



Exploration of China's technological innovation capacity from knowledge flows

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Innovation through the knowledge flows, use and creation has become a major driver for economic growth. The measure of technological innovation capacity has gained more and more attention of researchers.With the rapid development of science and technology in China, the extent of China's technological innovation capability has become a matter of public concern.

- We explore China's technological innovation capability
- Such knowledge can inform
 - Development of China's technological innovation capability from 2001 to 2012
 - Recommendations for further technology development





Technological Innovation

Knowledge Flows

Technological innovation depends on technological knowledge and is inevitably accompanied by knowledge flows.Knowledge flows are even considered one of the central elements in the development of an innovative region, and important in the context of global competitiveness.



Methodology



The two main methods in literatures:

(1) direct method patent citations

(2) indirect method

total factor productivity (TFP) growth on factors

the correlation between patent citations and reported

knowledge flows is high

Jaffe, A., Trajtenberg, M., 2002;

Duguet, E., MacGarvie, M, 2007;

Roach, Cohen, 2013





Misunderstanding :

- Countries and regions with more patents have more powerful technology capacity
- The number of patent citations only indicate the direction of knowledge flows

Due to the highly skewed distribution of patent values, patent counts only express knowledge stocks, rather than knowledge flows. The number of patent citations only indicate the direction of knowledge flows,ratner than the actual extent of knowledge flows.



Methodology













Process 1:

Macroscopic analysis

Self - cited Index = The number of cited patents which assignees/ applicants located in China The number of cited patents

A high "Self-cited Index" reflects the domestic technology base is solid enough to enble technological self-sufficiency.

Process 2:

Other - citing Index

= The number of citing patents which assignees/ applicants didn' t locate in China The number of citing patents

An increasing on "Other-citing Index" indicates Chinese technological capability has been recognised gradually by foreign countries.



Methodology



Microscopic analysis







I (Knowledge integration)

$$I = 1 - \frac{\sum_{k=1}^{n} \left(\sum_{i} \sum_{j} COS(IPC_{i} - IPC_{j})P_{i}P_{j}\right)}{n}$$

Knowledge integration, the most direct function of organization, is not only the foundation of knowledge innovation, but also critical factors for organizations to hold sustainable competitive advantage. A high "I" is defined as the high ability of knowledge absorption and recreation of a technology area/field.

D (Knowledge diffusion)

$$D = 1 - \frac{\sum_{k=1}^{n} \left(\sum_{i} \sum_{j} COS (IPC_{i} - IPC_{j})Q_{i}Q_{j}\right)}{n}$$

A high "D" reflects Technical knowledge has a wide range of diffusion and has an impact on many technical fields

n :the amount of patents included in each technological fields *i/j/k* :the technological category of the base patents/cited patents/citing patents respectively $P_i/P_j/P_k$: the percentage of base patents/cited patents/citing patents belong to the technical category i/j/k $COS(IPC_i - IPC_j)$:the cosine of the similarity between i and j(or k), which was calculated by using the IPC classes and their citation relationships from USPTO data (1976-2011) at four-digit levels (Leydesdorff et al. 2014).



Data description





the number of patents assignees/applicants located in China, granted in UR、EP、 and KR In the research, the subject of analysis is base patents whose assignees/ applicants is Chinese in the U.S. Patent and Trademark Office (USPTO) database. **The reason issued by the USPTO exhibit the main trend of Chinese offshore patents.**

In consideration of fewer patents registered before 2001, patents between 1976 and 2000 are not taked into account in our analysis. The patents issued **from 2001 to 2012** are specifically chosen because there needs a certain period of time for the base patents to have a sufficient number of both cited and citing patents.





Data collection

Source: USPTO database

Search strategy: the patents registered from 2001 to 2012 whose assignees/

applicants are Chinese

Retrieval time: April 1, 2017

Valid data: 33,805 object patents

	Number of patents						
	2001-2004	2005-2008	2009-2012				
Object patents	1539	7423	24843				
Cited patents	16125	91513	300709				
Citing patents	18706	30064	31870				









- Computer technology has the Most patents among 35 small technological categories.
- The number of patents in Electrical engineering has an overwhelming advantage over the other four technological fields.





technological field ——Chemistry:

Technological Categories	Number	Self-cited Index			Other-citing Index		
	-	2001-2004	2005-2008	2009-2012	2001-2004	2005-2008	2009-2012
Pharmaceuticals	T01	10.38%	14.52%	10.44%	81.34%	66.87%	76.79%
Organic fine chemistry	T02	6.94%	12.15%	9.93%	84.97%	70.56%	67.27%
Biotechnology	Т03	7.88%	8.72%	8.78%	91.71%	82.73%	64.58%
Chemical engineering	T04	5.62%	6.46%	14.07%	70.34%	80.54%	73.24%
Basic materials chemistry	T05	8.76%	11.25%	12.58%	88.41%	72.64%	77.45%
Macromolecular chemistry, polymers	T06	8.43%	9.63%	9.96%	85.83%	74.89%	68.25%
Materials, metallurgy	T07	5.87%	16.23%	15.54%	44.28%	72.90%	69.30%
Surface technology, coating	T08	4.60%	14.93%	12.60%	68.56%	43.22%	67.16%
Environmental technology	T09	1.57%	3.14%	11.63%	91.16%	87.20%	67.13%
Food chemistry	T10	9.89%	20.00%	11.44%	93.75%	55.81%	69.05%
Micro-structure and nano- technology	T11	7.27%	18.72%	22.36%	38.89%	68.18%	49.50%







Result

As the number of patents in each category showed a sustained growth trend over the three time periods, so the three bubbles of the same color, from big to small, respectively indicate 2001-2004,2005-2008,2009-2012.







technological field — Electrical engineering:

Technological Categories	Number	Self-cited Index			Other-citing Index			
		2001-2004	2005-2008	2009-2012	2001-2004	2005-2008	2009-2012	
Audio-visual technology	T12	12.66%	17.57%	21.00%	62.44%	52.89%	56.57%	
Computer technology	T13	9.78%	8.44%	14.48%	60.66%	67.90%	76.10%	
Electrical machinery, apparatus,energy	T14	6.36%	14.31%	20.44%	76.42%	65.07%	62.12%	
Telecommunications	T15	3.70%	9.84%	19.50%	87.82%	78.47%	77.87%	
Semiconductors	T16	15.03%	17.24%	16.51%	70.21%	53.82%	57.60%	
Digital communication	T17	2.06%	9.00%	20.98%	93.86%	85.32%	80.07%	
Basic communication processes	T18	1.57%	5.59%	13.27%	79.54%	70.75%	73.97%	
IT methods for management	T19	2.00%	3.23%	6.79%	100.00%	94.40%	92.03%	















technological field ——Instruments:

Technological Categories	Number	Self-cited Index			Other-citing Index		
		2001-2004	2005-2008	2009-2012	2001-2004	2005-2008	2009-2012
Measurement	T20	6.55%	8.47%	12.23%	89.53%	79.08%	72.46%
Optics	T21	6.50%	10.90%	17.79%	72.69%	64.58%	62.24%
Medical technology	T22	4.00%	4.56%	6.33%	96.30%	87.36%	80.04%
Control	T23	1.88%	7.52%	10.97%	93.67%	72.35%	69.51%
Analysis of biological materials	T24	3.98%	7.65%	9.16%	76.34%	71.32%	67.42%















technological field — Mechanical engineering:

	.	Self-cited Index			Other-citing Index		
Technological Categories	Number	2001-2004	2005-2008	2009-2012	2001-2004	2005-2008	2009-2012
Machine tools	T25	5.48%	5.47%	8.56%	83.62%	75.71%	67.40%
Thermal processes and apparatus	T26	9.87%	25.41%	15.64%	70.25%	41.84%	50.15%
Transport	T27	4.84%	5.04%	11.16%	85.14%	81.07%	75.60%
Other special machines	T28	4.95%	8.59%	7.98%	92.84%	79.37%	76.80%
Textile and paper machines	T29	7.49%	13.13%	24.89%	48.43%	38.64%	60.63%
Handling	Т30	5.64%	5.83%	8.80%	91.75%	83.64%	70.83%
Mechanical elements	T31	3.59%	9.84%	11.39%	76.08%	57.37%	65.53%
Engines, pumps, turbines	T32	6.67%	15.09%	14.81%	63.20%	51.16%	60.08%







Result

Only the index "I" of Transport(T27) and Textile and paper machines(T29) decline. Only the index "D" of Machine tools(T25) and Mechanical elements(T31) increase





technological field — Other fields:







On the whole, China has a rapid growth trend in the number of patents, and has also aroused widespread concern in China, but the attention of foreign technology market has declined. Most patent technologies lack the ability to absorb and integrate knowledge from different patent technologies, and only a few patents can penetrate into most fields of science and technology.





Thanks for your attention!

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