

Linkage Between Science and Technology- A Case Study of Global Leading Smartphone Companies

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Abstract

- In this study, the number and the strength of scientific linkage of smartphone related patents of global leading companies is analyzed. The results show that patents with litigation or transfer cite more journal papers. Therefore, the analysis of the strength of scientific linkage of smartphone related patents of global leading companies will help to evaluate the quality or value of the patents. The companies that have been listed in the worldwide smartphone vendor market share by IDC from 2012Q1 to 2013Q2 is included in this study. The results show that the top two smartphone companies, Samsung Electronics Co., Ltd and Apple Inc., both have strong technology capacities. Samsung Electronics Co., Ltd own 9,534 smartphone related patents, which is ranked second in the 10 companies. The strength of Apple Inc.'s patents is high though it has only 2,267 patents. The percentage of patents citing journal articles of Apple Inc. is the highest among the 10 companies. Both the patents of Samsung Electronics Co., Ltd and those of Apple Inc. have cited the journal articles published by the institutes in the country where these two companies are located.

Introduction

- In this study, the number and the strength of scientific linkage of smartphone related patents of global leading companies is analyzed.
- The strength of scientific linkage of smartphone related patents is analyzed by patent citation analysis for better understanding of the influence of the linkages on patents quality.

Literature Review (1/3)

- Economic activity has become increasingly technology-driven and knowledge based. Public science is a driving force behind high technology and economic growth [12, 13].
- Science and technology are closely connected, interacting and interdependent.
- The relationship between science and technology becomes one of the crucial issues for science policy guidance, innovation and economic studies.
- Many studies, like national innovation system research, have been done to investigate the interactions between universities, research institutions, and industry [9,14].

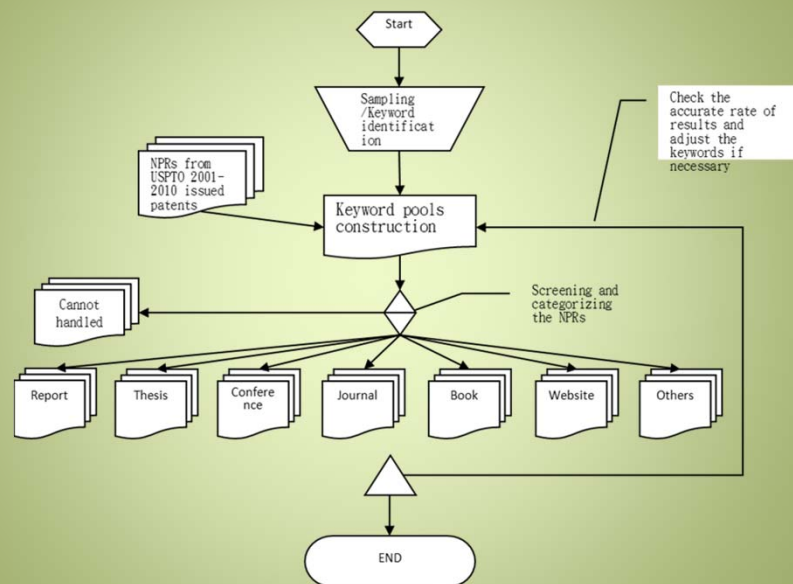
Literature Review (2/3)

- The Triple Helix model introduced the impact of the interactions between universities, industry, and government on innovation and science-based innovation has gained more and more attention [1],[2].
- Non-patent references encompass references to a variety of non-patent documents, such as scientific journal papers, conference papers, books, industrial standards, technical disclosures or engineering [11, 13].
- According to earlier studies, the patents which cited more journal papers gained more citations because those patents involved with original and complicated scientific knowledge [10,15].

Literature Review (3/3)

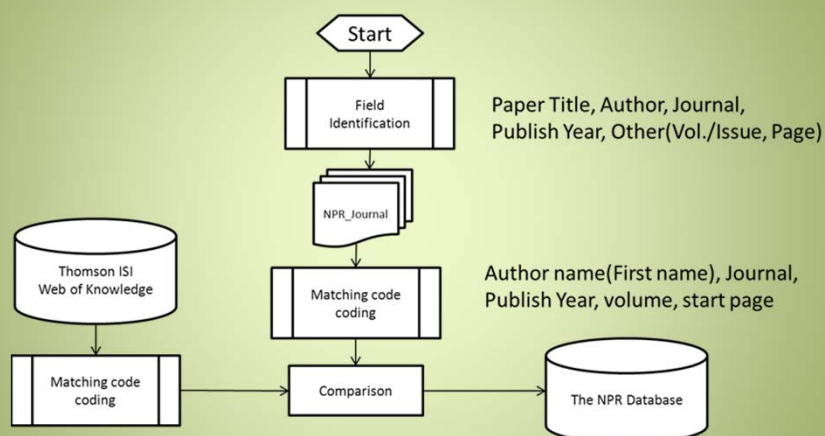
- Tracing the knowledge origin of patents by studying NPRs helps to investigate the linkages between science and technology and to find the impact of basic scientific research on industrial technology development.
- Several researchers used the knowledge flow relationship between science and technology to explain the complex interactive relationship between academic publication, industrial development, innovative activities and competitive strength of countries [16-19].

Methods: Data retrieval



Procedures of categorizing NPRs into seven categories

Methods: Data processing



Procedures of matching f NPRs information with ISI Thomson Database

Global leading smartphone companies

Company	Country
Apple Inc.	United States
HTC Corporation	Taiwan
Huawei Technologies Co., Ltd.	China
Lenovo Pte. Ltd.	Singapore
LG Electronics Inc.	South Korea
Nokia Corporation	Finland
BlackBerry Ltd	Canada
Samsung Electronics Co., Ltd	South Korea
Sony Corporation	Japan
ZTE Corporation	China

[3]-[8]

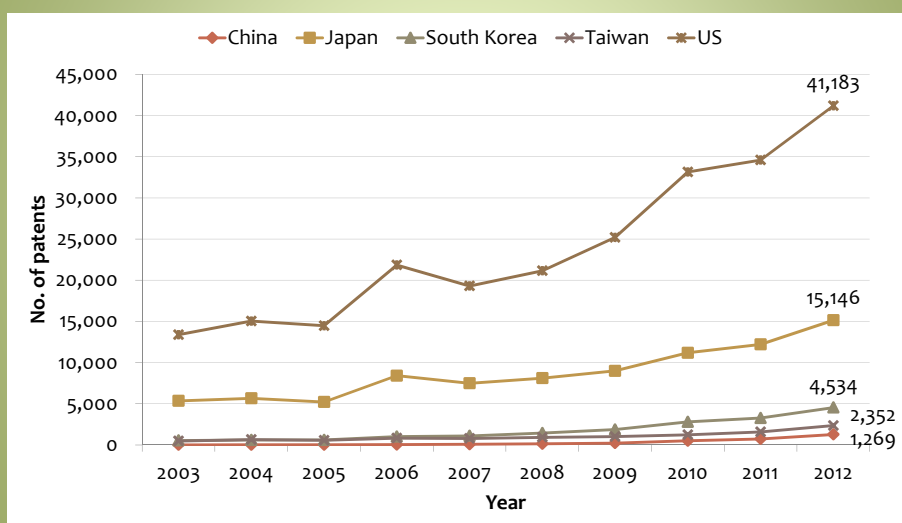
Smartphone-related patents (SRPs)

Subject	IPC*	Meaning of IPC
Electric communication technique	Ho4B	Transmission
	Ho4L	Transmission of digital information, e.g. telegraphic communication
	Ho4M	Telephonic communication
	Ho4N	Pictorial communication
	Ho4W	Wireless communication networks
Measuring; testing	G01C	Measuring distances, levels or bearings; surveying; navigation; gyroscopic instruments; photogrammetry or videogrammetry
Photography	G03B	Apparatus or arrangements for taking photographs or for projecting or viewing them; apparatus or arrangements employing analogous techniques using waves other than optical waves; accessories therefor
Computing	G06	Computing; calculating; counting
Music	G10	Musical instruments; acoustics

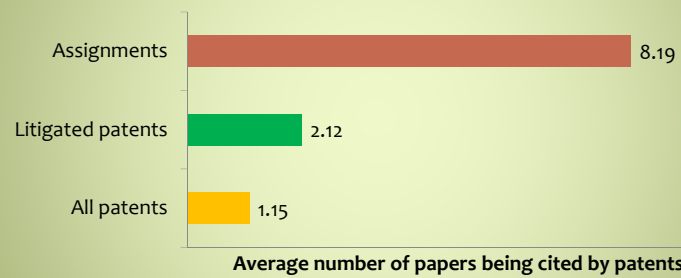
Scientometric indicators

Indicator	Meaning of indicator
Number of patents	Number of patents that were issued by USPTO owned by assignees located in a given geographical, geopolitical, or organizational unit (e.g., country or institution).
Percentage of patents that cited papers (PPC)	Percentage of journal papers, which were published over a specific time period, cited by patents that were issued in a given year. For the coverage of 80% of journal papers that were cited in patents in a given year, the citation window used in this study is 15 years.
Average number of papers being cited by patents (ANP)	Average number of journal papers being cited by patents that were issued in a given year.
Main institution being cited	Main institution being cited is to analyze the frequency of institutions that being cited by a company. This helps to understand the institutions that being cited most frequently by a specific company.

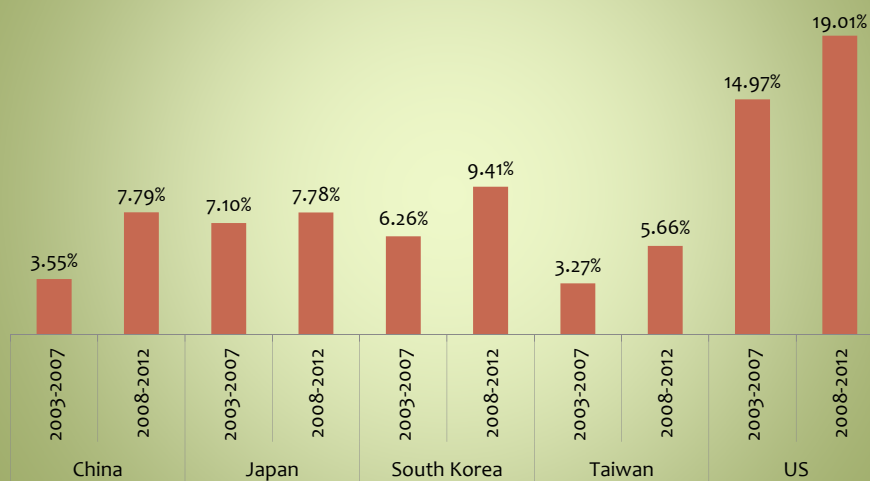
Number of SRPs in main countries (2003-2012)



Average number of journal papers being cited in patents (2003-2012)



Percentage of the main countries' SRPs that cited journal papers (2003-2012)

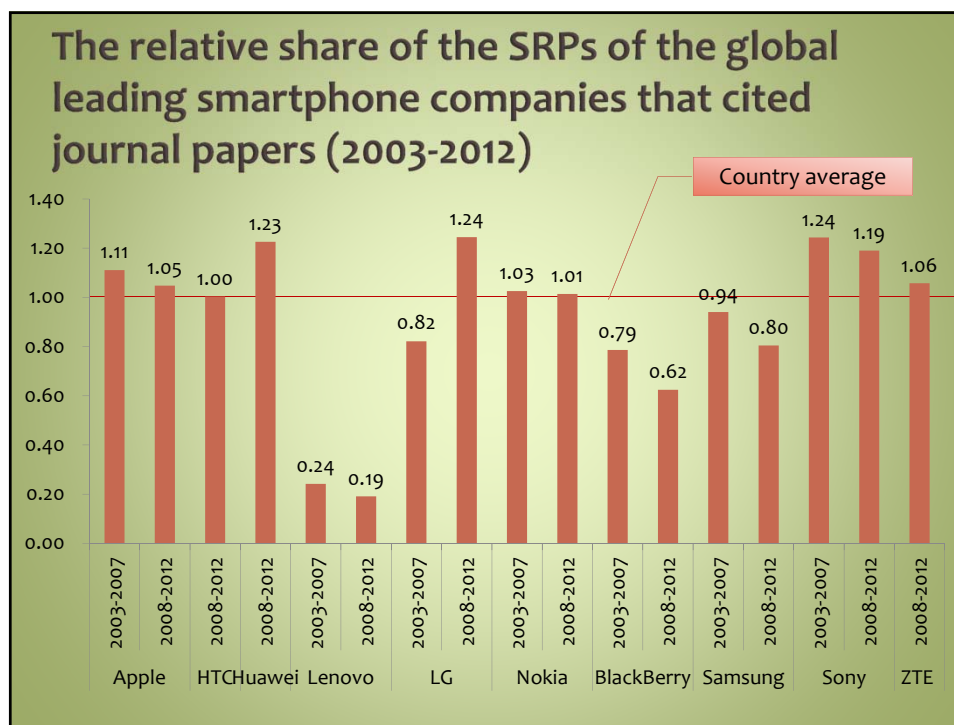
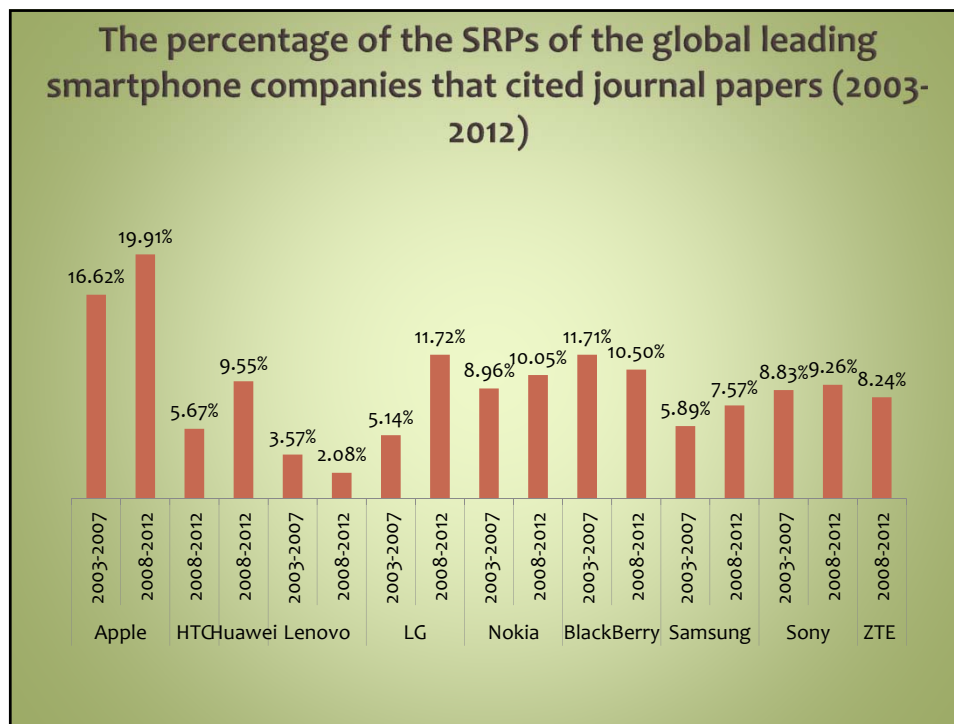


Number of the SRPs of the ten global leading smartphone companies (2003-2012)

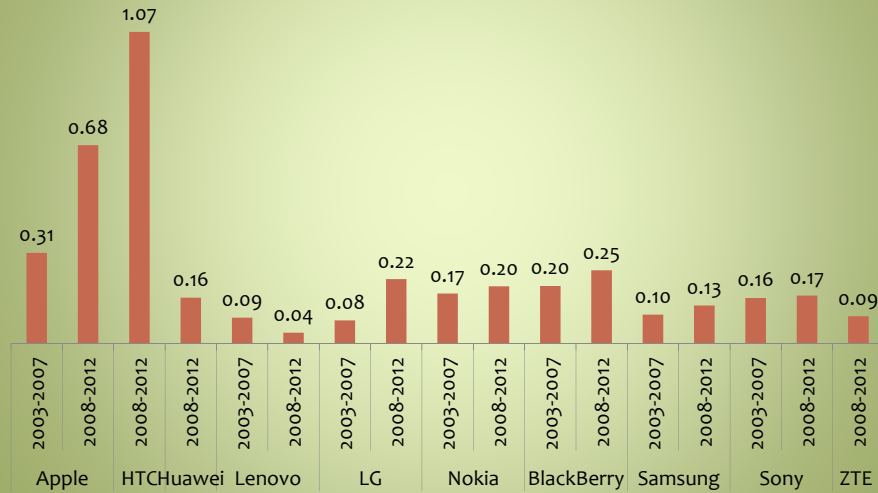
Company	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Apple	64	73	62	66	78	127	183	384	449	781	2,267
HTC	0	0	0	0	0	0	10	16	29	86	141
Huawei	0	3	7	8	16	39	67	217	303	474	1,134
Lenovo	0	0	6	48	58	53	45	58	51	82	401
LG	105	147	145	269	209	268	471	721	799	1,070	4,204
Nokia	249	340	286	457	442	449	589	684	547	626	4,669
BlackBerry	4	7	9	35	56	104	225	376	531	812	2,159
Samsung	298	313	313	514	618	849	984	1,470	1,781	2,394	9,534
Sony	554	585	503	940	781	933	1,135	1,547	1,649	2,198	10,825
ZTE	0	0	1	1	1	1	7	24	34	104	173

Percentage of the SRPs of the global leading smartphone companies that cited journal papers (2003-2012)

Company	% of patents that cited journal papers
Apple	18.45%
BlackBerry	10.68%
LG	10.08%
Huawei	9.25%
Nokia	9.00%
Sony	8.98%
ZTE	8.09%
Samsung	6.76%
HTC	5.63%
Lenovo	2.49%



Average number of papers being cited by the smartphone related patents of the global leading smartphone companies (2003-2012)



Apple Inc.		BlackBerry Ltd		LG Electronics Inc.		Samsung Electronics Co., Ltd	
Institution	P	Institution	P	Institution	P	Institution	P
Stanford Univ	17	AT&T BELL LABS	8	SEOUL NATL UNIV	8	MIT	27
AT&T BELL LABS	15	IBM CORP	5	MIT	6	AT&T BELL LABS	21
Princeton Univ	10	Columbia Univ	5	AT&T BELL LABS	5	Stanford Univ	21
MIT	10	Univ Calif Berkeley	5	Qualcomm Inc	5	IBM CORP	17
UNIV COLUMBIA	9	BRITISH Columbia Univ	5	Korea Adv Inst Sci & Technol	5	LUCENT TECHNOL	13
Univ So Calif	9	UNIV ILLINOIS	4	NATL SINGAPORE UNIV	5	Univ Minnesota	12
UNIV MARYLAND	8	Univ So Calif	4	Univ Calif Berkeley	4	CALTECH	10
UNIV ILLINOIS	7	Univ Waterloo	4	Zenith Elect Corp	4	Univ Calif Berkeley	10
Univ Washington	7	Nanyang Technol Univ	4	Columbia Univ	4	Yonsei Univ	10
IBM Corp	7	STANFORD UNIV	4	UNIV CALIF SAN DIEGO	4	Georgia Inst Technol	10
		Univ Calif San Diego	4			UNIV TORONTO	10
		Univ Calif Santa Barbara	4			SEOUL NATL UNIV	10
						Korea Adv Inst Sci & Technol	10
						Univ Washington	10

Most cited papers

Paper Title	Journal	Publish Year	Author Institution	Citations	Citing Company
A simple transmit diversity technique for wireless communications	IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS	1998	Cadence Design Syst AT&T Bell Labs	23	Huawei Nokia Blackberry Samsung ZTE
Space-time block codes from orthogonal designs	IEEE TRANSACTIONS ON INFORMATION THEORY	1999	AT&T Shannon Labs AT&T Labs Res	20	Huawei Nokia Samsung Sony
Manipulation and compositing of MC-DCT compressed video	IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS	1995	COLUMBIA UNIV UNIV CALIF BERKELEY	18	Nokia Blackberry Samsung Sony
Cooperative diversity in wireless networks: efficient protocols and outage behavior	IEEE TRANSACTIONS ON INFORMATION THEORY	2004	MIT UNIV CALIF BERKELEY	7	Huawei LG Nokia Samsung
Color indexing	INTERNATIONAL JOURNAL OF COMPUTER VISION	1991	UNIV CHICAGO UNIV ROCHESTER	6	Apple LG Samsung Sony
Adaptive deblocking filter	IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY	2003	Deutsch Telekom Video Inc Nokia Res Ctr TANDBERG	4	Apple Blackberry Samsung Sony

Discussions (1/3)

- The results show that the number of smartphone related patents in these five countries increased in recent 10 years and this also indicates the growth of the new technologies of smartphones.
- The analysis in this study showed that litigated patents and patents with assignments both cited more journal papers than the patents without litigation or assignment. These findings indicate that the strength of science linkage of patents is highly related with patents' quality.
- The scientific linkages in the five countries all became stronger from 2003 to 2012.

Discussions (2/3)

- Sony and Samsung had the most smartphone related patents. In total Sony had 10,825 smartphone related patents from 2003 to 2012 and Samsung had 9,534.
- The percentage of the smartphone related patents of Apple that cited journal papers is 18.45%, which is the highest among the 10 companies, and that of BlackBerry and LG is 10.68% and 10.08%, respectively.
- The percentage of the smartphone related patents of Samsung is low (6.76%) when compared with its high patent quantity.

Discussions (3/3)

- The percentage of the smartphone related patents of Apple, LG, Nokia, Sony, and Samsung that cited journal papers increased from 2003-2007 to 2008-2012. This indicates that the linkages between science and technology of the above companies became stronger.
- The result of the knowledge source analysis shows that Apple, BlackBerry, LG, and Samsung all cited the journal papers that published by the institutions in their original country. This implies efficient scientific knowledge usage and frequent industry academia collaborations. However, HTC did not cite journal papers from Taiwan.

Conclusions

- During 2012Q1 and 2013Q2, only Samsung and Apple remained being one of the top 5 global smartphone leading companies [3-8]. These findings indicate intensive competition in smartphone markets. Companies those do not invent new products that meet customers' needs hardly have large market share.
- Patent portfolio and patent quality are especially important. The results of this study can be references for quality/value of these smartphone companies patents and for R&D strategies planning of other companies in Taiwan.

References (1/2)

- [1] Etzkowitz, H. and Leydesdorff, L., "The triple helix university-industry- government relations: A laboratory for knowledge-based economic development," *EASST Review*, 14(4), 14–19, 1995.
- [2] Etzkowitz, H. and L. Leydesdorff, "The Dynamics of Innovation: From National Systems and 'Mode 2' to a Triple Helix of University-Industry-Government Relations," *Research Policy*, 29(2), 109–123, 2000.
- [3] IDC, "Worldwide Smartphone Market Continues to Soar, Carrying Samsung Into the Top Position in Total Mobile Phone and Smartphone Shipments, According to IDC," Retrieved 8/13/13 World Wide Web, <http://www.idc.com/getdoc.jsp?containerId=prUS23455612>
- [4] IDC, "Worldwide Smartphone Vendors Market Share, 2Q 2012," Retrieved 8/13/13 World Wide Web, http://www.icharts.net/chartchannel/worldwide-smartphone-vendors-market-share-2q-2012_m3vuwyjec
- [5] IDC, "Worldwide Smartphone Vendors Market Share, 3Q 2012," Retrieved 8/13/13 World Wide Web, http://www.icharts.net/chartchannel/worldwide-smartphone-vendors-market-share-3q-2012_m3nbwixac
- [6] IDC, "Worldwide Smartphone Vendors Market Share, 2012 Q4," Retrieved 8/13/13 World Wide Web, http://www.icharts.net/chartchannel/worldwide-smartphone-vendors-market-share-2012-q4_m3swy1cc
- [7] IDC, "Worldwide Smartphone Vendors Market Share, 2013, Q1," Retrieved 8/13/13 World Wide Web, http://www.icharts.net/chartchannel/worldwide-smartphone-vendors-market-share-2013-q1_m3ztyshgc
- [8] IDC, "Worldwide Smartphone Vendors Market Share, 2013, Q2," Retrieved 8/13/13 World Wide Web, http://www.icharts.net/chartchannel/worldwide-smartphone-vendors-market-share-2013-q2_m33swinec
- [9] Lundvall, B. Å., "Introduction," in *National Systems of Innovation: Towards A Theory of Innovation and Interactive Learning*, B. Å. Lundvall Ed. London: Pinter, 1992.
- [10] Henderson, R., L. Orsenigo and G. Pisano, "The Pharmaceutical Industry and the Revolution in Molecular Biology: Interactions among Scientific, Institutional and Organizational Change," in *Sources of Industrial Leadership: Studies of Seven Industries*, D. Mowery & R. Nelson, Eds. Cambridge: Cambridge University Press, 1999.

References (2/2)

- [11] McMillan, G. S., F. Narin and D. L. Deeds, "An analysis of the critical role of public science in innovation: The case of biotechnology," *Research Policy*, 29(1), 1–8, 2000.
- [12] Meyer, M., "Measuring Science-Technology Interaction In The Knowledge-Driven Economy: The Case of a small economy," *Scientometrics*, 66(2), 425–439, 2006.
- [13] Narin, F., K. Hamilton, and D. Olivastro, The Increasing Linkage Between US Technology and Public Science, *Research Policy*, Vol. 26, No.3, pp. 317–330, 1997.
- [14] Nelson R. R. and N. Rosenberg, "Technical Innovation and National Systems – Introduction," in *National Innovation Systems: A Comparative Analysis*, R. R. Nelson Ed. New York: Oxford University Press, 1993.
- [15] Sampat, B. N., D. C. Mowery and A. A. Ziedonis, "Changes in University Patent Quality after the Bayh-Dole Act: a Re-examination," *International Journal of Industrial Organization*, 21(9) 1371–1390, 2003.
- [16] Tijssen, R.J.W., R.K. Buter and Th.N. Van Leeuwen, "Technological relevance of science: validation and analysis of citation linkages between patents and research papers," *Scientometrics*, 47, pp. 389-412, 2000.
- [17] Tijssen, R.J.W., "Global and domestic utilization of industrial relevant science: Patent citation analysis of science-technology interactions and knowledge flows," *Research Policy*, 30, 35-54, 2001.
- [18] Tijssen, R.J.W., "Science dependence of technologies: Evidence from inventors and their inventions," *Research Policy*, 31 (4), 509-526, 2002.
- [19] Verbeek, A., K. Debackere, M. Luwel, P. Andries, E. Zimmermann and F. Deleus, "Linking science to technology: Using bibliographic references in patents to build linkage schemes," *Scientometrics*, 54 : 399-420, 2002.