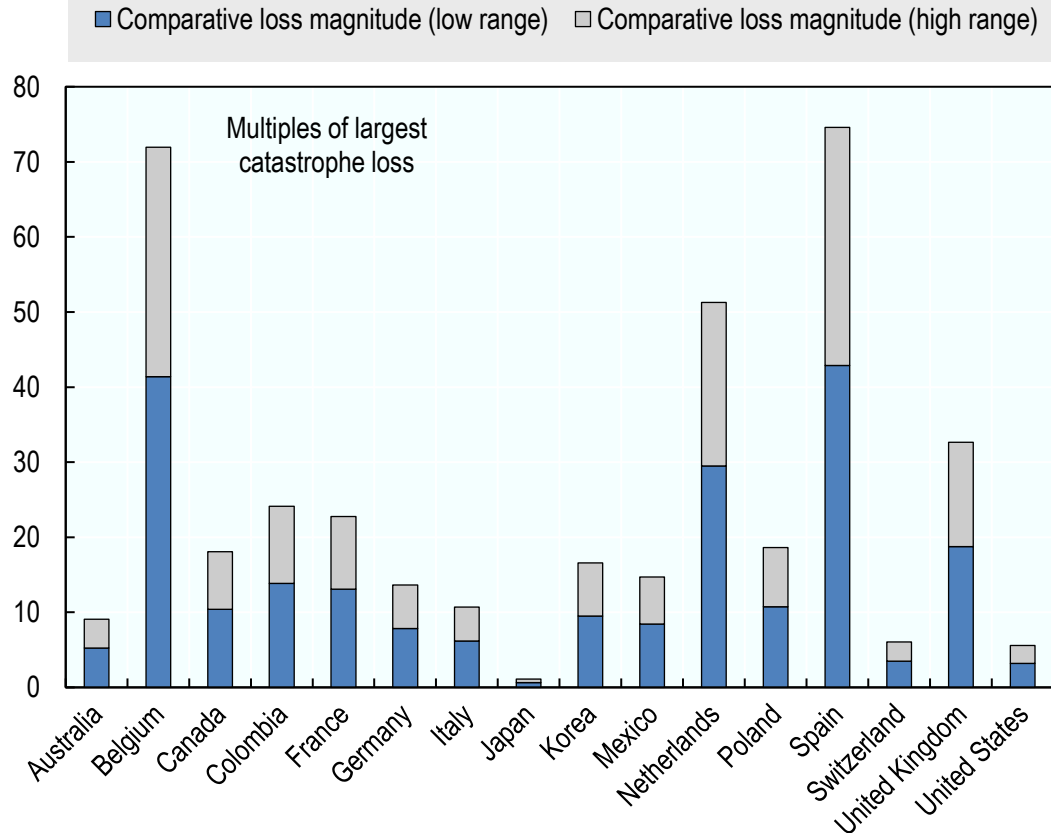
State-backed pools "the only way" to cover future pandemic: Munich Re's Golling

7 September 2020

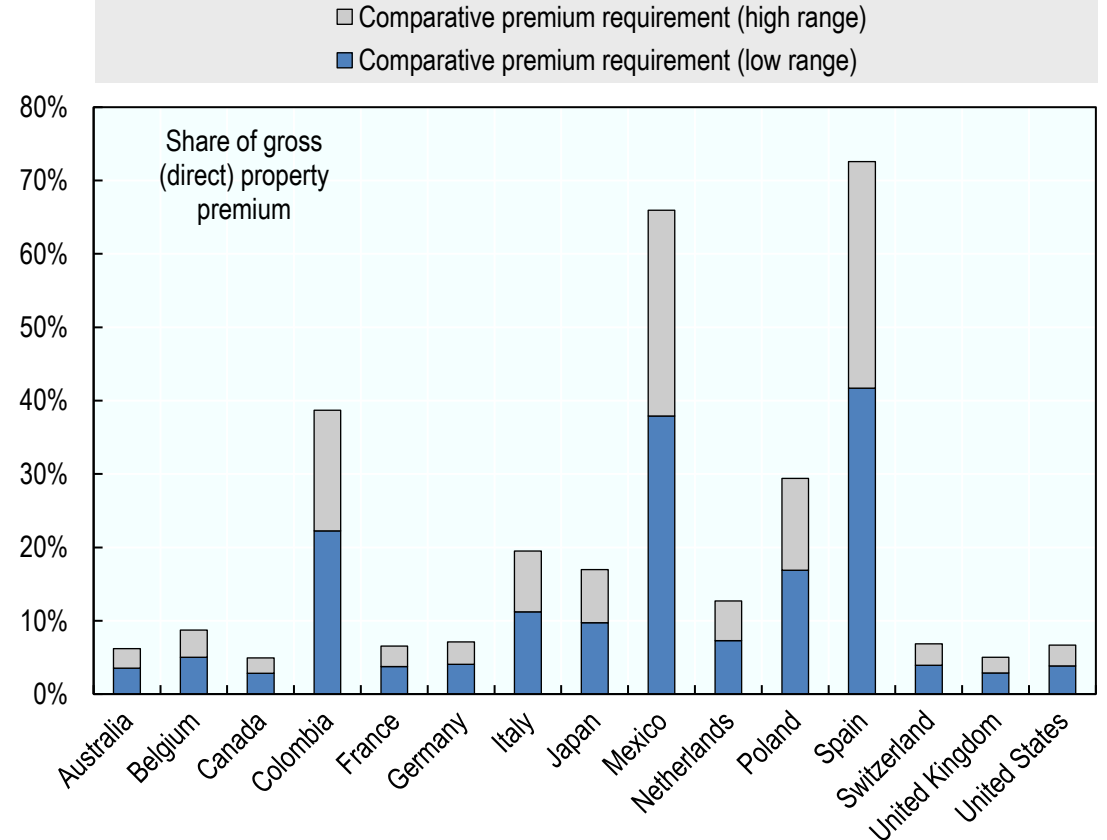
The Insurer

COVID-19 – loss magnitude and premium requirement estimates

Comparative loss magnitude



Comparative premium requirements



Note: Pandemic-related business interruption losses were estimated based on estimates developed: (i) in the United States by the American Property Casualty Insurance Association of monthly business interruption losses; and (ii) in France by Observatoire français des conjonctures économiques of total revenue losses to the economy (of which the corporate sector is estimated to account for 65%). These estimates were applied to other countries based on relative economic size. The loss estimate for each country was compared to the largest economic loss from a natural catastrophe since 2000 (as reported by Swiss Re) and is reported as a multiple of that loss. The premium requirement estimate was calculated as the 2-month business interruption loss estimate divided by 100 (assuming a 100-year return period) and is presented as a share of gross direct fire and property damage premium written in each country (for 2018 as reported to the OECD). It should be noted that the premium estimate includes both commercial and residential property coverage.

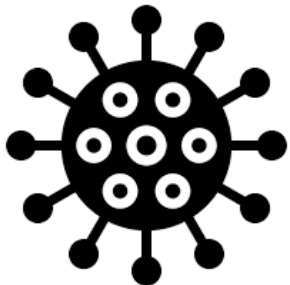
What future risks are insurable?

Expected loss magnitude



Increasing losses likely (how large?)

Increasing exposure with digitalisation



Increasing frequency? – improved capacity to manage?

Uncertainty

Well-modelled but uncertainty in climate impacts

Modelling at early stages/data gaps

Modelling of BI losses at early stage

Capital requirements (diversification, aggregation)

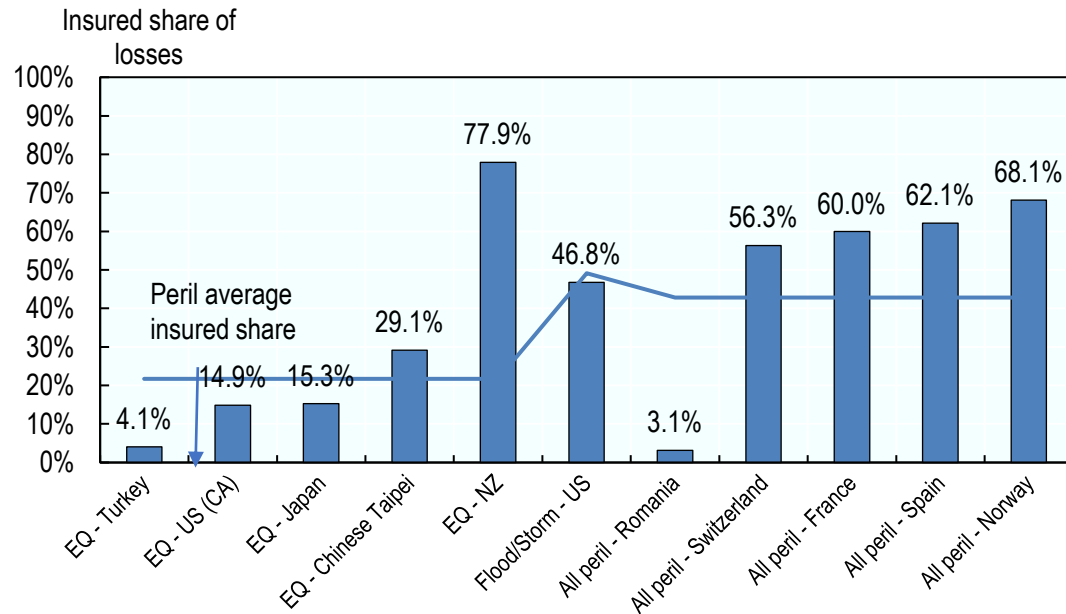
Geographic diversification should remain possible (correlated increase?)

Significant accumulation potential and limited geographic diversification

Global pandemic cannot be diversified – always global? (and always lockdown?)

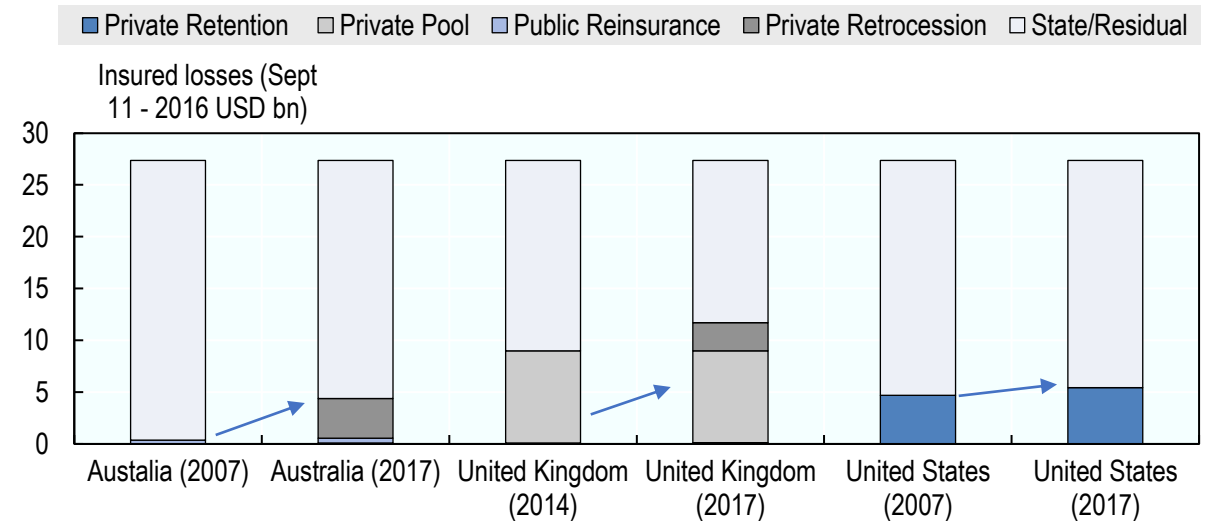


Can catastrophe risk insurance programmes reduce underinsurance and/or expand insurability?



Retention levels and reinsurance use can be adjusted over time as private market capacity increases (or returns)

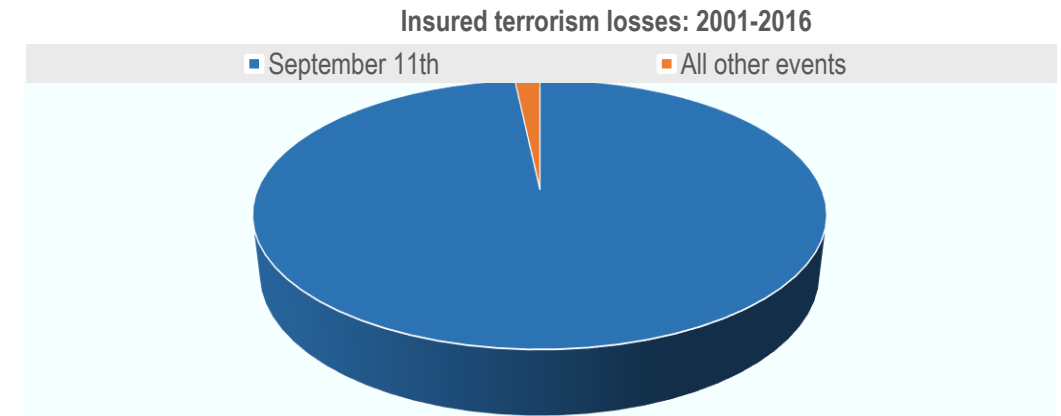
The existence of a catastrophe risk insurance programme often leads to a higher share of losses insured



Programmes can support the development of risk analytics for perils not covered in private markets (e.g. terrorism)

Some challenges with catastrophe risk insurance programmes

- Often designed to deal with the last event
- For reinsurance programmes - require corresponding changes in primary market
- Difficult to adapt to emerging risks – e.g. for terrorism pools:
 - Casualties vs. property losses
 - Loss of attraction
 - Cyber-terrorism and state-backed cyber



Source: OECD calculations based on data provided by Swiss Re sigma

Can add complexity for policyholders – is there not a way to provide an all-risk coverage

Thank you Discussion

Rade Musulin

Principal, Finity Consulting, Sydney, Australia

Leigh Wolfrom

**Policy Analyst, Directorate for Financial and Enterprise
Affairs, OECD, Paris, France**

