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EUROSYSTEM

Structure and Stability in Complex Systems

An empirical analysis of the interbank payment system ARTIS

Evidence

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Agenda

Motivation

Related Research

ARTIS Simulations

Network Indicators

Panel Data Analysis

Conclusion

Motivation and objectives

- **Motivation**
  - OeNB is in charge of payment system oversight
  - ESCB/OeNB objective: smooth functioning of the payment system
- **Objectives**
  - Statistical analysis for a better understanding of ARTIS
  - Analyse impact of operational risk in payment systems
  - On the system and the individual bank level
- **Policy implications?**

Research questions

- Based on Schmitz / Puhr (2006, 2007, 2009)
- We operate with real rather than simulated liquidity data
- We run various operational stress scenarios
- We observe large variations across scenarios and days
- We try to uncover systemically important accounts
- We try to explain variations across scenarios and / or days
- In particular with regard to payment system structure / topology

Methodological approach

- **Network theory**
  - Robustness studies
  - Typology of flow processes
  - Measures of network structure
- **Simulation studies**
  - Simulations of operational shocks generate contagion
- **Panel data econometrics**
  - Variations of contagion across scenarios and / or days

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Network theory

- **Robustness studies (Albert et al. 1999, 2000: Internet)**
  - Nature of shock: removal of nodes and links from network
  - Measure of impact: Connectivity measured by size of largest cluster and average path length
- **Robustness in ARTIS**
  - ARTIS is a physically complete network
  - Flow of liquidity not equal to flow of information in the internet
  - Connectivity inappropriate conceptualisation of network stability
  - Incoming links to stricken account not removed

Payment system research

- **Simulation studies (Leinonen (ed.) 2005, 2007, 2009)**
  - Many conducted with the Bank of Finland Payment System Simulator
  - Publicly available tool to simulate payment systems
  - Based on real and / or simulated transaction data
- **Network topology studies (Soramäki et al. 2006)**
  - The topology of interbank payment flows in FedWire
  - For a comparison of network indicators across networks refer to Schmitz et al. 2008

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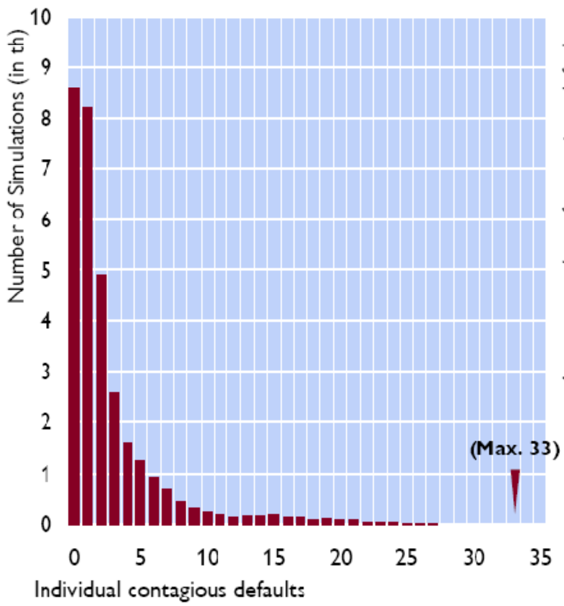
Data requirements

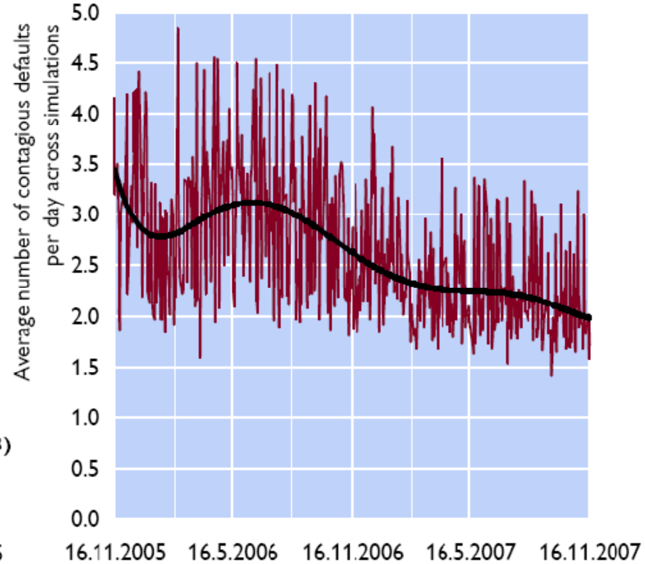
- **Transaction data**
  - Payer, payee, value, time stamp
  - If available prioritisation and underlying economic purpose
- **Liquidity data**
  - Beginning of day balance and collateral
- **Institutional data**
  - Settlement algorithm and attribution of accounts to economic entities
  - Institutional features: e.g. stop-sending rule, through-put rules, …
- **Additional data**
  - Qualitative information (e.g. experience of operators)

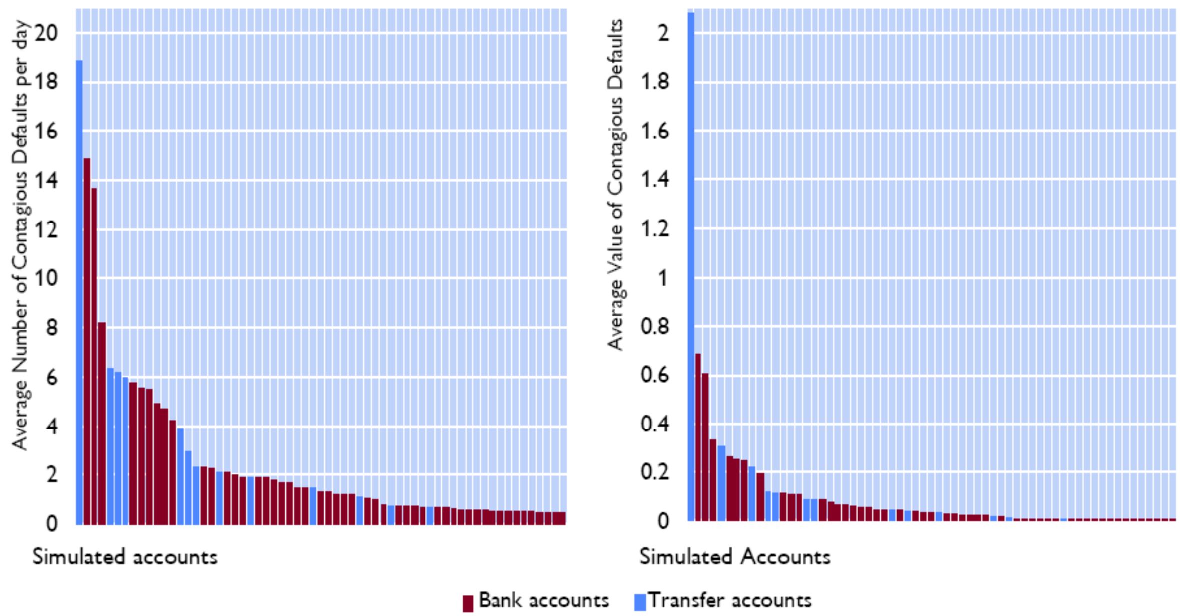
Simulations

- **Assumption: one day incapacitation to submit payments**
- **Sample period: 16 November 2005 to 16 November 2007 (497 days)**
- **63 scenarios**
  - 50 banks which are in GSCC on all days in the sample period
  - 13 transfer accounts which are part of the system on all days
- **Matlab based simulation tool**
  - Accounts for all institutional features of ARTIS (e.g. stop-sending rule, direct debit)
- **31 311 simulations (63×497) with 650 mn transactions**

Simulation results







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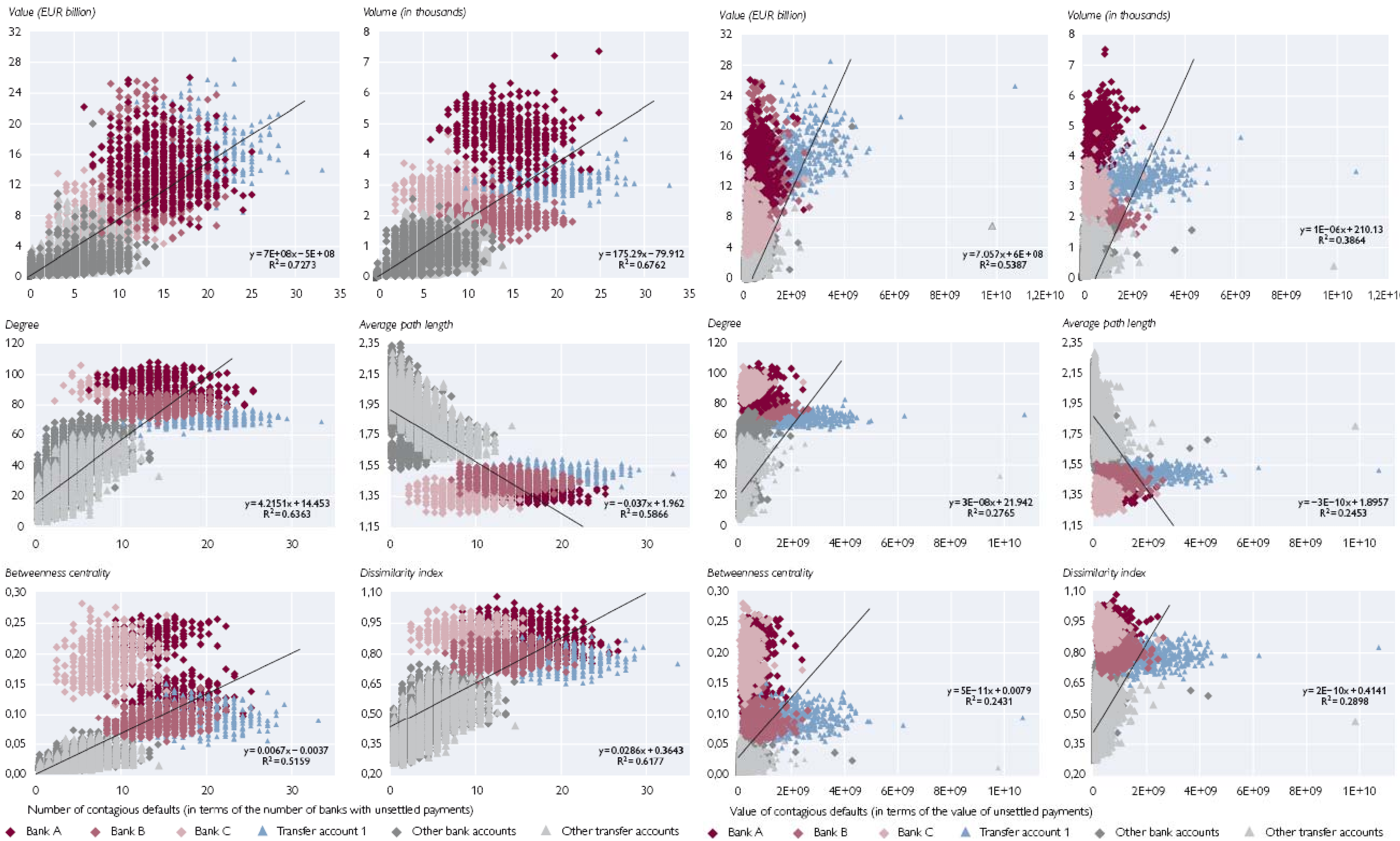
Network indicators

- **Appropriate measure of network structure?**
  - Directed / undirected? Weighted / unweighted?
  - Network level (44) & node level (stricken bank) (71)
- **Selection based on**
  - **Comparability (e.g. indicators that were used in other studies)**
    - Albert et al. (1999, 2000: Internet) – average path length
    - Boss et al. (2004: Interbank liabilities) – betweenness centrality
  - **Theoretical considerations**
    - Driven by typology of flow processes (Borgatti 2005)
    - Route / transfer characteristics
    - Liquidity follows a walk and is transferred

Node-level network indicators vs. unsettled payments



Correlation between volume, value and network indicators

	Volume	Value	Avg. PL	Degree	Conn.	Clust.	Btw. C.	Dissim.
Volume	100%	89%	-77%	84%	83%	-57%	89%	85%
Value		100%	-70%	76%	75%	-52%	77%	78%
Avg. PL			100%	-96%	-97%	62%	-79%	-85%
Degree				100%	99%	-72%	85%	95%
Conn.					100%	-72%	85%	93%
Clust.						100%	-56%	-78%
Btw. C.							100%	87%
Dissim.								100%

Source: OeNB. Average Path Length (Avg. PL), Connectivity (Conn.), Clustering Index (Clust.), Betweenness Centrality (Btw. C.), Dissimilarity Index (Dissim.).

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Dependent variables

- **Measures of contagion (excl. stricken bank)**
  - Value of unsettled payments at end of day
  - Number of unsettled payments at end of day
  - Number of banks with unsettled payments at end of day

Independent variables

- **Network level (constant across panels but not across time [Z])**
  - Aggregate liquidity

    (BoD balances + unencumbered collateral across banks)
  - Network indicators at the network level
- **Node level (varies across panels and across time [X])**
  - Liquidity loss due to operational problem at stricken bank

    (liquidity sink/drain, unrecieved payments)
  - Network indicators at the node level
- **Dummy for transfer accounts (D×unreceived payments)**

Model

$$\begin{bmatrix} y_1 \\ y_2 \\ . \\ y_{63} \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ . \\ X_{63} \end{bmatrix} \beta_1 + [Z]\beta_2 + \begin{bmatrix} \nu_1 \\ \nu_2 \\ . \\ \nu_{63} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ . \\ \varepsilon_{63} \end{bmatrix}$$

$$E\left[\varepsilon_{it} \middle| x_i, \nu_i\right] = 0 \qquad T = 1\ldots497, \quad N = 1\ldots63.$$

$$Var\left[\varepsilon_{it} \middle| x_i, \nu_i\right] = \sigma^2 I_T$$

$$Cov\left[\varepsilon_{it}, \varepsilon_{js}\right] = 0 \quad if \quad t \neq s \quad or \quad i \neq j.$$

Assumptions

- **Cross-panel conditional homoskedasticity**
  - Variance of error terms constant across panels (and across time)
- **Serial independence**
  - Error terms are serially uncorrelated within panels
- **Cross-panel independence**
  - Error terms are independent across panels
- **Strict exogeneity**
  - Error terms and explanatory variables are independent

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Estimation procedure

- **Estimate fixed-effects model (yields inconsistent standard errors)**
- **Correct for cross-section conditional heteroskedasticity, autocorrelation and cross-section-dependence**
- **Prais-Winsten regression, PCSE (Panel-Corrected Standard Errors)**
  - Accounts for heteroskedasticity and cross-panel correlation
  - Additional option panel-specific autocorrelation
- **Estimate three models without network indicators**
  - One for each measure of contagion
  - Add individual network indicators at node- and network-level
  - One at a time, due to high correlation between network indicators

Basic models used for tests

Model 1

$$simdefaults_{it} = \alpha_{it} + \beta_1 Liquidity_t + \beta_2 simunrvol_{it} + \beta_3 TransUnrVol_{it} +$$
$$+ \beta_4 nodeavgpath_{it} + \beta_5 netavgpath_t + u_i + \varepsilon_{it}$$

Model 2

$$simqueuednum_{it} = \alpha_{it} + \beta_1 Liquidity_t + \beta_2 simunrdvol_{it} + \beta_3 TransUnrVol_{it} +$$
$$+ \beta_4 nodeavgpath_{it} + \beta_5 netavgpath_t + u_i + \varepsilon_{it}$$

Model 3

$$simqueuedvol_{it} = \alpha_{it} + \beta_1 Liquidity_t + \beta_2 simunrvol_{it} + \beta_3 TransUnrVol_{it} +$$
$$+ \beta_4 nodeavgpath_{it} + \beta_5 netavgpath_t + u_i + \varepsilon_{it}$$

Estimation results (1/2)

- **Explanatory value of models is high (40 to 70 per cent)**
  - Much higher for between than for within panel variation
- **Results robust across specifications & estimation methods**
- **Higher liquidity reduces contagion effect**
- **Higher liquidity loss increases contagion effect**
  - Impact highest for value of unsubmitted payments
  - Less for liquidity drain and liquidity sink
  - Variable has very high explanatory power
- **Transfer accounts cause significantly more contagion**

Estimation results (2/2)

- **Higher value of transactions in the network reduces contagion**
  - Time trend?

- **At the network level no indicator is significant in all three models**

- **At the node level three network indicators are significant in all models**
  - Higher node degree and connectivity increase contagion
  - Higher average path length decreases contagion
  - More central nodes cause more contagion
  - Additional explanatory value:
    - 3 per cent regarding the number of contagiously defaulting banks
    - Negligible in the other two models

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Conclusion

- **Number of systemically important accounts is low**
  - At least one default / day: 11 transfer accounts & 28 banks
  - 0.1% of average total value / day: 7 transfer accounts & 17 banks
- **Network indicators in payment systems**
  - Degree seems to be adequate indicator
- **Panel approach yields high explanatory value**
  - Higher between scenarios than within
- **Most of the variation is explained by**
  - Aggregate liquidity, liquidity loss, and impact of transfer accounts
- **Some network indicators at node level (!) are significant**
  - Their explanatory contribution is low

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Thanks a lot for your attention!

Presentation is based on:

Stefan W. Schmitz & Claus Puhr
“Structure and stability in payment networks – a panel data analysis of ARTIS simulations”
in
Harry Leinonen (ed.)
“Simulation analyses and stress testing of payment networks”
Bank of Finland, Scientific Monographs E42, 2009

Also available at SSRN:
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1400883

Annex

Network Indicators

Panel Data Analysis:

- **Descriptive Statistics**
- **Assumptions & Tests**
- **Results**

Definition of network indicators (1/3)

The *average degree* k of the network is calculated by summing across all (active) links originating from each node (out-degree k_i^{out}) or terminating at each node (in-degree k_i^{in}) and than averaging across nodes:

$$k = \frac{1}{n}\sum_i k_i^{out} = \frac{1}{n}\sum_i k_i^{in} = \frac{m}{n}$$

We calculated the *average path length* for each (active) originating node ℓ_i by averaging across terminating nodes j and than averaged across originating nodes i to derive the average path length ℓ of the entire network.

$$\ell_i = \frac{1}{n-1}\sum_{j \neq i} d_{ij}$$

$$\ell = \frac{1}{n}\sum_i \ell_i$$

Considering the maximum eccentricity ε (the maximum path length between any originating and any terminating node) across nodes defines the *diameter* D:

$$D = \max_i \varepsilon_i$$

The *connectivity* of the network is defined by the number of actual directed links m over the number of possible directed links $n(n-1)$.

Definition of network indicators (2/3)

An indicator of the *distance* d_{ij} between nodes is the lowest possible number of links that connects each (active) node i with each other (active) node j in the network. It is referred to as shortest path length.

The *betweeness centrality* $C_B(h)$ of node h provides a measure of how many shortest paths d_{ij} pass through this node. Let $s_{ij}(h)$ be the number of shortest paths between all pairs of nodes i and j that pass through the node h and let s_{ij} the number of all shortest paths between all pairs of nodes i and j then

$$C_B(h) = \sum_{s \neq i \neq j} \frac{s_{ij(h)}}{s_{ij}}.$$

$C_B(h)$ is sometimes normalised by dividing it by the number of pairs of nodes not including the node h. The betweeness centrality of the network is

$$C_B = \frac{1}{n} C_B(h)$$

Definition of network indicators (3/3)

The *dissimilarity index* of two neighbours nodes i and j in a network is defined as

$$\Delta_{ij} = \frac{\sqrt{\left[\sum_{h \neq i,j}^{N} \left[d_{ih} - d_{jh}\right]^2\right]}}{(N-2)},$$

where d_{ik} are distance measures from nodes i and j to node h. It provides a comparison of the viewpoints of the entire network from the perspective of the all pairs of neighbouring nodes. For the entire network the dissimilarity index is

$$\Delta = \frac{1}{n(n-1)/2} \Delta_{ij}$$

The *clustering coefficient* $C_C(h)$ of an individual node h with k_h neighbours measures how well the latter are connected among each other. The number of potential links between the k_h neighbours is $k_h(k_h - 1)/2$. Let the actual number of nodes between them be E_h so that

$$C_C = \frac{E_h}{k_h(k_h - 1)/2}$$

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Descriptive statistics – dependent variables

Variable		Mean	Std. Dev.	Min	Max	Observations	
simnum~s	overall	2.607678	3.765892	0	33	N =	31311
	between		3.534751	.4507042	18.85714	n =	63
	within		1.373103	-6.301779	16.75053	T =	497
simque~m	overall	7.554757	21.71519	0	1172	N =	31311
	between		14.0254	.4507042	76.49899	n =	63
	within		16.67194	-55.94424	1145.718	T =	497
simque~l	overall	1.12e+08	3.35e+08	0	1.07e+10	N =	31311
	between		2.84e+08	3680408	2.08e+09	n =	63
	within		1.81e+08	-1.54e+09	9.79e+09	T =	497

Descriptive statistics – aggregate liquidity

Variable		Mean	Std. Dev.	Min	Max	Observations
liqbod~e	overall	7.47e+09	8.43e+08	5.49e+09	1.13e+10	N = 31311
	between		0	7.47e+09	7.47e+09	n = 63
	within		8.43e+08	5.49e+09	1.13e+10	T = 497
liqcol~l	overall	1.08e+10	2.89e+09	6.10e+09	2.53e+10	N = 31311
	between		0	1.08e+10	1.08e+10	n = 63
	within		2.89e+09	6.10e+09	2.53e+10	T = 497
Liquid~y	overall	1.83e+10	3.23e+09	1.17e+10	3.24e+10	N = 31311
	between		0	1.83e+10	1.83e+10	n = 63
	within		3.23e+09	1.17e+10	3.24e+10	T = 497

Descriptive statistics – liquidity loss

Variable		Mean	Std. Dev.	Min	Max	Observations
Liquid~s	overall	1.39e+09	3.07e+09	12032	2.86e+10	N = 31310
	between		2.92e+09	7869281	1.57e+10	n = 63
	within		1.02e+09	-7.11e+09	1.96e+10	T-bar = 496.984
simliq~n	overall	7.23e+08	1.69e+09	0	1.60e+10	N = 31310
	between		1.59e+09	452661.6	8.80e+09	n = 63
	within		6.16e+08	-3.91e+09	1.00e+10	T-bar = 496.984
simliq~k	overall	6.67e+08	1.53e+09	524	1.29e+10	N = 31310
	between		1.45e+09	1026011	6.92e+09	n = 63
	within		5.02e+08	-3.32e+09	9.59e+09	T-bar = 496.984

Descriptive statistics – network indicators node level

Variable		Mean	Std. Dev.	Min	Max	Observations
nodede~e	overall	25.44499	19.89985	2	105	N = 31311
	between		19.83007	6.428571	89.84708	n = 63
	within		3.000303	10.34036	43.26994	T = 497
nodeco~y	overall	.1930355	.1510905	.0153	.7949	N = 31311
	between		.1503863	.0490459	.6821545	n = 63
	within		.0238868	.075481	.3372814	T = 497
nodeav~h	overall	1.86558	.1817904	1.2137	2.3356	N = 31311
	between		.1782929	1.328216	2.102365	n = 63
	within		.0419877	1.67934	2.169161	T = 497
nodecl~x	overall	.5401702	.2014584	.1333	1	N = 31311
	between		.1873986	.1753167	.9800881	n = 63
	within		.0776117	.1056149	1.013537	T = 497
nodebe~y	overall	.013652	.0349052	0	.2761	N = 31311
	between		.0340873	6.04e-07	.1833795	n = 63
	within		.0086509	-.0796849	.1063725	T = 497
nodedi~x	overall	.4387912	.1369233	.2603	1.0754	N = 31311
	between		.13323	.312793	.9046616	n = 63
	within		.0357625	.281154	.626754	T = 497

Descriptive statistics – network indicators network level

Variable		Mean	Std. Dev.	Min	Max	Observations
netavg~e	overall	12.36032	.3990639	11.2609	14.35	N = 31311
	between		0	12.36032	12.36032	n = 63
	within		.3990639	11.2609	14.35	T = 497
netcon~y	overall	.0375596	.0027451	.0294	.0462	N = 31311
	between		0	.0375596	.0375596	n = 63
	within		.0027451	.0294	.0462	T = 497
netavg~h	overall	2.546561	.0594155	2.4025	2.6833	N = 31311
	between		0	2.546561	2.546561	n = 63
	within		.0594155	2.4025	2.6833	T = 497
netavgc~	overall	.4382753	.0279867	.3612	.5217	N = 31311
	between		0	.4382753	.4382753	n = 63
	within		.0279867	.3612	.5217	T = 497
netavg~y	overall	.0047867	.0002584	.0038	.0055	N = 31311
	between		0	.0047867	.0047867	n = 63
	within		.0002584	.0038	.0055	T = 497
netavg..	overall	1.269688	.9284118	.5946	5.228	N = 31311
	between		0	1.269688	1.269688	n = 63
	within		.9284118	.5946	5.228	T = 497

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Panel Data Analysis:

Descriptive Statistics

Assumptions & Tests

Results

Panel approach – the assumptions

- Cross-panel conditional homoskedasticity
    - Variance of error terms constant across panels (and across time)
- Serial independence
    - Error terms are serially uncorrelated within panels
- Cross-panel independence
    - Error terms are independent across panels
- Strict exogeneity
    - Error terms and explanatory variables are independent

Assumption of conditional homoscedasticity across panels

- **Likelihood ratio test**
  - **Compares log-likelihoods under restricted and unrestricted model based on iterated generalised least square estimates.**

Model 1	**LR chi2 (62) = 18501.32**	**Prob. = 0.00**
Model 2	**LR chi2 (62) = 103014.77**	**Prob. = 0.00**
Model 3	**LR chi2 (62) = 74980.00**	**Prob. = 0.00**

- **Assumption of conditional homoscedasticity rejected!**

Assumption of serial independence

- Wooldridge test
  - Based on residuals of regressions in first differences which are then regressed on lagged value t-1
  - Test is robust to conditional heteroskedasticity

Model 1	F (1, 62) = 14.388	Prob. = 0.00
Model 2	F (1, 62) = 3.076	Prob. = 0.08
Model 3	F (1, 62) = 23.636	Prob. = 0.00

- Assumption of serial independence rejected!

Assumption of cross-panel independence

- **Pesaran, Friedman, Frees tests**

Model 1	**Frees = 11.116**	**Prob. = 0.00**
	Pesaran = 363.108	**Prob. = 0.00**
	Friedman = 11728.05	**Prob. = 0.00**
Model 2	**Frees = 7.06**	**Prob. = 0.00**
	Pesaran = 147.08	**Prob. = 0.00**
	Friedman = 7378.70	**Prob. = 0.00**
Model 3	**Frees = 4.81**	**Prob. = 0.00**
	Pesaran = 120.80	**Prob. = 0.00**
	Friedman = 5744.16	**Prob. = 0.00**

- **Assumption of cross-sectional independence rejected!**

Random- versus fixed-effects

- **High correlation btw individual level effects and explanatory variables**
- **Breusch-Pagan LR test of random effects**
  - **Compares log-likelihoods under restricted and unrestricted model based on iterated generalised least square estimates**

Model 1	**LR test = 3.06E05**	**Prob. = 0.00**
Model 2	**LR test = 4.33E04**	**Prob. = 0.00**
Model 3	**LR test = 2.30E05**	**Prob. = 0.00**

- **Random-effects rejected!**

OeNB

Assumption of strict exogeneity

- Fundamental assumption
  - Error terms are not influenced by past, current or future values of explanatory variables
  - Values of explanatory variables are not influenced by past, current or future values of error terms
- Simulation design ensures strict exogeneity
  - Values of explanatory variables are empirical observations
  - Error terms cannot influence values of explanatory variables
    - E.g. banks cannot adjust liquidity holdings, node or network characteristics in response to observed error terms

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Network Indicators

Panel Data Analysis:

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# contagious bank defaults	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	3.28	4.02	3.38	2.32	14.73	6.97	4.63	-0.93
	13.71	16.58	3.08	5.14	10.10	14.04	7.25	-3.05
Liquidity	-1.05E-10	-9.69E-11	-9.91E-11	-8.39E-10	-9.31E-11	-9.40E-11	-9.70E-11	-1.18E-10
	-8.19	***-8.05***	***-9.16***	***-7.87***	***-7.56***	***-16.00***	***-7.67***	***-9.65***
SimUnrVol	1.65E-09	1.66E-09	7.77E-10	8.06E-10	1.01E-09	1.43E-09	1.07E-09	9.37E-10
	59.21	***58.92***	***28.64***	***30.80***	***38.61***	***55.18***	***0.00***	***33.17***
Transfer*SimUnrVol	2.51E-10	2.52E-10	6.12E-10	6.00E-10	5.27E-10	2.58E-10	5.44E-10	5.06E-10
	8.99	***8.93***	***23.28***	***23.92***	***20.57***	***9.66***	***19.29***	***19.42***
Nodedegree			9.20E-02					
			59.92					
Nodeconnectivity				1.22E+01				
				59.88				
Nodeavgpath					-8.09E+00			
					-56.71			
Nodeclusterindex						-4.00E+00		
						-51.65		
Nodebetweenness							3.38E+01	
							26.37	
Nodedissimilarity								1.11E+01
								40.07
Netvolume		-1.88E-11						
		-7.76						
Netavgdegree			-1.60E-01					
			-2.24					
Netconnectivity				-3.25E+01				
				-3.25				
Netavgpath					1.51E+00			
					2.52			
Netavgclusterindex						-3.60E+00		
						-3.42		
Netavgbetweeness							-3.42E+02	
							-3.00	
Netavgdissimilarity								3.00E-02
								0.82
R^2	69.23	69.35	69.96	**72.41**	71.58	70.88	66.54	68.69
Relative impact of Transfer Account (in %)	15%	15%	79%	74%	52%	18%	51%	54%

B

# contagious unsettled payments	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	7.32	9.90	-3.06	0.57	35.54	12.55	4.73	-0.36
	7.95	*10.67*	-0.93	0.34	*6.38*	*6.93*	*2.13*	-0.35
Liquidity	-2.79E-10	-2.49E+00	-2.70E-10	-1.97E-10	-2.25E-10	-2.52E-10	-2.59E-10	-2.91E-10
	-5.65	***-5.44***	***-6.18***	***-4.57***	***-4.75***	***-5.43***	***-5.29***	***-6.24***
SimUnrVol	6.61E-09	6.67E-09	4.97E-09	4.94E-09	5.32E-09	6.29E-09	5.59E-09	5.41E-09
	41.91	***41.84***	***24.31***	***24.17***	***28.22***	***38.61***	***22.59***	***26.62***
Transfer*SimUnrVol	2.40E-09	2.38E-09	3.10E-09	3.10E-09	2.95E-09	2.45E-09	2.91E-09	2.84E-09
	8.36	***8.29***	***10.53***	***10.55***	***10.08***	***8.49***	***9.52***	***9.72***
Nodedegree			1.80E-01					
			13.51					
Nodeconnectivity				2.46E+01				
				13.85				
Nodeavgpath					-1.71E+01			
					-13.92			
Nodeclusterindex						-6.25E+00		
						-10.84		
Nodebetweenness							5.40E+01	
							5.65	
Nodedissimilarity								1.90E+01
								10.02
Netvolume		-6.67E-11						
		-8.15						
Netavgdegree			5.10E-01					
			1.93					
Netconnectivity				3.09E+01				
				0.86				
Netavgpath					1.21E+00			
					0.56			
Netavgclusterindex						-5.29E+00		
						-1.40		
Netavgbetweeness							4.27E+02	
							1.09	
Netavgdissimilarity								5.00E-02
								0.52
R^2	39.79	39.81	39.90	40.01	40.02	39.77	39.72	39.67
Relative impact of Transfer Account (in %)	36%	36%	62%	63%	55%	39%	52%	52%

Value of contagious unsettled payments	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	5.22E+07	7.37E+07	2.47E+07	3.63E+07	2.87E+08	5.94E+07	4.24E+07	5.35E+07
	5.30	*7.16*	0.59	1.70	*4.08*	*2.63*	1.44	*4.59*
Liquidity	-2.70E-03	-2.19E-03	-2.70E-03	-2.50E-03	-2.10E-03	-2.68E-03	-2.62E-03	-2.72E-03
	-5.01	***-4.29***	***-5.08***	***-4.72***	***-3.57***	***-4.77***	***-4.80***	***-4.97***
SimUnrVol	9.56E-02	9.60E-02	9.22E-02	9.04E-02	9.09E-02	9.72E-02	9.65E-02	9.56E-02
	47.60	***47.77***	***35.69***	***35.17***	***38.17***	***45.99***	***33.87***	***36.91***
Transfer*SimUnrVol	1.59E-01	1.59E-01	1.60E-01	1.61E-01	1.61E-01	1.58E-01	1.58E-01	1.59E-01
	34.54	***34.48***	***34.24***	***34.39***	***34.55***	***34.60***	***33.08***	***34.04***
Nodedegree			3.33E+05					
			2.34					
Nodeconnectivity				6.85E+07				
				3.63				
Nodeavgpath					-5.76E+07			
					-4.42			
Nodeclusterindex						2.78E+07		
						3.66		
Nodebetweenness							-4.65E+07	
							-0.53	
Nodedissimilarity								-2.52E+06
								-0.12
Netvolume		6.20E-04						
		-5.49						
Netavgdegree			1.76E+06					
			0.52					
Netconnectivity				7.28E+07				
				0.16				
Netavgpath					-5.32E+07			
					-1.92			
Netavgclusterindex						-5.39E+07		
						-1.11		
Netavgbetweeness							1.93E+07	
							0.36	
Netavgdissimilarity								5.25E+05
								0.41
R^2	70.62	70.63	70.64	70.65	70.69	70.68	70.60	70.61
Relative impact of Transfer Account (in %)	166%	166%	174%	178%	177%	163%	164%	166%