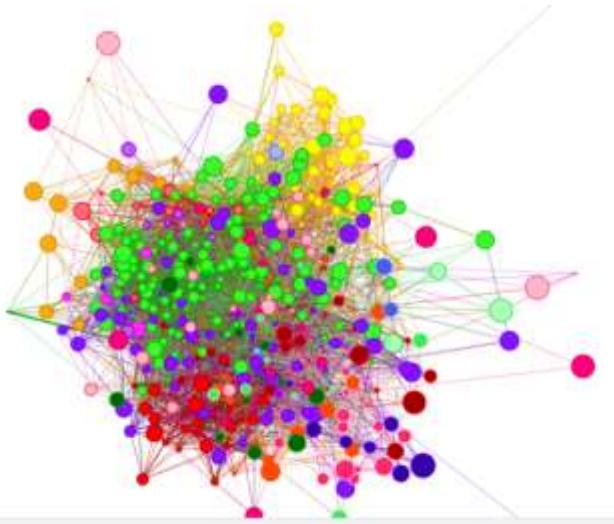




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Network Structure of Inter- Industry Labor Mobility in Argentina

Viktoriya Semeshenko

in collaboration with SA De Raco, D Heymann

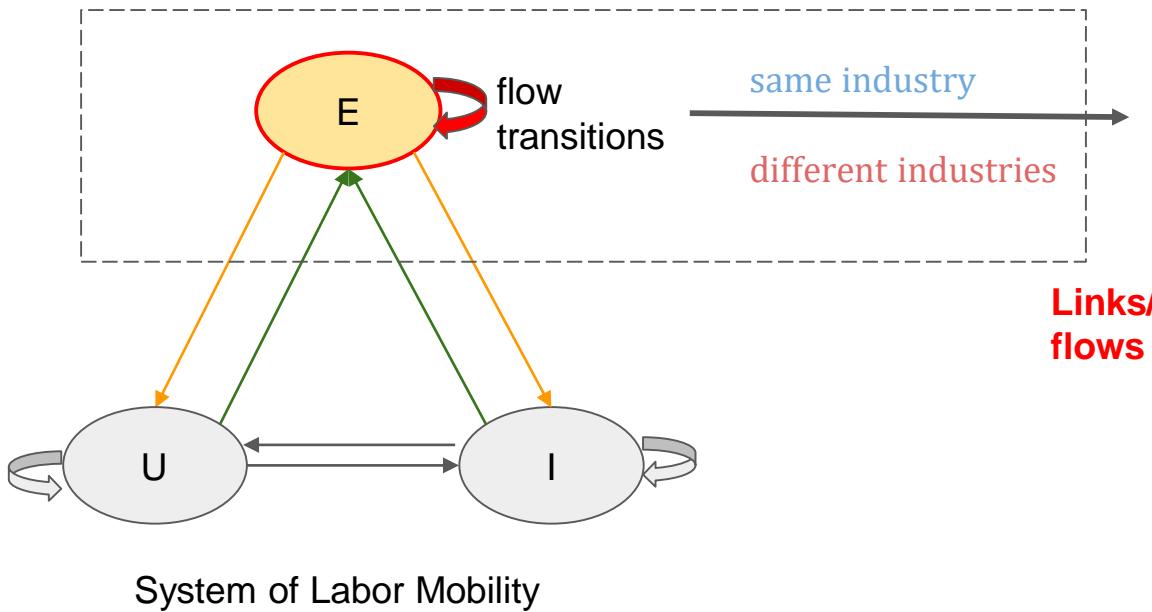
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CONICET-Universidad de Buenos Aires. Instituto Interdisciplinario de Economía Política de Buenos Aires.

Empirical Observations

- Labor mobility summarizes dynamic and structural aspects of the functioning of the labor market
- Job switchings **between firms of different industries** carry information about:
 - **capabilities and knowledge exchange** between industries
 - local **productive structure**

Data

- Administrative records of private formal employment (SIPA) 2009-2014, to 4-digits of economic activity classifier at ISIC Rev 4



		Nodes/ Sectors		
		I	II	III
t \	t+1			
I				
II				
III				

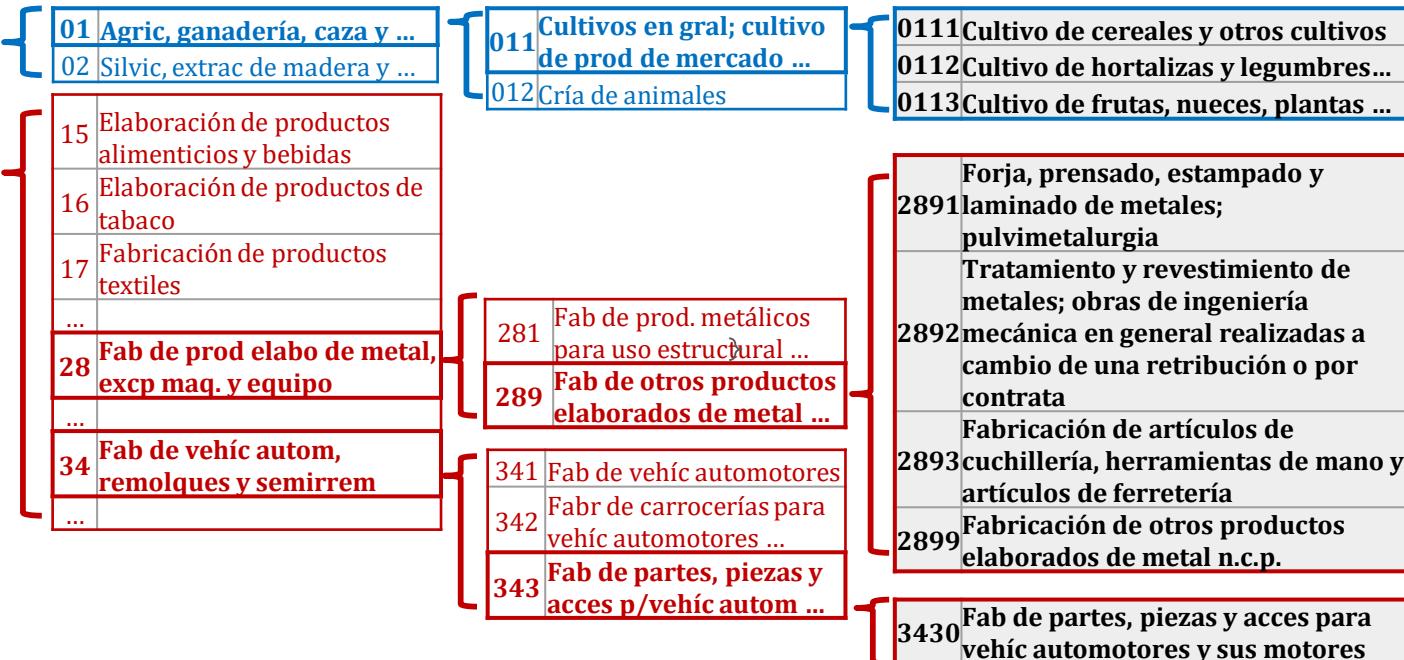
employment transition
/ adjacency matrix

Data: Unit of analysis and its complexity - Example

CIIU	Secciones
Rev 3	# 17



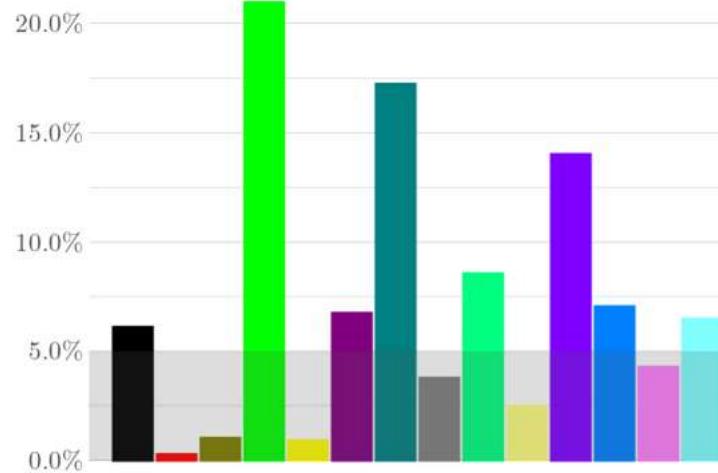
A	Agricultura, ganadería, caza y silvicultura
B	Pesca
C	Explotación de minas y canteras
D	Industrias manufactureras
E	Electricidad, gas y agua
F	Construcción
G	Comercio
H	Hoteles y restaurantes
I	Transporte, almacenamiento y...
J	Intermediación financiera
K	Actividades empresariales...
L	Administración publica ...
M	Enseñanza
N	Servicios sociales y de salud
O	Otras actividades de servicios...
P	Hogares privados...
Q	Organiz. y órganos extraterrit.



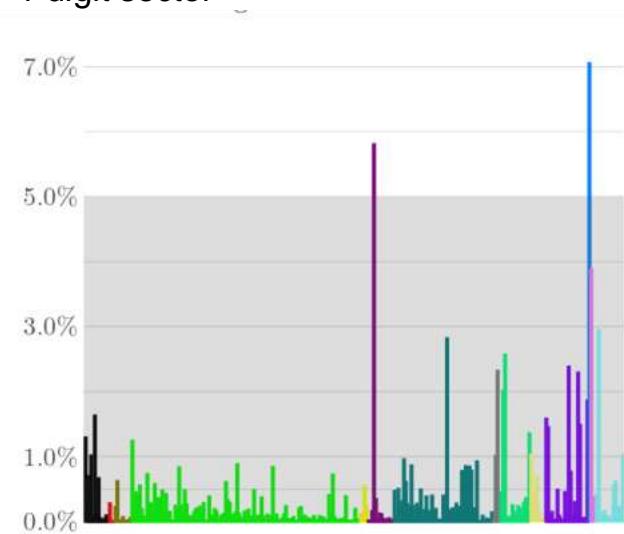
Data: Unity of analysis and its complexity - Example

Sectoral employment

1-digit sector (letter)



4-digit sector

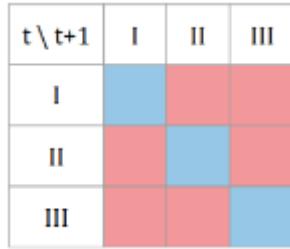


Fuente: Elaboración propia en base a SIPA

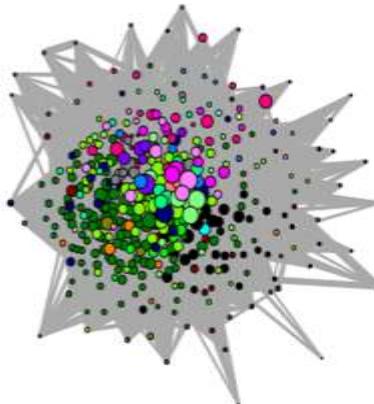
Objective

- Characterize the productive system of Argentina from the dynamics of formal employment
 - Extract structure of labor interactions and the Industrial Space
 - How informative are the derived networks?
- Comparison between countries (AR vs DE)

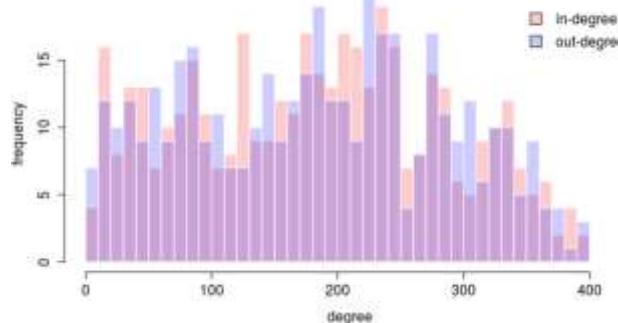
Network of Flows



● s/e
● A
● B
● C
● D
● E
● F
● G
● H
● I
● J
● K
● L
● M
● N
● O
● P
● Q



degree distribution

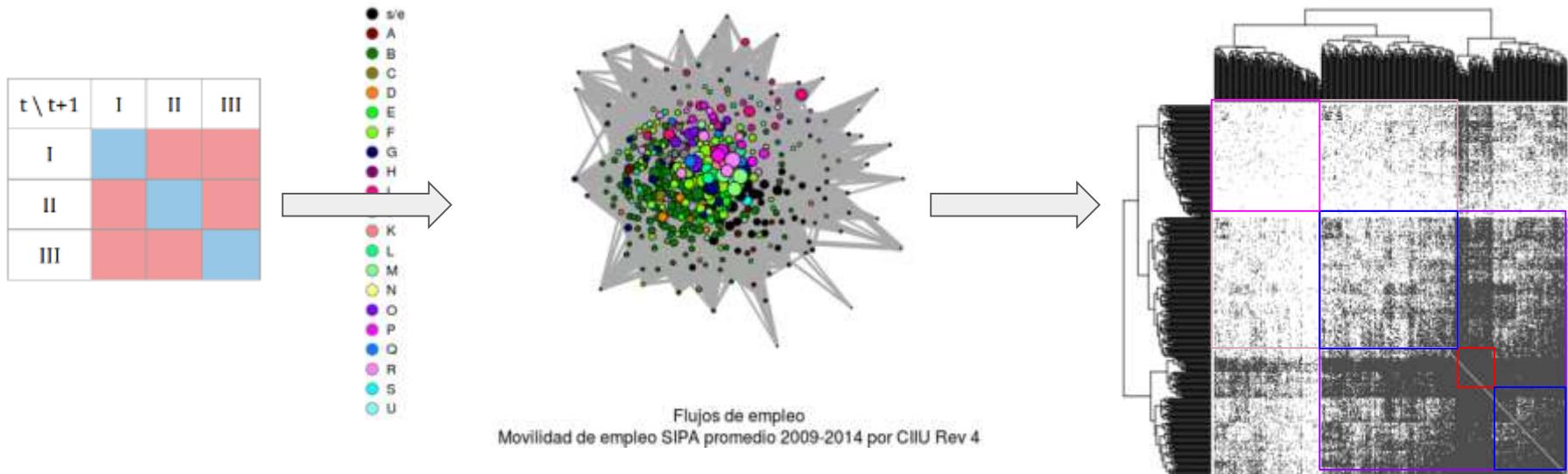


Flujos de empleo
Movilidad de empleo SIPA promedio 2009-2014 por CIU Rev 4

- **Properties:** Small world
- High clustering coefficient (transitivity)
 - Short average paths

Nodes (order)	416
Edges (size)	76,544
Weights	206,028
Cohesion	
Density	0.4434
Reciprocity	0.7983
Transitivity (global)	0.7404
Node centrality	
Average total degree (*)	368
Connectivity	
Diameter	3
Average shortest path	1.5577
Components	1

Network of Flows (cont.)



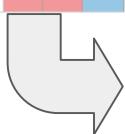
- Core-periphery structure
 - Core: subset of high degree nodes, highly interconnected
 - Periphery: subset of low degree nodes, connected (almost only) with core nodes

Industry Space

Skill-Relatedness indicator (SR)

- There are mobility costs associated with specificities (firm, industry, task) in the accumulation of worker human capital
- Labor flows reveal degree to which human capital moves between industries (Neffke *et al.* (2017))
- SR Indicator shows divergence between observed and expected flows (similar to an χ^2 independence test in contingency tables)

t \ t+1	I	II	III
I			
II			
III			



Observed Flows

$$\begin{array}{cccc|c} f_{11} & f_{12} & \dots & f_{1n} & F_1 \\ f_{21} & f_{22} & \dots & f_{2n} & F_2 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ f_{n1} & f_{n2} & \dots & f_{nn} & F_n \\ \hline F_1 & F_2 & \dots & F_n & F \end{array}$$

Expected values
(in cell)

$$f_{ij}^e = \frac{F_{i\cdot} \cdot F_{\cdot j}}{F_{\cdot\cdot}}$$

SR + normalization

$$R_{ij} = \frac{\text{observed}}{\text{expected}} = \frac{f_{ij}}{f_{ij}^e}$$

$$\hat{R}_{ij} = \frac{R_{ij} - 1}{R_{ij} + 1}$$

\hat{R} matrix

$$\begin{bmatrix} \hat{R}_{11} & \hat{R}_{12} & \dots & \hat{R}_{1n} \\ \hat{R}_{11} & \hat{R}_{12} & \dots & \hat{R}_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ \hat{R}_{n1} & \hat{R}_{n2} & \dots & \hat{R}_{nn} \end{bmatrix}$$

Industry Space (cont.)

Labor flows

$t \setminus t+1$	I	II	III
I			
II			
III			



Indicator SR

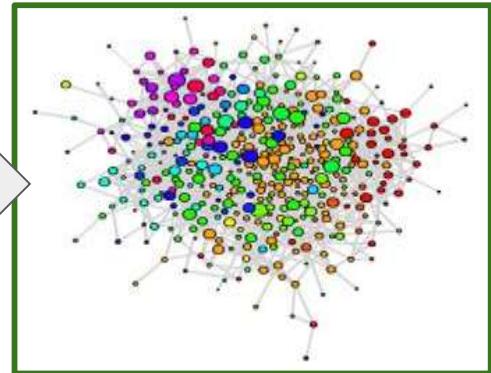
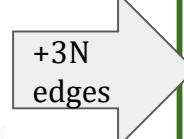
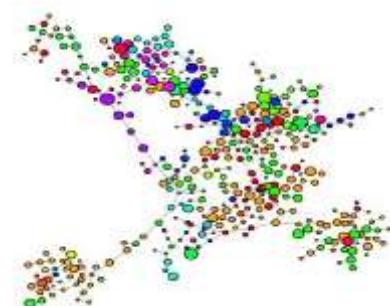
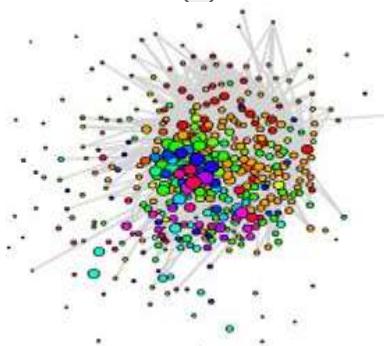
$$\begin{matrix} \hat{R}_{11} & \hat{R}_{12} & \dots & \hat{R}_{1n} \\ \hat{R}_{11} & \hat{R}_{12} & \dots & \hat{R}_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ \hat{R}_{n1} & \hat{R}_{n2} & \dots & \hat{R}_{nn} \end{matrix}$$



➤ A network reduction technique to obtain industry space:

- SR indicator matrix symmetrization (undirected graph)
- Maximum Spanning Tree on the symmetrized matrix
- Link addition: MST + 3N strongest SR links

- A - AFF
- B - MQ
- C - Manuf
- D - EGSA
- E - WSSA
- F - Const
- G - WRTF
- H - TS
- I - AFS
- J - IC
- K - FI
- L - RE
- M - PST
- N - AS
- O - PADC
- P - Edu
- Q - HHSW
- R - AER
- S - OS



Industry Space [cont.]

Argentina

k-core	Employment		Sectors		Degree			
	#	%	#	%	Min	Max	Avg	SDev
1	28,620	0.5	28	6.8	1	2	1	0.31
2	76,385	1.4	31	7.6	2	4	2	0.62
3	164,689	2.9	36	8.8	3	5	3	0.55
4	470,714	8.4	62	15.1	4	9	5	1.30
5	776,840	13.9	62	15.1	5	12	7	1.48
6	4,079,098	72.9	191	46.6	6	31	12	4.29
Total	5,596,346	100.0	410	100.0				

k-coreness

- AR: large heterogeneous max-core capturing 3/4 of total employment

Inter-industry employment flows

Workers (thousands)	Germany (*)	Argentina (**)
	1999-2008	2009-2014
	NACE Rev 1.1	ISIC Rev 4
	5-digits	4-digits

Stock:

Employment	19,897.1	5,619.1
------------	----------	---------

Absolute flows:

Job Switchers	1,206.7	412.1
No Industry Switch	321.1	206.1
Industry Switch	885.7	206.0
Different Sector	519.8	119.4
Same Sector	365.9	86.6
Same 2-Digit Industry	225.9	37.1
Same 3-Digit Industry	117.3	14.6
Same 4-Digit Industry	62.3	n.a.

Relative flows (w.r.t. total average employment):

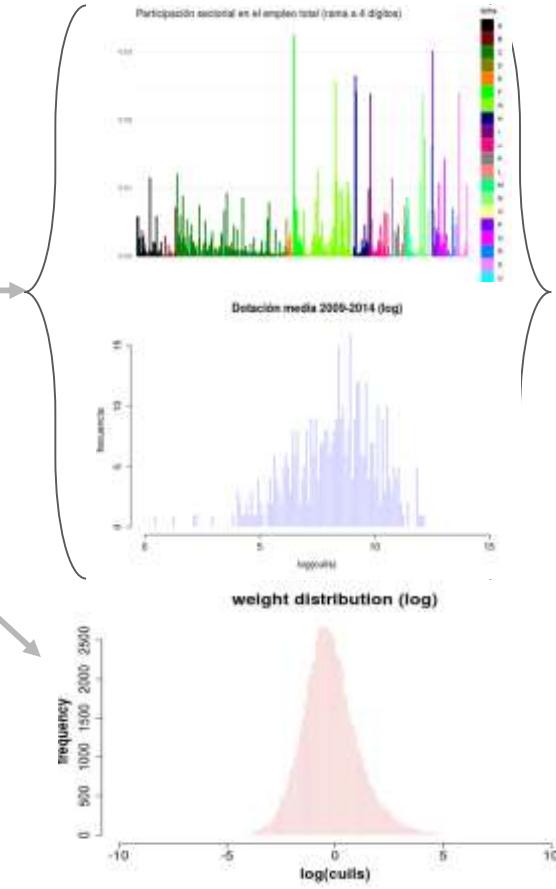
Job Switchers	6.1%	7.3%
No Industry Switch	26.6%	50.0%
Industry Switch	73.4%	50.0%
Different Sector	58.7%	58.0%
Same Sector	41.3%	42.0%
Same 2-Digit Industry	25.5%	18.0%
Same 3-Digit Industry	13.2%	7.1%
Same 4-Digit Industry	7.0%	n.a.

- 1
- 2
- 3

1 Job switching is a relatively small fraction of employment

2 Activity disaggregation positively correlates with inter-industry switchings

3 Sectoral level crossing (letter-level) is very frequent



Nodes
(attrib.)

Edges
(attrib.)

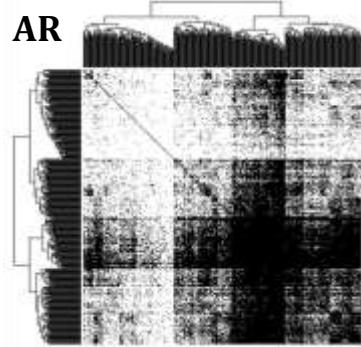
Comparison networks - AR and DE

Grand division	Description	Abbrev	Argentina ISIC Rev4, 4d			Germany NACE Rev2, 4d		
			Employment		Sector	Employment		Sector
			#	%	#	#	%	#
A	Agriculture, forestry and fishing	AFF	319,233	5.7	34	229,394	0.8	30
B	Mining and quarrying	MQ	79,511	1.4	15	85,754	0.3	14
C	Manufacturing	Manuf	1,162,085	20.8	134	6,446,209	23.0	230
D	Electricity, gas, steam and air conditioning supply	EGSAS	45,465	0.8	4	236,283	0.8	8
E	Water supply; sewerage, waste management and remediation activities	WSSWR	39,997	0.7	6	225,906	0.8	9
F	Construction	Const	378,701	6.8	13	1,640,705	5.9	22
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	WRTRV	1,033,359	18.5	62	4,083,799	14.6	91
H	Transportation and storage	TS	401,544	7.2	19	1,467,801	5.2	22
I	Accommodation and food service activities	AFS	220,460	3.9	4	873,633	3.1	8
J	Information and communication	IC	177,059	3.2	24	862,878	3.1	26
K	Financial and insurance activities	FI	173,152	3.1	15	1,000,463	3.6	18
L	Real estate activities	RE	64,594	1.2	2	217,893	0.8	4
M	Professional, scientific and technical activities	PST	177,160	3.2	13	1,707,804	6.1	19
N	Administrative and support service activities	AS	462,142	8.3	20	1,148,587	4.1	30
O	Public administration and defence; compulsory social security	PADCSS	1,800	0.0	1	1,685,782	6.0	9
P	Education	Edu	266,215	4.8	8	1,104,130	3.9	11
Q	Human health and social work activities	HHSW	224,485	4.0	12	3,985,586	14.2	12
R	Arts, entertainment and recreation	AER	79,367	1.4	8	240,827	0.9	15
S	Other service activities	OS	290,017	5.2	16	806,438	2.9	19
T	Activities of Households as Employers; Undifferentiate Goods and Services Producing Activities of Households for Own Use	HUGP						
U	Activities of Extraterritorial Organisations and Bodies	EO						
Total			5,596,346	100.0	410	28,049,872	100.0	597

Comparison networks - AR and DE [cont.]

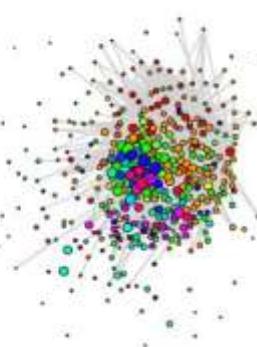
Heatmap

AR



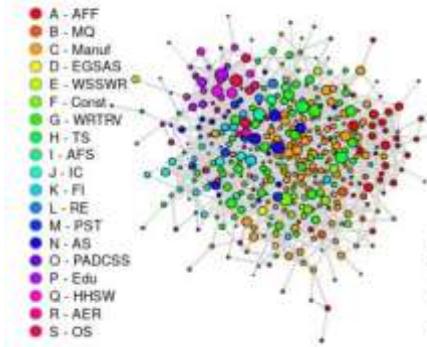
Original SR

- A - AFF
- B - MQ
- C - Manuf
- D - EGASAS
- E - WSSWR
- F - Const
- G - WRTRV
- H - TS
- I - AFS
- J - IC
- K - FI
- L - RE
- M - PST
- N - AS
- O - PADCSS
- P - Edu
- Q - HHSW
- R - AER
- S - OS

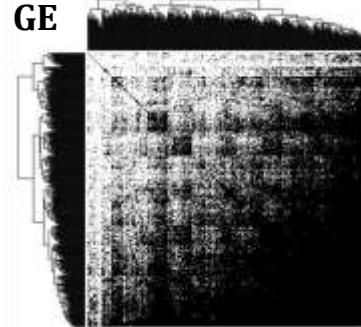


Industry space

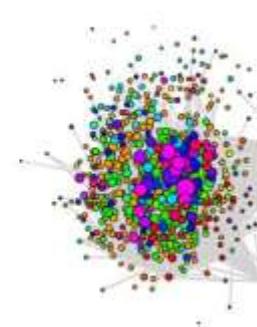
- A - AFF
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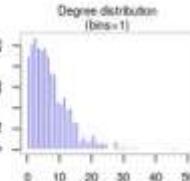
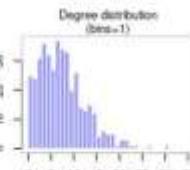
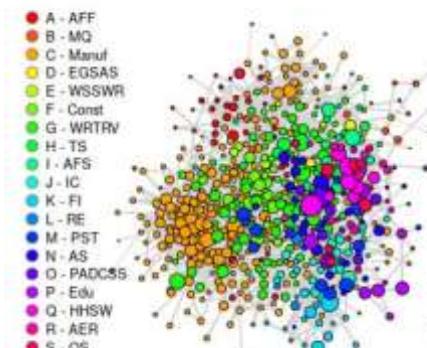
GE



- A - AFF
- B - MQ
- C - Manuf
- D - EGASAS
- E - WSSWR
- F - Const
- G - WRTRV
- H - TS
- I - AFS
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Comparison Industry Space Networks [cont.]

Argentina

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1	28,620	0.5	28	6.8	1	2	1	0.31	
2	76,385	1.4	31	7.6	2	4	2	0.62	
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6	4,079,098	72.9	191	46.6	6	31	12	4.29	
Total	5,596,346	100.0	410	100.0					

Germany

k-core	Employment		Sectors		Degree				
	#	%	#	%	Min	Max	Avg	SDev	
1	244,069	0.9	47	7.9	1	2	1	0.20	
2	523,642	1.9	61	10.2	2	3	2	0.40	
3	1,230,904	4.4	69	11.6	3	7	4	1.00	
4	4,026,870	14.4	97	16.3	4	11	6	1.69	
5	9,731,103	34.7	121	20.3	5	18	8	3.05	
6	8,951,832	31.9	145	24.3	6	34	12	4.98	
7	436,633	1.6	11	1.8	8	19	11	3.04	
8	1,033,986	3.7	18	3.0	9	29	16	5.45	
9	1,870,833	6.7	28	4.7	12	46	22	7.26	
Total	28,049,872	100.0	597	100.0					

k-coreness

- AR: large heterogeneous max-core capturing 3/4 of total employment
- DE: more stratified, highly connected small max-core concentrated in manufacturing activities

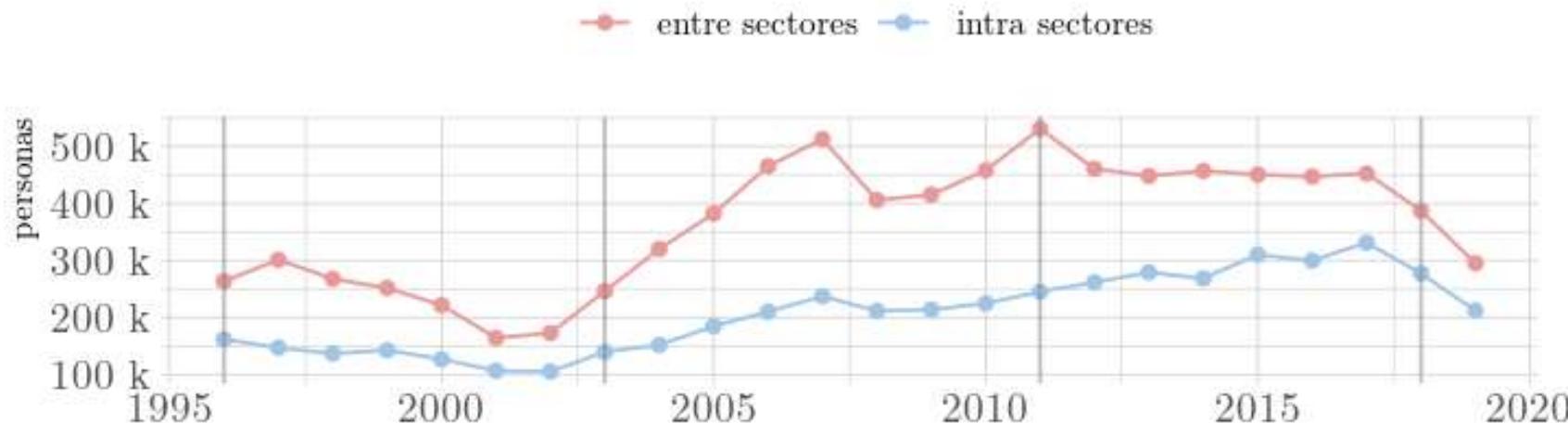
Final Remarks

- Inter-industrial Flow Network
 - Demonstrates relevant structure not observed in analysis at a higher level of aggregation
 - Dense and connected network
 - Unique giant component
 - Small world property, core-periphery structure
- Industry Space Network
 - Dense and core-periphery structure
 - Similar distribution of short path lengths, reciprocity and transitivity
 - Incorpora un nivel mayor de significatividad a la estructura observada
 - Utilidad: diversificación de actividades productivas
- Industry Spaces Comparison
 - Manufacturing and related activities inside more connected core
 - Deeper coreness structure in GE
 - Contrast in the sectoral composition of the core and periphery subsets

Thank you !

Transiciones de empleo formal privado

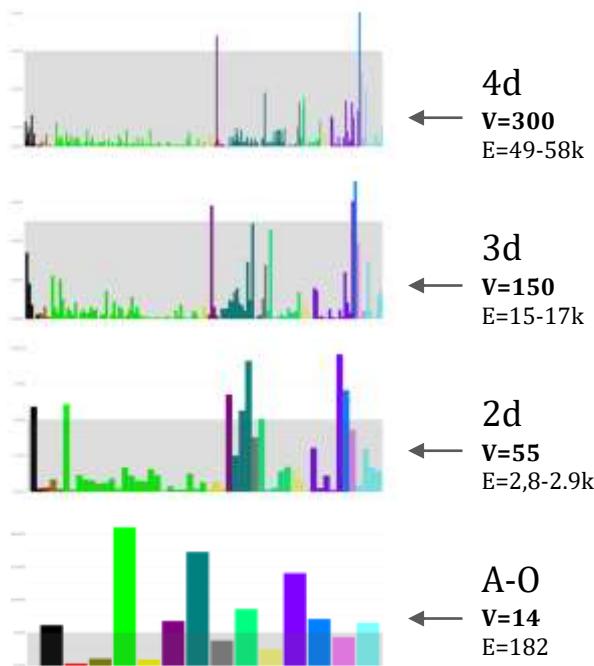
Actividades a 4 dígitos CIIU Rev 3



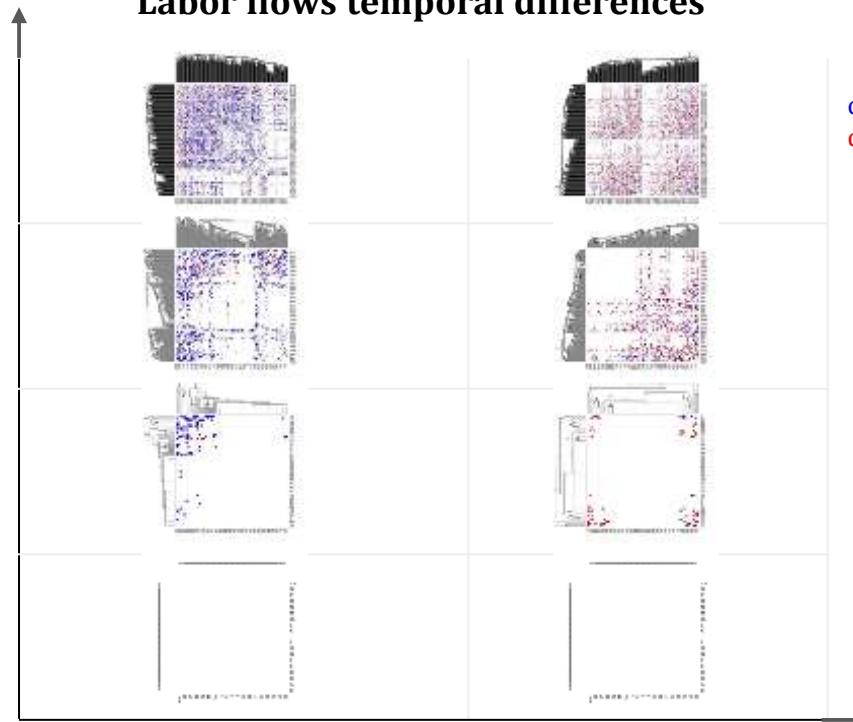
Fuente: Elaboración propia en base a SIPA

¿Qué observamos?

Sectoral employment %



Labor flows temporal differences



¿Qué encontramos?

- **Granularidad**
 - Menor detalle (letra): grafos completos, estructura de conectividad interindustrial persistente y estable.
 - Mayor granularidad:
 - Heatmaps densos, cambios detectables.
 - Dificultad incremental para la interpretación de la información de conectividades intersectoriales.
- **Evolución**
 - Mayor granularidad aporta más riqueza en la información de evolución de los flujos.
 - Post-Convertibilidad (2003-2011) vs Convertibilidad (1996-2003): Mayor proporción de creación de nuevos vínculos entre sectores.
 - Estancamiento (2011-2018) vs. Post-Convertibilidad (2003-2011): Prevalencia de la destrucción de conexiones.

Línea de trabajo

- Interpretación económica de resultados
 - Relaciones sectoriales mediante SR y estructura productiva
 - Agrupamientos, comunidades, centro-periferia, k-cores
- Análisis de redes temporales (evolución y dinámicas sobre la red)
 - SIPA: muestra longitudinal y universo.
 - **Tesis en curso:** Análisis de estabilidad de patrones y agrupamientos
 - EPH: análisis de actividades y ocupaciones en sistema abierto. Relación con SIPA.
- Comparación y cooperaciones en curso y en vista
 - **DE, SE, FI, otros países europeos:** correspondencia de clasificadores; intento de cooperación con datos administrativos (vía Neffke, Guerrero, OIT)
 - **UY:** cooperación en curso con datos administrativos (doctorando DH)
 - **CL:** posible cooperación en tratativas
 - **BR:** existen publicaciones del grupo de Hidalgo y MTEySS tiene algún contacto
 - **MX:** publicación de Guerrero, Axtell y López utiliza muestra longitudinal equivalente a AR