



Image: Chris Ryan_KOTO / stock.adobe.com

Insuring Pandemics in Non-Life (Structuring and Modelling)

14. Weiterbildungstag der DGVFM, 28th September 2023

Epidemic Risk and Insurance

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Anyonw still remembers the Pandemic?
(e.g., getting an orange juice while traveling in May 2020)



Tailor-made solution for your company, developed together with Munich Re's Epidemic Risk Solutions Team

We are a specialised unit ...



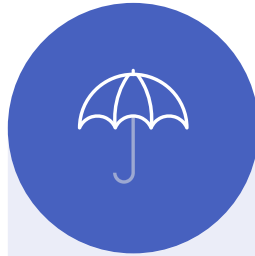
International team of experts

Epidemiologists
Financial experts
Actuaries
Lawyers
Underwriters



Global network

London
Munich
Singapore
Zurich



Covering the previously uninsurable

BI and CBI losses caused by disease outbreaks

... with a track record

- 2015 Start of Innovation Project Epidemic Risk Business
- 2017 World Bank Pandemic Emergency Finance Facility (PEF) – first ERS public sector transaction
- 2017 Munich Re Board mandates Epidemic Risk Solutions (ERS)
- 2017 First ERS Non-Life transaction (product launch with primary insurer)
- 2018 Dedicated business unit ERS fully set up**
- 2018 First ERS Life transaction (mortality stop loss)
- 2019 Start of the COVID-19 outbreak**
- 2021 First ERS Non-Life transaction post start of COVID-19
- 2021 First ERS Life transaction post start of COVID-19
- 2021 Pandemic risk placed with capital markets
- 2022 ABAC recommendations to APEC Finance Ministers to establish an Epidemic Risk Markets Platform as Public-Private Partnership
- 2023 First ERS Event Cancellation Policy of a prestigious sports event
- 2023 ERS wins the Trade Risk Award 2023 – Closing the Protection Gap Initiative of the Year award

01

Risk



02

Structure



03

Model





Risk

01



Frequency & severity of emerging infectious diseases are increasing

Hence, better risk management solutions are required in the future

Every year there are **5 new** emerging infectious diseases reported & the WHO publishes ~ **100** Disease Outbreak News¹

Metabiota² predict the probability of another pandemic of the same or greater magnitude as COVID-19 to be **22%-28%** within the next 10 years.

Airfinity's³ latest risk modeling suggests that there is a **27.5%** chance that a pandemic as deadly as COVID-19 could occur within the next 10 years.

UK National Risk Register 2023

highlights a **5-25%** likelihood of a pandemic over a 5 year period.

Major contributors to this phenomenon are

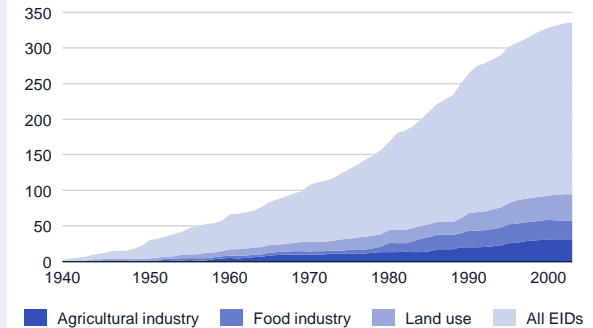


There have already been **3 significant coronavirus outbreaks** within 17 years

- **SARS** (2002/2003)
- **MERS** (2012/2015)
- **COVID-19** (2019 and on-going)

Increasing trend:
Emerging Infectious Diseases (EIDs)

Cumulative EID events



Source: Rohr et al, Nature Sustainability, 2019

Pandemic is the most likely catastrophic event in the next five years.

(Source: UK National Risk Register)

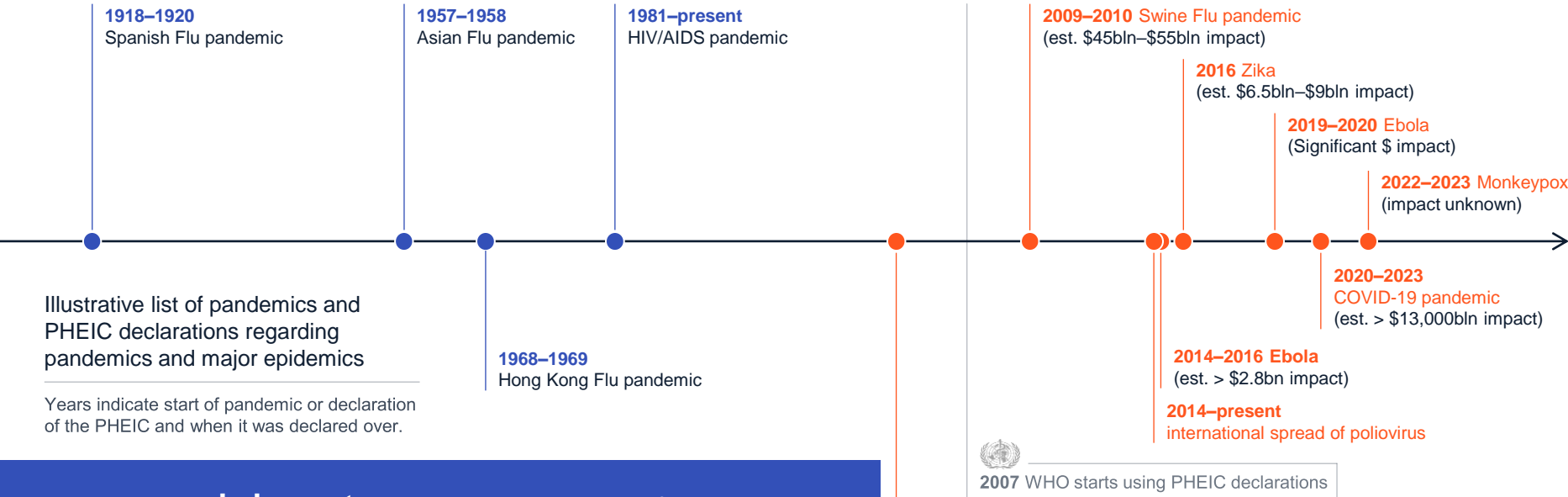
¹ WHO standard reporting for outbreaks that could spread internationally or disrupt international travel or trade

² Rebranded Ginkgo Bioworks in 2022 (Cheney, devex, 31 July 2021)

³ London-based disease forecasting company (Fortune, Apr 18, 2023 and Bloomberg, Apr 14, 2023)

Frequency and severity of outbreaks are increasing

Since 2007 the WHO declares outbreaks with the greatest public health risk through international spread and potential interference with trade and travel as Public Health Emergencies of International Concern (PHEIC). PHEICs are marked in **orange** below.



Illustrative list of pandemics and PHEIC declarations regarding pandemics and major epidemics

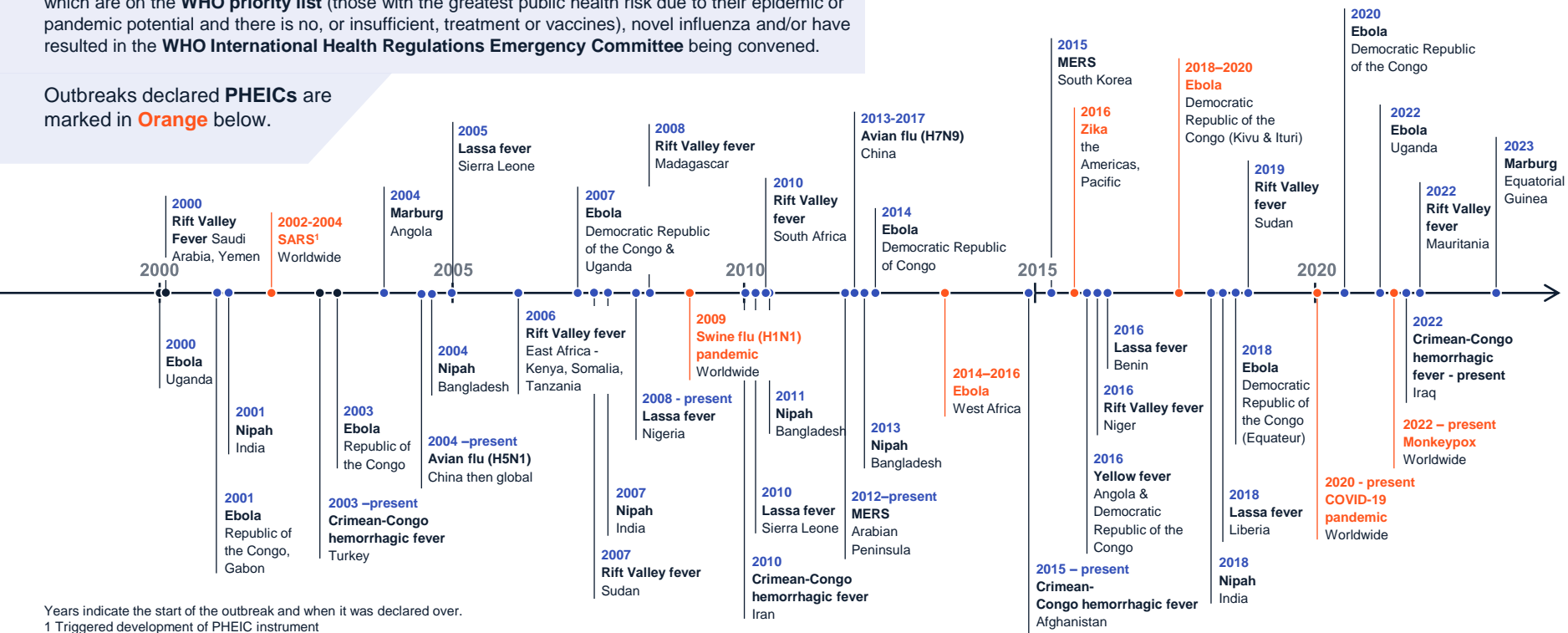
Years indicate start of pandemic or declaration of the PHEIC and when it was declared over.

The **economic impact** varies but is always significant.
All PHEICs have been in relation to viral diseases.

Increasing trend requires improved risk management in the future

Illustrative list of **large epidemics with high case fatalities (≥ 20)** caused by; infectious diseases which are on the **WHO priority list** (those with the greatest public health risk due to their epidemic or pandemic potential and there is no, or insufficient, treatment or vaccines), novel influenza and/or have resulted in the **WHO International Health Regulations Emergency Committee** being convened.

Outbreaks declared **PHEICs** are marked in **Orange** below.



Years indicate the start of the outbreak and when it was declared over.
 1 Triggered development of PHEIC instrument

Many unknown viruses can cause the next pandemic

COVID-19 is not the last...

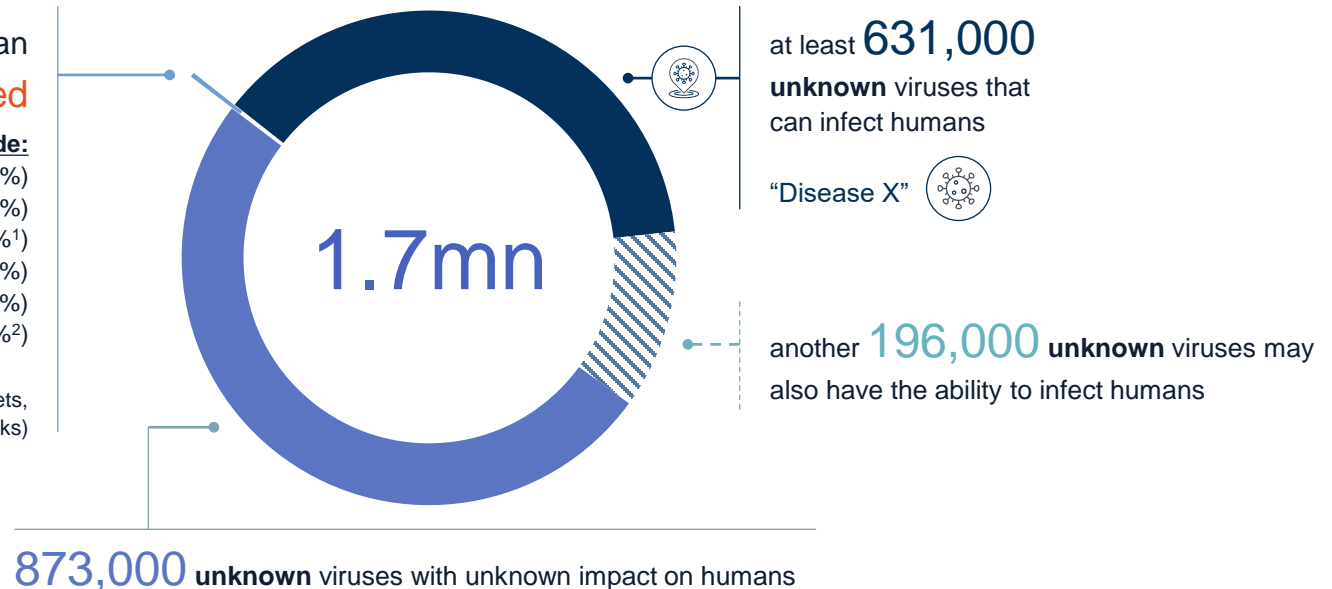
An estimated **1.7 million** currently undiscovered viruses are thought to exist in mammal and avian hosts. Of these, 631,000-827,000 could have the ability to infect humans. (United Nations – IPBES)

Only **263** virus species that can infect humans have been **classified**

some examples include:

- SARS-CoV-1 (11%)
- MERS-CoV (~35%)
- SARS-CoV-2 (2.17%¹)
- Zaire Ebolavirus (~50%)
- Lassa Mammarenavirus (1%/15%)
- Rabies lyssavirus (100%²)

(Average Case Fatality Rate in brackets, CFR may differ between countries/outbreaks)



¹ CFR may vary during duration of outbreak and from country to country, number chosen for SARS-CoV-2 illustrates average CFR in July of 2021, already showing the influence of extensive pharmaceutical and non-pharmaceutical interventions

² once clinical symptoms appear

Source: <https://www.npr.org/sections/goatsandsoda/2021/03/19/979314118/next-pandemic-scientists-fear-another-coronavirus-could-jump-from-animals-to-hum?t=1622625437955>
<https://www.ecohealthalliance.org/2018/03/disease-x>



Structure

02



Class of Business

Prevention → Loss → Insuring the burning house

1. Early response cover (increasing preparedness)

Before the epidemic becomes pandemic:

- containment
- vaccination

2. Non (property) damage business interruption

- Loss of revenue
- Liquidity
- Loss mitigation

3. Health related insurance (e.g., personal accident, travel)

- Selling insurance after the pandemic has started

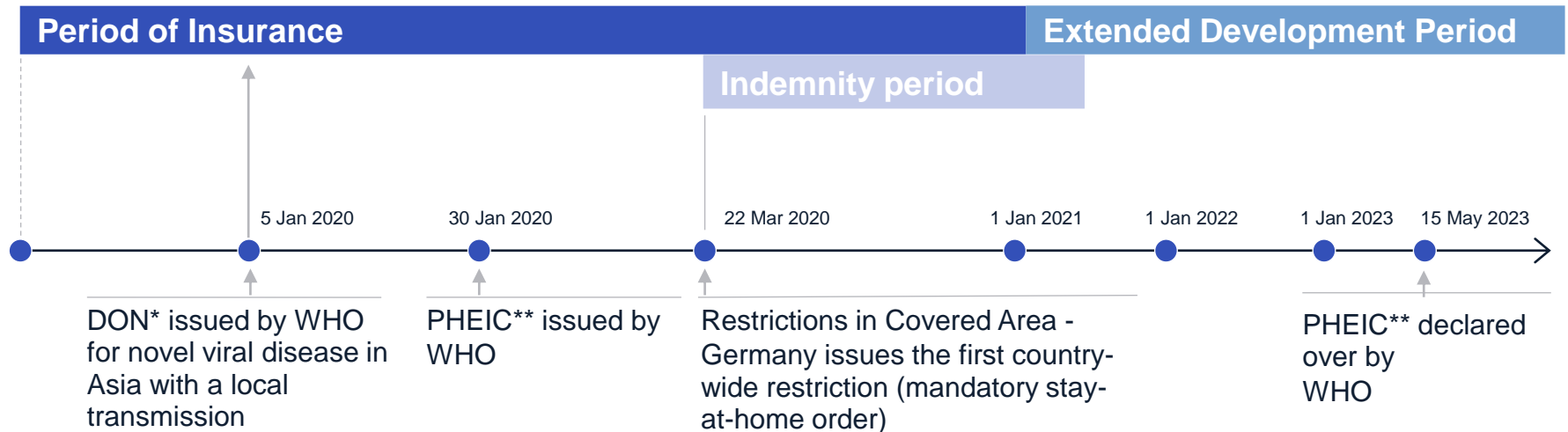
4. Contingency (e.g., event cancelation)

- Short term cover
- Non-appearance

5. General Liability

- unclear

How to connect the timeline of a pandemic to the timeline of insurance?



*DON = Disease outbreak News report issued by the World Health Organisation

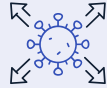
**PHEIC = Public Health Emergency of International Concern declaration issued by the World Health Organisation

The key elements of the Insurance Risk Transfer Solution

Trigger Design

Epidemic/Pandemic Trigger

Epidemic/pandemic



Economic Trigger

Business impact



Payout

Payout to the insured



Parametric

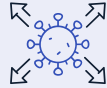
Parametric
or
Indemnity based

The key elements of the Insurance Risk Transfer Solution

Offered by Munich Re

Epidemic/Pandemic Trigger

Epidemic/pandemic



Parametric – objective data points

When

e.g., WHO reports a new outbreak

What

e.g., WHO declares a Public Health Emergency of International Concern (PHEIC)

Where

e.g., Civil Authority Restriction issued in relation to the disease within the Covered Area

Economic Trigger

Business impact



Financial impact to business operations, for example

- Loss of Gross profits/earnings
- Wage roll
- Debt obligations
- Extra Expense
- Employee benefits
- Contingent loss from suppliers/customers
- Execution of planned counter measures
- ...

Payout

Payout to the insured



Claim submitted by insured

Parametric insurance format
or

Derivative instrument format
(no economic trigger)

Early response cover

e.g., Filovirus

Reporting Source

“Weekly Bulletin on Outbreaks and Other Emergencies (WHO Regional Office for Africa)”
WHO publishes weekly updates and confirmed case numbers on outbreak events across Africa.

Trigger Metric

Layer 1: Number of Confirmed Cases per outbreak event ≥ 5

Layer 2: Number of Confirmed Cases per outbreak event ≥ 10

Note the triggers are not based on aggregate case numbers, but per event.

Capacity

USD 5m annual aggregate:

Layer 1: 33 % or USD 1.65m

Layer 2: 67 % or USD 3.35m

Early response cover

e.g., Meningitis

Reporting Source

“WHO Africa Meningitis Weekly Bulletin”.

From January, at the commencement of the meningitis season, WHO consistently publishes country data on the Number of Districts in Alert and Epidemic Phase. A district is assigned Alert Phase or Epidemic Phase status if it meets specific numbers of suspected cases.

Trigger Metric

A1: Number of Districts in Alert or Epidemic Phase \geq 12; AND

A2: Number of Districts in Epidemic Phase \geq 1; AND

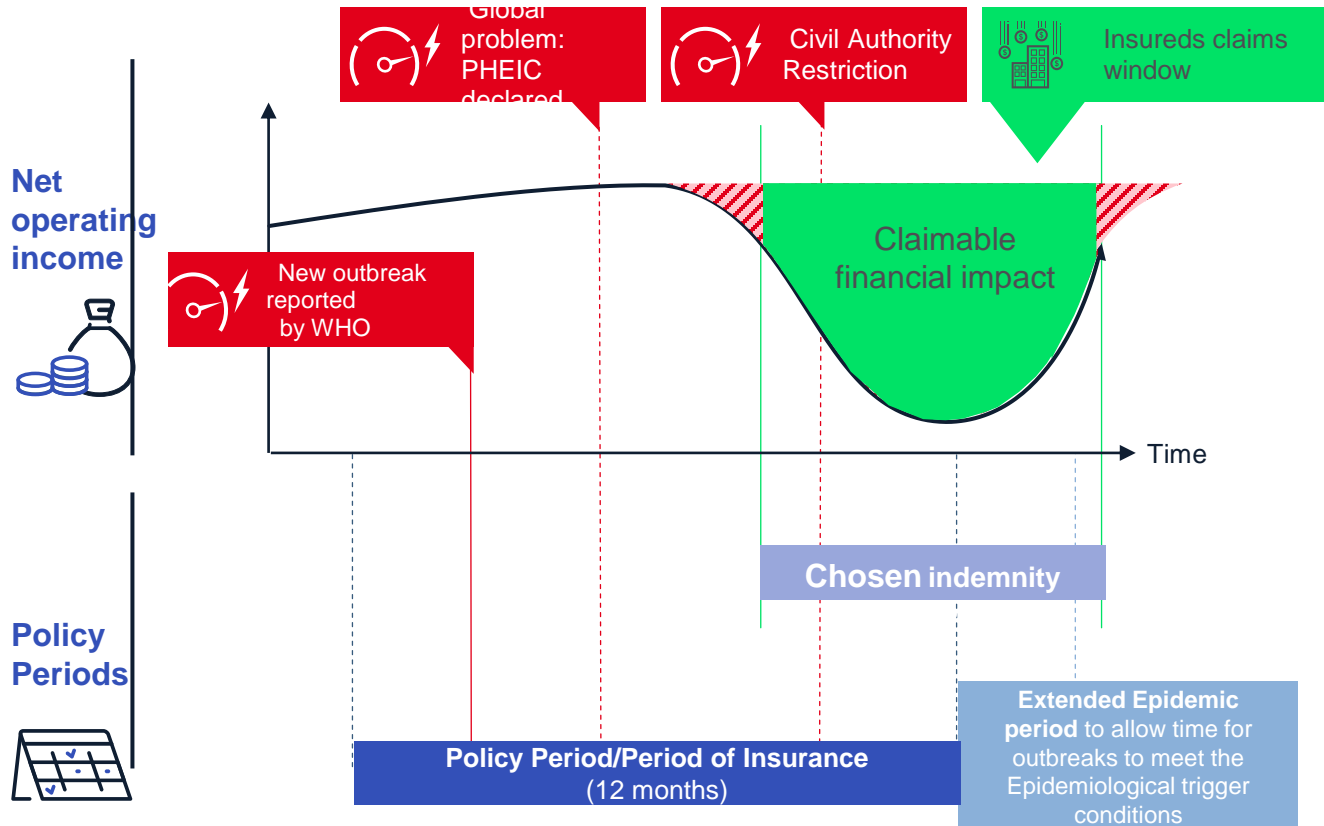
A3: Reporting Source specifies causative pathogen OR ICG* Approval

Due to A1 and A2 being based on **suspected** cases this metric is associated with **moral hazard**, hence the introduction of A3. This trigger period is Weeks 1-16 of the meningitis season.

Capacity

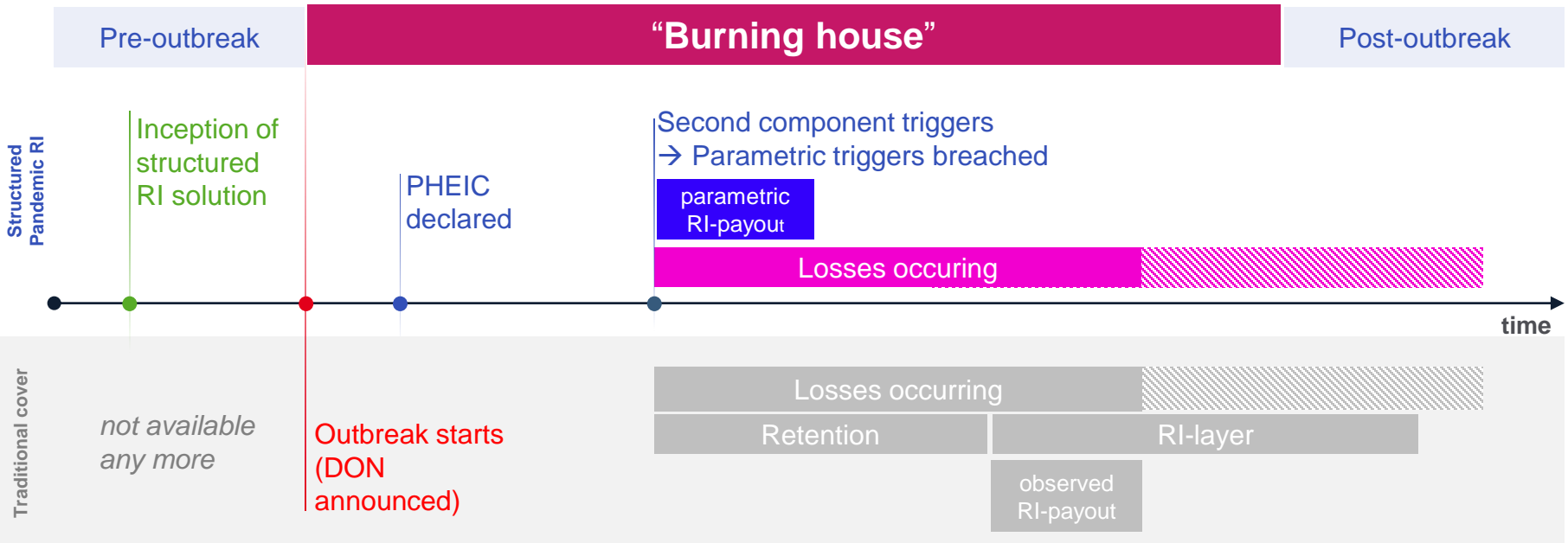
USD 1m annual aggregate.

Typical loss example for a loss of Gross Profits Cover



Structured Reinsurance during a Pandemic Event

Structured RI decouples the PI losses from the RI payout by introducing a parametric structure.
PI continues to sell policies during a pandemic event while the RIs provide ex-ante solution.



Parametric Triggers remove ex-ante uncertainty.



Model

03



**Mathematical methods have been available for more than 25 years.
Then What changed?**

- **Computing power has heavily increased**
- **Data availability has heavily increased**
- **We just had a pandemic**

Rating Model and Pricing the Risk

Modelling of Epidemic NDBI

Deductibles, limits, coinsurance, first loss curves / exposure curves, diversification, accumulation, inter alia.

Insurance structure

More than 100 years of Munich Re single risk, . business interruption underwriting.

Relative Resilience e.g. essential vs non-essential, company preparedness and culture, diversification, dependencies, etc.

Vulnerability

industry sector and single company level

Worldwide epidemic impact data on company level
. for larger epidemics (e.g. COVID19, Ebola,
. MERS, SARS etc.)

Epidemical and financial triggers modelled separately. Model complexity depending on trigger type.

Policy Triggers

Reporting structures, WHO, local authorities, health infrastructure

Data base of epidemic reporting,
. local authority interventions, etc.

Forward modelling of pathogens by individual characteristics and trends in various geo-political environments.

Geographical Spread

Socio-economic factors, climate zones, biomes, animal spread, preparedness, etc.

Including ca. 70 influencing
. geographical factors for
. geographical contagion.

Many years specialised in epidemic BI modelling - between epidemiological and actuarial experts.

Epidemic Outbreak Model

frequency-severity-models, fitted distributions, SIR-models, extreme scenarios

Database of ca 30,000 disease outbreaks (GIDEON, Metabiota, WHO, inhouse, etc.)

Epidemic outbreak model, Types

When, What, Where

Vendor Model

- + Independent modeller
- + Well established in life insurance
- Limited availability

SIR Model

- + does not depend on statistics
- + high parameter detail possible
- High development / calibration / simulation effort

Statistical Model

- + Well known in insurance world
- + automatization possible /easy model update
- Limited detail

e.g., WHO, Disease Outbreak News

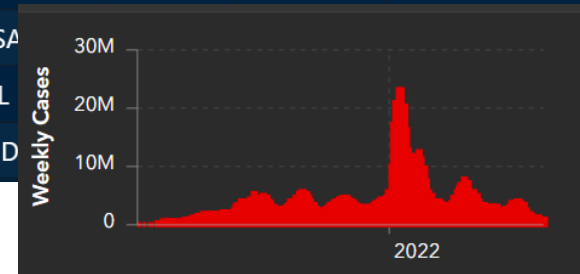
Pneumonia of unknown cause – China

5 January 2020

On 31 December 2019, the WHO China Country Office was informed of cases of pneumonia of unknown etiology (unknown cause) detected in Wuhan City, Hubei Province of China. [...]

Condensed Outbreak Information (e.g., GIDEON, Metabiota, JHO, etc.)

disease_cleansed	year	ISOa3	cases	deaths	notes
Salmonellosis	2007	IRL	185	NA	
Giardiasis	1976	USA	128	NA	
Cholera	2010	IND	288	3	Outbreak among w
Typhoid	1975	IND	9000	NA	Outbreak in Sangli
Escherichia infection	2005	USA			
Leptospirosis	2004	IRL			ate
Hepatitis E	2005	IND			



Epidemic Outbreak Model

When, What, Where

SIR Model

S usceptible

I nfectious $I_{n+1} = S/N * R_0 * I_n$

R ecovered

Additional compartments as needed.

Simulations of new event / Back-testing
to known events

Statistical Model

- Homogeneous groups of diseases
- Frequency
- Severity

Fitted event probabilities / discrete or
fitted distribution for event size

Geographic, Socioeconomic and Epidemiological Data

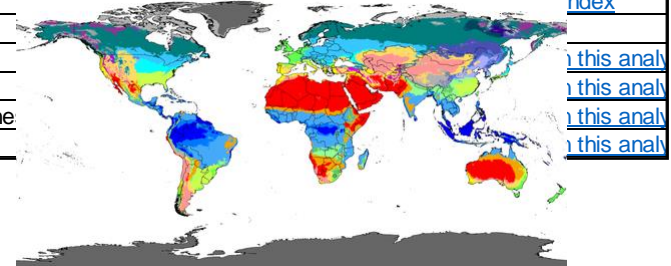
Factors that could influence the spark, spread and the size of an epidemic in a country.

- Initial list had 176 entries
- Reduced to 75 usable factors mainly due to data availability issues

Both, publicly available and proprietary datasets

e.g.:

Factor	Specifics	Description
Aedes Albopictus		The observations of Aedes are s Underlying Paper
Aedes Aegypti		The observations of Aedes are s Underlying Paper
Age Distribution		Population ages 65 and above as World Bank
Alcohol/Drug Abuse		Proxy for Distribution of High Risk Our World In Data
Anopheles		We have used the Malaria Atlas Description of Package
Antibiotic Use in Livestock		Antibiotics are used in livestock f Our World In Data
Area		Surface area is a country's total World Bank
Bats		The data is is from the USAID PF USAID Health Map
Biodiversity		Index
Bushmeat Hunting		
Climate	General	this analy
Climate	Biomes	this analy
Climate	Climate Zone	this analy
Climate	Elevation	this analy



SIR Model

Simulation of / calibration to:

- Virus characteristics
 - Transmission , incubation, etc
 - Habitat, animal reservoir
- Human behaviour
 - Containment (e.g., quarantine)
 - Mitigation (e.g., lock down)
 - Travel pattern (flights, tourism)
 - Travel restrictions

Statistical Model

Machine learning to find influencing factors for:

- Country individual spark probabilities
- Size factor
- Spread type / accumulation

Parametric trigger options

- Reported case numbers / fatalities in country (e.g., early response cover)
 - Trigger is already within modelled outbreaks
- PHEIC and local transmission in country
 - probability for PHEIC as mixture of WHO process rules, statistics, epidemiological adjustments
- PHEIC and Civil Authority Restriction in country
 - probability for Civil Authority Restriction as mixture of scenario considerations, statistics

(partially) Parametric

Industry sector index

Parametric reinsurance &
Indemnity based Primary
insurance

Predefined containment /
vaccination cost

Indemnity based

Mostly Business interruption / Event Cancellation insurance

Before Covid19:

- few statistics, “expert judgment”

After Covid19:

- 1,000,000 usable balance sheets
- Good prediction power of pre pandemic P&L
- Statistical first loss curves with high level of detail
- Additional qualitative risk assessment

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Image: Chris Ryan_KOTO / stock.adobe.com

Thank you for your attention!

Dr. Hjalmar Böhm, Senior Actuary, ERS

www.munichre.com/epidemic-risk-solutions

Munich RE 

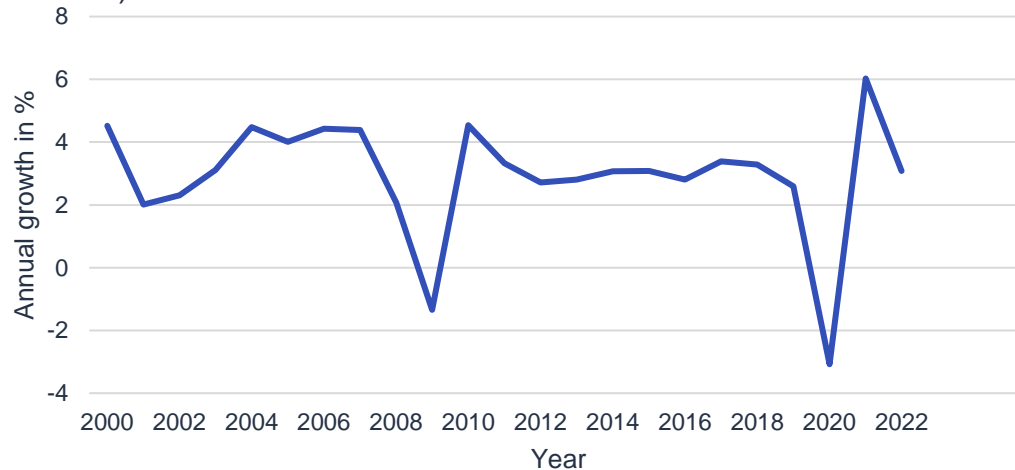
Major economic impact of COVID-19

Example: Drop in global GDP growth

The COVID-19 pandemic sent shock waves through the world economy and triggered the largest global economic crisis in more than a century.

World GDP growth

(annual %)



- Major **drop in GDP growth** in 2020 due to COVID-19 (+2.5% down to -3%)
- Spill-over and “**economic contagion**” on the macro and micro level
- **Little to no economic preparedness** for the COVID-19 hit

- 1. Poor pandemic preparedness (public and private sector) lead to reactive measures**
- 2. Over-optimized supply chains and unexpected dependencies**
 - Over-reliance on single countries/suppliers
 - Tourism/Event sector fully dependent on peoples' ability and willingness to meet and travel
- 3. Huge burden put on healthcare and education systems**
- 4. Pandemic Insurance was largely not in place**
 - incl. ambiguous wordings and insurance gaps, misunderstanding of covers etc.

Private Sector companies

Do nothing

Evaluate risk exposure

&

Adjust business strategy

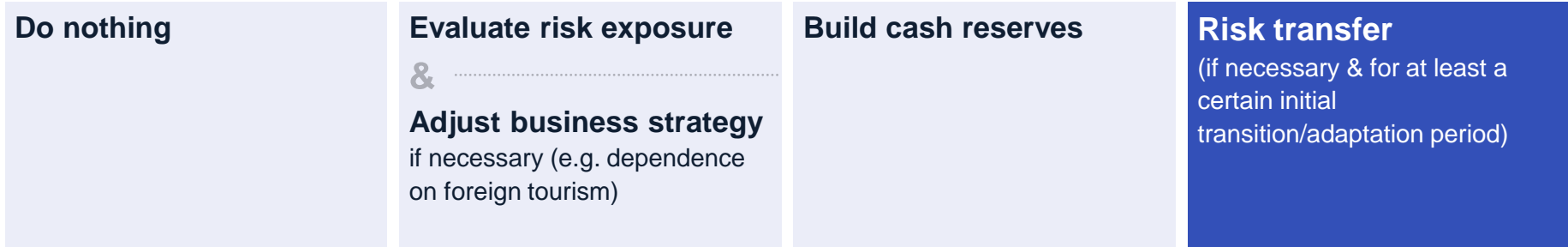
if necessary (e.g. dependence on foreign tourism)

Build cash reserves

Risk transfer

(if necessary & for at least a certain initial transition/adaptation period)

Private Sector companies



Public Sector

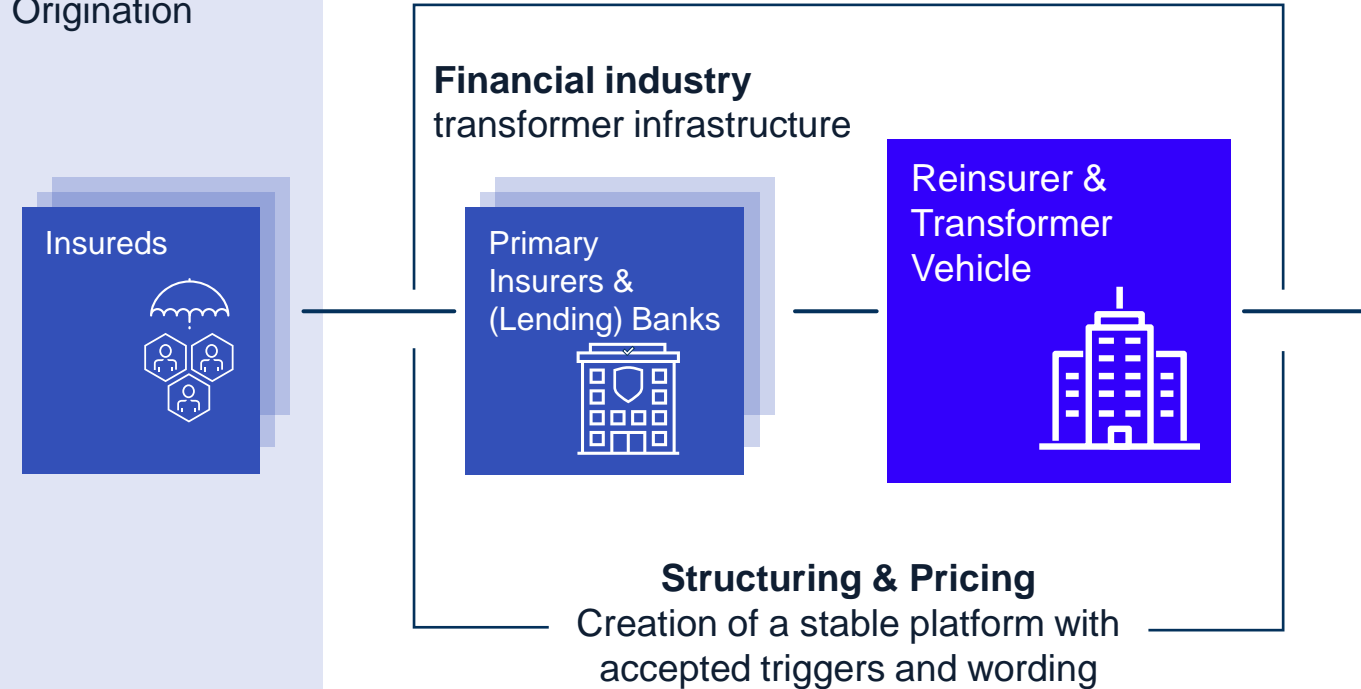


The Epidemic Risk Markets Platform – Risk Transformation

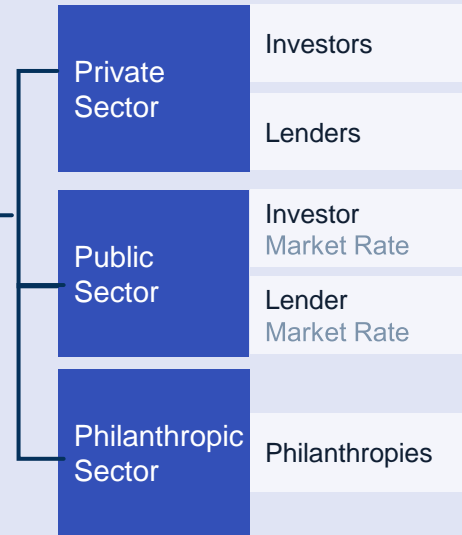
Value Chain including Public, Private and Philanthropic Partnerships

Phase 1: Kick-starting a sustainable insurance market **Phase 2: Scaling up capacity**

Origination



Distribution/ capacity provision



Tailor-made Public Sector programs

Example: Senegal (with African Risk Capacity)

The **first ever** parametric insurance product designed to protect an individual African sovereign state against high-impact epidemic risks.

Closing the Protection Gap Initiative of the Year category

for the Outbreaks & Epidemics Programme of the African Risk Capacity

Winners:

African Risk Capacity Group and

Munich Re Group

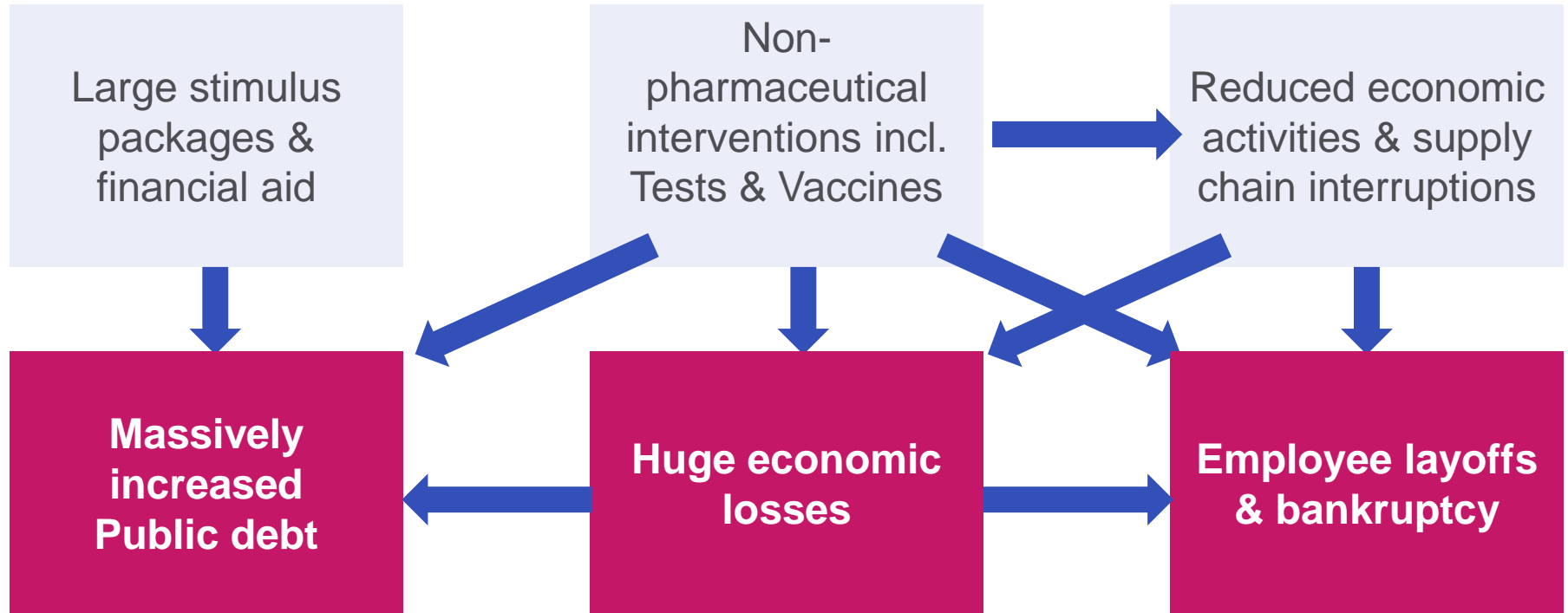


Transaction Overview

- **Insured:** Senegal
- **Insurer:** ARC Ltd
- **Reinsurers:** Munich Re (lead), Hiscox Re, Swiss Re and Global Parametrics
- **Term:** 2-year, with 2 individual annual periods

Why pandemic risk matters – economic perspective

We survived COVID-19 but what is next?



Non-exhaustive illustration

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