



清華大學
Tsinghua University

Evolution of Regional Scientific Collaboration Networks in Nano-science between China and EU-15 Member States

Yantai Chen (Zhejiang University of Technology, China)

Dimitris Assimakopoulos (Grenoble Ecole de Management, France)

(EuSPRI Conference,
Karlsruhe, Germany/ June 13, 2012)





清华大学
Tsinghua University



Outline

- **Research Questions**
- **Methodology and Data**
- **Collaboration networks in three nano sub-fields / general networks between China Provincial Level and EU Member States**
- **Driving forces and Influential factors**
- **Conclusions**



清華大學

Tsinghua University

Research Questions

1. How common is the China-EU Member Nations regional research collaboration in nanoscience?
2. What are the driving forces behind these dynamics of bilateral collaborations on this emerging nanotechnology field?
3. What factors are either conducive to bilateral collaborations to regional science or detrimental to engage in the innovation network?



Methodology and Data

- Methodology

We utilize the social network analysis method and bibliometric analysis. The software of *Ucinet*, has been adopted.

- Data

-- Geographic Scope.

The EU15: comprised the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and United Kingdom. (Switzerland and Poland are selected for comparative analysis.)

China Regional: 16 provincial regions in mainland China (13 provinces and 3 municipal cities), which have national nano-related research infrastructures



清華大學

Tsinghua University



Methodology and Data

- Data

-- Nano Research Scope:

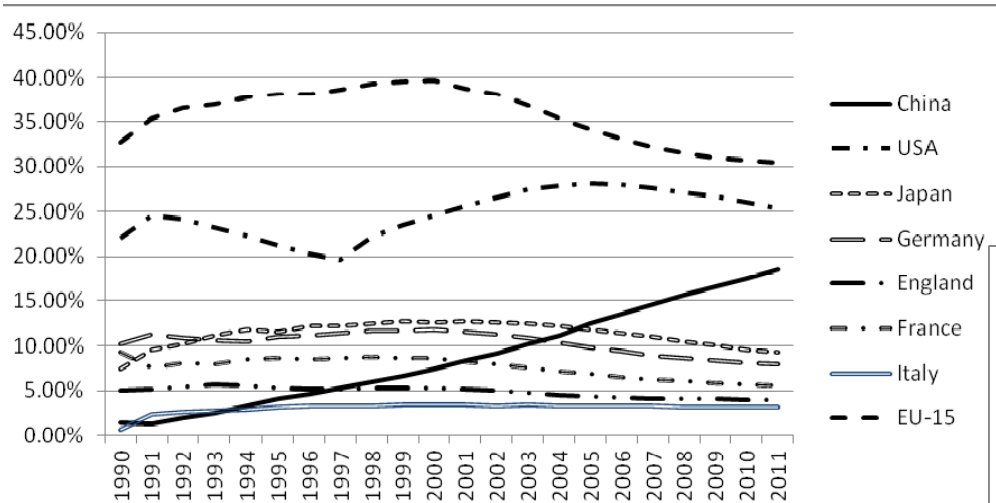
This research examines the general term of Nano related research first, and then divides three specific nano research sub-fields into Nano materials, Nano biotechnology & Nano medicine, Nano electronics & Nano devices. Here the research fields classification is adopted as *Georgia Tech Modular Nano Search Algorithm* developed by Georgia Institute of Technology.

The main idea was to search for research paper in the Web of Science database, with a “nano*” for the general search, and then specific searches which three nano sub-fields terms was defined by Tang (2011) as the key words in the recommended nano-related journals.



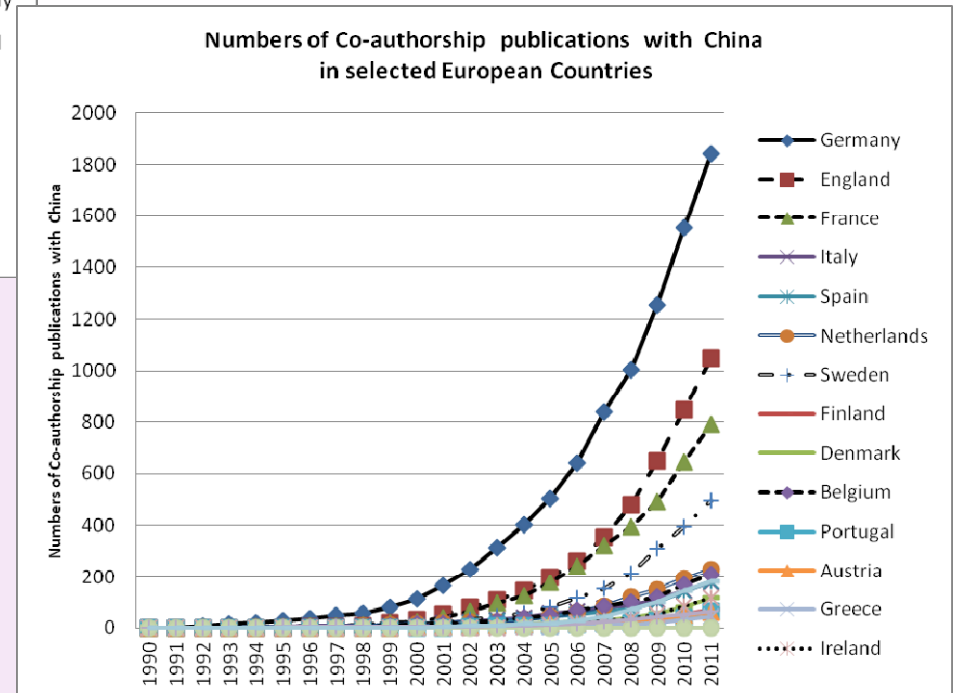
General Descriptive Analysis

Global share of nano-publications by major nations



EU-15, USA, China, Japan, Germany, England and France take the lead in global nano-publication. Rapid growth in China (Global No.2 from 2005)

→ Germany, England, France, Sweden, the Netherlands and Belgium rank top 6 European countries working with China.





How about the collaboration intensity between China-EU nations?

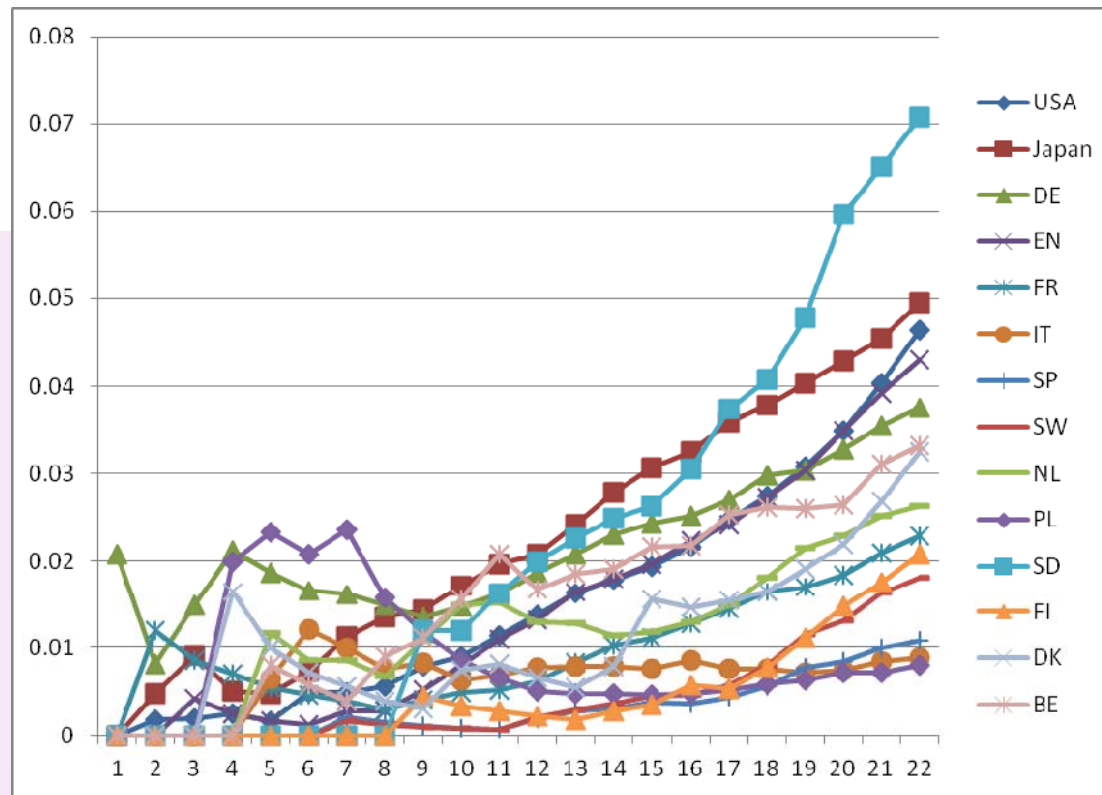


Figure. The Collaboration Intensity between China-EU
(Number of Co-publication Paper/ Total Paper in Nano Science in Each Country)

-- Generally, The international co-publication with China in Nano-Science is increasing. **Less than 5% (5 out of 100)** are collaborative work for EU nations in general.

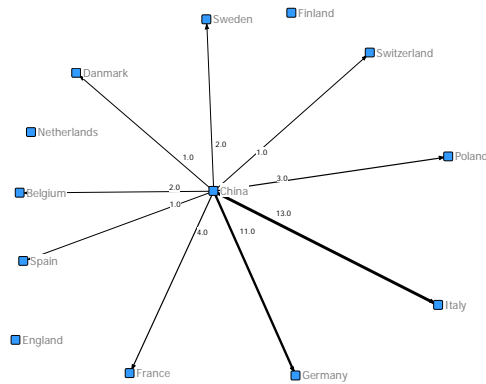
--China has intensive co-publication with **Japan, US scientists than EU-Nations** (Despite of Germany in early stage and Sweden from 2006)

-- **Sweden, Germany, England, Belgium and Netherland** has the high publication intensity with China in Nanoscience.



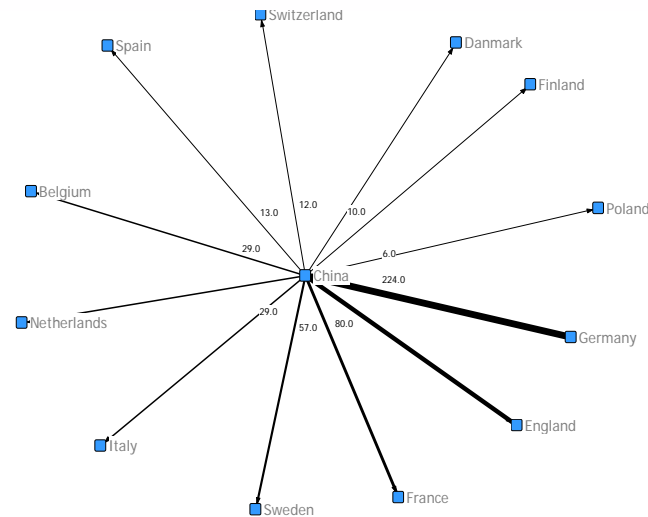
Collaboration networks in three nano sub-fields: Nano- Material

The period From 1980-1995



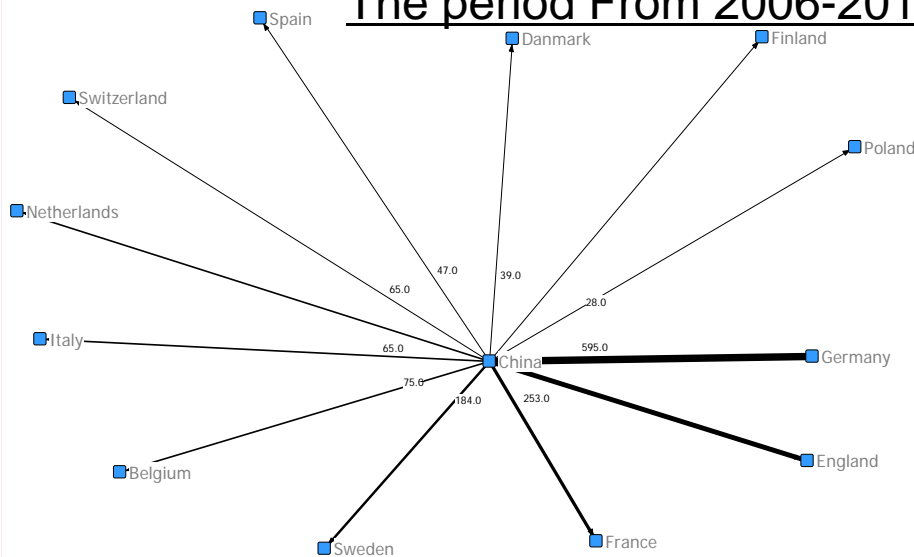
← Few co-publication. Italy, Germany, Poland worked actively with China.

The period From 1996-2005



↑ Germany, England, France and Sweden were major collaborators with China in this stage.

The period From 2006-2011

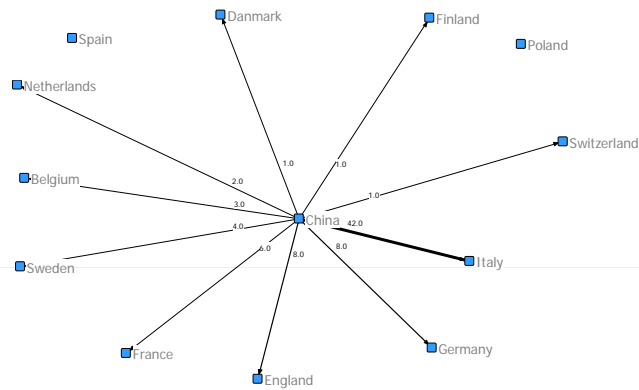


← An average of three times as the accumulated numbers before 2006. Germany, England, France, Sweden, the Netherlands and Belgium were major collaborators with China in this stage.



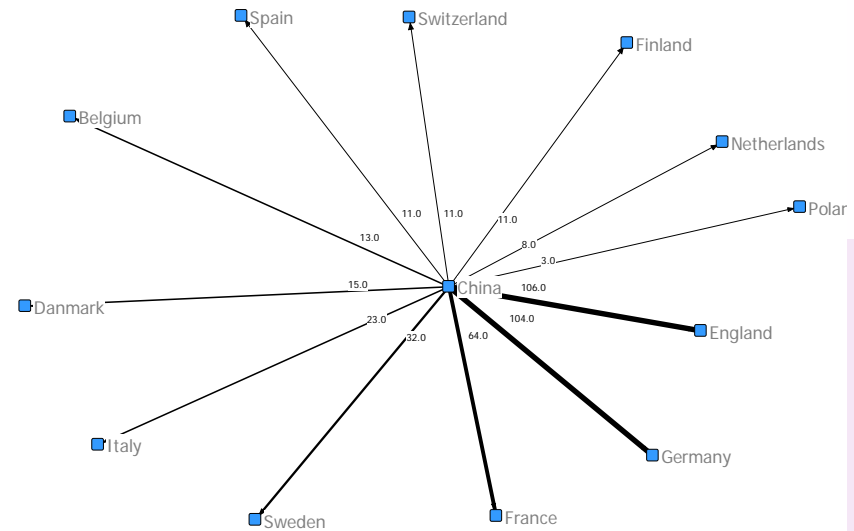
Collaboration networks in Nano biotechnology & Nano medicine

The period From 1980-1995



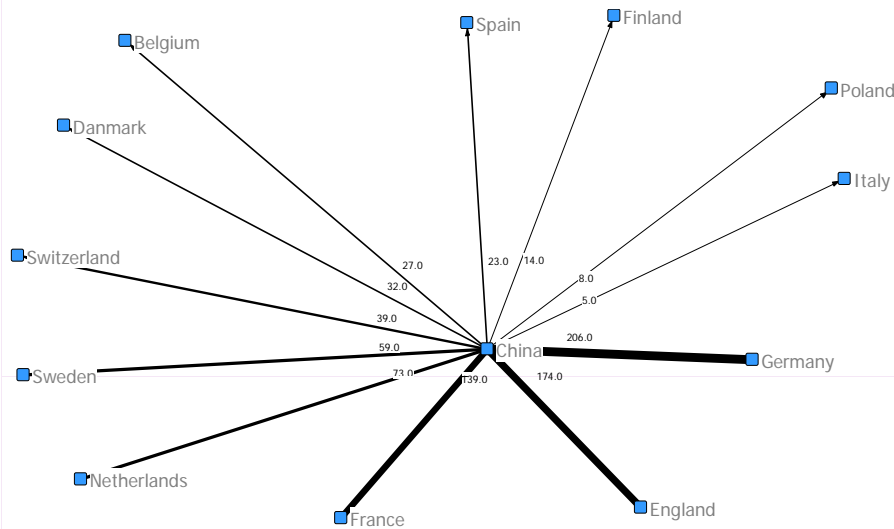
← Few co-publication. Italy, Germany, England began to work with China.

The period From 1996-2005



↑ Germany, England, France and Sweden were major collaborators with China in this stage too.

The period From 2006-2011

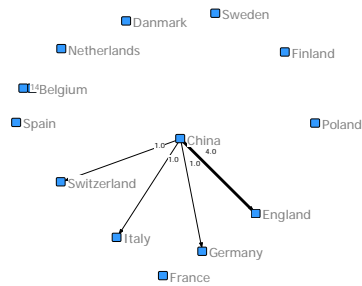


← Germany, England, France, **Sweden**, **Switzerland**, and the Neitherlands were major collaborators with China in this stage.



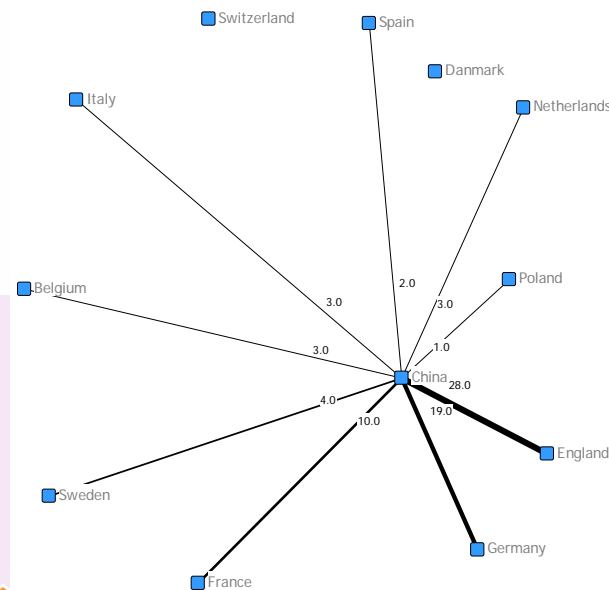
Collaboration networks in Nano-electronics and nano devices

The period From 1980-1995



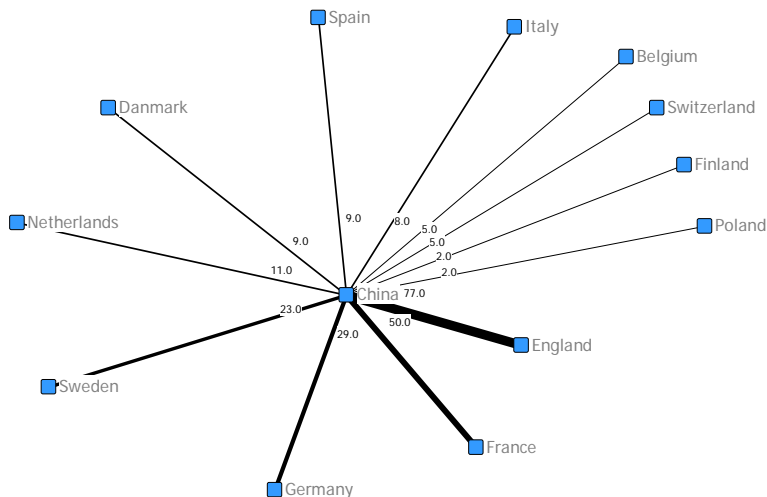
Very few co-publication. Only four nations in EU with China. England had 4 records.

The period From 1996-2005



England, Germany and France had more than 10 co-pubcations with China in this stage.

The period From 2006-2011



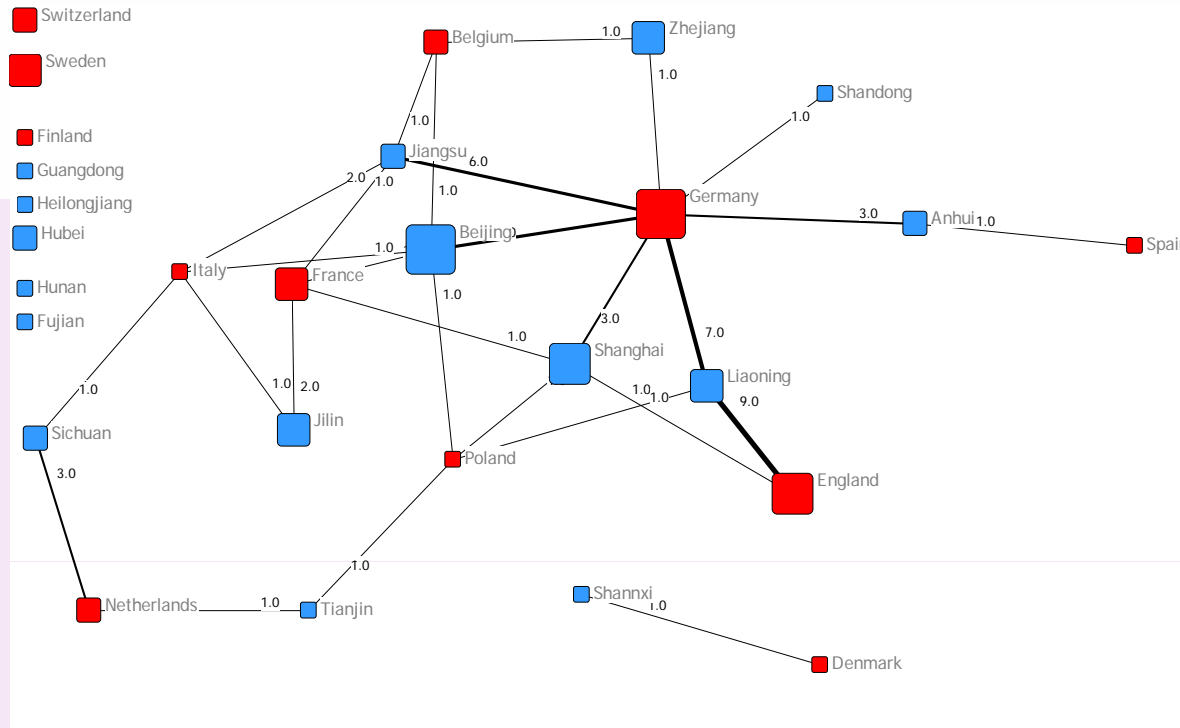
England and France had over 50 records, Germany and Sweden had over 20 with China in this stage.

Still in the primarily stage in this sub-fields.



Collaboration networks between China Provincial Level and EU Member States (1)

The regional Collaboration in the period From 1980-1995



In EU side:

Germany played the dominant role, with collaborative partners from 7 regions in China. Italy, France, Poland and Belgium were also positive.

In China side:

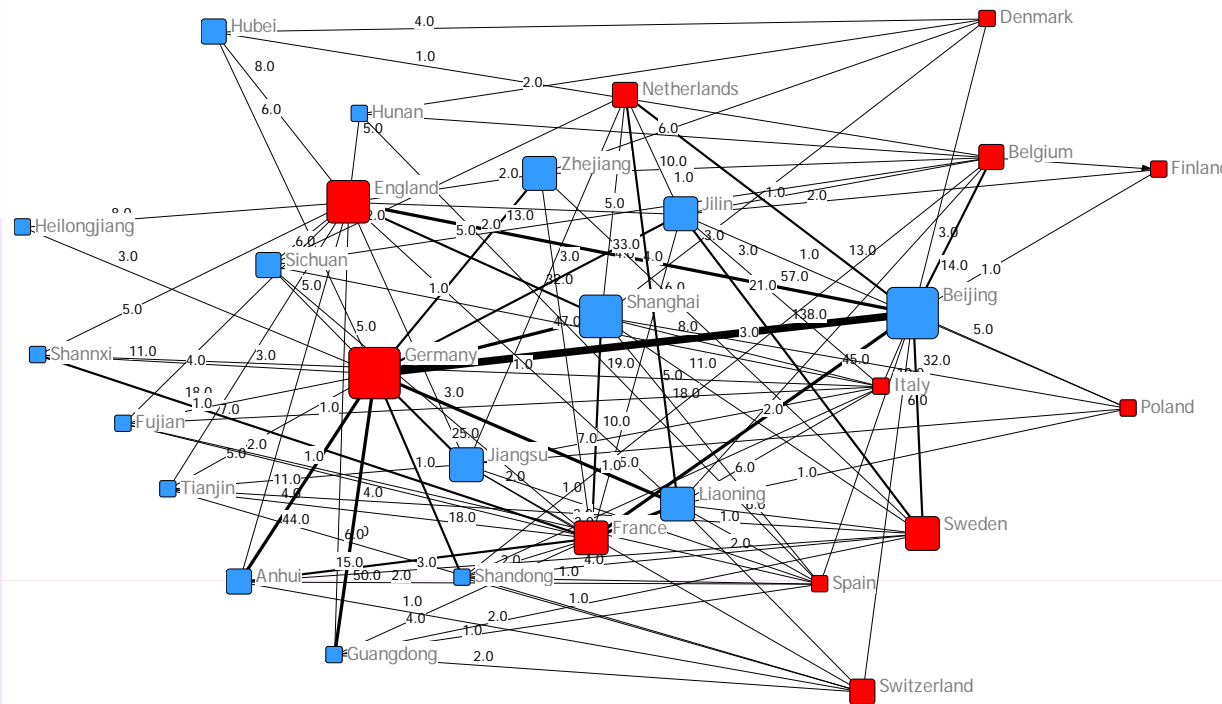
Beijing, Shanghai, Jiangsu and Liaoning were the most active players in collaborations with European partners.

➔ **Scientific capability and diplomatic relations have influenced the regional scientific network in terms of EU-China level.** Inside China, the difference of scientific base in regions has determined the international collaboration intensity.



Collaboration networks between China Provincial Level and EU Member States (2)

The regional Collaboration in the period From 1996-2005



In EU side:

Germany, England and France had worked almost all of 16 Chinese regions for co-publications in this stage. Italy also worked intensively with Chinese regions

In China side:

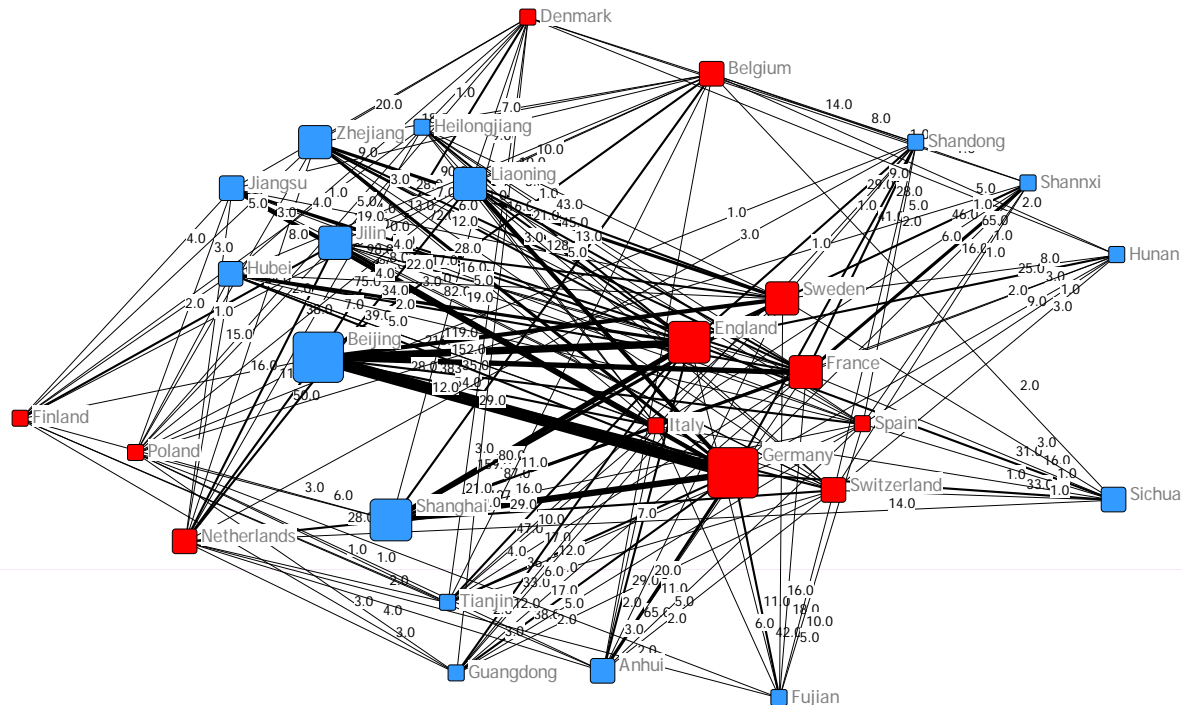
Beijing and Shanghai worked closely with multiple nations. In North-east China, Jilin and Liaoning, as well as coastal province Jiangsu worked intensively with multiple partners.

➔ Besides Scientific capability, economic linkages and mobility of researchers have influenced the regional scientific network. Inside China, the differences of scientific base and economic linkage with Europe in regions have determined the collaboration intensity.



Collaboration networks between China Provincial Level and EU Member States (3)

The regional Collaboration in the period From 2006-2011



In EU side:

Germany, England, France and Sweden acted as the major players. Switzerland, the Netherlands, Denmark and Finland followed in working with China.

In China side:

Beijing has produced more than 1/4 of total co-publications. Shanghai produced another 1/6. Zhejiang, Jiangsu, Jilin and Liaoning were other major players.

➔ **Scientific capability, economic linkages, mobility of researchers and favorable policy have promoted the regional scientific network.** Inside China, the differences of the accumulation in scientific base, economic size and availability of researchers in regions have determined the collaboration intensity.



Collaboration networks between China Provincial Level and EU Member States (3)

From 1996-2005:

1. **Germany**-Beijing (138):
2. **England**- Beijing (57):
3. **Germany**- Guangdong (50):
4. **France** – Liaoning (49):
5. **Germany** – Shanghai (47):
6. **France** – Beijing (45):
6. **Germany** – Liaoning (45):
8. **Germany** – Anhui (44):
9. **Germany** – Jilin (33):
10. **England**- Shanghai (32):
10. **Sweden** – Shanghai (32):

Most Notable Collaboration Networks from 2006-2011:

1. **Germany**-Beijing (383): →
2. **England**- Beijing (216): →
3. **Germany**-Shanghai (197): 2↑
4. **England** – Shanghai (159): 1↑
5. **France** – Beijing (152): 1↑
6. **Germany** – Liaoning (128): →
7. **Sweden** – Beijing (119): ↑
8. **Germany** – Jiangsu (98): ↑
9. **Sweden** – Zhejiang (90): ↑
10. **France** – Shanghai (87): ↑
11. **Sweden** – Shanghai (80): →

Path
Dependence
In regional
Science
Collaboration

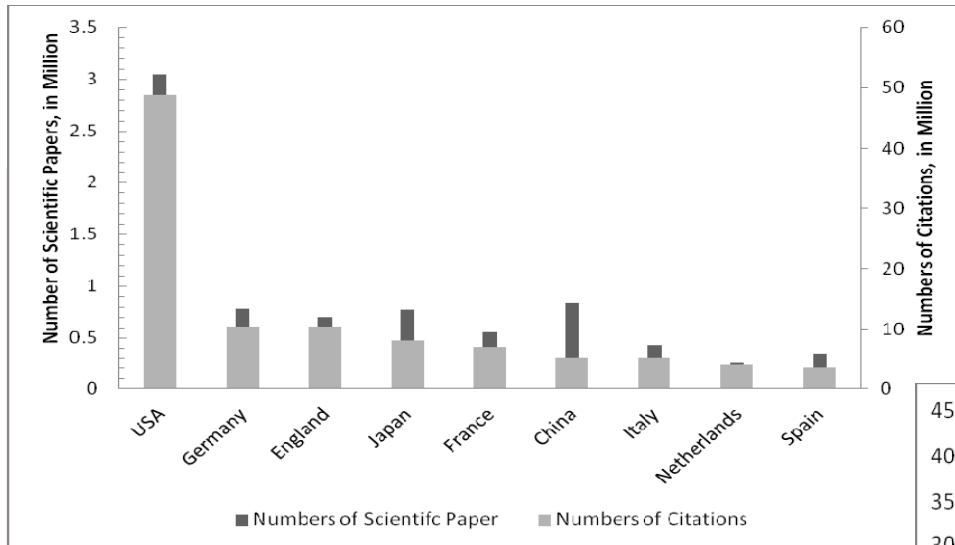
→ **Germany** took the lead working with different Chinese regions during different period (6/10 from 1996-2005; 4/10 from 2006-2011) ; **England and France** were also active working with different Chinese provinces; **Sweden** has accelerated the connection with China.

→ **Beijing and Shanghai** were taking the lead working with European nations (possessing 3/11 to 4/11 seats respectively in two different period); **coastal provinces** (Zhejiang and Jiangsu) rose up.



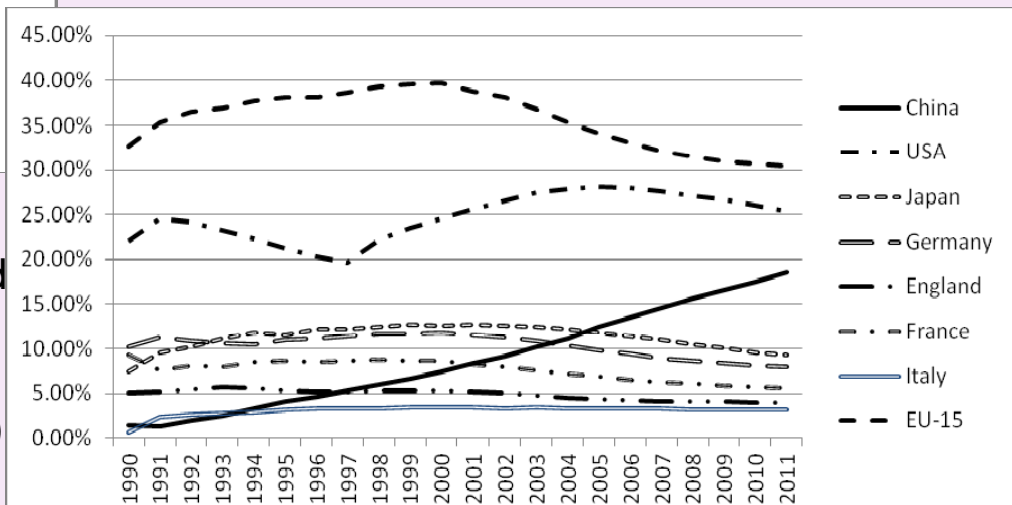
Driving Forces for Collaboration Network

- *The accumulation of Scientific Capability*



Global scientific publications and citations of major players accumulated from 2001 to 2010.

➔ High growth in nano-field scientific output both in China and EU-15. China has surpassed **England, France and Germany** in Nano publication in 1999 (3,143 vs. 2,498), 2001 (6,341 vs. 6,291) and 2004 (18,064 vs. 16,627) respectively.





Driving Forces for Collaboration Network

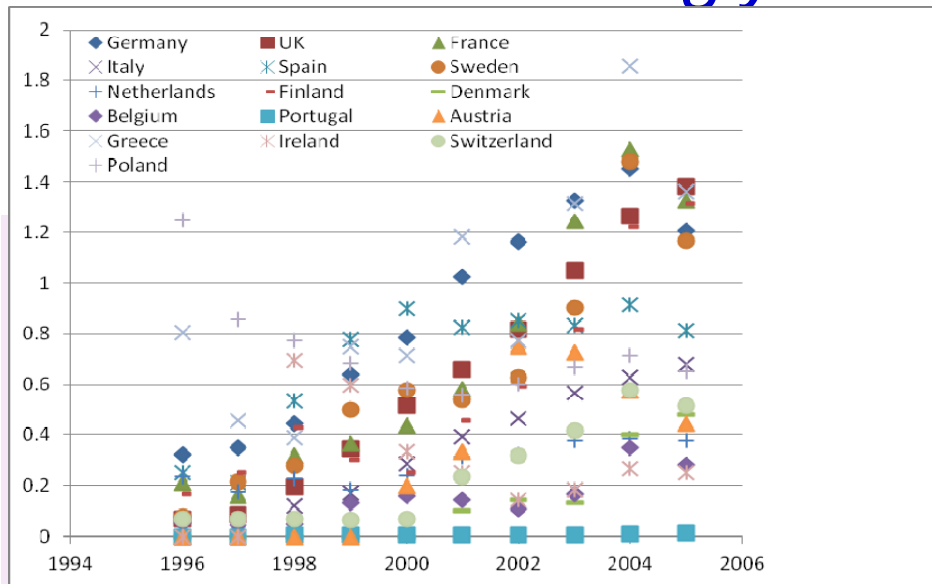
- Policy: Bilateral Collaboration Mechanisms Targeting to Promoting Scientific Sources Flow

- A 'strategic partnership' between China and the European Union was announced **in 2003**, followed **in October 2006** by a Communication entitled "*EU-China: Closer Partners, Growing Responsibilities*", which paves the way for increasingly strengthening collaborations in various fields.
- In October 2002, EU Research Commissioner and the Chinese Minister for Science and Technology (MOST) signed a co-operation agreement ("implementing arrangement") in the field of material sciences.
- In May 2005, another joint declaration was made at a joint forum attended by EU Science and Research Commissioner and China's MOST with dialogues in ministry-level, **opening the basic research projects for bilateral scientists.**
- There are also some joint institutions cofounded such as China-EU Science and Technology Cooperation Promotion Office (CECO).
- There are some promotion initiatives to strengthen China-EU **member nations** on scientific collaboration which **provide funding and scientists' mobility.**



Driving Forces for Collaboration Network

- *The increasingly trade and economic linkages*



Germany, England and France, both major trade and scientific partners with China from 1996 to 2005, have quite positive relationships in trade and science collaborations with China. **From 2006 to 2011**, the co-publications of **England** with China also take leads.

“Co-publication/ Trade” intensity (CTI) can be calculated as following (Equation 1):

$$CTI_{ij} = \frac{\text{(The number of Co-authorship paper)}_{ij}}{\text{(The total volume of import and export)}_{i(j-2)}} \quad (1)$$

($i=1, 2, 3, \dots, 16, 17$; $j=1996, 1997, \dots, 2009, 2010, 2011$)

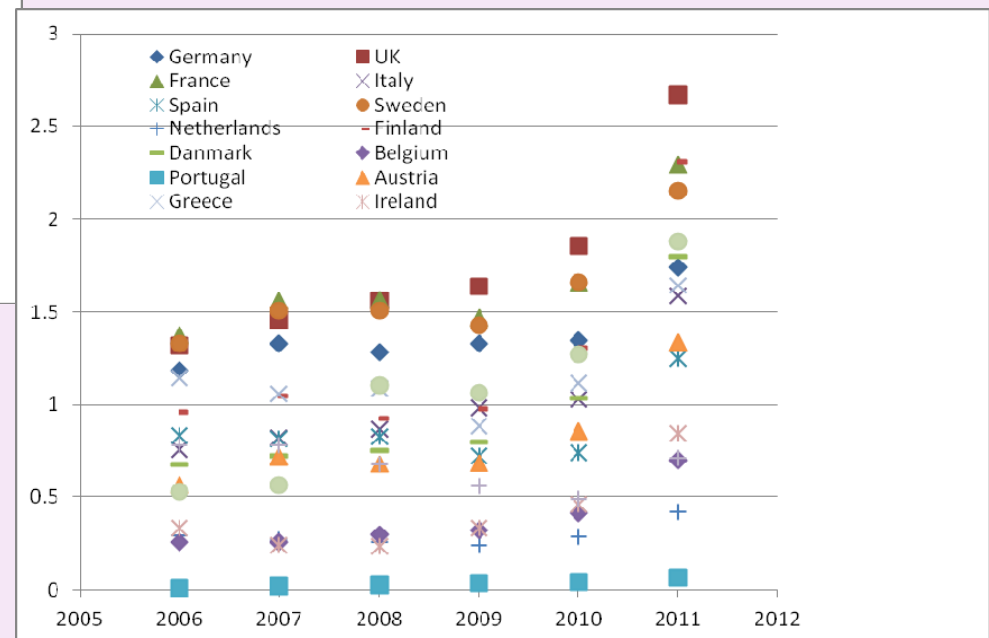


Table 1. Participation in Projects involving at least one Chinese Participation



清华大学
Tsinghua University



Factors Conducive to Build Collaboration Network

- The availability of bilateral financial supports

Country	Number of participations			% of total
	FP5	FP6	Total	
Germany	74	365	439	12%
United Kingdom	56	349	405	11%
France	65	258	323	9%
Italy	42	263	305	8%
Netherlands	24	199	223	6%
Spain	31	180	211	6%
Belgium	39	102	141	4%
<i>Other EU25</i>	<i>176</i>	<i>667</i>	<i>843</i>	<i>23%</i>
<i>Other non-EU25</i>	<i>136</i>	<i>594</i>	<i>730</i>	<i>20%</i>
Total	643	2,977	3,620	3,620
<i>China</i>	<i>154</i>	<i>351</i>	<i>505</i>	<i>12%</i>
Total participations	797	3,328	4,125	4,125



Financial supports from EU level and national level:

- Framework Research Programs to support Chinese scientists.
- National research foundations such as Humboldt Foundation, DFG; Royal Society, The French National Research Agency Project et al.

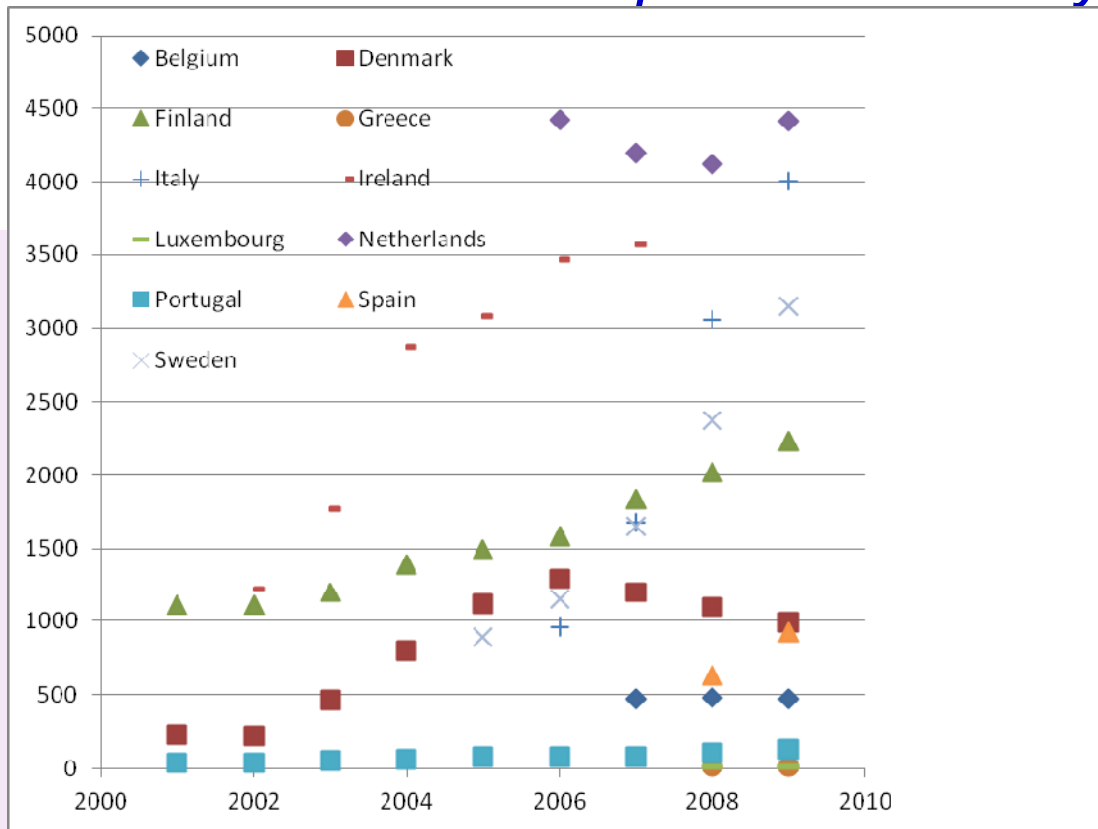
→ Financial supports from China:

- MOST opens up basic research participation for EU scientists
- CAS funds international collaborations through its Bureau of International Cooperation.
- The Bureau of International Cooperation of NSFC is in charge of the management of international cooperation and exchange activities



Factors Conducive to Build Collaboration Network

- *The facilitators to promote mobility of scientists and students*



The mobility of Chinese Scientists and Students to EU

← Returnees have a higher tendency to engage in co-publication behavior with their former host country, “Scientific Social Capital” (Jonkers & Tijssen, 2008).

-- EU-15 have attracted more Chinese students than and Japan did after 2004 (Jonkers, 2008b)

-- the countries receiving highest numbers of Chinese students (stock) are the **UK** (40% of total), **France** (23%) and **Germany** (20%), followed by **the Netherlands** (4%), **Italy, Ireland and Sweden** (3% respectively), **Finland**.

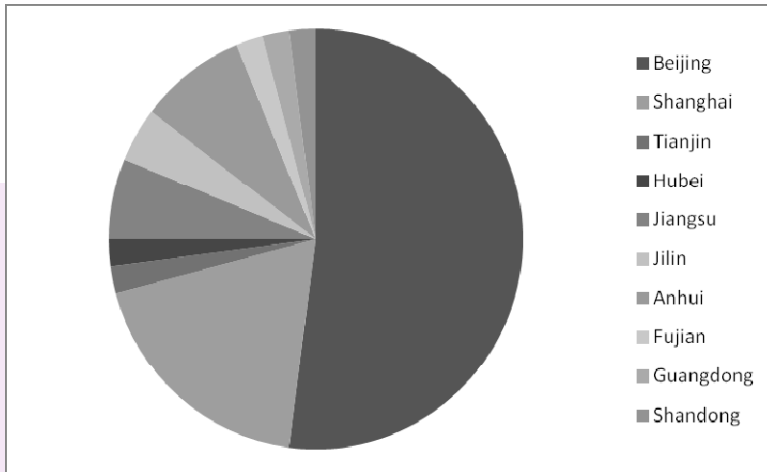


清华大学
Tsinghua University



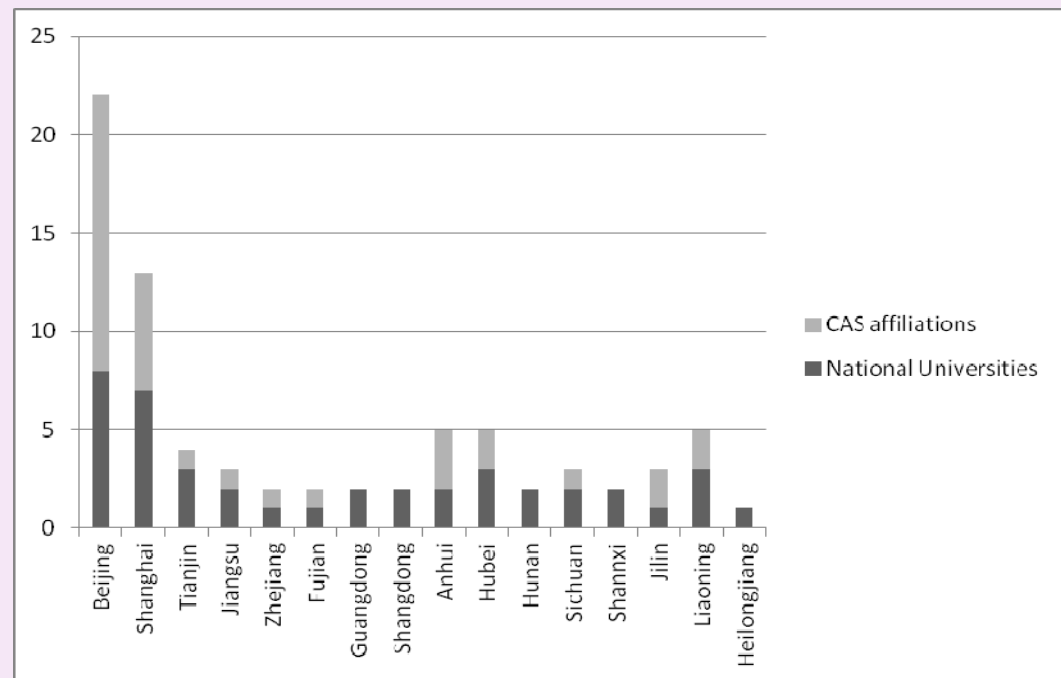
Factors Influencing the Collaboration Network

- Uneven Scientific Infrastructure Distribution in China



➔ Location Distribution of Major National Universities and CAS Affiliations involved in Nano research in China.

← Location Distribution of Specific Nano Funding Fields allocated by MoST Key National Research Projects in China.





Conclusions- Empirical Findings (I)



The regional scientific collaborations between China and selected EU member nations are rising with an astonishing speed since 1996, especially after 2006.

Germany, England, France ranks top three in building collaboration networks with China. **Sweden, the Netherlands and Belgium** followed the active partners of China in the nano science collaborations in terms of co-publication records after 2006.

However, in terms of **collaboration intensity** cross Europe-Asia continent, Sweden, Germany, Belgium and England rank top partners with China.



清華大學

Tsinghua University



Conclusions- Theoretical Contributions

- 1. The driving forces for regional scientific collaboration network between EU-China:** the dynamic scientific capacity in China, formal scientific cooperation mechanism, and increasingly importance of economic and trade linkages.
- 2. Open Innovation for regions:** *The mobility of scientists and students and The availability of bilateral financial supports.*
- 3. Path Dependence** during the evolution of regional scientific collaboration: *historical-friendly relationship* between two regions, *accumulations of scientific capability* .



清華大學

Tsinghua University



Conclusions- Policy Suggestions

1. **Stable economic and diplomatic relationships** can benefit bilateral collaboration in emerging science.
2. **Bilateral supporting system for open innovation:** the policies for the mobility of talents and funding mechanism, attracting more *European scientists* visiting China since there are much less European scientists in China than Chinese in EU.
3. **Capability building and Sustainability:** reducing the regional imbalances in scientific infrastructure within China, will benefit China in the long run.



清華大學
Tsinghua University



Thanks for your listening !

Prof. Dr. Yantai Chen

(Zhejiang University of Technology;

Adjunct Research Fellow, CISTP, Tsinghua University)

chenyantai@tsinghua.edu.cn