The spread of economic crisis in an interconnected financial network

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1

The Problem

Economic Crisis

Working questions

➢ At what speed does an economic crisis spread?

➢ What is the importance of crisis origin?

➢ Which countries will be affected the most?

➢ When should politicians and central banks take the most action?

2

The Approach

Two-fold approach
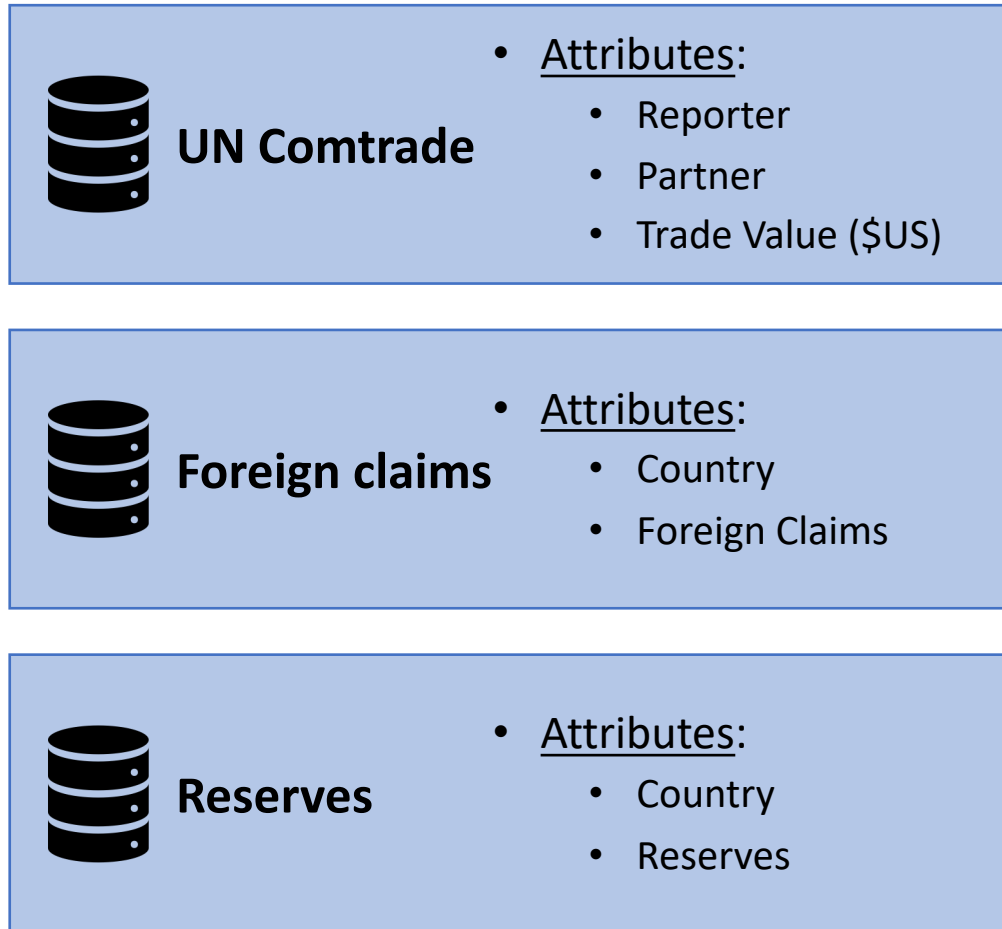
Connectivity of national economies

Weighted directed Network graph
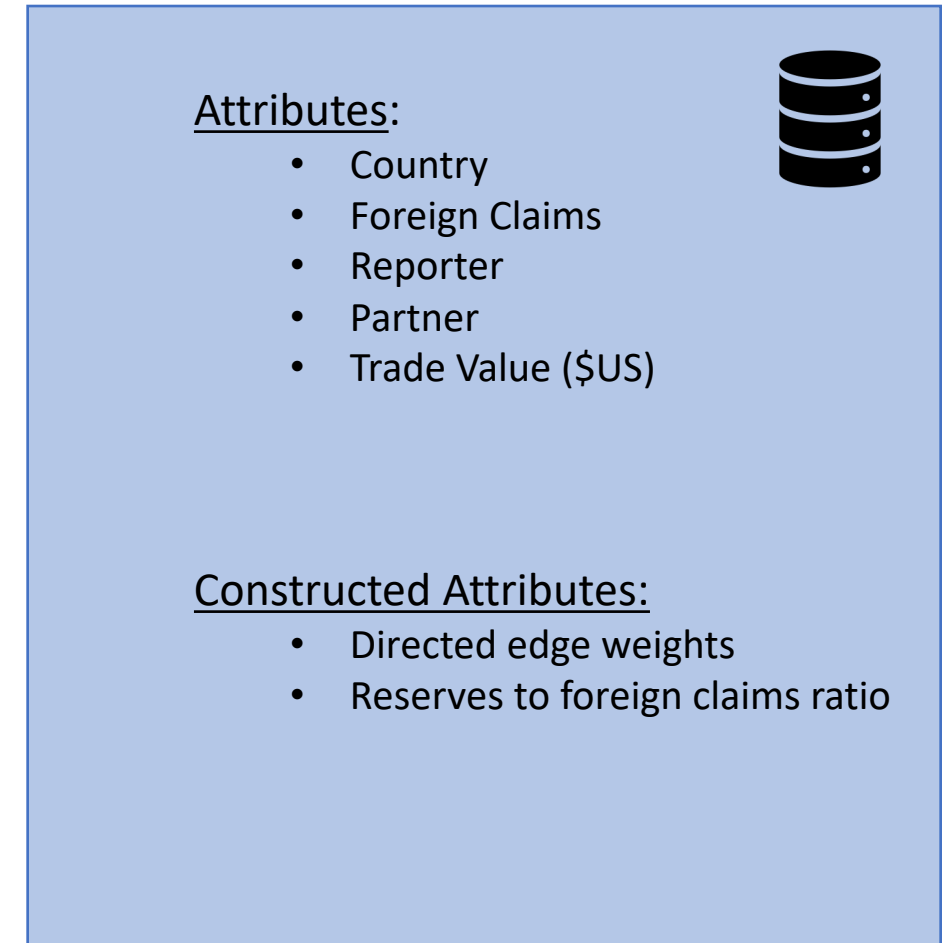
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Epidemiological spreading of crises
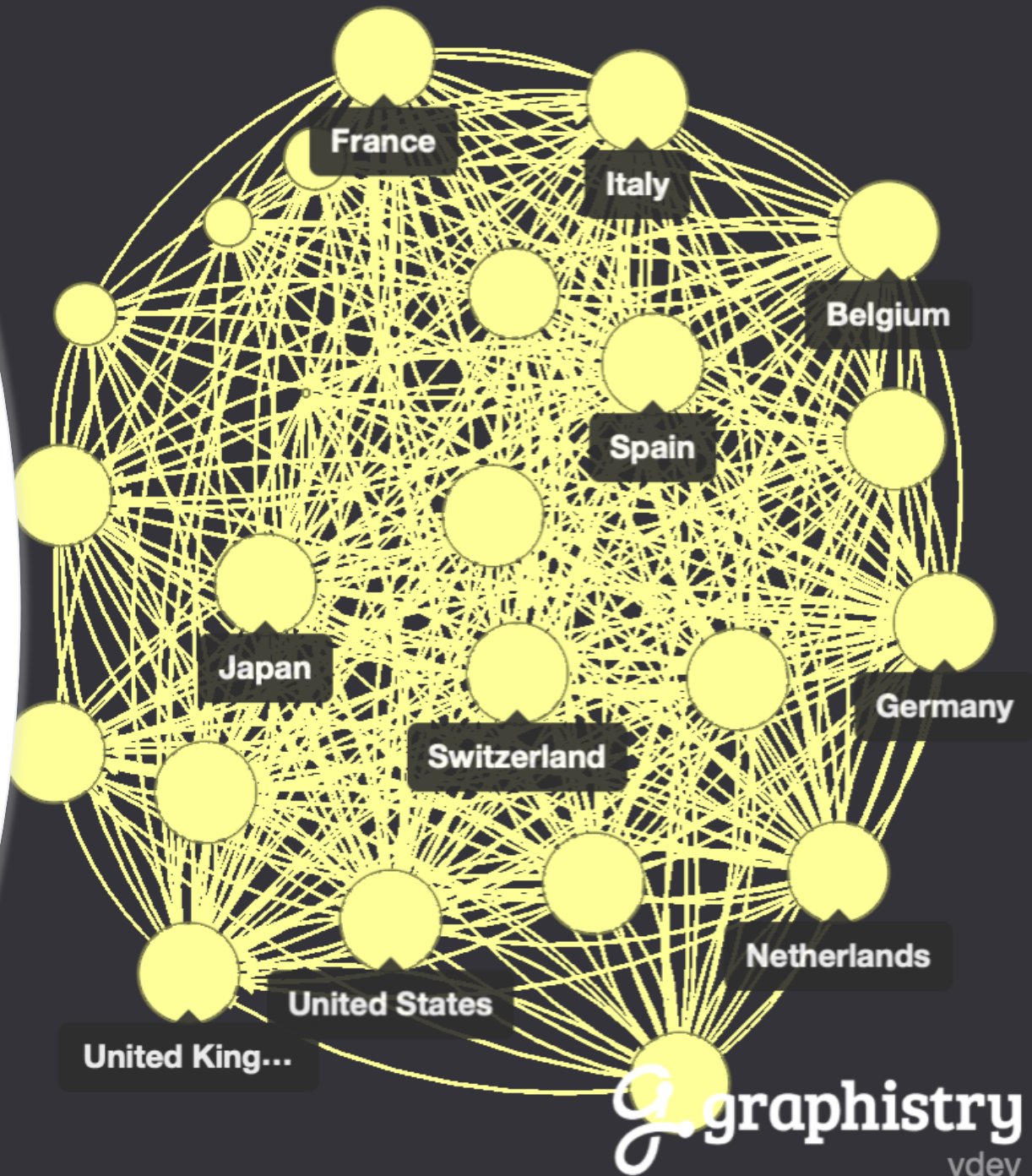
SIS experiments based on MMCA model

Data exploration

Final Data

UN Comtrade
- Attributes:
  - Reporter
  - Partner
  - Trade Value ($US)

Foreign claims
- Attributes:
  - Country
  - Foreign Claims

Reserves
- Attributes:
  - Country
  - Reserves

Merge on Country

Attributes:
- Country
- Foreign Claims
- Reporter
- Partner
- Trade Value ($US)

Constructed Attributes:
- Directed edge weights
- Reserves to foreign claims ratio

23 Countries (nodes)
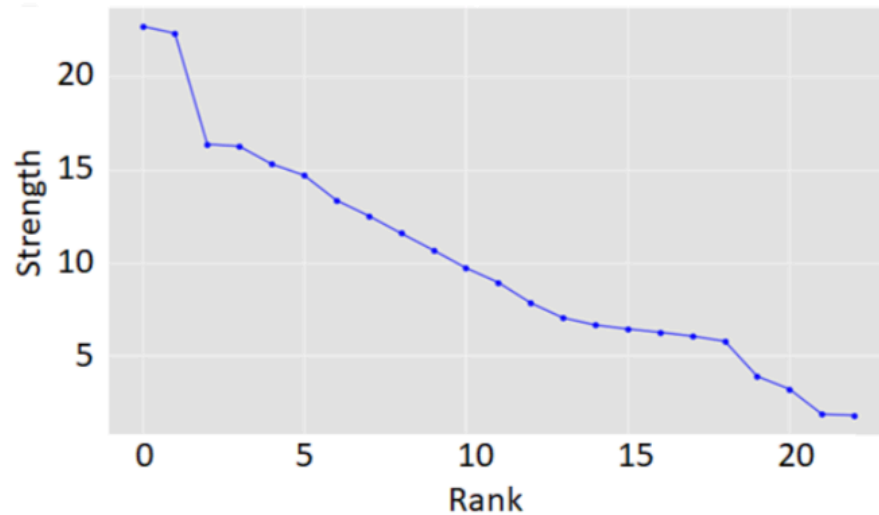354 Tradeflows (edges)

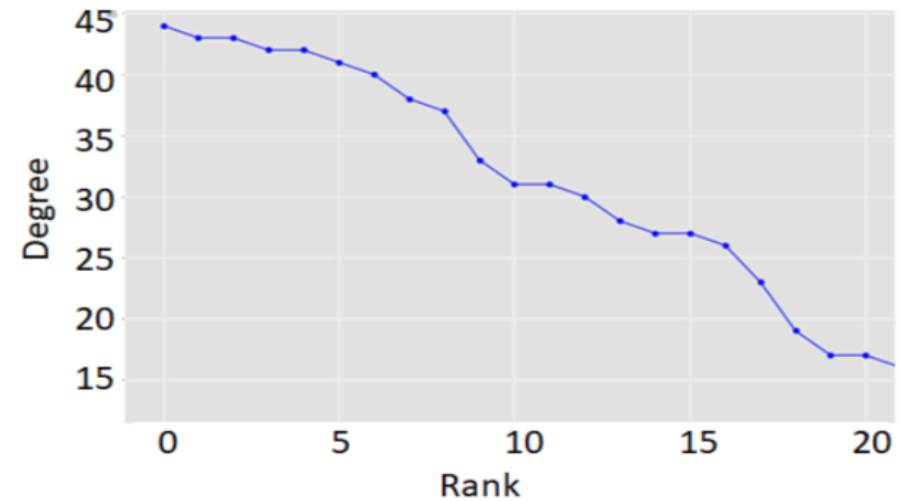# Network Topology

United Nations Comtrade

Excluded edges with strength in bottom 30 %

Strength Rank Plot

Degree Rank Plot

Country selection for scenarios

Top 3 most connected countries

UK

Germany

United States

Bottom 3 least connected countries

Finland

Chile

Greece

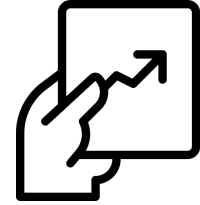Countries are selected based on edge weights

MMCA Model

Homogenous Model	Origin Country	β Infectivity Rate	μ Recovery Rate
Heterogenous Model		β Modified Infectivity Rate based on high risk countries	

Country selection for beta manipulation

Reserves to outstanding debt

Country	Ratio
Netherlands	0.09943%
Finland	0.17518%
France	0.21333%
Austria	0.29788%
Germany	0.31586%
United States	0.31880%

Countries with the lowest ratio are selected as «high risk» nations for which betas are manipulated to approximate real world

Two scenarios:

Medium risk: **β * 1.5**

High risk: **β * 2**

3

The Results

Homogenous Model

Initiated in Top 3 countries (US, UK, Germany)
Homogenous parameters

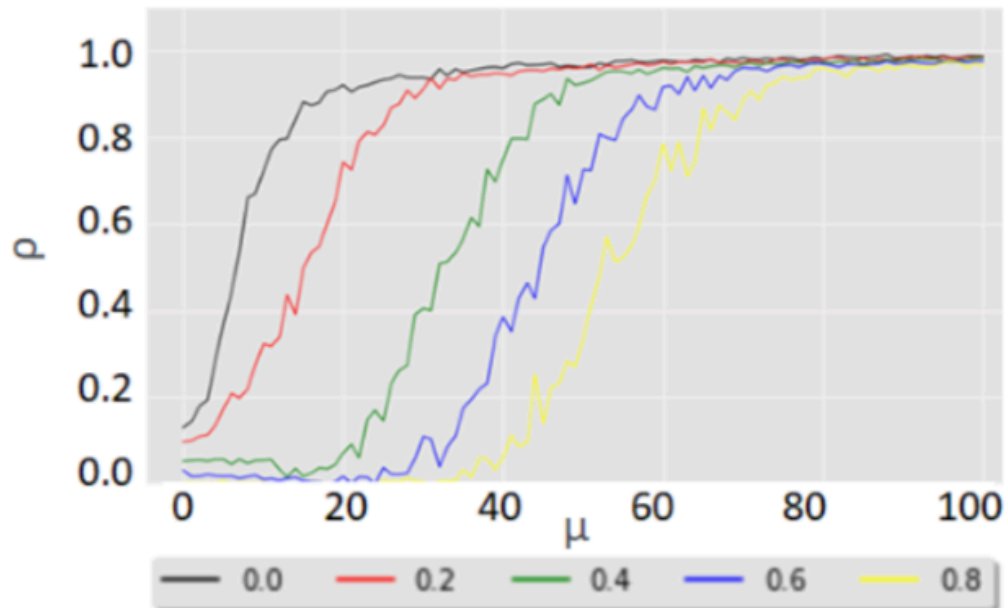**Initiated in Bottom 3 countries (Greece, Chile, Finland)**
Homogenous parameters
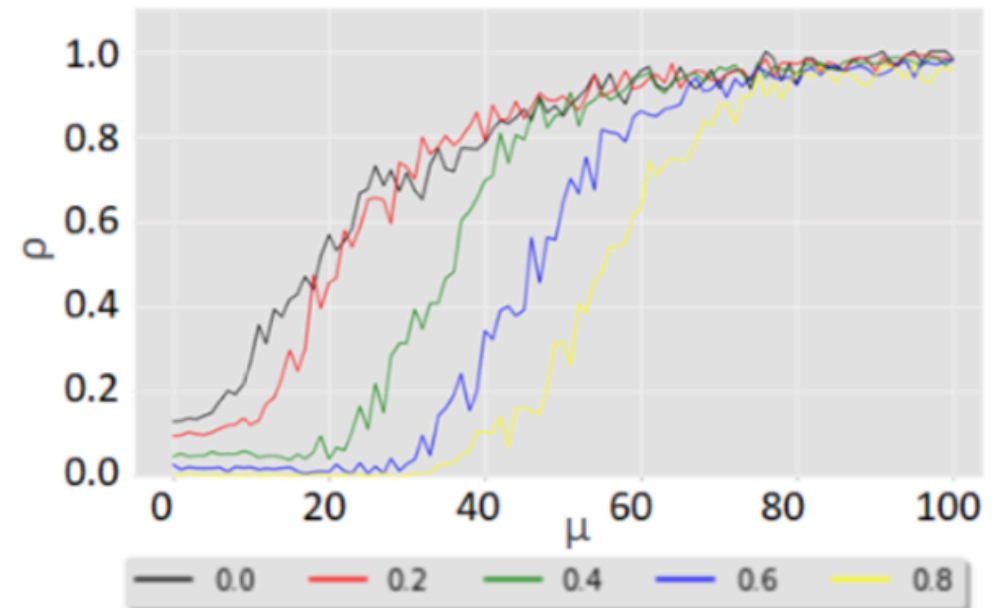
An economic crisis spread much faster when initiated in one of the three most interconnected nations

Heterogenous Model (1.5)

Initiated in Top 3 countries (US, UK, Germany)
Heterogenous parameters, β Mulitplier of 1.5

Initiated in Bottom 3 countries (Greece, Chile, Finland)
Heterogenous parameters, β Mulitplier of 1.5
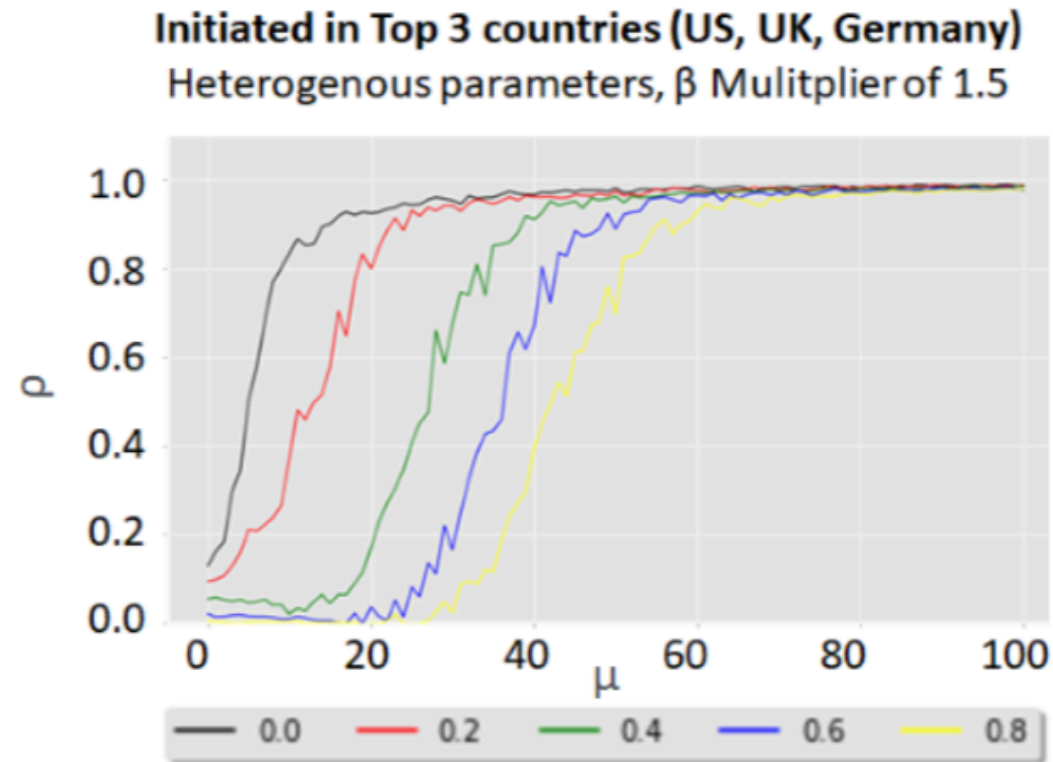
Comparing to the homogenous model, the values of β necessary for the infection to reach 80% of the network have decreased across the board

Heterogenous Model (2.0)

Initiated in Top 3 countries (US, UK, Germany)
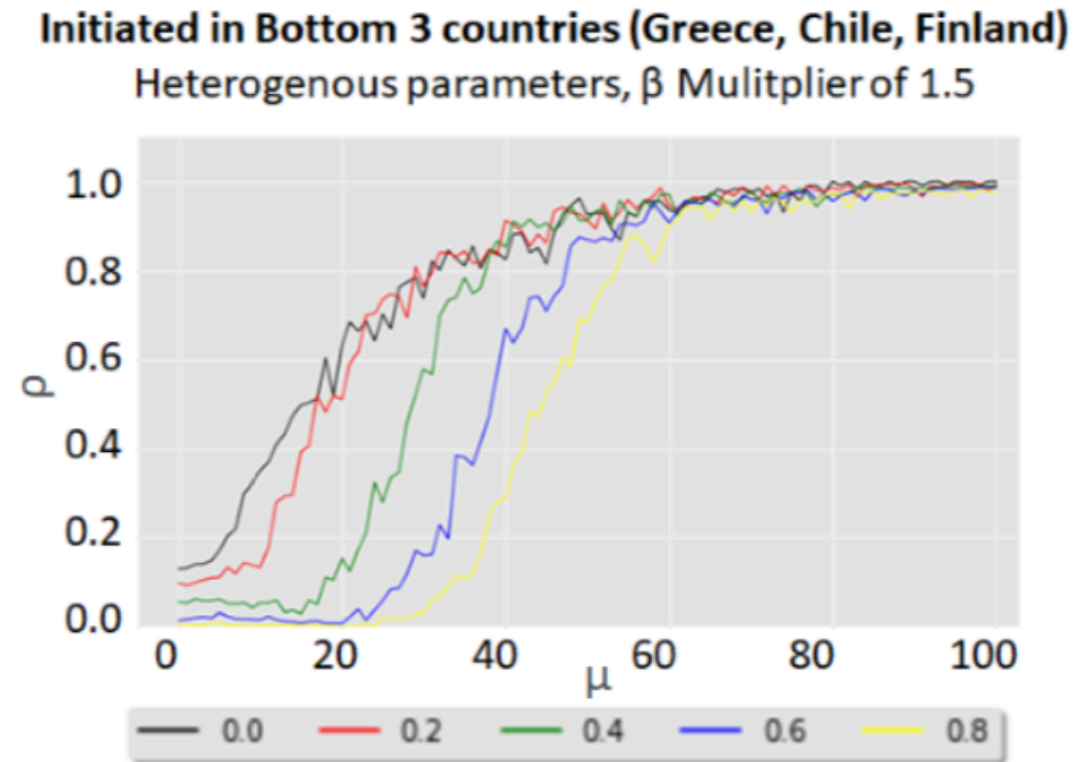Heterogenous parameters, β Mulitplier of 2

Initiated in Bottom 3 countries (Greece, Chile, Finland)
Heterogenous parameters, β Mulitplier of 2
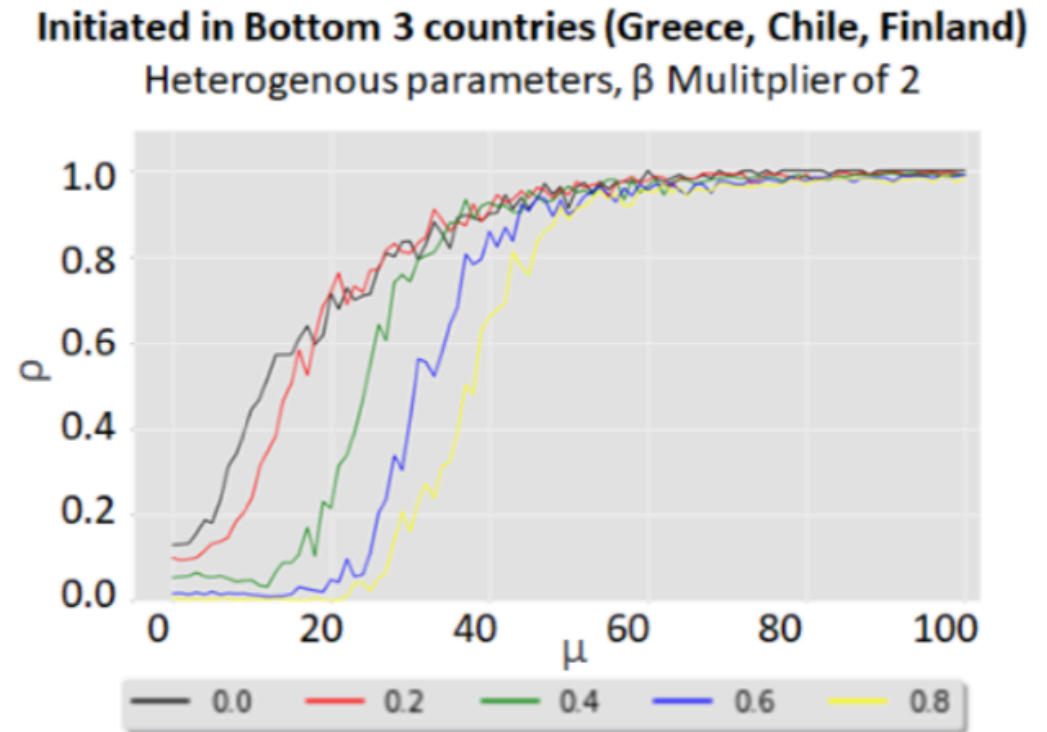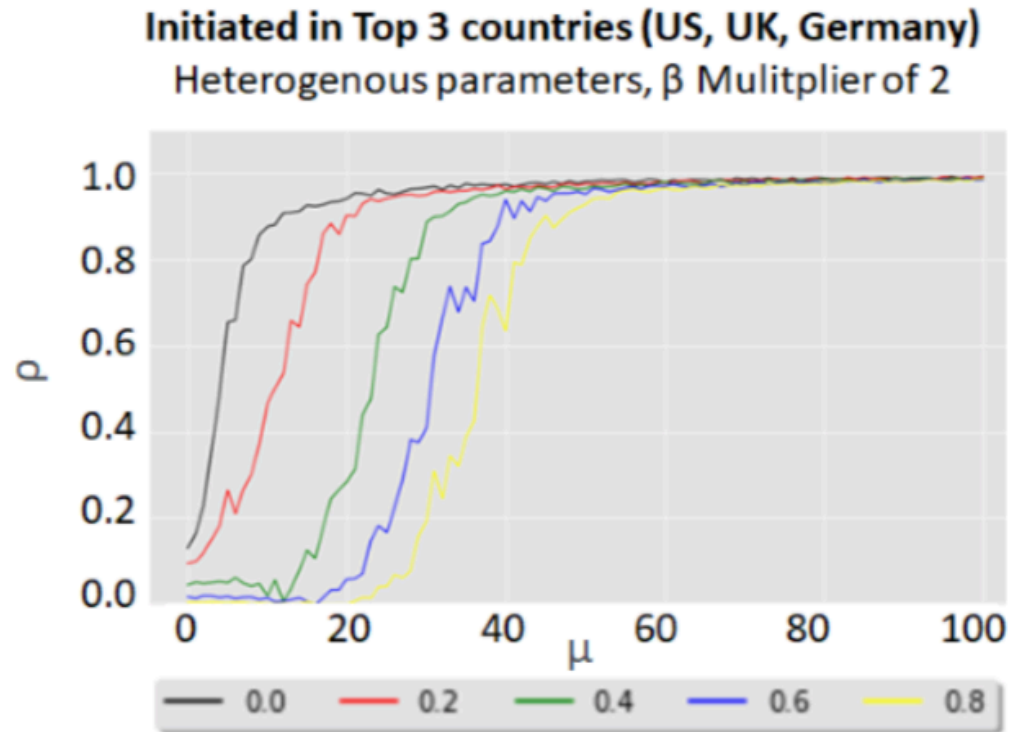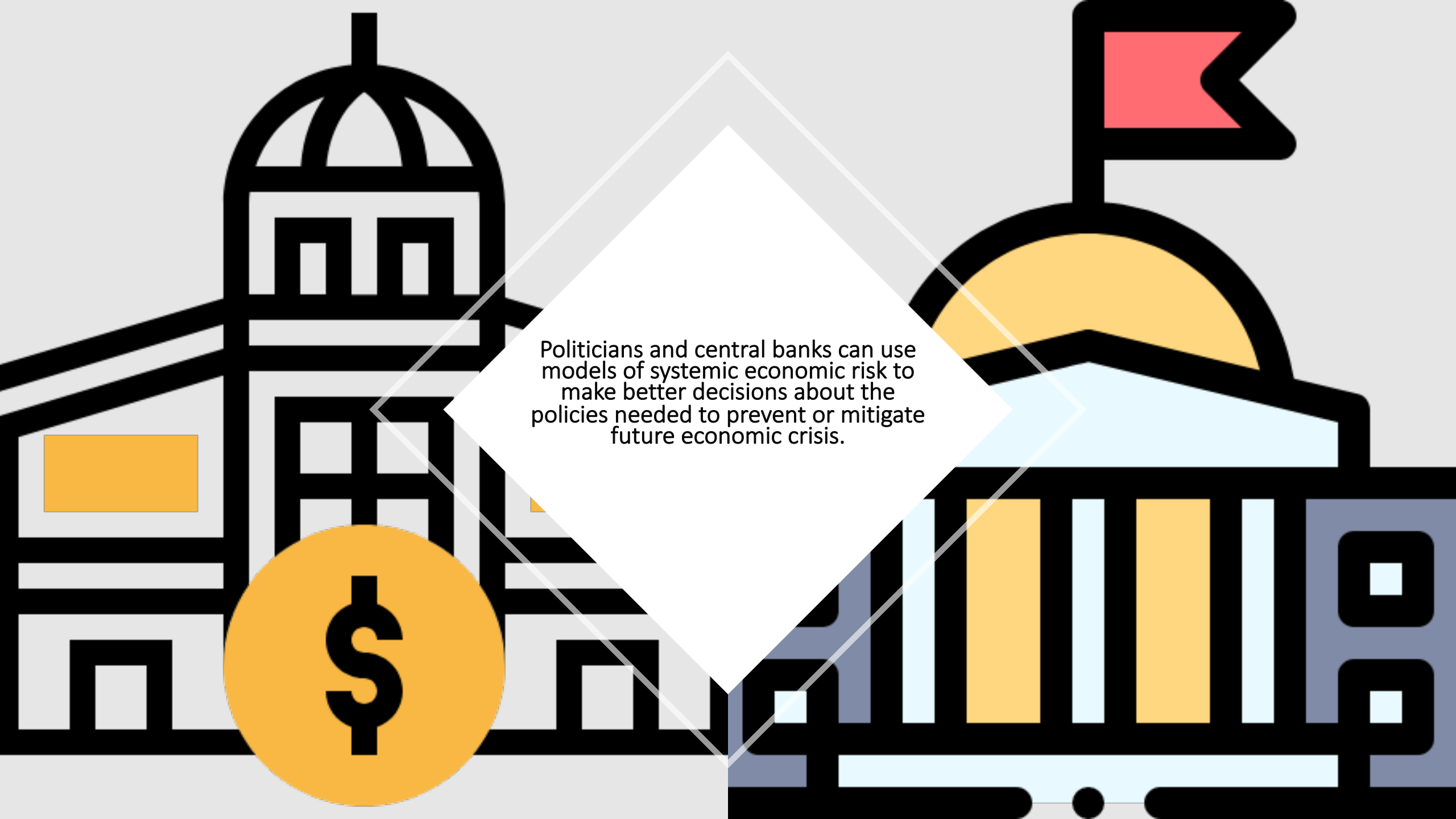
Increasing the multiplier to 2.0 creates an extreme case in which the countries that are considered to be at risk due to their values of reserves as a percentage of outstanding debt have their infectivity ratios (β) doubled. This scenario continues the trend we have observed when we first introduced heterogeneity.

4

The Implications

Politicians and central banks can use models of systemic economic risk to make better decisions about the policies needed to prevent or mitigate future economic crisis.

Implications:

Results:

Large differences in the severity of financial crisis dependent on the country of origin

Adding heterogeneity to the model increases the magnitude of the spread of the crisis across the network, but also decreases the impact of the inherent recovery rate

Some countries with the highest interconnectivity across the network, have the largest inherent risk on the basis of the reserve to outstanding debt ratio

Economic Policy Implications:

Higly interconnected countries should be strongly monitored

Prevention of a crisis may be a better approach than mitigation

Reserves over outstanding obligations ratio may be a good measure to identify a country's ability to sustain economic shocks.

Increasing minimum requirements of national reserves/debt ratios in strongly interconnected countries can significantly reduce the risk of a crisis to spread quickly across the network
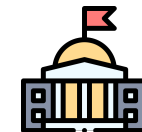
Gracias!

And Q&A

Reserves Table – Multiplier Slide

Country Name	Reserves	GDP	Reserves % GDP	Outstanding Debt	Reserves % Debt
Netherlands	13,194,707,105 €	9,136,580,000,000 €	0.14%	13,271,000,000,000 €	0.09943%
Finland	8,284,157,187 €	2,767,430,000,000 €	0.30%	4,729,000,000,000 €	0.17518%
France	66,103,290,547 €	27,775,400,000,000 €	0.24%	30,986,000,000,000 €	0.21333%
Austria	11,653,251,921 €	4,552,860,000,000 €	0.26%	3,912,000,000,000 €	0.29788%
Germany	59,173,100,675 €	39,476,200,000,000 €	0.15%	18,734,000,000,000 €	0.31586%
United States	114,757,000,000 €	205,443,000,000,000 €	0.06%	35,996,000,000,000 €	0.31880%
Spain	59,030,411,978 €	14,190,400,000,000 €	0.42%	17,566,000,000,000 €	0.33605%
Canada	83,925,602,808 €	171,334,170,487,701 €	0.05%	18,979,000,000,000 €	0.44220%
United Kingdom	159,872,000,000 €	28,553,000,000,000 €	0.56%	36,057,000,000,000 €	0.44339%
Greece	2,918,421,299 €	2,180,320,000,000 €	0.13%	577,000,000,000 €	0.50579%
Ireland	4,975,323,463 €	3,824,870,000,000 €	0.13%	928,000,000,000 €	0.53613%
Italy	51,330,748,572 €	20,838,600,000,000 €	0.25%	8,516,000,000,000 €	0.60276%
Australia	51,048,086,920 €	14,339,000,000,000 €	0.36%	6,876,000,000,000 €	0.74241%
Belgium	17,486,655,859 €	5,427,610,000,000 €	0.32%	2,335,000,000,000 €	0.74889%
Portugal	9,158,607,287 €	2,406,750,000,000 €	0.38%	956,000,000,000 €	0.95801%
Sweden	55,385,715,101 €	5,560,860,000,000 €	1.00%	3,465,000,000,000 €	1.59843%
Japan	1,238,940,000,000 €	49,713,200,000,000 €	2.49%	43,718,000,000,000 €	2.83394%
Singapore	287,466,000,000 €	3,641,570,000,000 €	7.89%	5,676,000,000,000 €	5.06459%
Switzerland	744,167,000,000 €	7,051,400,000,000 €	10.55%	10,842,000,000,000 €	6.86374%
Korea	398,780,000,000 €	16,194,200,000,000 €	2.46%	1,978,000,000,000 €	20.16077%
Chile	39,848,699,140 €	2,982,310,000,000 €	1.34%	142,000,000,000 €	28.06246%
Turkey	72,866,830,470 €	7,713,500,000,000 €	0.94%	259,000,000,000 €	28.13391%
India	374,425,000,000 €	27,187,300,000,000 €	1.38%	856,000,000,000 €	43.74124%