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The strength of strong ties: co-authorship and productivity of Italian economists

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Outline

- ✓ Related Literature
  - Scientific production
  - Collaborative behavior and scientific production
  - Network Analysis and Network Topology
- ✓ The datasets:
  - Italian economists in 2006 according to MIUR database;
  - Journal Articles (JA) in 2006 indexed in Econlit.
  - Our dataset
- ✓ The models
- ✓ The empirical results
- ✓ Conclusions and further research

Related literature (1/2)

Recently, an increased specialization and the diffusion of scientific collaborations are becoming more and more diffused in the community of social scientists.

In the meantime the practice of evaluating scientific research and personnel through bibliometric indicators is increasingly used by departments, universities, government bodies and funding agencies.

These two phenomena are hardly independent; on the contrary we believe – in so comforted by an extensive stream of literature (see, among others: Sauer, 1988; Barnett et al., 1988; Piette and Ross, 1992; Laband and Piette, 1994; Hudson, 1996; Laband and Tollison 2000 and 2006) that they are strongly **interdependent** since the increased pressure to publish on academics has caused a rinsing propensity to co-authoring papers due to a series of demand-side and supply-side factors.

In economic terms a generic "scientific production function" is affected by different aspects:

- his/her **attributive** features (i.e. formation, gender, academic position, etc.);
- his/her **relational** features (i.e. co-authorships, scientific connections, etc.);
- his/her **positional** features (i.e. the structural position within the network of scientists of the same field);

Related literature (2/2)

Considering a generic “scientific production function” the role of co-authorship is very relevant because affects (demand and/or supply side factors):

the **quantity** of scientific production

- **Greater output and risk-spreading** (Barnett *et al.*, 1988)

the **quality** of scientific production

- **Specialization** (McDowell and Melvin, 1983)
- **Technological complementarities** (Hudson, 1996)
- **Synergies from collaborative work** (Hudson, 1996)

But, especially in social sciences, the **number of co-authors** is very important because there exist

Increasing/decreasing returns to the number of co-authors in the same paper

Increasing/decreasing returns to interactions with the same co-author(s). (**Stability of interactions**)

The dataset of Italian Economists

We consider:

- a population of **1620 authors** composed by any person in the Cineca-MIUR database holding an **official academic position** in Italian Universities and belonging to one of 6 **economic scientific disciplinary groups** [Economics, SECS-P/01; Economic Policy, SECS-P/02; Public Finance, SECSP/ 03; History of Economic Thought, SECS-P/04; Econometrics, SECS-P/05; Applied Economics, SECS-P/06].

- **8679 journal articles** published between the January 1st 1969 and 31st December 2006 in the journals listed in the Econlit database;

[Data on publications were downloaded between August 2007 and February 2008, and manually corrected for mistypes in names and double entries].

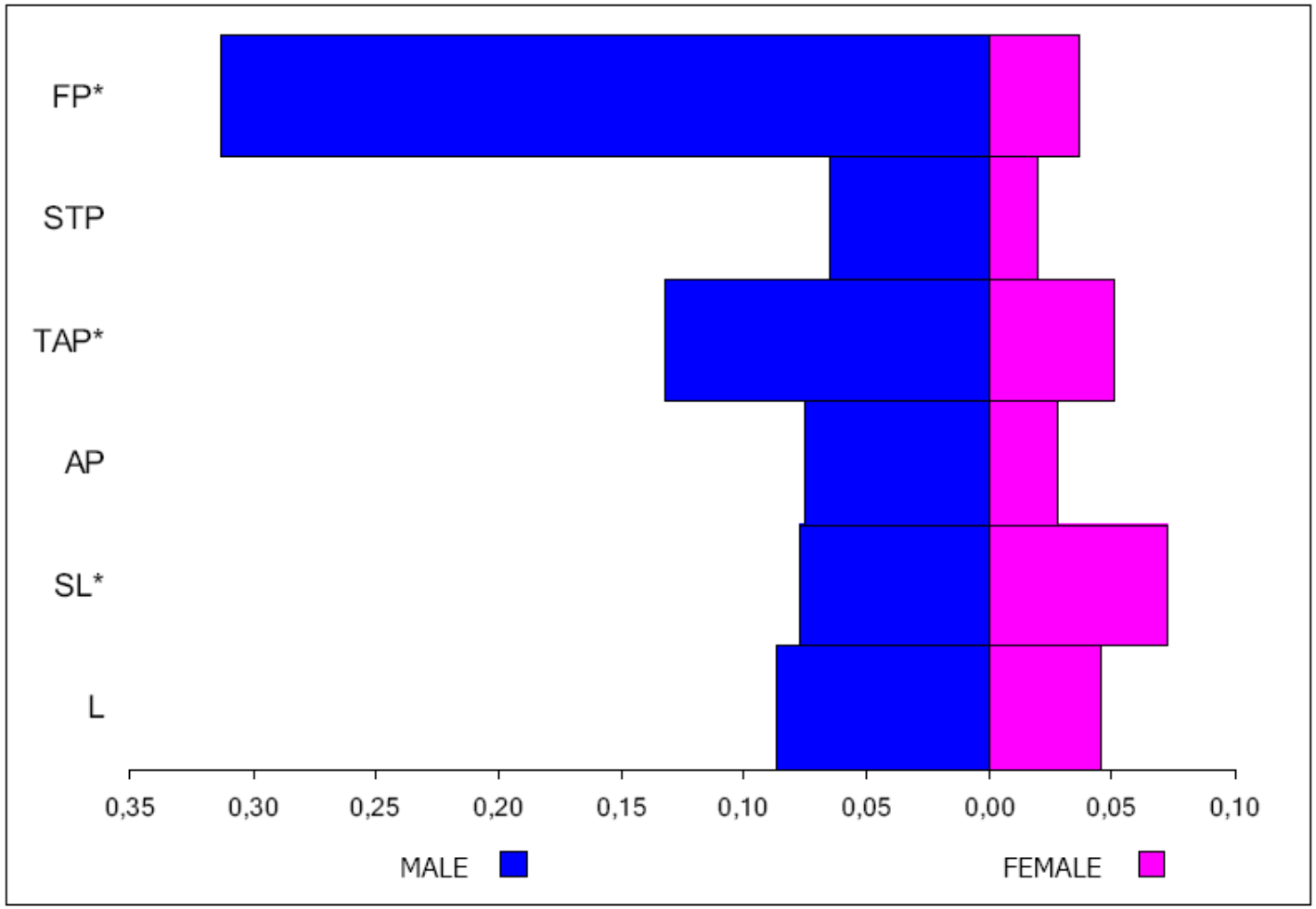
The database: some descriptive statistics

Scientific Field	L	SL*	AP	TAP*	STP	FU*	TOTAL
ECONOMICS	14,0	15,0	10,6	18,5	8,0	34,0	**1153**
ECONOMETRICS	13,1	13,1	9,8	13,1	13,1	37,7	**61**
PUBLIC ECONOMICS	13,5	16,0	4,5	14,0	8,0	44,0	**200**
OTHERS	8,7	13,6	14,6	22,8	10,2	30,1	**206**
TOTAL	**214**	**241**	**167**	**296**	**137**	**565**	**1620**

* these academic positions are considered as **tenured** positions

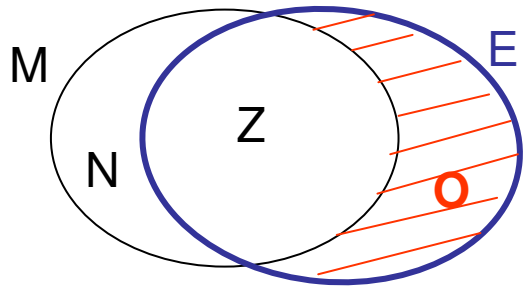
Source: our calculations on MIUR database at 31 December 2006

Population pyramid of Italian economists



Source: our calculations on MIUR database at 31 December 2006

The dataset of the JA 1/2



M = 1620 people
E = 2972 people
Z = 1317 people, 8679 articles
O = 1655 people

M: **MIUR population**, “Italian” economists holding an official academic position

E: **Econlit population**, “Italian” economists (as defined in **M**) who are authors of publications indexed in Econlit and their co-authors (if any) with any affiliation

Z: **Our Dataset** “Italian” economists (as defined in **M**) who are authors of publications indexed in Econlit

N: Non publishing **MIUR population**, “Italian” economists (as defined in **M**) without entries in Econlit

O: publishing non MIUR population, co-authors of **Z** not holding a position in Italian Universities

The dataset of the JA 2/2

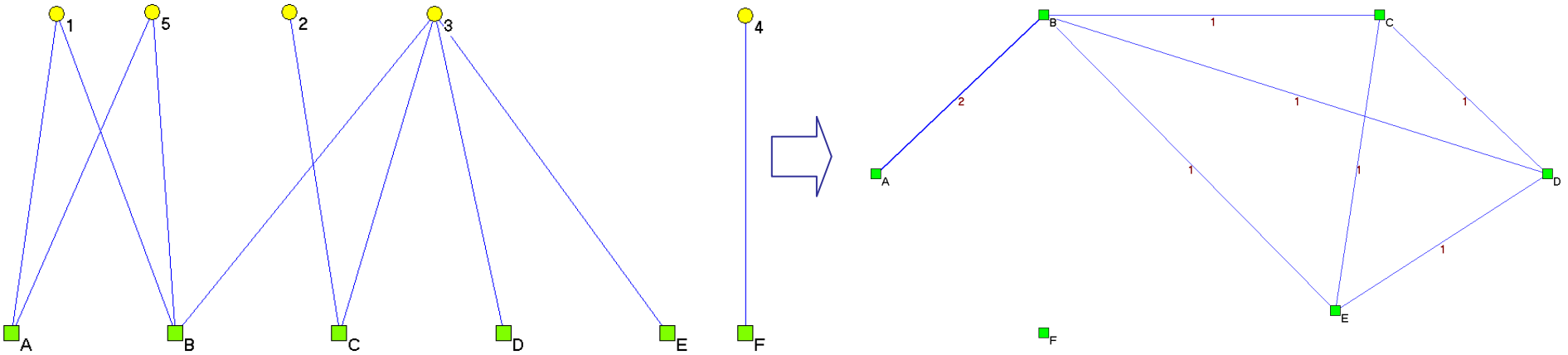
Nodes

- MODE 1 = **8679 journal articles** ranked in Econlit from 1969 until 2006
- MODE 2 = **2972 economists** writing papers

Relational tie: it appears when two scholars are writing an article together

Bipartite (Two-mode) network		**One-mode network**
authours and articles as nodes	⇨	authours as nodes, articles as links

Articles: 1, 2, 3, 4, 5… 8679th article

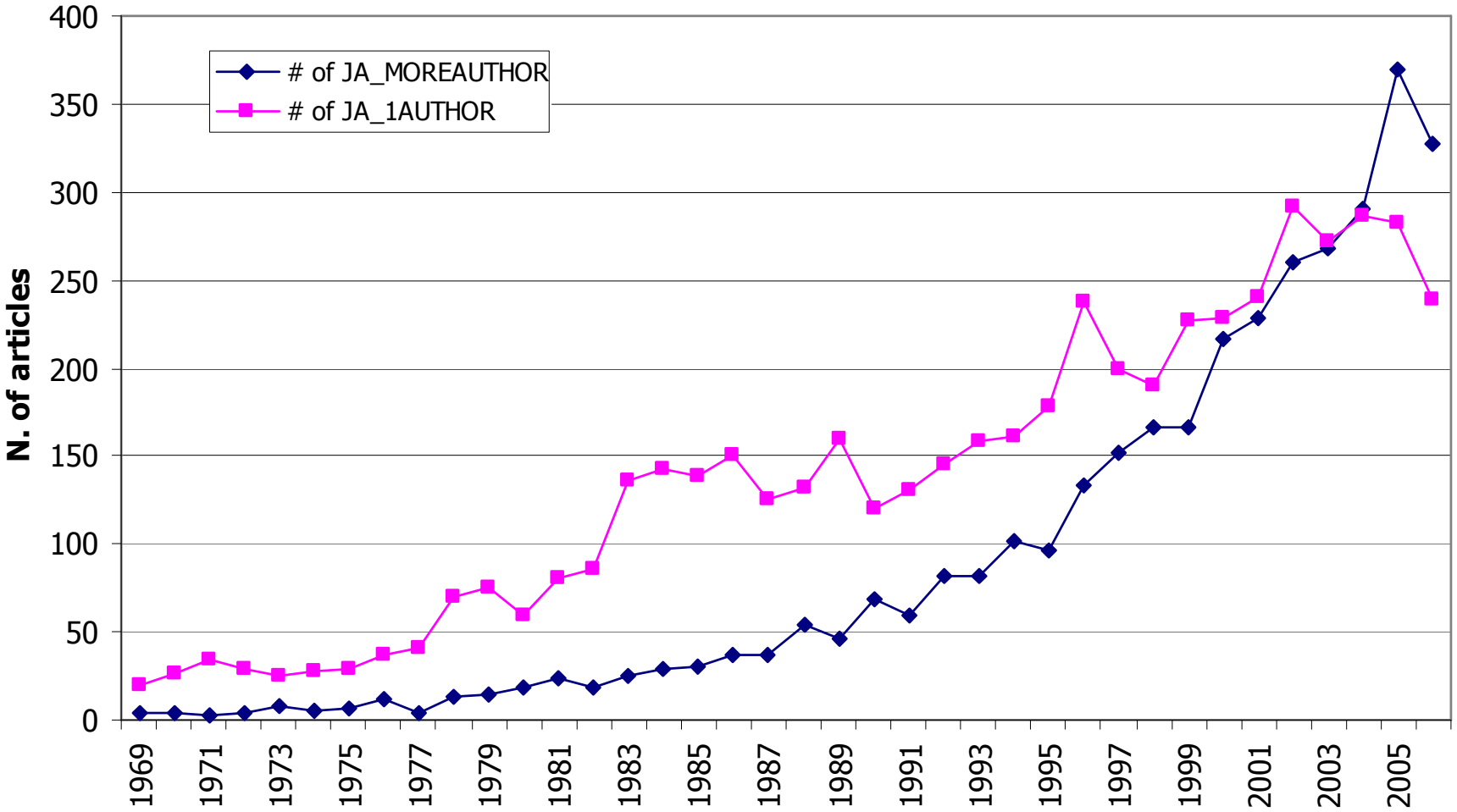


Authors: a, b, c, d, e, f … 2972nd economist

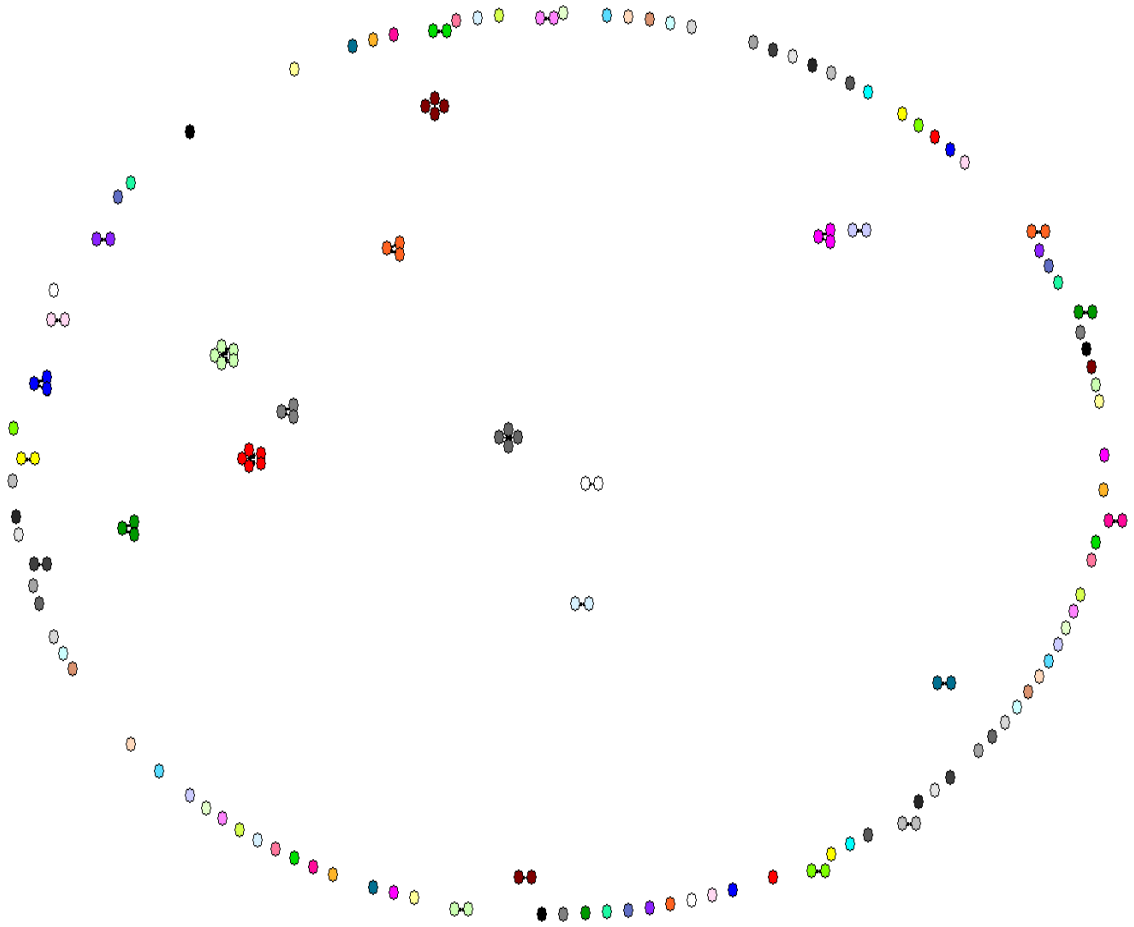
Authors: a, b, c, d, e, f … 2972nd economist

The results on the SNA of the economic network from 1969 until 2006 divided into 4 sub-periods

The evolution of the co-authorship behaviour



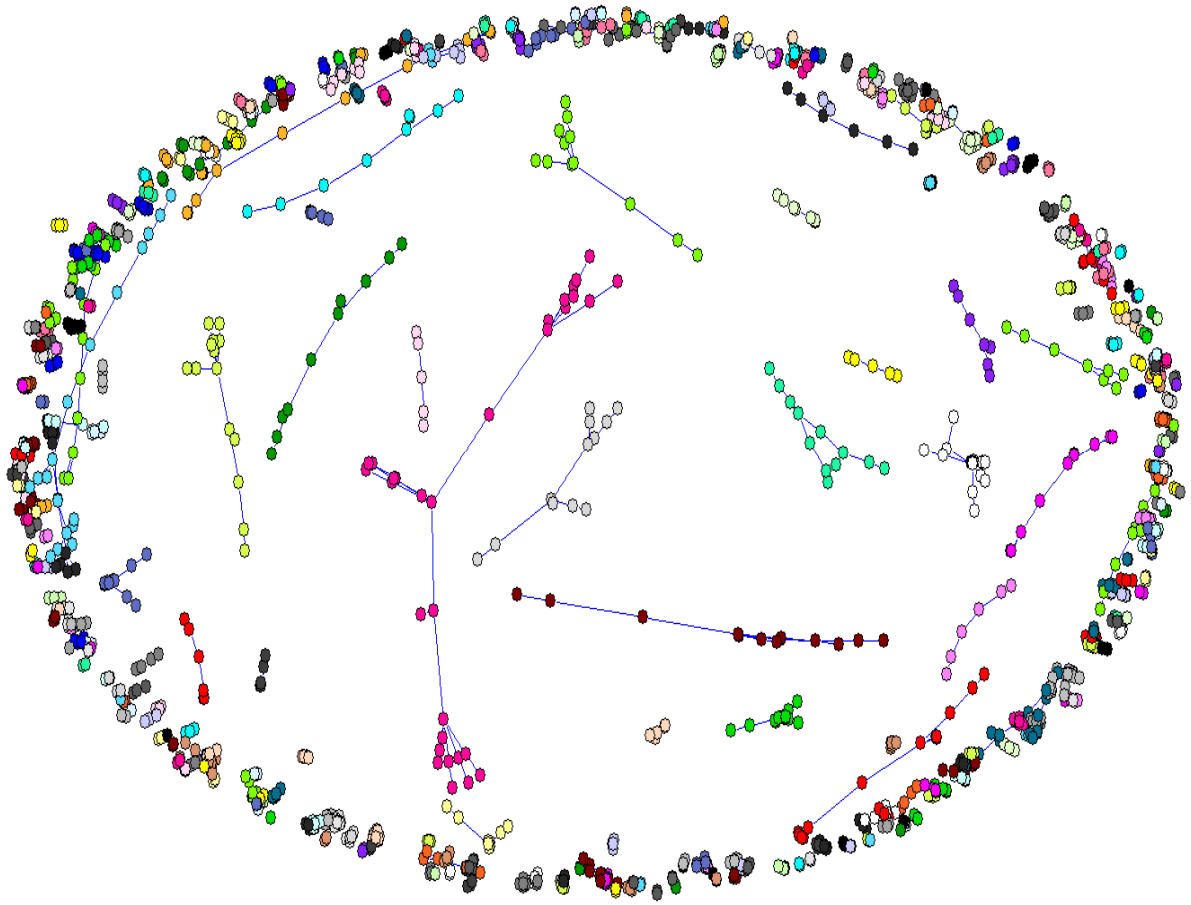
PERIOD 1: 1969-1976
274 articles



Nodes (N)	**159**
average path lenght	1.328
diameter	3
CC	0.458
centralization (degree)	0.0221
# diads	17
# triads	5
# subgroups with n>3	4
Isolated nodes	92
Main Component	No
Average Degree	0.553
Min	0
MAX	4
Sd	0.774

Nodes (*n*) are economists, colors indicate *n* belonging to the same subgroup

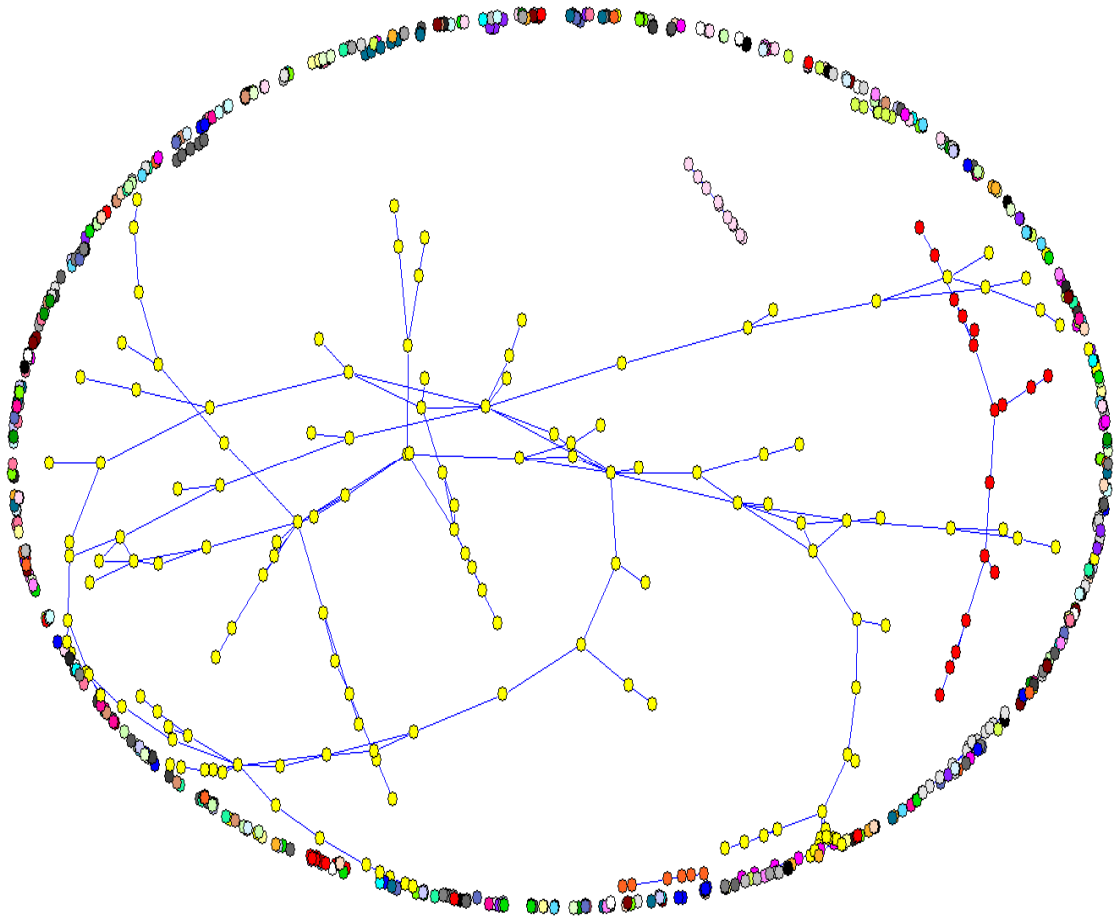
PERIOD 2: 1977-1986
1195 articles



Nodes (N)	**580**
average path lenght	1.751
diameter	5
CC	0.606
centralization (degree)	0.0108
# diads	55
# triads	16
# subgroups with n>3	23
Isolated nodes	293
Main Component	No
Average Degree	0.786
Min	0
MAX	7
Sd	1.147

Nodes (*n*) are economists, colors indicate *n* belonging to the same subgroup

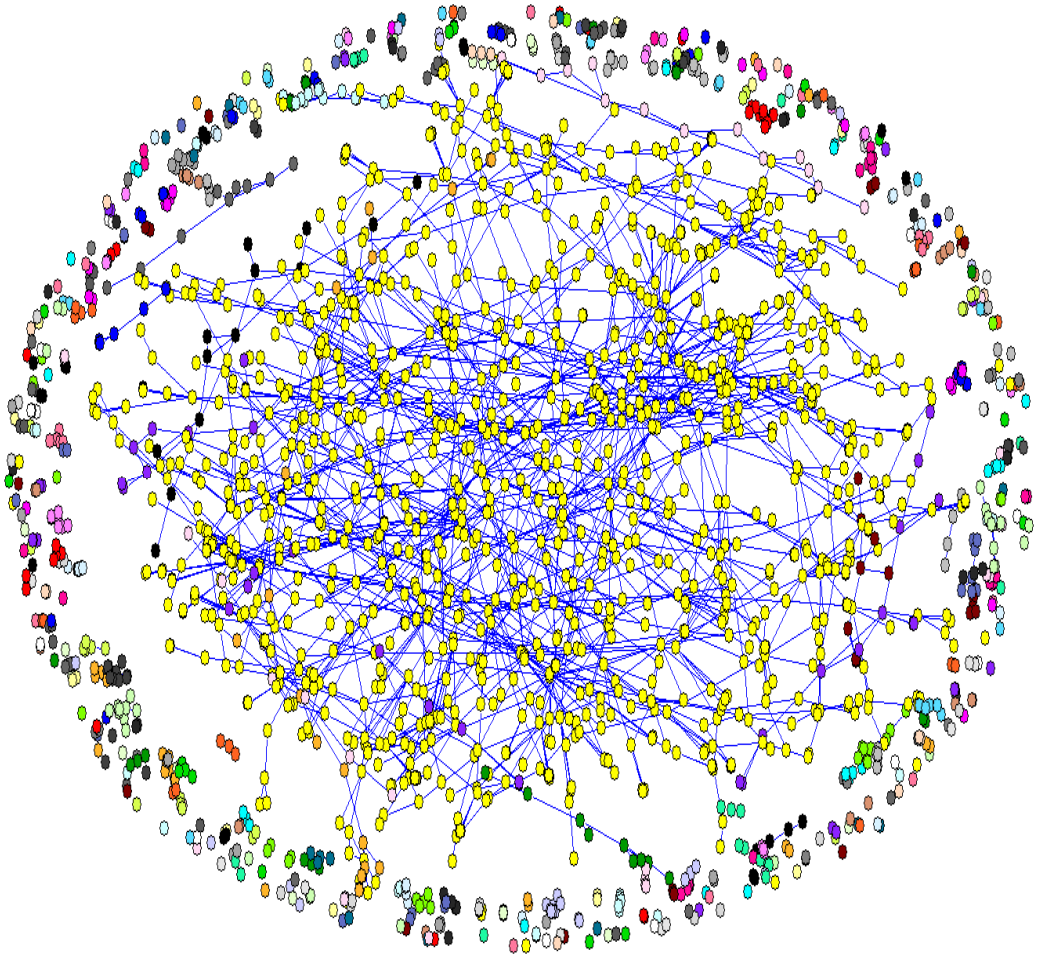
PERIOD 3: 1987-1996
2309 articles



Nodes (N)	**1094**
average path lenght	8.180
diameter	21
CC	0.535
centralization (degree)	0.097
# diads	88
# triads	43
# subgroups with n>3	42
Isolated nodes	295
Main Component	Yes (214)
Average Degree	1.364
Min	0
MAX	12
Sd	1.498

Nodes (*n*) are economists, colors indicate *n* belonging to the same subgroup

PERIOD 4: 1997-2006
4901 articles

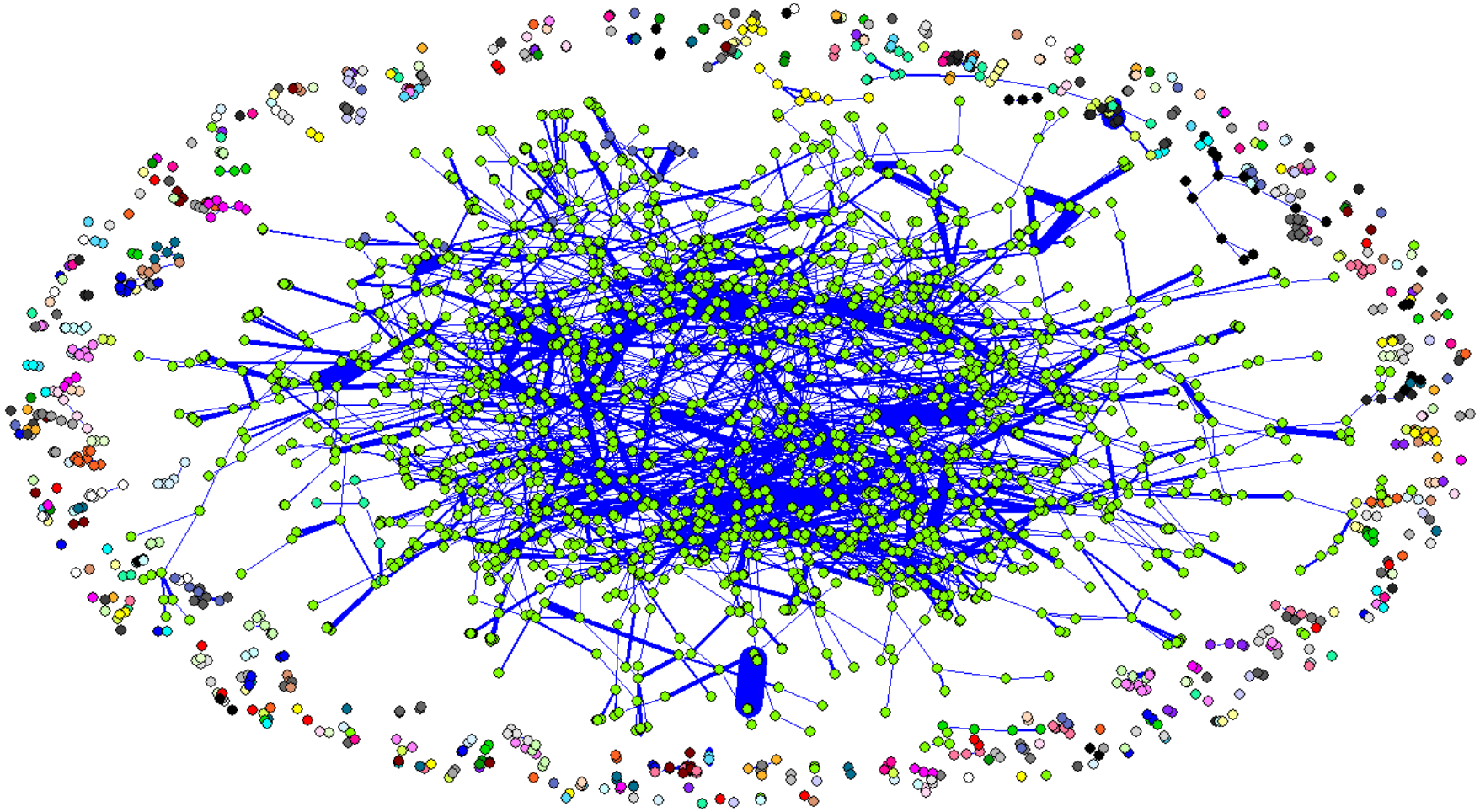


Nodes (N)	**2424**
average path lenght	8.282
diameter	20
CC	0.596
centralization (degree)	0.0098
# diads	114
# triads	46
# subgroups with n>3	56
Isolated nodes	263
Main Component	Yes (1380)
Average Degree	2.328
Min	0
MAX	26
Sd	2.459

Nodes (*n*) are economists, colors indicate *n* belonging to the same subgroup

The whole network 1969-2006

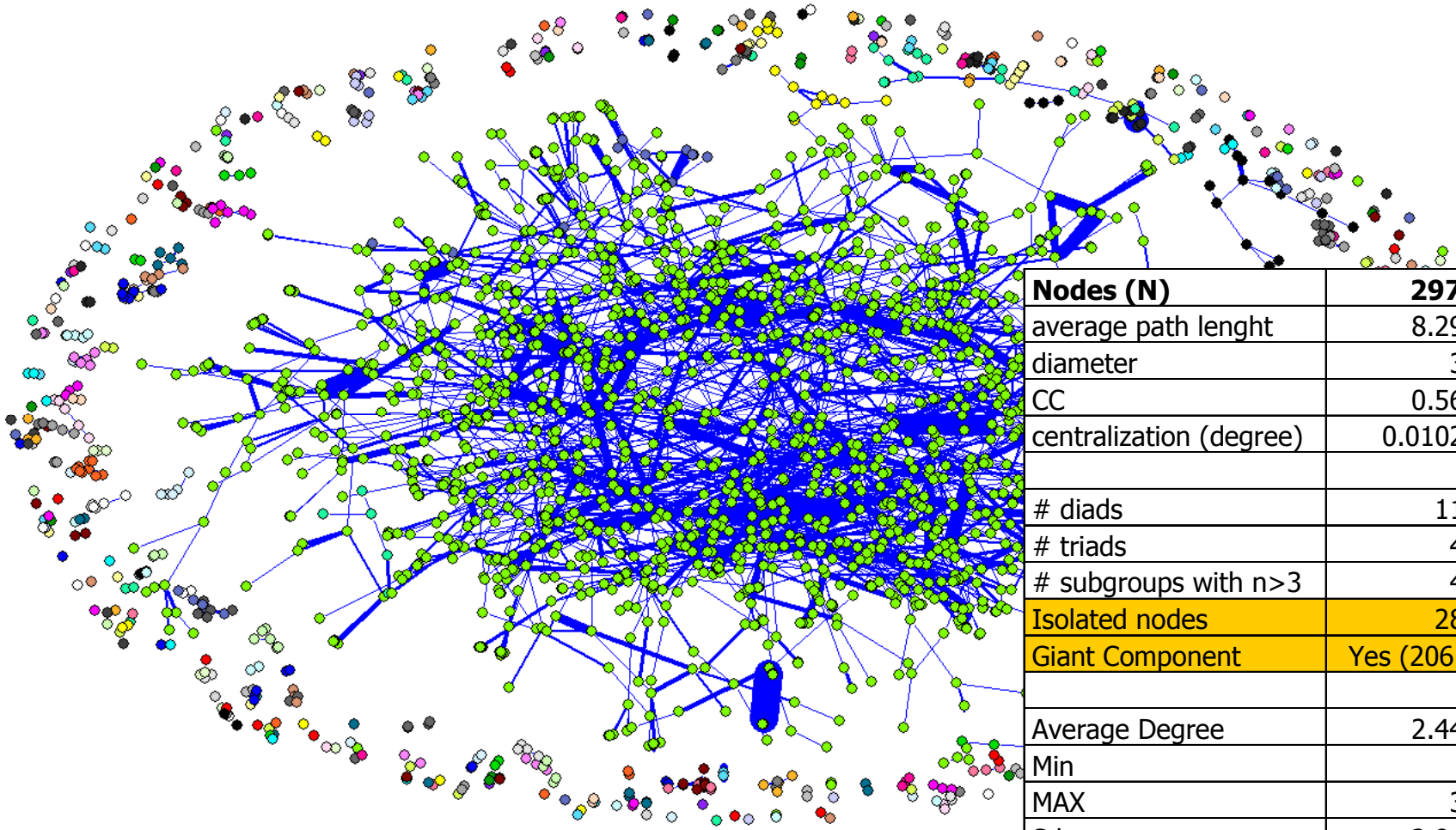
2972 nodes writing 8679 articles (E): 1317 M, 1655 O



Nodes (*n*) are economists, colors indicate *n* belonging to the same subgroup

The whole network 1969-2006

2972 nodes writing 8679 articles (E): 1317 M, 1655 O



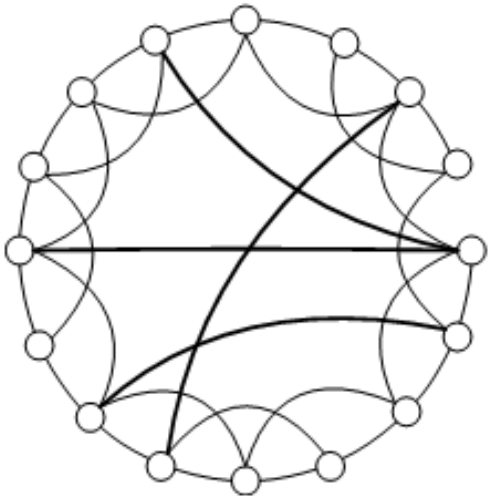
Nodes (N)	**2972**
average path lenght	8.290
diameter	30
CC	0.569
centralization (degree)	0.01029
# diads	113
# triads	43
# subgroups with n>3	44
Isolated nodes	283
Giant Component	Yes (2061)
Average Degree	2.447
Min	0
MAX	33
Sd	2.841

Nodes (*n*) are economists, colors indicate *n* belonging to the same subgroup

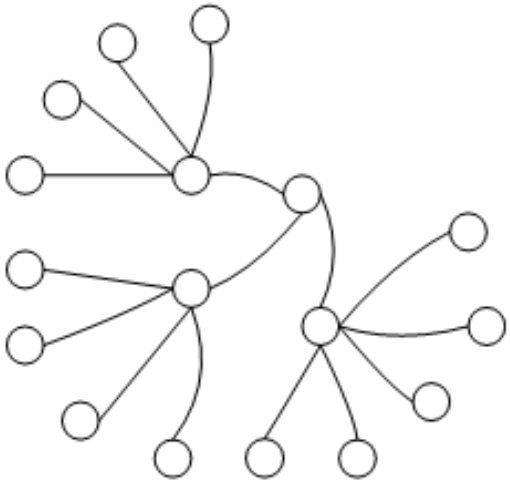
The topology of the economists' network

Question:
Is the Italian economists network a small world network?

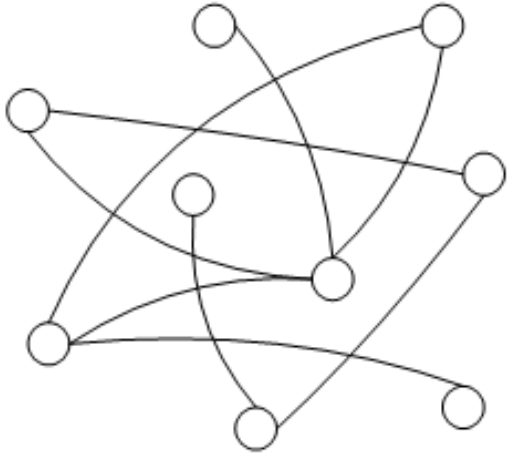
(a) Small-World Network (SWN)



(b) Scale-Free Network (SFN)



(c) Random Network (RN)



Is the Italian economists' network a SWN network?

real nets					
Total (1969-2006)		2nd period (1987-1996)		3rd period (1997-2006)	
N	**2061**	**N**	**214**	**N**	**1380**
density	0,0015	density	0,0120	density	0,0022
average degree	3,026	average degree	2,561	average degree	3,041
average path lenght	8,296	average path lenght	8,533	average path lenght	8,295
CC	0,552	CC	0,531	CC	0,564
random nets					
total		2nd period		3rd period	
N	***2061***	***N***	***214***	***N***	***1380***
density	*0,0015*	*density*	*0,012*	*density*	*0,0022*
average degree	*3,090*	*average degree*	*2,551*	*average degree*	*3,038*
average path lenght	*6,739*	*average path lenght*	*5,349*	*average path lenght*	*6,383*
CC	*0,001*	*CC*	*0,007*	*CC*	*0,001*
Q_1	**448,40**		**47,55**		**434,00**

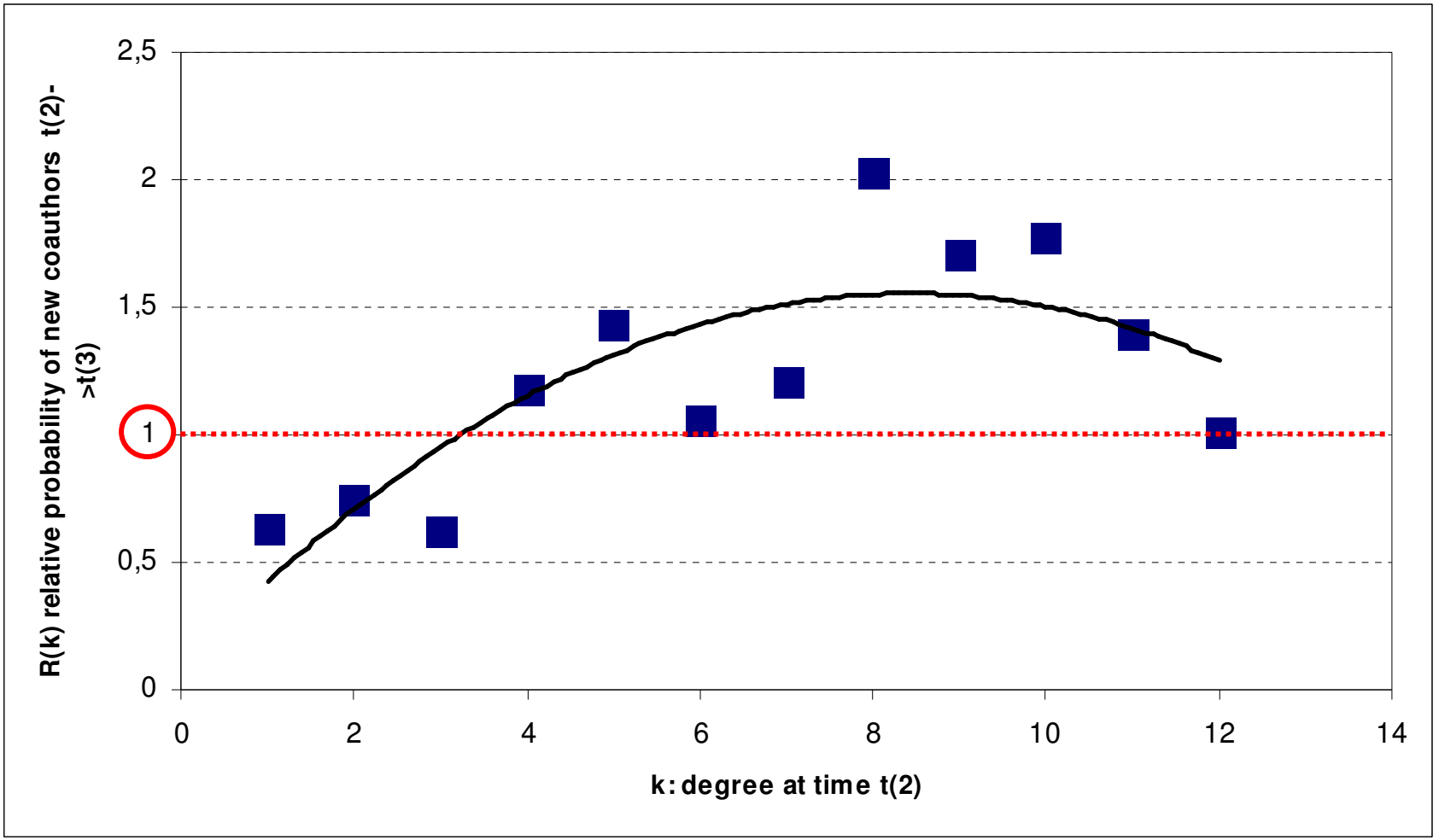
All networks display a SWN behaviour:

1) CC real >> CC random

2) APLreal ~ APLrandom

3) calculate Q index: $\frac{\frac{CC_{real}}{APL_{real}}}{\frac{CC_{random}}{APL_{random}}}$

Existence of preferential attachment (t_2 -> t_3) for k > 3
Marginal decreasing returns to co-authorships after 8



$$R(k) = \frac{\text{proportion of new links to nodes of degree } k_i}{\text{proportion of nodes with degree } k_i}$$

Under no p.a. R(k) = 1

The models for the econometric analysis

1st model: Identification of the attributional determinants of the probability to publish (i.e to be an element of Z) [dprobit]

2nd model: (only for Z members) identification of the relational driving forces of scientific productivity [IV]

3rd model: The impact of positional variables (Co-authorship MC) on scientific productivity [Heckman procedure]

1st model

Dependent variable:

- Z is equal to 1 if the economist has published at least a JA in Econlit during 1969-2006, and 0 otherwise.

Regressors:

- set of **attributional** variables available for all the economists in the population (i.e. gender, tenure, scientific sub-sector, faculty of Economics, geographic location and lecturer academic position without tenure) that could affect this probability of publishing.

1st model: The results

Estimation method: dprobit

Dep. var.: z=1; 0

		[1]		[2]		[3]		[4]	
		dF/dx	*t-value*	*dF/dx*	*t-value*	*dF/dx*	*t-value*	*dF/dx*	*t-value*
+	Gender	0.086**	3.80	0.086**	3.81	0.086**	3.80	0.075**	3.41
-	Tenured	-0.041**	-2.01	-0.038*	-1.88	-0.039*	-1.94	-0.163**	-6.10
+	Economics	…	…	0.064**	2.22	0.066**	2.27	0.080**	2.78
	Econometrics	…	…	0.114**	2.36	0.112**	2.30	0.092*	1.81
	Public Econ.	…	…	0.006	0.18	0.008	0.24	0.027	0.80
	Others	…	…	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
+	Fac_Economics	…	…	…	…	0.038**	1.96	0.036*	1.90
+	North West	…	…	…	…	…	…	0.042*	1.76
	North East	…	…	…	…	…	…	0.055**	2.13
	Centre	…	…	…	…	…	…	Ref.	Ref.
	South	…	…	…	…	…	…	-0.039	-1.33
-	Islands	…	…	…	…	…	…	-0.170**	-4.05
-	Lecturer	…	…	…	…	…	…	-0.345**	-7.14
	N. Obs.	1.620		1.620		1.620		1.620	
	Pseudo R2	0.011		0.018		0.020		0.07	
	Obs. P	0.812		0.812		0.812		0.812	
	Pred. P	0.815		0.817		0.817		0.834	

Note: Standard errors are robust to heteroskasasticity.
Legend: ** significant at 5%; ** significant al 10%

2nd model (1/2)

We explain the individual productivity (i.e. the number of JA weighted according to the "scientific age" of each individual) of Italian economists in terms of **relational** driving forces (i.e. propensity to co-authorship and to have international connections) and we control for attributional variables (i.e. gender, tenure, geography and age classes).

2nd model (2/2)

Dependent variable:

- **Scientific productivity**: log of number of JA publications weighted by the "scientific age" of each economist (estimated as the difference between the year of the first Econlit publication and 2006). We are missing the "biological age".

Regressors:

- **Propensity to co-authorship**: for each author is calculated the proportion of collaboration on his/her papers. It ranges between 0 and 1: 0 = no collaboration,
  1 = all papers are written in collaboration;
- **Foreign**: proportion of foreign co-authors;
- **Mills ratio**: to control for the sample selection bias
- **Dummy variables controlling for**: gender, tenure, age class

2nd model:
Some empirical issues (1/2)

- There could be a **sample selection bias**, since we are analysing exclusively those economists belonging to **Z**.

    We solve this problem calculating the inverse Mills ratio.

- **Endogeneity problem**: i.e. cooperation affects productivity, but productivity may affect cooperation (i.e. I may choose a co-author because he/she is very productive) generating a reverse causality problem.

    We solve this problem adopting IV strategy, instrumenting the propensity to cooperate using the number of collective volume articles (**CVA**) written by each author.

CVA as IV (2/2)

- We use collective volume articles (**CVA**) written by each author as instrument of propensity to co-authorship.

- In the literature, it is assumed that **CVA** are the effect of connections and are not quality comparable with JA and may reflect alternative use of a scientist's time (i.e. if a scientist writes contribute for a CVA he/she has no time to write a JA). Thus **CVA** may measure the propensity to socialise irrespective of the impact on scientific productivity.

Tests confirm that both instruments are OK!

2nd model: The results

Estimation method: IV 2SLS

Dep. var.: log of JA by scientific age

	[1]		[2]	
	Coeff.	*t-value*	*Coeff.*	*t-value*
+ Propensity of coauthorship	5.686 **	5.21	2.912**	3.40
+ Foreign	…	…	0.383**	2.25
+ Gender	0.404 **	2.64	0.327**	3.79
Tenured	0.196	1.47	0.126	1.30
North West	-0.227	-1.40	-0.065	-0.56
North East	-0.373**	-2.05	-0.295**	-2.52
Centre	Ref.	Ref.	Ref.	Ref.
South	-0.092	-0.49	0.005	0.05
Islands	-0.156	-0.45	-0.086	-0.53
Age1_10	-0.326	-1.35	-0.052	-0.26
Age11_20	-0.310*	-1.55	-0.055	-0.46
Age21_30	Ref.	Ref.	Ref.	Ref.
Age31_40	0.475**	2.20	0.134	0.84
- Mills Ratio	-0.581	-1.07	-1.359**	-3.61
N. Obs.	1,317		1,015	
Hausman (p-value)	0.000		0.000	

Note: regressions also include a constant term. Standard errors are bootstrapped (50 replications) in order to account for the generated regressor problem.
Legend: ** significant at 5%; * significant al 10%

3rd model

Dependent variable:

- **Scientific productivity**: defined as before

Regressors:

- we focus our empirical analysis on **positional** variables characterising the main component (MC)

  clustering coefficient,

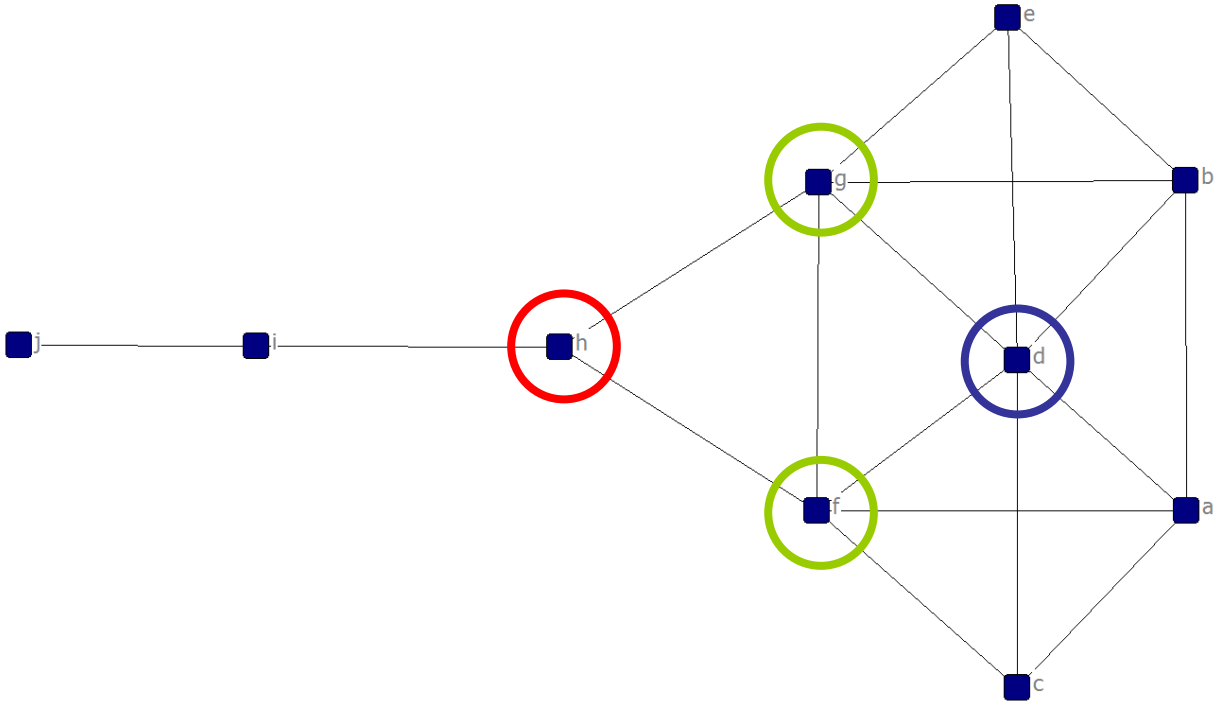
  closeness

  betweenness

  instability of scientific cooperation (i.e. a value that ranges between 0 – i.e. all co-authors are the same - and 1 – i.e. all co-authors are different).

Here endogeneity is less of a problems because these are "unobservable" networks features.

Some elements of SNA (1/2)



Node d is the node with the highest degree value (direct connections)

Node h is the node with the hightest betweenness value (bridging role)

Nodes g and f are the nodes with the hightest closeness value (indipendency role)

Some elements of SNA (2/2)

Clustering coefficient (CC): is a measure of “neighborhood”, it could be synthesized as follows: The CC is the degree to which nodes in a graph tend to cluster together. It measures the cliquishness of networks of node *i’s* neighbors.

$$CC_i = \frac{\Lambda_i}{v_i}$$

where Λ_i indicates the number of edges in the neighborhood of node i and v_i the total number of possible edges of node i.
The index varies between **0** (no neighbor of any vertex is adjacent with any other neighbor of vertex i) and **1** (individually complete neighbors).

3rd model: The results

Estimation method: Heckman two-stages procedure

Dep. var.: log of JA by scientific age

		[1]		[2]		[3]		[4]	
		Coeff.	*z-value*	*Coeff.*	*z-value*	*Coeff.*	*z-value*	*Coeff.*	*z-value*
-	CC	-0.174**	-2.64	-0.224***	-3.73	-0.083	-1.30	-0.112*	-1.90
+	Foreign	0.460***	3.48	0.445***	3.85	0.362***	4.00	0.352**	3.27
-	Instability	-1.182***	-13.66	-1.190***	-11.34	-1.147***	-12.57	-1.192***	-13.33
+	Closeness	…	…	2.637***	5.79	…	….	1.103**	2.63
+	Betweenness	…	…	…	…	3.878***	13.10	3.393***	8.39
+	Gender	0.314***	5.81	0.256***	4.34	0.256***	5.68	0.244***	4.65
	Tenured	-0.050	-0.79	-0.047	-0.93	-0.075	-1.43	-0.084*	-1.80
	Geogr. dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Age dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N. Obs.		1,249		1,249		1,249		1,249
	Censored Obs.		588		588		588		588
	Uncens. Obs.		661		661		661		661

Note: Regression include a constant term. Standard errors are bootstrapped (50 replications) in order to account for the generated regressor problem.

Legend: *** significant at 1%; ** significant at 5%; * significant al 10%

Conclusions

1) The probability of publishing is influenced by gender, disciplinary groups, geographical area, faculty.

2) If one economist does publish, his/her productivity depends positively with his/her propensity to collaborate and on his/her international connections (intrinsic quality vs. editorial boards!?).

3) Position in the networks affects productivity. Being "central" is a plus and being a "bridge" is better that being globally central. cliquishness is bad for science! (hint: star structure and exploitation of co-author gives good results?) Stability (and fidelity) pays! Keeping the same authors, at least for an Italian economist, is the best strategy in order to improve his/her productivity.

Further research

a. Structural stability test

b. Longitudinal analysis

c. Geography (e.g. distance between co-authors)