The Euro Area Money Market Network During the Financial Crisis

A Look at Cross-Border Fragmentation

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Summary

T2 data on euro area unsecured overnight loans 2008-6 to 2014-2

Evolution of (cross-border) network fragmentation

Methods

- Community analysis (weighted directed network)
- Core-periphery analysis (weighted undirected network)

Findings

- Fragmentation responded to crisis events and policy interventions
- Lending core-to-periphery most sensitive

Outline

1. Data and stylised facts
2. Community analysis
3. Core analysis
4. Conclusions

Data

Unsecured interbank overnight loans extracted from TARGET 2 payments platform (Frutos et al., 2014)

Consolidated proprietary trades among 412 banks (June 2008 - Feb 2014)

Cross-checked with Spanish e-mid

These data have been used by the ECB MaRs research network

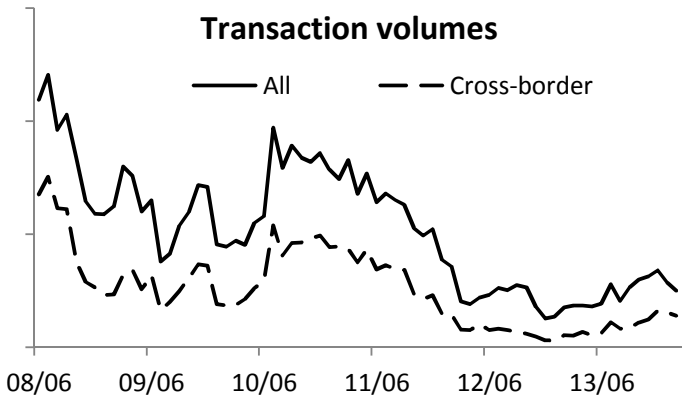
We aggregate the data to quarterly frequency

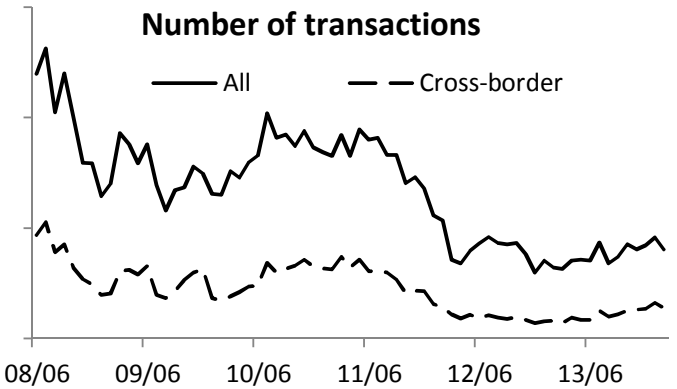
Timeline of Events

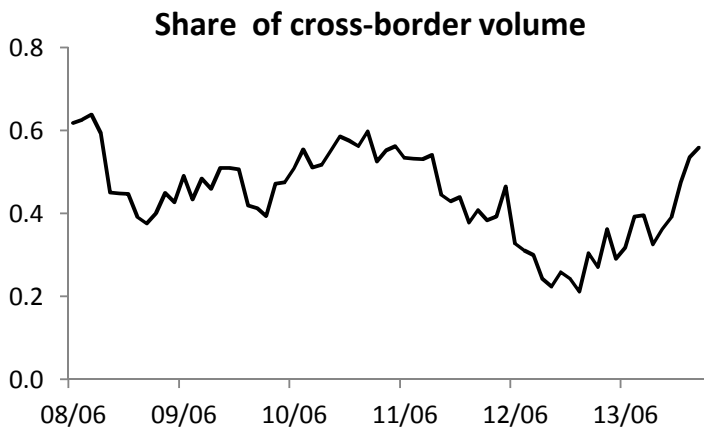
Sep	2008	Lehman bankruptcy
May	2009	ECB launches CBPP and 1-year LTRO
Sep	2009	Greek debt crisis mounts
Dec	2009	ECB launches 1-year LTRO
Apr	2010	Greece seeks financial support
May	2010	ECB Security Markets Programme (SMP) European Financial Stability Facility (EFSF) set up
Nov	2010	Financial support for Ireland
July-Sep	2011	Interest rates on IT, ES bonds start to rise
Dec-Mar	2011	ECB 3-year Long-Term Refinancing Operation (LTRO)
Jul	2012	Eurogroup grants financial assistance to Spain's banking sector
Jul	2012	'Whatever it takes ' speech by ECB president Draghi

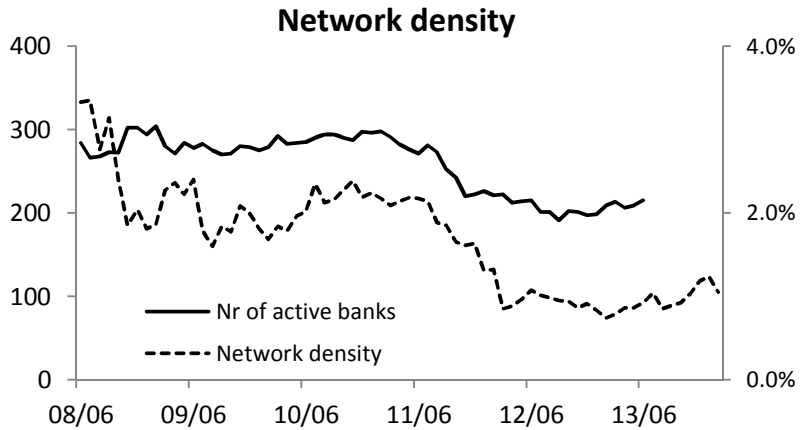
Market Activity I

Network Activity



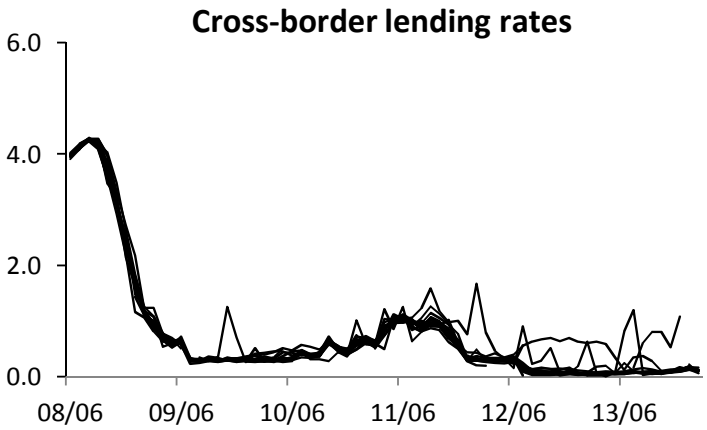


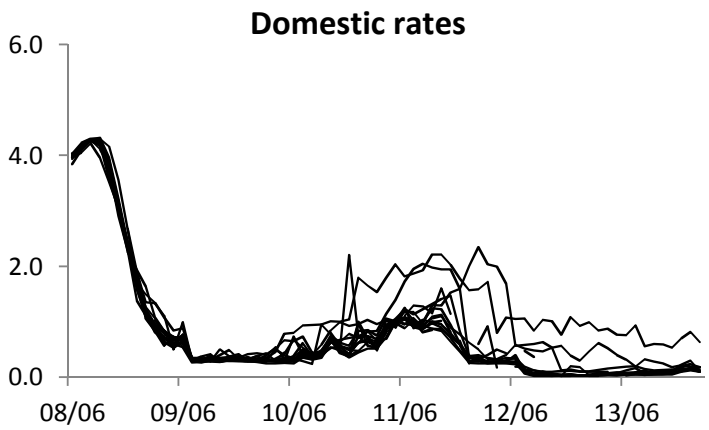


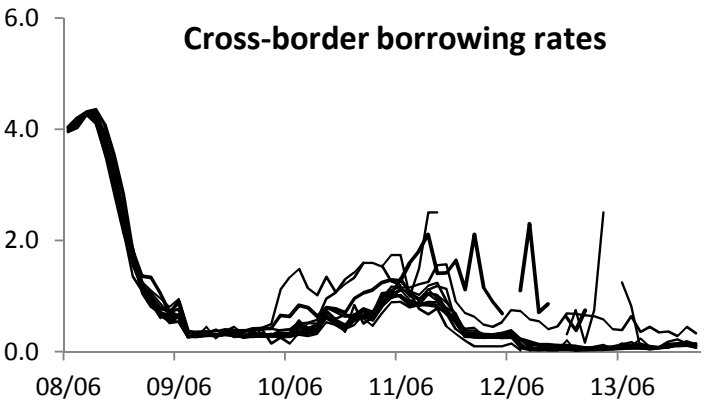


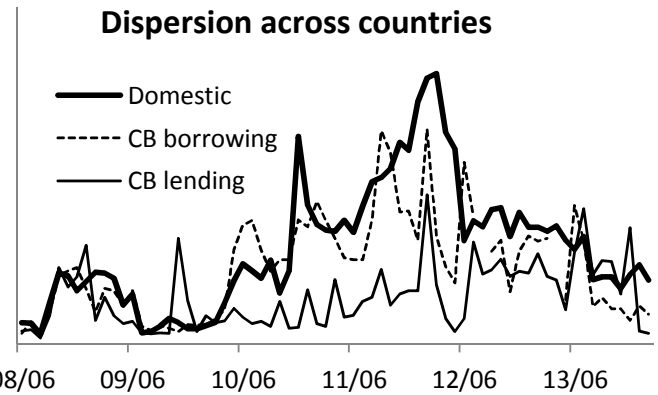
Market Activity II

Country-level interest rates

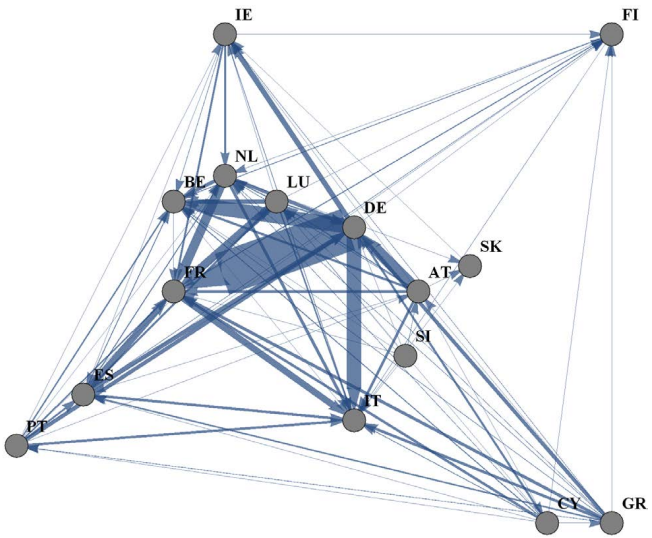


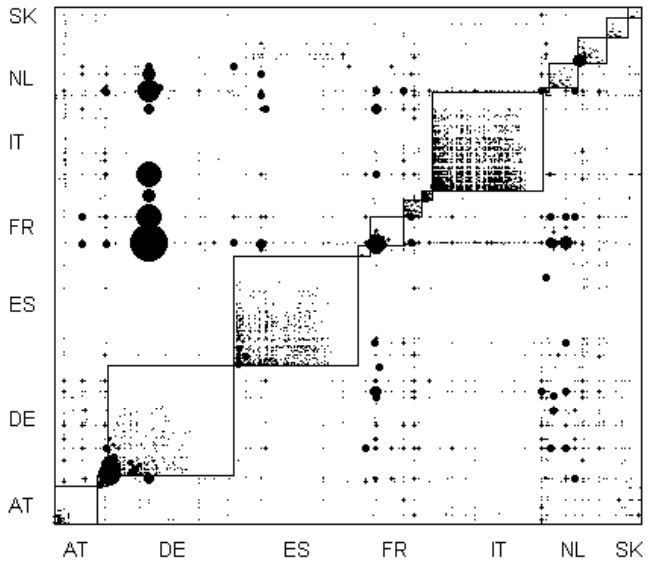






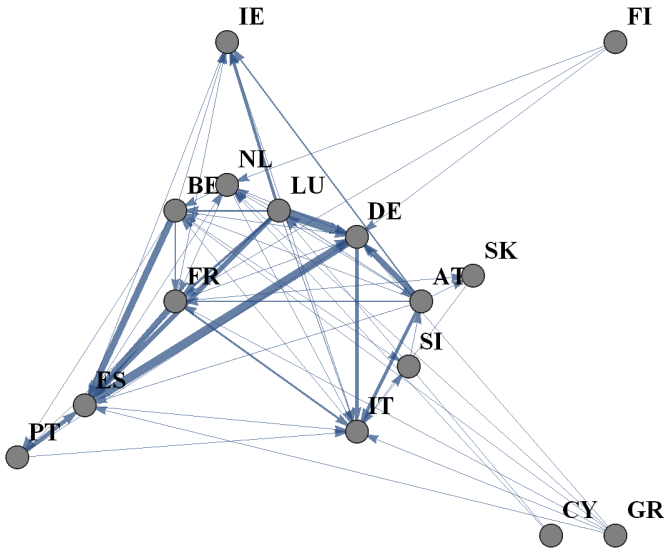
Network Graphs 2010 Q4

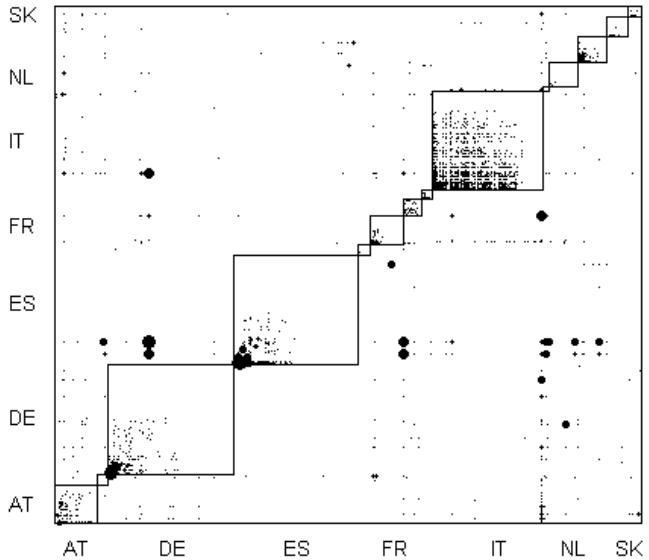




Net lending flows across countries (left) and bilateral lending among banks (right). The size of the circles indicates the volume of lending from bank row to bank column

Network Graphs 2012 Q2





Net lending flows across countries (left) and bilateral lending among banks (right).
The size of the circles indicates the volume of lending from bank row to bank column

Community and Core Analysis

Did the network fragment into communities? How did fragmentation respond to crisis events and policy measures?
We use Newman-Leicht (2007) modularity approach

How did cross-border fragmentation evolve?
Inspect correspondence among communities and national borders

Role of core and periphery in cross-border flows?
Estimate core from Bonacich centrality

Communities I

Modularity approach for directed weighted networks
We adopt Newman-Leicht (2007) to the weighted case

Partition network V into 2 groups d_i, $i = 0, 1$ such that

- Network density within groups is maximised against expected value
- Expected value is given by random network assumption
- Hierarchical approach to obtain binary tree of partitions

Communities II

Consider matrix of bilateral transaction volumes V

Find vector of community membership $d = (d_1, \ldots, d_n)$ of 0/1 to maximize Q

$$\max Q = 2\left(|V|\right)^{-1} \sum_{b \neq j} b_{ij}$$

$$b_{ij} = \left(V_{ij} - \mathbb{E}V_{ij}\right) \mathbb{I}(d_i = d_j)$$

$$\mathbb{E}V_{ij} = \left(|V|\right)^{-1} v_i^{out} v_j^{in}$$

Modularity $0 \leq Q \leq 1$ is a measure of fragmentation

Communities III

One step partitions network into 2 communities

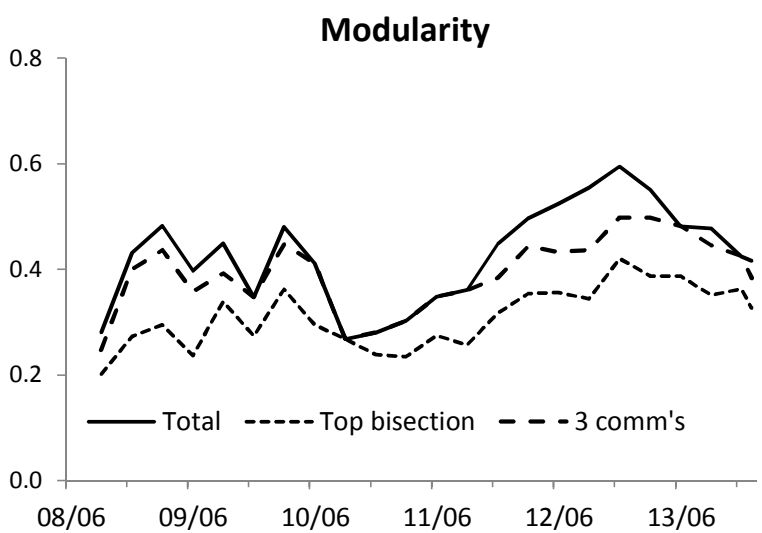
- Hierarchical approach to obtain binary tree of bisections
- Stop once contribution to modularity $Q < \varepsilon$.

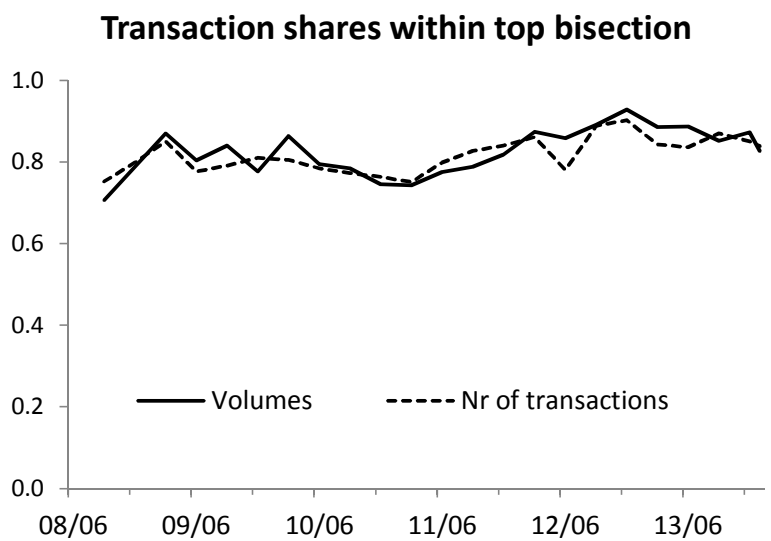
Estimation in 2 steps

- Find first eigenvector of $B + B^T$
- Iterative switching algorithm

Modularity

Measures of fragmentation

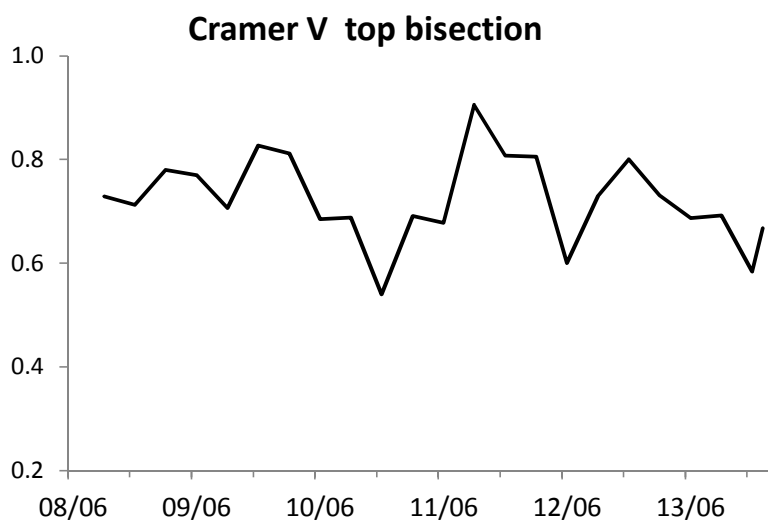


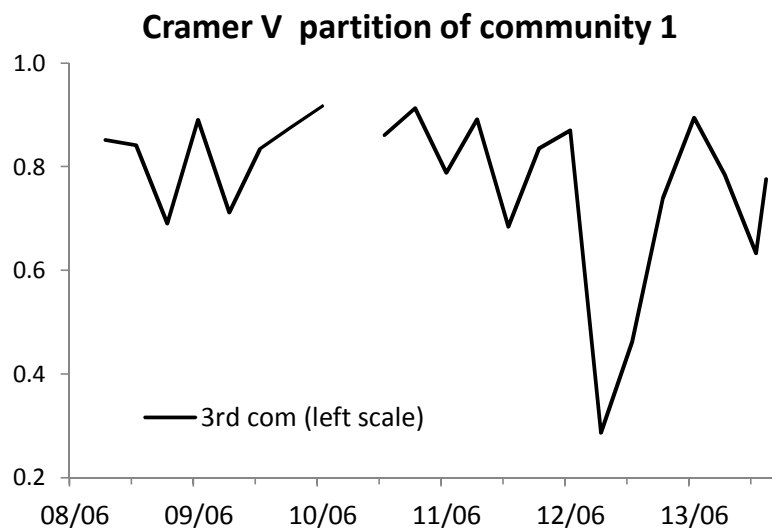


The number of communities ranges from 3 to 5

Cross-border fragmentation index

Measures of cross-border fragmentation





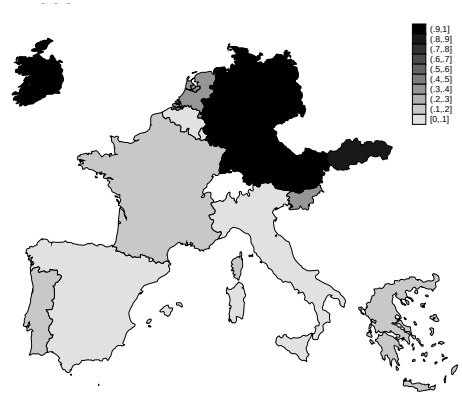
Cramer V measures correspondence of community membership and bank location

North-south divide

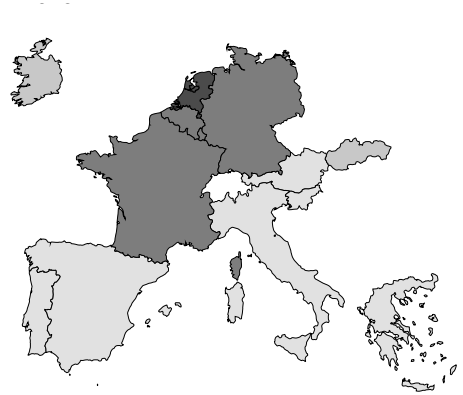
Country allocation to top bisection

Period	2009 Q4		2010 Q4		2011 Q3		2012 Q6		2014 Q1	
Cramer V	0.83		0.54		0.91		0.60		0.67	
Cluster	I	II	I	II	I	II	I	II	I	II
Size	203	96	250	56	167	144	190	71	182	54
North	21	82	67	41	6	114	81	23	72	38
South	182	14	183	15	161	30	109	48	110	16

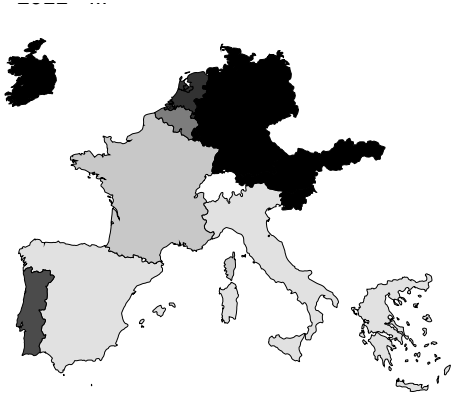
Euro Area Maps



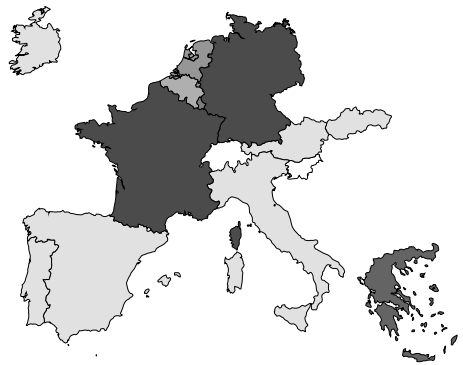
2009 Q4



2010 Q3



2011 Q3



2014 Q1

The maps show community membership of banks per country. Dark-shaded areas indicate a high share of banks in top bisection 2.

Counterfactual Modularity

	2009 Q4	2010 Q4	2011 Q3	2012 Q2	2014 Q1
2009 Q4	1.00	.53	.69	.15	.46
2010 Q4	.72	1.00	.69	.37	.72
2011 Q3	.47	.65	1.00	.44	.60
2012 Q2	.61	.39	.61	1.00	.33
2014 Q1	.42	.57	.51	.29	1.00

The table shows the modularity values of applying the partition that is derived from from period row to the actual data from period column.

Core and Periphery

Craig and von Peter (2014), Lelyveld and in 't Veld (2013) find strong evidence for core/periphery structure

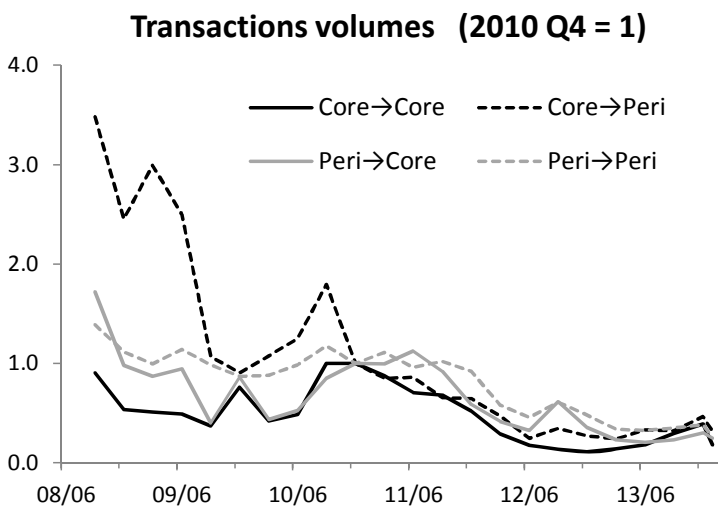
A weighted measure of the core amounts to Bonacich centrality (Borgatti and Everett, 1999)

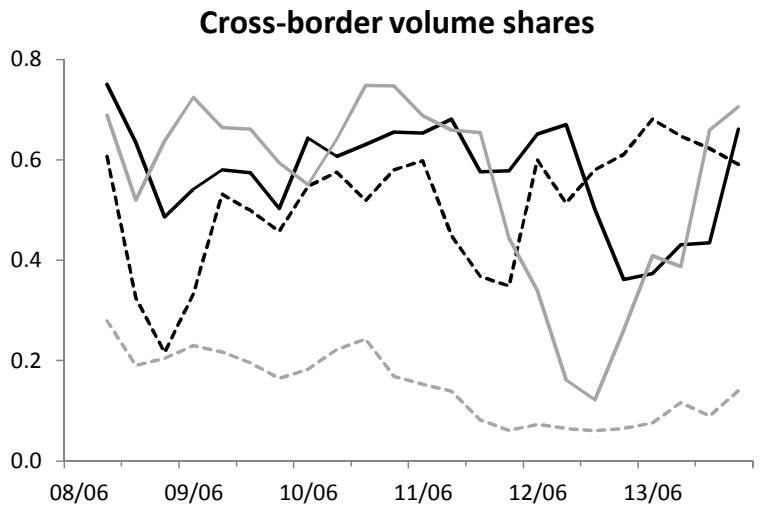
- $c = \beta W_r c + x = (I - \beta W_r)^{-1} x$
- W_r is normalised undirected network matrix
- x is total trading values

We set the size of the core as 15% of nr of banks

C-P Transaction Volumes

Core and periphery





Conclusions

Market fragmentation aligned with crisis events and policy interventions

Sovereign debt stress: market fragmentation increases and

- Cross-border fragmentation increases
- *Lending* of core to periphery declines

EFSF reverses these trends

Post-LTRO: further rise in market fragmentation, but

- Cross-border fragmentation declines
- Transactions *within core* decline