

NETWORK TOPOLOGY DUTCH INTERBANK PAYMENTS SYSTEM

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Payment and Settlement Simulation Seminar
August 2008



Agenda

- Research questions
- Data description
- Aggregate payments behaviour
- Structural flows
- Network properties
- Vulnerability
- Turbulence financial markets
- Conclusions



Research questions

First attempt to describe the Dutch payment network:

- What does the Dutch interbank payments network look like?
- What are the crucial players from a network perspective?
- How does the network change during a business period (hour, day, week etc)?
- What is the characteristic timescale of the network?



Data description

- 257 days from June 2005 –May 2006
- Opening hours only (7.00 – 18.00)
 - Evening settlement period left out (exception: net value transfer)
- Participant can have several accounts, but are seen as one
- Banks in foreign country share one TARGET participant number



International comparison

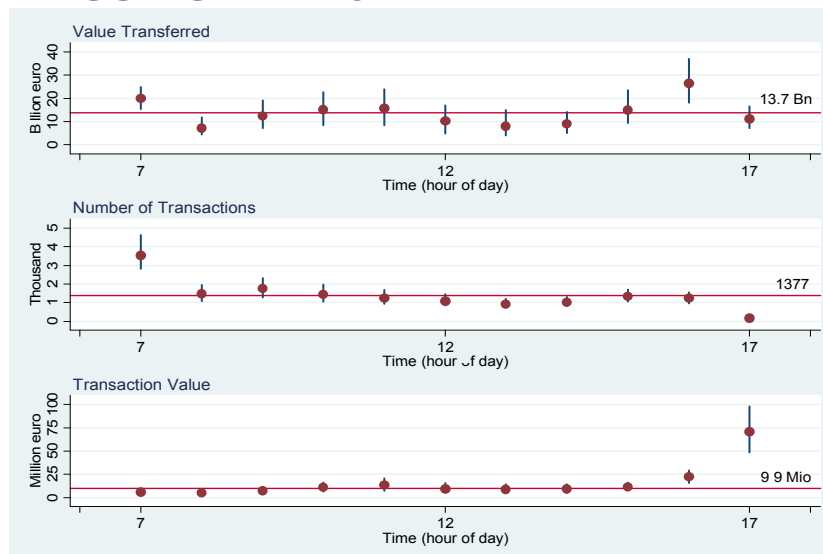
	TOP (NL)	TARGET (Europe)	CHAPS * (UK)	Fedwire * (USA)
Period	June 2005 – May 2006	2005	2005	2005
Direct Part.	155	10,197	NA	6,819
Indirect Part.	100	1,126	15	NA
Transactions (*1000)	15.1	312	116	519
Value (Billion €)	151	1,987	297	1,634
Average value (Million €)	9.9 (6.5)	6.4	2.6	3.1

Source: TOP (DNB), TARGET (ECB Bluebook), CHAPS and Fedwire (BIS Redbook 2007)

* Pound Sterling and American Dollars are converted to euro given the exchange rates by Redbook



Aggregate payments behaviour



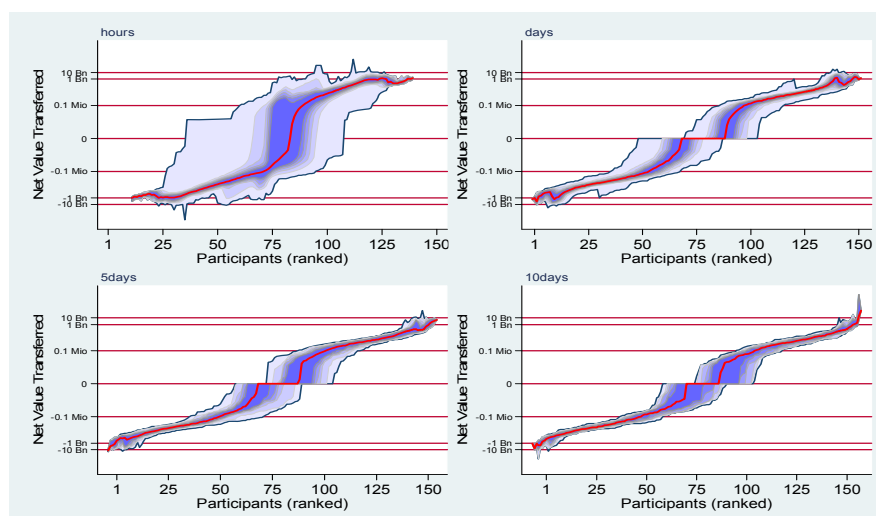
(1) Gross value , (2) transactions, (3) average transaction value

Structural flows: Net value transferred (1)

- Structural flows between participants
 - Net value transfer, circular flows
 - Dependencies might increase vulnerability to failures
- Domestic banks and large foreign banks
 - Net payments include payments to/from TARGET countries
- Net value snapshots for different time periods
 - 1 hour, 1 day, 5 days, 10 days
- Participants per time snapshot sorted to net payments (ranking) → picture shows distribution of rankings
 - Extreme right (left): largest paid (received) sum of money
 - Ranking specific participant changes between snapshots



Net value transferred (2)



Structural cross-border net circular flows

net value transfer from NL to country	value (in bn Euro)	net value transfer from UK to country	value (in bn Euro)
GB	414	DE	827
DE	99	FR	619
IE	37	EU	104
SE	4	SE	92
PT	-2	ES	62
DK	-14	DK	53
GR	-16	GR	29
AT	-16	AT	16
FI	-22	FI	5
LU	-24	PT	-12
FR	-76	IE	-19
EU	-83	LU	-69
BE	-97	NL	-414
ES	-103	IT	-427
IT	-113	BE	-866
Total	-13	total	0

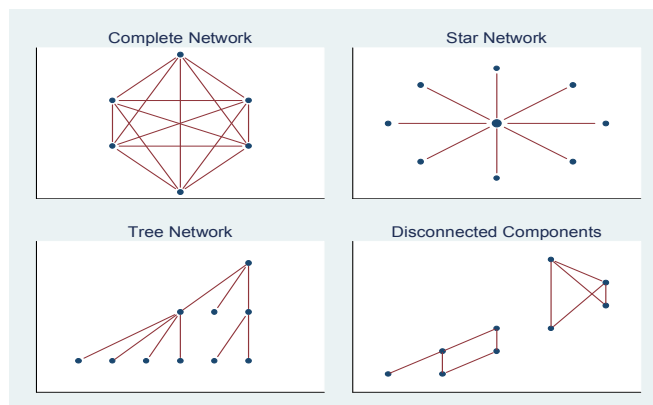
- Large international net circular flow (order of GDP)
- Patterns between countries could entail channels of contagion

Source: ECB (bluebook)



Basic types of networks

- Confidentiality data limits application to financial networks
- Temporary link: future work dedicated to link weight & mortality
- Dominant network component representative after 10 minutes
- Central core of large banks



Development of network properties (1)

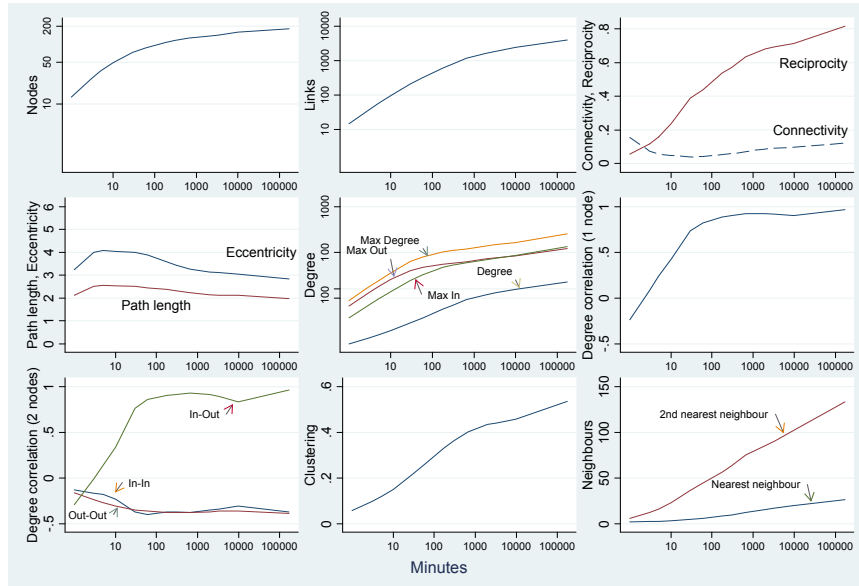
- Nodes, links, connectivity, reciprocity
- Bech, US > 5000; Inaoka, Jp: 354
- *Possible* links increase with nodes *squared*
 - Connectivity declines in first hour
- Reciprocity high, but says little about intensity

	1 hour	1 day	1 year
Nodes	88 ± 6	129 ± 5	183
Links	326 ± 76	1182 ± 61	4079
Connectivity	0.04 ± 0.01	0.07 ± 0.00	12%
Reciprocity	0.44 ± 0.12	0.63 ± 0.12	

Development of network properties (2)

- Average path length (maximum) declines over time
 - Form 2.5 (4.1) to 2.0 (2.8)
- One intermediary node random or central core of banks?
- Close relationship between degree and length
- Node degree from 3.7 (1H) to 9.2 (1D) to 22.3 (1Y)
- Growth differs from theoretical models assuming fixed degree
- Maximum degree 79 (1H): presence highly connected nodes
 - Degree distribution
- Structure takes more time to build up than size
- Clustering measures density at a local level
 - From 0.26 (1H) to 0.40 (1D) to 0.53 (1Y)

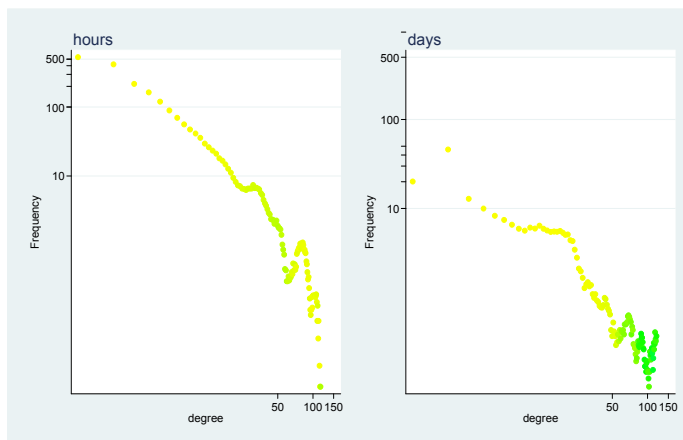
- Fast development < 1 hour, slower rates afterwards
- Small, compact, sparse network



Note: panes displaying nodes, links and degrees use a logarithmic y-axis

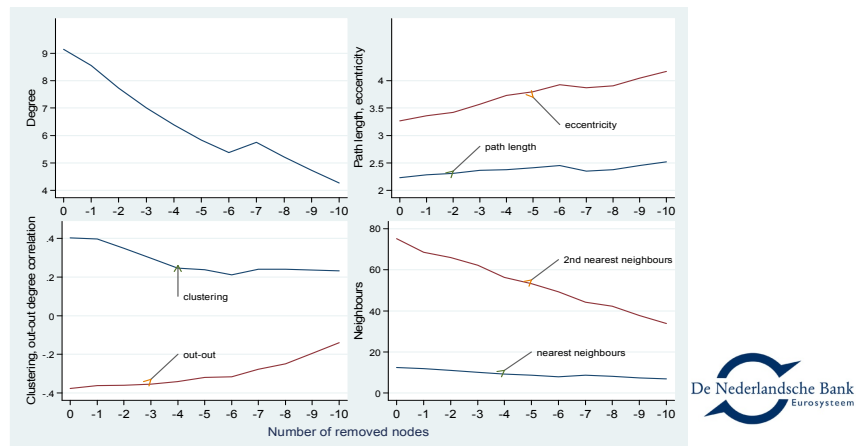
Degree distribution ('popularity')

- Humps indicate groups of individual nodes
- Small number of highly connected nodes
- Too few orders of degree for fitting (e.g. to a power-law distribution)



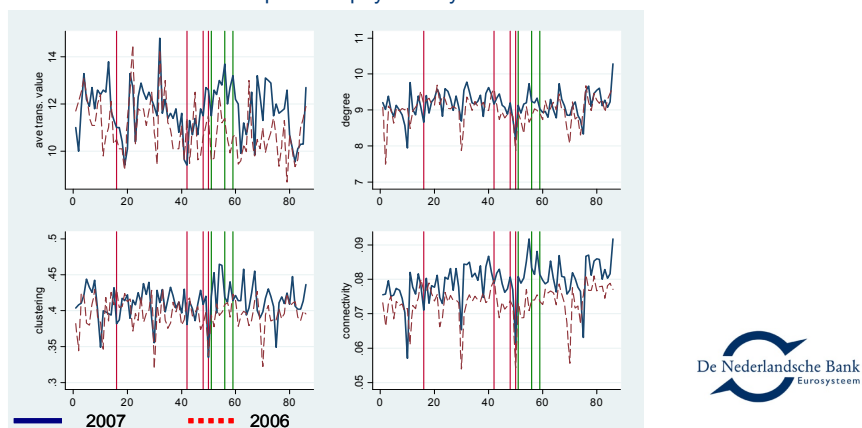
Vulnerability network structure

- Removal, one by one, most highly connected nodes
- Central role highly connected nodes (especially top 4)
- Strong impact is indirect indication vulnerability



Turbulence financial markets

- Monitoring of traditional and network properties June-Sept 06-07
- Vertical bars indicate 'events'
- Liquidity crisis, loss of confidence:
 - No noticeable disruptions in payment system



Conclusions (1)

- Network properties add value to traditional measures
- Structural circular flows exist (especially cross border)
- Dutch network is active, small, compact, sparse
 - Small number of highly connected nodes
- Relevant timescale < 1D (say: 1H)
- Limited impact turbulence on payments network



Conclusions (2)

- Payment system
 - Small (in nodes and links)
 - Compact (in path length and eccentricity)
 - Sparse (in connectivity)



Future steps

- Differentiate between payment types
 - Highly urgent payments: CLS, EBA
 - Clearing houses
 - Loans to other banks
 - Liquidity transfers
 - Administrative payments
- Add weight to a link and include direction
- Define stress scenarios
 - Calculate scenarios with simulator
- Check how network characteristics change

