BANQUE DE FRANCE
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The topography of the European CDS market: implications for contagion risk

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References

- Clerc, Gabrieli, Kern, el Omari (2013): the topography of the European CDS market and its implications for contagion risks, Banque de France-ESMA, mimeo.

- Brunnermeier, M., Clerc, L. and Scheicher M.(2013): “Assessing contagion risks in the CDS market”, BdFFinancial Stability Review, N°17, April.

- ESRB report on CDS, directed by M. Brunnermeier and L. Clerc, ESRB Occasional Paper Series, N°4, September 2013.

1- Interconnections on the CDS market

- Context: ESRB Expert Group on CDS
- Access to data collected by Trade repositories
- Mandate of this group: (1) Data issues (ESMA), (2) Scope for contagion (3) On-going regulation and new regulatory initiatives
- main market characteristics & developments over time
- Potential for contagion in CDS networks
  - Structure of the networks of CDS exposures: patterns & structural changes
  - Identification of key market players using centrality metrics
  - Financial resiliency of the potential “super-spreaders”

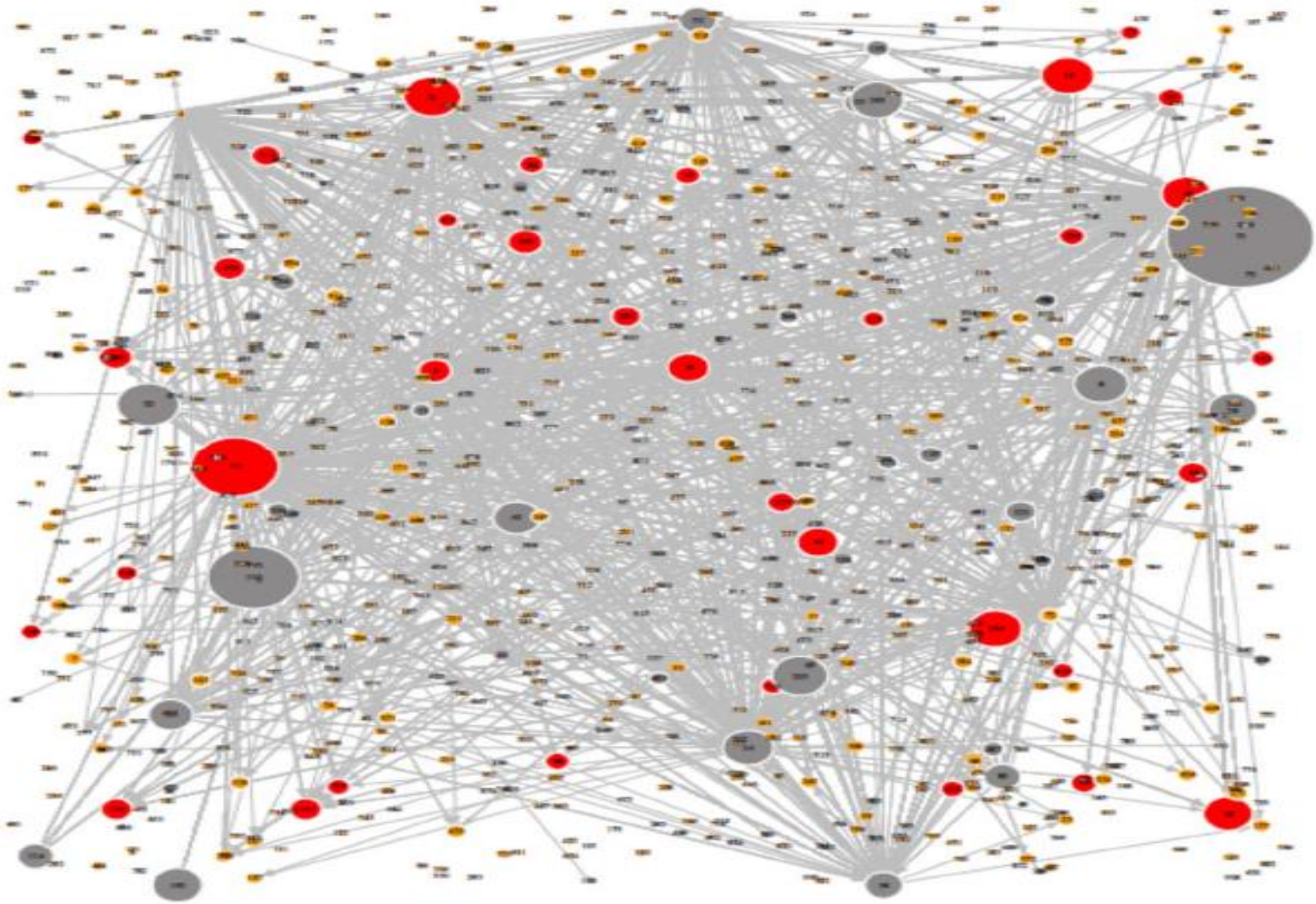
What is a CDS?

- A Credit Default Swap is a derivative financial instrument used to hedge against the default risk of a given reference entity (whose debt is the underlying asset)
  - Buyer holds the insurance, seller takes the risk. Buyer receives a positive pay-out if a credit event occurs & pays periodic premiums to seller in return

- Main characteristics
  - CDS are traded **OTC**
  - Pay-offs are **highly asymmetric** and asymmetry increases in times of stress
  - A contract can end in several ways (besides a credit event)
    - Novation, compression cycles, early termination clauses
  - The most common way is to enter into an "offsetting deal" with another trader

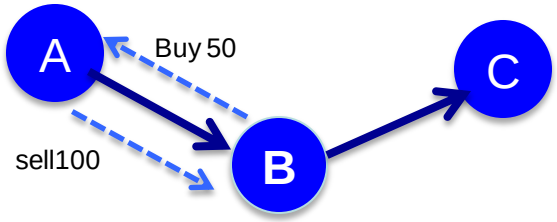
    ➔ **offsetting deals create networks of CDS exposures**

How complex is the network of exposures?



What do we do to analyze interconnections?

- Exploratory analysis of the structure of the networks of credit exposures determined by trades of single name CDSs on **EU reference entities** (or involving at least one EU party as seller/buyer)
  - Data= **notional** values of CDS positions outstanding on each week Friday as recorded in DTCC. **Parties are anonymous**
  - CDS market participants are the *nodes;* net bilateral exposures form directed *links*



- We study time series of weekly network metrics – at system & at node level
  - 213 directed networks from January 4, 2008 to January 27, 2012
  - Four different network representations: three "sectoral" (**Financials, Non-Financials, Sovereigns**), one overall network – **all CDS positions** included

What do we do?

- Rank institutions that are possible *super-spreaders*, explore correlations, variation of rankings over time, and try to single out non-dealer/non-bank players

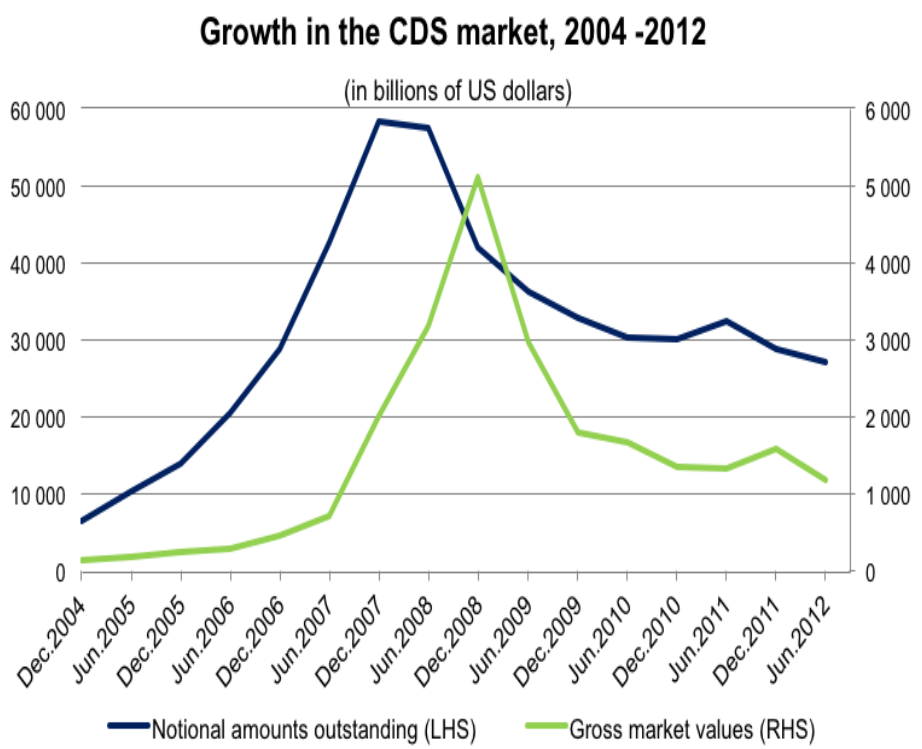
- Match banks' CDS exposures to balance sheet items to assess their financial resilience

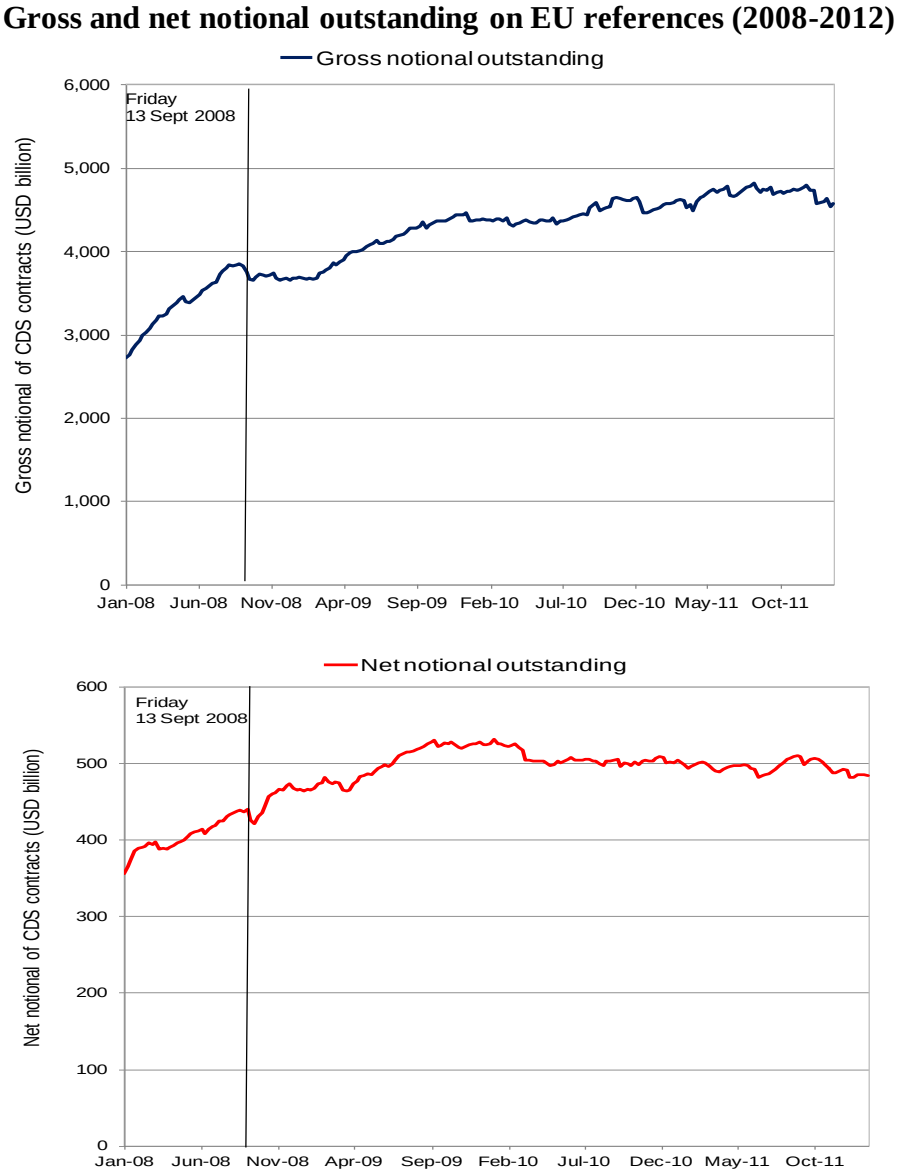
- Caveat: we focus on counterparty risk!
  - Why **aggregate** market representations?
    - Our main interest is the default of participants, not of ref entities. Consistent with the outcome of current market practices & risk-mitigation mechanisms (e.g. *close-out netting*)
  - Why **notional & net** amounts?
    - Net notional values represent the **max possible net fund transfer** between net sellers & net buyers of protection that could be required upon occurrence of a credit event
  - **Limits** for a throughout analysis of risks in CDS positions / no data yet on collateral

Related literature

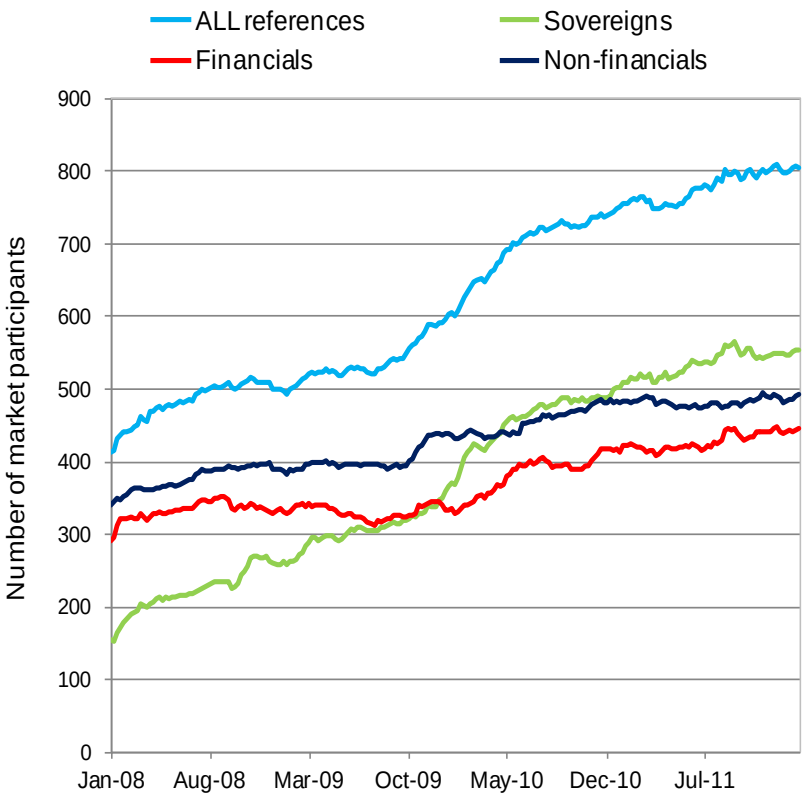
- Lack of data, limited literature so far on CDS networks
  - Markose et al (2012)
- Recent network models of CDS contagion
  - Heise and Khun (2012) : corporates & financials
  - **Guillemey and Peltonen** (2012): study SOV default & spillovers to EU banks. Use both CDS positions & portfolios of underlying credit exp., allow for risk mitigation. Model calibration using 2011 data on EU capital exercise shows relatively minor role of CDS exp. for contagion *versus* **major role** of **sudden increases** in collateral requirements on multiple correlated exp. and **risk mitigating mechanisms**
- More similar to approach
  - Brunetti and Gordy (2012): network topology analysis of CDS market for US ref. entities. Similar results but the only work on two “snapshots” of data (2 days in 2010): not published but referred to by Yellen (2013)

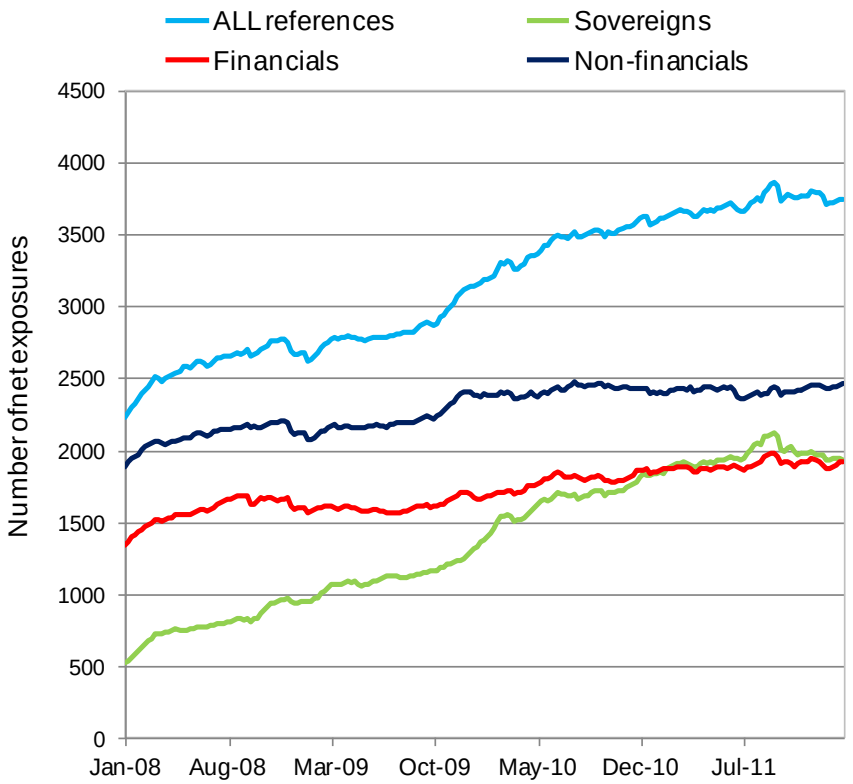
Main market developments



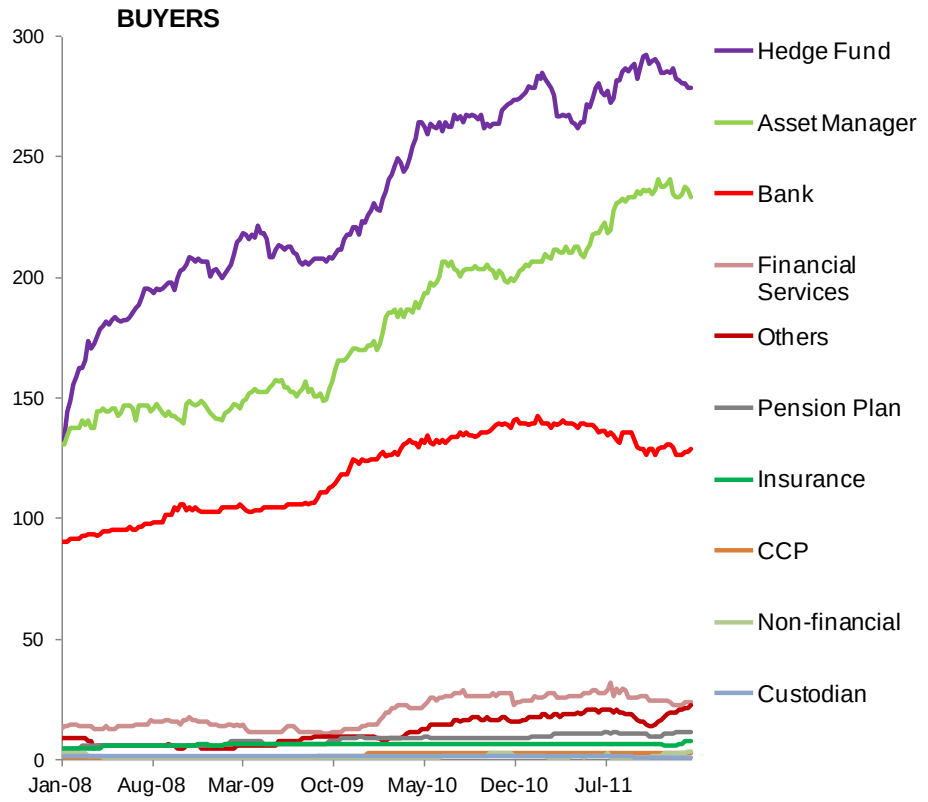


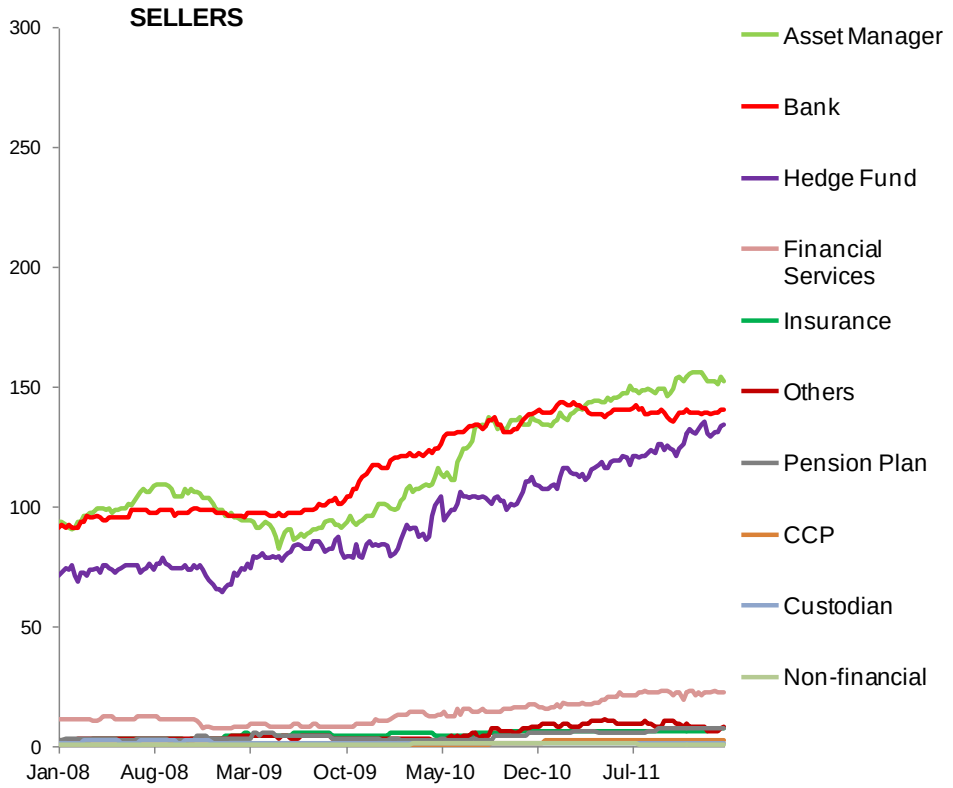
Network analysis: order & size





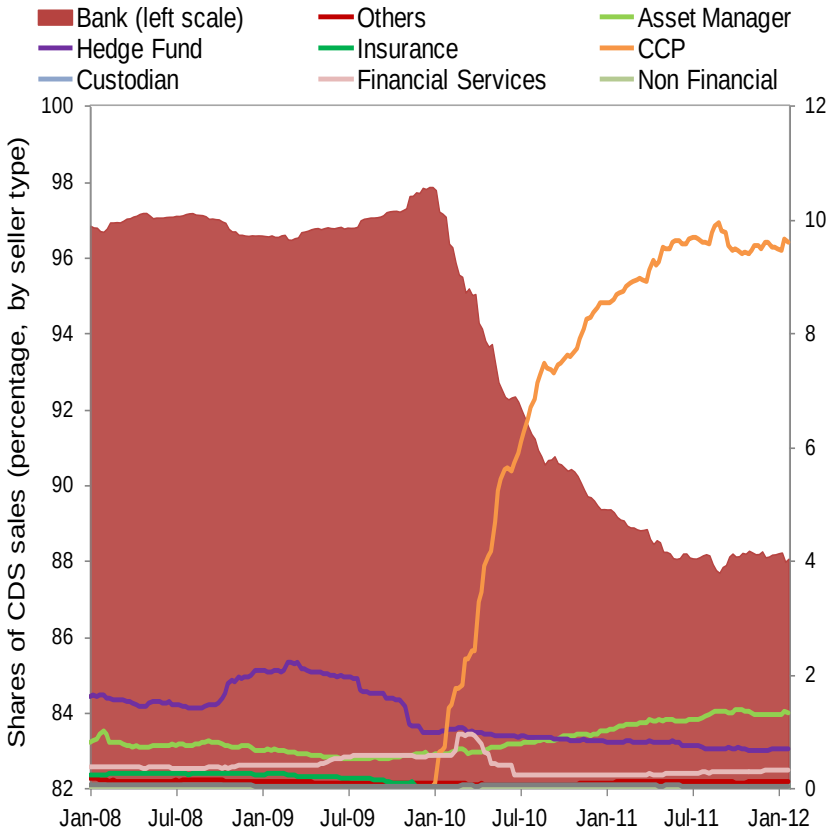
Market participants – number, by type

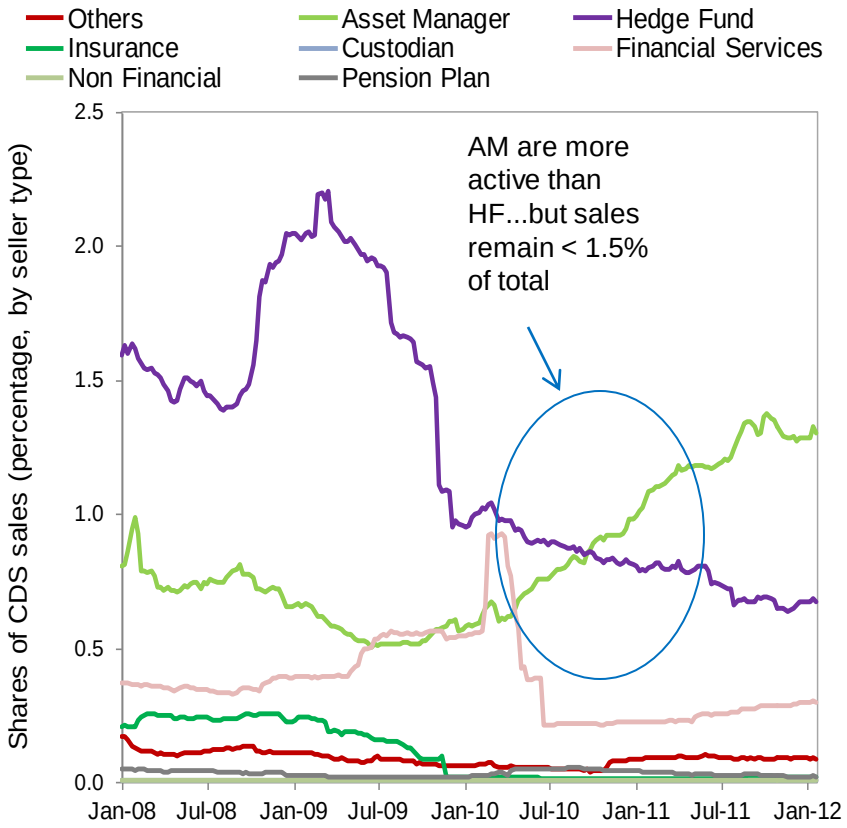




Hedge funds represent 40% of the total number of buyers in 2012, **asset managers 33%**, **banks 18%.** The remaining 10% is made up of FS,10 pension plans, 7 insurance companies. Two CCPs appear since Sept and Dec 2009. **On the sell side, it is again** HF, AM, and banks **that dominate the market, each with a share of 30%**

Market participants: Market shares





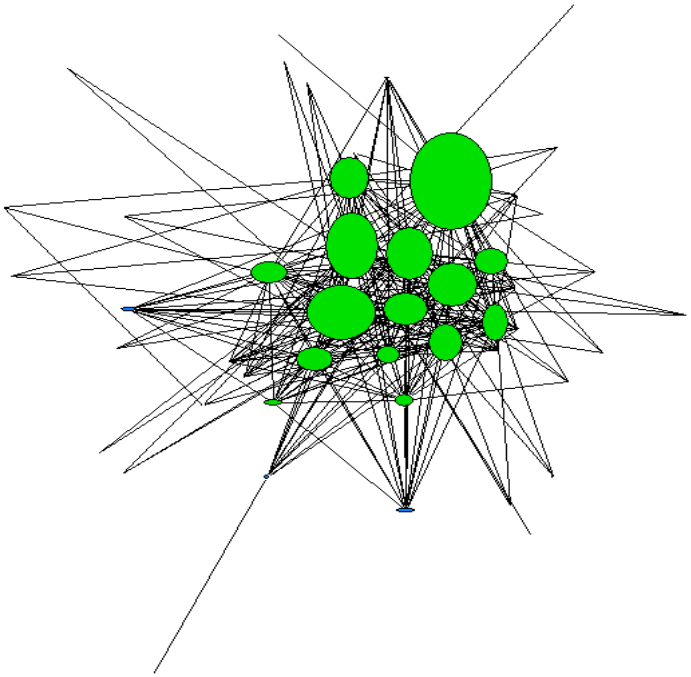
Network analysis: a short intro

- A network is defined by two sets: $N = \{1,\ldots, n\}$, the set of *nodes*, and L the set of ordered pairs of elements (i,j) called *links* that connect the nodes
  - Net bilateral buyers or sellers are the nodes; a *directed* link is defined if an institution is a net buyer of protection from another. Each link has a *weight* (w_{ij}), given by the size of the net bilateral position of the net seller vis-à-vis net buyer

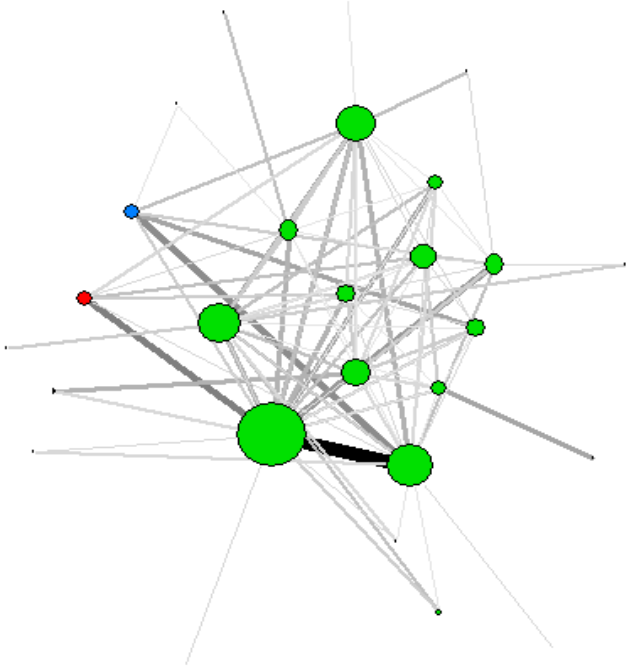
- A network may be represented by its adjacency matrix $G(g) = \{g_{ij}\}$, i.e. the N-square matrix that keeps track of directed links
  - If a node i has a direct link to node j then $g_{ij} = 1$; $g_{ij} = 0$ otherwise
  - If i and j are not directly linked, i.e. $g_{ij} = 0$, they may nonetheless be connected if there is a *path* from i to j. A path is an ordered sequence of nodes $[i_0, i_1, \ldots, i_k]$ starting from i and terminating at j (i.e. $i_0 = i$ and $i_k = j$) such that = 1 for all $0 < s < k-1$
  - We also consider the weighted adjacency matrix $W(g) = \{w_{ij}\}$

Network visualisation – EU sovereigns

CDS network on EU SOV on 27.1.2012
182 nodes & 716 links; links>USD 100 million



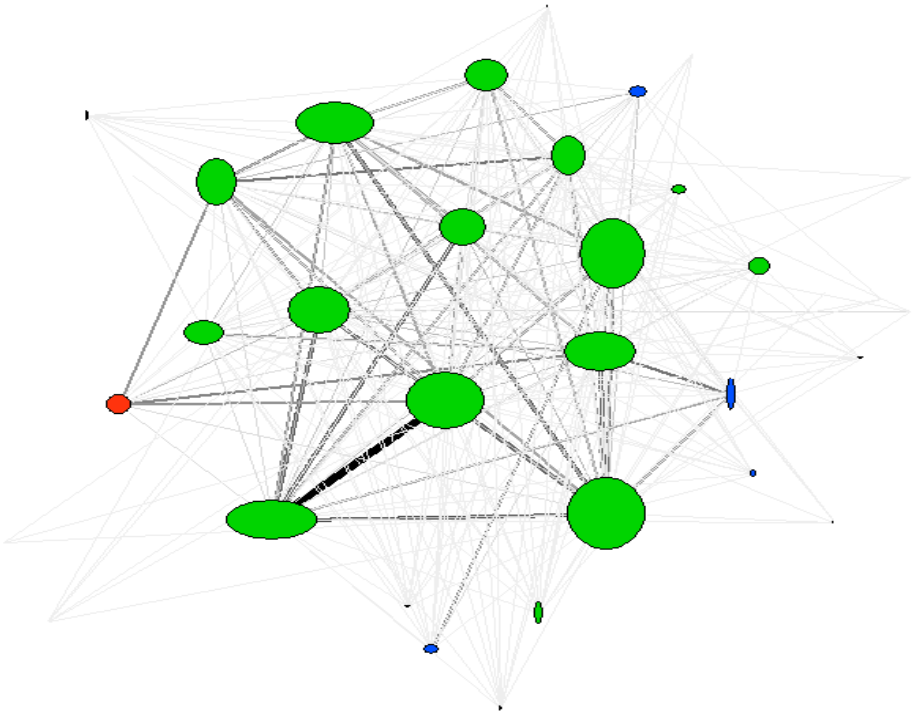
***Core* CDS network on EU SOV on 27.1.2012**
27 nodes & 104 links; links>USD 1 billion



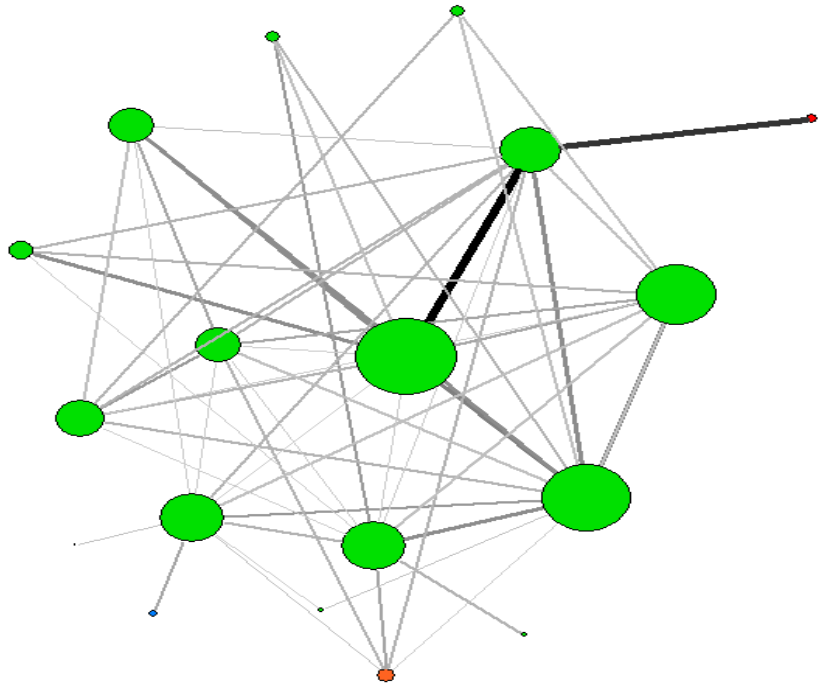
The size of the firms is proportional to their activity: **15 bank-dealers stand out**, exposed for more than USD 3bn as sellers & as buyers; **most institutions cannot be distinguished**. Zooming into the ***core*** (104 largest net bilateral exp, i.e. 45% of tot notional outstanding) we can single out the **G15** (green), a non-dealer (blue), and a non-dealer/ non-bank (red). The largest exp is between 2 dealers; 2nd & 3rd largest link an AM and a bank to two dealers

Network visualisation – EU financials

CDS network on EU FIN on 27.1.2012
87 nodes & 495 links; links>USD 100 million

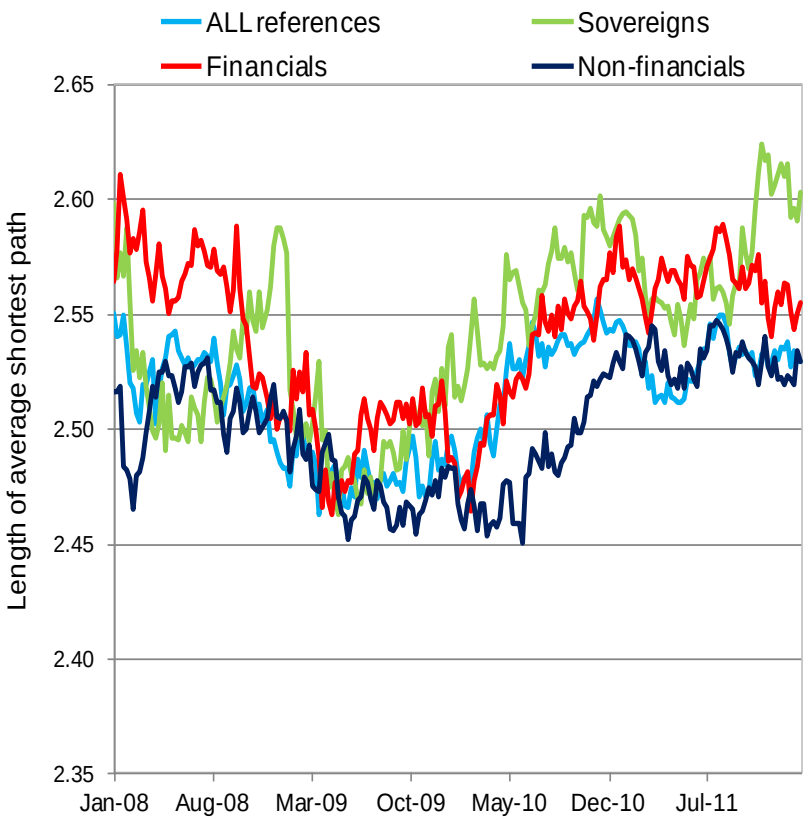


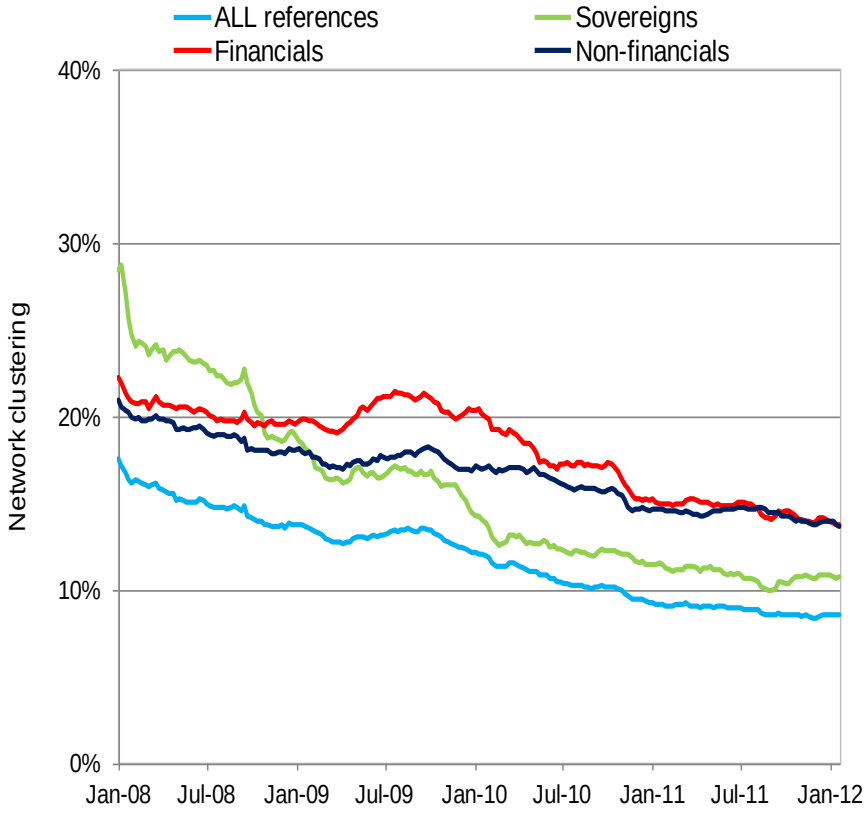
***Core* CDS network on EU FIN on 27.1.2012**
18 nodes & 61 links; links>USD 1 billion



The FIN network is 2 times more connected than the SOV ➔ SOV network is much more concentrated. **G15 dealers** stand out as **most prominent players**. Some are more active on the sell-side (longer), some on the buy-side (wider). Some non-dealer banks are visible (blue), and one CCP (orange, with rounded shape). The ***core*** network (61 largest net bilateral exp) shows large variation across major dealers.

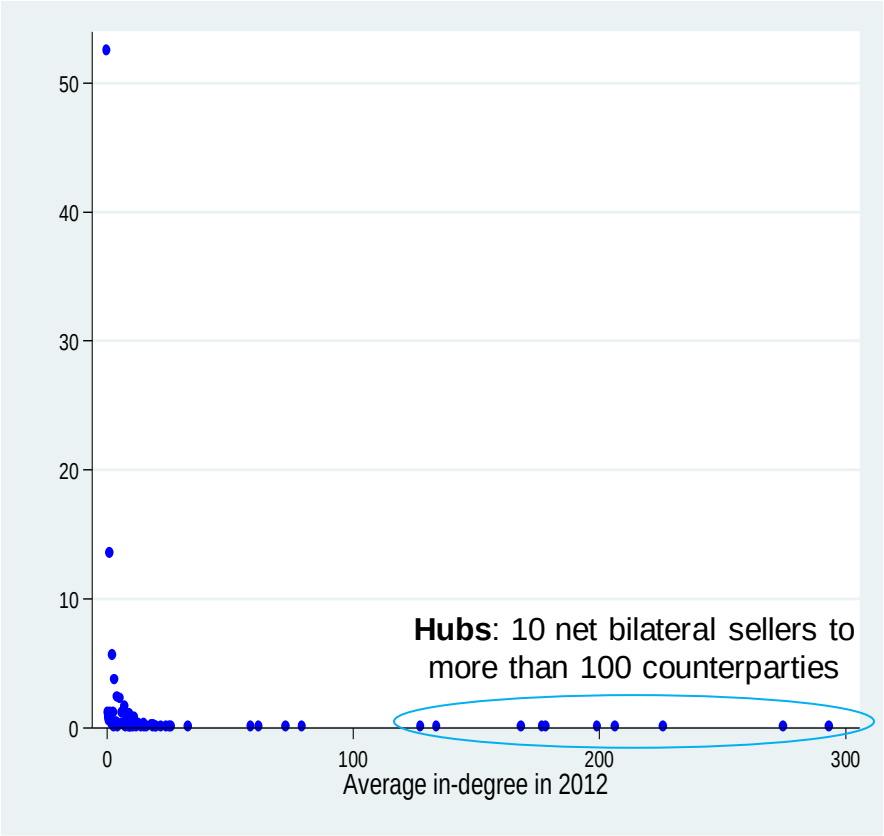
Network analysis: distance & clustering

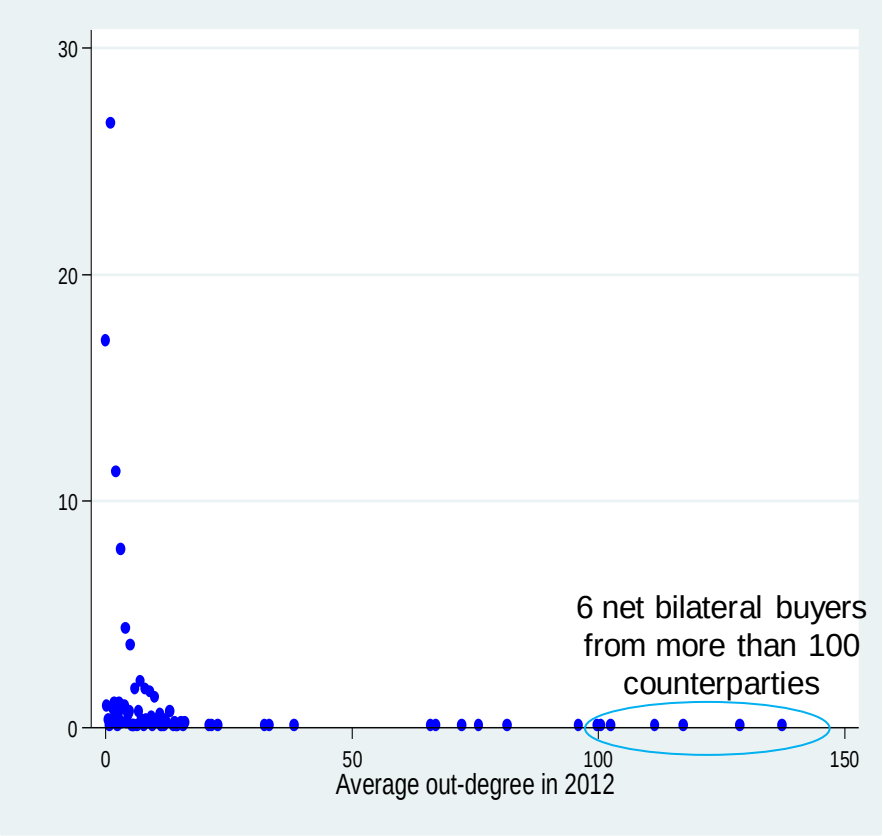




The average distance between any pair of firms was of 2.51 links (± 0.02) and the diameter of 5 ➔ **CDS networks are highly compact, shocks can rapidly transmit even to the "farthest away" participant.**

Network analysis: in- and out-degree

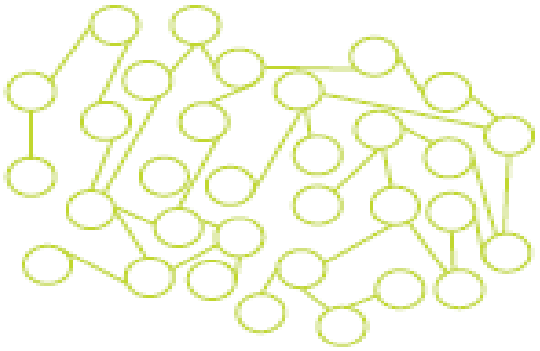




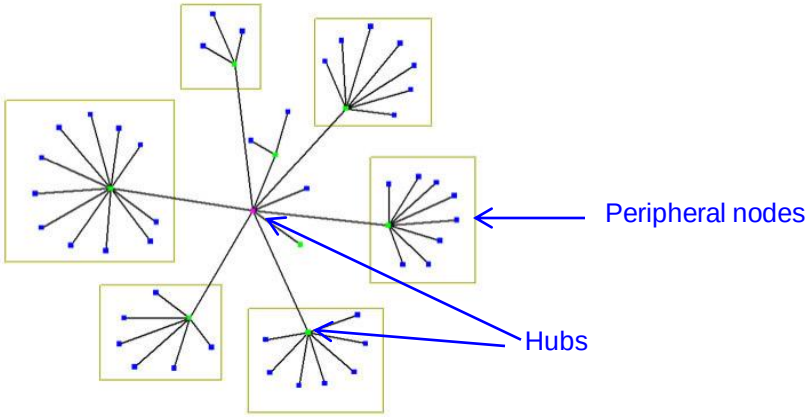
Left: **few nodes-*hubs* sell protection to many** participants, **most nodes to few**. Right: **most buyers buy from few net sellers**; few buyers buy from many.

How stable is the network?

Random network



Scale free network



degree correlation & fit to a power law (α)

	(USD EQ)	α	Kolmogorov-Smirnoff test statistics	Results	Size of the tail	Size in %
Jan-08	460,000,000	1.60	0.0710	fail to reject	68/223	30%
Jan-09	884,718,544	1.62	0.1075	fail to reject	56/213	26%
Jan-10	513,575,000	1.55	0.0870	fail to reject	71/259	27%
Jan-11	123,024,009	1.48	0.0593	fail to reject	123/327	38%
Jan-12	163,500,000	1.53	0.0611	fail to reject	124/366	34%

w_{ij}

Results of Kolgomorov and Smirnov test of goodness-of-fit to a theoretical power law (α): $P(k) \sim k^{-\alpha}$ 1.5 < α < 3, for large values of *k*

Network analysis: **in sum**…

- The analysis suggests that CDS exposures trace “scale-free” networks: net sellers are the *hubs*

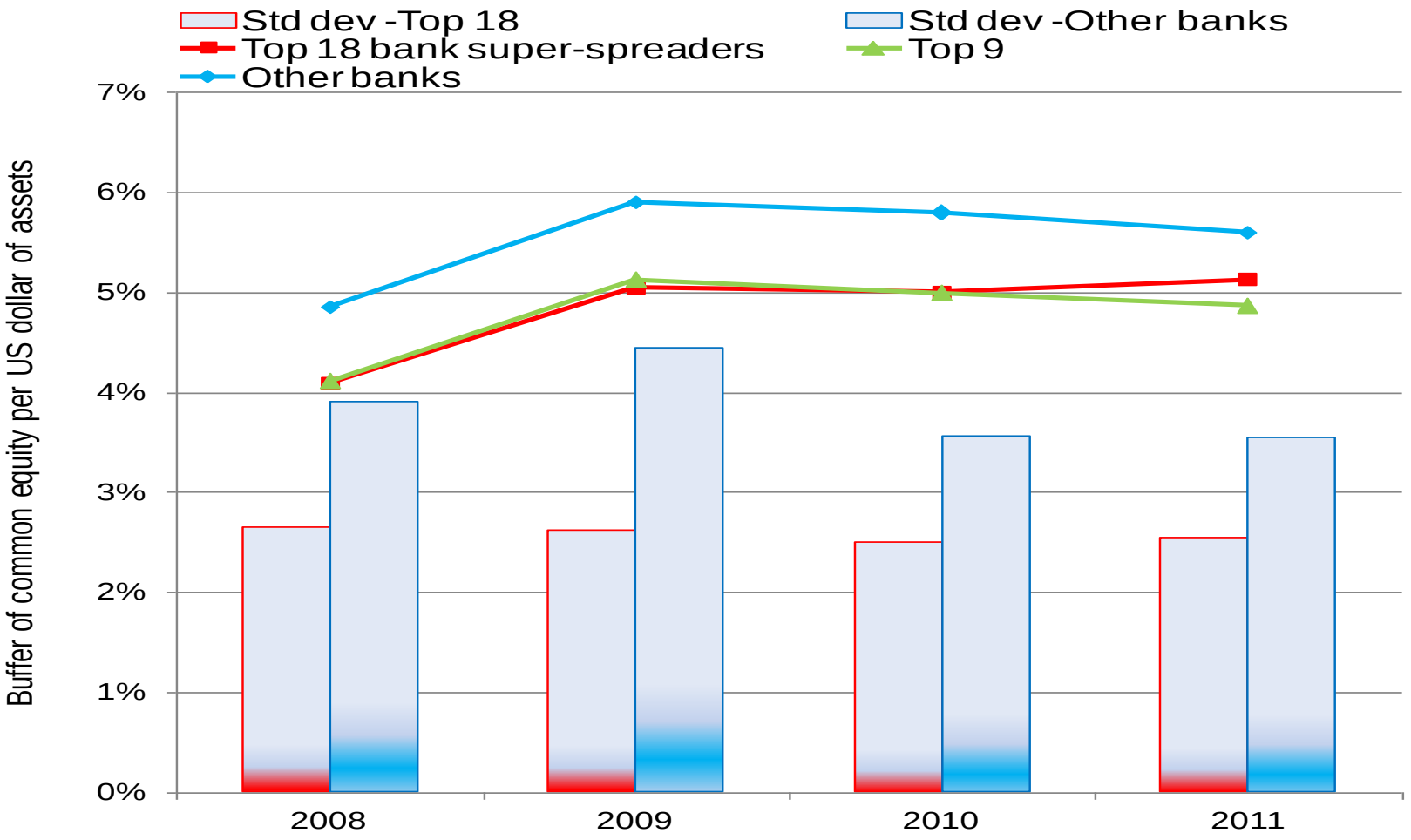
- Scale-free property strongly correlates with network robustness to failure. A hierarchical structure allows for *fault tolerant* behaviour
  - **If failures occur at random** and the vast majority of nodes are those with few counterparties, the probability that a *hub* will be affected is almost negligible. Even in case of hub-failure, the network will remain connected thanks to remaining hubs
  - However, in case **a shock hits few major hubs together**, the network could possibly lose its connectedness hence its capacity to function

- *Robust-yet-fragile* property of complex networks ➔ ensuring safety of the hubs ensures safety of the system

Who are the “Super-spreaders”?

Rank 2011	Largest net bilateral CDS sellers		Largest net bilateral CDS buyers		Largest net multilateral CDS sellers	
	Ranking	Expo./TCE	Ranking	Expo./TCE	Ranking	Expo./TCE
1	Bank 312*	45%	Bank 497*	67%	Bank 312*	44%
2	Bank 622*	23%	Bank 356*	63%	AM 860	N.A.
3	Bank 765*	56%	Bank 317*	94%	Bank 821	66%
4	Bank 497*	41%	Bank 765*	53%	Bank 186*	17%
5	Bank 1045*	48%	Bank 622*	15%	Bank 622*	8%
6	Bank 1172*	41%	Bank 148*	28%	HF 508	N.A.
7	Bank 186*	26%	Bank 276*	13%	Bank 656	65%
8	Bank 148*	23%	Bank 136*	10%	Bank 389	90%
9	Bank 317*	55%	Bank 1172*	38%	Bank 1045*	12%
10	Bank 136*	9%	Bank 1045*	36%	Bank 627	N.A.
11	AM 860	N.A.	Bank 954*	13%	AM 104	N.A.
12	Bank 356*	24%	CCP 565	N.A.	Bank 1176*	12%
13	Bank 821	66%	Bank 553*	7%	Bank 412	18%
14	Bank 553*	8%	Bank 289	32%	Bank 553*	1%
15	Bank 276*	7%	Bank 186*	9%	Bank 804	8%
16	CCP 565	N.A.	Bank 1176*	20%	FS 920	N.A.
17	Bank 954*	10%	Bank 782	19%	FS 1075	N.A.
18	HF 508	N.A.	Bank 804	15%	Bank 765*	3%
19	Bank 1176*	32%	Bank 304	N.A.	Bank 1172*	3%
20	Bank 656	67%	AM 873	N.A.	Bank 628	N.A.

Super-spreaders & financial stability



How do network statistics correlate with market price information?

Table 10: Correlations between market-price and exposure-based measures

(06 Jan 2012)	Eigenvector	Betweenness	Exposure	Indegree
Contr-CoVaR	0.542	0.545	0.688	0.635
Exp-CoVaR	0.031	-0.069	0.106	-0.013
Contr-CoCDS	0.043	-0.277	0.048	-0.300
Exp-CoCDS	-0.184	-0.247	-0.214	-0.305
CDS-val	-0.237	-0.312	-0.204	-0.330
MES-val	0.138	-0.089	0.251	-0.013
Rel. Cap.shortfall	0.639	0.583	0.712	0.643
Market-val	0.107	0.266	0.202	0.220
(08 Jan 2010)	Eigenvector	Betweenness	Exposure	Indegree
Contr-CoVaR	0.118	-0.086	0.105	0.016
Exp-CoVaR	0.174	-0.088	0.093	0.030
Contr-CoCDS	0.012	-0.412	-0.138	-0.294
Exp-CoCDS	-0.060	-0.344	-0.200	-0.243
CDS-val	-0.233	-0.220	-0.269	-0.266
MES-val	0.130	0.070	0.076	0.086
Rel. Cap.shortfall	0.579	0.216	0.704	0.623
Market-val	0.245	0.273	0.371	0.369

2/ Main insights from a contagion model

Five transmission channels from sovereign to banks are featured in the model:

1. direct losses on sovereign bond holdings
2. write-downs on other (AFS) sovereign exposures;
3. direct CDS repayments triggered by the credit event;
4. increased collateral requirements to cope with higher CDS spreads on other non-defaulted reference entities;
5. contagious propagation of counterparty failures.

Calibration made using public data released by the European Banking Authority (EBA) on 65 major European banks related to the EU 2011 Capital Exercise.

The dataset includes both sovereign bond and CDS holdings at a bank level for 28 European sovereign entities, while bilateral CDS exposures are estimated and their market values simulated. Additional balance sheet data are retrieved from Bloomberg. Exogenous sovereign default scenarios are studied for four stressed euro area countries (Italy, Ireland, Spain, Portugal) for a wide range of recovery rates.

Assessing contagion risk from the CDS market

Main results tend to show:

1/ the damage caused by the failure of a sovereign depends crucially on the recovery rate.

2/ the main source of failures and contagion is due to direct losses on sovereign bond holdings

3/ Significant losses arise due to write-downs on other (AFS) sovereign exposures

4/ liquidity shocks arising from increased collateral requirements to cope with higher CDS spreads on other non-defaulted reference entities are the third significant channel of default

5/ direct CDS repayments triggered by the credit event are usually rather small and unlikely to cause major breakdown

Main conclusions (1/2)

- Our analysis points to the role of large & very interconnected net sellers as *hubs* ➔ *primary locus of systemic counterparty risk*

- The mean size of individual exposures & non-local network metrics point to some non-dealer/non-bank (AM, HF) as possible super-spreaders

- Match of CDS positions with balance sheet items allows to spot very high ratios of exposures/TCE

Main conclusions (2/2)

- Our analysis suggests
  - Importance of regular monitoring of outstanding positions through collection of TR data
  - Hubs are the weakness & the strength of the networks!
  - **Ensuring their safety** is crucial to ensure system stability
- Going forward…
  - Look at other network representations
  - Risk-weighted networks
  - Other quality issues!
  - More generally, need for **holistic view** of exposures to properly assess contagion