Exploring Informative Scales of Labor Networks in Argentina

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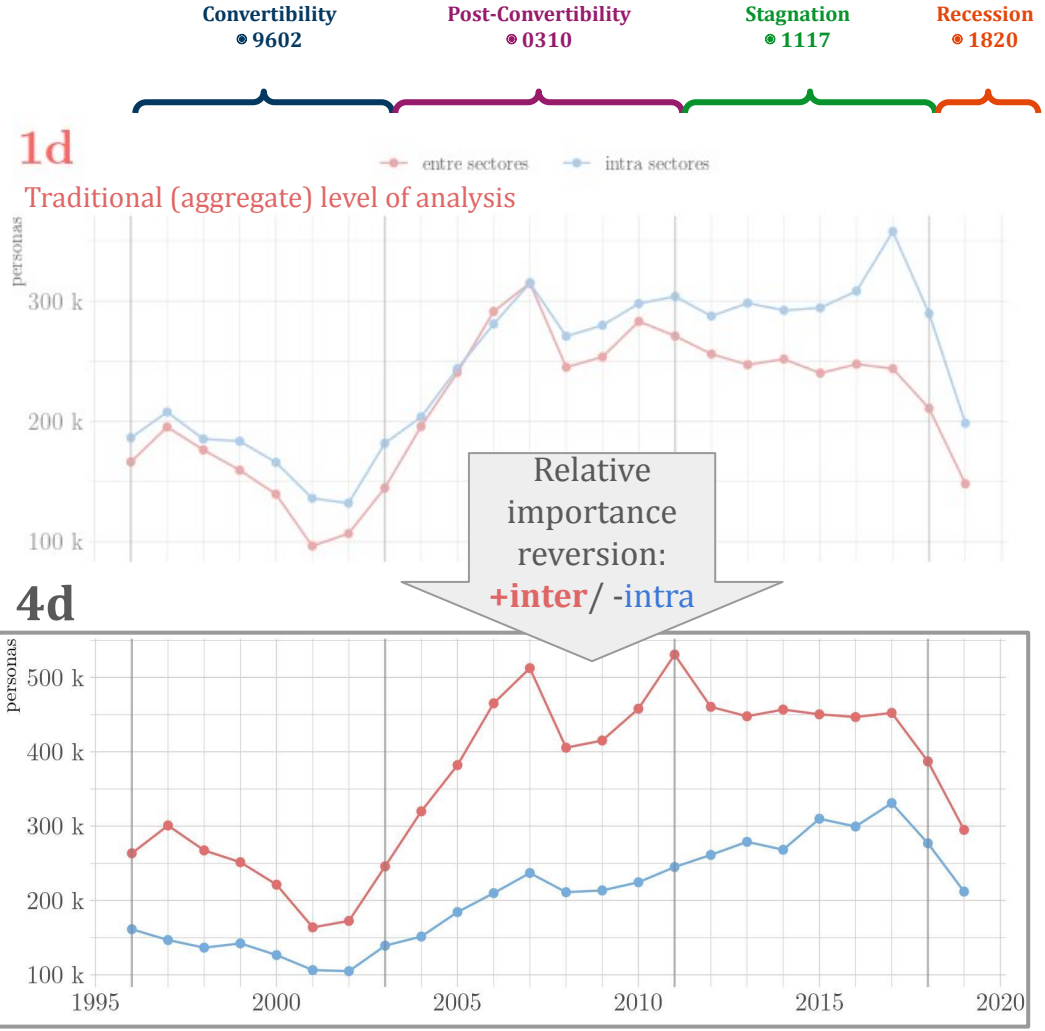
Labor Flow Networks (LFN)

- Economics of labor flows
  - **Job-to-job transitions** carry information about skills (co-)demanded in **different economic activities**
  - **ARGENTINA**: network structure findings
    - Flows (De Raco and Semeshenko, 2019a, De Raco, 2021)
      - High prevalence of low-weight flows
      - Dense network with small world, core-periphery and community structure
    - Skill-Relatedness (De Raco and Semeshenko, 2019a, 2019b, De Raco, Tumini and Ernst, 2019c)
      - Industry space with heterogeneous max k-core, less specialized (vs GER)
- Exploration of representative flows structure and informative scales
  - Data thresholding (focus on “labor flow corridors”)
  - Sparser networks
  - Entropy-based framework: Effective information (Klein and Hoel, 2020, Hoel et al., 2013)
    - Coarse graining (macronodes)
    - Meso-structure

Data

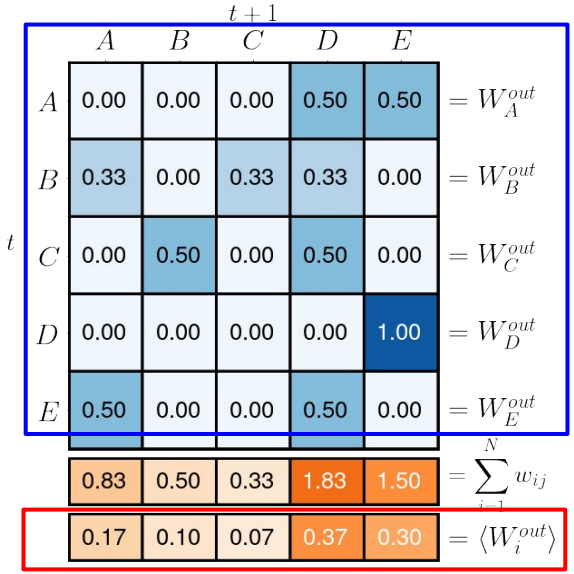
- Inter-sectoral job-to-job transitions
- Source: administrative data
  - 1996-2020 year-over-year (24 time periods)
  - 4d economic activity ISIC Rev 3 (287 sectors)
  - Flows >= 40 pers/year (1.4k median links, 177k med. flows)

Argentine Integrated Pension System (SIPA)



Methods

- Effective Information (EI): Entropy-based coarse graining
- Economic application to labor networks (novelty)



t \ $t+1$	A	B	C	D	E	
A	0.00	0.00	0.00	0.50	0.50	$= W_A^{out}$
B	0.33	0.00	0.33	0.33	0.00	$= W_B^{out}$
C	0.00	0.50	0.00	0.50	0.00	$= W_C^{out}$
D	0.00	0.00	0.00	0.00	1.00	$= W_D^{out}$
E	0.50	0.00	0.00	0.50	0.00	$= W_E^{out}$
	0.83	0.50	0.33	1.83	1.50	$= \sum_{i}^{N} w_{ij}$
	0.17	0.10	0.07	0.37	0.30	$= \langle W_i^{out} \rangle$

$$EI = H\left(\left\langle W_i^{\text{out}} \right\rangle\right) - \left\langle H\left(W_i^{\text{out}}\right)\right\rangle$$

$$\text{determinism} = \log_2(N) - \left\langle H\left(W_i^{\text{out}}\right)\right\rangle$$

$$\text{degeneracy} = \log_2(N) - H\left(\left\langle W_i^{\text{out}} \right\rangle\right)$$

$$EI = \text{determinism} - \text{degeneracy}$$

$$\text{effectiveness} = \frac{EI}{\log_2(N)}.$$

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The Emergence of Informative Higher Scales in Complex Networks

Brennan Klein [1,2] and Erik Hoel [3]

RESEARCH ARTICLE | BIOPHYSICS AND COMPUTATIONAL BIOLOGY

Quantifying causal emergence shows that macro can beat micro

Erik P. Hoel, Larissa Albantakis, and Giulio Tononi | Authors Info & Affiliations

Edited by Michael S. Gazzaniga, University of California, Santa Barbara, CA, and approved October 22, 2013 (received for review August 6, 2013)

November 18, 2013 | 110 (49) 19790-19795 | https://doi.org/10.1073/pnas.1314922110

arXiv:1908.07565 (cs)

[Submitted on 20 Aug 2019 (v1), last revised 16 Feb 2022 (this version, v2)]

Finding the right scale of a network: Efficient identification of causal emergence through spectral clustering

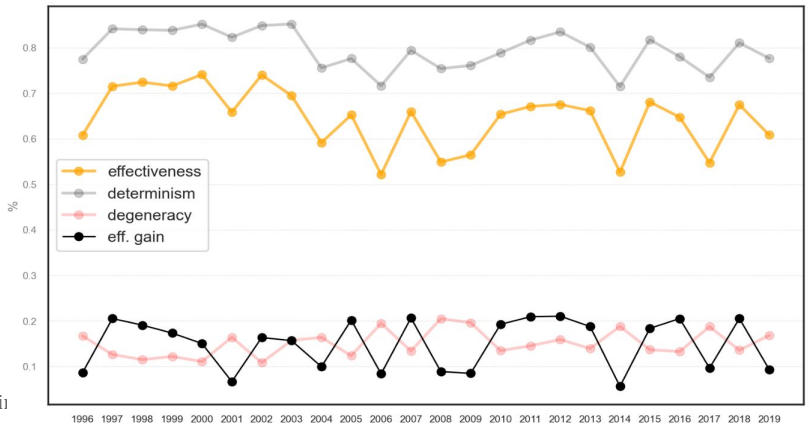
Ross Griebenow, Brennan Klein, Erik Hoel

Klein, B., & Hoel, E. (2020). The emergence of informative higher scales in complex networks. *Complexity*, *2020*, 1-12.

Effectiveness, determinism, and degeneracy

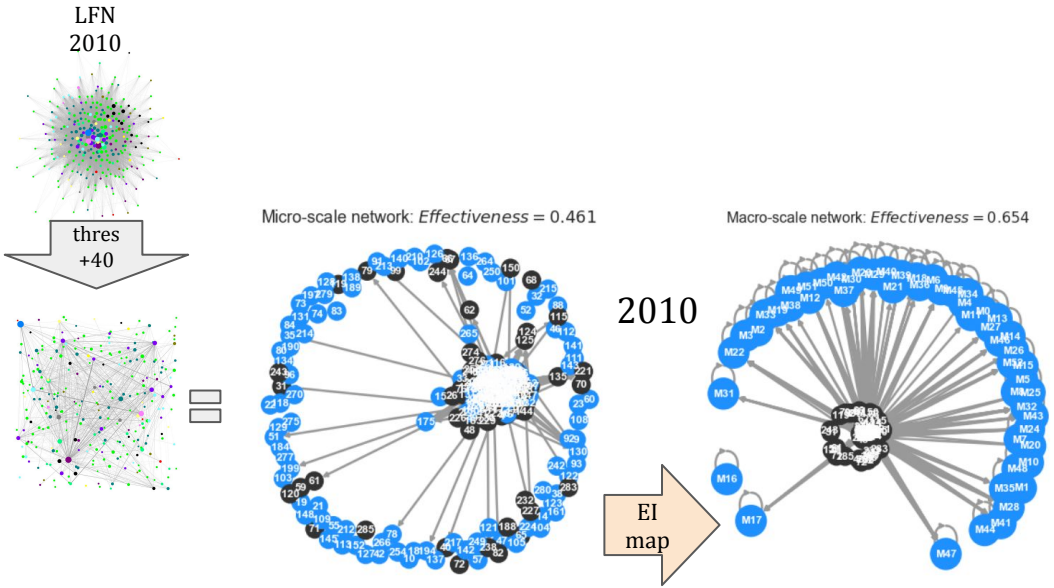
- Informative macroscales:
  Effectiveness correlates positively with number of macronodes (#20-42)

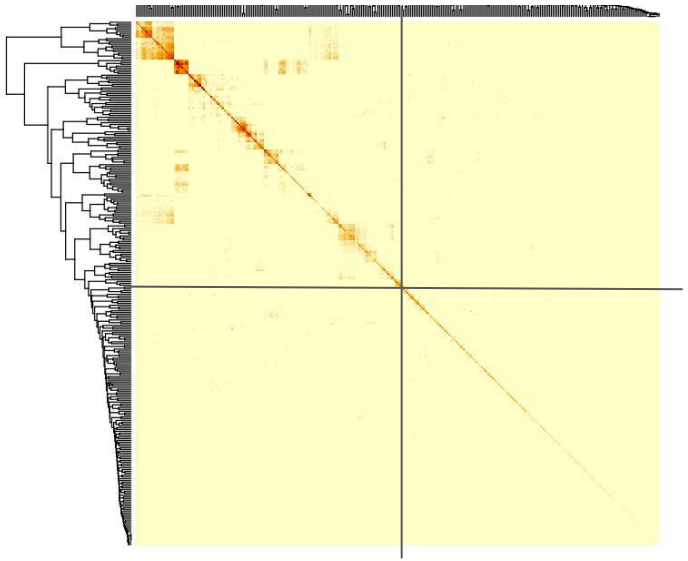
- High determinism, low degeneracy
- Relatively low effectiveness gain



Macronodes

- Prevalence of small groupings (2-4 micronodes)
- Co-occurrence of micronodes in macronodes show low persistence





Findings

- EI coarse graining provides a principled more informative scale (information gain) of LFN
- EI requires data flow filtering for spectral clustering (challenge: economics!)
- Original labor networks (dense, lack of connectivity specificity)
  - **Low EI**, with low degeneracy and low determinism
  - Lack of connectivity specificity
- Filtered labor networks (sparser)
  - **Higher EI** (2x), as other technological networks, with high determinism, low degeneracy
  - Low persistence of macronodes memberships

Work ahead

- Filtering criteria exploration
- Macronodes
  - Stability
  - Mesostructure in comparison with
    - Communities / core-periphery
    - Data granularity
- Motif analysis
- Co-occurrence and cointegration of micronodes

Thank you!