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Effect of the economic crisis on the production of immunology patents managed through the Patent Cooperation Treaty agreement from 2004–2011

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Summary

Objectives: To determine the evolution of patents in immunology, as a result of research and innovation in the years 2004–2011.

Design: The search for patents published internationally in immunology was made by using the SCOPUSTM database. SCOPUS gives information about over 23 million patents. The extracted data from patents were: inventors and applicants; their nationalities; sections, classes and subclasses of the International Patent Classification.

Participants: 89 countries

Setting: Data have been obtained from the database SCOPUS. It has been used for the international patent classification.

Main outcome measures: Patents by country, Productive sectors, Productive areas

Results: A total of 17,281 patents were applied for immunology during 2004–2011 of which 16,811 were from 30 Organisation for Economic Cooperation and Development countries, and 5326 from 28 countries in the European Union. These patents were granted in 89 countries and 13,699 of them were submitted by researchers from only one country. Private entities applied for 62.45% of all patents, universities 17.48%, hospitals 3.40% and public research organisations and private applicants applied for the rest. The university that made more applications was the University of California with 315 and the company was Genentech Inc. (US) with 302. The reduction in the number of applications of international patents in all disciplines of science also affected the area of immunology.

Conclusions: Collaboration in immunology between universities, companies and hospitals is hard because their interests are different. It is shown in patent applications that the majority of patents in immunology are applied for by only one entity. Patents in immunology are developed, mainly, in aspects such as medical preparations, peptides, mutation or genetic engineering, therapeutic activity of chemical compounds and analysing materials by determining their chemical or physical properties.

Keywords

patents, technological balance, immunology, PCT, innovation

Background

Research is reckoned as an important contributor to the technological and economic development of a country, which is why public and private entities invest large sums of money in it.[1] This has recently produced a large amount of literature based on bibliometric analyses of scientific production[2] but very few analyses on intellectual property;[3,4] thus, it is difficult to quantify the value of indicators such as patents. These analyses are useful in the fields of innovation, technology transfer and industrial competitiveness, as well as to promote investment in innovation and to provide a framework for the trading of the assets of industrial property via patents and trademarks.[5]

The economic problems in recent years have affected all countries, with short- and medium-term consequences, particularly related to lack of confidence. Confidence in the future depends greatly on the capacity for innovation shown by businesses and the state.

Investment in knowledge creation had increased in recent years, reaching about 1.1 billion dollars in 2009.[5] The demand for industrial property fell in 2009, but despite the difficult economic conditions, it recovered in 2010. The recovery in international patent filings observed in 2010 gained strength in 2011.[6]

Among the countries with the highest number of patent applications through the Patent Cooperation Treaty in 2011 are Saudi Arabia (81.48%), China (33.42), Ukraine (26.60), Russia (20.80), Japan (20.95), Poland (19.59), Mexico (18.84), Austria (17.79), Brazil (17.21), Belgium (12.78), Turkey (12.70), Denmark (11.83) and India (11.19). However, countries such as Malaysia (−24.28), Hungary (−17.44), Portugal (−17.24), Netherlands (−14.00), Ireland (−4.96), Finland (−2.71), Spain (−2.65), Luxembourg (−1.99), Australia (−1.80),

Israel (−1.62) and the United Kingdom (−0.96) had a smaller growth.

Patents in this context are the result of a big effort in innovation. Thus, the connection between science and politics is a priority for the European Union, as it was agreed in the Lisbon Strategy for Growth and Jobs.[7] It is therefore important to be aware of the evolution of patents in the specific setting of scientific knowledge, in order to analyse the possible opportunities and forms of future development. The 2008 Compendium of Patent Statistics established a series of very interesting conclusions about patents, particularly in such fields as information and communication technology, nanotechnology, biotechnology, technologies related with the environment, nuclear energy and fuel cells.[8]

Despite that the generation and transfer of knowledge between science and industry are very important to achieve a good technological balance, bibliometric studies on patents are scarce in specific areas of knowledge.[9]

Methods

A search about patents applied internationally in the field of immunology was carried by using the SCOPUS™ database. SCOPUS gives information about over 23 million patents.

For this study, only patent applications under the Patent Cooperation Treaty were considered. The patents were obtained by using the search term 'immunology' in the years 2004 to 2011 during February of the following year.

Obtained data from patents were: inventors and applicants, their nationalities, and sections, classes and subclasses of the International Patent Classification (IPC), using eighth version 2008.01 (http://www.wipo.int/classifications/ipc/en).

Results

Evolution by countries

A search in the SCOPUS database for immunology patents produced a total of 17,281 patent applications during 2004–2011 of which 16,811 were from 30 Organisation for Economic Cooperation and Development (OECD) countries and 5326 from 28 countries in the European Union.

The analysis of these patents shows that they were granted in 89 countries; 13,699 (79.27%) of them were submitted by researchers from only one country, 2781 by researchers from two countries, 446 by researchers from three countries, 74 by researchers from four countries, 5 by researchers from five countries, 3 by researchers from six countries, and only one by researchers from eight countries.

It was in the year 2007 that we found the highest number of patent applications, and from that year it decreased progressively in all countries, except China (Table 1).

Despite the recovery in the number of patent applications produced in 2011 in the field of immunology, there was still a reduction in international patent applications. Likewise, the so-called emerging countries have hardly any patents applied through Patent Cooperation Treaty in recent years.

The United States was the main patent applicant with 10,464 (60.55% of the total), 8445 were carried out just by US researchers and 2019 together with researchers from other countries, 60.02% of patents from OECD and 38.85% from the European Union were granted to researchers from one single country (Table 1).

Productive sectors

Private entities produced 10,793 (62.45%) of all patents, followed by universities (3022, 17.48%) and hospitals (588, 3.40%); the other 1960 came from Public Research Organizations (PROs) and, mostly, private applicants.

On the few occasions when there has been collaboration between different sectors, in most cases this has been established between private entities and universities; collaborations between universities and hospitals are very few (Table 2).

Productive areas

Patents in immunology are assigned mainly (9212) in subclass A61K (preparations or medical dressing, dental), 5455 to C07K (peptides), 3987 to C12N (microorganisms or enzymes, compositions thereof, spread, preservation or maintenance of microorganisms, mutation or genetic engineering), 3865 to A61P (therapeutic activity of chemical compounds or medicinal preparations), and 3097 to G01N (investigating or analysing materials by determining their chemical or physical properties) (Table 3).

Top applicants

The University of California (US) with 315 patent applications was the largest filer among educational institutions, followed by Johns Hopkins University (US), the University of Texas (US), the

Table 1. Evolution of immunology patents managed under the Patent Cooperation Treaty agreement during 2004–2011.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2004–2011
United States	1,069	1,301	1,660	1,738	1,584	1,339	819	954	10,464
Great Britain	186	163	199	259	218	197	132	94	1,448
Germany	156	177	189	210	188	180	111	100	1,311
Switzerland	97	80	109	134	123	139	93	106	881
France	83	104	147	133	134	102	70	68	841
Canada	66	79	103	102	106	74	46	56	632
Israel	59	77	103	87	79	89	67	62	623
Australia	85	76	89	86	96	67	62	40	601
Holland	57	65	68	90	82	52	29	34	477
Japan	68	68	81	97	58	44	35	18	469
Italy	35	43	74	65	48	50	34	35	384
Belgium	25	35	54	61	69	67	29	31	371
Denmark	8	41	56	49	53	48	31	26	341
Sweden	29	37	36	61	62	36	21	18	300
Austria	42	25	27	35	24	24	14	9	200
Spain	23	23	27	31	25	24	15	25	193
China	16	19	18	27	16	20	26	36	178
South Korea	13	19	35	20	28	25	15	6	161
India	7	23	29	25	20	24	9	13	150
Singapore	7	11	20	26	19	21	23	17	144
All the countries									
Patents	1,837	2,090	2,656	2,828	2,602	2,218	1,555	1,495	17,281[a]
From one country	1,497	1,684	2,140	2,293	2,040	1,762	1,114	1,169	13,699
From several countries	329	384	513	520	518	452	299	305	3,320
OECD									
Patents	1,805	2,030	2,594	2,751	2,516	2,174	1,509	1,432	16,811
European Union -28									
Patents	606	640	808	880	8012	717	455	418	5,326

[a]262 patents do not specify the nationality or the researchers or the applicants.

Table 2. Evolution of immunology patents managed under the Patent Cooperation Treaty agreement during 2004–2011, by productive sector.

Year	2004	2005	2006	2007	2008	2009	2010	2011	Total
Private entities	1,247	1,307	1,695	1803	1,548	1,304	963	926	10,793
Universities	215	312	455	508	489	424	340	279	3,022
Hospitals	53	97	91	108	113	66	42	18	588
Others	231	246	290	304	260	285	177	167	1,960
Private entities + universities	23	34	43	40	50	42	31	40	303
Private entities + hospitals	6	16	15	6	12	13	5	4	77
Private entities + others	19	14	15	15	27	39	15	9	153
Universities + hospitals	6	9	8	6	11	7	12	10	69
Universities + others	16	20	27	20	35	26	18	30	192
Hospitals + others	9	8	9	5	4	4	8	2	49
Private entities + universities + hospitals	2	0	0	0	3	0	1	2	8
Private entities + universities + others	4	0	3	2	4	2	3	5	23
Private entities + hospitals + others	1	0	0	0	0	3	0	1	5
Universities + hospitals + others	3	5	2	2	2	3	0	2	19
Private entities + universities + hospitals + others	0	1	0	0	0	0	0	0	1

University of Harvard (US) and the University of Michigan (US).

Likewise, the top five applicant companies with highest number of patent applications in the Patent Cooperation Treaty during this period were Genentech Inc. (US), Novartis AG (CH), Abbott Lab (US), Wyeth Corp (US) and Glaxo Group Ltd (GB) (Table 4).

Patents and population and gross national income

The applications published by each country showed no correlation with population size or with its gross national income per capita (Table 5).

Discussion

This is one of the first systematic reviews of patents to analyse countries, authorship details, centres and research fields. Studies on patents are useful to ensure effective research funding from both public and private organisations. These studies stimulate research and technological innovation, and are quite important for improving indicators that measure the benefit of the innovation.[10]

The Knowledge Society is changing, not just academically (Bologna Plan, or the lesser known Alexandria Plan) but also in areas like science, technology and economy; progress and wealth sources that affect the quality of life. Technological innovations in immunology are contributing to the design of new drugs and new methods of clinical diagnosis. Future models, dealing with basic homeostasis, immunity against pathogens, antigen presentation mechanisms, cytokines, mechanisms of autoimmunity, gene recombination, cell cycle regulation, signal transduction and cell sociology will all generate patentable advances such as vaccines and/or treatments.

From the research and development (R&D) point of view, immunology covers three main areas. First, immunodiagnostics, which uses the processing and analysis of images to detect abnormalities in the immune system during the early stages of a disorder, thus reducing the healthcare costs for the health care-provider. Second, immunotechnology, which takes elements from the immune system to be used as drugs, thus acting more efficiently and with fewer adverse effects on the relevant cells and areas of the

Table 3. Distribution by international patent classification section, class and subclasses, of the Immunology patents managed under the Patent Cooperation Treaty agreement during 2004–2011.

Section	Class	Subclass	Year									% 2011/ maximum
			2004	2005	2006	2007	2008	2009	2010	2011	**Total**	
A	all		1,515	1,596	2,317	2,719	2,300	2,019	1002	902	14,370	33.17
	A01	all	80	73	74	95	96	86	81	56	1,493	58.33
		A01K	45	35	33	45	32	18	19	10	237	22.22
		A01N	28	28	15	29	39	45	33	34	251	**75.55**
		A01H	7	10	24	20	22	11	27	11	132	40.74
	A23	all	38	43	25	32	25	25	6	7	201	16.27
		A23L	22	22	12	17	12	15	4	5	109	22.72
	A61	all	1,395	1,440	1,688	2,590	1,908	1,859	945	875	12,700	33.78
		A61K	985	1,140	1,123	1,727	1,269	1,233	895	840	9,212	48.63
		A61P	332	230	520	782	592	581	408	420	3,865	**53.70**
		A61B	41	35	11	15	9	9	2	4	126	9.75
		A61L	6	15	12	14	17	19	9	10	102	**58.82**
		A61F	7	6	7	17	7	6	6	3	59	17.64
B	all		56	56	34	27	43	24	47	8	295	14.28
	B01	all	24	14	12	13	10	15	6	5	99	20.83
C	all		2,186	2,176	1,775	2,476	1,885	1,722	968	863	14,051	34.85
	C07	all	1,143	1,141	840	1,298	902	843	647	520	7,334	40.06
		C07K	879	877	614	803	653	655	507	467	5,455	**53.12**
		C07D	141	141	123	386	150	127	119	95	1,282	24.61
		C07H	91	93	77	77	63	53	32	40	526	43.01
		C07C	20	17	17	23	25	0	12	11	125	44.00
	C08	all	2	14	18	19	19	14	4	13	103	**68.42**
	C12	all	1,027	1,004	896	1,119	939	835	482	462	6,764	41.28
		C12N	632	613	485	644	516	472	336	289	3,987	44.87
		C12Q	297	305	316	349	331	278	163	162	2,201	46.41
		C12P	80	68	82	96	71	61	55	61	574	**63.54**
		C12M	13	9	6	25	11	12	9	9	94	36.00
	C40	all	10	5	15	30	19	22	16	25	142	**83.33**

(continued)

Table 3. Continued.

Section	Class	Subclass	Year 2004	2005	2006	2007	2008	2009	2010	2011	**Total**	% 2011/ maximum
D+E+F+H	all		8	8	7	11	13	16	3	0	66	0.00
G	all		413	487	440	527	492	414	278	297	3,348	**56.35**
	G01	all	389	456	398	479	443	387	277	288	3,117	**60.12**
		G01N	388	452	397	474	442	384	274	286	3,097	**60.33**
	G06	all	23	29	37	44	47	26	4	13	223	27.65
		G06F	22	26	30	36	32	14	3	11	174	30.55
	None		0	36	530	59	168	57	25	42	917	25.00

Table 4. Entities with the highest production of patents during 2004–2011.

Entities	Patents
Univ California [US]	315
Genentech Inc [US]	302
Novartis AG [CH]	268
Abbott Lab [US]	155
Wyeth Corp [US]	152
Glaxo Group Ltd [GB]	148
US Government [US]	146
Univ Johns Hopkins [US]	137
Hoffmann la Roche (CH)	130
Amgen Inc [US]	122
Inst Nat Sante Rech Med [FR]	122
Univ Texas [US]	118
Centocor Inc [US]	112
Schering Corp [US]	108
Yeda Res & Dev [IL]	100
Pfizer Prod Inc [US]	97
Harvard College [US]	91
GlaxoSmithKline Biolog SA (BE)	83
Scripps Research Inst (US)	78
Dana Farber Cancer Inst Inc (US)	77
Gen Hospital Corp [US]	77
Merck & Co Inc (US)	76
Univ Michigan (US)	74
Biogen Idec Inc [US]	73
Astrazeneca AB [SE]	72
SmithKline Beecham Corp [US]	71
Pasteur Institut (FR)	69
Centre Nat Rech Scient (FR)	68
Zymogenetics Inc [US]	65
Univ Leland Stanford Junior [US]	63
Univ Florida (US)	53

(continued)

organism. And third, immunotools, which uses elements of the immune system for the detection, localisation, management and repair of damaged organs and tissues.

Development and progress in science, technology and economy in immunology, as in many other fields, are determined by different factors, such as a more business-oriented culture; in order to improve this,

Table 5. Countries by published patents, population and gross national income per capital.

Country	Patents 2004–2011	Population by millions inhabitants	Gross national income per capita/billions of dollars
US	10,464	307	46,360
GB	1,448	62	41,370
DE	1,311	82	42,450
CH	881	8	65,430
FR	841	63	42,620
CA	632	34	41,980
IL	623	7	25,790
AU	601	22	43,770
NL	477	17	48,460
JP	469	128	38,080
IT	384	60	35,110
BE	371	11	45,270
DK	341	6	59,060
SE	300	9	48,840
AT	200	8	46,450
ES	193	46	32,120
CN	178	1,331	3,650
KR	161	49	19,830
IN	150	1,155	1,220
SG	144	5	37,220

some universities have already incorporated into their study plans subjects related to how to start up a business and support programme to strengthen the connection between R&D and businesses. It is also important to note the fact that due to the current economic situation business people are changing their minds in this respect, and they are seen to be more willing to welcome this kind of collaboration.[11]

History has shown that countries and companies that invested in new products and innovative activities during periods of economic recession have found themselves in an optimal position to take advantage from the situation once the economy has recovered.[12]

Patent applications, as a whole, decreased in 2009 but began increasing in 2010 and 2011. However, the trend in immunology was decreasing until 2011, which was not expected by the World Intellectual Property Organization (WIPO) for 2020.[13]

It is important to notice the scarce collaboration between different economic sectors in immunology. As the president of the European Patent Office said, the most successful countries in innovation are the ones that promote a good cooperation between universities, research centres and industries.[14]

In immunology, this collaboration between public and private research sectors should therefore be supported and encouraged, although this is not a definitive solution.[15]

At the same time, the inter-institutional collaboration is maintained in a conceptually elusive and difficult area to achieve, for various reasons such as: cultural clashes, overly bureaucratic agencies, rewards poorly designed or ineffective management of the offices of university technology transfer.[16]

The organisations that fund research want results to be easily measured (articles or impact factors) and the researchers themselves try to fill their curriculum with the sort of contributions that work faster. The goals of research are sometimes confused with the means of making the results known.

To establish a good connection between sectors, it is necessary to establish clear criteria for the selection of partners and addressing conflicts of interest; likewise, cooperation can sometimes interfere with academic freedom and altruistic research.

It is shown that immunology patents are assigned to fewer sections, classes and subclasses of the International Patent Classification during the last two years.

The cultural tradition in the European Union and the cultural and economic ties with the United States make this country the main technological partner for researchers. Almost half of all patents are presented together with a United States partner. China is starting its internationalisation.

Less than 20% of patents come from universities, although some of them are part of the group of entities that have the most patents in immunology.

In 2008–2009, expenditure on R&D&i is maintained despite the financial crisis. In the European Union, the fall of Gross Domestic Product was higher than the amounts allocated to R&D, producing a net effect of increasing the percentage of investment in R&D&i.

It is also important to consider the impact of intellectual property rights protection on the growth rate of a country. Regression techniques have shown that in countries with a Gross Domestic Product below

3400 US dollars (in 1980 dollars) there is no significant relation between intellectual property rights and growth, but above this threshold the relation is significantly positive.[17]

Falvey et al.[17] found that those countries that gave greater intellectual property rights protection were more attractive destinations for foreign patents. Countries need companies to investigate and put products on the market; otherwise, the countries will become technological colonies of other countries.

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