



Cambridge Centre for Risk Studies
Advisory Board Research Showcase – 24 January 2017

Modeling Economic Contagion/Spillover

Centre for
Risk Studies

 UNIVERSITY OF
CAMBRIDGE
Judge Business School

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Agenda

- Multi-layer network view of economic/financial contagion
- Economic spillover
- Bilateral trade as one important layer
- Parameterising shock propagation using OEM
- Summary of latest results
- Plan for further development

We Need a Better Understanding of Contagion

- **Crash was economists' 'Michael Fish' moment, says Andy Haldane**
Jan 6th 2017
- The 2007 financial crisis has shown that economists have been behind the curve in regard to **mapping**, **modelling** and **monitoring** the highly **interconnected** and global financial system
- The failure of financial institutions has led to fears of system failure from **domino effects** of one failed entity bringing down others. This has given rise to concepts such as financial contagion and **“too interconnected to fail”**.

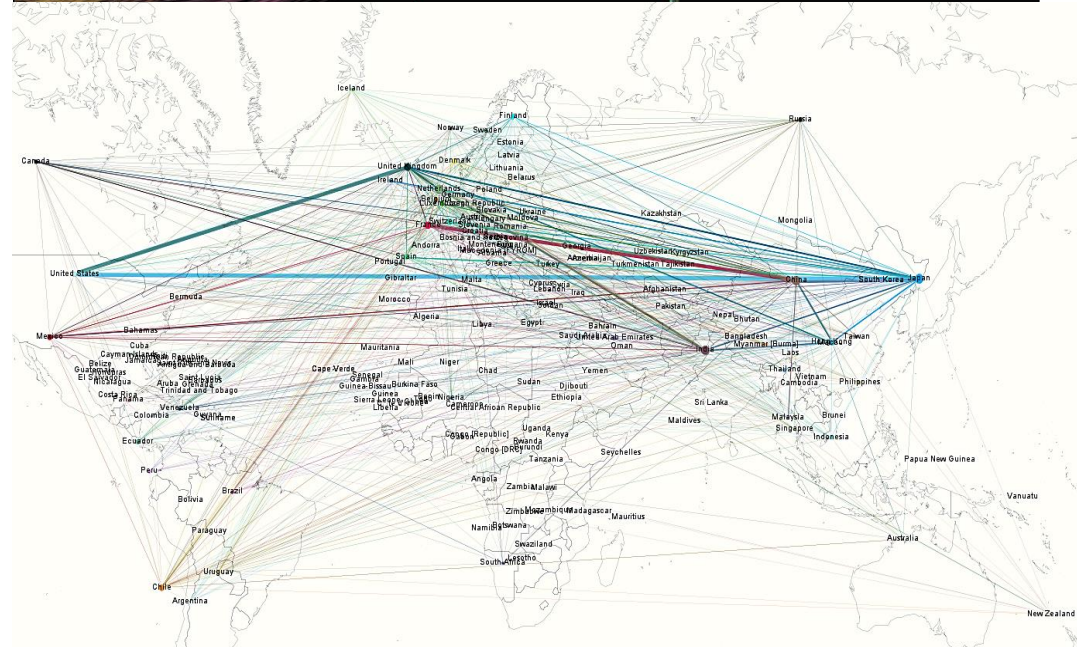
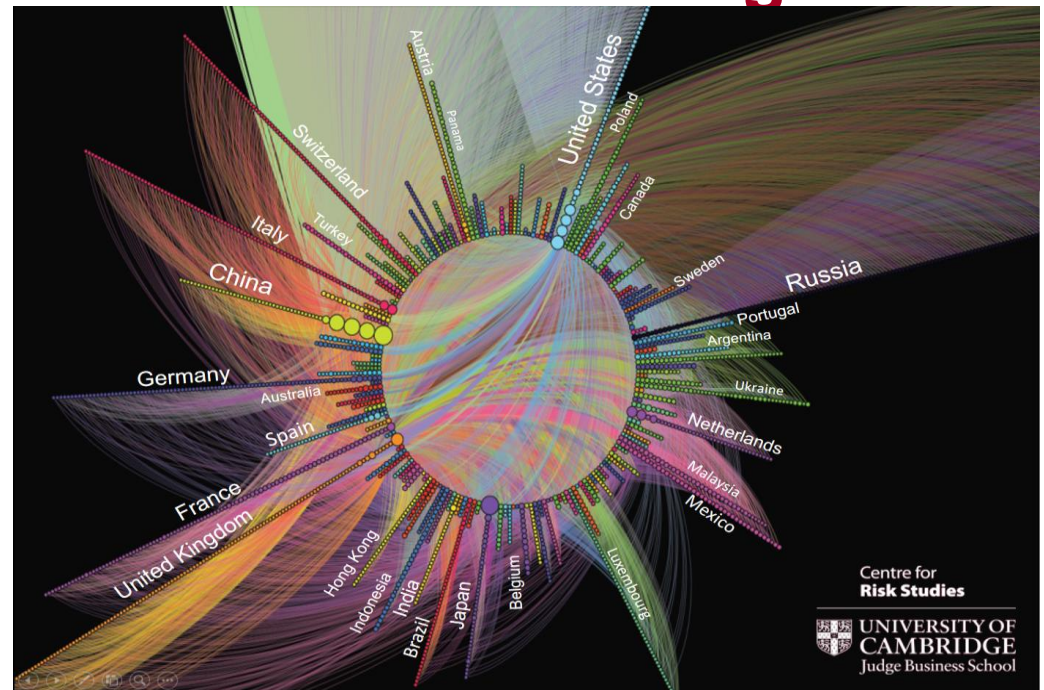


Systemic Risk and Interconnectedness

- **Systemic Risk** : Risk associated with the failure of the entire financial system
- **Channels of Contagion**
 - Interbank lending, Security settlement, FX settlement, Derivative exposures, Equity cross-holdings, Asset prices
 - **Interaction** between these contagion mechanisms is more important than a single mechanism on its own
- **Why does interconnectedness matter for financial stability?**
 - Structure of links between nodes matters
- Two methodological problems of financial contagion and systemic risk:
 - **Paradox of Volatility** and the pitfalls of market price data based systemic risk measures hence **structural bilateral data based networks modelling needed**
 - non-trivial **Negative Externalities problem** → the need for holistic visualization

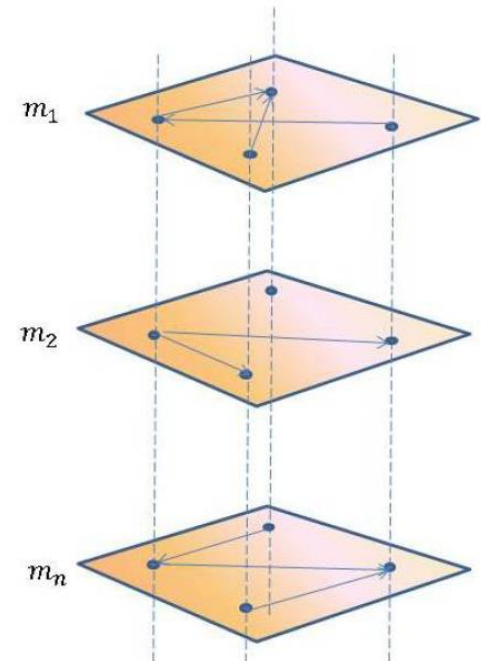
CRS Work and Network Models of Contagion

- Extensive research using network models to quantify contagion
- CRS Global Banking Model financial system using global banks balance sheet data
- Balance sheet data on Financial Institutions
 - Iteration 1: 18,516 Banks Total market value of \$214 Trillion Total equity value of \$17.4 Trillion
 - Iteration 2: 5134 Banks
 - Bank Scope global bank balance sheet data
 - Bank of International Settlement Cross-border exposure data



Multi-Layer Networks

- In reality banks are interrelated in several **dimensions** of their business activities.
 - The basic notion is that unless contagion risk across the **many layers of interrelations** between banks are taken into account, it is likely that contagion effects will be substantially underestimated.
- The complexity of the financial system and the existence of **multiple channels of contagion** of naturally leads to the concept of multilayered networks (also referred to as multiplex networks).
- Such representations enable researchers and practitioners to carefully map the various **direct and indirect** channels of contagion in a system.
- We also believe that a multilayer network methodology could enable more precise **representation** of the financial obligations and exposure networks.

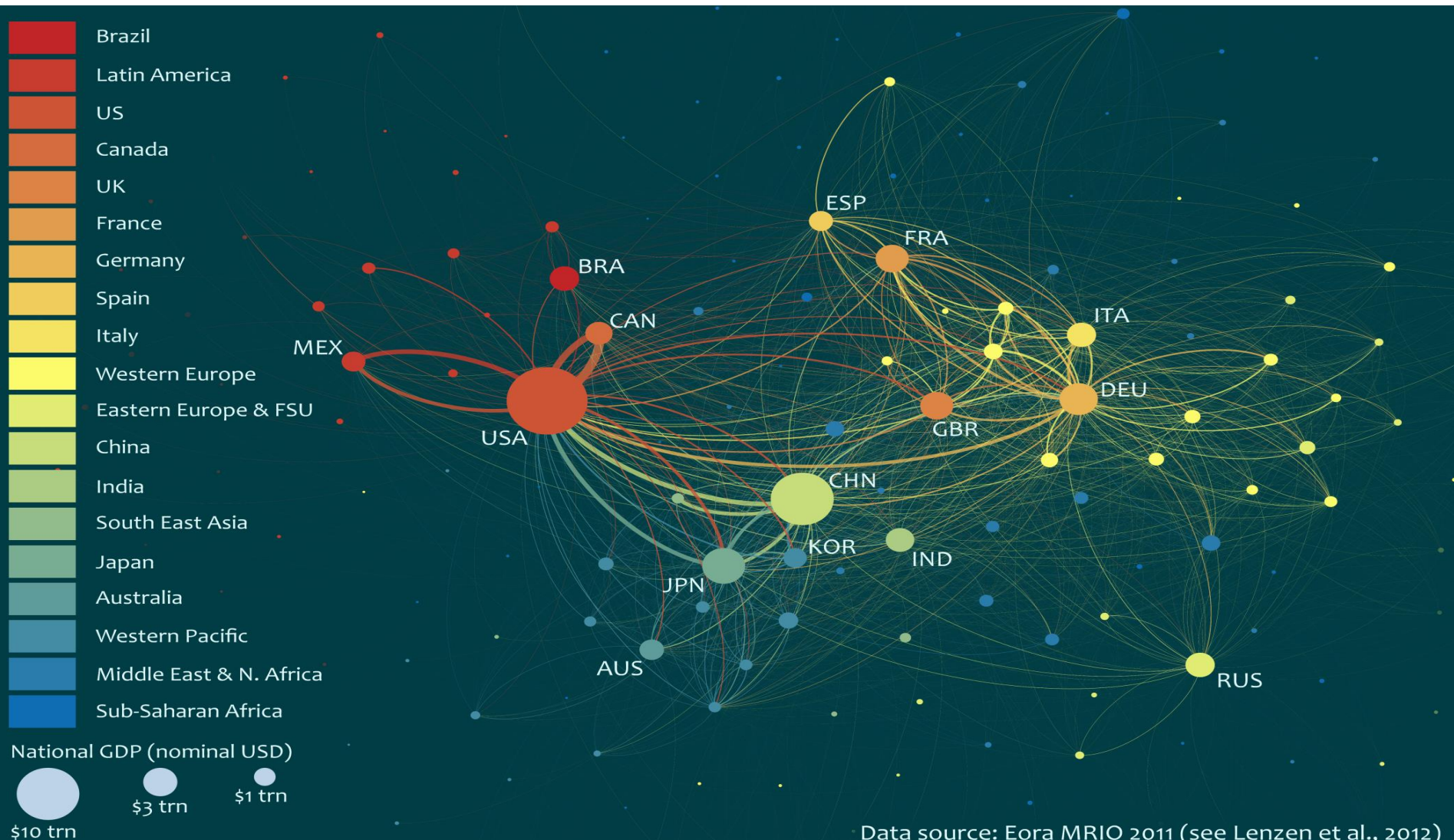


Economic Spillover/Contagion

- International spillovers reflect the impact of macroeconomic changes, possibly following a policy action, in one country on other countries
 - integrated nature of the international economy
 - multiple flows in balance of payments
 - multilayer network properties of balance of payments
- International spillovers **originate** from a shock at the epicenter country
 - developments in the epicenter country, such as a domestic banking crisis, loss of consumer confidence, fiscal contraction, or exogenous developments such as a drop in international prices for the main export commodity, natural disasters, or geopolitical crises.

Spillover Channels

- Spillovers operate through several channels.
- **Trade** and **financial flows** are the most important channels of shock spillovers for most countries.
- The strength of shock spillovers can be amplified by network effects



City Interconnectivity

- We have developed an economic interdependency matrix between the cities
- This will characterize how cities are related economically
- The model will estimate how a catastrophe for one city will also affect its primary trading partners
 - e.g. if New York is impacted, how much will London's economy be affected?
- Economic spillover modelling will quantify the expected impacts of consequential economic shocks on city trading partners



National Impact

- Estimated using these parameters
 - Threat Spread Score
 - Share of national GDP covered by Pandora Cities

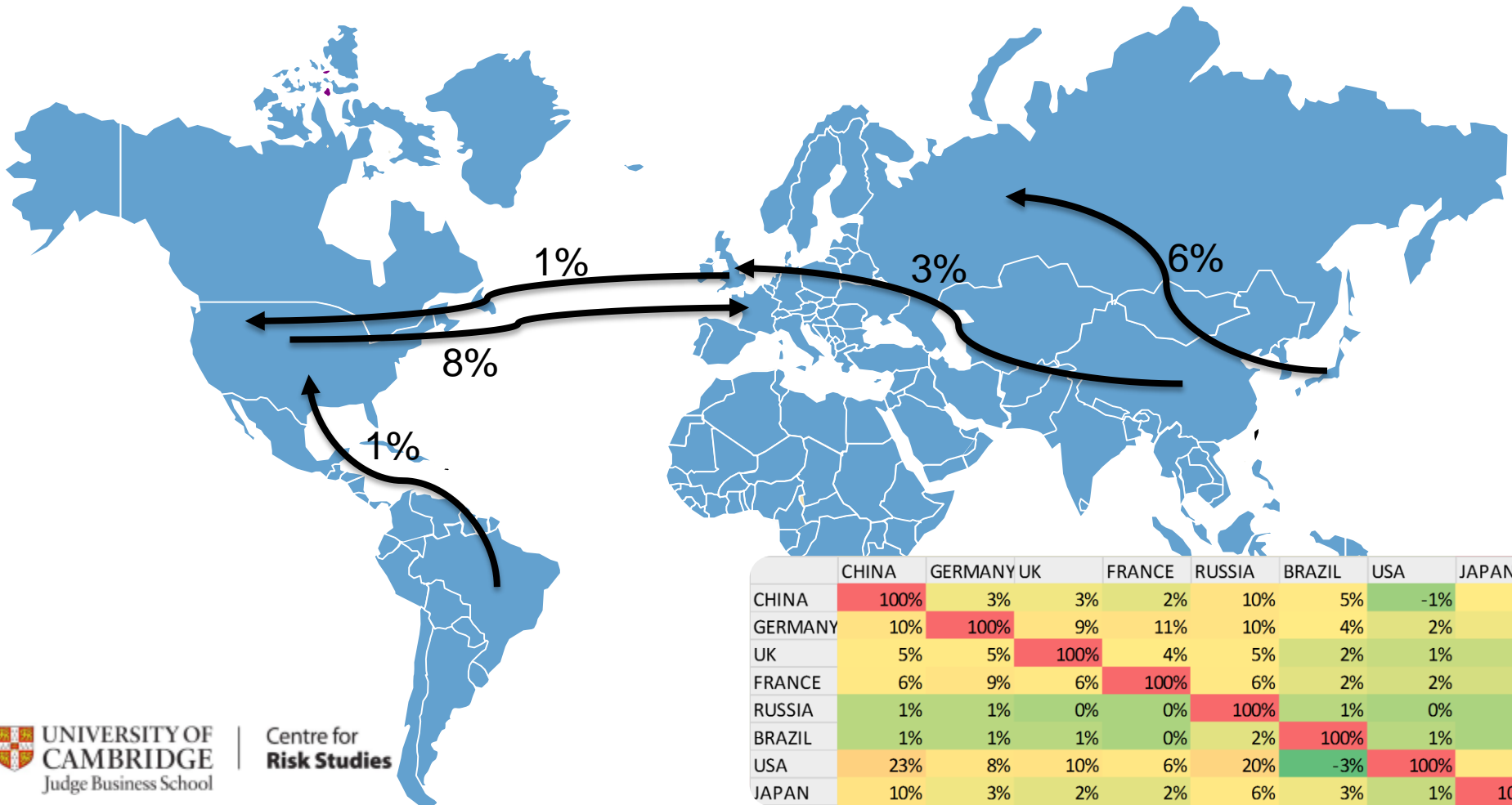
International Impact

- Modeled using international trade network

Macroeconomic Shock Propagation

Economic Models links the individual countries in a number of ways Trade (Exports driven by weighted matrix of trading partners' import demand)

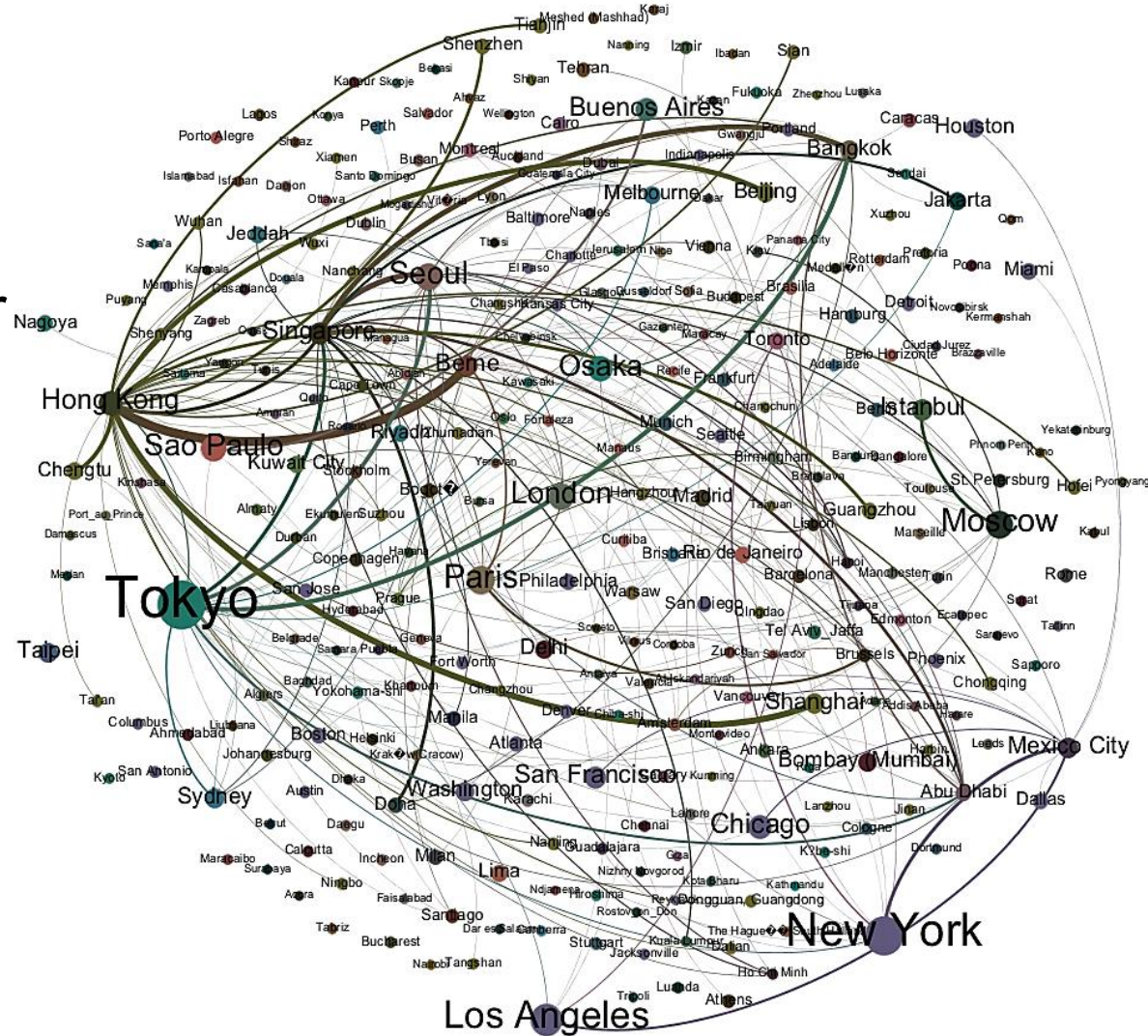
- Competitiveness (IMF relative unit labour costs where available, relative prices elsewhere)
- Interest Rates and Exchange Rates
- Commodity Prices (e.g. oil, gas and coal prices depend on supply/demand balance; metal prices depend on growth in industry output)
- World Price of Manufactured Goods



	CHINA	GERMANY	UK	FRANCE	RUSSIA	BRAZIL	USA	JAPAN
CHINA	100%	3%	3%	2%	10%	5%	-1%	4%
GERMANY	10%	100%	9%	11%	10%	4%	2%	3%
UK	5%	5%	100%	4%	5%	2%	1%	1%
FRANCE	6%	9%	6%	100%	6%	2%	2%	2%
RUSSIA	1%	1%	0%	0%	100%	1%	0%	0%
BRAZIL	1%	1%	1%	0%	2%	100%	1%	0%
USA	23%	8%	10%	6%	20%	-3%	100%	7%
JAPAN	10%	3%	2%	2%	6%	3%	1%	100%

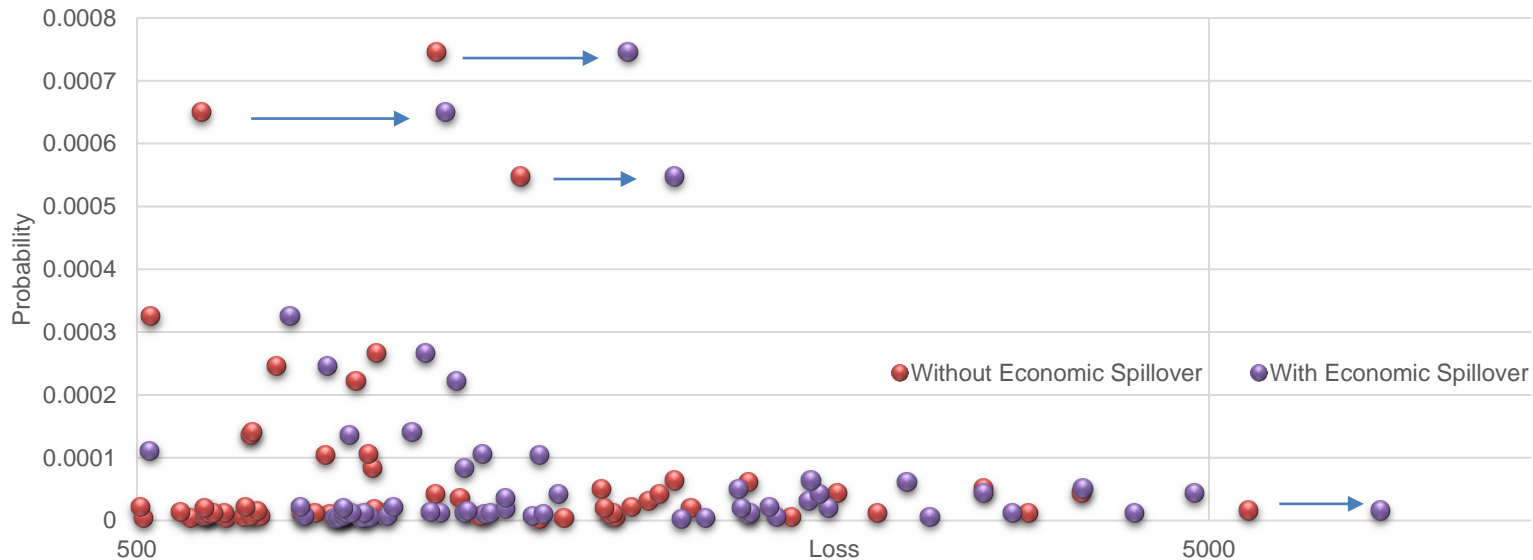
Pandora Economic Spillover Model

- Footprints of threat scenarios are used to quantify international and domestic spillover
- The global bilateral trade data is used to estimate Pandora cities trade network
- The reconstructed network is a complete city to city trade flow representation



Cambridge Risk Index City Connectivity
Source: United Nations Comtrade Database, CRS Analyses

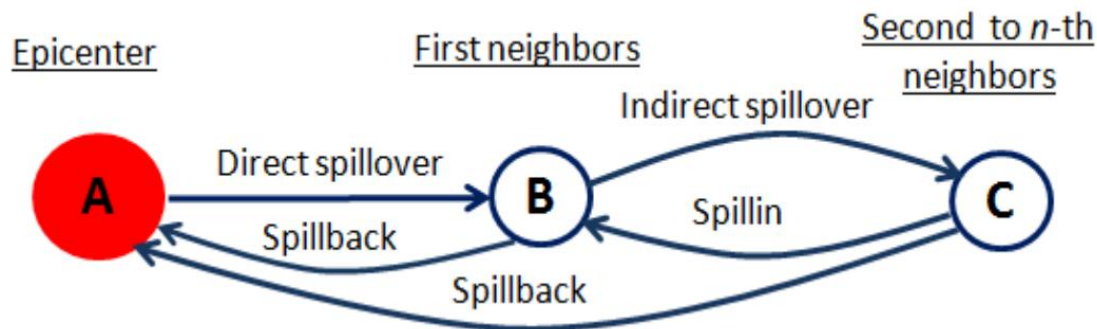
Economic Spillover in case of Flood Scenarios



Severity	Trigger	Affected Regions	Id	National	International
340.13	Central Europe	[Lyon: 3, Turin: 1, Paris: 1]	FL.1	12.19	8.54
160.30	NE USA	[Baltimore: 2, Philadelphia: 1]	FL.2	76.21	53.37
1,001.87	Northeastern USA	Northeastern USA	FL.3	159.67	135.13
823.66	Kanto Plain, Japan	Kanto Plain, Japan	FL.4	49.57	43.07
808.47	California, USA	California, USA	FL.5	119.15	146.13
801.03	West Europe	West Europe	FL.6	104.74	75.27
515.46	Central Europe	Central Europe	FL.7	157.33	288.92
1,141.32	Pearl River Delta	Pearl River Delta	FL.8	62.11	129.41
1,045.17	Lower Yangtze River	Lower Yangtze River	FL.9	69.58	77.65
406.28	North Sea Floods	North Sea Floods	FL.10	39.97	103.70
837.47	Bohai Economic Rim	Bohai Economic Rim	FL.11	111.99	79.05
638.44	CHN	EAS	FL.12	215.17	142.66
578.90	AFG	IND	FL.30	150.96	104.70
816.86	COL	NAM	FL.46	125.82	131.58
507.52	MEX	NAM	FL.47	162.74	69.00

Future work

- To Create a dynamic model of Economic Spillover
- Characterising countries into these categories amplify, absorb, or block spillovers
- Model Indirect Shock and feedback loop effects



- Include other channels of economic impact

Conclusions

- We presented how the economic impact of catastrophes is quantified
- The size of the network effects is generally higher for small open economies and lower for large and relatively closed economies.
- The profile of spillovers depends on the network structure, including the size and location of the epicenter country in the network, the number and economic characteristics of its partners, and the direction and strength of economic flows among them.

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