

# Does interdisciplinary research lead to higher scientific impact?

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# Introduction

Conventional wisdom: breakthroughs come from interdisciplinary research (IDR).

- Policy initiatives favouring IDR.
- Anecdotal evidence that more IDR leads to breakthrough: high risk, high reward (e.g. Hollingsworth, 2006).

However:

- Little systematic evidence of effect IDR on research performance.
- Lack of consensus on IDR measures (Wagner et al., in press, Leydesdorff & Rafols, J of Informetrics, in press).

Yet strong policy demand :

- HEFCE → IDR is not discriminated!!
- NESTA → IDR needs support!!

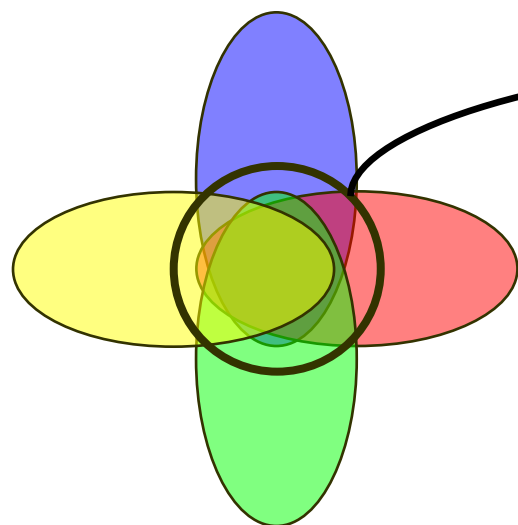
# Evidence on scientific performance of IDR

	Larivière, V., Gingras, Y. (2010)	Levitt J.M. & Thelwall M. (2008)	Adams, J.; Jackson, L.; Marshall, S. (2007)	Rinia, E.J. et al. (2001)
<b>Sample</b>	All science articles	All science and social science articles	Articles from two UK universities	All academic physics groups in the Netherlands
<b>Database</b>	WoS	WoS and Scopus	WoS	WoS
<b>Unit of analysis</b>	Article	Journal	Article	Research programs
<b>IDR indicator</b>	• % cited refs. to other SC	• SC of journals	• % cited refs to other SC • N° cited SC • Shannon diversity index	• SC of journals
<b>Correlation IDR vs Impact</b>		No effect in SS — in some science disciplines	No effect	No effect
<b>Inverted U-shape relationship</b>	✓		✓	

Results are descriptive: graphs and (bi-variate) correlations

# IDR as Integration – basis for indicators

“Interdisciplinary research (IDR) is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice”. **National Academy of Sciences, 2004.**

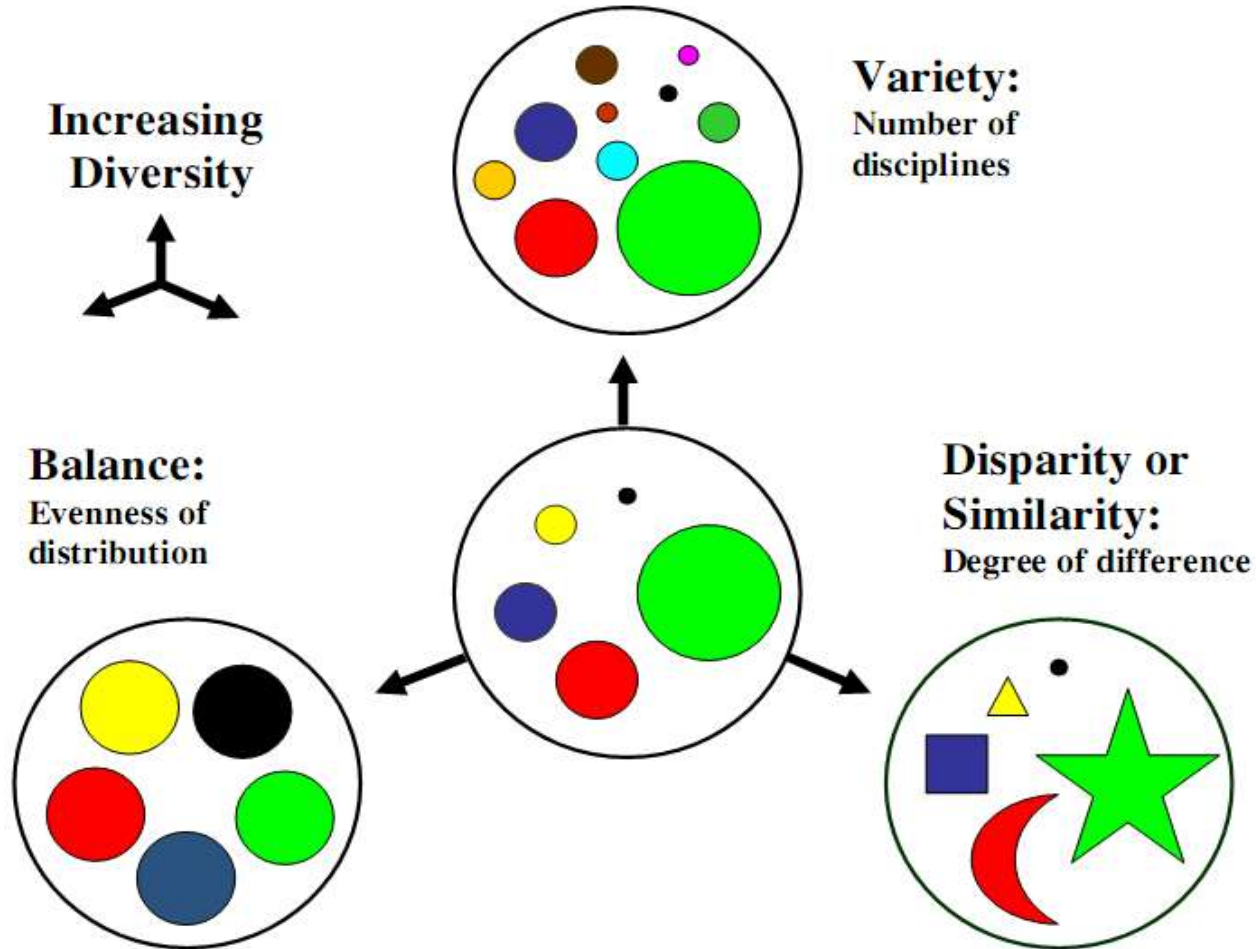


**INTEGRATION**

Most bibliometric indicators of  
interdisciplinarity implicitly rely on this idea:

**Diversity of disciplines**  
*Integrated in the reference list*

# Conceptualisation of diversity



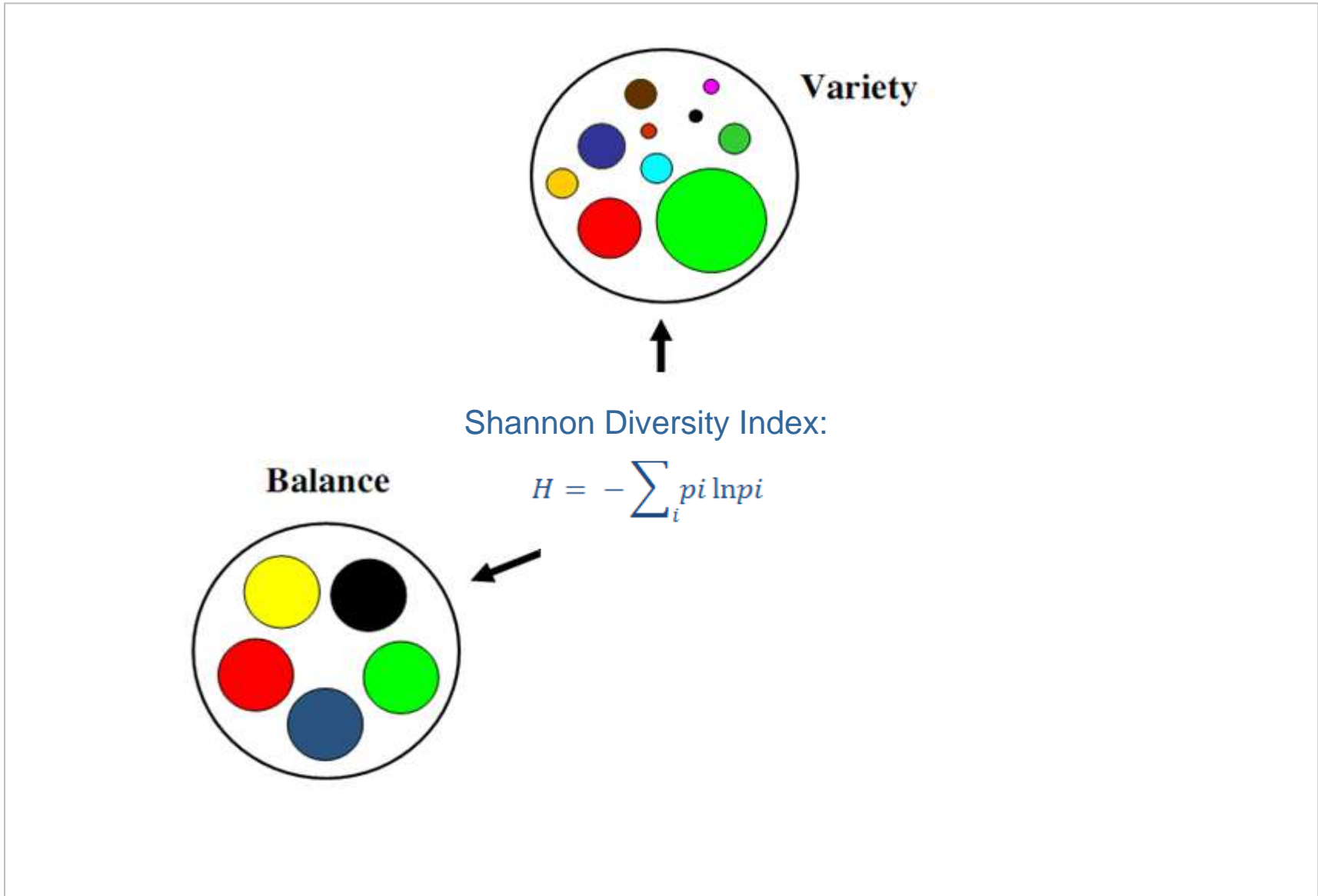
Stirling, 1998

# Research question

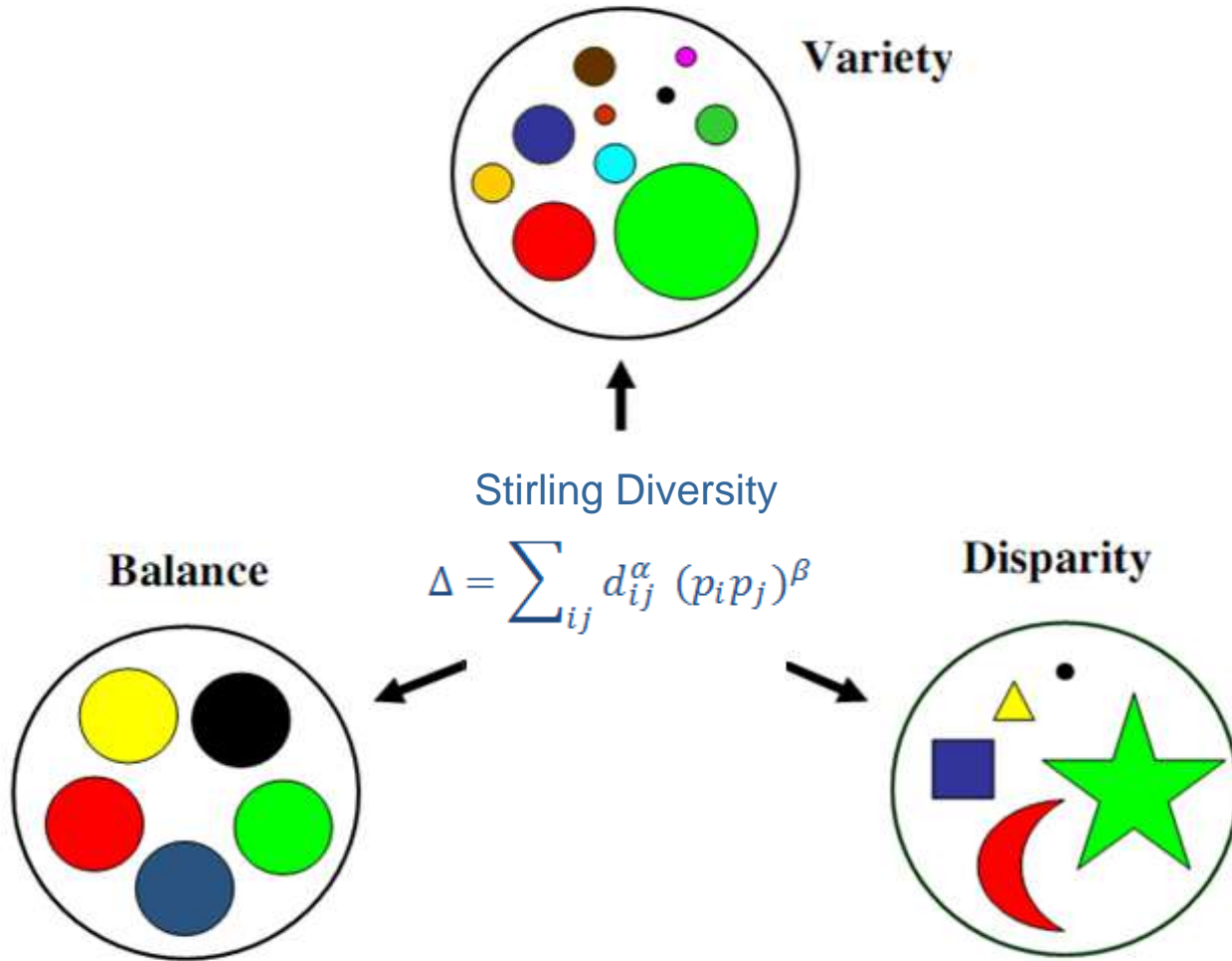
## **Does IDR lead to a higher scientific impact?**

- New methodological advances in measuring IDR: capturing the different attributes of diversity
- To what extent the different attributes of diversity have a distinct effect on scientific impact?
- Article level analysis

# Diversity indexes



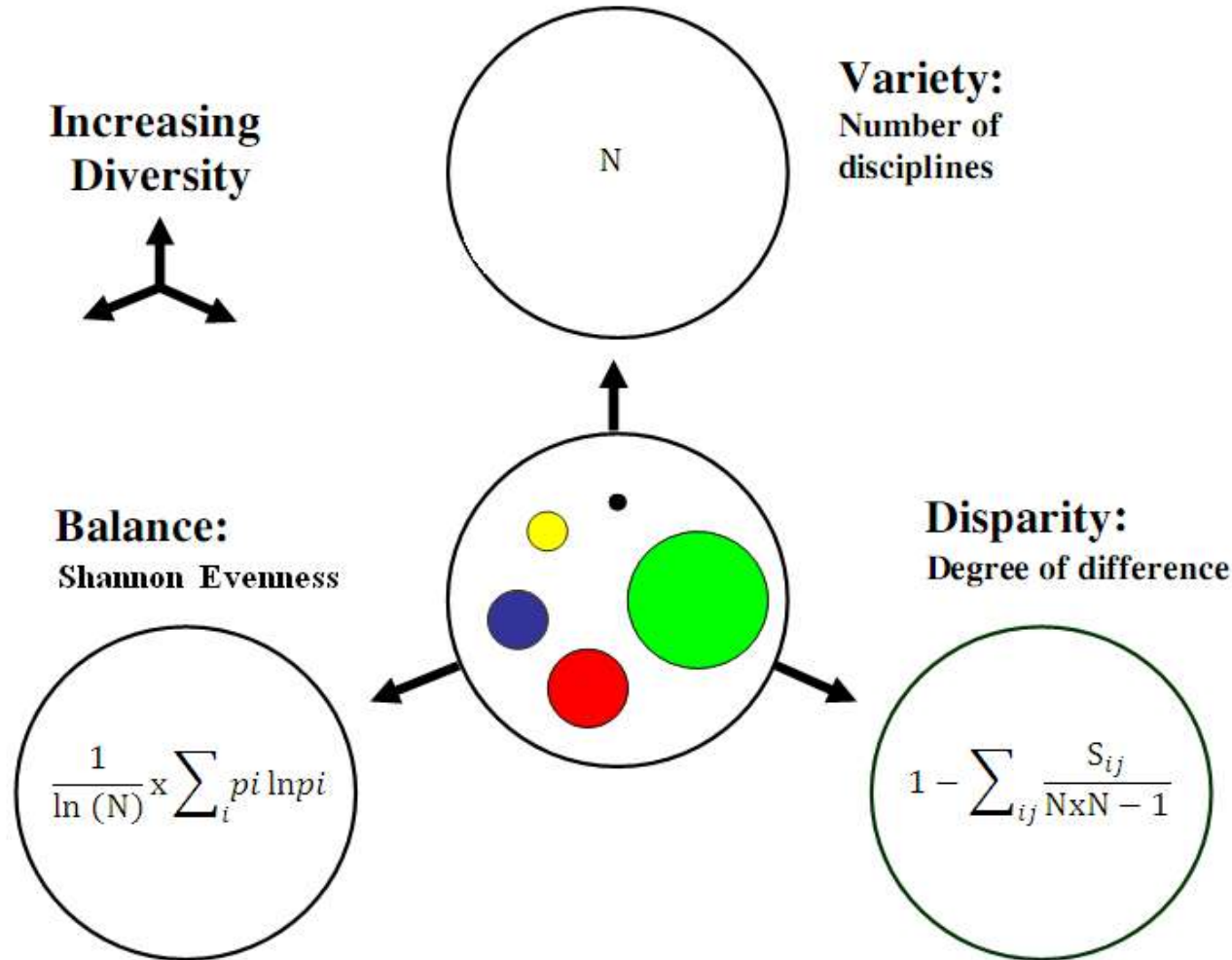
# Diversity indexes



Integration score in Porter et al., 2007



# Different aspects of diversity



For each property other operationalisations are possible

Cognitive distance, from science maps (Leydesdorff & Rafols, 2009)

# Data and Method

## Data

- CSIC research groups taking part in the Spanish Food Technology Program (SFTP) from 1988 to 1999
- 2863 unique articles and reviews retrieved from SCI-E (full abstract records were downloaded)

## Diversity

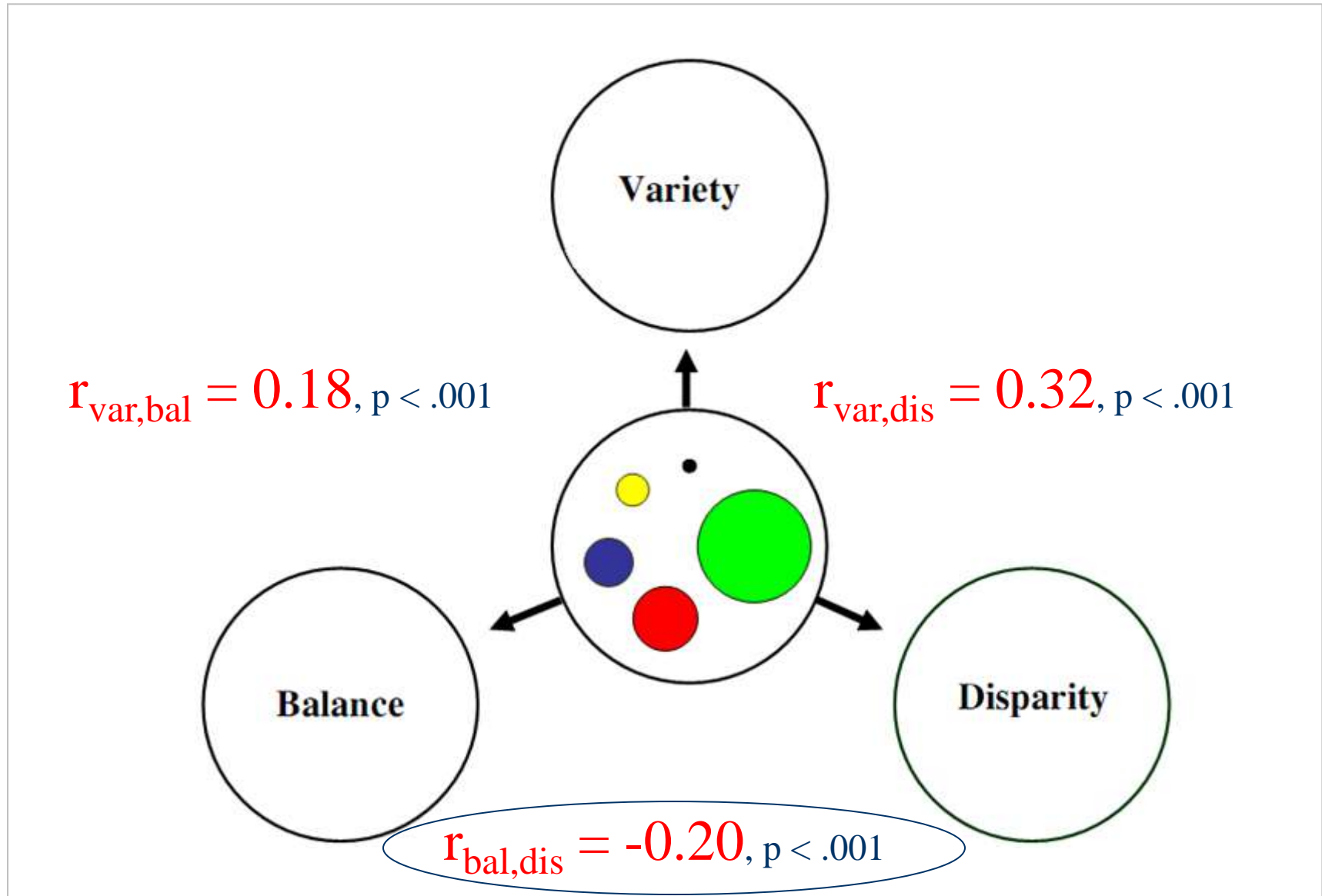
- Discipline = Subject Category (SC) in SCI-E
- 285 articles with fewer than 4 references linked to SCs were excluded (final dataset = 2578 unique articles)
- Calculation of *Shannon diversity*, *variety*, *balance* and *disparity* indexes for each publication

## Scientific Impact

- Citation window: 5 years
- Document type
- Field normalization: actual number of citations (C) divided by FCSm calculated for Spain (ES-FCSm) – (Van Raan A.F.J, 2004)

# authors, # institutions, collaboration type, journal country of publication

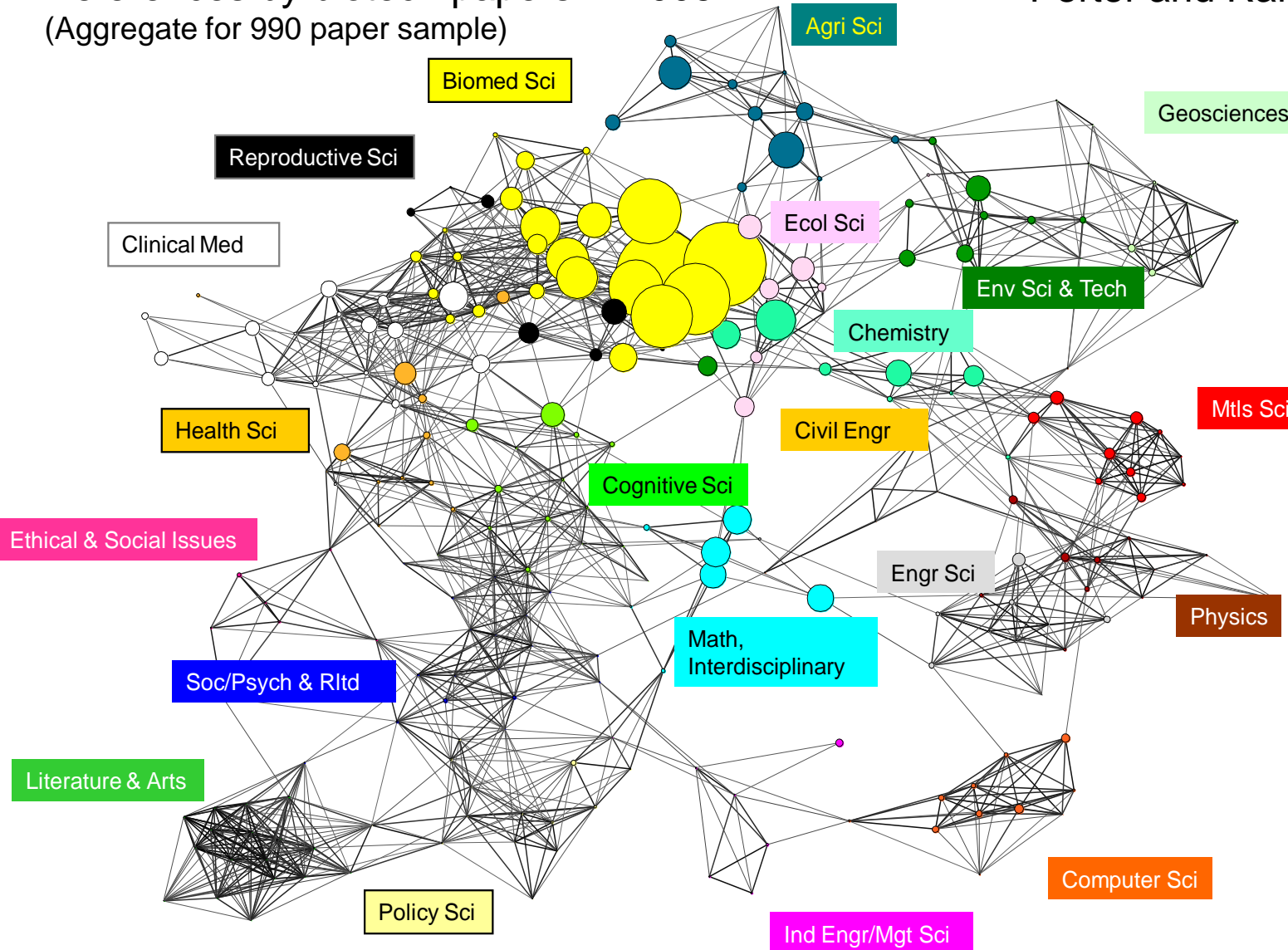
# Weak degree of correlation (n=2578)



# Illustration of correlations

References by biotech papers in 2005  
(Aggregate for 990 paper sample)

Porter and Rafols (2009)



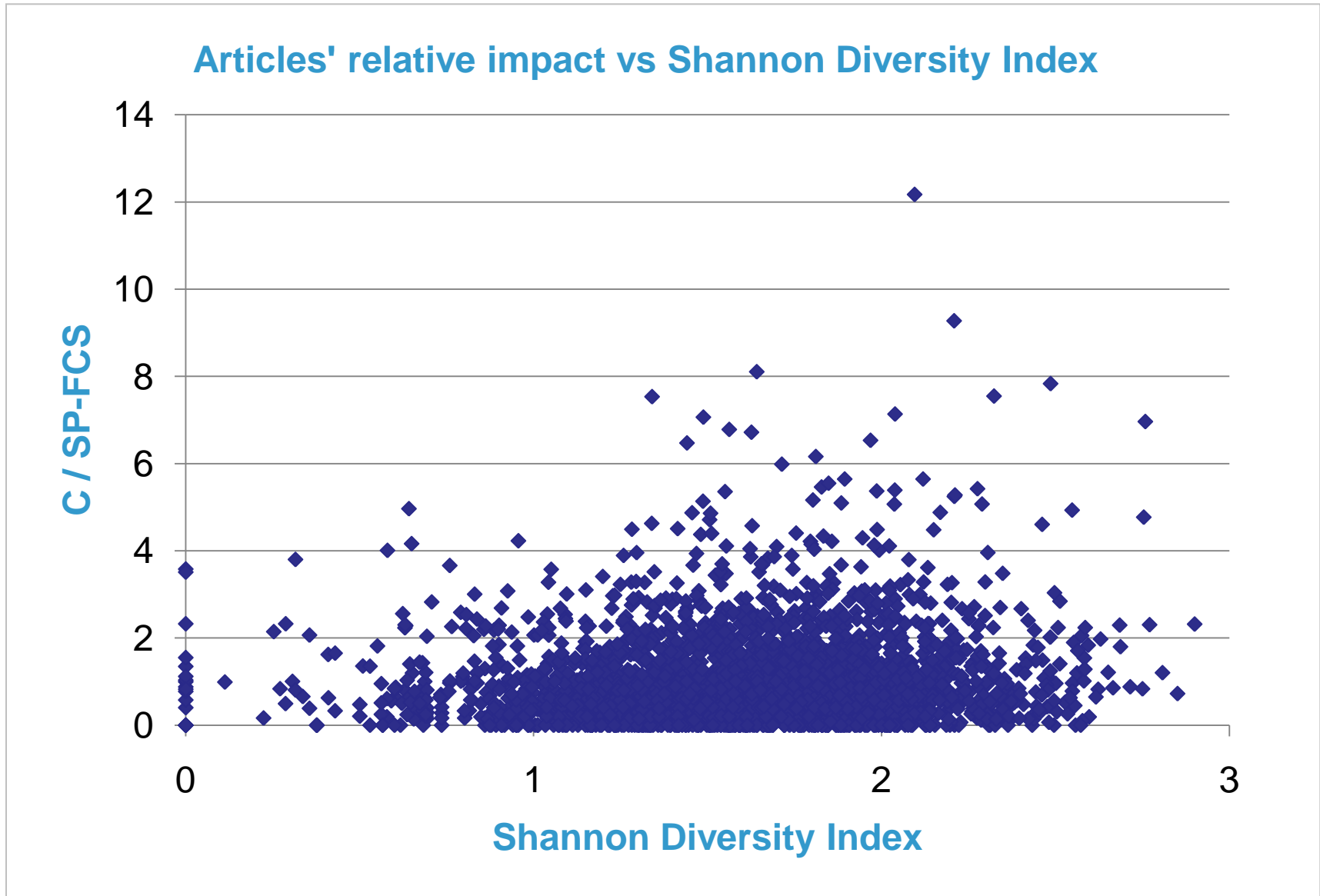
# Regression analysis

## Ordinary Least Squares (OLS)

- Dependent variable: normalized number of citations per paper (log transformed)
- Explanatory variables:
  - Shannon Diversity Index
  - *Standardized Variety / Balance / Disparity*
- Control variables:
  - No. authors / No. institutions / Collaboration type / journal country
  - For all CSIC research groups
  - Spanish regions

Total number of observations: 2578

# Shannon Diversity Index



# Results OLS regression

Dependent variable: C/ES-FCSm		
Independent variables	(1)	(2)
<b>Shannon Diversity Index</b>	<b>0,174***</b>	-
<b>Variety</b>	--	<b>0.168***</b>
<b>Balance</b>	--	<b>- 0.094***</b>
<b>Disparity</b>	--	<b>- 0.050**</b>
No. Authors	0.042**	0.044**
No. Institutions	-0.006	-0.003
Collaboration type	0.092**	0.085**
Journal nationality	0.614***	0.619***
Observations	2578	2578
R square	0.082	0.097
Adj R squared	0.058	0.073

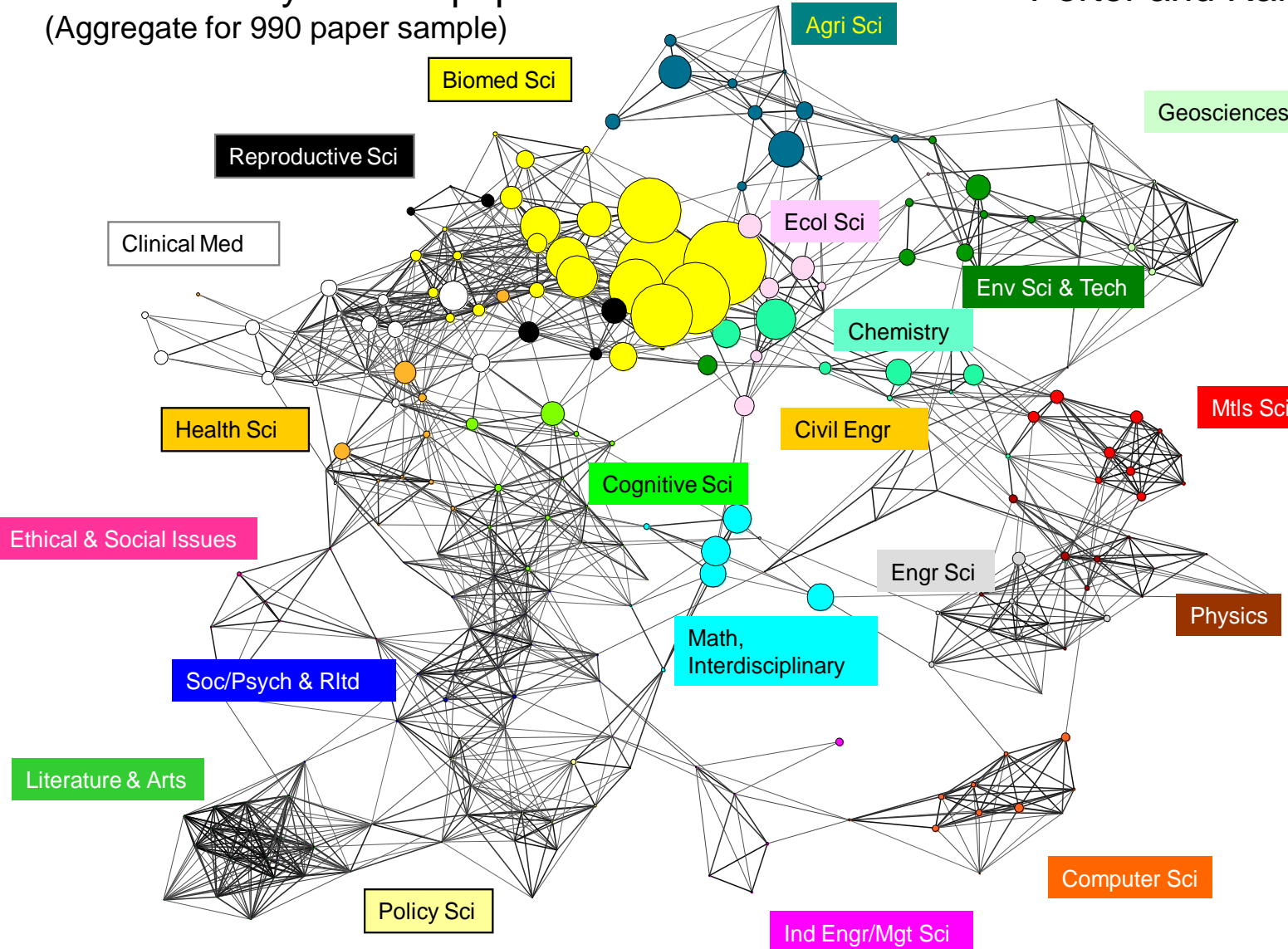
Results do not depend on normalisation of citations per field



# Illustration of regression

References by biotech papers in 2005  
(Aggregate for 990 paper sample)

Porter and Rafols (2009)







## Limitations

- Use of problematic predefined categories (ISI SCI)
  - Other units of analysis (e.g. thematic clustering?)
- References not classified as SC.
  - Discipline analysis only for those references to other source articles in SCI-E (26,8% references not linked to SCs)

# Discussion

Summary: Variety favours scientific impact. Balance and cognitive distance has a negative effect.

## T-shape interdisciplinarity:

A successful article is one that has a clear disciplinary focus but that “touches upon” disciplines of its cognitive neighbourhood.

## Successful research

- Building on cumulative knowledge (Pavitt, 1987)
- *State-of-art* expertise in one field by capacity to integrate *standard* knowledge from other fields (qualitative studies: Brusoni, 2001 ; Rafols, 2007)

# Discussion

Summary: Variety favours scientific impact. Balance and cognitive distance has a negative effect.

Or is IDR is discriminated against?

A successful article is one that *positions* itself so that it can be read and cited by a disciplinary audience.

Disciplines can enforce the reading of papers that are considered important.

Without a community, IDR papers do not have tools to enforce citation/reading.

**Normative interpretation is problematic**

- The results *do not explain* what type of IDR *should be supported*. Only what type of IDR is currently rewarded given present institutions in science