

IMK-Workshop

Netzwerkökonomik: Teil II

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12. August 2016



University of
Zurich^{UZH}

Übersicht

- ① Einführung
- ② “Backbone of Complex Networks of Corporations”
- ③ “Network of Global Corporate Control”
- ④ “Architectures of Power: The Evolution of the Global Ownership Network”
- ⑤ DebtRank and Systemic Risk
- ⑥ Disentangling

Was macht man mit Ownership-Netzwerken?

- ① Netzwerk-Topologie: **Ordnungsprinzipien**
 - Ownership-Muster
 - Globale Strukturen: Fragmentiert oder integriert
- ② Netzwerk-Funktion: **Fluss der Kontrolle**
 - Wer sind die Hauptakteure?
 - Verteilung der Kontrolle
- ③ Das **entstehende** Bild: Machtstrukturen
- ④ Die **Evolution** des Netzwerks

Backbone of Complex Networks of Corporations

Die Daten

ORBIS Datenbank von Bureau van Dijk¹

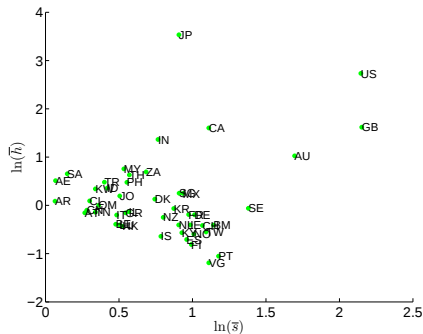
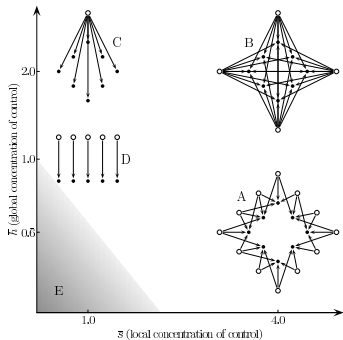
- Ownership-Daten für **30 Millionen Aktionäre und Konzerne** in 194 Länder von **2007**

Nationale Netzwerke

- **48 Länder-Netzwerke**, mit 131'018 Knoten (24'877 Konzerne und 106'141 Aktionäre) und 545'896 Verknüpfungen

¹<http://www.bvdep.com/orbis.html>

Ownership-Muster



Lokale Streuung von Besitz assoziiert mit **globaler Konzentration** von Besitz und umgekehrt

Network of Global Corporate Control

Die Studie



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The Network of Global Corporate Control

Article Metrics Related Content Comments: 5

Stefania Vitali, James B. Glattfelder, Stefano Battiston*
Chair of Systems Design, ETH Zurich, Zurich, Switzerland

Abstract [Top](#)

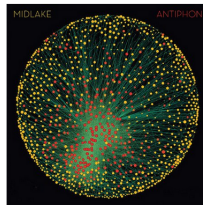
The structure of the control network of transnational corporations affects global market competition and financial stability. So far, only small national samples were studied and there was no appropriate methodology to assess control globally. We present the first investigation of the architecture of the international ownership network, along with the computation of the control held by each global player. We find that transnational corporations form a giant...

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Die Verschwörung



Physicists Shed Light on Illuminati

5 Comments | September 7, 2009 | Amelia Crater

In [The Book of the Damned](#) Charles Fort opined, "I think we're groovety. I should

Illuminati Proven by Physics and Siberian Skulls

By [dad2009](#) on September 10, 2009 | [Leave a comment](#)

Via the [Mysterious Universe](#):

New World Order, Interlocking Directorships

MONDAY, JANUARY 22, 2006

[New World Order, Interlocking Directorships](#)

New World Order and Cross-Corporate Directorships

Die Daten

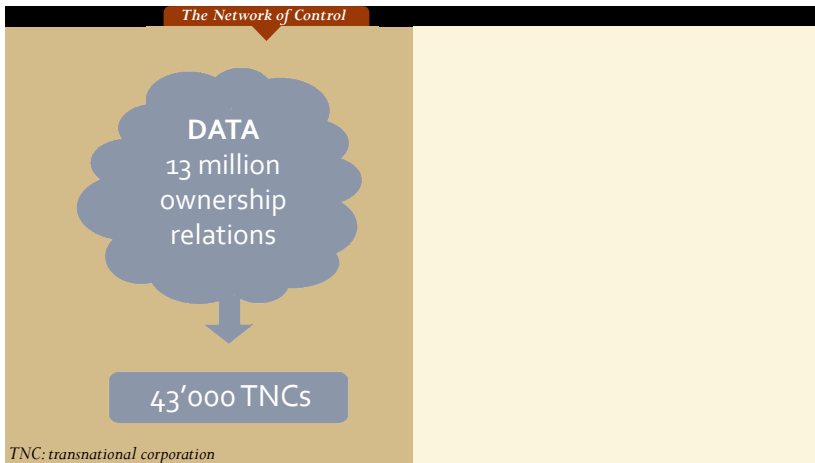
ORBIS Datenbank von Bureau van Dijk

- Ownership-Daten für **30 Millionen Aktionäre und Konzerne** in 194 Länder von **2007**

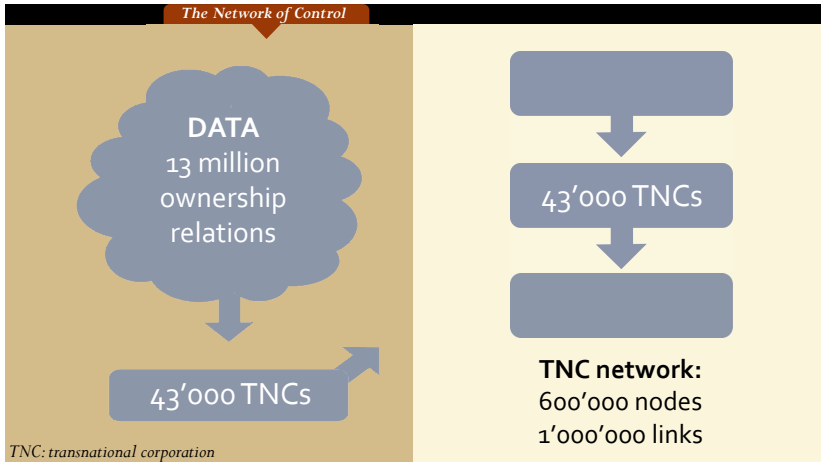
Globales Netzwerk

- Das globale Netzwerk um alle **transnationalen Konzerne** (TNC: 43'060), mit **600'508 Knoten und 1'006'987 Verbindungen**

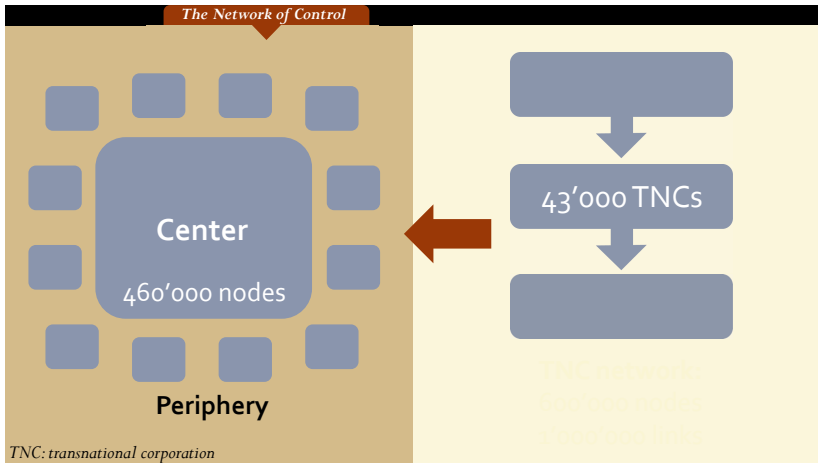
Die Daten



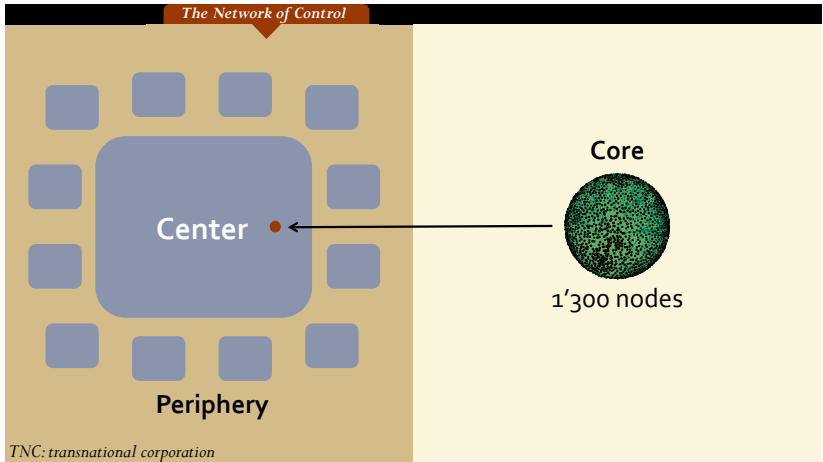
Die Hierarchie



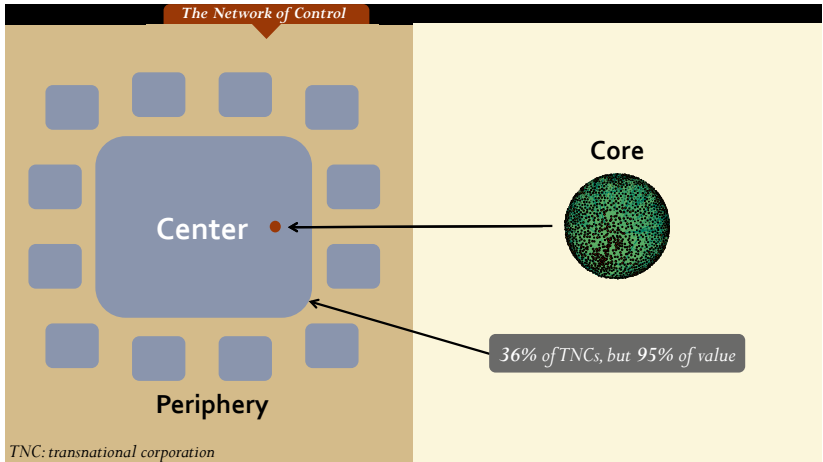
Die Struktur



Der Kern



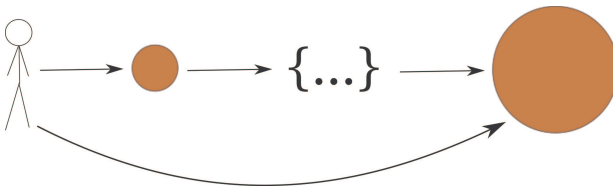
Die Organisation



Der Fluss der Kontrolle

- Beteiligungen objektiv erfassbar
- Kontrolle: Beteiligungen ergeben **Stimmrechte**
- Drei Modelle um die Kontrolle abzuschätzen:
 - 1 **One-share-one-vote principle**
 - 2 **Threshold model**
 - 3 **Relative model**

Der Fall des Marco Tronchetti Provera:



Das Netzwerk hat Bedeutung: Kontrollpyramide ergibt einen Hebel von 26

Die Berechnung der Kontrolle

Definition	Solution	First Correction	Second Correction
$\tilde{\nu}^{\text{int}} = W(\nu^{\text{int}} + \nu)$ $\nu^{\text{net}} = W\nu^{\text{net}} + \nu$	$\tilde{\nu}^{\text{int}} = \widetilde{W}\nu$ $\nu^{\text{net}} = \tilde{\nu}^{\text{int}} + \nu$	$\hat{\nu}^{\text{int}} = \widehat{W}\nu$ $\hat{\nu}^{\text{net}} = \hat{\nu}^{\text{int}} + \mathcal{D}\nu$	$\bar{\nu}^{\text{int}} = \overline{W}\nu$ $\bar{\nu}^{\text{net}} = \bar{\nu}^{\text{int}} + \mathcal{D}\nu$
$\mathcal{D} = \text{diag}((I - W)^{-1})^{-1}, \quad \widetilde{W} = (I - W)^{-1}W, \quad \widehat{W} = \mathcal{D}\widetilde{W}, \quad \overline{W} = W(\widehat{W} + \mathcal{D}).$			

Die Berechnung der Kontrolle



<http://stockarch.com>

Kontrolle fließt wie Wasser in einem Netzwerk aus Rohren

Die Bedeutung der Kontrolle

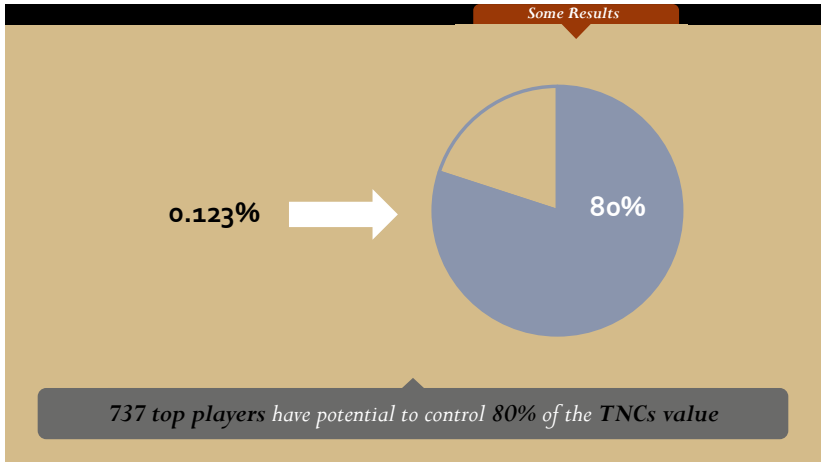
Ein Mass für potentielle Macht

Wahrscheinlichkeit die eigenen Interessen gegenüber einer Opposition durchzusetzen (M. Weber).

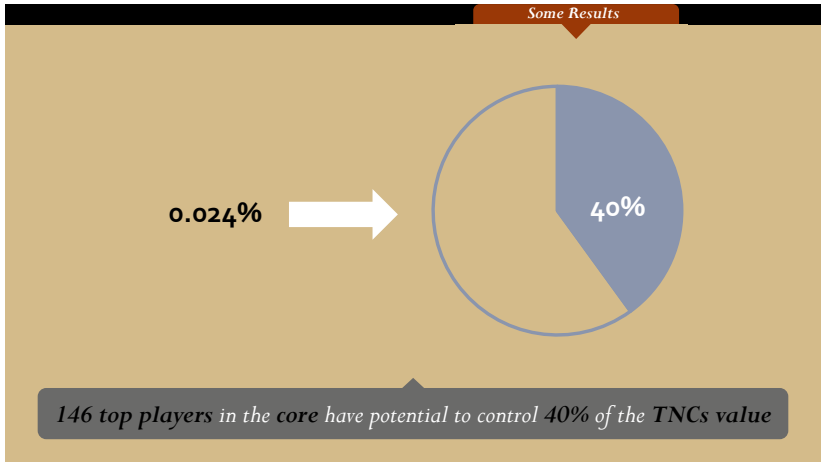
Die Top-Player

Rank	Threshold Model	Linear Model	Relative Model
1	BARCLAYS PLC	BARCLAYS PLC	BARCLAYS PLC
2	CAPITAL GROUP	CAPITAL GROUP	CAPITAL GROUP
3	FMR CORP	AXA	AXA
4	AXA	FMR CORP	FMR CORP
5	STATE STREET CORP	STATE STREET CORP	STATE STREET CORP
6	JPMORGAN CHASE & CO.	JPMORGAN CHASE & CO.	LEGAL & GENERAL GROUP
7	LEGAL & GENERAL GROUP	LEGAL & GENERAL GROUP	JPMORGAN CHASE & CO.
8	VANGUARD GROUP	VANGUARD GROUP	UBS AG
9	UBS AG	UBS AG	LLOYDS TSB GROUP
10	MERRILL LYNCH & CO.	MERRILL LYNCH & CO.	VANGUARD GROUP

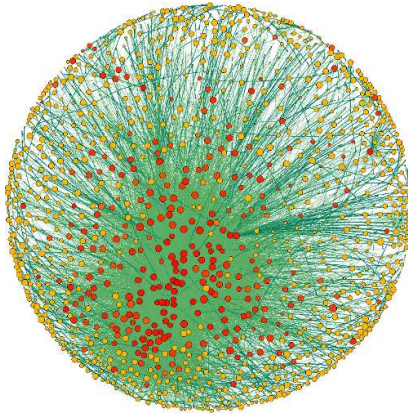
Die Konzentration der Kontrolle



Die Konzentration der Kontrolle



Das systemische Risiko: “Too connected to fail”



Machststruktur: Der Kern des Netzwerks besteht aus 1'318 Knoten, welche auch die Top-Akteure sind.

Was ist der Ursprung?



“Physicists Shed Light on Illuminati”

Simulationen: **Selbstorganisation** vs. **Verschwörung**

Aber...

Jeder weiss das doch schon

- Intuition vs. empirische Beweise
- Erste Analyse des globalen Beteiligungsnetzwerkes

Grosser Aktienbesitz ergibt grosse Kontrolle

Hedgefonds üben doch keine Kontrolle aus

- Keine globale Studie wie Finanzinstitute Kontrolle ausüben
- Verdeckte Macht
- Anekdote

Reaktionen

“...but the authors are physicists. They want to apply their methodology to a large data set with lots of nodes.” (Y. Smith, Naked Capitalism)

Ökonomische Netzwerke sind eine momentane Modeerscheinung.

“[The Network of Control] is an impression of the moon’s surface. It’s not a street map.” (G. Davis, Prof. of Management)

“[The Network of Control] gave us a tantalizing glimpse of a brave new world for finance.” (A. Haldane, Bank of England)

Architectures of Power: The Evolution of the Global Ownership Network

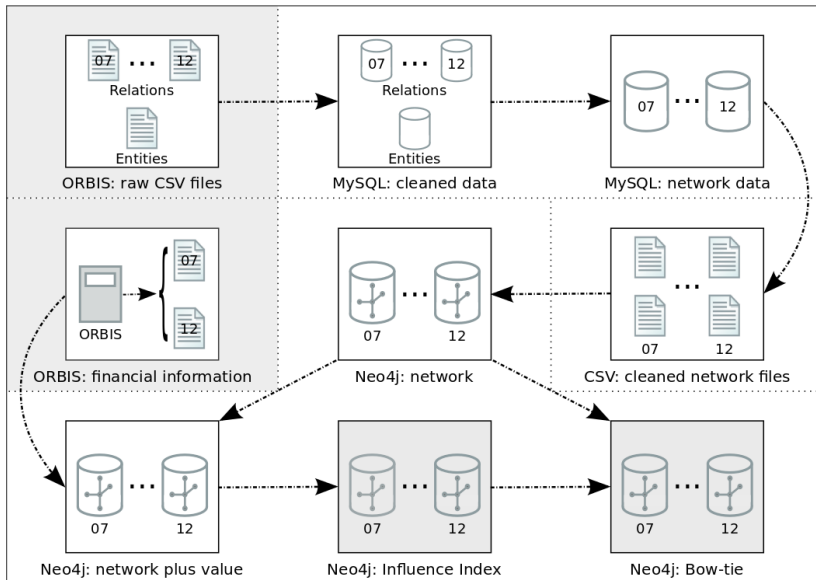
Forschungsprogramm

Economic Networks: The New Challenges

The current economic crisis illustrates a critical need for new and fundamental understanding of the structure and dynamics of economic networks.

(F. Schweitzer, G. Fagiolo, D. Sornette, F. Vega-Redondo, A. Vespignani, D.R. White, Science, 2009)

Arbeitsablauf



Die Daten

2007**2012****Links**

- Raw: 87 m
- Usable: **14 m**

- Raw: 213 m
- Usable: **27 m**

Nodes

- Raw: 114 m
- Usable: **16 m**

- Raw: 114 m
- Usable: **35 m**

Nodes with value

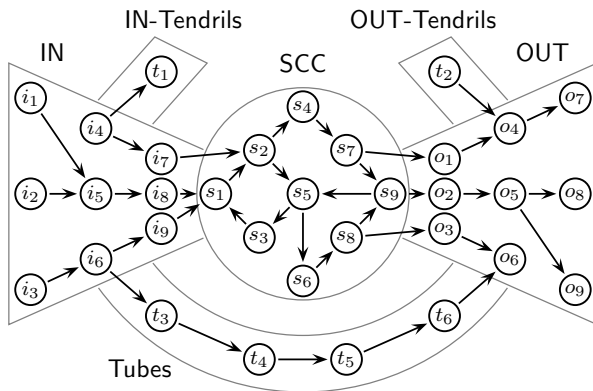
- Raw: 10 m
- Usable: **2 m**

- Raw: 22 m
- Usable: **4 m**

The Global Ownership Network

	Nodes		Relations
	Total number	With value	
2007	16'636'351	2'242'010	14'724'489
2008	18'807'808	2'733'421	16'261'139
2009	23'312'973	3'704'436	20'022'388
2010	24'356'469	3'981'925	20'594'177
2011	30'563'099	4'256'246	24'545'148
2012	35'839'090	4'004'331	27'307'642

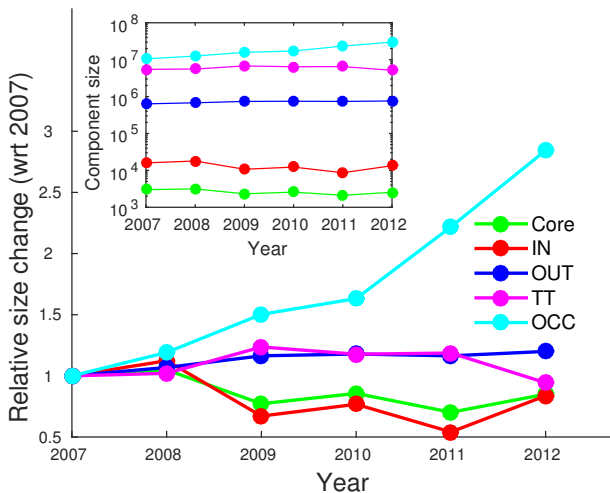
Bow-Tie



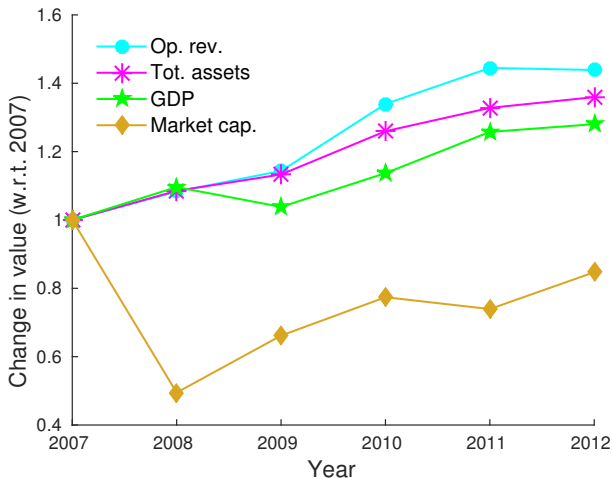
Network Structure

	2007	2008	2009	2010	2011	2012
IN	15'980	17'957	10'727	12'263	8'645	13'375
Core	3'005	3'151	2'320	2'574	2'110	2'554
OUT	634'773	678'336	738'775	748'072	738'737	761'571
TT	5'464'982	5'577'945	6'754'951	6'432'513	6'484'955	5'156'336
LCC	6'118'740	6'277'389	7'506'773	7'195'422	7'234'447	5'933'836
OCC	10'517'611	12'530'419	15'806'200	17'161'047	23'328'652	29'905'254
v in LCC	88.95%	87.79%	87.22%	87.17%	86.35%	87.03%

Bow-Tie Evolution



The Financial Crisis



The Methodology: Influence Index

- **Generalization:** from control to influence
- **Influence Index** ξ_i per node: value in USD of indirect portfolio
- **Cumulative Influence Index** ξ_S : no over-counting

Centrality and Influence

Network centrality measures:

- Eigenvector
- Hubbell
- Bonacich

Variant:

$$\chi = W\chi + Wv \quad (1)$$

Hence:

$$\chi = (1 - W)^{-1} Wv \quad (2)$$

Portfolio Value and Influence

Direct:

$$p_i = \sum W_{ij} v_j \quad (3)$$

Indirect:

$$\hat{p}_i = \sum W_{ij} W_{jk} v_k + \dots \quad (4)$$

Influence Index:

$$\xi_i := p_i + \hat{p}_i \quad (5)$$

Influence Index and Centrality

$$\xi = p + \hat{p} = \sum_{n=1}^{\infty} W^n v \quad (6)$$

Observe:

$$(1 - W)^{-1} W = \sum_{n=1}^{\infty} W^n \quad (7)$$

Proving:

$$\xi = \chi \quad (8)$$

Problem with Cycles

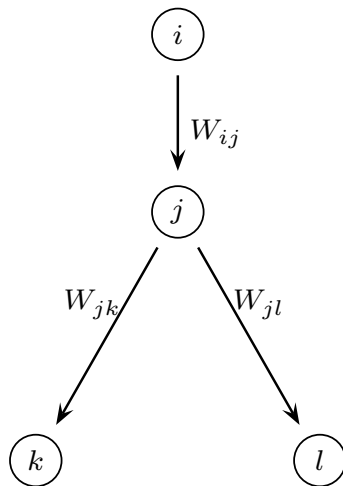
Algorithm 2 $\mathcal{CD}(r, \hat{w}, \xi)$

```

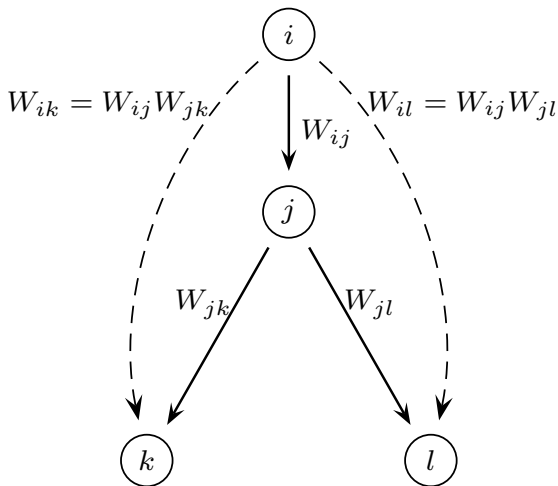
1:  $s \leftarrow$  end node of  $r$ 
2: if  $s$  active then
3:   return  $\xi$ 
4: end if
5:  $v_s \leftarrow$  value of  $s$ 
6:  $w_r \leftarrow$  weight of  $r$ 
7:  $\bar{w} \leftarrow w_r \cdot \hat{w}$ 
8:  $\bar{\xi} \leftarrow \bar{w} \cdot v_s$ 
9:  $\hat{\xi} \leftarrow \bar{\xi} + \xi$ 
10: activate  $s$ 
11: if  $s$  has no outgoing relationships then
12:   deactivate  $s$ 
13:   return  $\hat{\xi}$ 
14: end if
15: for all relationships  $\hat{r}$  in set of all outgoing relationships of  $s$  do
16:    $\hat{\xi} \leftarrow \mathcal{CD}(\hat{r}, \bar{w}, \hat{\xi})$ 
17: end for
18: deactivate  $s$ 
19: return  $\hat{\xi}$ 

```

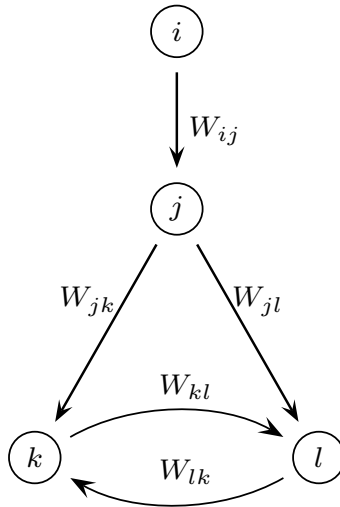
The Methodology: Computation



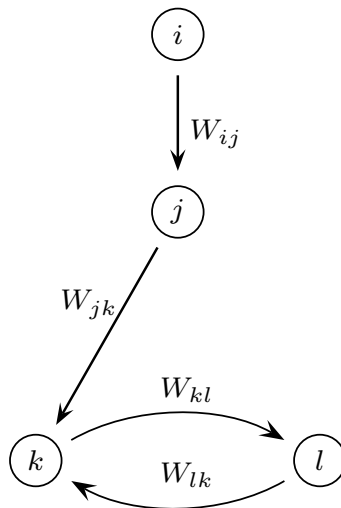
The Methodology: Computation



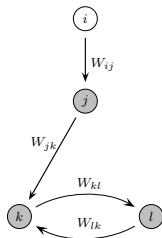
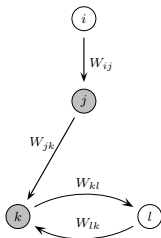
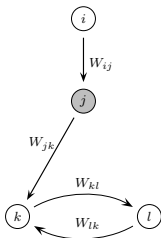
The Methodology: Computation



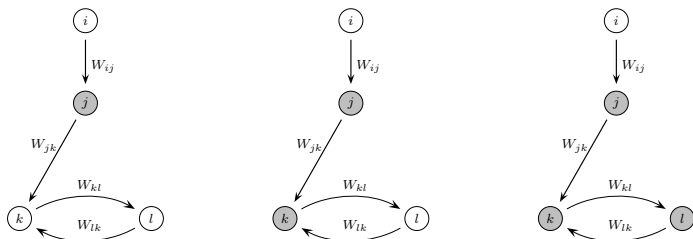
The Methodology: Computation



The Methodology: Computation



The Methodology: Computation



Influence Index:

$$\begin{aligned} \xi_i := & W_{ij} v_j + \\ & (W_{ij} W_{jk} v_k + W_{ij} W_{jk} W_{kl} v_l) + \\ & (W_{ij} W_{jl} v_l + W_{ij} W_{jl} W_{lk} v_k) \end{aligned}$$

Direct Value vs. Influence

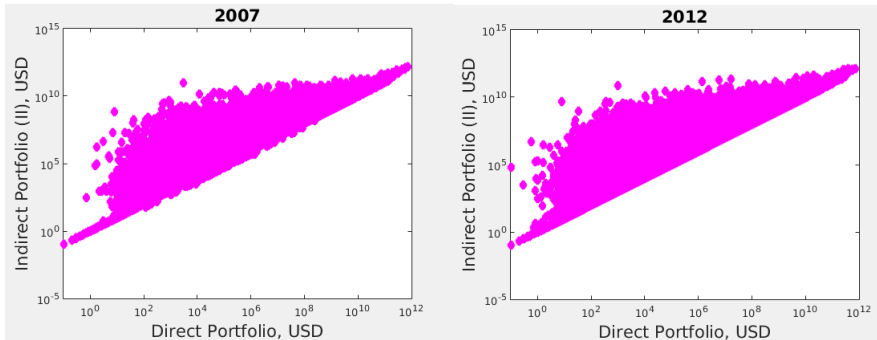


Figure : Correlation: direct portfolio value vs. total portfolio value (ξ).

Leverage

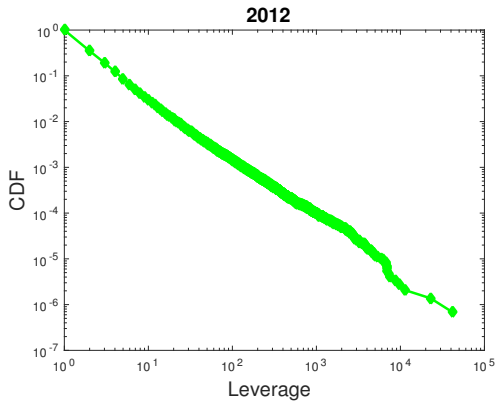


Figure : CDF of the leverage of the firms in 2012.

Results: The Ranking

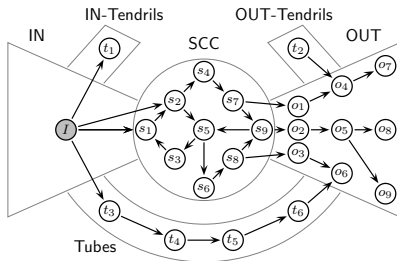
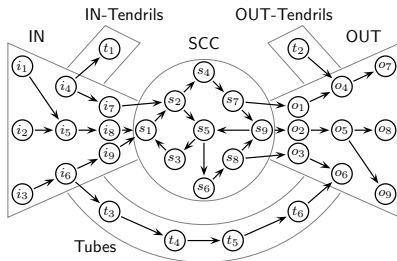
2007

		ξ_i (T USD)
Barclays PLC	GB	1.45
Capital Group Companies	US	1.32
AXA	FR	0.95
FMR LLC	US	0.94
JPMorgan Chase & Co	US	0.82

2012

		ξ_i (T USD)
BlackRock Inc	US	2.18
Vanguard Group	US	1.31
Government of Norway	NO	1.22
SASAC	CN	1.21
Capital Group Companies	US	1.20

Interlude: Cumulative Influence Index



Power-Structures

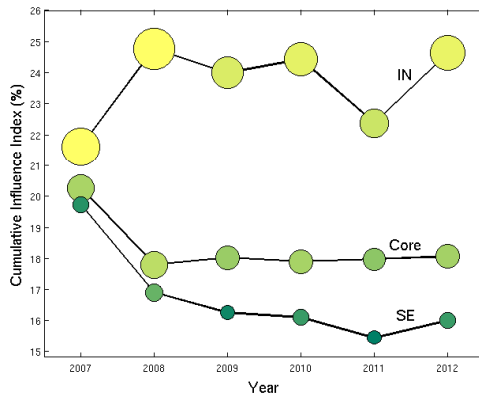


Figure : Color represents ξ_i per node, the darker the higher the value; size represents number of nodes.

Summary

The Network of Global Shareholder Influence

- Topology:
 - bow-tie with tiny core;
 - structural stability.
- Influence:
 - centrality;
 - no problem with cycles;
 - efficient algorithm; measured in USD;
 - cumulative version.
- Function:
 - core comprised of most influential actors;
 - structural resilience.

DebtRank

Systemic Risk

Levels of systemic risk:

- Too **big** to fail
- Too **connected** to fail
- Too **central** to fail

In the data: Wells Fargo & Co. same systemic risk as Citigroup, with 1/4 of assets

Systemic Risk

Standard economic understanding of diversification (local view):

- **High connectivity** → risk sharing → **stability**

Network approach (bird's-eye view):

- **High connectivity** → propagation of shocks → **systemic crisis**

Real-world systems:

- Feedback loops and amplification
- Threshold effect: knife-edge properties
- Endogenous shocks
- Complex systems approach: simulation

DebtRank

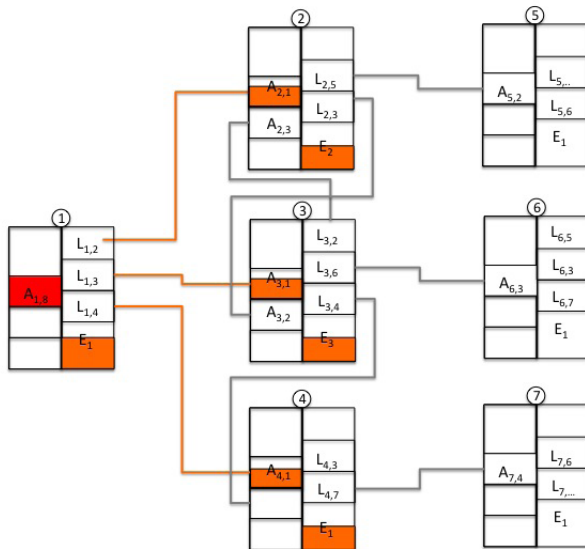
Data

- **FED emergency loans** for global financial institutions during 2008 — 2010: USD 1.2 trillion
- Analysis of **22 financial institutions** that received most of the funds
- Same TNC ownership data from 2007

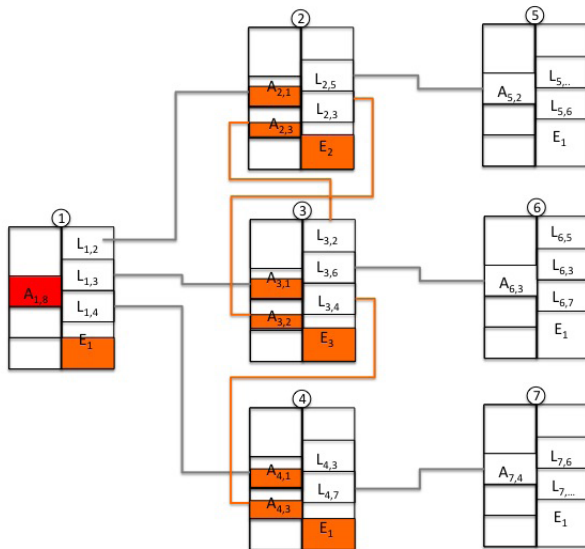
Methodology:

- Inspired by PageRank and Network Control
- “I am important if my neighbors are important”
- Measure of economic value that is destroyed if bank defaults
- Impact on balance sheets
- Higher-order effects

Example



Example



Results

Before peak of the crisis

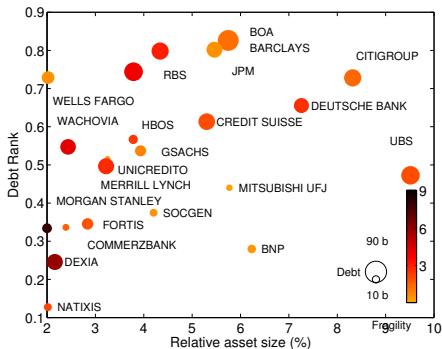
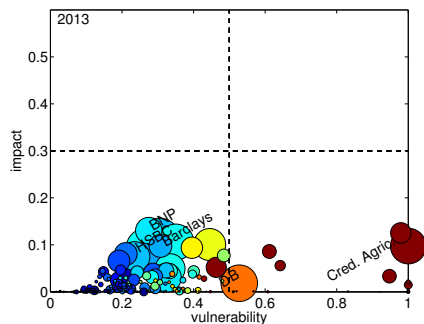
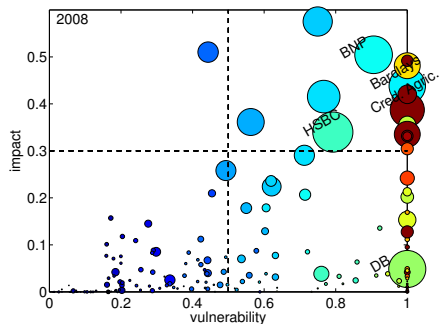


Figure : Size proportional to outstanding debt; color reflects fragility (ratio of debt over market capitalization).

DebtRank 0.5 = impact on 50% of economic value in network

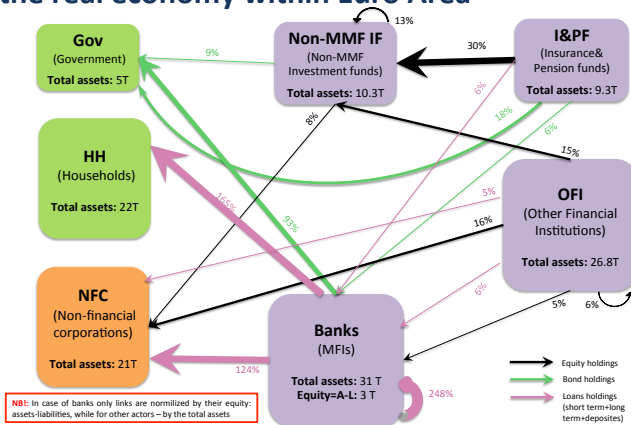
Results



Disentangling

Results

Indirect paths from financial institutions to the real economy within Euro Area



Quellen



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