U.S.-Based Global Intellectual Property Creation

An Analysis

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Executive Summary

The Patent Cooperation Treaty (PCT), concluded in 1970, offered a means for inventors to safeguard their intellectual property in multiple countries with a single application. This global effort to streamline the process of achieving international intellectual property protection evidences the importance of this protection in today's economy. International intellectual property rights ensure that creators can reap the rewards of their endeavors, encouraging future innovation and, ultimately, economic growth.

The PCT patent applications filed in the United States arguably represent some of the most sophisticated inventions developed in this country. Not only does the perceived need for international intellectual property protection indicate that the inventions are characterized by a higher level of sophistication than those submitted only to the United States Patent and Trademark Office (USPTO), but also the costly and time-intensive application process for PCT patents suggests that inventions described in these applications largely have market potential in multiple countries, global visibility, or diverse applications.

An analysis of the database of PCT applications filed in the United States, then, offers a unique lens on technological change in this country. This report summarizes results of an analysis of this database focusing on its geographic characteristics. It offers an opportunity to understand where this measure indicates that innovation is happening in the United States, which organizations are driving change, and the technical areas that are the focus of U.S. filing. Key findings include:

- The number of U.S. PCT applications has increased. In 1998, there were an average of 14.9 PCT applications filed per one hundred thousand workers in the fifty U.S. states and the District of Columbia. By 2006, this average had increased to 25.1 applications per one hundred thousand workers.
- The U.S. share of PCT applications has decreased from 37.4 percent to 34.1 percent in the last four years alone. While the absolute number of U.S. applications has increased, other countries—particularly in the developing world—have seen more substantial growth.
- Delaware had the highest number of PCT applications per one hundred thousand workers in 2006, with 82.1 PCT applications per one hundred thousand workers. Massachusetts and Minnesota followed with 79.0 applications per one hundred thousand workers and 69.5 applications per one hundred thousand workers, respectively. The states with the fewest applications per one hundred thousand workers in 2006 were South Dakota, Alaska, and Arkansas.
- Oregon, Vermont, and North Dakota saw significant increases in their numbers of applications per one hundred thousand workers between 1998 and 2006. Idaho and Louisiana witnessed the largest decreases.

- In 2006, 92.2 percent of PCT applications were filed by industry, representing a modest increase from 91.1 percent in 1998. California alone contributed almost one-quarter (22.2 percent) of the U.S. PCT applications from industry, and New York and Massachusetts also contributed a significant portion. 3M Innovative Properties Company, QUALCOMM Incorporated, and Intel Corporation were the corporations responsible for the greatest numbers of PCT applications, with 3M accounting for 1.5 percent of all PCT applications originating from U.S.-based industry, and the other two firms each representing 1.4 percent. 3M's strong presence in this domain may play a significant role in Minnesota's leadership in applications per worker.
- Universities and research institutions were responsible for only 8.9 percent of all PCT applications in 1998 and for 7.8 percent in 2006. The states with the greatest number of university applications were California, Massachusetts, and New York. The University of California system contributed more international patent applications than any other university, with 10.9 percent of all PCT applications originating in universities in 2006. The Massachusetts Institute of Technology and Columbia University in New York City also were responsible for larger shares of the total university PCT applications, with 4.4 percent and 2.7 percent, respectively.
- Industry and universities appear to seek patent protection in distinct fields of research. While universities have applied for more patents in biological, testing, and chemical-related International Patent Classification (IPC) categories, the industry filings included more electronics and personal medical care patent applications.

Introduction

Protection of intellectual property ensures that inventors have an incentive to bring their innovations to market, and promises them the opportunity to create new businesses with their ideas and, ultimately, to reap the rewards of their work. In this country, the U.S. patent system historically has provided the legal protection that encouraged scientists and others to work toward radical or transformative innovation. As the economy has become increasingly international, however, the vulnerability of U.S.-patented inventions to opportunists abroad could pose an additional barrier to their successful commercialization in the United States. In today's global economy, inventors who are protected from those who would appropriate their ideas at home face another threat when their ideas are not safeguarded in other countries.

Global protection of intellectual property has, therefore, become increasingly important to U.S. industry and universities, the primary sources of patented inventions in this country. In response to the need for international intellectual property protection and the burden of filing separate patent applications in multiple countries, the Patent Cooperation Treaty (PCT), administered by the World Intellectual Property Organization (WIPO), made it possible to seek patent protection for an invention in more than one hundred countries simultaneously by filing a single, international patent application. The increase in the number of applications for these international patents testifies to the growing importance of this protection. Since it began in 1978, the WIPO PCT has witnessed continuous growth, with an especially dramatic increase in patent application activity between 1998 and 2006. A record 145,300 applications were filed in 2006.[1]

In recent years, the United States has filed significantly more PCT applications than any other country. The United States has seen a steady increase in its number of PCT applications since 2003, and the U.S. share of PCT applications remains greater than that of any other country. However, as other nations, particularly developing countries, have witnessed remarkable growth rates in recent years, the U.S. share of international patent applications has decreased, dropping from 37.4 percent to 34.1 percent over the last four years alone. Figure 1 presents the number of PCT applications and the percentage of the total for each of the top five applicant nations.

To U.S. industry, the importance of global protection of intellectual property is only expected to increase. Future waves of U.S. outsourcing likely will focus on research and development operations, and multinational corporations will find it difficult to maintain proprietary control over next-generation technology without international intellectual property protection.

[1] Provisional estimate from the World Intellectual Property Organization. WIPO continues to receive PCT applications filed with national offices in 2006 throughout the first half of the year. World Intellectual Property Organization, "Record Year for International Patent Filings with Significant Growth from Northeast Asia," February 8, 2007, http://www.wipo.int/pressroom/en/articles/2007/article_0008.html.

Given the importance of global intellectual property protection to continued innovation and growth in the United States, an inquiry into trends in U.S. PCT applications offers a unique lens on technological change in this country and on the country's role in global intellectual property creation. The database of PCT applications filed through WIPO's U.S. Receiving Office—i.e., the international patent applications filed from the United States—likely is a subset of the patent applications received by the USPTO.

The PCT applications, however, arguably represent some of the most sophisticated inventions originating in this country. Not only does the perceived need for international intellectual property protection indicate that the inventions are characterized by a higher level of sophistication than those submitted only to the USPTO, but also the costly and time-intensive application process for PCT patents suggests that inventions described in PCT applications largely have market potential in multiple countries, global visibility, or diverse applications. In short, these are some of the technologies that are likely to have high global utility and contribute to U.S. competitiveness in the long run. An analysis of these applications, then, offers an opportunity to understand where this measure suggests that innovation is happening in this country, which organizations are driving change, and the technical areas that are the focus of U.S. filings.

Dedicated to investigating and understanding the rapidly evolving dynamics of globalization, the Global Engineering and Entrepreneurship @ Duke group conducted this extensive analysis of U.S. PCT filing activities to learn about innovation in this country that has high global utility. While this paper discusses the geographic findings from this analysis, a companion paper, "Intellectual Property, the Immigration Backlog, and a Reverse Brain-Drain," presents demographic findings, focusing on America's skilled immigrants.

To conduct this analysis, the group used full records of all 1998 and 2006 PCT applications published by WIPO's U.S. Receiving Office. WIPO records were first available in electronic form in 1998 and, at the time of this paper's publication, 2006 was the most recent year for which complete data were available. Only PCT applications with inventors living in the United States were used for these analyses. The state of a patent application's origin was determined using the zip code, or state abbreviation if the zip code was missing, in the owner address field. If the owner address field was blank, the first inventor address field was used in its place. The owner field also allowed for PCT applications to be grouped by industry or university affiliation, enabling separate analyses of industry and university applications. More detail concerning the data set and definitions are provided in the Appendix to this report.

Figure 1
Top Five PCT Applicant Nations, 2002-2006

	United States of America		Japan		Germany		Republic of Korea		France		Total (All Countries)
	Apps.	Percent of total	Apps.	Percent of total	Apps.	Percent of total	Apps.	Percent of total	Apps.	Percent of total	Apps.
2002	41,296	37.4%	14,063	12.7%	14,326	13.0%	2,520	2.3%	5,089	4.6%	**110,392**
2003	41,028	35.6%	17,414	15.1%	14,662	12.7%	2,949	2.6%	5,171	4.5%	**115,199**
2004	43,350	35.4%	20,263	16.5%	15,218	12.4%	3,558	2.9%	5,185	4.2%	**122,624**
2005	46,697	34.2%	24,841	18.2%	16,000	11.7%	4,688	3.4%	5,741	4.2%	**136,500**
2006 estimate	49,555	34.1%	26,906	18.5%	16,929	11.7%	5,935	4.1%	5,902	4.1%	**145,300**

Source: World Intellectual Property Organization, "Record Year for International Patent Filings with Significant Growth from Northeast Asia," February 8, 2007, http://www.wipo.int/pressroom/en/articles/2007/article_0008.html.

Figure 2
State PCT Applications per One Hundred Thousand Workers, 1998 and 2006

	PCT applications per one hundred thousand workers		Ranking		
State	2006	1998	2006	1998	Change
Delaware	82.1	55.6	1	1	0
Massachusetts	79.0	37.8	2	3	+1
Minnesota	69.5	39.9	3	2	-1
California	58.5	33.2	4	6	+2
Connecticut	57.4	29.3	5	7	+2
New Hampshire	56.0	35.9	6	4	-2
New Jersey	52.3	33.3	7	5	-2
Oregon	44.8	13.7	8	24	+16
Washington	38.0	18.5	9	14	+5
Utah	34.5	20.9	10	11	+1
Pennsylvania	33.9	20.9	11	10	-1
Colorado	32.9	25.3	12	8	-4
Vermont	31.7	12.8	13	26	+13
Maryland	31.1	24.0	14	9	-5
Michigan	30.9	18.4	15	15	0
New York	30.0	13.1	16	25	+9
Illinois	29.6	15.6	17	21	+4
Ohio	26.7	20.5	18	13	-5
Wisconsin	26.4	16.3	19	18	-1
North Carolina	26.4	15.1	20	22	+2
Arizona	25.9	17.3	21	16	-5
Rhode Island	25.0	14.6	22	23	+1
Idaho	23.6	20.7	23	12	-11
Texas	23.4	16.4	24	17	-7
Indiana	22.0	15.9	25	19	-6
Georgia	19.8	10.6	26	29	+3
Tennessee	19.1	10.6	27	28	+1
New Mexico	18.7	15.8	28	20	-8
Virginia	17.8	9.1	29	32	+3
Nevada	17.2	7.6	30	37	+7
Florida	16.7	9.1	31	31	0
Missouri	14.5	10.8	32	27	-5
South Carolina	13.8	7.8	33	36	+3
Maine	13.6	6.8	34	39	+5
Iowa	13.5	8.5	35	33	-2
Kansas	12.2	7.9	36	35	-1
West Virginia	12.2	6.0	37	41	+4
Montana	10.4	8.2	38	34	-4
North Dakota	10.3	1.3	39	51	+12
Oklahoma	10.0	7.1	40	38	-2
Louisiana	9.3	9.3	41	30	-11
Kentucky	9.0	4.7	42	44	+2
Nebraska	8.4	6.0	43	42	-1
Wyoming	8.2	6.7	44	40	-4
Alabama	8.1	5.1	45	43	-2
District of Columbia	6.7	3.2	46	46	0
Mississippi	6.2	2.1	47	49	+2
Hawaii	5.5	3.4	48	45	-3
Arkansas	4.0	2.7	49	48	-1
Alaska	2.5	1.8	50	50	0
South Dakota	1.3	3.1	51	47	-4
Average	**25.1**	**14.9**			

Source: World Intellectual Property Organization PCT Application Database 1998, 2006; Quarterly Census of Employment and Wages (QCEW), Bureau of Labor Statistics; Duke University.

U.S. PCT Application Filing by State

To determine the areas of the United States that contribute most to global intellectual property, the database of U.S. PCT applications first was analyzed by state. As there is wide variation in the population of employed individuals among states, the total number of patent applications for each state was normalized against the state worker population. This calculation was performed for each state for both 1998 and 2006, allowing for a comparison of competitiveness and innovation across states in each year, and for consideration of the change in individual states over the nine-year period.

There was a very high level of variation among states, and this disparity increased substantially over the nine-year period. While there was significant growth in the number of applications for international patents during this time, this growth does not appear to have occurred throughout the country. In 1998, the number of patent applications filed per one hundred thousand workers in an individual state ranged from 1.3 to 55.6, with an average of 14.9. By 2006, the range grew from 1.3 to 82.1, with an average of 25.1.

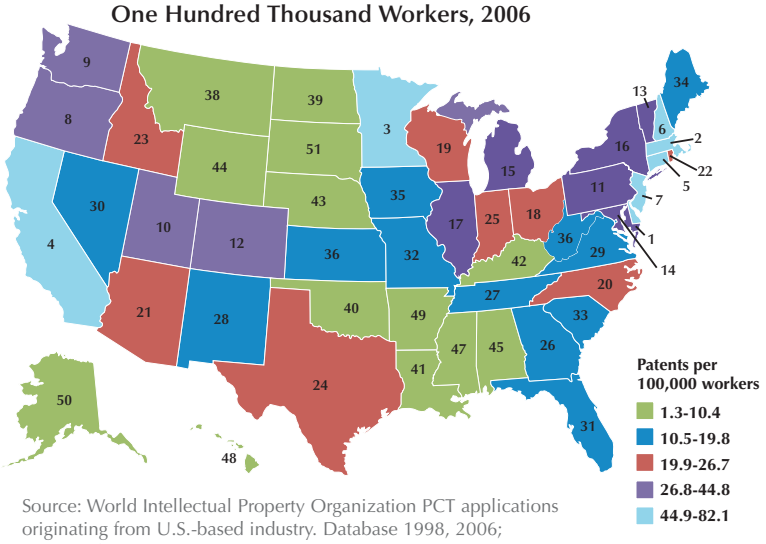
Figure 2 presents the number of PCT applications per one hundred thousand workers for all fifty states and the District of Columbia in both 1998 and 2006, as well as the ranking of these states in each time period, and the change in the relative placement of each state over the nine-year period. Figure 3 illustrates this geographic variation in levels of patents per one hundred thousand workers across the United States in 2006. Absolute numbers of patents in each state are presented in the Appendix to this report. Delaware had the highest number of patents per workers in 2006, with 82.1 PCT applications per one hundred thousand workers. Massachusetts and Minnesota followed closely, with 79.0 applications per one hundred thousand workers and 69.5 applications per one hundred thousand workers, respectively. It is important to recognize that, while Delaware did not produce a very high number of patents in absolute terms, the state's very small workforce generated the highest number of patents per one hundred thousand workers. Minnesota, a state with a moderate-size workforce, produced twice the average of patents per one hundred thousand workers. Finally, Massachusetts' high ranking—as well as the rankings of California and New Jersey in the top ten—is consistent with other measures of innovative activity in these states.

The lowest numbers of PCT applications per one hundred thousand workers in 1998 were in North Dakota (1.3), Alaska (1.8), and Mississippi (2.1). While North Dakota increased its patent activity substantially by 2006 (10.3), Alaska and Mississippi continued to lag near the bottom of the rankings. Oregon and Vermont also saw significant increases in the number of patents per one hundred thousand workers between 1998 and 2006, and Idaho and Louisiana witnessed the largest decreases during this time.

Industry Contributions to U.S. PCT Patent Applications

An analysis of PCT applications' owner fields allowed for the grouping of patents by their

Figure 3
State PCT Applications per One Hundred Thousand Workers, 2006

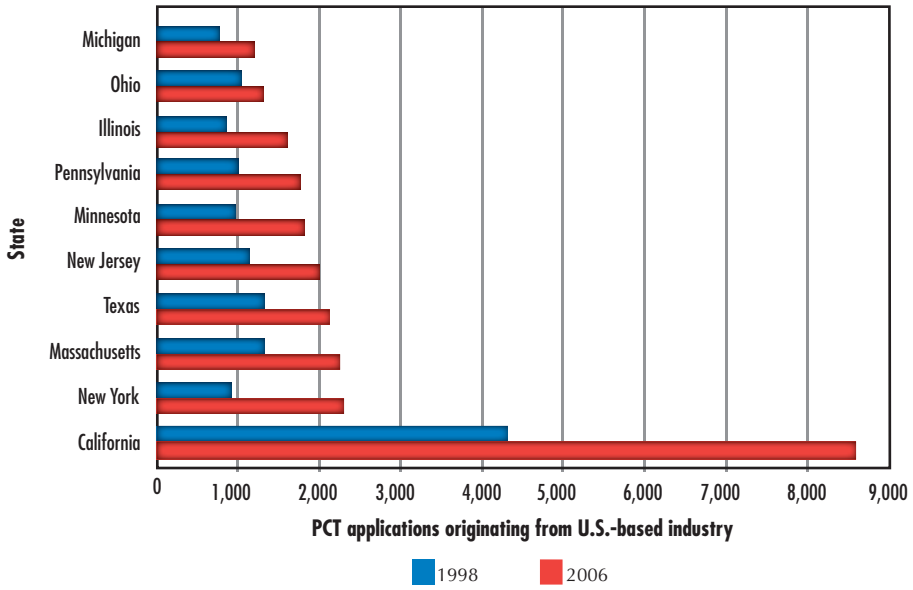


Source: World Intellectual Property Organization PCT applications originating from U.S.-based industry. Database 1998, 2006; Bureau of Labor Statistics; Duke University.

institutional origins, enabling an examination of the relative contributions of both industry and universities. The vast majority of U.S. PCT applications were filed by industry in 1998, and this proportion only grew over the nine-year period. In 2006, 92.2 percent of PCT patents were filed by industry, an increase from 91.1 percent in 1998. Figure 4 presents the ten states with the highest industry contributions to U.S. PCT applications. California alone contributed almost one-quarter (22.2 percent) of all U.S. WIPO patent applications from industry; New York and Massachusetts also contributed significant portions.

A more-detailed analysis of industry patents allows for a list of the specific corporations that filed the most PCT applications from the United States in 2006. As shown in Figure 5, 3M Innovative Properties Company, QUALCOMM Incorporated, and Intel Corporation were the most significant contributors to U.S. PCT applications during that year. While 3M accounted for 1.5 percent of all industry applications, both QUALCOMM and Intel represented 1.4 percent. The strong presence of 3M (a Minnesota-based corporation) and DuPont (a Delaware-based corporation) likely play a significant role in Minnesota's and Delaware's leadership in applications per worker. Interestingly, although the United States had a higher number of PCT applications than all other countries in 2006, none of the top five corporations internationally (Philips Electronic N.V., Matsushita, Siemens, Nokia, and Bosch) was a U.S. company.[2]

Figure 4
Top State Contributions to PCT Applications Originating from Industry, 1998 and 2006



Source: World Intellectual Property Organization PCT Application Database 1998, 2006; Duke University.

[2]World Intellectual Property Organization, "Record Year for International Patent Filings with Significant Growth from Northeast Asia," February 8, 2007, http://www.wipo.int/pressroom/en/articles/2007/article_0008.html.

Figure 5
Corporations Filing Highest Number of PCT Applications through the U.S. Receiving Office, 2006

Rank	Corporation	Total PCT applications*	Percentage of all 2006 industry PCT applications
1	3M Innovative Properties Company	618	1.5%
2	QUALCOMM Incorporated	614	1.4%
3	Intel Corporation	583	1.4%
4	Motorola Inc.	550	1.3%
5	DuPont & Company	468	1.1%
6	Honeywell International Inc.	466	1.1%
7	Hewlett-Packard Company	413	1.0%
8	Eastman Kodak Company	346	0.8%
9	The Procter & Gamble Company	344	0.8%
10	Boston Scientific Limited	315	0.7%
11	Medtronic	288	0.7%
12	Kimberly-Clark, Incorporated	279	0.7%
13	Exxon Mobil	248	0.6%
14	General Electric Company	247	0.6%
15	Microsoft Corporation	244	0.6%
16	Cisco Systems, Incorporated	230	0.5%
17	SIEMENS Incorporated	210	0.5%
18	Merck & Co, Incorporated	204	0.5%
19	The Government of the United States of America	201	0.5%
20	Wyeth	189	0.4%
21	Texas Instruments Incorporated	171	0.4%
22	Corning Incorporated	168	0.4%
23	Thomson Licensing	168	0.4%
24	Freescale Semiconductor	167	0.4%
25	General Motors Corporation	167	0.4%

*Note that these totals may differ from those published on the WIPO Web site, as applications not based in the United States were removed from this analysis. In addition, PCT applications held by subsidiaries that do not carry the corporations' names on their patents were not included.

Source: World Intellectual Property Organization PCT Application Database 2006; Duke University.

University Contributions to U.S. PCT Applications

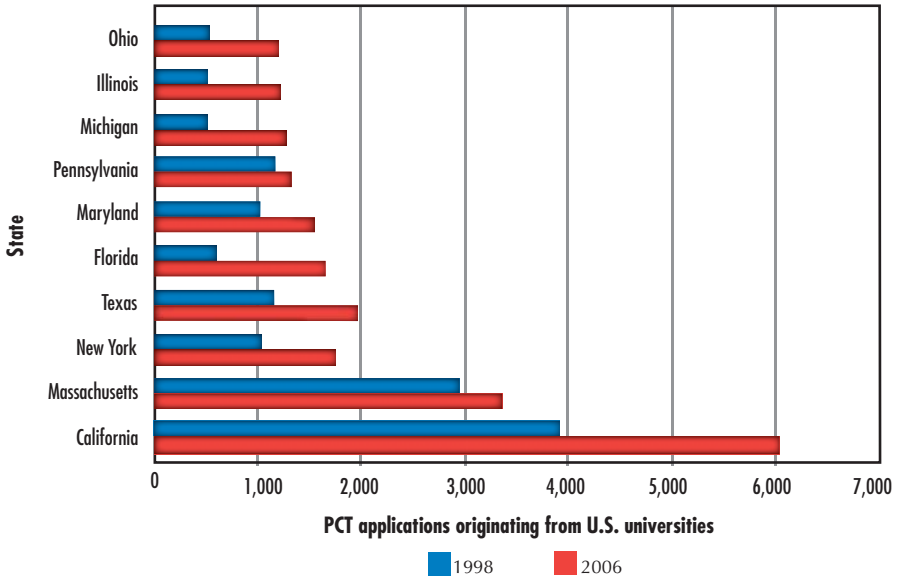
While industry has very clear incentives to protect its investment in intellectual property development, the relationship between academia and technology commercialization is more complicated. Technology commercialization, in fact, can be seen as directly at odds with academic principles and values in some cases. Publication in peer-reviewed journals is a key driver in advancing tenure-track faculty, and these professors often have greater incentives to publish their research than to commercialize it. Furthermore, the academic predisposition toward full disclosure of new research by publishing it in academic journals does not always align with the process of disclosing this research in intellectual property filings instead. At many universities, technology commercialization is discouraged rather than rewarded.

The divergence in the attitudes of industry and academia toward intellectual property can be seen in the fact that universities and research institutions were responsible for only 8.9 percent of all PCT applications in 1998 and for 7.8 percent in 2006. While the total number of PCT applications produced by U.S. universities and research institutions actually increased during this period, the greater increase in industry patent applications during the same period resulted in a decrease in the university share.

Figure 6 presents university and research institution contributions to PCT applications by state for 1998 and 2006. As in industry applications, California was responsible for far more patents than any other state, followed by Massachusetts and New York. While Massachusetts ranked second in both 1998 and 2006, the state's share of PCT applications significantly decreased over the nine-year period. Taken together, California, Massachusetts, and New York accounted for 40 percent of the country's PCT applications originating from universities in 1998 and for 36.5 percent in 2006. Conversely, these states' contributions to PCT patents originating from industry grew from 31 percent to 34 percent during this time period.

A more-detailed analysis of the PCT applications originating from U.S. universities and research institutions offers information regarding the specific institutions driving these applications.

Figure 6
Top State Contributions to PCT Applications Originating from Universities, 1998 and 2006



Source: World Intellectual Property Organization PCT Application Database 1998, 2006; Duke University.

Figure 7
Top Universities/Research Institutions Filing PCT Applications through the U.S. Receiving Office, 2006

Rank	University/Research Institution	Total PCT applications	Percentage of all 2006 University/Research PCT applications
1	The University of California (Calif.)	391	10.9%
2	Massachusetts Institute of Technology (Mass.)	159	4.4%
3	Columbia University in New York City (N.Y.)	95	2.7%
4	University of Florida (Fla.)	94	2.6%
5	Johns Hopkins University (Md.)	66	1.8%
5	Stanford University (Calif.)	66	1.8%
7	University of Texas (Tex.)	60	1.7%
8	University of Michigan (Mich.)	57	1.6%
9	University of Illinois (Ill.)	52	1.5%
10	California Institute of Technology (Calif.)	51	1.4%
11	Harvard University (Mass.)	49	1.4%
12	University of Minnesota (Minn.)	48	1.3%
13	University of Pennsylvania (Pa.)	42	1.2%
13	University of Rochester (N.Y.)	42	1.2%
15	Yale University (Conn.)	41	1.1%
16	Duke University (N.C.)	36	1.0%
17	University of South Florida (Fla.)	35	1.0%
18	University of Washington (Wash.)	33	0.9%
18	Southwest Research Institute	33	0.9%
20	Scripps Research Institute (Calif.)	32	0.9%
20	University of Utah (Utah)	32	0.9%
20	University of Virginia (Va.)	32	0.9%
23	Battelle Memorial Institute	31	0.9%
24	University of Massachusetts (Mass.)	26	0.7%
25	University of Iowa (Iowa)	24	0.7%

Note: States are not included for research institutions with multiple locations.
Source: World Intellectual Property Organization PCT Application Database 2006; Duke University.

Figure 7 presents the twenty-five universities and research institutions that filed the greatest number of PCT applications through the U.S. Receiving Office in 2006. The University of California system was responsible for substantially more global patents than any other institution was, with 10.9 percent of all patents originating in universities. Strong patent activity in other California schools (Stanford University, California Institute of Technology), as well as Scripps Research Institute, also contributed to California's lead in this area. Similarly, the leadership of Massachusetts and New York appears to be driven by the large contributions of only a few institutions. It is important to note that the share of total university patent applications from each of these leading schools is much larger than the portion of the industry group from any single corporation, but no university contributes as many PCT applications as the leading corporations.

U.S. PCT Application Filing by Patent Classification Codes

The divergence in university and industry approaches to intellectual property protection also is evident in the distinct areas of research for which these groups seek patent protection. WIPO's use of International Patent Classification (IPC) Codes allows for an analysis of patent applications by the specific technical areas in which U.S. universities have filed for international intellectual property protection. Figure 8 presents a comparison of the IPC fields in which universities and industry filed the most international patent applications. Fields that appear in both lists are highlighted to assist in a visual comparison. While industry and universities share a primary field of focus, they only have four other fields in common among the top ten areas for each. Universities appear to apply for more patents in biological, testing, and chemical-related IPC categories, and the industry filings include more electronics and personal-medical-care patent applications.

Figure 8
Top University and Industry WIPO IPC Fields, 2006

Universities

	Description	PCT apps
1	Preparations for Medical, Dental, or Toilet Purposes	950
2	Investigating or Analyzing Materials by Determining their Chemical or Physical Properties	356
3	Micro-Organisms or Enzymes	313
4	Measuring or Testing Processes Involving Enzymes or Micro-Organisms	289
5	Peptides	203
6	Diagnosis, Surgery, Identification	138
7	Semiconductor Devices; Electric Solid-State Devices not Otherwise Provided for	126
8	Preservations of Bodies	125
9	Electric Digital Data Processing	122
10	Sugars, Nucleosides, Nucleotides, Nucleic Acids	117

Industry

	Description	PCT apps
1	Preparations for Medical, Dental, or Toilet Purposes	3,812
2	Electric Digital Data Processing	3,275
3	Diagnosis, Surgery, Identification	1,728
4	Transmission of Digital Information	1,541
5	Semiconductor Devices; Electric Solid-State Devices not Otherwise Provided for	1,454
6	Heterocyclic Compounds	1,237
7	Contraceptive Devices, Bandages, Dressings	1,231
8	Investigating or Analyzing Materials by Determining Their Chemical or Physical Properties	1,223
9	Therapeutic Activity of Chemical Compounds or Medicinal Preparations	1,191
10	Pictorial Communication (e.g., Television)	827

Note: Each application may have more than one IPC classification and, therefore, may be counted multiple times.
Source: World Intellectual Property Organization PCT Application Database 2006; Duke University.

Conclusion

PCT patent applications filed through WIPO's U.S. Receiving Office likely represent some of the most innovative ideas developed in this country and, therefore, serve as one of many measures of competitiveness and innovation in the United States. Analysis of these applications yields important information concerning variation in state contributions to American global intellectual property, both overall and from industry and universities independently. Delaware, Massachusetts, and Minnesota had the highest numbers of patents per one hundred thousand workers in 2006, while South Dakota, Alaska, and Arkansas had the lowest numbers. There was significant movement up and down these rankings between 1998 and 2006, with Oregon, Vermont, and North Dakota seeing substantial movement up and Idaho and Louisiana witnessing dramatic movement down the rankings.

The vast majority of patents (92.2 percent in 2006) originated in industry. Of the total patents from industry, California contributed the greatest portion, followed by New York and Massachusetts. 3M Innovative Properties Company, QUALCOMM Incorporated, and Intel Corporation were the corporations responsible for the greatest number of applications. As with industry filings, California, Massachusetts, and New York were responsible for the greatest number of patent applications from universities and research institutions. The University of California contributed significantly more PCT patent applications than any other university did, but the Massachusetts Institute of Technology and Columbia University in New York City also were responsible for significant shares.

In a global economy in which growth is driven by innovation, PCT applications are just one of many important measures of progress and potential. States competing for economic and productivity growth in today's economy will focus not only on fostering the innovation that directly precedes applications for PCT patents, but also on building the knowledge base of their citizenry and the infrastructure that will support development of entrepreneurial businesses. Delaware, Massachusetts, and Minnesota, in addition to leading the nation in PCT applications per worker, rank highly in a number of other indicators of competitiveness, from the percent of the population that uses the Internet and the number of package exports, to levels of industry research and development, and shares of the country's fastest-growing firms.[3] Each of these indicators, like PCT application activity, offers states a snapshot of their state economy's potential and a measure of their progress toward creating a more innovative economy.

[3] Information concerning these other measures of innovation and competitiveness can be found in *The 2007 State New Economy Index: Benchmarking Economic Transformation in the States*, by Robert D. Atkinson and Daniel K. Correa of the Information Technology and Innovation Foundation (February 2007).

Author Biographies

Vivek Wadhwa

Vivek Wadhwa is a Wertheim fellow with the Labor and Worklife Program of Harvard Law School and executive-in-residence/adjunct professor for the Pratt School of Engineering at Duke University. He also is an entrepreneur who has founded two successful technology companies, an active mentor and advisor to various startups and a columnist for *BusinessWeek.com*. Wadhwa was named a "Leader of Tomorrow" by *Forbes.com*, and his company, Relativity Technologies, was named as one of the 25 "coolest" companies in the world by *Fortune* magazine. Wadhwa holds a bachelor's in computing studies from Canberra University in Australia and a master's from New York University.

Ben Rissing

Ben Rissing is a Wertheim fellow with the Labor and Worklife Program at Harvard Law School. He was previously a research scholar at the Pratt School of Engineering of Duke University. He has a bachelor's in mechanical engineering from the University of Virginia and a master's in engineering management from Duke. He has been involved in initiatives ranging from engineering design/technology commercialization to cardiovascular laboratory research and public policy development in Washington, D.C. Rissing has traveled extensively, enjoys multiculturalism, and is a nationally ranked competitive fencer.

Aneesh Chopra

Aneesh Chopra is Virginia's Secretary of Technology serving Governor Tim Kaine. In this capacity, he leads the Commonwealth's strategy to effectively leverage technology in government reform, promotes Virginia's innovation agenda, and fosters technology-related economic development with a special emphasis on entrepreneurship. Prior to joining Governor Kaine's cabinet, Chopra served as managing director with the Advisory Board Company, a publicly traded health care think tank serving nearly 2,500 hospitals and health systems. Chopra graduated with a master's in public policy from Harvard University's John F. Kennedy School of Government in 1997. He graduated with a bachelor's from The Johns Hopkins University in 1994.

Ramakrishnan Balasubramanian

Ramakrishnan Balasubramanian is from Mumbai, India, where he studied electronics and telecommunication engineering. He has had a variety of rewarding experiences, ranging from interning at a large telecommunications network firm and an airline, to being part of a non-profit entrepreneurial venture. Balasubramanian graduated in 2007 from Duke University with a master's in engineering management, after which he joined PricewaterhouseCoopers' advisory practice in Washington, D.C. He is widely traveled, speaks four languages fluently, and is an avid philatelist.

Alyse Freilich

Alyse Freilich is a manager in research and policy at the Ewing Marion Kauffman Foundation in Kansas City, Mo. Freilich's responsibilities include support for academic and policy research in entrepreneurship. She previously has held positions at health care research firms in both Kansas City and Washington, D.C., and she served as a research associate in the Urban Institute's immigration studies program. She holds a bachelor's in social studies from Harvard University.

Full records of all Patent Cooperation Treaty (PCT) applications published by the World Intellectual Property Organization's (WIPO) U.S. Receiving Office were obtained with the assistance of Neopatents, a Raleigh, N.C.-based patent research and analytics firm. Neopatents' Spore® Search software was then used to select records for 1998 and 2006. Analysis was limited to these two years, as 1998 was the first year for which WIPO records are available in electronic form and 2006 was the most recent full year of data available at the time of this paper's publication. The Spore® software was used because it offered search flexibility not available in the search function on the WIPO Web site, and it allowed for full data sets to be exported as Excel files. Furthermore, Spore® could be used to combine WIPO PCT search results into "SmartSets" that eliminated overlapping data to ensure that records were not counted multiple times.

This data set then was analyzed in Excel to eliminate records outside the United States, and to identify state contributions and the technical areas of inventions. While the full PCT application records include a great deal of information regarding both the invention and the inventors, only the following fields were used in this analysis:

- First inventor residency
- First inventor address (at the time of filing the PCT application)
- First inventor address
- International Patent Classification (IPC) Code

The first inventor residency field was used to determine if the inventor lived in the United States. As only patent records with one or more inventors living in the United States were included, 1,094 PCT applications filed through the U.S. Receiving Office in 1998 were omitted, and 2,583 applications filed in 2006 were omitted. These omissions constituted approximately 5 percent of the total filings in each year.

Chmura Economics and Analytics, an economic research and quantitative solutions firm, scanned the owner address field to determine if a PCT application was from industry or an academic institution. Application records that had both university and private industry affiliations were grouped with university applications. PCT applications that were categorized as industry applications had only private industry owners. This being said, a small percentage of PCT applications classified in the "private industry owners" category are authored by individuals. These PCT applications represent an estimated 1 percent of applications in this group. Chmura then cross-referenced patents' state of ownership, university/industry affiliation, and IPC code. The state of origin for each patent was determined using the owner address field or the first inventor address field if the owner address was left blank. The zip codes in these fields, or state abbreviations if the zip codes were missing, were used to map a patent record to a state. International patent classification codes were used to tie an application to a broader field of technology and inventions. It is important to note that each application record can list multiple IPC codes. As a result, the patent IPC code analysis in this report is non-cumulative and instead tracks patent classification activity across the range of IPC filings.

State Rankings of PCT Applications Filed per One Hundred Thousand State Workers in 1998 and 2006

		Patents per 100,000 workers		Rank of patents per 100,000 workers	
State	State Name	1998	2006	1998	2006
Ala.	Alabama	5.1	8.1	43	45
Alaska	Alaska	1.8	2.5	50	50
Ark.	Arkansas	2.7	4.0	48	49
Ariz.	Arizona	17.3	25.9	16	21
Calif.	California	33.2	58.5	6	4
Colo.	Colorado	25.3	32.9	8	12
Conn.	Connecticut	29.3	57.4	7	5
Del.	Delaware	55.6	82.1	1	1
D.C.	District of Columbia	3.2	6.7	46	46
Fla.	Florida	9.1	16.7	31	31
Ga.	Georgia	10.6	19.8	29	26
Hawaii	Hawaii	3.4	5.5	45	48
Idaho	Idaho	20.7	23.6	12	23
Ill.	Illinois	15.6	29.6	21	17
Ind.	Indiana	15.9	22.0	19	25
Iowa	Iowa	8.5	13.5	33	35
Kans.	Kansas	7.9	12.2	35	36
Ky.	Kentucky	4.7	9.0	44	42
La.	Louisiana	9.3	9.3	30	41
Maine	Maine	6.8	13.6	39	34
Md.	Maryland	24.0	31.1	9	14
Mass.	Massachusetts	37.8	79.0	3	2
Mich.	Michigan	18.4	30.9	15	15
Minn.	Minnesota	39.9	69.5	2	3
Miss.	Mississippi	2.1	6.2	49	47
Mo.	Missouri	10.8	14.5	27	32
Mont.	Montana	8.2	10.4	34	38
Neb.	Nebraska	6.0	8.4	42	43
Nev.	Nevada	7.6	17.2	37	30
N.H.	New Hampshire	35.9	56.0	4	6
N.J.	New Jersey	33.3	52.3	5	7
N. Mex.	New Mexico	15.8	18.7	20	28
N.Y.	New York	13.1	30.0	25	16
N.C.	North Carolina	15.1	26.4	22	20
N. Dak.	North Dakota	1.3	10.3	51	39
Ohio	Ohio	20.5	26.7	13	18
Okla.	Oklahoma	7.1	10.0	38	40
Ore.	Oregon	13.7	44.8	24	8
Pa.	Pennsylvania	20.9	33.9	10	11
R.I.	Rhode Island	14.6	25.0	23	22
S.C.	South Carolina	7.8	13.8	36	33
S. Dak.	South Dakota	3.1	1.3	47	51
Tenn.	Tennessee	10.6	19.1	28	27
Tex.	Texas	16.4	23.4	17	24
Utah	Utah	20.9	34.5	11	10
Vt.	Vermont	12.8	31.7	26	13
Va.	Virginia	9.1	17.8	32	29
Wash.	Washington	18.5	38.0	14	9
W. Va.	West Virginia	6.0	12.2	41	37
Wis.	Wisconsin	16.3	26.4	18	19
Wyo.	Wyoming	6.7	8.2	40	44
	Average	**14.9**	**25.1**		

State Breakdown of PCT Applications Owned by Universities and Industry in 1998 and 2006

State	State Name	Total 1998	Total 2006	University 1998	Industry only 1998	University 2006	Industry only 2006
Ala.	Alabama	98	159	15	83	18	141
Alaska	Alaska	5	8	1	4	0	8
Ark.	Arkansas	30	49	4	26	13	36
Ariz.	Arizona	357	675	9	348	28	647
Calif.	California	4,716	9,196	393	4,323	605	8,591
Colo.	Colorado	510	747	25	485	44	703
Conn.	Connecticut	482	976	33	449	63	913
Del.	Delaware	218	349	5	213	14	335
D.C.	District of Columbia	19	45	6	13	4	41
Fla.	Florida	639	1,338	61	578	166	1,172
Ga.	Georgia	519	805	39	480	43	762
Hawaii	Hawaii	18	34	4	14	4	30
Idaho	Idaho	108	153	1	107	2	151
Ill.	Illinois	914	1,735	52	862	123	1,612
Ind.	Indiana	461	643	18	443	27	616
Iowa	Iowa	120	201	31	89	34	167
Kans.	Kansas	104	163	11	93	21	142
Ky.	Kentucky	80	162	6	74	11	151
La.	Louisiana	174	168	10	164	14	154
Maine	Maine	39	82	1	38	3	79
Md.	Maryland	552	795	103	449	157	638
Mass.	Massachusetts	1,643	2,603	296	1,347	337	2,266
Mich.	Michigan	821	1,337	52	769	129	1,208
Minn.	Minnesota	1,003	1,877	30	973	47	1,830
Miss.	Mississippi	24	70	3	21	13	57
Mo.	Missouri	287	400	35	252	41	359
Mont.	Montana	30	45	4	26	8	37
Neb.	Nebraska	51	110	14	37	10	100
Nev.	Nevada	70	221	6	64	7	214
N.H.	New Hampshire	209	354	7	202	18	336
N.J.	New Jersey	1,246	2,116	87	1,159	119	1,997
N. Mex.	New Mexico	111	152	34	77	22	130
N.Y.	New York	1,067	2,551	139	928	245	2,306
N.C.	North Carolina	566	1,047	71	495	109	938
N. Dak.	North Dakota	4	35	1	3	9	26
Ohio	Ohio	1,112	1,436	54	1,058	121	1,315
Okla.	Oklahoma	100	152	6	94	10	142
Ore.	Oregon	213	770	12	201	30	740
Pa.	Pennsylvania	1,130	1,915	118	1,012	133	1,782
P.R.	Puerto Rico	5	2	0	5	0	2
R.I.	Rhode Island	73	124	5	68	10	114
S.C.	South Carolina	137	260	11	126	18	242
S. Dak.	South Dakota	11	5	0	11	1	4
Tenn.	Tennessee	276	526	32	244	33	493
Tex.	Texas	1,454	2,329	117	1,337	197	2,132
Utah	Utah	207	404	28	179	43	361
Vt.	Vermont	36	97	4	32	15	82
V.I.	Virgin Islands	1	4	0	1	0	4
Va.	Virginia	318	655	25	293	68	587
Wash.	Washington	484	1,088	47	437	57	1,031
W. Va.	West Virginia	42	87	0	42	3	84
Wis.	Wisconsin	434	742	3	431	6	736
Wyo.	Wyoming	15	22	3	12	2	20
	Total-United States	**23,343**	**42,019**	**2,072**	**21,271**	**3,255**	**38,764**
	Percent of total			**8.88%**	**91.12%**	**7.75%**	**92.25%**

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