The Structure of the Mexican Interbank Market

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Outline

- Introduction
- Interbank tiering model
- Data
- Results
- Robustness checks and significance tests
- Conclusions

Motivation

- The structure of the interbank market is a key element in achieving the two more common mandates of central banks:

  - **Price stability.** Monetary policymakers would like to know whether it plays a role in the mechanisms through which monetary policy impacts real economic activity and inflation.

  - **Financial stability.** The structure of the interbank network is a critical determinant of systemic risk because the propagation mechanism depends greatly on network topology.

Evidence

- The study of the topology of interbank markets in various countries has shed light on the properties of these networks.
- The evidence shows that (Ficke and Lux, 2012):
    i. interbank networks are sparse,
    ii. degree distributions and transaction volumes appear to be scale-free,
    iii. clustering coefficients are usually quite small,
    iv. interbank networks are close to small-world structures, and
    v. the networks show disassortative mixing.

Models

- The lack of detailed data usually represents a barrier to study the properties of real-world interbank networks.
  - Complete networks -> Maximum Entropy (Upper and Worms, 2004; van Lelyveld and Liedorp, 2006; Mistrulli, 2007).
  - Random networks -> Random graphs (Erdös and Rényi, 1959), Small-world (Watts and Strogatz, 1998), Scale-free (Barabási and Albert, 1999).
  - Core-periphery networks (Borgatti and Everett, 1999; Craig and von Peter, 2011).

Evidence: Interbank tiering

- Indirect tests of tiering have been conducted for the **U.S.** (Furffine, 1999) and **Japan** (Imakubo and Soejima, 2010).

- Minoiu and Reyes (2012) suggest tiering in a global banking network.

- Direct tests of tiering has been conducted for the interbank markets in **Germany** (Craig and von Peter, 2010), **Italy** (Ficke and Lux, 2012) and the **Netherlands** (van Lelyveld and in 't Veld, 2012).

- All these cases support interbank tiering.

Tiering definitions

- **Interbank intermediation.** An interbank intermediary is a bank acting both as lender and borrower in the interbank market.
- **Interbank tiering.** Some banks (the top tier) lend to each other and intermediate between other banks, which participate in the interbank market only via these top-tier banks.

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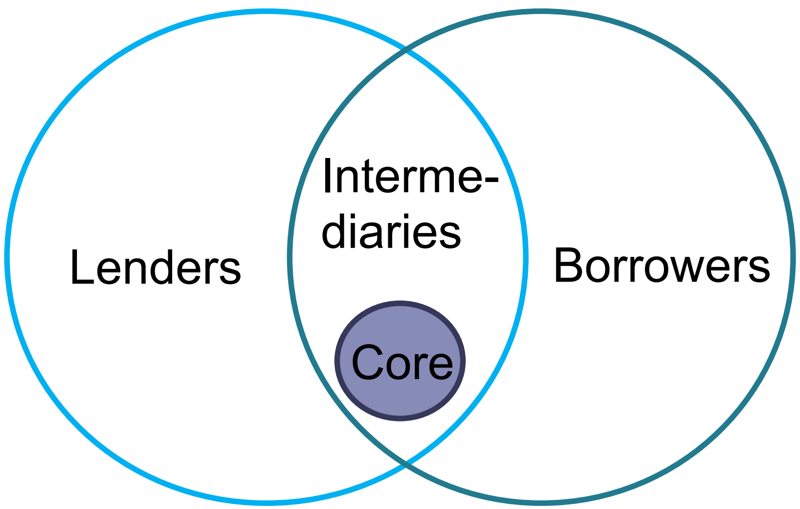
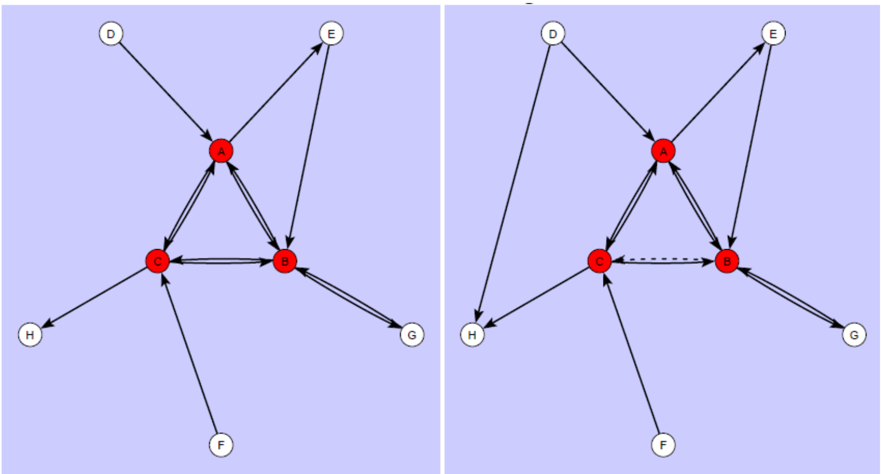


Tiering model

- Two tiers: core and periphery.
- In a perfectly tiered structure, banks in the core are linked to each other and to those in the periphery, while banks in the periphery are only linked to those in the core.
- The key characteristic of core banks is that they intermediate between those in the periphery.



Source: Craig y von Peter (2011).

Estimation

$$\mathrm{T} = \begin{pmatrix} \mathrm{CC} & \mathrm{CP} \\ \mathrm{PC} & \mathrm{PP} \end{pmatrix} = \begin{pmatrix} 1 & \mathrm{RR} \\ \mathrm{CR} & 0 \end{pmatrix}$$

Estimation

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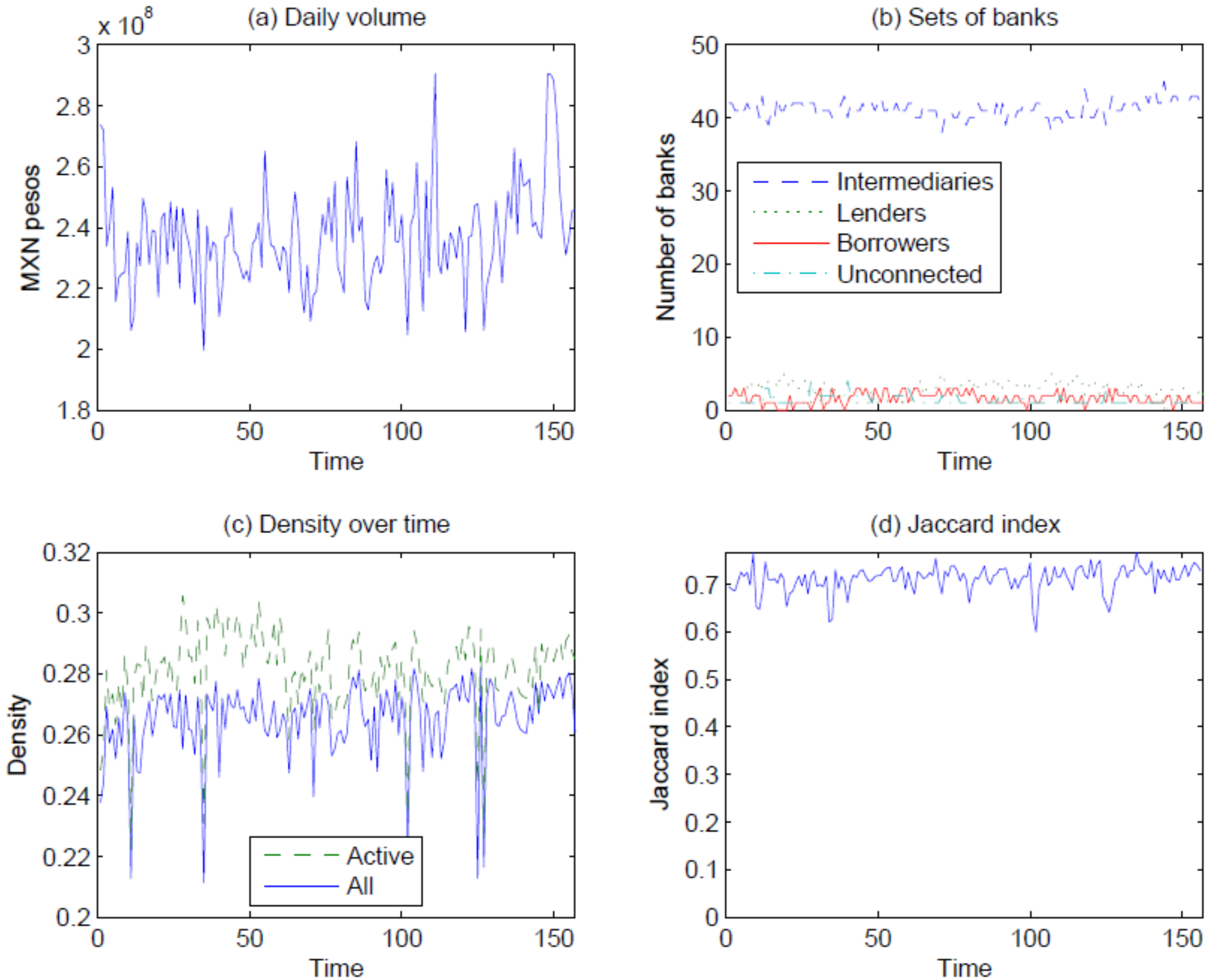
$$E = \begin{pmatrix} c\,(c-1) - \sum_{i \in C} \sum_{j \in C} N_{ij} & (n-c) \sum_{i \in C} \max\left\{0, 1 - \sum_{j \notin C} N_{ij}\right\} \\ (n-c) \sum_{j \in C} \max\left\{0, 1 - \sum_{i \notin C} N_{ij}\right\} & \sum_{i \notin C} \sum_{j \notin C} N_{ij} \end{pmatrix}$$

$$e = \frac{E_{11} + E_{22} + (E_{12} + E_{21})}{\sum_i \sum_j N_{ij}}.$$

Data

- Daily data from January 3 to August 15, 2011 (157 matrices).
- Bilateral exposures between 41 commercial banks and 6 development banks.
- Exposures:
  - deposits, credits and loans
  - issuer (commercial bank securities)
  - counterparty (repos, derivatives)
  - FX

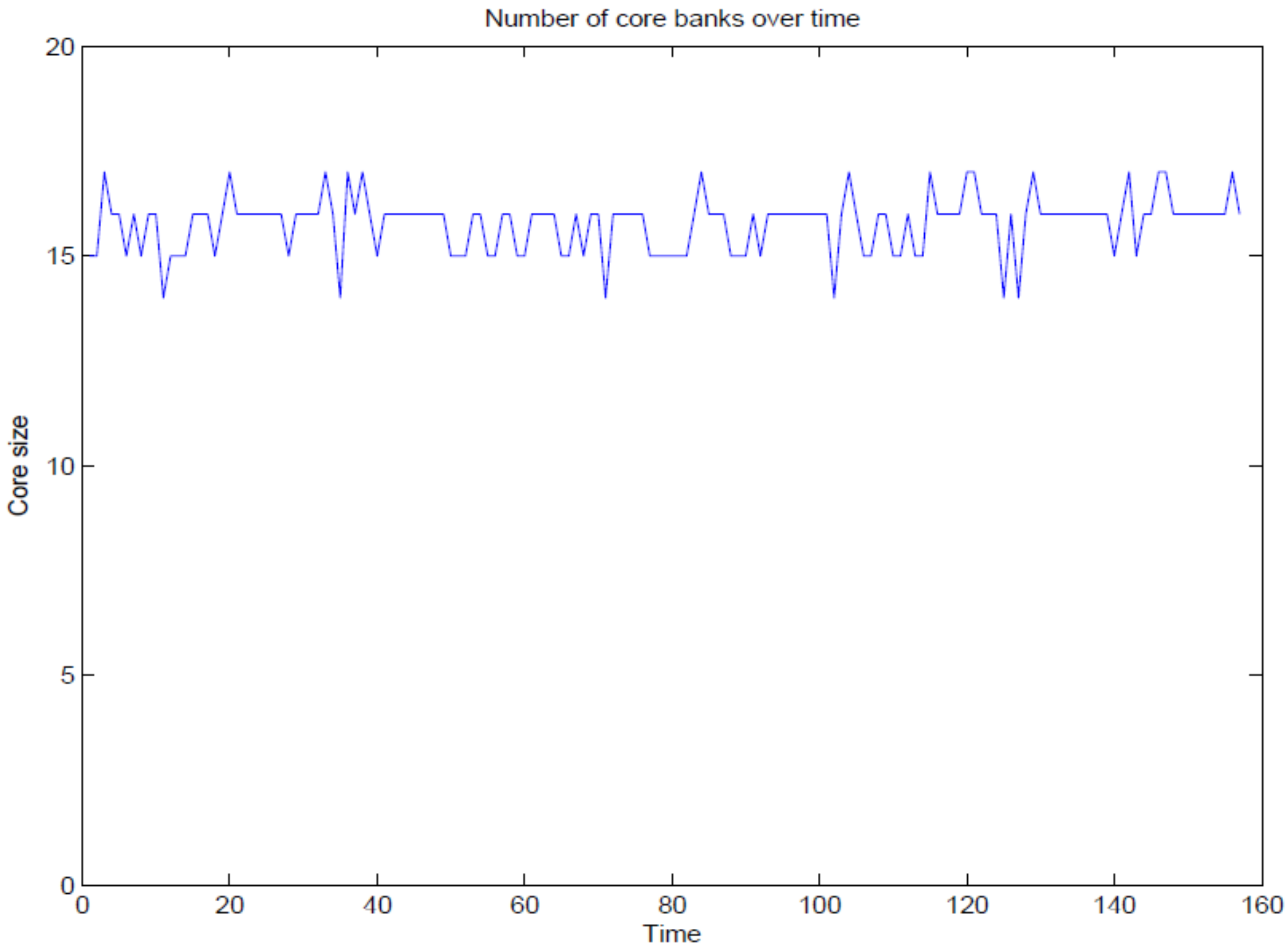
Statistics


(a) Daily volume
x 10^8
MXN pesos
Time
(b) Sets of banks
Number of banks
Intermediaries
Lenders
Borrowers
Unconnected
Time
(c) Density over time
Density
Active
All
Time
(d) Jaccard index
Jaccard index
Time

Statistics per type of exposure

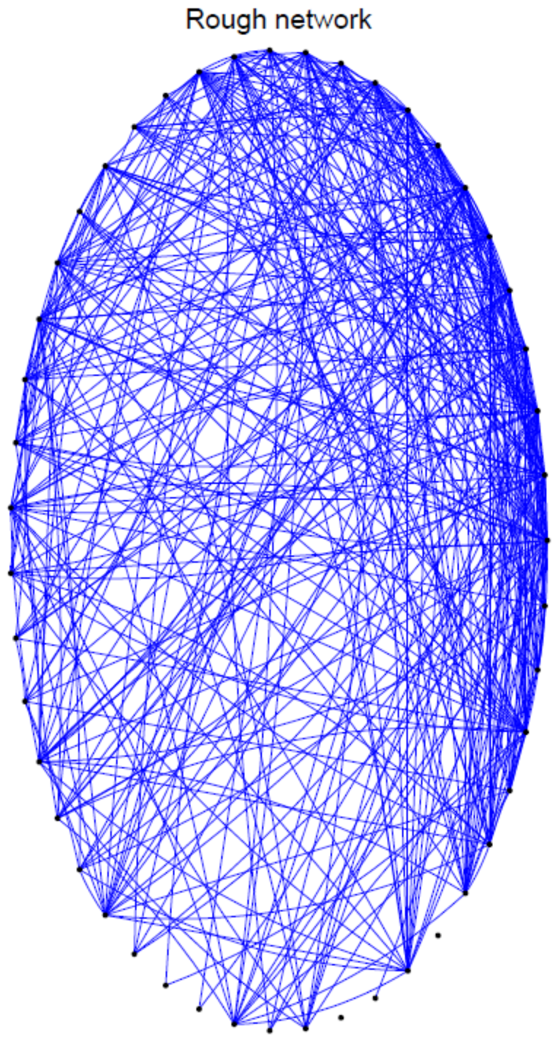
	Interbank	Issuer	Countpty	FX
Volume (MXN mill.)	48.2	148.1	14.1	26.4
Intermediaries	29.97	21.29	33.1	25.3
Lenders	5.52	9.75	2.79	0
Borrowers	3.43	2.73	4.44	0.01
Unconnected	8.08	13.24	6.68	21.69
N density (%)	8.16	7.59	11.24	6.92
Density of active (%)	11.98	14.86	15.34	24.64
Jaccard index	0.76	0.96	0.51	0.48

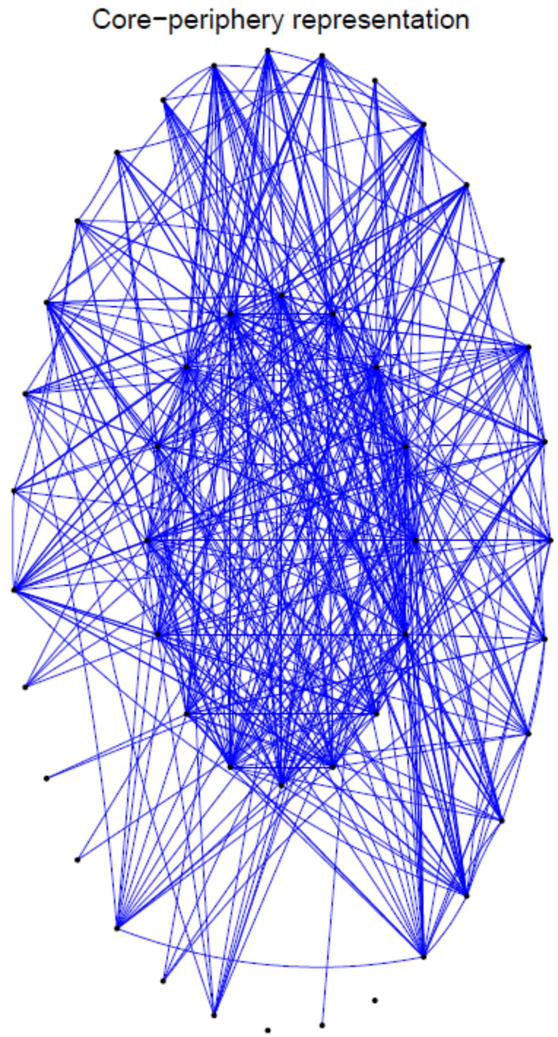
Results



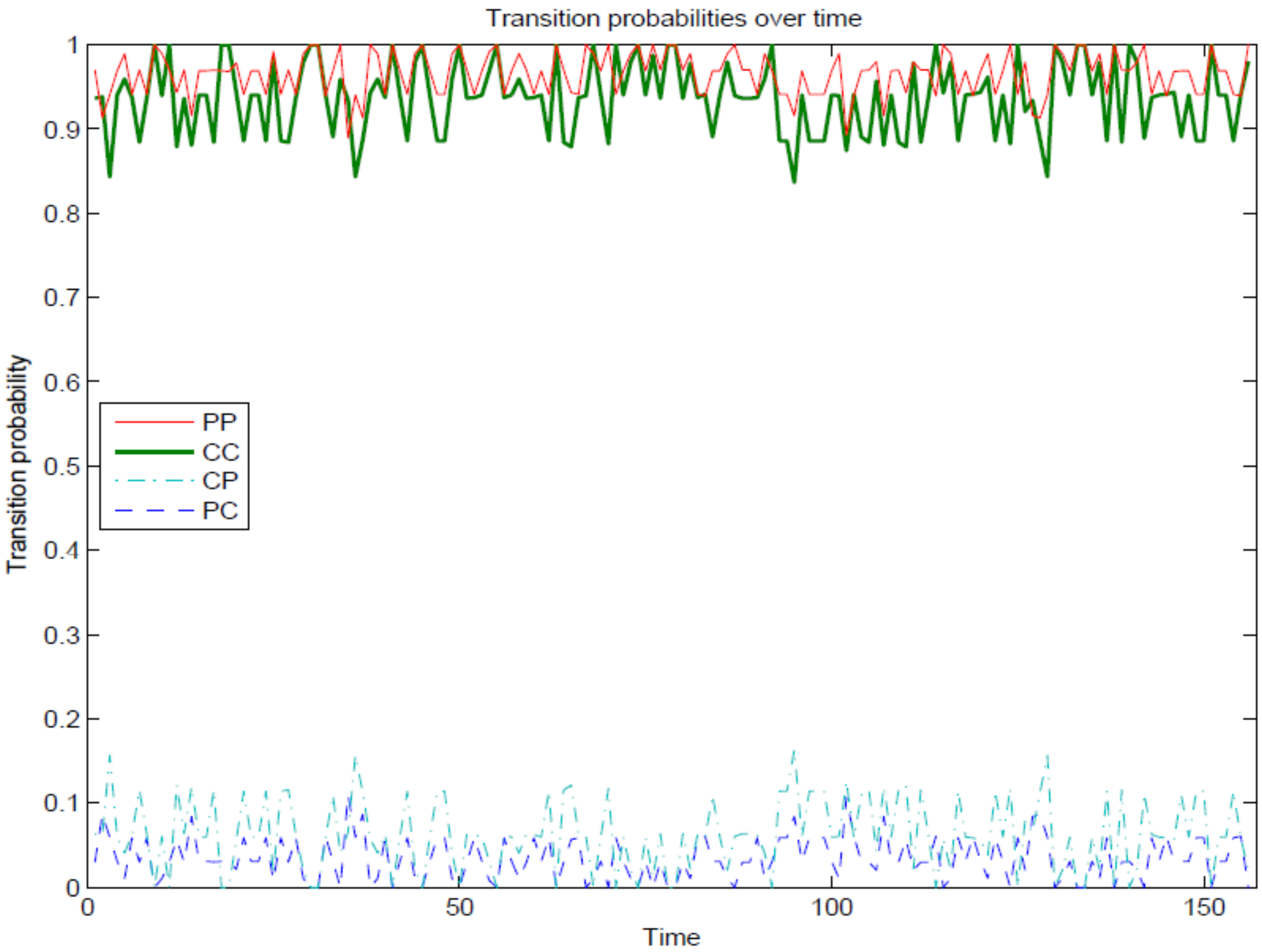
Number of core banks over time
Core size
Time
0
5
10
15
20
0
20
40
60
80
100
120
140
160

Core-periphery representation





Transition probabilities over time



Tiering in Europe and Mexico

	Germany	Italy	Netherlands	Mexico
Banks	2182	118	100	47
Active banks	1802	118	100	46
Intermediaries as % of banks	76.6	75	-	87.7
Core size	45	32	15	16
Core size as % of interm.	2.7	36	-	38.3
Error score	0.12	0.42	0.29	0.25
N density (%)	0.41	21	8	26
CC density (%)	66	56	-	74.2
$P_{core \to core}$ (%)	94	83.2	83	94.06
$P_{periph. \to periph.}$ (%)	99.1	90.5	96	96.96
$P_{core \to periph.}$ (%)	4.9	15.6	16	5.94
$P_{periph. \to core}$ (%)	0.1	5.55	2	3.04
Data frequency	Qtrly.	Qtrly.	Qtrly.	Daily

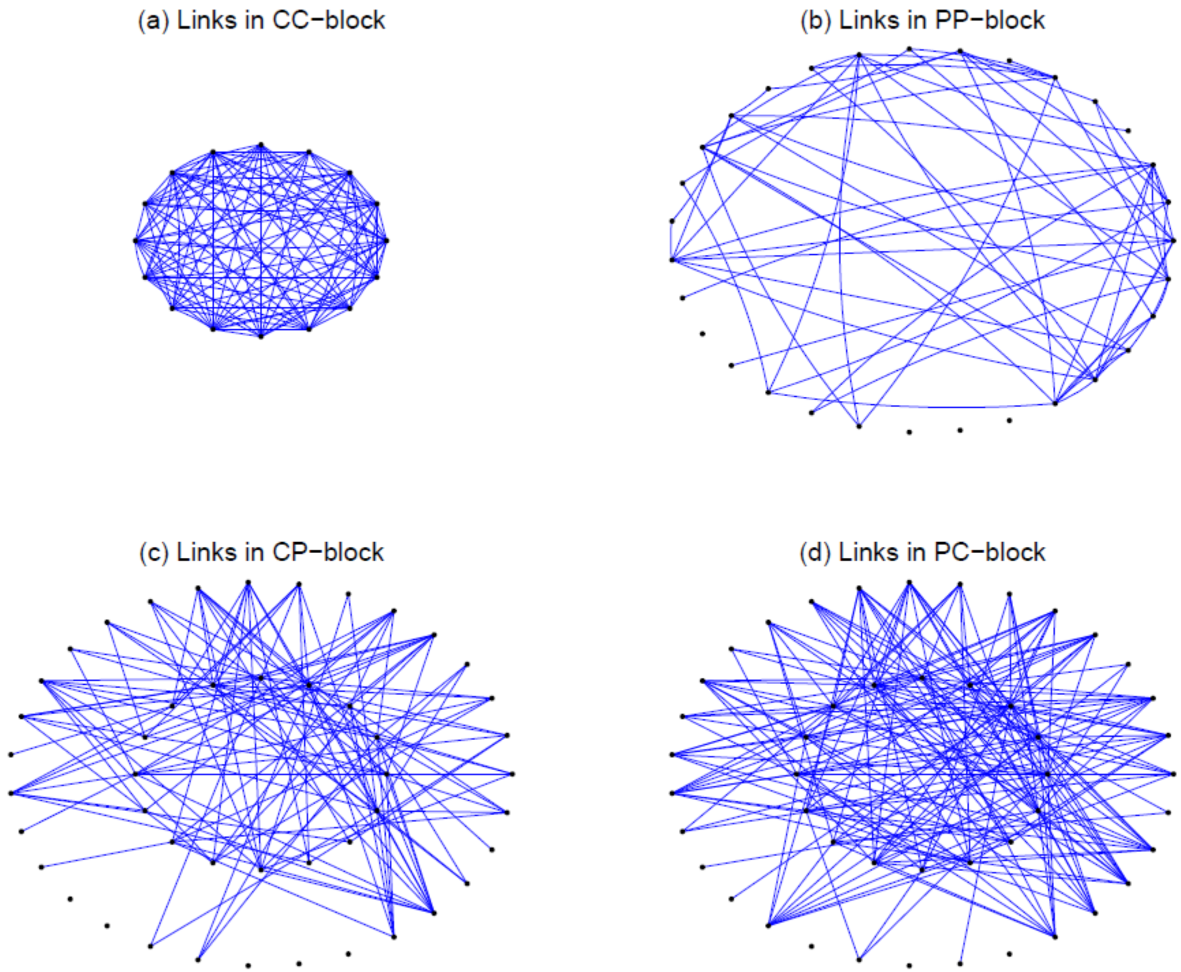
Source: Craig and von Peter, 2011 (Germany); Fricke and Lux, 2012 (Italy) and van Lelyveld and in 't Veld, 2012 (Netherlands).

Asymmetry

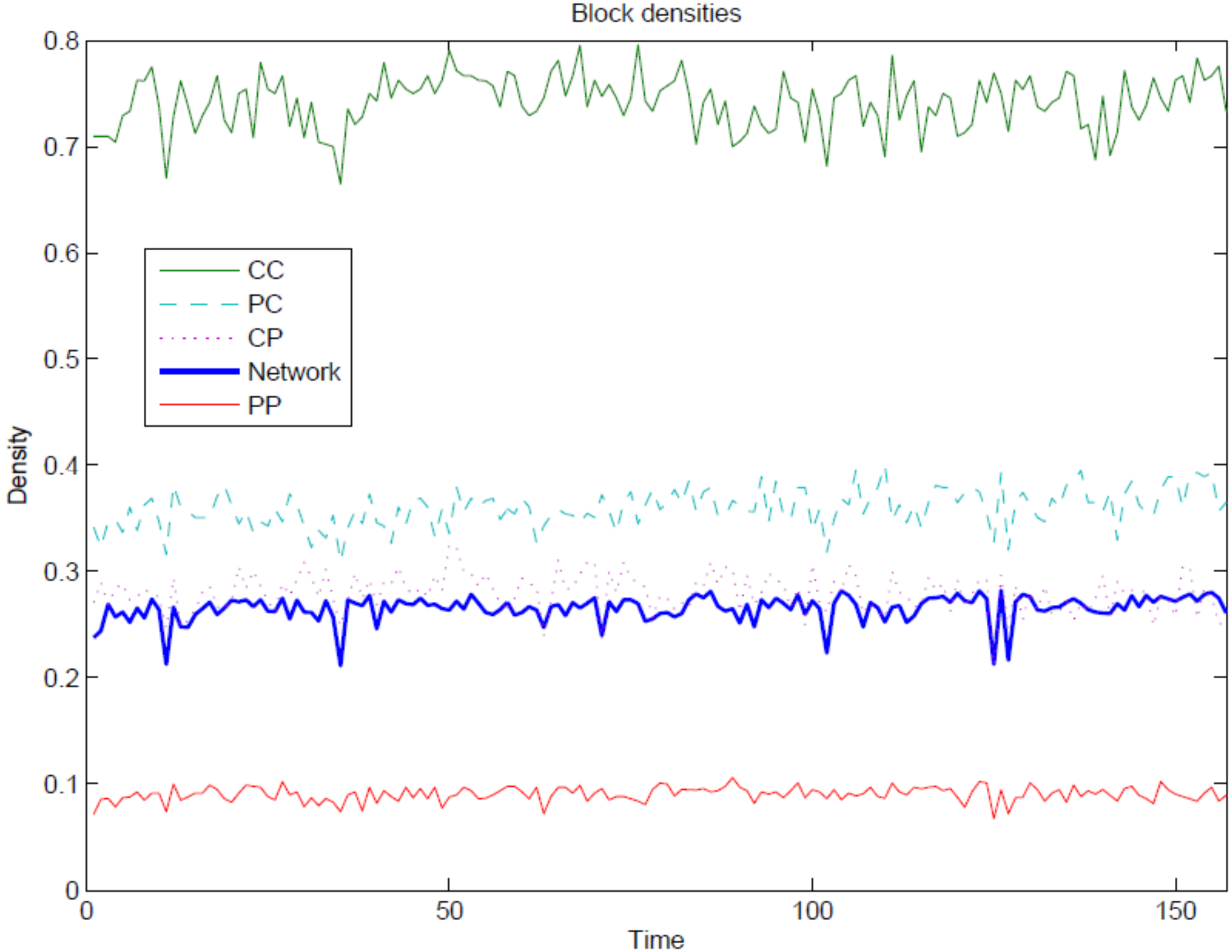
- An interesting finding from applying the core-periphery model to the Mexican interbank networks is that the lending and borrowing between the tiers differ.
  - There exists asymmetry between the lending core banks provide to those in the periphery (CP-block) and the borrowing the former receive from the latter (PC-block).

	Transaction volumes (%)	Transition probabilities (%)	Densities (%)
CC-block	51.37	94.06	74.19
PP-block	7.72	96.96	9.03
CP-block	20.3	5.94	27.93
PC-block	20.61	3.04	35.86

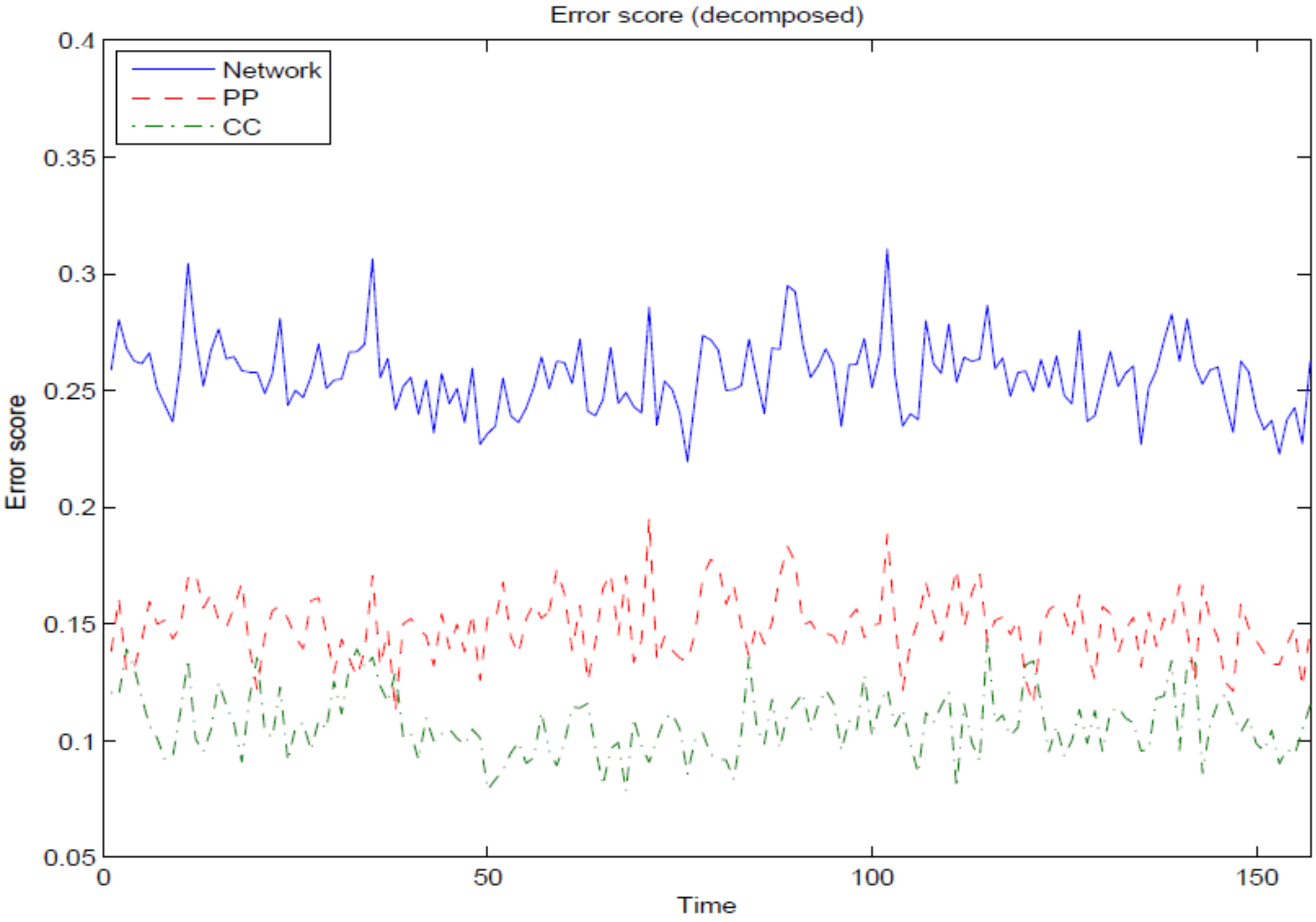
Core-periphery links per block



Asymmetry


Block densities
Density
Time
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
50
100
150
CC
PC
CP
Network
PP

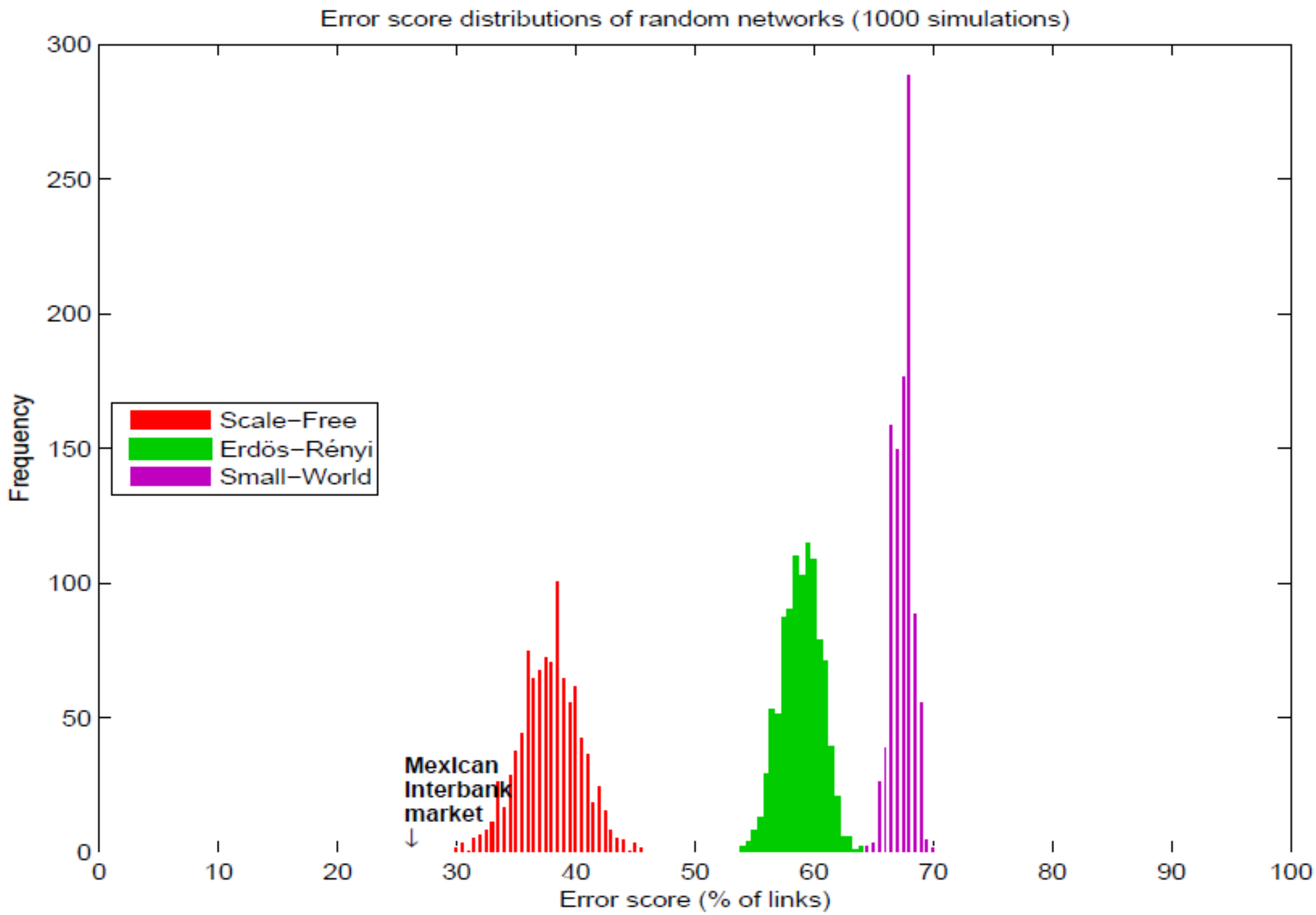
Error score


Error score (decomposed)
Network
PP
CC
Error score
Time
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
50
100
150

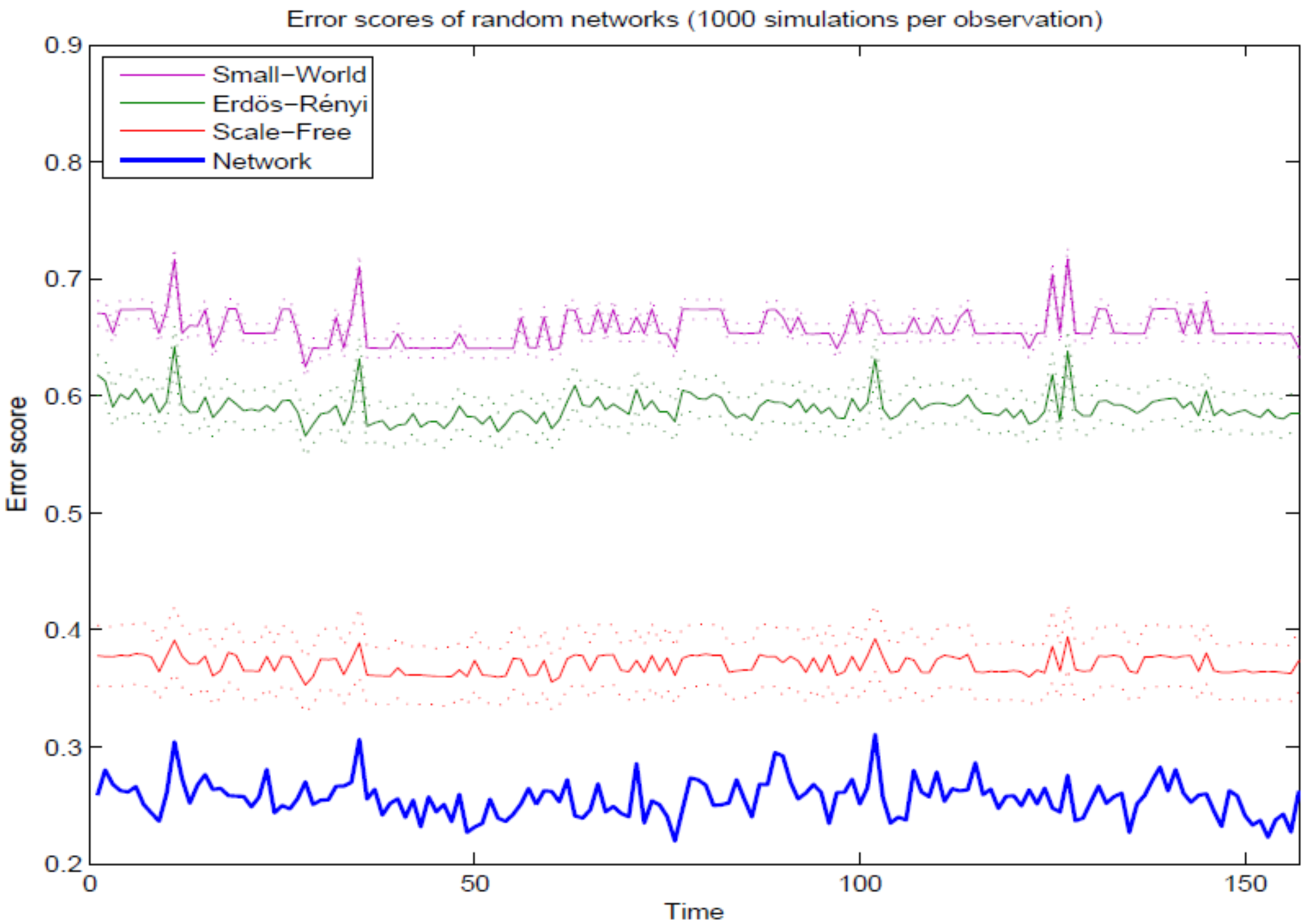
Significance tests

- It is important to assess the extent of tiering observed.
- **Strategy:** Fitting the model to simulated random networks with similar characteristics (dimension and density) as the original network and calculating the error score from the corresponding theoretical tiered network per simulation.
  - If the error score of the optimal core for actual networks is lower than a predefined percentile of the distribution of error scores obtained from the simulated random networks, it is then rejected that the original network is random.
- The random models used for the simulations are:
  - Erdös-Rényi
  - Small-World
  - Scale-Free

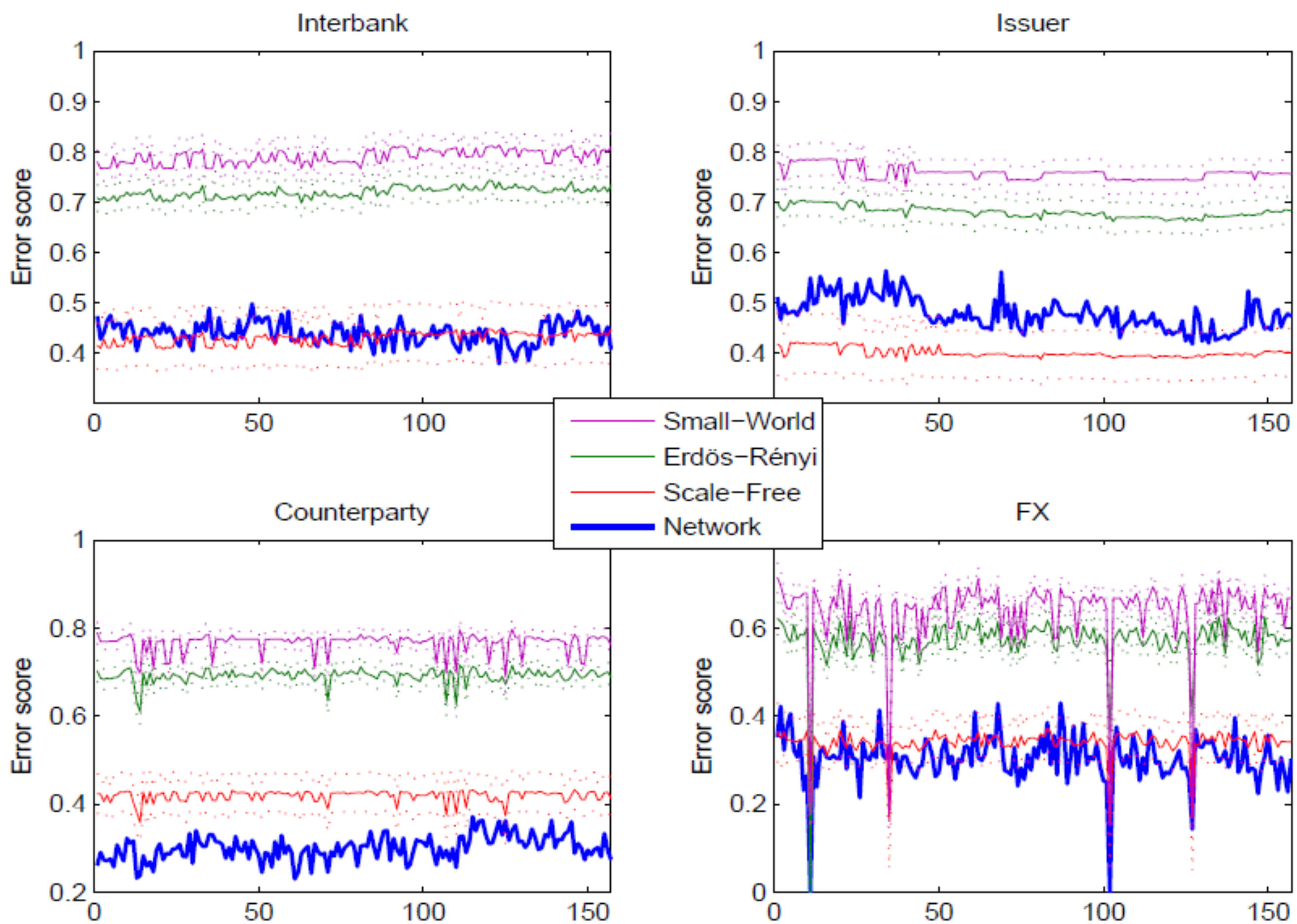
Significance test 1



Significance test 2



Significance test per type of exposure



Robustness checks

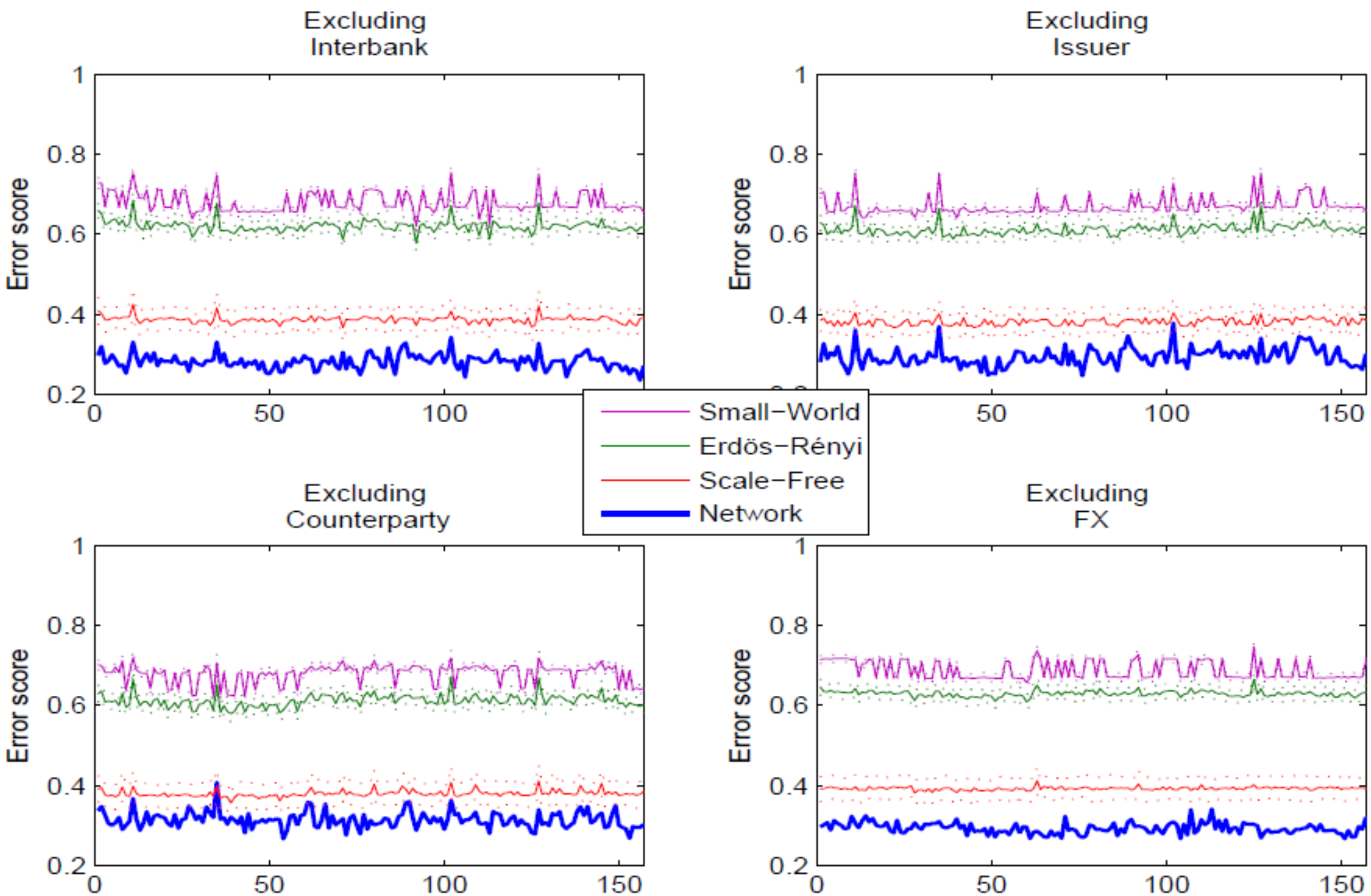
- Removing banks from the core

	Bank removed				
	A	B	C	D	E
N density (%)	24	24	25	24	24
Core size	15.09	15.01	15.19	15.13	15.08
CC density (%)	73	73	74	72	72
Error score	0.266	0.2686	0.2590	0.2681	0.269

- Changing the weights to the errors in each tier

	Balanced	Tighter core	Tighter periphery
Core size	15.8	15.09	16.83
CC density (%)	74	76	72
Error score	0.2562	0.2476	0.2629

Robustness checks



Conclusions

- Evidence that the Mexican interbank market is tiered.
  - There are money center banks that intermediate between the other banks in the market.
- The size and the composition of the core is remarkably stable over time.
  - Core size is greater than what is commonly used (G7).
- It is possible to identify which banks are in the core and the market(s) where they play a significant role.
- It has also been found that the relation between the tiers is asymmetric.
  - Periphery banks are more prone to lend to rather than to borrow from the core.
  - It is more likely that a bank leaves the core than becoming part of it.

Conclusions

- The results are robust and significant.
- This may help financial authorities to focus resources when carrying out their duties regarding the financial safety net in Mexico.
  - Additional criteria for determining ‘systemicness’?
- A similar analysis can be made with a broader set of financial institutions (insurers, investment firms, pension funds and foreign financial institutions).

Conclusions

- The findings in this paper can be complemented with the analysis of topological measures of the networks, mainly those using valued networks.
- The work in this paper can also be extended to study the effects of the recent financial crisis on the Mexican interbank structure.
  - Recent studies (van Lelyveld and in 't Veld, 2012; Fricke and Lux, 2012) have pointed out that the structure changes (the core size and the density in the CC-block tend to decrease) during a crisis and that a crisis mainly affects the behavior of core banks and the volume of transactions.