Characterising the Dynamics of Nano S&T: Implications for Future Policy

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FRENCH- RUSSIAN CONFERENCE “ECONOMIE, POLITIQUE ET SOCIETE: NOUVEAUX DEFIS ET PERSPECTIVES”

SECTION ECONOMICS OF S&T AND INNOVATION - 28-29 October 2010

Content

- Our question: How do nanotechnology develop? Will it like previous scientific revolutions, be the source of a new major industry? What policy portfolio can be implemented?
- Our central hypothesis: nanotechnology as a ‘general purpose technology’ but it needs to be managed locally. Cannot rely on past ‘best practices’
- The presentation in brief:
  - Revisiting past post WWII revolutions and the policy portfolios
  - Analysing the 1st generation of policy instruments in nano
  - Analysing S&T dynamics : 1. a general purpose technology and 2. A high degree of geographical concentration
  - Redefining a policy mix and characterising clusters

A retrospective view

- A reappraisal of past dynamics on features associated to the physics, IT and bio ‘waves’.

- Driving to the policy hypothesis: different institutional ‘mechanisms’ associated to the emergence (variety generation & selection) of new science-based markets

  - physics and large programmes (Space, Aeronautics)
  - IT and ‘technological’ / collaborative programmes
  - Bio and IP/‘start-up’/venture capital policies (to package/demonstrate value of knowledge developed by public sector research)

Leading science’	Physics	Computer science/ IT	Molecular biology
Dynamics Crystallisation	Large objects or technical systems	Distributed IP (patent pool) Strong industry-university relations	Science based / ‘individual’ IP, transfer / licences
Trajectory	Early selection of design / cumulative improvements	Adoption of standards and design tools	Competition between paradigms
Critical infra-structures	Specific very large equipments	Generic infrastructures	No / (limited) entry barriers
Modes of coordination	‘Large programme’ (product oriented)	Technological programmes	Networks & clusters (bottom-up)
Main industrial actors	‘national’ champions (specialising in public infrastructures)	MNF (oriented toward mass markets). Specialised firms (B to B) to better relate to users	Start-up & venture capital in initial phase/ Concentration around large established firms during diffusion
Typical ‘industries’	Nuclear energy, Space, civil aero-nautics, digital wired telecoms	Information technolo-gy, mobile telecom-munications (GSM)	Biotechnologies

What about 1st generation of nanotechnology programmes?

- Since 2001 : NNI. Quickly followed worldwide

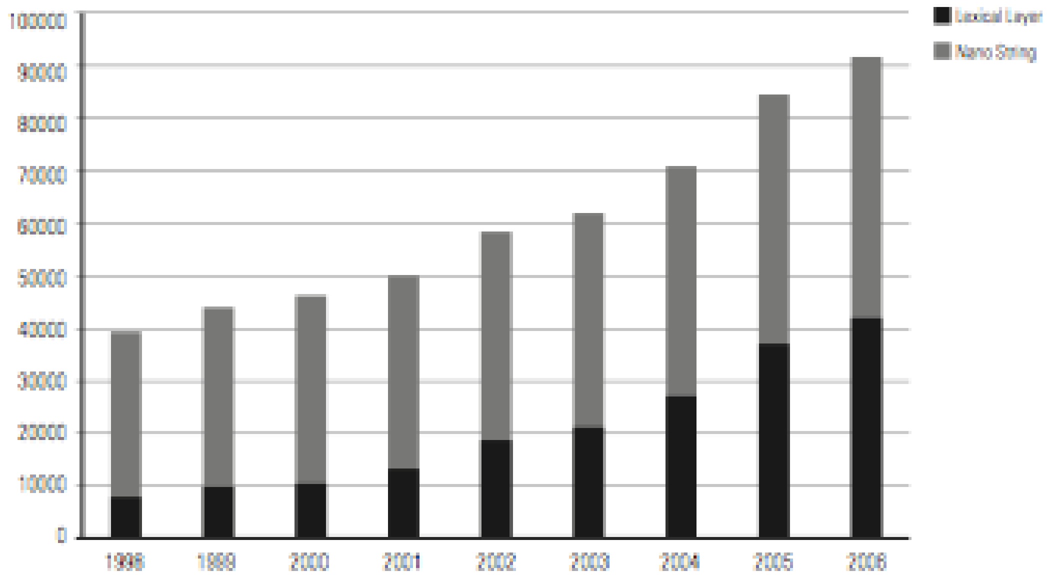
- Isomorphism in the resource allocation
  1. Development of facilities like in the physics and bio waves
  2. Focus on fostering a ‘friendly ecology’
  3. Research at the core of the programmes
     - one central programme to develop common abilities (Fr, Japan, Korea, EU)
     - or targeted programmes based on applications (US)

- Isomorphism in the main principles
  1. Supporting ‘frontier science’ and technological exploration
  2. Developing programmes on instruments, methods, processes
  3. Focusing on collaborative and PP partnerships on strategic applications

Large investments to address the issue

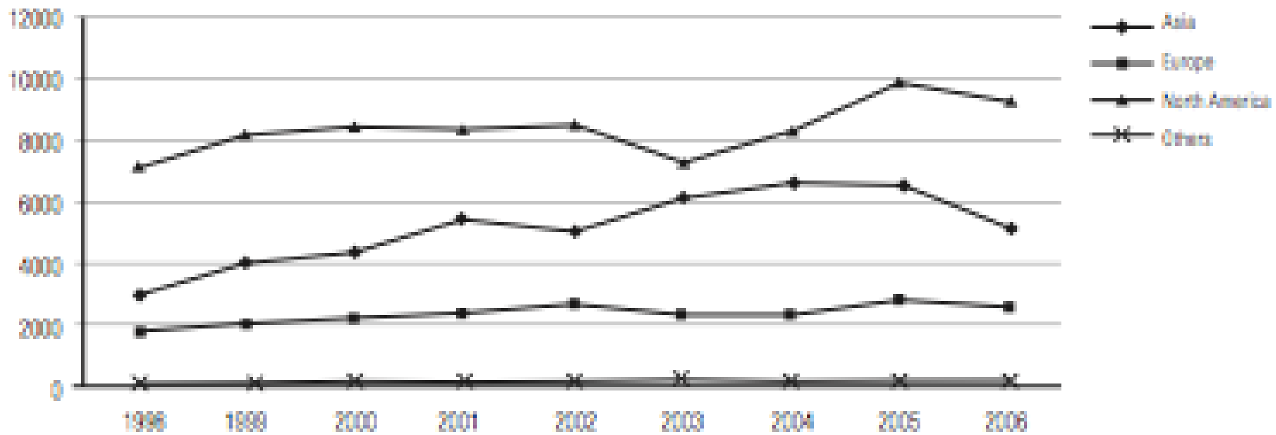
- Building databases (publications & patents) --> delineating emerging fields (see Mogoutov & Kahane, 2007)
- Sources: articles (WoS) + patents (Patstat)
- Methods developed - key criterion: automated, reproducible, non expert-based and evolutive.
- Building clusters on a world-wide basis (based on automated, reproducible processes) -->
  - geolocalisation of all addresses,
  - aggregation on a geographical base (not administrative, nor institutional)
  - actor identification (Univ; Govt labs; firms)

A ‘turbulent’ scientific growth ….but still exploring (technology)



30000 articles in 1998,
over 90000 in 2006

=> Targeted programmes



A General Purpose technology

firms in DTI scoreboard	total	nano	%
Chemicals	93	76	82%
Electronic & electrical	102	68	67%
Oils & gas, forestry	44	29	66%
Automobile & parts	78	51	65%
Tech hardware &equipment	225	136	60%
Construction & materials	20	12	60%
Healthcare	53	30	57%
Aerospace & defence	34	19	56%
Pharmaceuticals & biotech*	152	75	49%
Industrial engineering	70	33	47%
Leisure & personal goods	44	17	39%
General industrials	43	16	37%
Media & telecom	17	6	35%
Other	152	42	28%
Software & comp services	111	23	21%
total	1238	633	51%

Not 1 industry but the need to master competences broadly and to integrate them into their products

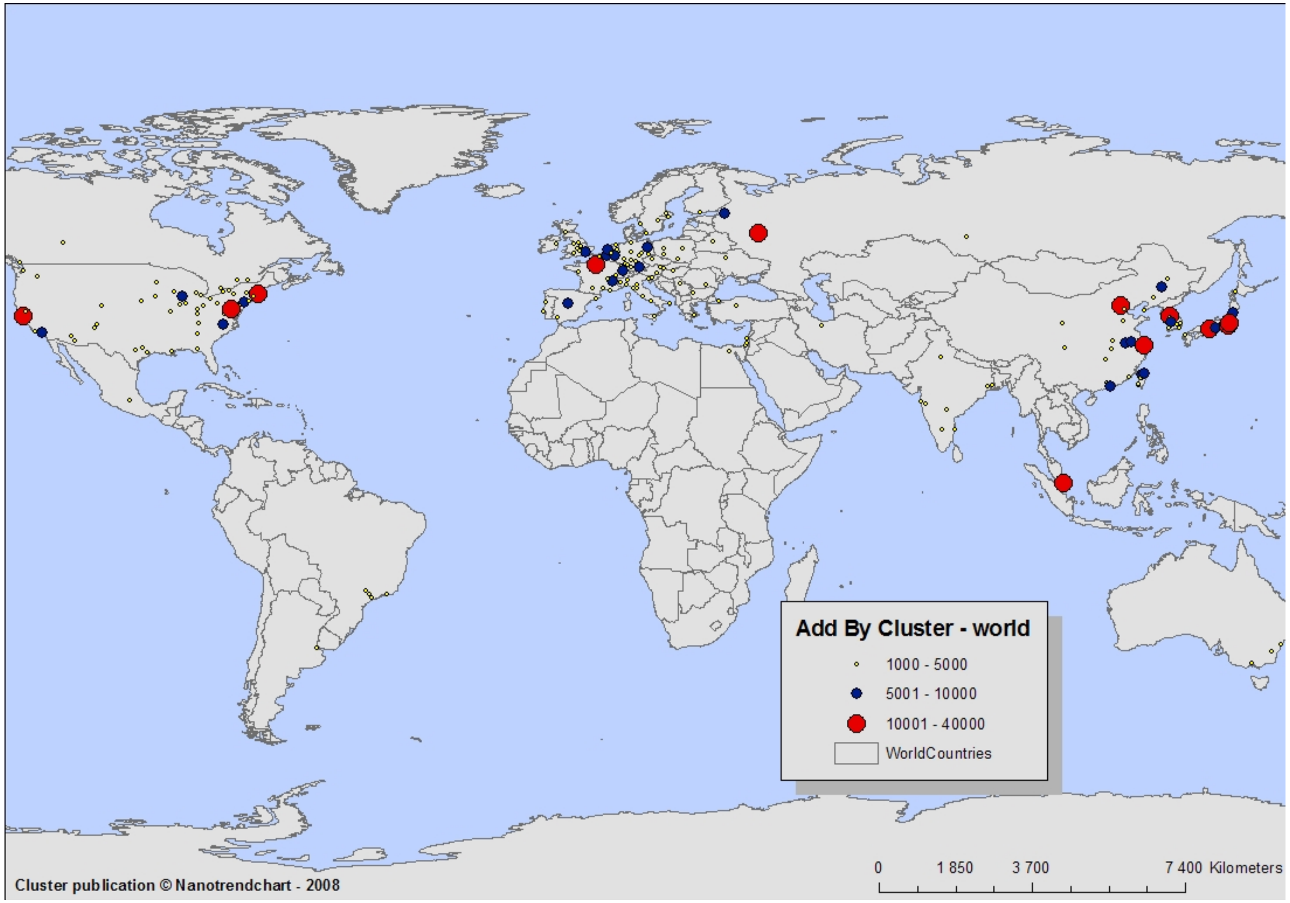
⇒Diffusion based programmes

Diffusion + production programmes

Options

- Technological centers (for tailored tools see the physics waves) and/or technological platforms
- Industry targeted programmes
- Capability building (higher education + integrating researchers in firms)
- Start up policies?
  - Instrumentation
  - Acceptability/demonstration

A strong concentration phenomenon



203 world clusters shape the world of knowledge production in nanotechnology (80% of 1998-06 production)

=> Rethinking the diffusion policies by engineering linkages at both the industry and the geographical levels

Characterising clusters to adapt the policy mix

Indicator 1 : institutional diversity

Role of governmental labs: as a locus for costly instrumentations; as a proxy for scientific platform

Indicator 2 : cognitive (sectoral/thematic) diversity

60 strong & balanced clusters and 80 specialized clusters

Indicator 3 : agglomeration

History matters for patent applications
Existing industrial zones are already the most active

Indicator 4 : Visibility

Highly cited articles (top 1%) display the attractiveness of new concepts

Indicator 1 : institutional diversity

Ex: Role of governmental labs

• as a locus for costly instrumentations
• as a proxy for scientific platform
• represent for 23% of publications
• 18 clusters amounts for 50% of govt labs publications (40 for universities)
• 33 clusters account for 66% of govt labs publication (71 for universities)
• Including 5 major DOE nanoresearch centers in the US and CEA labs in France

Indicator 2 : cognitive (sectoral/thematic) diversity

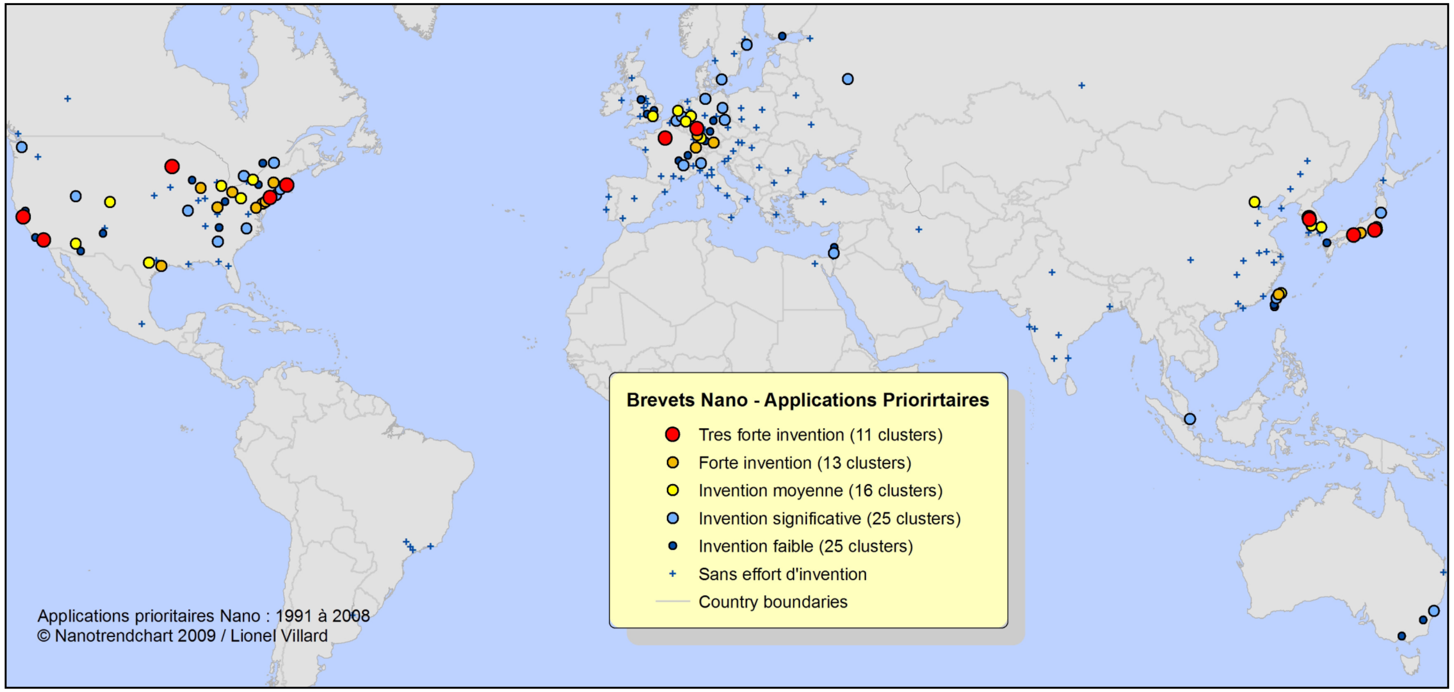
Présence thématique : engagement et équilibre thématique						
	v.strong & balanced	strong & balanced	bi-specialised	mono specialised	without significant engagement	total
US	8	9	5	15	18	55
Asia	8	4	14	11	12	49
Europe	17	12	11	15	26	81
other	1	1	4	4	8	18
total	34	26	34	45	64	203

Thematic presence : a balanced cluster has to be present in the top 80% of the three themes (Physic – electronics, chemistry – materials, biotech – life science)

- 60 strong & balanced clusters and 80 specialized clusters
- No real difference in continental distribution

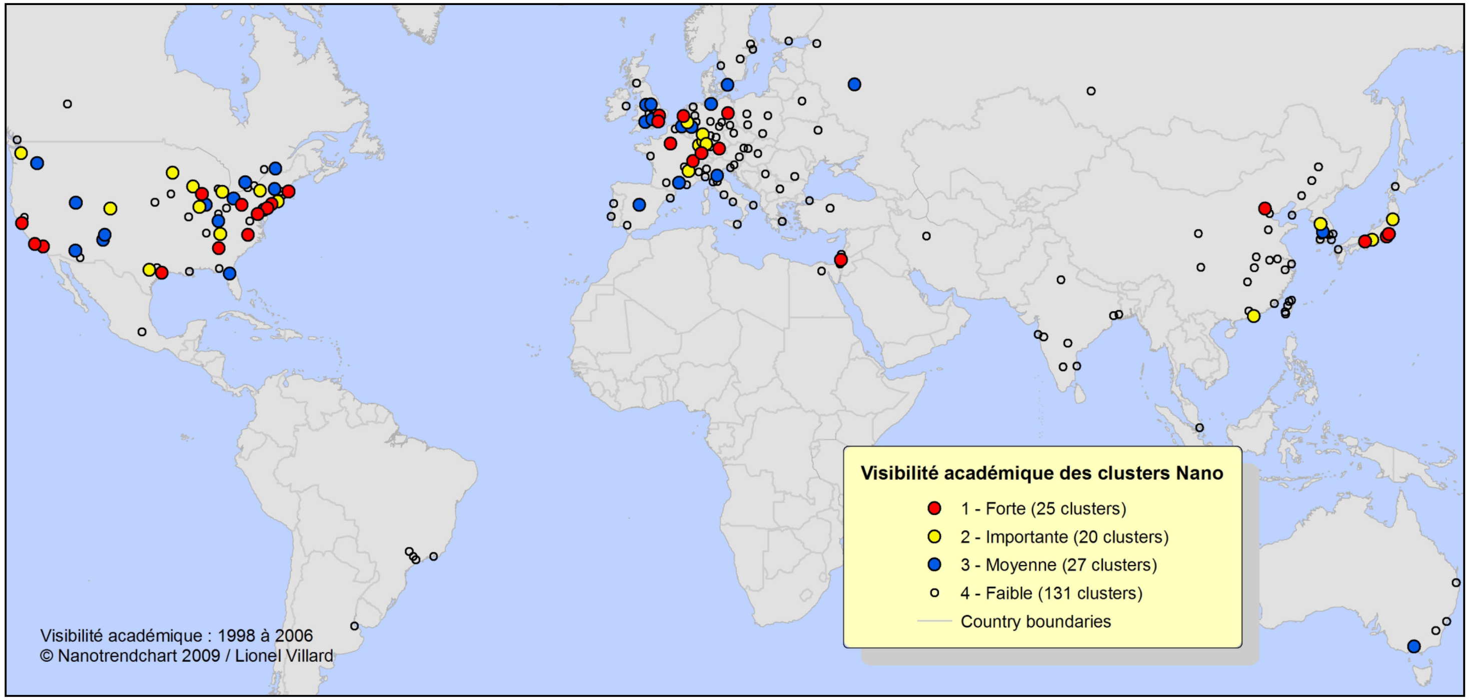
Indicator 3 : agglomeration

History matters and cumulativity of knowledge
But we see also new places in Europe and Asia (high rate of growth)

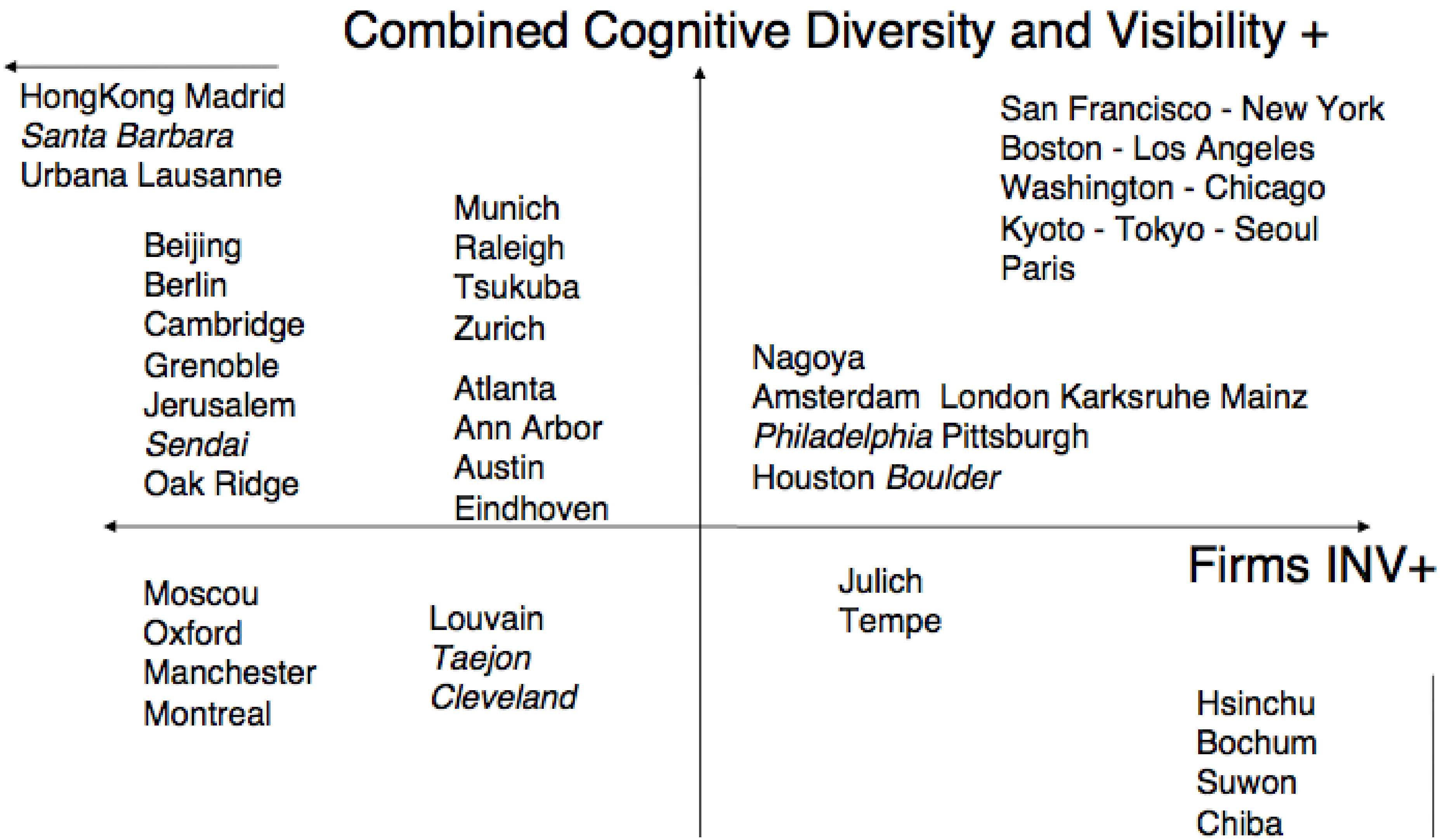


- Role of S&T platforms
- Role of anchor tenant

Indicator 4 : Visibility



- Highly cited articles (top 1%) display the attractiveness of new concepts
- 50% of main clusters display Top 1% articles
- Visibility is the business of Triadic countries : North America (22) , Europe (15), Asia (8 mainly in Japan)


Combined Cognitive Diversity and Visibility +
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Santa Barbara
Urbana Lausanne
Beijing
Berlin
Cambridge
Grenoble
Jerusalem
Sendai
Oak Ridge
Munich
Raleigh
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