



# Methodology Overview

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# What's ground breaking about this study?

## This study looks at the risk of economic output from catastrophes

- Not just how catastrophes damage property

## It analyses cities as urban economic systems

- Compiled profiles of the economies of 301 of the world's leading cities

## We have analyzed a wide range of catastrophe threats

- Developed assessments of the likelihood of 18 threat types impacting each city
- In some cases, pioneered analysis of previously un-modelled threats

## Developed metrics for economic consequences of catastrophe

- GDP@Risk

## Provided a framework for thinking about this problem

- Identifying which cities and threats are most important

# Cities and Economies

A city economy is a system

People



Physical Assets



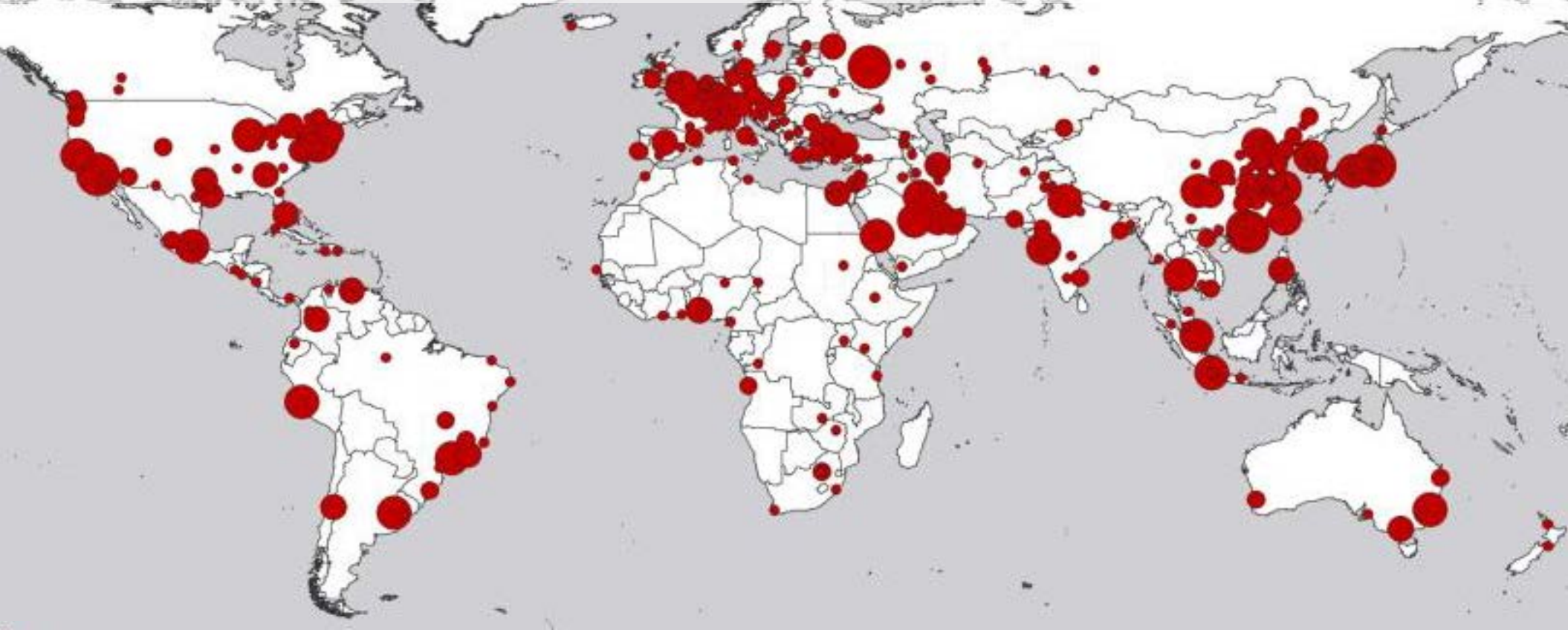
Utilities



Connections

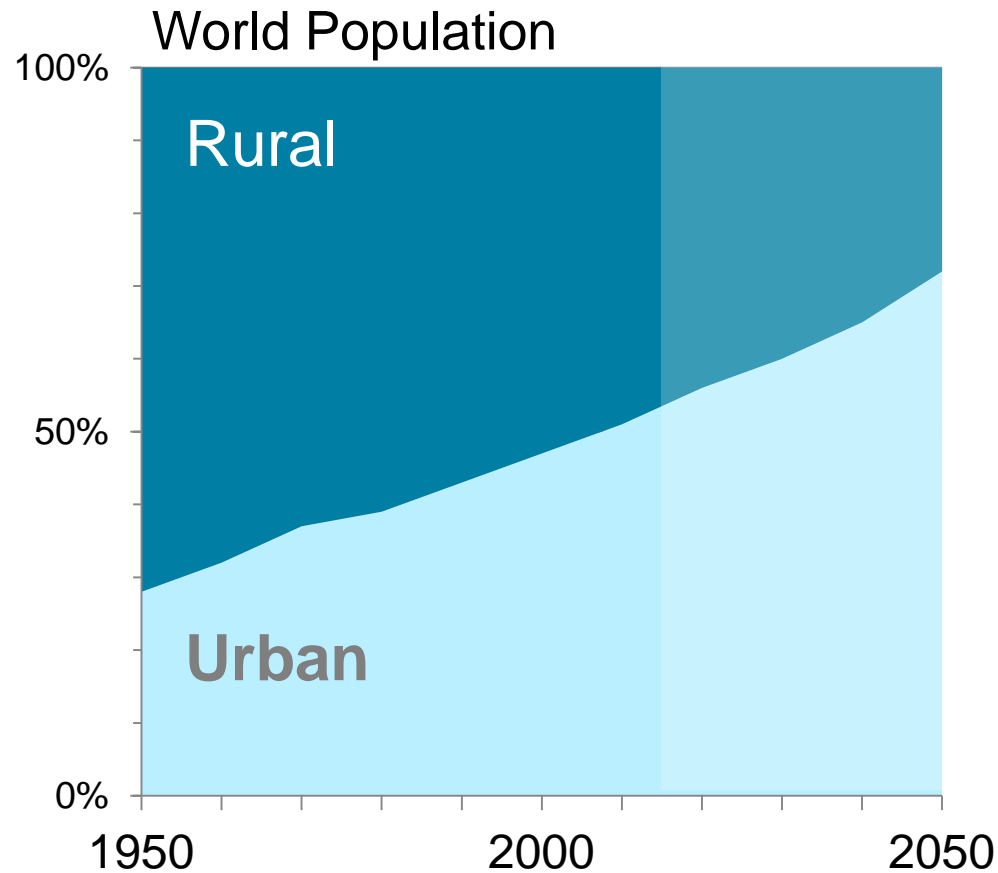


## 301 Cities that drive the world's economy

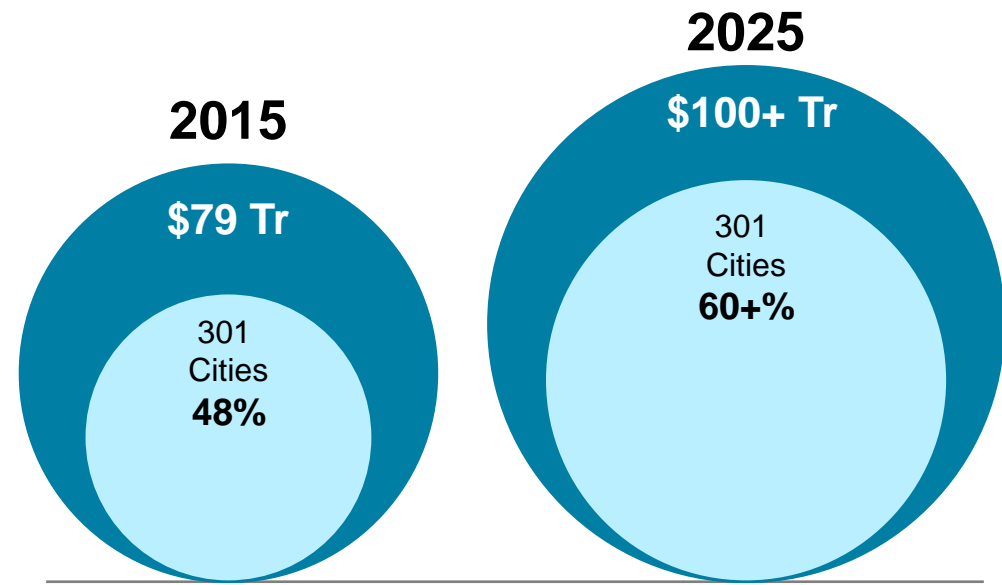


- Includes the largest cities in the 50 largest economies in the world
- Includes all 34 of the UN designated 'Megacities'
- Includes all cities over 3m population in the world
- Consist of half of the world's capital cities

# The world's economy is increasingly urbanized



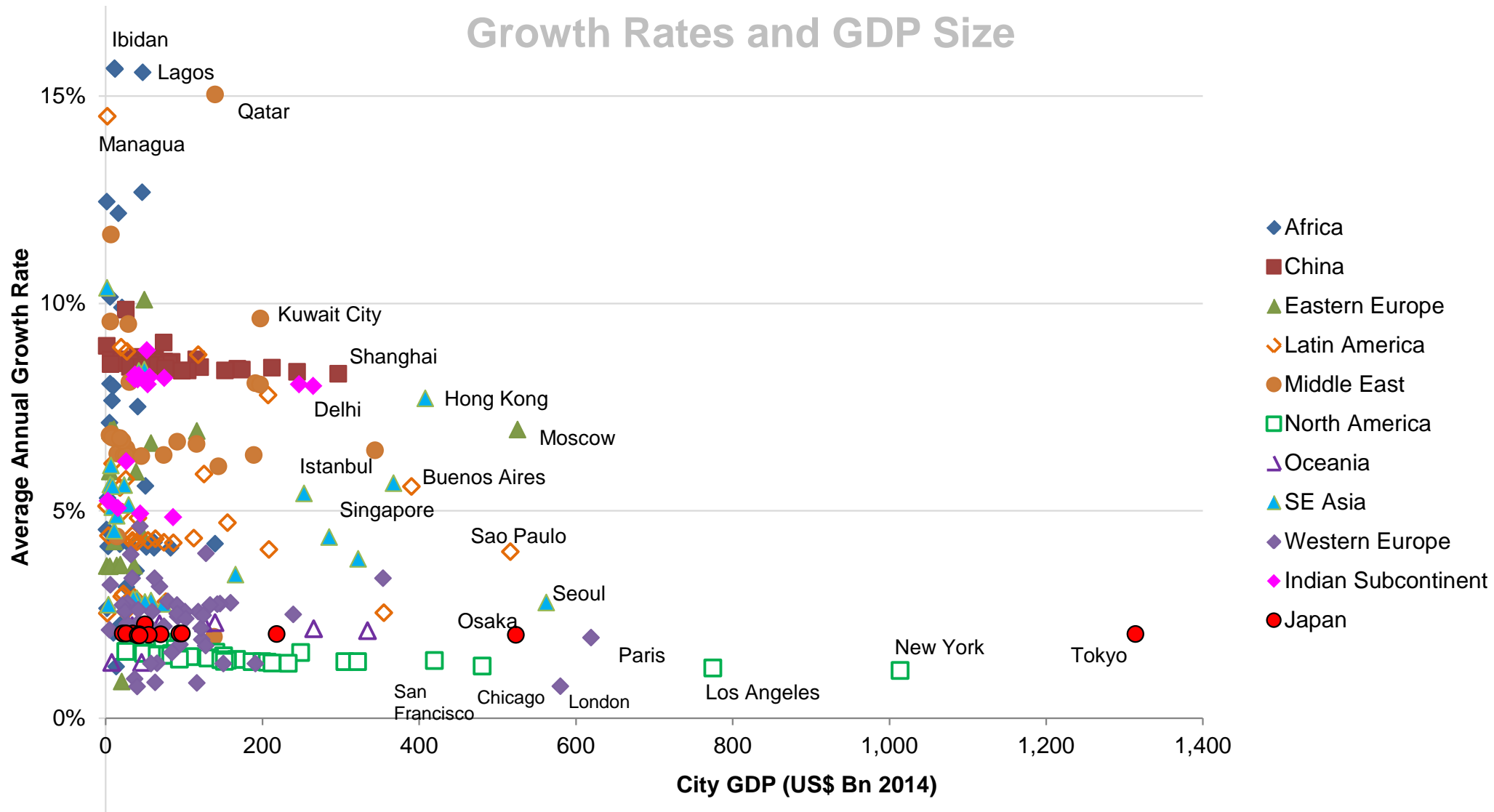
Proportion of Global Economy provided by 301 Cities



For example...

London economic region has increased its share of UK output from **15%** in 1960s to **45%** today

# Cities, GDP & Projected Growth Rates



# Towards the Knowledge Economy

Old

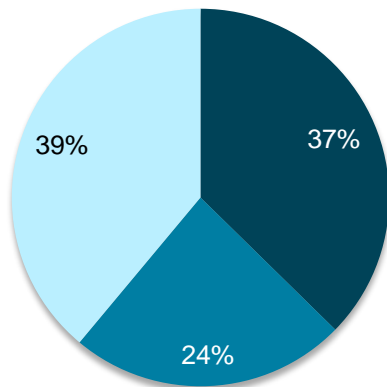


New

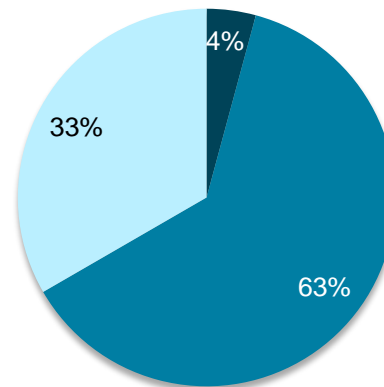


## Cities economies categorized by type

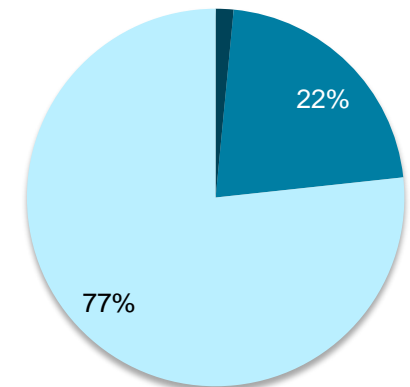
G: Agriculture with Industry & Service



E: Industrial-Oriented Economy



A: Service-Dominated Economy



■ Agriculture  
■ Industrial  
■ Service



## Earthquake

**Event:** Great Hanshin earthquake, 1995

**Location:** Kobe, Japan

**Economic cost:** \$150bn, two-thirds in infrastructure and property damage and one-third in economic disruption.

**Description:** A magnitude 6.9 earthquake struck 20 kilometres from the city of Kobe, 16 kilometres below its epicentre, on 17 January 1995.

**Damage:** More than 6,400 people died and 15,000 were injured. Around 82 hectares of urban land was devastated by fire. The city's subway system and stations were damaged, along with 400,000 buildings, and its supply lines interrupted by damage to regional trunk roads, monorails, railway lines and stations. Liquefaction wrecked all but six of the 187 shipping berths in Kobe's container port.

**Insight:** Domestic insurers covered about \$3bn, and the

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LLOYD'S [elect a case study](#)

*"In California, take up of earthquake insurance is only about 12%. In lieu of these covers being made compulsory, the industry needs to work harder at promoting the value of and driving the take up of these products, so that disaster risk financing is in place when the 'Big One' happens."*



Earthquake

Event: Great Hanshin  
earthquake, 1995  
Location: Kobe, Japan

# Economic development hasn't all been smooth sailing

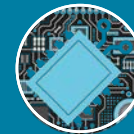
The 301 cities have experienced many catastrophes over the past 50 years



Lost more than a million of their citizens to earthquakes



Seen a third or more of their economic capital wiped out by stock market crashes 5 times



Experienced thousands of cyber attacks



Half of them have suffered a serious flood



A quarter of them have been flooded more than 5 times



32 cities have had to cope with a volcanic eruption less than 100 km away



Suffered more than 1,000 terrorist car bombs in city centres



Financial crisis of their governments defaulting on sovereign debts on 50 occasions



Had to combat the outbreak of a previously unknown disease five times

kilometres below its epicentre,

and its supply lines interrupted

# 18 Threat Types

## Finance and Trade



Market  
crash



Sovereign  
default



Oil price  
shock

## Geopolitics and Society



Terrorism

## Natural Catastrophe and Climate



Earthquake



Wind  
storm



Tsunami



Flood



Volcanic  
eruption



Drought



Freeze



Heatwave

## Technology and Space



Nuclear  
accident



Power  
outage



Cyber  
attack



Solar  
storm

## Health and Humanity



Human  
pandemic



Plant  
epidemic

# 18 Threat Types – **Manmade** and Natural

## Finance and Trade



Market  
crash



Sovereign  
default



Oil price  
shock

## Geopolitics and Society

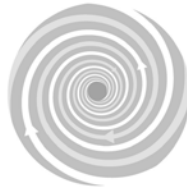


Terrorism

## Natural Catastrophe and Climate



Earthquake



Wind  
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Flood



Volcanic  
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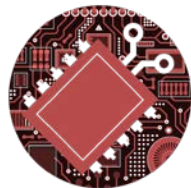
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Nuclear  
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Cyber  
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Solar  
storm

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# 18 Threat Types - Emerging

## Finance and Trade



Market  
crash



Sovereign  
default



Oil price  
shock

## Geopolitics and Society

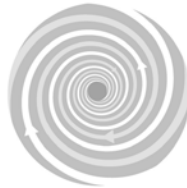


Terrorism

## Natural Catastrophe and Climate



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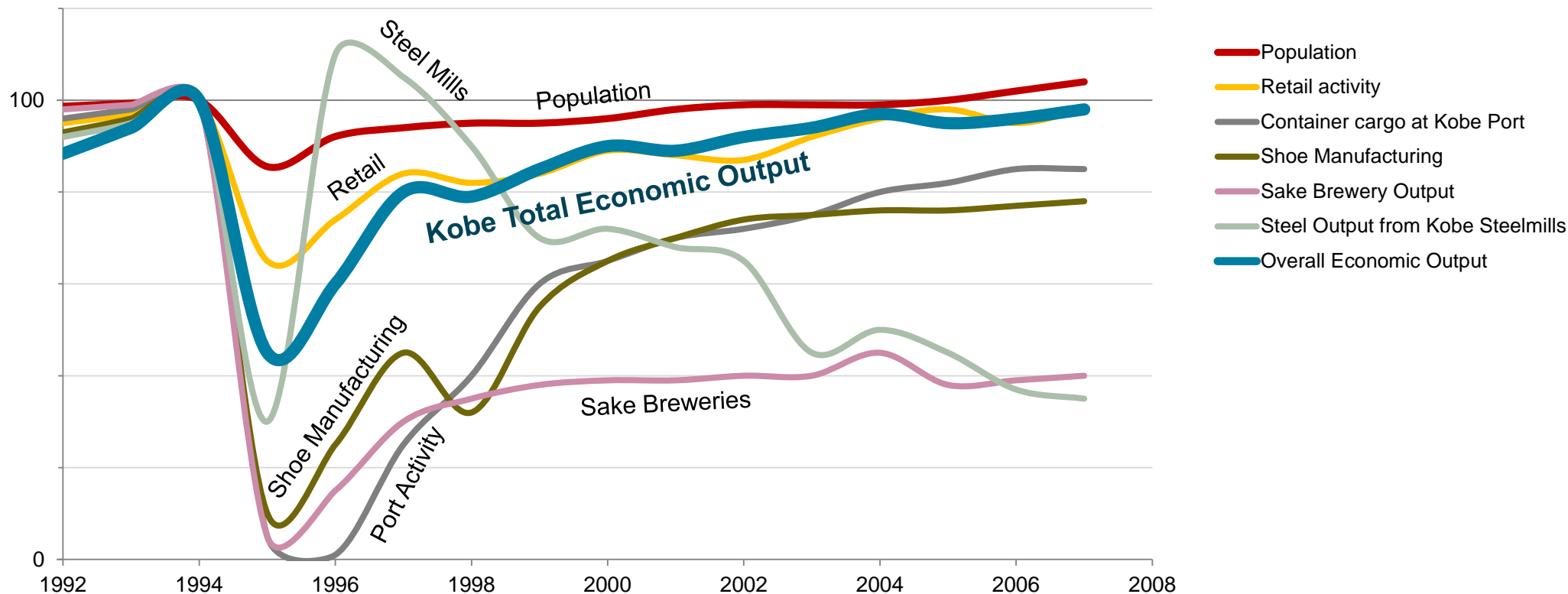


Human  
pandemic



Plant  
epidemic

# Impact of 1995 Earthquake on Economy of Kobe, Japan



- Great Hanshin earthquake January 17, 1995, Magnitude 7.3
- Death toll 6,400; Direct damage costs \$100 billion
- The port of Kobe, one of the world's busiest, was destroyed
- Kobe Steel Ltd, major steel maker, heavily damaged
- 80% of shoe factories damaged
- 50% of the region's sake breweries put out of action
- Kobe's economic output halved in 1995, reducing Japan's total industrial output by 2.6 percent

# Analysis of Economic Loss in a Catastrophe

## Supply Shock



Destruction of Physical Assets



Disruption of Labour Availability



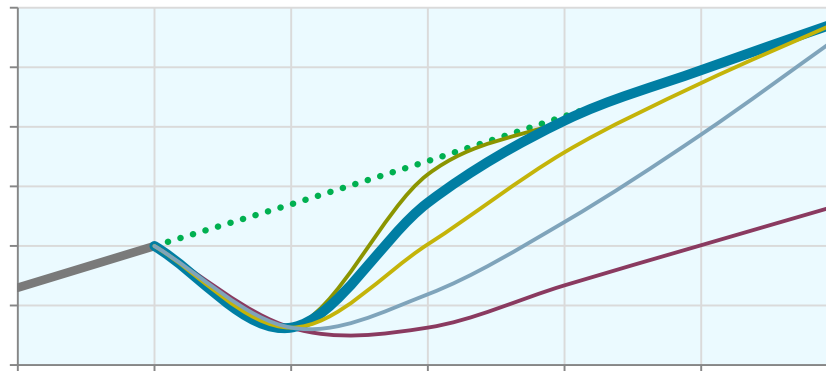
Flight of Capital



Inability to Export



Government Recovery Stimulus



Catastronomics Model

## Demand Shock



Consumer Confidence



Shortage of Private Capital



Share Price Reduction

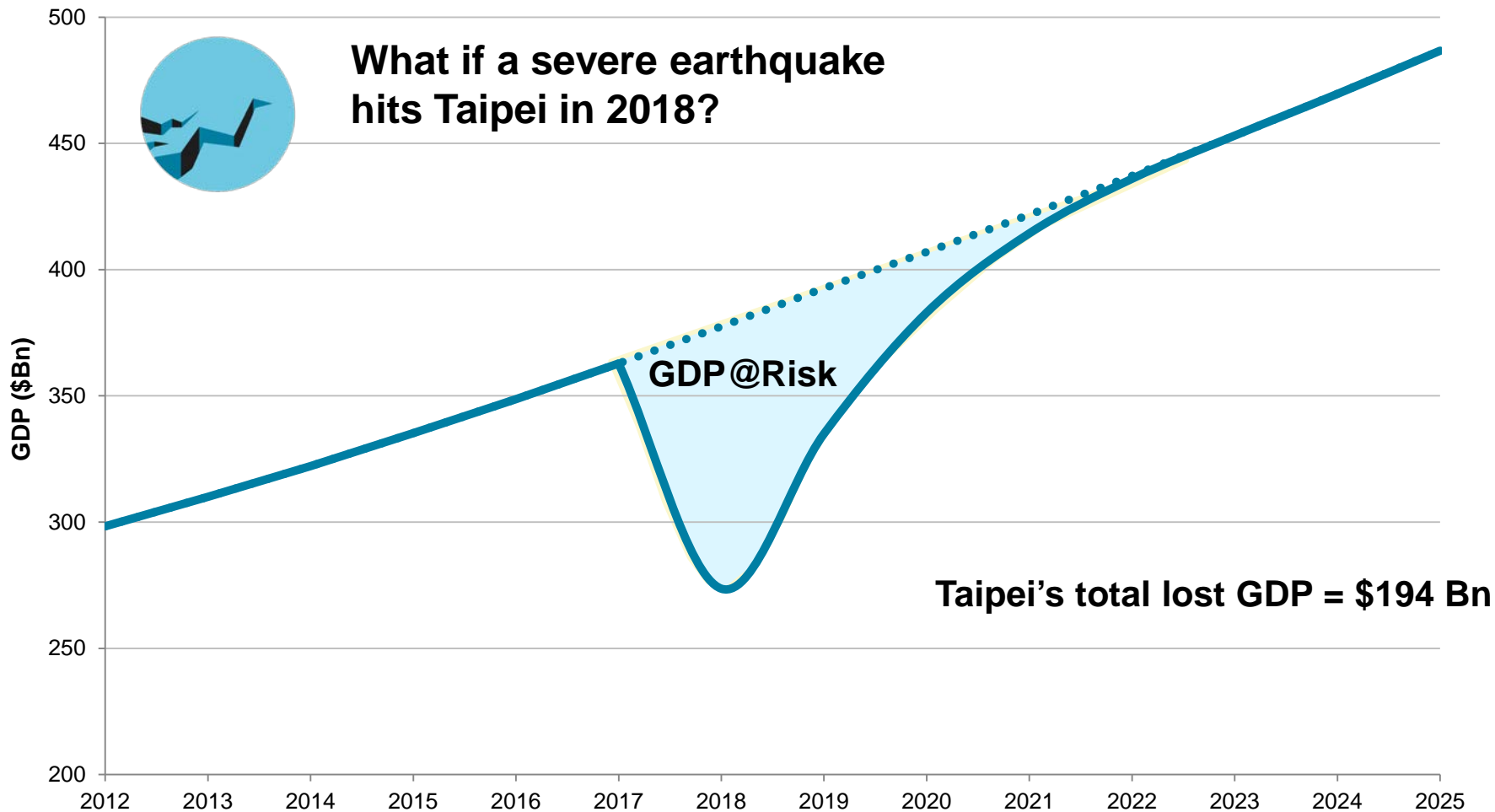


Inability to Import



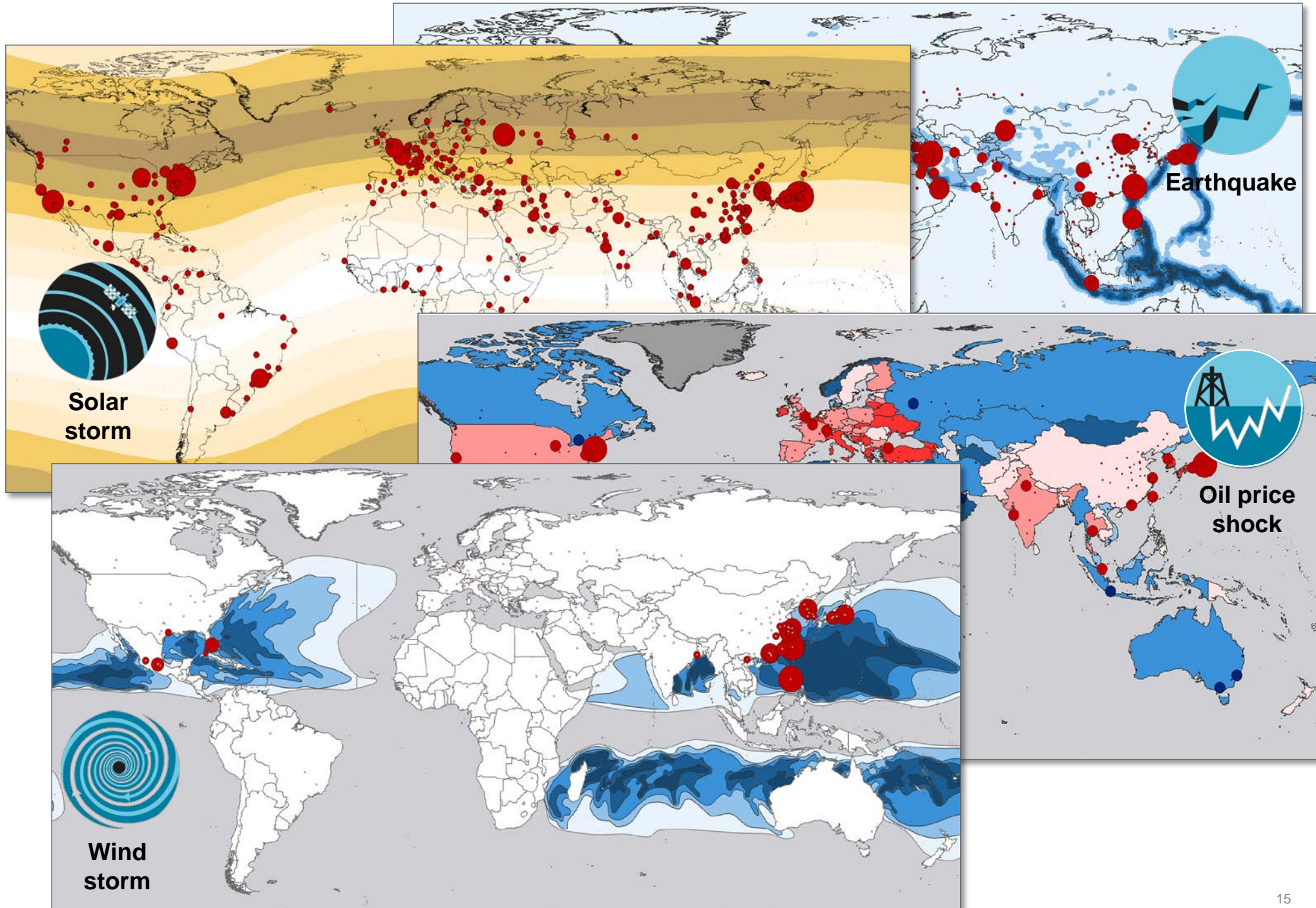
Inflation: increased cost of inputs

# GDP@Risk



- Taipei has a Threat Assessment Grading for earthquake of 'Very high threat' based on United States Geological Survey earthquake design code assessment of Taipei
- An earthquake that would affect the city centre with shaking of PGA 400-600 cm/s<sup>2</sup> (MMI VIII) could be expected approximately once every 133 years (annual probability of 0.0075)

# Mapping the Threat



# Putting them together into the City Risk Index

For each city:

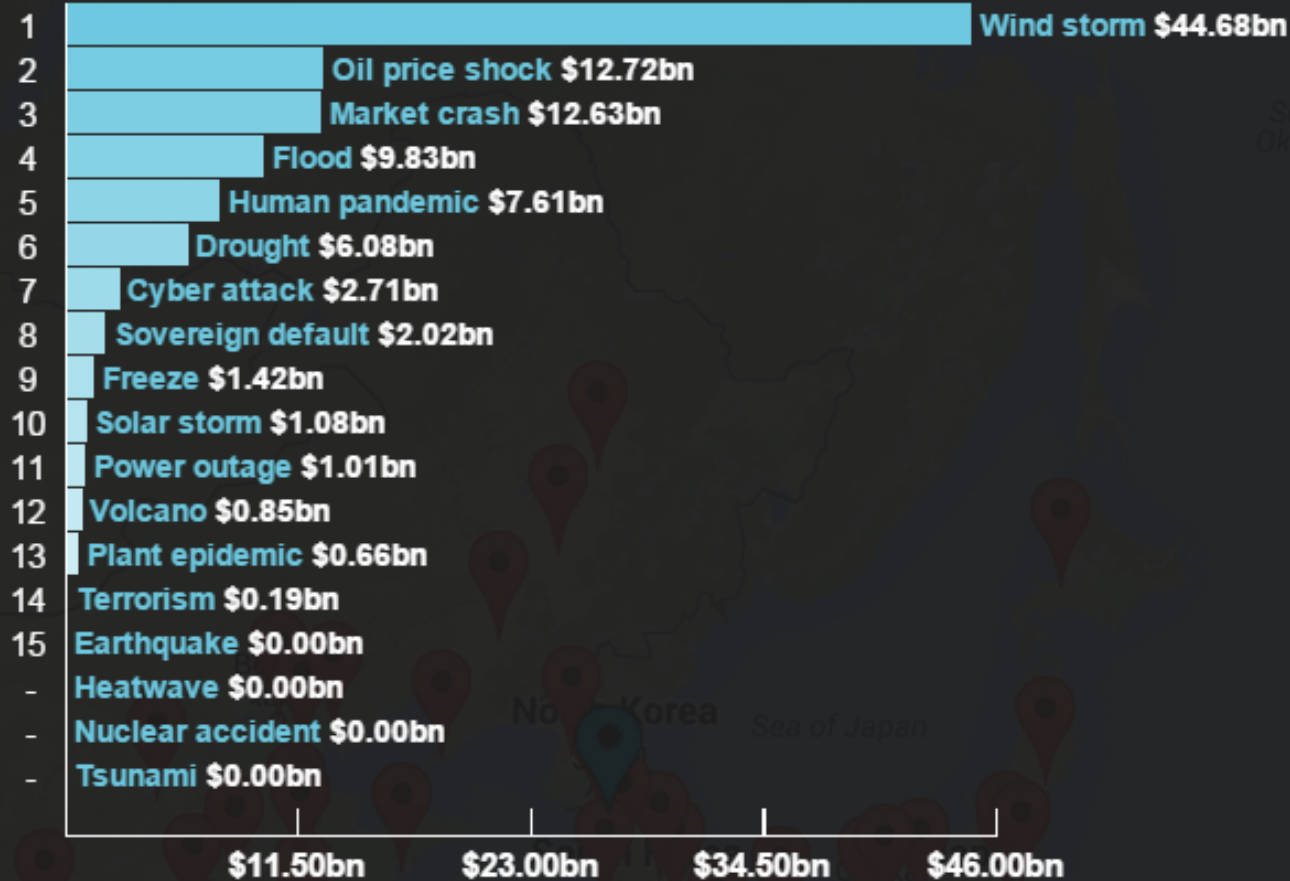
- We assess the threat of all 18 threat types
  - i.e. how likely that city is to experience a number of representative scenarios of different magnitudes from that threat (3 representative scenarios)
- We model the economic consequences of each scenario for the city
  - We have modelled  $301 \times 18 \times 3 = \mathbf{16,254}$  scenarios
- The GDP@Risk is the 'expected loss' – the loss x the probability
- We combine the GDP@Risk from the various threats and cities, assuming that the events are generally independent

# GDP@Risk metrics for a city – a risk profile

## Seoul

GDP@Risk: All threats

**\$103.50bn**



# Results – the world's top 20 cities

Select threat

All threats

**All threats**

GDP@Risk: All cities

**\$4.56trn**

GDP@Risk: Top 20 cities

**\$1.61trn**

35.20% of All cities total

GDP@Risk: Top 5 cities

1	Taipei	\$181.20bn
2	Tokyo	\$153.28bn
3	Seoul	\$103.50bn
4	Manila	\$101.09bn
5	New York	\$90.36bn

[View top 20](#)

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GDP@Risk: Top 20 cities

**All threats**

1	Taipei	\$181.20bn
2	Tokyo	\$153.28bn
3	Seoul	\$103.50bn
4	Manila	\$101.09bn
5	New York	\$90.36bn
6	Los Angeles	\$90.32bn
7	Istanbul	\$82.50bn
8	Osaka	\$79.32bn
9	Shanghai	\$78.21bn
10	Hong Kong	\$74.51bn
11	Lima	\$69.36bn
12	Tehran	\$64.14bn
13	Sao Paulo	\$62.95bn
14	Mexico City	\$60.74bn
15	Moscow	\$55.77bn
16	Paris	\$54.94bn
17	London	\$53.43bn
18	Singapore	\$51.11bn
19	Buenos Aires	\$50.31bn
20	Jakarta	\$48.23bn

How much of the world's economy might be eaten up by catastrophes

This is also known as the 'technical premium' – if you could insure the economy of a city, here's how much it would cost to insure against catastrophe loss

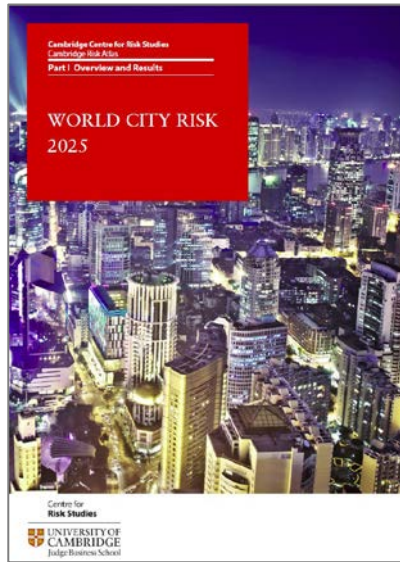
A big city with a large economy will pay more than a city with a small economy for the same risk

# Overall conclusions

- In this study we have made a first-order assessment at how catastrophes impact the economy of the world
  - Where the risk is most severe
  - What the threat drivers are in each location
- Globalization is boosting city hubs as generators of economic growth
- The nature of the economies is changing in these engines of growth
- Managing the risks of economic disruption requires different thinking to protecting physical assets
- This study provides the first step to understanding and managing the risks of economic catastrophe

# Technical resources to help understand this

<http://cambridgeriskframework.com/wcr>



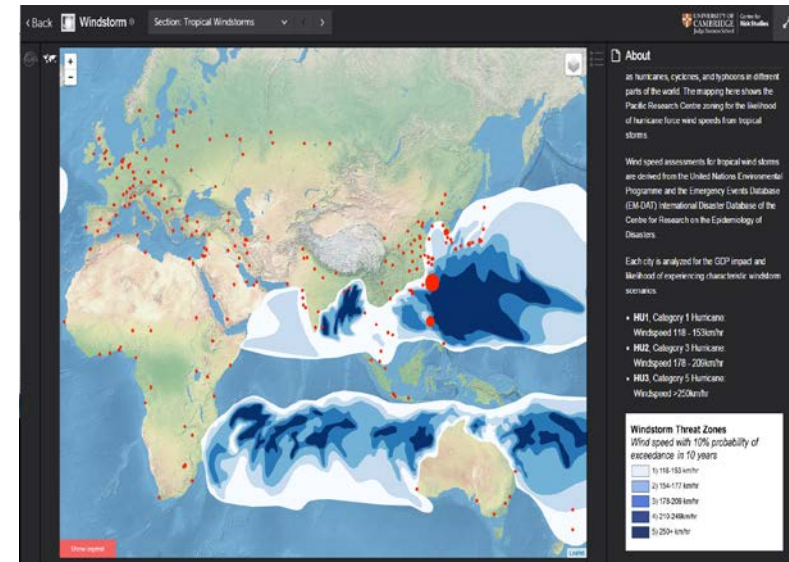
Methodology  
Documentation



Presentations  
and printable risk atlas



Threat  
Observatory



Online interactive  
threat maps

## Special Methodology Seminar

### Lloyd's City Risk Index - Methodology and Usage of City Economy Risk Analysis

Tuesday 6 October 2015

16:30-18:30, at Lloyd's, London

Registration: <http://www.risk.jbs.cam.ac.uk/>

# Lloyd's City Risk Index 2015-2025

*301 cities*

*18 threats*

*US\$4.56trn at risk*

Lloyd's City Risk Index 2015-2025 analyses the potential impact on the economic output (GDP@Risk) of 301 of the world's major cities from 18 manmade and natural threats.

Based on original research by the [Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School](#), the Index shows that governments, businesses and communities are highly exposed to systemic, catastrophic shocks and must do more to mitigate

## Lloyd's City Risk Index 2015-2025



And the global distribution  
of wealth is changing rapidly



0:28 / 1:58



YouTube



