Ebola and Pandemics
Defining a Risk Test Scenario for managing the business risks posed by infectious disease outbreaks
University of Cambridge Centre for Risk Studies

Research Application Partners

Collaborators
Catastrophe Modelling in Complex Systems

- The Centre for Risk Studies arises from shared interests by the participants in exploring areas of intersection between
  - Catastrophe modelling and extreme risk analytics
  - Complex systems and networks failures

- Advance the scientific understanding of how systems can be made more resilient to the threat of catastrophic failures

To answer questions such as:
‘What would be the impact of a [War in China] on [Trade Networks] and how would this impact the [Global Economy]?

Regional Conflict  Air Travel Network  Global Economy

[Image of soldier and Air Travel Network with GDP graph]
Cambridge Taxonomy of Threats

**Financial Shock**
- Asset Bubble
- Financial Irregularity
- Market Crash
- Sovereign Default
- Bank Run

**Trade Dispute**
- Cartel Pressure
- Nationalization
- Tariff War
- Labour Dispute
- Trade Sanctions

**Geopolitical Conflict**
- External Force
- Civil War
- Nuclear War
- Conventional War
- Asymmetric War

**Political Violence**
- Organized Crime
- Assassination
- Social Unrest
- Terrorism
- Separatism

**Natural Catastrophe**
- Earthquake
- Windstorm
- Volcanic Eruption
- Flood
- Tsunami

**Climatic Catastrophe**
- Drought
- Freeze
- Tornado & Hail
- Electric Storm
- Heatwave

**Environmental Catastrophe**
- Wildfire
- Pollution Event
- Atmospheric System Change
- Sea Level Rise
- Ocean System Change

**Technological Catastrophe**
- Nuclear Meltdown
- Industrial Accident
- Cyber Catastrophe
- Technological Accident
- Infrastructure Failure

**Disease Outbreak**
- Human Epidemic
- Animal Epidemic
- Waterborne Epidemic
- Zoonosis
- Plant Epidemic

**Humanitarian Crisis**
- Famine
- Water Supply Failure
- Refugee Crisis
- Child Poverty
- Welfare System Failure

**Externality**
- Space Threat
- Ozone Layer Collapse
- Satellite System Failure

**Cyber Catastrophe**
- Cyber Catastrophe
- Technological Accident
- Infrastructure Failure

**Other**

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[Images and diagrams of threats categorized by type]
2013-14: Selected Scenarios from the Threat Universe

- Financial Shock
- Natural Catastrophe
- Financial Catastrophe
- Stress Test Scenarios
- Climate Catastrophe
- Climates Catastrophe
- Externality
- Space Catastrophe
- Other
- Technological Catastrophe
- Cyber Catastrophe
- Financial Catastrophe
- Stress Test Scenarios
- Human Epidemic Scenario
- São Paulo Pandemic
- Animal Epidemic
- Plant Epidemic
- Waterborne Epidemic
- Zoonosis
- Disease Outbreak
- Financial Shock
- Natural Catastrophe
- Environmental Catastrophe
- Environmental Catastrophe
- Sea Level Rise
- Ocean System Change
- Atmospheric System Change
- Pollution Event
- Wildfire
- Environmental Catastrophe
- Technological Catastrophe
- Infrastructure Failure
- Technological Catastrophe
- Cyber Catastrophe
- Sybil Logic Bomb
- Cyber Catastrophe Scenario
- Other
- Geopolitical Conflict
- China-Japan Conflict
- Geopolitical Conflict Scenario
- Millennial Uprising
- Social Unrest Scenario
- Other
- Trade Dispute
- Trade Dispute
- Labour Dispute
- Tariff War
- Trade Sanctions
- Nationalization
- Cartel Pressure
- War
- War
- Space Threat
- Space Threat
- Nuclear War
- Asymmetric War
- Conventional War
- Civil War
- External Force
- Geopolitical Conflict
- Terrorism
- Separatism
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- Financial Irregularity
- Bank Run
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- Stress Test Scenarios
- Cyber Catastrophe
- Sybil Logic Bomb
- Social Unrest Scenario
- Other
- University of Cambridge
- Centre for Risk Studies
Published Reports on Stress Test Scenarios

Taxonomy of Threats

Social Unrest Stress Test Scenario
Cyber Catastrophe Stress Test Scenario
Pandemic Stress Test Scenario
Geopolitical Conflict Stress Test Scenario

Available for Download from Website: CambridgeRiskFramework.com
Network Models and Interconnected Risks

International Trading Networks

Travel Flows of People and Goods

Business Relationships between Companies

Communications and Social Media
Future London Risk Briefings

Tues 16 December – Cyber Catastrophe Risk

Thurs 22 January – Social Unrest Risk

Thurs 19 February – Geopolitical Conflict Risk

Registration at

http://www.risk.jbs.cam.ac.uk/
Pre-Publication Bulletins on Current Events

- Centre for Risk Studies Blog
  - http://www.blogs.jbs.cam.ac.uk/risk-studies-viewpoint/

- New CRS insights broadcast on Twitter
  - Follow us @Risk_Cambridge

- LinkedIn Community
  - Join LinkedIn Group Cambridge Centre for Risk Studies

- CRS Research Platform
  - New publications and Threat Observatory
  - http://cambridgeriskframework.com/

- CRS Website
  - http://www.risk.jbs.cam.ac.uk/
Ebola and Pandemics

Cambridge Centre for Risk Studies
London Risk Briefings

Ebola and Pandemics

Dr. Andrew Coburn
CRS Team Lead, Pandemic Risk
Ebola Outbreak 2014
At 20 November 2014:

- **14,618** confirmed cases of ebola
- Estimated total infected population: **28,000 - 44,000**
- Total deaths: **5,537**
- Cases in US and Europe: **6**
- Deaths in US and Europe: **2**
- Active Outbreak: **Liberia, Sierra Leone, Guinea**
- Liberia weekly new caseloads stabilized / declining
- Now declared disease free: **Nigeria, Senegal**
- New active outbreak in **Mali 23 October**
- Freetown, capital of Sierra Leone, now infected
- Currently **100 - 300** new cases a day in West Africa
Current Status

Source: Leopoldo Martin R
How Will the Epidemic Play Out?

Source: RMS Ebola Event Report #2, 22 October 2014
West Africa Ebola outbreak projection using US CDC Ebola Model
Economic Impact: West Africa

Liberia, Sierra Leone and Guinea,

**Key Economic Sectors**

- Mining and Quarrying, 27%
- Agriculture, 9%
- Transport, 16%
- Hospitality & Tourism, 7%
- Transport Equipment, 6%
- Wholesale Trade, 5%
- Education, & Health, 4%
- Telecoms, 3%
- Retail Trade, 3%
- Food & Beverages, 2%
- Construction, 2%
- Electrical and Machinery, 2%

**Key Trading Markets**

- Europe 69%
- Asia 14%
- Americas 8%
- Africa 5%
- Latin America 3%
- Oceania 1%
- Other

**Exports by Sector**

World Bank estimates Ebola outbreak “could cost West Africa’s economy $32.6 Bn”

8 Oct 2014

8 Oct 2014
The Fear Multiplier

- Ebola kills half of the people who catch it
  - It is highly virulent and symptoms are horrific
- People’s fear of catching ebola changes their behaviour
  - Some behaviour is out of proportion to the threat
- The fear of disease can have more economic impact than any direct costs of the disease itself
- Virulent diseases in the past have caused significant economic damage from the fear they engender
- Outbreaks of SARS, Polio, Asian Flu, and other diseases have had significant impacts on localized economies
The Fear Multiplier At Work

Following the death from ebola in Dallas, Texas, of Thomas Duncan, a Liberian patient, on 8 October:

- Dallas parents kept their children from going to school,
- Diners at restaurants down 5% from same period a year earlier
- Bars and clubs saw custom drop 11%
- Hotel occupancy down 7%, as people cancelled business trips to the city

Not all businesses suffered though:

- Army-Navy stores in East Texas had boom in people buying survivalist equipment e.g. water purification tablets, gas masks, and emergency fuel
SARS 2003 Impact on Retail & Tourism

Retail in China

Tourism & Trade in Singapore

- Singapore Real Retail Sales, Visitor Arrivals, Shipping Tonnage and Airline Freight Carried (Jan 2001 = 100)
- SARS outbreak
- Air freight
- Shipping tonnage
- Visitor arrivals
Evaporation of the Feelgood Economy

- Asian Flu (1957)
- Polio (1952)

Quarter-to-Quarter Change in Consumption (%)

- Motor vehicles and parts
- Furnishings and durable household equipment
- Recreational goods and vehicles
- Other durable goods
- Food and beverages off-premises
- Clothing and footwear
- Other nondurable goods
- Gasoline and other energy goods

Asian Flu (1957)
Polio (1952)
How Might the Current Ebola Epidemic Affect Us?

- Most projections now expect ebola to become endemic in West Africa
  - Eradication is becoming unlikely

- Over 200,000 people a month normally fly from the affected region to other parts of the world
  - Most of them travel to Europe as a hub to the rest of the world
  - Half of transferring travellers go to United States

- Individual cases will appear in Europe & United States

- Estimates of the number of US cases we are likely to see:
  - RMS: “US could see 15 to 130 new ebola cases” (Press Release 3 Nov 2014)
  - National School of Tropical Medicine, Texas: “between 5 and 100”
  - David Relman, Prof. of Infectious Diseases, Stanford University:”it is quite possible that every major (US) city will see at least a handful of cases”
Cambridge ‘Contingency’ Scenario: Ebola in US and Europe

- It would be prudent for businesses to plan for contingencies around economic disruption from ebola cases in US and Europe
- This is **not** a prediction or ‘expected’ outcome
  - It is an analysis of the consequences of the upper bounds of published epidemiological projections
  - It is intended as a ‘What If…’ exploration for business preparedness planning
- The Cambridge ‘Contingency’ Scenario for ebola consists of:
  - Several hundreds of individual cases and clusters of cases in US and Europe
  - These occur sporadically between now and mid-year 2015
  - Most major cities have a minor outbreak or a scare
  - Each localized outbreak is quickly contained and dealt with. There is minimal contagion within US and European urban populations
  - Each outbreak causes localized panic and avoidance of public gatherings, reduction in discretionary travel, reduction in economic activity and consumption
Macroeconomic Analysis of Ebola ‘Contingency’ Scenario

- Ebola cases disrupt economic activities in:
  - United States – 20 major cities (accounting for a third of US national GDP)
  - UK, Germany, France, Spain, Italy – 15 major cities (accounting for a quarter of their combined GDP)

- Consumption decreases for 0.5% for 2Q
  - Similar to Polio outbreak of 1952

- Labour and participation rate drops by 5% for 2Q
  - Similar to Polio outbreak of 1952

- Tourism earnings drop 50% in Q2 and recover to 90% by Q4
  - Similar to impact of SARS 2003 on infected cities

- These economic consequences are felt by each country’s trading partners and cascade through the world economy
Economic Impact Consequences

- Inflation – suppression of consumer spending due to ebola triggers an initial *deflationary* phase in economy for two years, followed by an inflation boom, end of year 3
- Interest rates expected to rise as a result, adding a % point to rates in many countries
- Unemployment rates increased generally – ebola outbreak could double unemployment in UK
**Ebola ‘Contingency’ Scenario Would Cost the Global Economy Over a Trillion Dollars**

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
</table>

**USA GDP@Risk**

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>2015 GDP@Risk</th>
<th>Next 5 Years GDP@Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total US$</td>
<td>% of Total</td>
</tr>
<tr>
<td><strong>United States GDP Loss</strong></td>
<td>0.30 Trillion</td>
</tr>
<tr>
<td><strong>Europe (DE, FR, UK, IT, ES)</strong></td>
<td>0.24 Trillion</td>
</tr>
<tr>
<td><strong>Global GDP Loss</strong></td>
<td>0.77 Trillion</td>
</tr>
</tbody>
</table>
How Much Would it Have Cost to Have Contained it?

World Health Organization Cost Estimates to Contain Ebola Outbreak
Appeal to National Governments for Assistance

<table>
<thead>
<tr>
<th>Date</th>
<th>Cost Estimate Appeal</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 2014</td>
<td>$4.8 million</td>
</tr>
<tr>
<td>July 2014</td>
<td>$100 million</td>
</tr>
<tr>
<td>August 2014</td>
<td>$500 million</td>
</tr>
<tr>
<td>October 2014</td>
<td>$1 Billion</td>
</tr>
</tbody>
</table>

- By 15 October, only $257m had been received, with another $162m pledged
  - Only a third of the resources needed

- The opportunity to eradicate the disease has been lost through inability of international community to fund the early eradication of a threat in a external location
What Should Your Ebola Contingency Plans Be?

- Information and communication to employees and counterparties
  - Be proactive with reassurance: put the risk into perspective

- Expect disruption to processes, suppliers, and markets
  - Have business continuity plans ready
  - Expect absenteeism – have overlapping coverage of essential tasks

- Prioritize protection of workforce
  - Ensure work practices are safe for employees
  - Ebola is spread by close physical contact, not airborne infection: Ensure protection measures reinforce education not myth

- Implement higher tolerance of credit risk from counterparties

- Be ready to switch to conservative investment strategies for asset portfolio resilience

- Give generously to ebola containment charities
### Historical Infectious Disease Pandemics

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Middle East Respiratory Syndrome Coronavirus</td>
<td>MERS-CoV</td>
</tr>
<tr>
<td>2002</td>
<td>Severe Acute Respiratory Syndrome</td>
<td>SARS</td>
</tr>
<tr>
<td>1981-today</td>
<td>Acquired Immunodeficiency Syndrome</td>
<td>HIV/AIDS</td>
</tr>
<tr>
<td>1918-1922</td>
<td>Russian Typhus Epidemic</td>
<td>Typhus</td>
</tr>
<tr>
<td>1855-1959</td>
<td>Third Pandemic</td>
<td>Bubonic plague</td>
</tr>
<tr>
<td>1862-1966</td>
<td>El Tor Cholera Pandemic</td>
<td>Cholera</td>
</tr>
<tr>
<td>1899-1923</td>
<td>Sixth Cholera Pandemic</td>
<td>Cholera</td>
</tr>
<tr>
<td>1881-1896</td>
<td>Fifth Cholera Pandemic</td>
<td>Cholera</td>
</tr>
<tr>
<td>1863-1875</td>
<td>Fourth Cholera Pandemic</td>
<td>Cholera</td>
</tr>
<tr>
<td>1846-1863</td>
<td>Third Cholera Pandemic</td>
<td>Cholera</td>
</tr>
<tr>
<td>1826-1837</td>
<td>Second Cholera Pandemic</td>
<td>Cholera</td>
</tr>
<tr>
<td>1816-1824</td>
<td>Asiatic Cholera Pandemic</td>
<td>Cholera</td>
</tr>
<tr>
<td>1793; 1690-1878</td>
<td>Yellow fever, U.S.</td>
<td>Yellow fever</td>
</tr>
<tr>
<td>1775-1782</td>
<td>North American smallpox</td>
<td>Smallpox</td>
</tr>
<tr>
<td>1679</td>
<td>Great plague of Vienna</td>
<td></td>
</tr>
<tr>
<td>1665-1666</td>
<td>Great plague of London</td>
<td></td>
</tr>
<tr>
<td>1629-1631</td>
<td>Italian plague/</td>
<td>Bubonic plague</td>
</tr>
<tr>
<td>16th C</td>
<td>Spread of smallpox thru</td>
<td>Smallpox</td>
</tr>
<tr>
<td>1500-1800</td>
<td>Epidemics throughout Europe</td>
<td>Multiple</td>
</tr>
<tr>
<td>1577-1579</td>
<td>Following Black Assize</td>
<td></td>
</tr>
<tr>
<td>1489</td>
<td>Spanish Siege of Moorish Granada</td>
<td>Typhus</td>
</tr>
<tr>
<td>1347-1350</td>
<td>Black Death</td>
<td>Bubonic plague</td>
</tr>
<tr>
<td>639</td>
<td>Plague of Emmaus/Amwas</td>
<td>Bubonic plague?</td>
</tr>
<tr>
<td>541-750</td>
<td>Plague of Justinian</td>
<td>Bubonic plague</td>
</tr>
<tr>
<td>251-266</td>
<td>Plague of Cyprian</td>
<td>Smallpox or measles?</td>
</tr>
<tr>
<td>165-180</td>
<td>Antonine Plague</td>
<td>Smallpox or measles?</td>
</tr>
<tr>
<td>430 BC</td>
<td>Plague of Athens</td>
<td>Typhoid/Plague/Measles?</td>
</tr>
</tbody>
</table>

### Historical Influenza Pandemics

<table>
<thead>
<tr>
<th>Date</th>
<th>Notes</th>
<th>Influenza Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Mexican Swine Flu</td>
<td>H1N1</td>
</tr>
<tr>
<td>1977-1978</td>
<td>Russian Flu ‘benign’ pandemic, possibly caused by a lab release</td>
<td>H1N1</td>
</tr>
<tr>
<td>1968</td>
<td>Hong Kong Flu</td>
<td>H3N2</td>
</tr>
<tr>
<td>1957-1958</td>
<td>Asian Flu Pandemic</td>
<td>H2N2</td>
</tr>
<tr>
<td>1918-1919</td>
<td>Spanish Flu ‘The Great Influenza’</td>
<td>H1N1</td>
</tr>
<tr>
<td>1889-1893</td>
<td>Russian Flu</td>
<td>H3N8 or H2N2</td>
</tr>
<tr>
<td>1830-1848</td>
<td>Four influenza epidemics occurring almost continuously 1830 to 1848, possibly originating in China</td>
<td></td>
</tr>
<tr>
<td>1788-1790</td>
<td>Initiated a pandemic era, of heightened global influenza activity for almost 20 years</td>
<td></td>
</tr>
<tr>
<td>1780-1782</td>
<td>Began in Southeast Asia and spread to Russia and eastward into Europe</td>
<td></td>
</tr>
<tr>
<td>1761-1762</td>
<td>Begun in Americas and spread to Europe and around the globe. First pandemic to be scientifically studied.</td>
<td></td>
</tr>
<tr>
<td>1729-1730, 1732-1733</td>
<td>First detected in Russia</td>
<td></td>
</tr>
<tr>
<td>1580</td>
<td>Swept over the entire globe, spreading east to west from Asia</td>
<td></td>
</tr>
<tr>
<td>1557-1558</td>
<td>Asia origin. Highly fatal, and associated with severe complications</td>
<td></td>
</tr>
<tr>
<td>1510</td>
<td>First recognizable pandemic. Invaded Europe from Africa.</td>
<td></td>
</tr>
</tbody>
</table>
Where Will the Next Emergent Disease Come From?

Emerging Infectious Disease Risk Map

Source Data: Global distribution of the relative risk of an EID event, from ‘Global trends in emerging infectious diseases’ Jones et al., (2007); Study by Institute of Zoology, UK, Consortium for Conservation Medicine, New York.
Diseases: Infectiousness vs Virulence

Virulence

Death Rate in Infected Cases
‘Case Fatality Rate’

Infectiousness

Fear is the economic disruptor

Absenteism is the economic disruptor

Reference Mortality
Total death rate in a disease cycle to the entire population, without intervention

Black Death
Europe, winter of 1349

Avian Flu
H5N1 caught from birds

1%

SARS

0.1%

Ebola

10%

São Paulo

1918 Spanish Flu Pandemic

1957 Flu Pandemic

Average flu season

0%

% of Population Infected

0% 10% 20% 30% 40% 50% 60%
Selecting the Scenario

Probability of Population Infection Rate in a Pandemic based on RMS Infectious Disease Model

- 1% annual probability of exceedance
- 43% of population infected
- ‘100-year-return-period’ event
An Outbreak of Mystery Illness in Brazil Poultry Farmers

Virus warning for Brazil

Mystery virus spreads as government warn citizens to avoid Brazil

Wednesday, Nov 12

Sao Paolo (1048 GMT – 0648 BRT) - The UK Foreign & Commonwealth Office and US State Department have issued a travel advisory warning for Brazil following an outbreak of an unidentified deadly virus.

Brazilian government officials have condemned the moves, calling them a “reckless, irresponsible and expensive overreaction”, but UK officials point to WHO specialists arrive in Brazil to investigate the mystery virus that has caused over 100 deaths.
The Mystery Virus Kills Many of its Initial Victims

- Over 100 deaths are reported in 10 days
- Many deaths are in teenagers and young adults
- Case Fatality Rate estimates are wildly variable (nobody knows how many people are infected)
- Some reports suggest that 10% of people who catch the virus die
- Contact tracing of infected contacts puts 8,000 people into quarantine in São Paulo
WHO Officials Identify it as ‘H8N8’

- A completely new strain of influenza virus
- Mutated in poultry populations and jumped into humans
- Appears to be highly infectious
- No vaccine exists to prevent infection
- Antiviral drugs like Tamiflu are the only treatment
Stockmarkets React

- Fear of a potential pandemic hits trading
- Latin American currencies are badly hit
- Flight to quality – emerging markets punished
- Airline stocks decline
- Healthcare providers stocks go up
Sao Paolo Virus sweeps across globe

Cases of the deadly new virus reported in US and Europe

Thursday, Nov 27

Atlanta, US (1454 GMT – 0954 EST) – Fear is gripping the world as hospitals struggle to cope with increasing numbers of sick people. Researchers at the CDC are “making progress” in identifying the genetic characteristics of the Sao Paolo Flu Virus.

Much is still unknown about Sao Paolo Virus; although health officials have stated it is one of the most infectious viruses known to man. Research is ongoing.

Business and tourism is trying to continue as usual but economists say productivity is down by a significant amount.
São Paolo Pandemic Spread - Start

Week

Number of People Infected in City

100,000 250,000 500,000 1 million 1.5 million
São Paolo Pandemic Spread - Middle

Week

Number of People Infected in City

100,000 250,000 500,000 1 million 1.5 million
São Paolo Pandemic Spread - Advanced

Week

Number of People Infected in City

100,000  250,000  500,000  1 million  1.5 million
Schools Are Closed as Part of Pandemic Response Plans

WHO declares global pandemic

Some countries declare martial law to contain the outbreak

Tuesday, Dec 23

Geneva (1723 GMT – 1123 CDT) - The WHO finally declared a global pandemic, requiring governments around the world to shut down public areas and prioritise medical attention.

Critics argue that this announcement is coming weeks later than it should have done causing tens of thousands of unnecessary deaths and millions of extra infections.

Mexican army drafted in to contain virus outbreak in Mexico City

Thus far, casualties have been much lower in the west, where anti-viral
# Healthcare Resources Are Overwhelmed

## UK

<table>
<thead>
<tr>
<th>Normal GP consultations per week:</th>
<th>4,672,200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pandemic demand in peak week:</td>
<td>3,778,900</td>
</tr>
</tbody>
</table>

| Total Hospital Beds in UK:       | 136,486   |
| Normal Occupancy Level:          | 86%       |
| Pandemic Hospital Bed Demand:    | 312,000   |

| Total Intensive Care beds in UK: | 3,770     |
| Normal Occupancy Level:          | 85%       |
| Pandemic Intensive Care Bed Demand: | 58,000   |
Absenteism comes from illness, caring for dependents, and fear of becoming infected.

At absenteeism levels above 10%, productivity drops off disproportionately.

At 20% absenteeism, many businesses cannot operate and are likely to suspend operations.

Managers may take precautionary measures to close offices pre-emptively before staff are ill.

Companies that deal with general public are more at risk.

Highest risk are healthcare providers.
Average Absenteeism in Workforce

UK Modelled results

15 days above 20%

33 days above 10%

Around 1 in 8 organizations will be hit by infection rates of **twice the national average** in their workforce

(Around 1 in 50 will have 3x the national average)
Vaccinations begin for Sao Paolo Virus

Pharmaceutical companies struggle to meet demand for new drug

Wednesday, March 30

London, England (1029 GMT) - The NHS unveiled its vaccination plan today, prioritizing health workers and the most vulnerable people to receive the first wave of vaccines. The UK death toll has already reached 40,000 but authorities believe that the worst may already be over.

Despite long queues and some angry exchanges, most countries are managing the vaccination process in a

Chicken eggs are used to create the vaccination for the Sao Paolo Virus, also known as H8N8.

In the UK, optimism is beginning to
‘Open for business’ as Sao Paolo fades

WHo: “Infection rates are slowing but there is still a threat”

Tuesday, April 5

New York (1438 GMT – 0938 EST) - The head of the WHO rang the opening bell on the NYSE with gusto this morning. It was a signal that the city is open for business, but not without caution.

The threat of Sao Paolo Virus still lingers on the streets of New York, as it does on most of the world’s cosmopolitan hubs. Their multicultural blend of everything created a Facemasks are required on the NYC and London transport systems

The return to normal has been inconsistent though, with several
Headline Death Toll

- Worldwide: 19 million deaths
- United States: 425,000 deaths
- UK: 70,000 deaths
Global Life Insurance Industry Exposure Database

A joint development project between Axco and the Centre for Risk Studies

- $2.4 Trillion of Life Insurance Premium worldwide
- 1.2 Billion Life Insurance policies
- Total aggregate value of life cover: $78 Trillion
## Total Payout by the Life & Health Insurance Industry

<table>
<thead>
<tr>
<th></th>
<th>Total Payout</th>
<th>Loss Ratio (% of annual PI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Insurance Payouts</td>
<td>$99.2 Bn</td>
<td>4.0%</td>
</tr>
<tr>
<td>Personal Accident &amp; Health</td>
<td>$92.7 Bn</td>
<td>9.2%</td>
</tr>
<tr>
<td>Total</td>
<td>$191.9 Bn</td>
<td>5.5%</td>
</tr>
</tbody>
</table>

- Average Annual Life Insurance Payout approx $940 Bn
- Life Insurance pandemic payout represents about 11% excess
Insurance Claims on Other Business Lines

- **Life insurance death benefits**
  - Excess mortality from infection

- **Healthcare insurance**
  - Increased numbers of people wanting treatments

- **Accident & Health coverages**
  - Reimbursement for illness treatment

- **Government (Local Authority) liability**
  - Deaths that might be blamed on local authority decision-making

- **Healthcare liability**
  - Deaths that may be blamed on medical malpractice

- **Event cancellation insurance**
  - Public gatherings cancelled by public health officials

- **Biotech product liability**
  - Vaccine deficiencies (possible waiver from government authorities)

- **Management Liability**
  - Major business losses deemed attributable to poor pandemic response decision-making by senior management

- **Property loss**
  - Increased incidence of fire, water escape damage in buildings left unoccupied during office closures

- **Agriculture**
  - Losses from untended crops and unfed animals as a result of sick farm workers

- **Contingent BI**
  - Named suppliers unable to meet obligations due to illness

- **Civil Authority BI**
  - Possible prevention of business operations (e.g. restaurants) by public health act

- **Auto Insurance**
  - **Decrease** in claims from lower car usage during pandemic progress

- **Annuity & Pensions**
  - **Decrease** in liabilities from premature deaths of annuitants
Key Macroeconomic Effects of Pandemic

- Reduction in ‘Labour Participation’ through absenteeism and office closures
- Consumer spending appetite is suppressed
  - Final Consumption reduces – some is deferred
- Increases unemployment and ‘Output Gap’
  - UK unemployment increases from 6% to 13%
- Government expenditure increases (healthcare and emergency response measures)
- Sectoral impacts include heavy impact on discretionary economy, such as tourism and travel
Interest Rate Changes

Long Term Interest Rates
Scenario S1, modelled as at Q4 2014

Brazil, India, Thailand, Spain, Mexico, China, Ireland, United Kingdom, Canada, United States, Austria, Germany, Denmark, Japan

Interest Rate %

Prior (2013) vs. Increase resulting from pandemic

Interest Rate Changes
Global GDP Impact of Scenario and Variants

Pandemic Scenario Variants
- S1: 43% Infection
- S2: Poor Government response
- S3: Vaccine failure
- X1: Poor response + Vaccine failure

Global GDP Impact of Scenario and Variants

Human Pandemic
Sao Paolo Virus Pandemic
### Impact of the Pandemic Scenario and Variants

<table>
<thead>
<tr>
<th>Scenario Variant</th>
<th>Infection Rate</th>
<th>Global Death Toll</th>
<th>Duration of Wave</th>
<th>GDP@Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S1</strong>: Standard Scenario</td>
<td>43%</td>
<td>19 million</td>
<td>7 months</td>
<td>$7 Trillion</td>
</tr>
<tr>
<td><strong>S2</strong>: Poor government response</td>
<td>43%</td>
<td>22 million</td>
<td>8 months</td>
<td>$10 Trillion</td>
</tr>
<tr>
<td><strong>S3</strong>: Vaccine failure</td>
<td>43%</td>
<td>24 million</td>
<td>9 months</td>
<td>$14 Trillion</td>
</tr>
<tr>
<td><strong>X1</strong>: Poor gov response &amp; vaccine failure</td>
<td>43%</td>
<td>25 million</td>
<td>12 months</td>
<td>$23 Trillion</td>
</tr>
</tbody>
</table>

2007-2012 Great Financial Crisis                      $18 Trillion

Great Financial Crisis as if at 2014                  $20 Trillion
Hypothetical Investment Portfolio of an Insurance Company

Focus on
• high quality
• fixed income

<table>
<thead>
<tr>
<th>Portfolio structure</th>
<th>USD</th>
<th>GBP</th>
<th>Euro</th>
<th>Yen</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government med/long</td>
<td>8%</td>
<td>7%</td>
<td>5%</td>
<td>2%</td>
<td>2%</td>
<td>24%</td>
</tr>
<tr>
<td>Government short</td>
<td>6%</td>
<td>5%</td>
<td>4%</td>
<td>2%</td>
<td>3%</td>
<td>20%</td>
</tr>
<tr>
<td>Cash</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td></td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>AAA short</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td>8%</td>
</tr>
<tr>
<td>AAA med/long</td>
<td>4%</td>
<td>3%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>10%</td>
</tr>
<tr>
<td>AA short</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td></td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>AA med/long</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>6%</td>
</tr>
<tr>
<td>A short</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>A med/long</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>8%</td>
</tr>
<tr>
<td>BBB and lower</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td></td>
<td>1%</td>
<td>6%</td>
</tr>
<tr>
<td>Equities etc</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>4%</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>31%</td>
<td>26%</td>
<td>20%</td>
<td>8%</td>
<td>15%</td>
<td></td>
</tr>
</tbody>
</table>

**Portfolio Structure Diagrams**

- Fixed Income: 31%
- Equities & Cash: 26%
- Other Assets: 20%
- Other: 8%
- Yen: 5%
- USD: 4%
- GBP: 3%
- Euro: 2%
- Equities etc: 1%

**Other Asset Breakdown**
- BBB and lower: 10%
- A med/long: 6%
- A short: 3%
- AAA med/long: 15%
- BBB med/long: 10%
- AAA short: 8%
- Cash: 5%
Pandemic Impact on Investment Portfolios

Baseline: 3.94%

Pandemic Scenario Variants:
- S1: 43% Infection
- S2: Poor Government response
- S3: Vaccine failure
- X1: Poor response + Vaccine failure

Percentage Changes:
- S1: -1.40%
- S2: -1.80%
- S3: -3.00%
- X1: -4.10%
Fixed Income vs Equities

Change Relative to Baseline
Pandemic Scenario S1

-1500%
-1000%
-500%
0%
500%
1000%
1500%

2013 2014 2015 2016 2017

Fixed Income
Equities
Stress Test Scenario - Conclusions
São Paolo Virus Pandemic
Exploring the issues of insurance risk from a human disease threat

- Debilitation of the population is the key societal issue during a pandemic of high infectiousness
  - Death toll significant, but major social impact is absenteeism
  - Workforce absenteeism may be too high for many companies to stay operational

- Duration of debilitation is lengthy – multiple months in individual countries and 8-9 months globally

- It affects everything

- Economic impact will be significant
São Paulo Pandemic Scenario Report

Pandemic Stress Test Scenario

Available for Download from Website: CambridgeRiskFramework.com

Tues 16 December – Cyber Catastrophe Risk
Registration at http://www.risk.jbs.cam.ac.uk/