

# **Modelling systemic risk in inter-bank networks: From theoretical to data-driven models**

Elena Rovenskaya, Stefan Thurner, Sebastian  
Poledna, Matt Leduc, and Stefan Hochreiner

*IIASA, Laxenburg, Austria*

*Gaidar Forum, 14 January, Moscow, Russia*

# What is systemic risk?

- Risk: Effect of **uncertainty** on **objectives** (ISO 31000)
- Single/Individual risk (UNISDR 2013): emerges between two counterparties
- Single risk may lead to a disaster in part of the system, to which an object belongs



- Financial systems: Credit risk – failing to make the full pre-specified payments
- Management option: higher interest rates to borrowers who are more likely to default

# What is systemic risk?

- Systemic risk originates from the **connections between objects**
  - sometimes also called “**networked risks**” (Helbing 2013)
  - Systemic risk is a network property => Domino effect
- Systemic risk, by definition, leads to a **breakdown** or at least **major dysfunction of the whole system** (Kovacevic and Pflug 2014)
- Different topologies have different probabilities of contagion
- Management of systemic risk is a matter of **restructuring financial network**

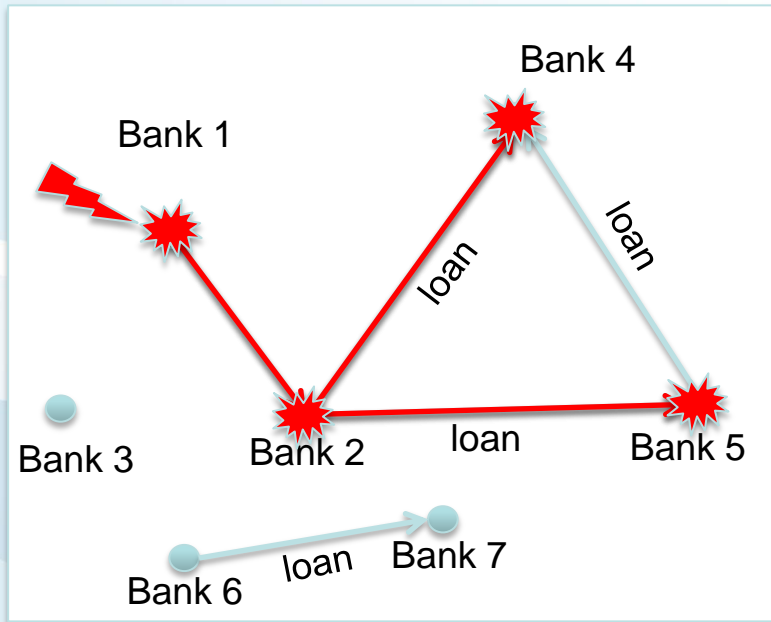


# Systemic risk is a global issue

- **Financial crisis of 2008** increased the interest in and funding for systemic risk (focusing mostly on the financial sector) to unprecedented levels (May and Arinaminpathy 2009)
- **“Failure of financial mechanism or institution”** – one of the major risks in The Global Risks Report 2017, World Economic Forum
- **Markets and financial flows are global, but there is no global governance** of these (Mau, Gaidar Forum 2017)
- Measurement of systemic risk is a challenge

# Science view

- Economic-financial systems as networks of interconnected nodes

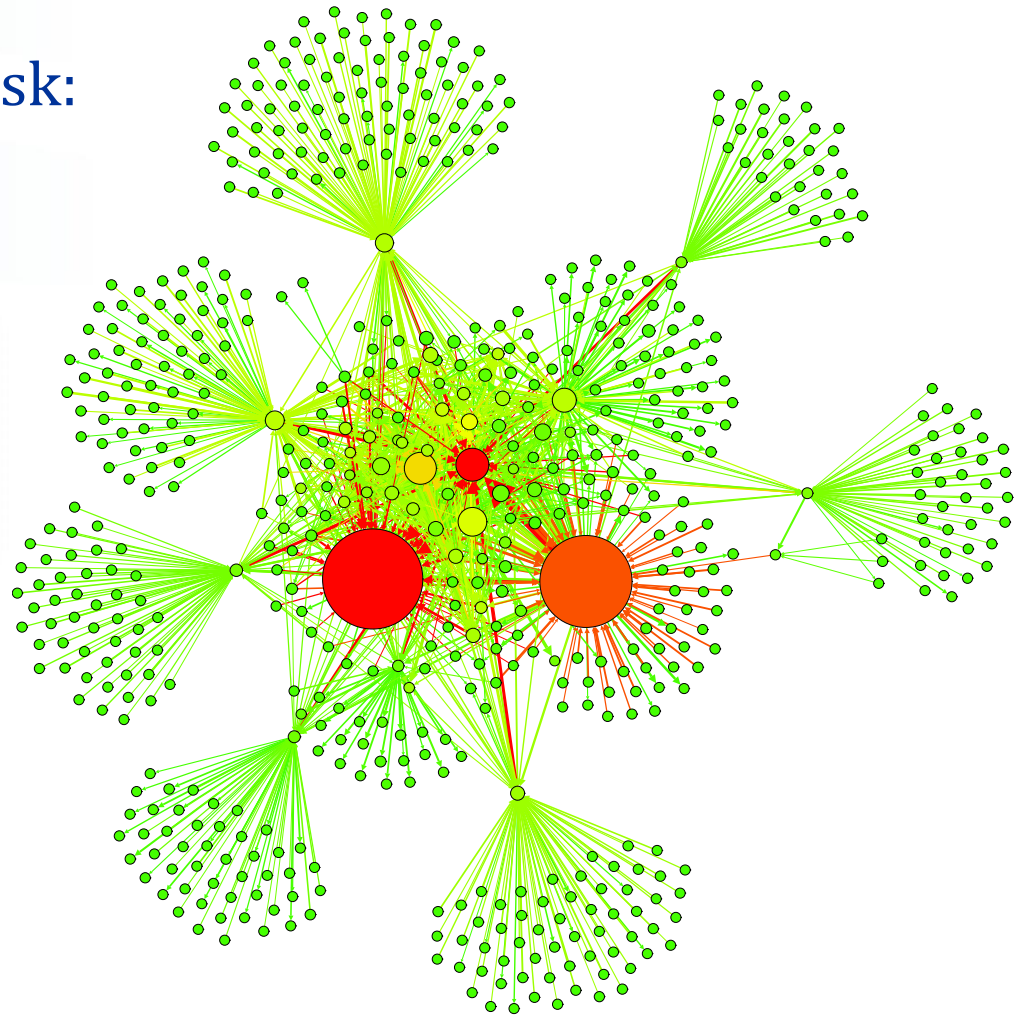


- Nodes: banks
- Links: liabilities (loans)
- Failures spread from one node to another causing cascading failures

**System-wide collapse could be caused by cascading failures**

# Example: Banking network of Austria

- A measure of systemic risk:  
DebtRank = fraction of the economic value that is potentially affected by a collapse of the node
- Related to the node's centrality



# How to measure systemic risk?

- Poledna et al. (2015) introduced the notion of an incremental increase in systemic risk caused by an individual financial transaction: **marginal systemic risk**

# Every loan creates systemic risk

Note orders of  
magnitude!

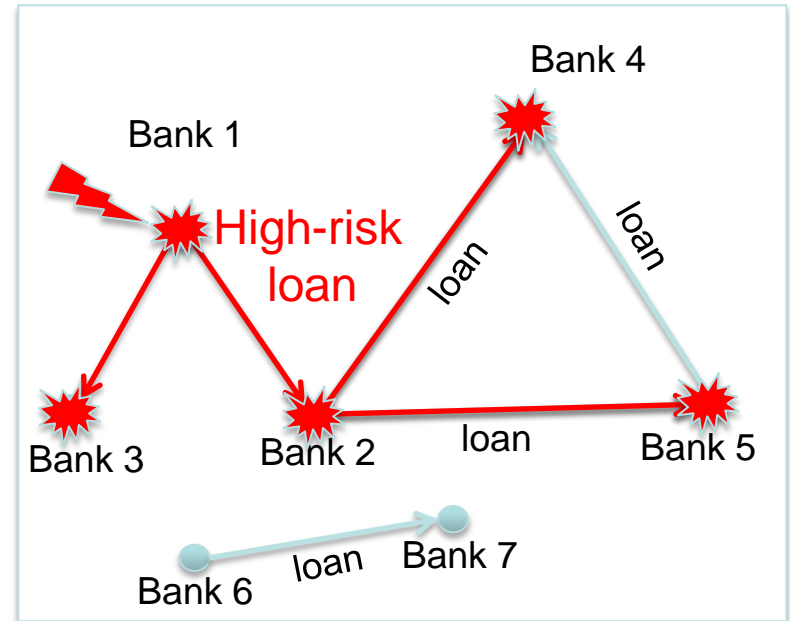


# Mitigating systemic risk: Systemic risk can be managed by restructuring the network

**How?** Incentivize agents to avoid risky transactions

**Simple way:** Tax risky transactions

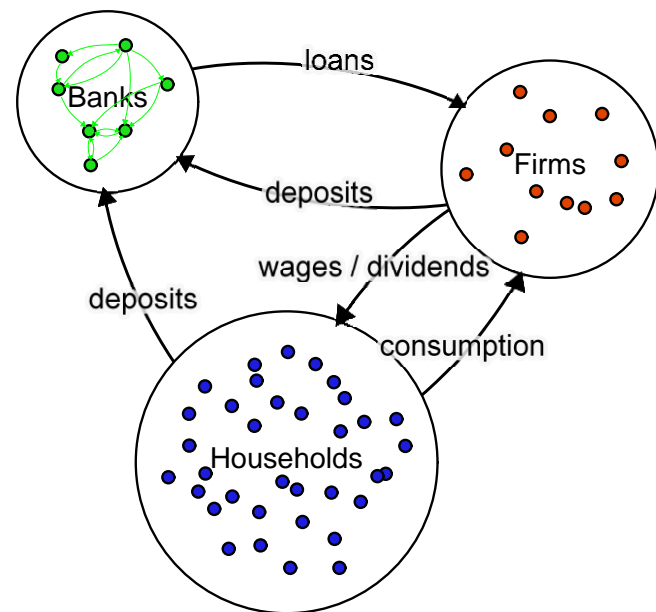
- Agents look for loans with low systemic risk.
- Liability networks re-arrange
- Mitigates the risk of cascading failure



# Testing the tax policy with the CRISIS model

Compared three schemes:

- No systemic risk management
- Systemic Risk Tax (SRT)
- Tobin-like tax (0.2% on all transactions)



The CRISIS model is an agent-based model of the economy and financial system that is based on how people and institutions actually behave



UNIVERSITÀ  
CATTOLICA  
del Sacro Cuore



UNIVERSITÀ  
DEGLI STUDI  
DI PALERMO

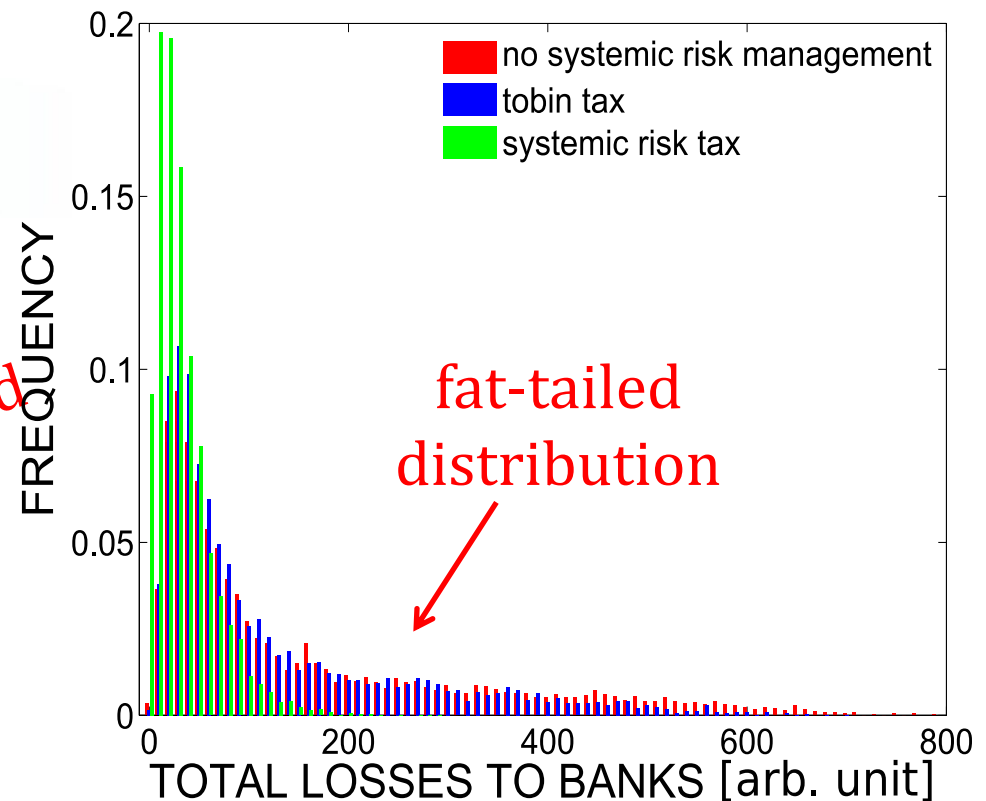


SCUOLA  
NORMALE  
SUPERIORE



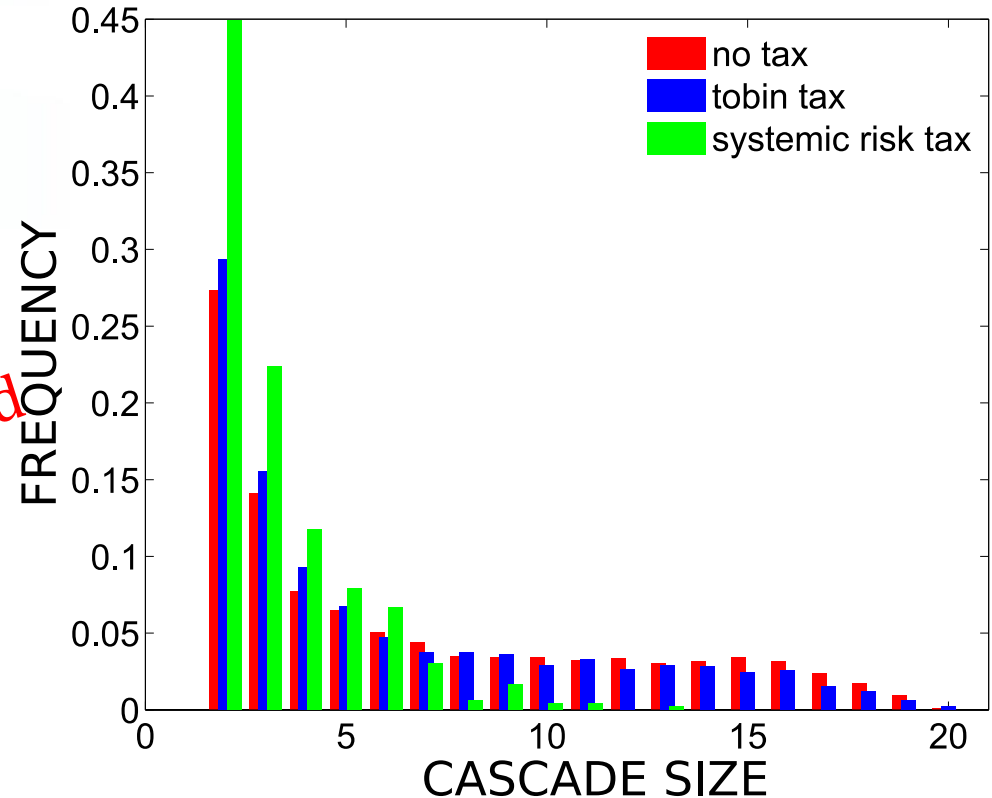
# Model results: distribution of losses

With the Systemic Risk Tax, the possibility for cascading defaults is significantly reduced



# Model results: cascade size

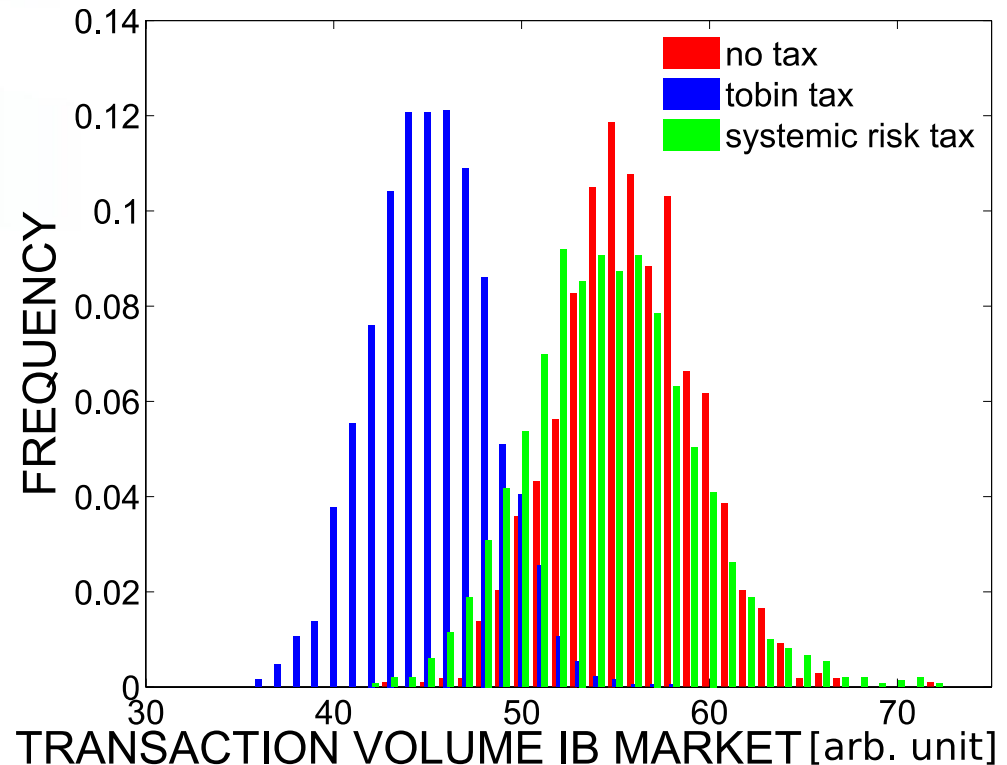
With the Systemic Risk Tax, the possibility for cascading defaults is significantly reduced



Poledna & Thurner (2016)

# Model results: transaction volume

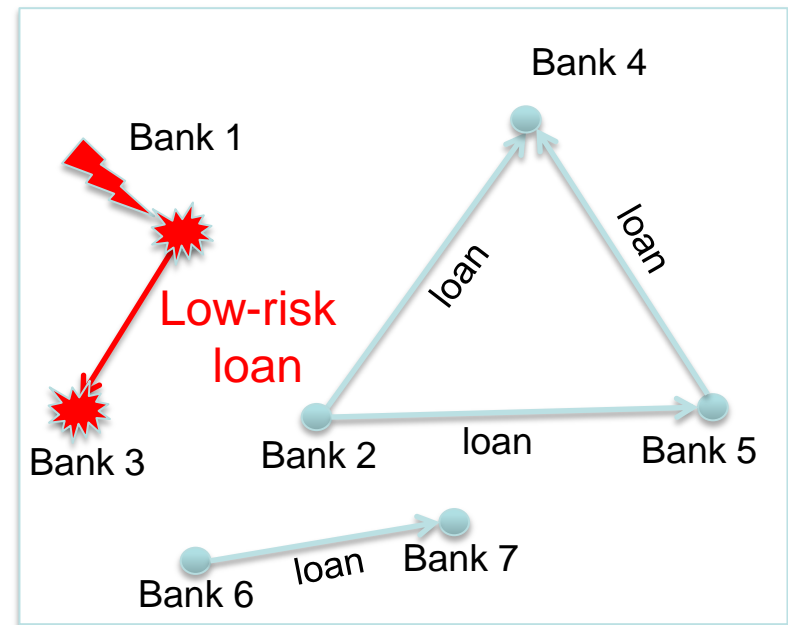
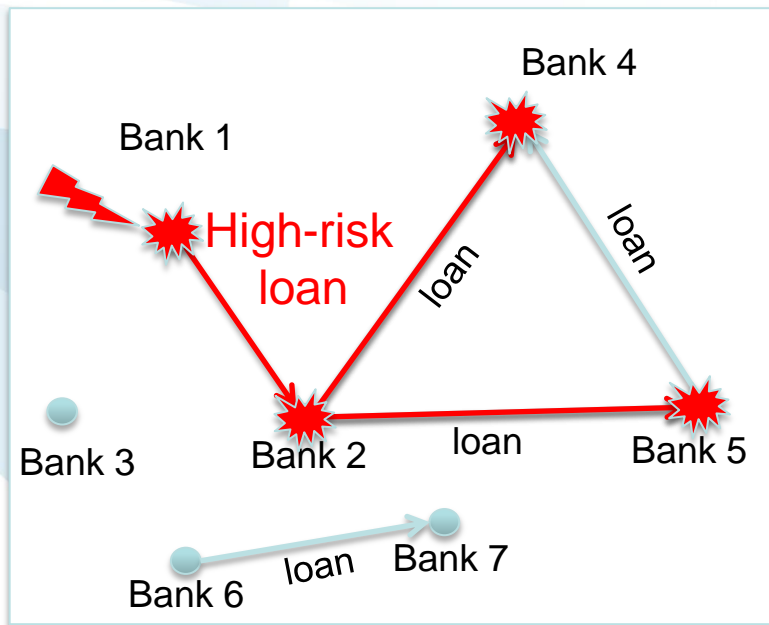
Tobin tax reduces risk by  
reducing credit volume



Poledna & Thurner (2016)

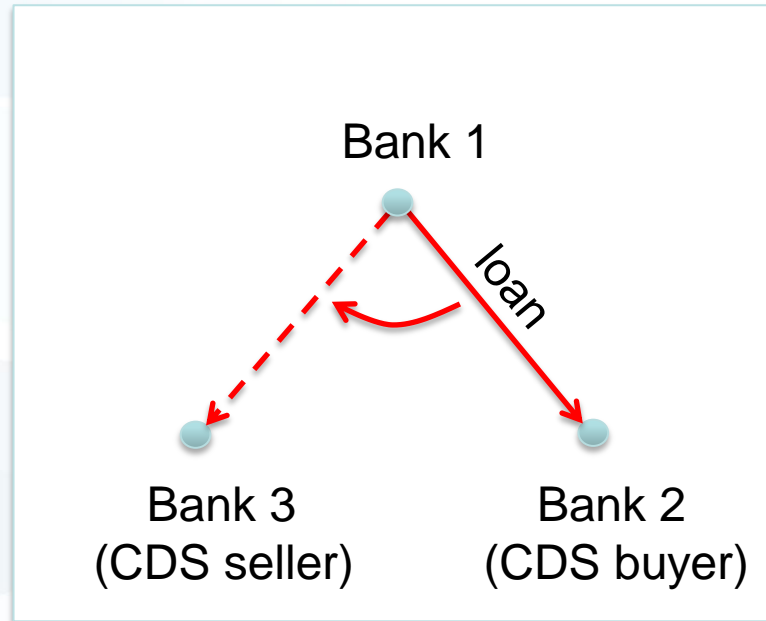
# Are there other ways to reorganize the network of exposures?

- Different loans have different incremental effects on systemic risk
- We can transfer an exposure from one bank to another using a Credit Default Swap (CDS)



# Reorganizing the network of exposures

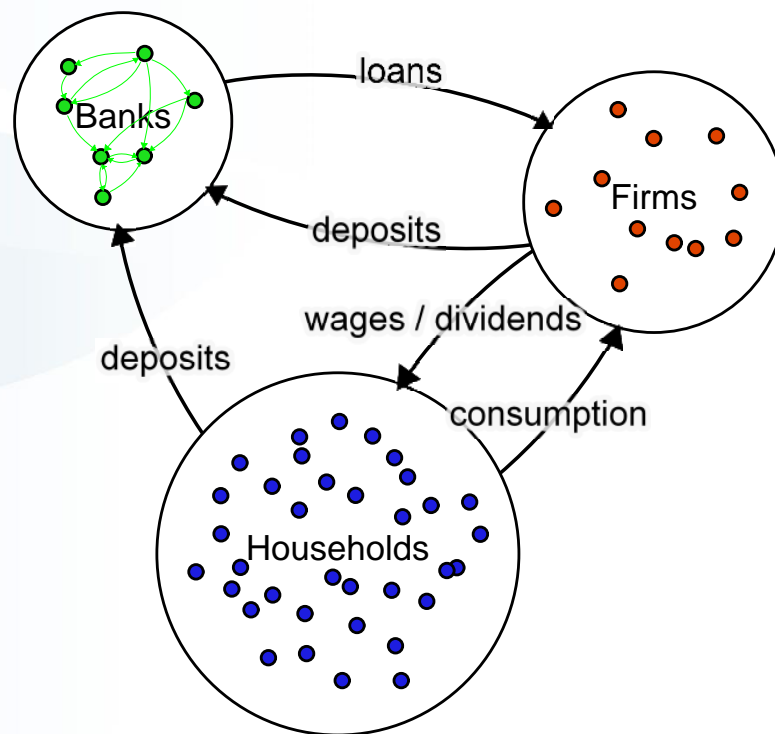
- A Credit Default Swap (CDS) is a form of insurance against default risk:



- A CDS transfers an exposure from one bank to another
- CDSs have a bad reputation, since they can be used for speculation.
- However, if used properly, they effectively rewire the network!

# Regulating the CDS market

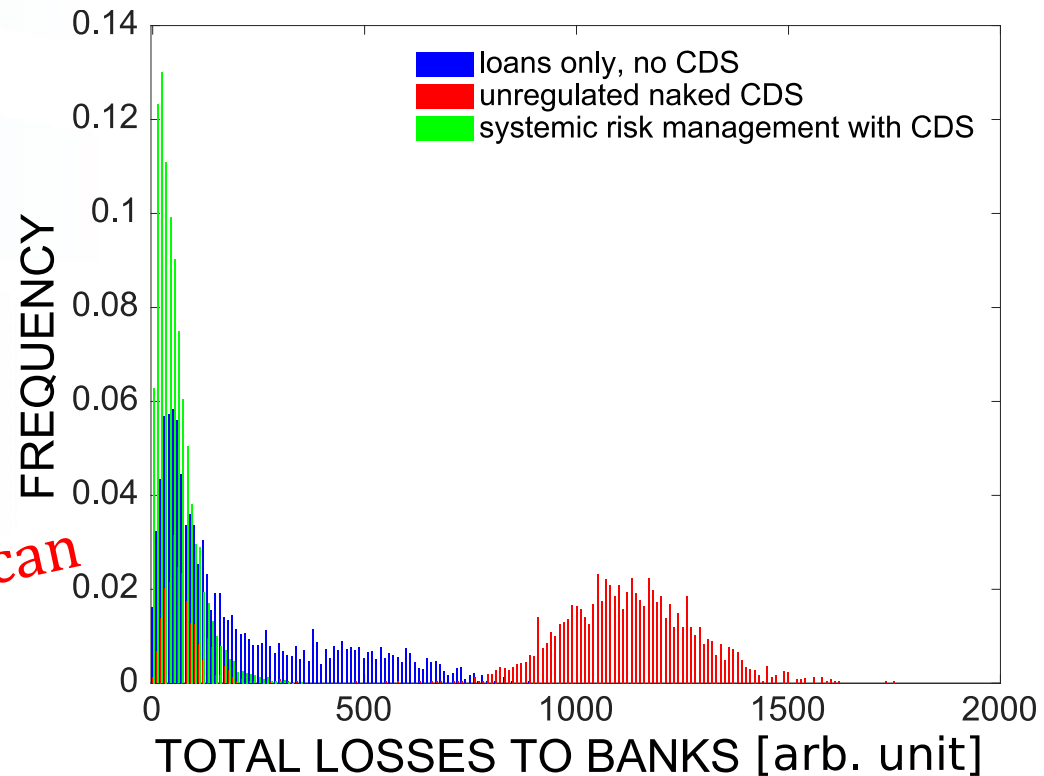
- The CDS transactions that increase systemic risk can be penalized and the CDS transactions that decrease it can be encouraged
- Such policy is simulated using the CRISIS model



# Model results: distribution of losses

A regulated CDS market can  
**decrease** systemic risk

An unregulated CDS market can  
**increase** systemic risk



# Publications

S Poledna and S Thurner (2016): Elimination of systemic risk in financial networks by means of a systemic risk transaction tax, *Quantitative Finance*, 16(10): 1599-1613

S Poledna et al (2015): The multi-layer network nature of systemic risk and its implications for the costs of financial crisis, *Journal of Financial Stability*, 20: 70-81

M Boss et al (2004): Network topology of the interbank market, *Quantitative Finance*, 4: 677-684

Questions? Comments?

Contact: Elena Rovenskaya  
[rovenska@iiasa.ac.at](mailto:rovenska@iiasa.ac.at)