What the network of bank security cross-positions can tell us about the evolution of the banking structure

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Disclaimer: The views expressed are those of the author and do not necessarily reflect those of the Eurosystem

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Outline

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   - Leverage individual institutions' importance
2. Structural characteristics and data
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   - Measures of Association
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4. Measures of Financial Stability
   - Financial network leverage
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Perspective determines the chosen network's aptness

What system and which kind of interactions?

Financial networks represent complex *interactions* ultimately determining the financial system's propensity to *systemic* malfunction

$$\mathscr{D} = \{V, E, \mathbf{w}\}$$

Bank networks involve relations, importantly also reflecting directed transactions

- Fragility stems from a form of irreversibility of the exposures (maturity matters)
- Fragility from third party perceptions (e.g. covariation) goes beyond network (GE framework?)
- Having $\mathscr{D}$, fragility is still a function of (i) observable metric - topological *and* (ii) banks' reaction - contagion

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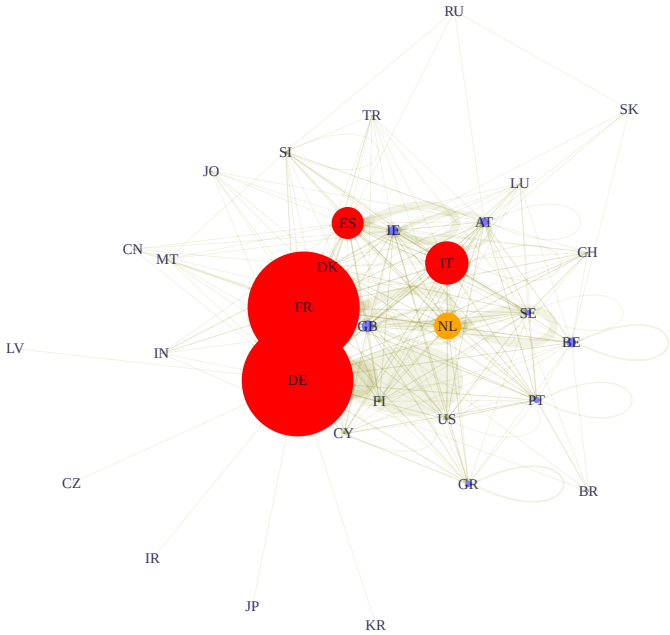
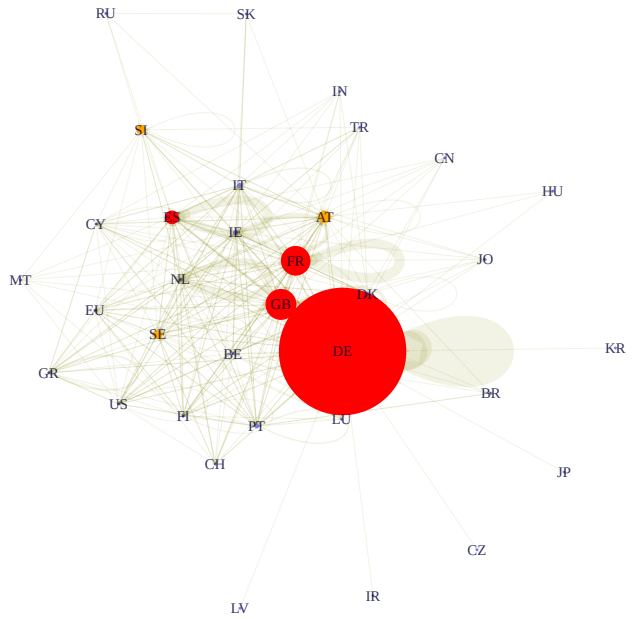
The choice of each aspect matters

Metrics determine how networks and their fragility to breakdowns are perceived



(a) Size



(b) Betweenness

Figure: The country-level securities network on 7 October 2009

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Financial networks are central to financial stability

The empirical analysis of networks is needed yet it is incomplete

- Networks provide information in addition to capital (e.g. Nier et al., 2007; Gauthier et al., 2010)
- Exposures known to be tiered and clustered, identifying important players (e.g. Boss et al., 2004; Puhr et al., 2012)
- Analyses focus on short term exposures, e.g. Kuo et al. (2013), or selected regions, e.g. Puhr et al. (2012)
- Support of early warning analysis is in its infancy, e.g. Minoiu et al. (2013)

A measure of network leverage or systemic stability is needed frequently pooling fragility of the financial network to key payers

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Policy makers voice the need of useful metrics

Concreteness needed in the policy debate on interconnectivity

Policy driven by foresight, yet implemented on concrete evidence

- Debate on mechanics has evolved, leading to the obvious question of which policy and when
- Discussion increasingly points at the need of metrics in shaping the policy on interconnectivity
- Results have to be clear and sensible, and recommendations manageable

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Source of the information

Collateral pledged at the ESCB for monetary policy operations

Operations are supported by collateral provided to the Eurosystem, which typically have a substantially larger volume than operations themselves, including securities issued by other banks

- Bank-issued securities pledged by monetary policy counterparties are (part of) their cross exposures
- Information held at the ISIN level, thus allowing very granular look at the type of exposure (e.g. maturity)
- Identification of the issuing bank made on the basis of ISIN information, and considered only if it can be identified as a counterparty (closed network)
- The data covered about 2/3 of large bank long term bilateral security exposures at end 2011

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Information's weakness and strength

Weighing coverage against frequency in network analysis

Information has key limitations . . .

- Information only available since late 2008 and limited to collateral posted (not holdings per se) - not available for longer term analysis (at the EA level)
- Comprises only marketable securities (Scope must be kept in mind when designing the analysis)

. . . yet it provides analytical value added vis-à-vis ad-hoc approaches

- Comes close to actual holdings, in particular those related to structural (longer-term) issues
- Available for a very large number of banks and on a weekly frequency (only a couple of days delay)

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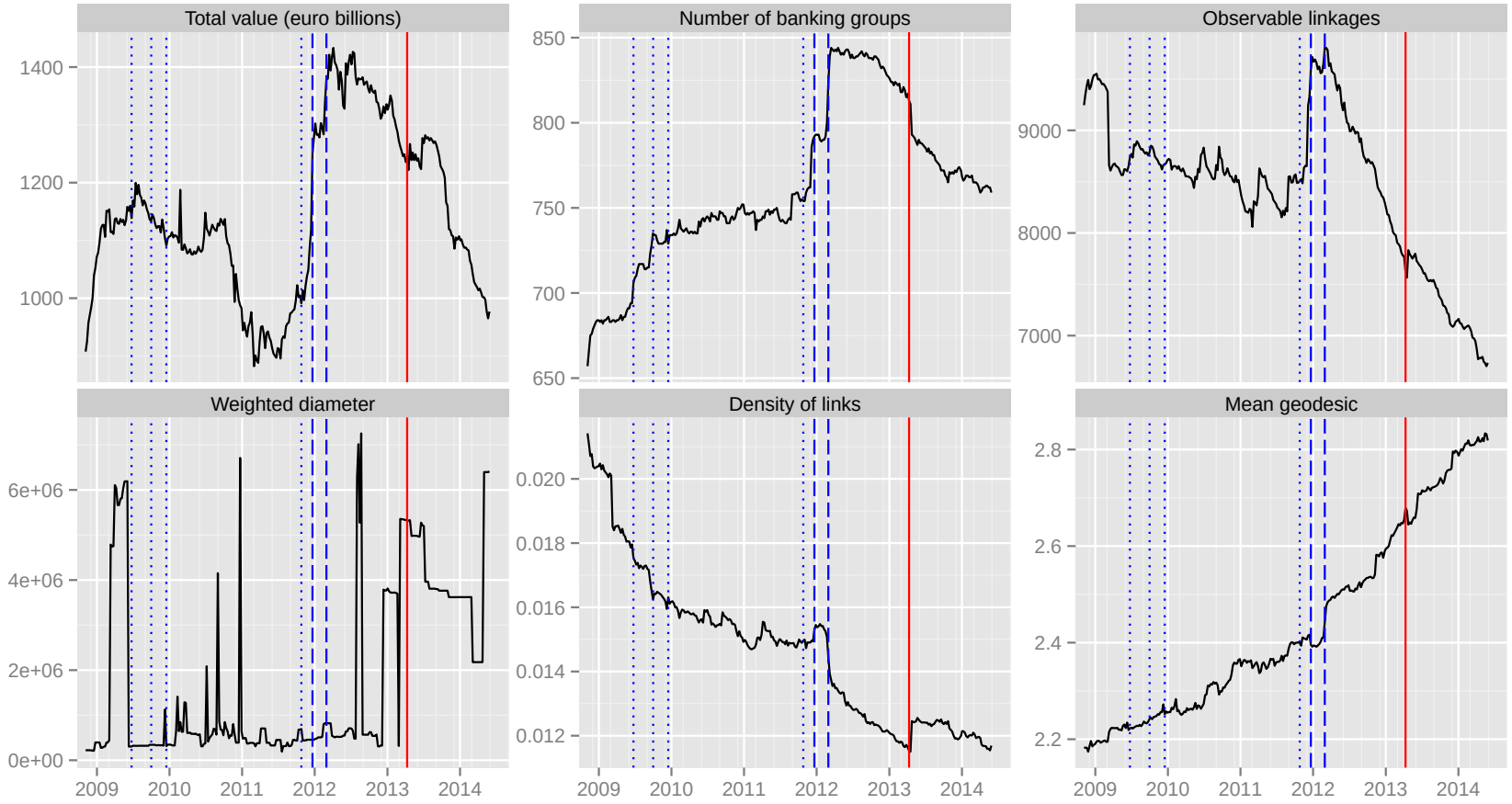
Evolution of the euro area interbank securities network

Descriptive (first row) and more analytical (second row) measures



Long term operations marked in blue and a technical discontinuity in asset backed securities in red

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Limits of the information for network analysis

Data limitations become less important, the more structural the analysis becomes

Usefulness increases with the depth of the analysis

- The limits of the information are evident for more descriptive statistics of exposures
- The network structure appears more robust to changes in the approximation to true exposures
- Network leverage least affected by "observability"

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The recent thinning of interconnectedness

Covariation networks suggest evolution can be important (e.g. Saldias and Craig, 2014)

Evidence of substantial network evolution over time

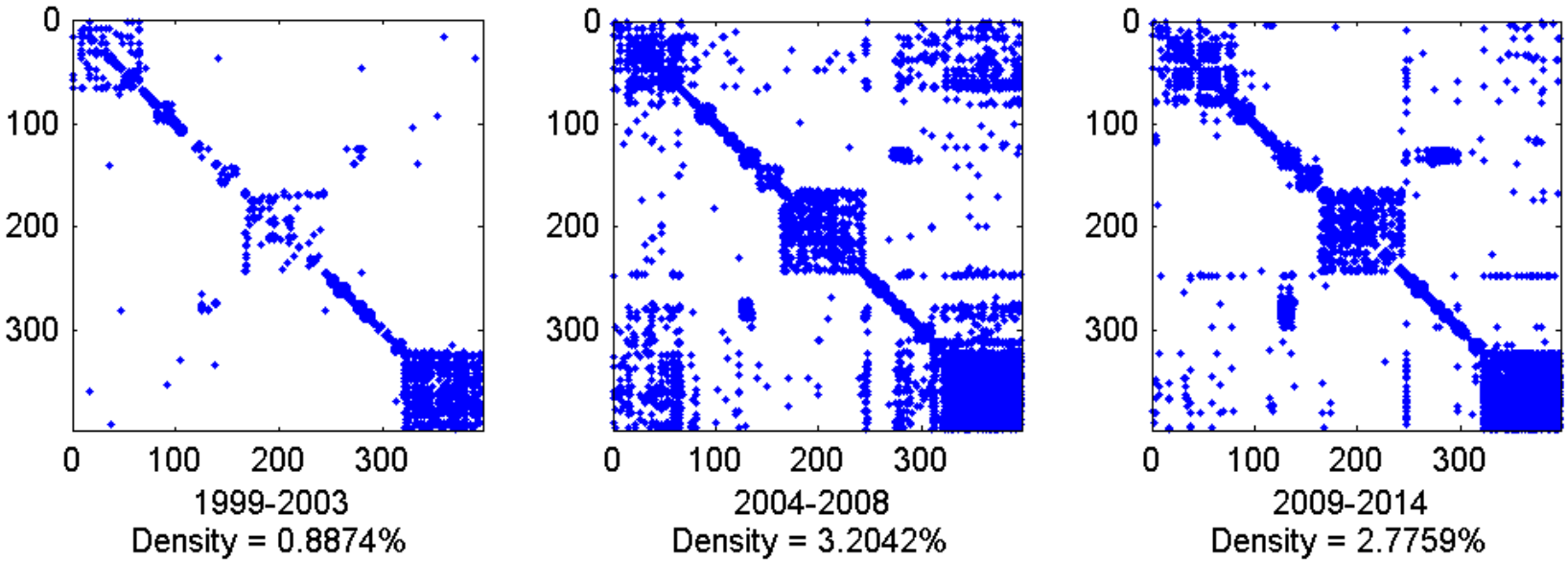

Figure: Bank network evolution - correlation relationship between 396 global banks over time (having filtered common factor effects and thinned not significant correlations)

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Bank association in the financial network

Systemic associativity in the financial network

measure	**relationship to systemic risk**
Size of largest clique	Larger, more integrated groups reflect greater flexibility and resilience to absorb shocks
Transitivity	Known as clustering, gauges established relations between banks and tends to decrease prior to economic crises
Reciprocity	Illustrates established bank relationships, whereby lower values represent more functional one-way financing
Assortativity	Specialisation in the provision of funds is represented by a negative value, whereby less negative values denote increasingly similar banks (less economic functionality)

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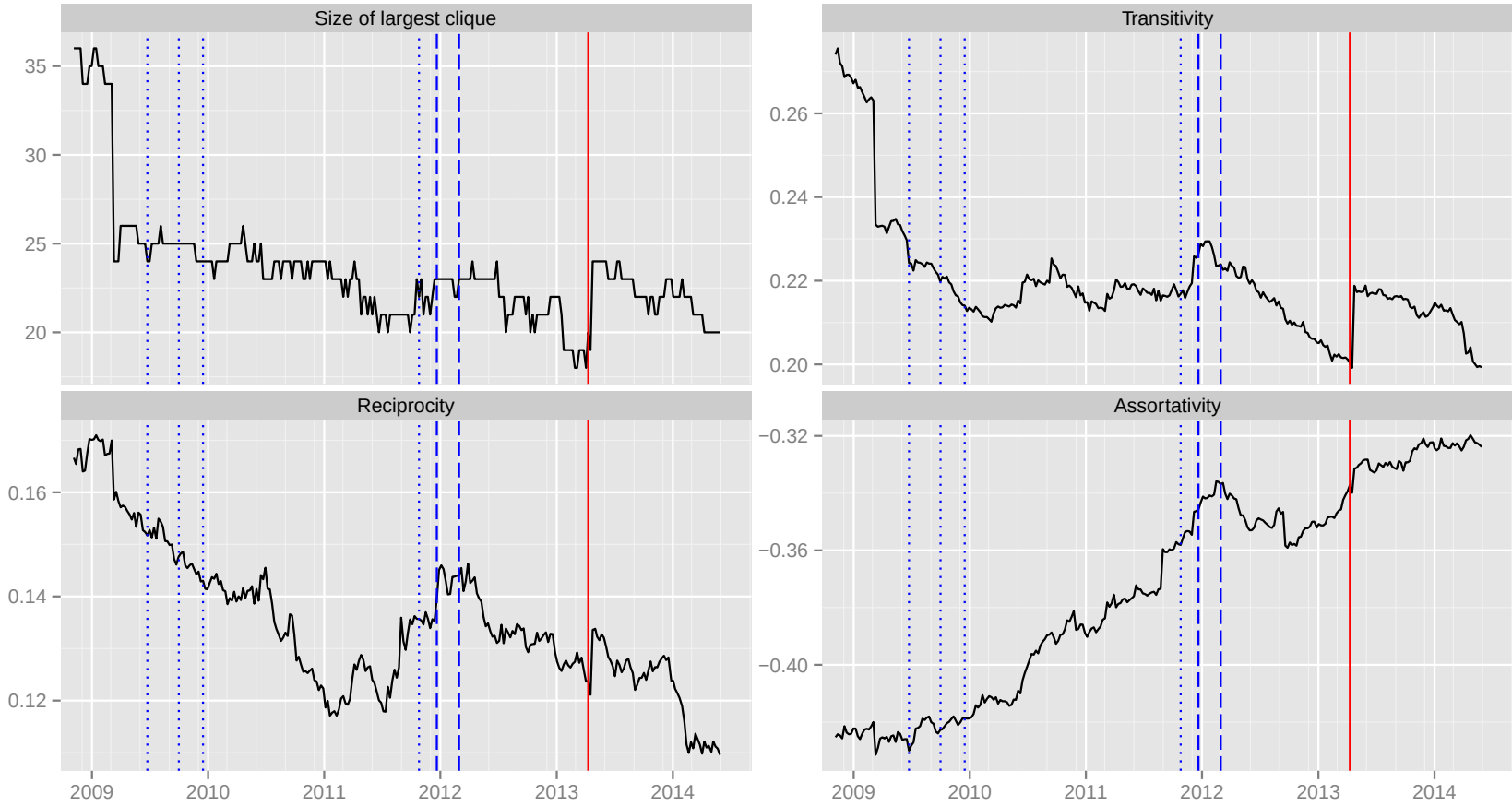
Bank association in the euro area financial network

Evolution of measures of interaction in the securities network



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Integration shows sign of weakening

Standard graph theoretic measures of integration count fewer and less integrated key banks

Measures derived from the topology of the financial network suggest that interconnectedness among euro area banks generally fell since 2009

- Already evident in the lower levels of *clustering* or transitivity observed above
- *Cliques* of banks of banks are fewer and smaller in size
- *k -cores* (maximal sub graph in which every node/bank has at least k linkages, i.e. higher k -valued cores are increasingly formed by more interconnected banks) show lower interconnectedness

Both the falling intensity of linkages of highly interconnected banks and the higher number of poorly interconnected bank communities indicate a general fragmentation of the interbank securities network.

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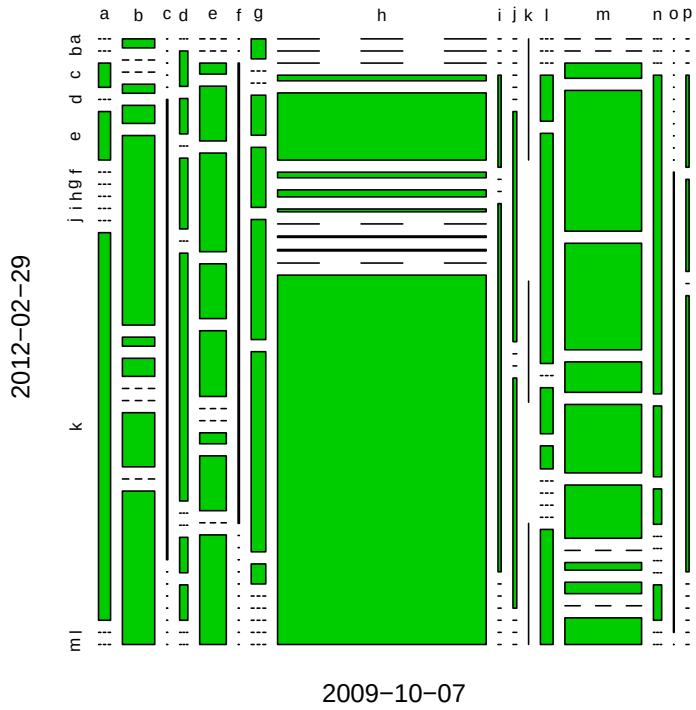
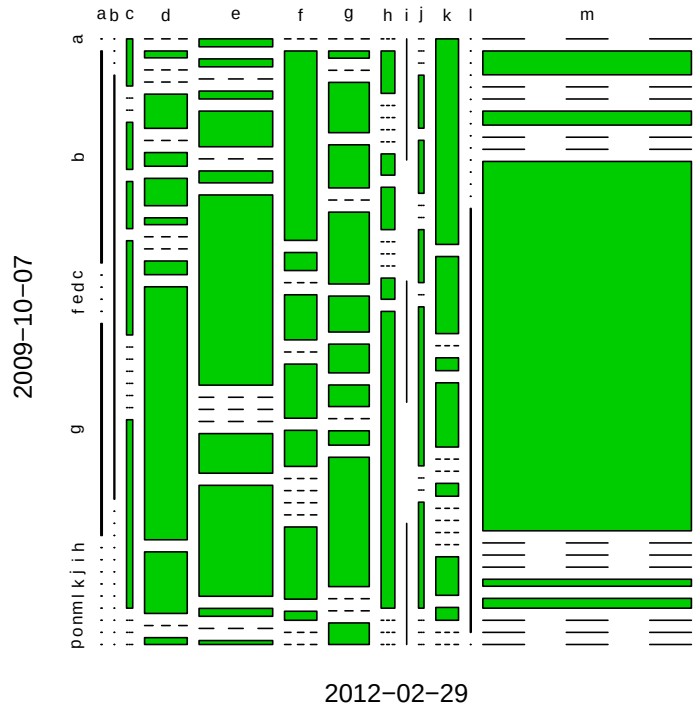
Communities have become thinner

Bank communities in 2009 and 2012 identified by the spin glass method





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Factors evident in the change in bank community perimeters

Communities in 2012 more nationally oriented in 2009 and diverse banking models across countries

- Fragmentation is strengthening the national composition of bank communities, as the large previously mixed communities are increasingly national
- Policy effectiveness likely has a differential impact on banks in different countries, as the core-periphery structure in banking seems different across countries

The results highlight the still distinct role that euro area financial interconnectedness policy may have across national jurisdictions

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Concentration of bank importance in the network

A potential measure of systemic fragility

From local metrics of importance to global measures of fragility

- Banks have varying and varied centrality or interconnectedness
- For social networks *network fragility* is the tendency of a single point to be more central than other (the speed and efficiency of the network in problem solving proved related to the tendency of a single point to be outstandingly central)
- This is recognised for banks, as institutions central to the operation of the system are recognised as *too-big-to-fail* banks, and deemed specially important for the stability of the financial system

The interpretation of network centrality measures as representing a form of *fragility*, has a symmetric interpretation in terms of *efficiency*

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Systemic fragility measure

The *centralisation index* measures concentration at the network level

A simple dispersion measure, properly normalised, serves as indicator so systemic fragility

$$c = \frac{\sum_{v \in V} [c^* - c(v)]}{\max \{\sum_{v \in V} [c^* - c(v)]\}},$$

where $c^* = \max c(\mathscr{D}, \ldots)$, the maximum value of the measure in graph $\mathscr{D}$, and the denominator normalises the measure over all possible graphs or order N_v

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There are varied forms of systemic fragility

Measures of fragility in the securities network

Measure	**Dependence on**	**Change**	**Impact**
Degree	Highly connected institutions	$-$	Lower fragility and intermediation
Eigenvalue / PageRank	Highly interconnected institutions	$+$	Possibly higher fragility
Closeness	Highly exposed institutions	$+$	Higher fragility
Betweenness	Highly intrinsic institutions	$++$	Higher fragility

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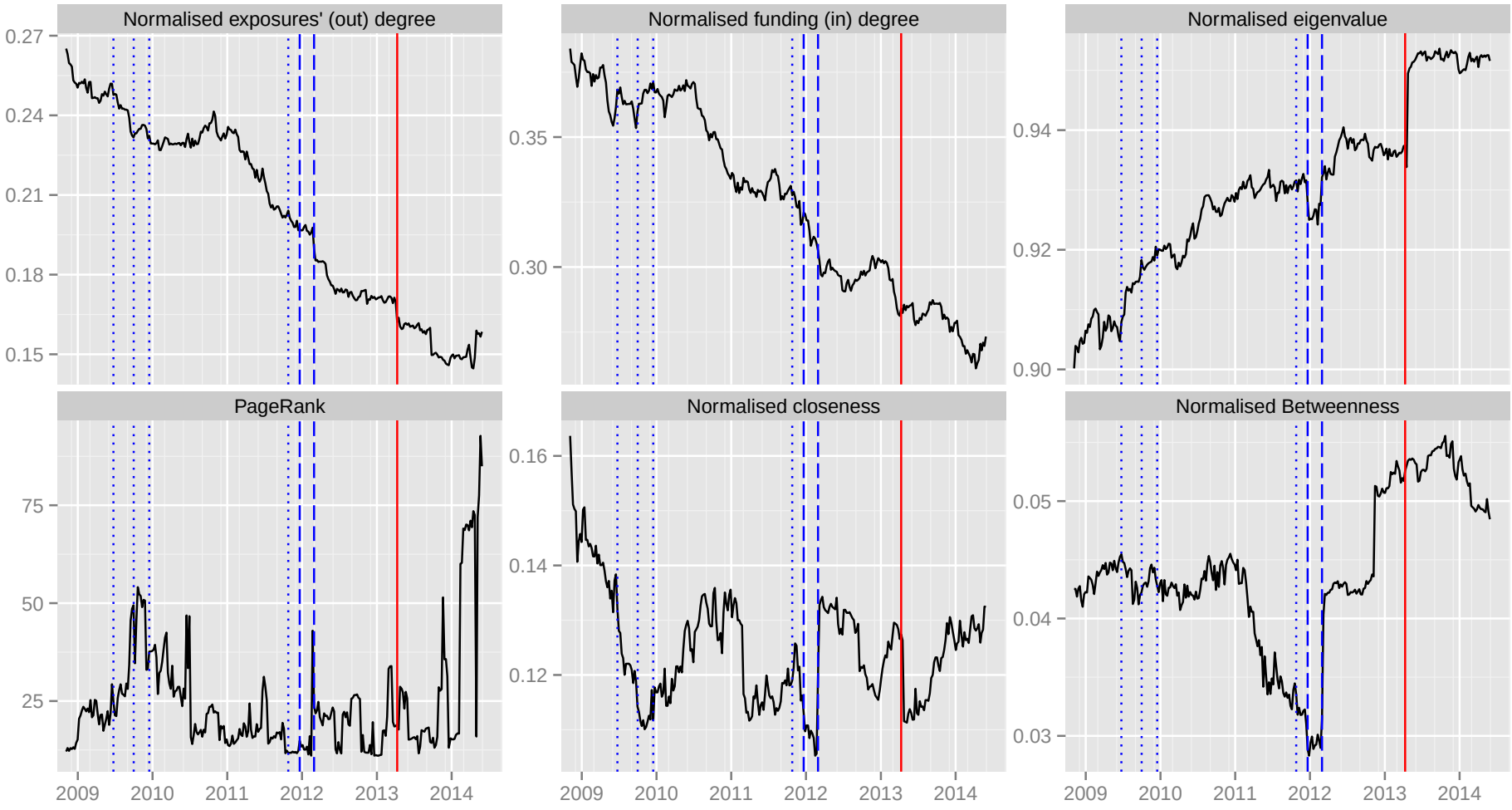
Measures of network leverage

Evolution of graph fragility measures



Concluding remarks

Looser banking communities and growing systemic fragility?

- Unique information supports analysis needed for macro prudential policy
- Usefulness of the information grows as the questions become more structural
- The euro area banking system is undergoing a gradual *thinning*, or less interconnected
- Fragility measured by *network leverage* appears to be gradually increasing

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