Ciencias de la Información Vol. 41, No.3, septiembre - diciembre, pp. 38 - 44, 2010

Economic Growth and Scientific activities. Interrelations

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This study aims to investigate the relation between GDP of countries and patent applications issued by the United States Patent and Trademark Office (USPTO), the World Intellectual property Organisation (WIPO), and European Patent Office (EPO) through 2002-2005.

The main trend of U.S. patenting applications and granted patents is presented over 40 years (1965-2005). The changes over time in the rate of patenting and the number of granted patents are exhibited. The Analyses of data showed that The USA is the leading country filing and granting patents followed by Japan and Germany respectively. The relationship between patent applications and gross domestic product (GDP) of the countries, with applications greater than 500 patents annually, is a linear relationship with a strong correlation coefficient (R > 0.96), in contrast to the relation of patent applications to the population size R = 0.42 (power law).

***Keywords**: GDP, R&D, Patent, Patentometry, Scientific publication*

RESUMEN

ABSTRACT

Este estudio tiene como objetivo investigar la relación existente entre el PIB de los países y las solicitudes de patentes procesadas por la Oficina de Patentes y Marcas Registradas de los Estados Unidos (USPTO), la Organización Mundial de la Propiedad Intelectual (WIPO) y la Oficina Europea de Patentes (EPO) entre el 2002 y el 2005.

Se presenta la tendencia principal de la solicitud de patentes y las patentes concedidas en los Estados Unidos durante un período de 40 años (1965 - 2005). Se muestran los cambios acaecidos en el tiempo en la tasa de patentes y en la cantidad de patentes otorgadas. Los análisis de los datos muestran que Estados Unidos es el país líder en el procesamiento y otorgamiento de patentes seguido por Japón y Alemania, respectivamente. La relación entre la solicitud de patentes y el producto interno bruto (PIB) de los países, con más de 500 solicitudes de patentes al año, es una relación lineal con un fuerte coeficiente de correlación (R > 0.96), en contraste con la relación entre la solicitud de patentes y la cantidad de habitantes R = 0.42 (índice potencial).

***Palabras clave**: PIB, ID, Patente, Patentometría, Publicación científica.*

Introducción

The increase of publications, databases, and networked computerized resources by providing information and sharing knowledge experiences has turned our world into a global village- a common and easy accessible place where many sources are located. The emergence of the internet by providing sophisticated collaboration and relationship between scientists and researchers has turned our world into an open network. Globalization has facilitated their access to information retrieval more thoroughly, effectively and attractively all over the world so that «today we are evolving rapidly into knowledge-based society, a shift in culture and technology as profound as the shift that took place a century ago when our agrarian societies evolved into Industrial nations.» (Duderstadt, 2006). According to the report of Nielsen//NetRatings, a global

leader in internet media and market research, on October 13th 2005, the education reference web sites attracted nearly 46.4 million web users. This marks a 22 percent jump in this category from the previous year, which can be attributed mainly to the triple-digit growth of Wikipedia and Yahoo! Education. (James., 2005)The positive influences of such opportunities appear in scholarly works, scientific collaborations and eventually emerging innovations and publishing their scientific output in different forms. «The number of scientific articles catalogued in the internationally recognized peer-reviewed set of Science and Engineering (S&E) journals covered by the *Science Citation Index (SCI)* and *Social Sciences Citation Index (SSCI)* grew from approximately 466,000 in 1988 to nearly 700,000 in 2003, an increase of 50% (S and E. I. 2006) «These are indicators for science and technology development in countries which may be used as statistics that measure quantifiable aspects of the creation, dissemination and application of science and technology. As indicators they describe the science and technology system, enabling better understanding of its structure, and the impact of policies and programs on society and the economy. Analysing of patent applications field by scientists in a country is a metric that maps the innovation activities within a country.

«There is a strong correlation between innovation activity and the economic well being of a country. The World Bank data showed that in high-income countries, there was one (1) domestic patent filing for every 1,300 people (in 1997); in middle-income countries, one (1) patent application for every 20,000 people; and in low-income countries, (one) 1 patent application was filed for every 144,000 people. There are many related reasons for this discrepancy. One of those reasons is that there are five times as many scientists and technologists in research and development activities in high-income countries than medium-income countries. Low-income countries are even further disadvantaged. This factor along with capital-formation differences between these countries leads to the uneven distribution of economic growth throughout the world.» (Przybylowicz, Edwin P. 2003). To our aware the first person who found out that national science is proportional to GDP was Derek De Solla Price. Francis Narin also found out that large countries patenting is proportional to GDP and noted that the scientific and technological productivity of countries, as measured by papers and patents, are associated with economic activity. (Narin, Francis (1994)

A **patent** is a right granted for any device, substance, method or process which is new, inventive and useful. «A patent is legally enforceable and gives the owner the exclusive right to commercially exploit the invention for the life of the patent (This is not automatic; the inventor must apply for a patent (from a patent office) to obtain exclusive rights to exploit his or her invention).» (Types of Intellectual Property, 2006)

There are three types of patents:

Utility patents: «Utility Patents may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement.» (Kontaxx international, 2006)

Design patents: «Design patents may be granted to anyone who invents a new, original, and ornamental design for an article of manufacture.» (Kontaxx international, 2006)

Plant patents: «*Plant patents* may be granted to anyone who invents or discovers and asexually reproduces any distinct and new variety of plant.» (Kontaxx international, 2006)

Method

All USPTO patents data were extracted from the office of electronic information products / patent technology monitoring division. WIPO and EPO patents data were extracted from the websites of World's Intellectual Organisation and European Patent Office respectively.

The World Economic outlook database (WEO, 2007) was used to extract the GDP of countries.

In this study the scientific activity of countries was investigated versus GDP rather than the R&D expenditure. The reason is that, data about R&D expenditures deviates highly in different sources. At first because there are different kinds of R&D expenditures (money from foundations, the government, the industry, military institutions, the universities, etc.) and at second because the different types of scholarship, that makes the definition of R&D expenditures ambiguous.

Figure 1 shows the number of patent applications in the United State and Trademark office through 1965-2005 by entire world (all countries + the USA). It is considerable that annual number of patent applications by entire world show unremarkable growth during 1965 and 1985. It seems remaining roughly constant up to 1985, oscillating around 1996, and then takes off exponentially, the peak emerges in 2004.

Accurately it can be divided in 2 stages:

Stage A (1965-1985): In this stage the number of patent application is roughly constant in

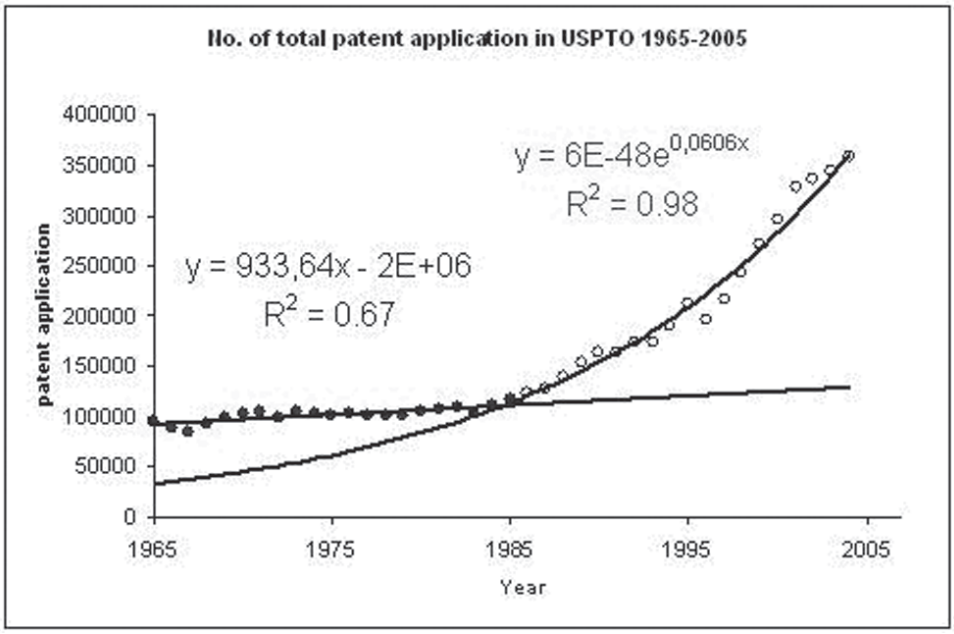


Figure 1. Number of total patent application (utility patent) filed in the United States patents and Trademark Office 1965-2005 (uspto, 2006) / Cantidad total de solicitud de patentes (patentes generales) procesadas por la Oficina de Patentes y Marcas de los Estados Unidos 1965 – 2005

spite of some fluctuation throughout the period of study.

Stage B (1986-2005): This stage indicates that the number of patent application through 1986-2005 has increased exponentially with a doubling time of 11.4 years.

As stage A shows, the growth of patent application throughout 1965-1985 is very slight. Figure shows an increase of +933 applications per year.

The figure indicates that there is a linear correlation between the number of patent application and the year of under study with a regression coefficient R = 0.82.

Stage B shows, the number of patent application throughout 1986-2005 took off exponentially with a doubling time of 11.4 years. The formula $R^2 = 0.98$ indicates that the correlation between the years and the number of patent application in the USPTO is very high (R = 0.99).

The Figure shows that countries change in their patenting position quite dramatically over relatively small periods of time, and this is probably reflected in the patent count versus GDP data.

The growth of granted patents issued for France and Canada until 1997 shows slight increase. The number of granted patents for Germany from 1963 to 1996 shows slight increase, but since 1997 shows a relatively high growth.

Japan enjoys a sharp increase in the term of granted patents from 1984 peaking in 2003.

In comparison the rate of granted patens among these countries, indicates that before 1975 patent application by Germany was higher than the others, but from 1980 the patent application by Japan increased rapidly and paced ahead of Germany.

All the countries enjoy relatively increase since 1999 to 2003. There is a slight decrease for all countries in 2004 and 2005.

Figure 3 shows the number of patent applications in USPTO versus GDP of 42 more productive countries in 2002. There is a linear correlation between the GDP and the amount of patent applications of countries in the USPTO. The formula «$R^2 = 0.9586$» indicates that, the correlation coefficient between the patent application in the USPTO and the amount of GDP is very high (R = 0.979). The richer a country is in term of GDP, the more applied for patents in the USPTO. It is evident that most of the countries with lower applications are beneath the regression line. It seems more logical to choose the better fitting power law in figure 4.

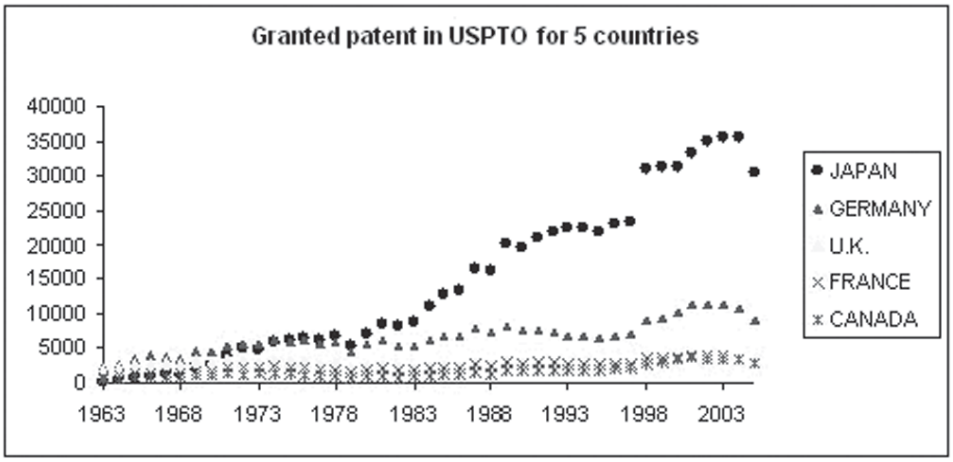


Figure 2. Number of granted patent issued by USPTO for Japan, Germany, U.K., France and Canada 1963-2005 / Cantidad de patentes concedidas por la USPTO para Japón, Alemania, Reino Unido, Francia y Canadá entre 1963 – 2005.

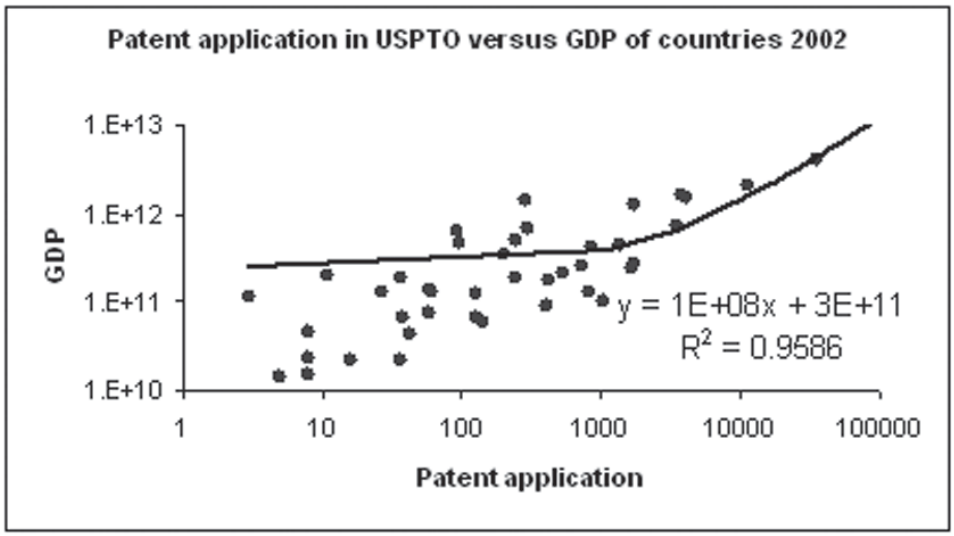


Figure 3. patent application in USPTO versus GDP of 42 countries in 2002 / Solicitud de patentes ante la USPTO versus el PIB de 42 países en el 2002.

The average costs of a patent in the USPTO sum up to 115million US$.

Figure 4 shows the number of patent applications in USPTO versus GDP of 42 more productive countries in 2002 with a power law correlation. The figure indicates that there is a power law correlation between the GDP and the amount of patent applications of countries in the USPTO. The correlation coefficient is high (R = 0.82).

As figure 5a shows, there is a linear correlation between the GDP of countries and the number of patents application in WIPO with a strong correlation coefficient (R = 0.973). It is evident that most of the points below ~500 patent applications per country are beneath the regression line. The cause for this bias is very simple. Low values have much smaller square values than GDP values in the range of 10 (Price, D. J. de Solla,1969). $. In so far it is sensible to choose the better fitting power law in figure 5b. The costs for patents of more productive 49 countries were calculated in relation to their GDP. The average amount of GDP that is associated with a patent count in WIPO sum up about to 264 million US$.

As figure 5b illustrates, the scattering of points on the regression line is more appropriate than

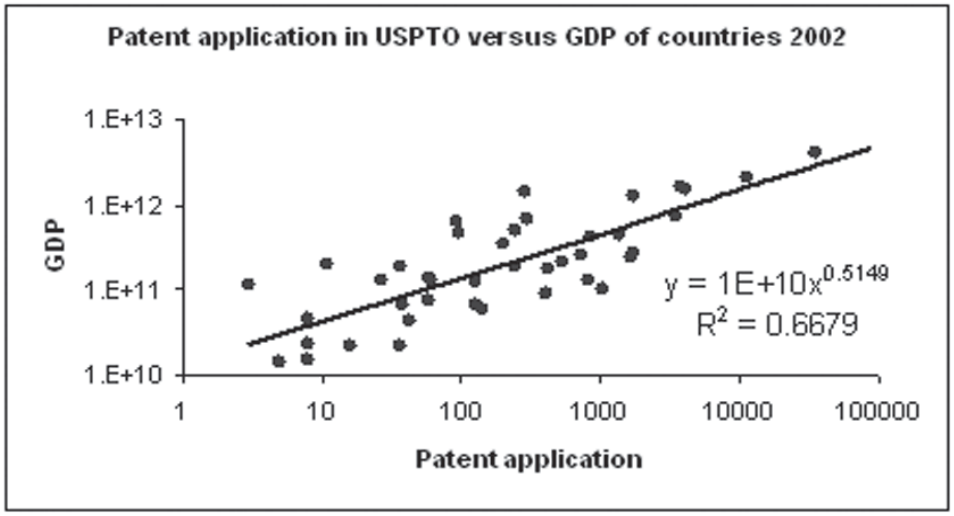
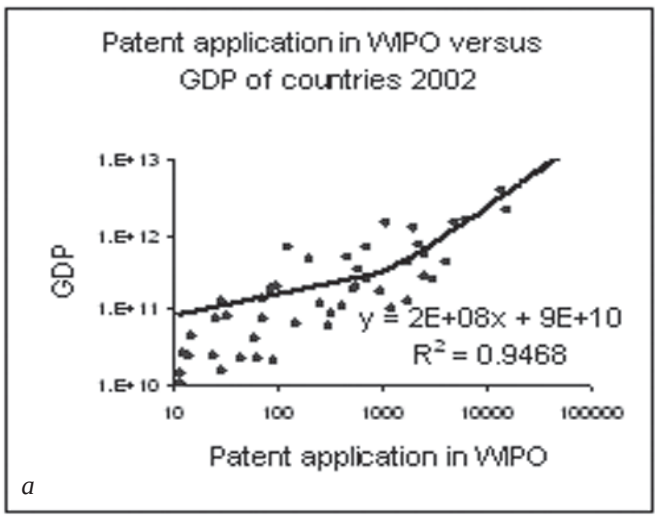


Figure 4. Patent applications in USPTO versus GDP of 42 countries in 2002 / Solicitudes de patente ante la USPTO versus el PIB de 42 países en 2002.

figure 5a (the linear method). The figure shows a correlation coefficient of R = 0.868.

The formula «y = 4E+09x$^{0.6671}$» indicates that if there is a patent application in WIPO per country in the fiscal year 2002, then GDP is \$4 10^9. The USA with 44,609 patent applications should need only \$ 5.05 10 (Price, D. J. de Solla,1969), but the real value in 2002 was 207% higher (\$ 1.05 10^{13}).

Figure 6 shows the number of patent applications in WIPO versus GDP of countries, those applied for more than 500 patents in 2002. As figure indicates there is a linear correlation between the GDP of countries and the number of patent application with a correlation coefficient of R = 0.973.



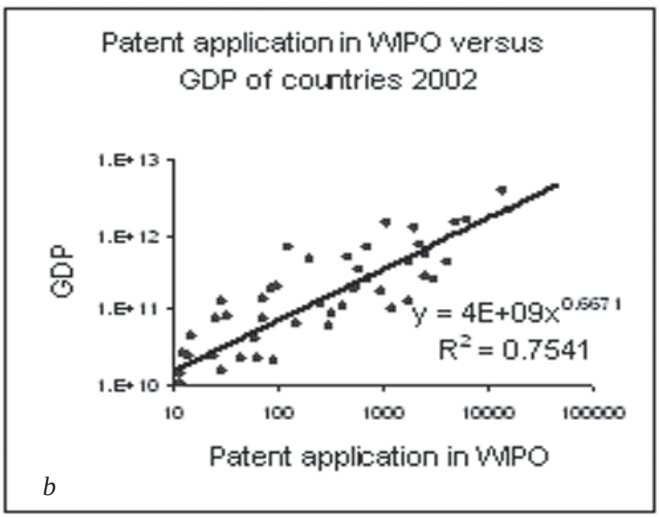


Figure 5. Patent application in WIPO versus GDP of 49 more productive countries(Wipo, 2006) / Solicitud de patentes ante la WIPO versus el PIB de 49 países más productivos.

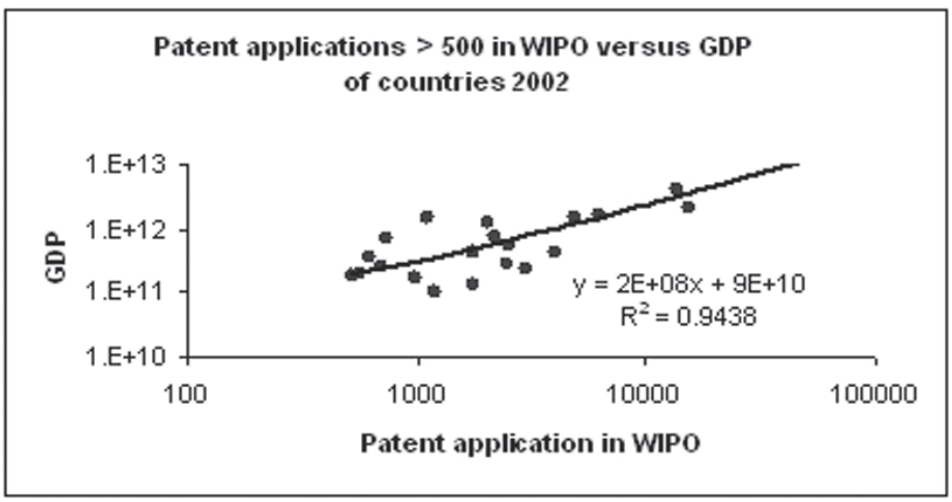


Figure 6. Patent applications higher than 500 in WIPO versus GDP of countries in 2002 / Solicitudes de patente mayores de 500 en la WIPO versus el PIB de países en el 2002.

In order to explore whether the relationship between the amount of GDP and the productivity of countries is a common phenomenon; patent application of most productive countries (those their paten application was more than 500 times in the WIPO) in 2003, 2004 and 2005 was analysed, likewise in 2002. The obtained results showed that the correlation between patent applications greater then 500 and GDP of countries is linear with a regression greater than 0.96.

What figure 7 also shows, is that there is weak correlation between the size of a population and the number of applied patents. The figure indicates that the bigger the population of a country is; the number of patent application stays almost flat. The reason is that, money

for research activities in the countries is more important than the size of population. Although the probability of higher educated people in the countries with high population seems to be greater than in the small countries, this correlation is not as important of an indicator as the wealth of the countries.

As figure 8 shows, there is a power law correlation between the number of patent application in European patent Organization (EPO) and the amount of GDP. One can say that, the more the country richer is, the more applications has applied for patents to EPO. The correlation coefficient is high, it indicates that the relation between the number of patent application in the EPO and the amount of GDP is strong. The formula «$y = 5E+09x^{0.6193}$ « indicates that if there is only one patent per country in EPO, then GDP is \$5 10^9 The average costs of a patent in the EPO sum up to 238 million US\$.

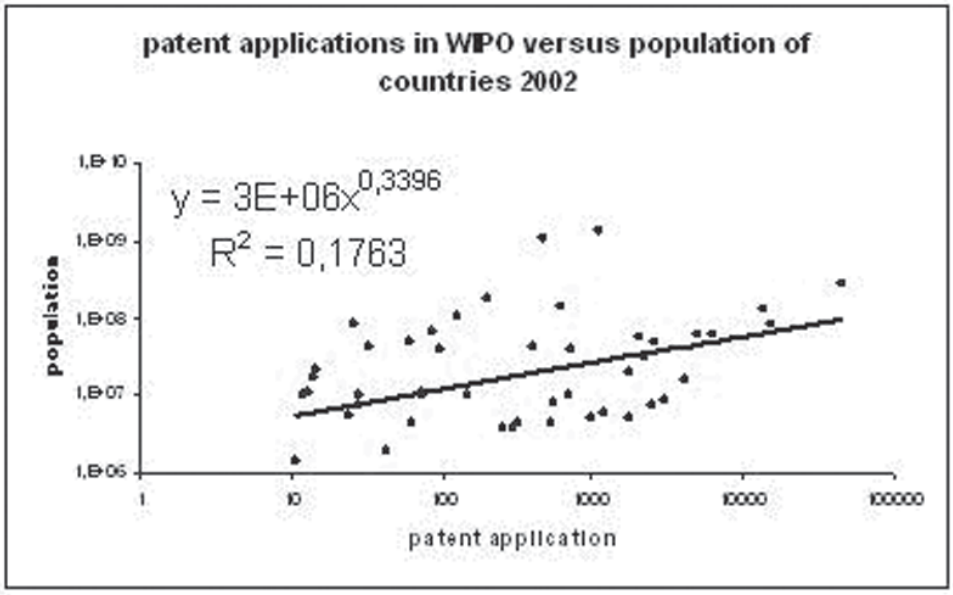


Figure 7. Population versus patent application in the WIPO by 49 most productive countries in 2002 / Población versus solicitud de patentes en la WIPO por parte de los 49 países más productivos en el 2002.

Results

Analysis of data showed that more than half of all patent applications (58%) as well as granted patents issued by USPTO through 1965-2005 belong to the USA; the portion of other countries throughout the study is 42%. The number of patent applications as well as the number of granted patents from 1965 to 1985 by USA decreased slightly, whereas the number of patenting activiety by other countries (all countries excluding the USA) during the same period increased slightly. It indicates that the portion of scientific activity for the countries all around the world since 1965 has begun to increase. Since 1986 the number of patent applications as well as the number of grated patents by the USA and other countries enjoyed a sharp increase. Analysis of data indicated that the USA is the leading country filing patents as well as granting patents, followed by Japan, Germany, U.K., France and Canada.

Analysis of data further showed that, there is a strong correlation between the productivity of a country in the term of patent application as well as scientific publication and GDP. Most probably the positive effects of innovation activities in the countries percolate through

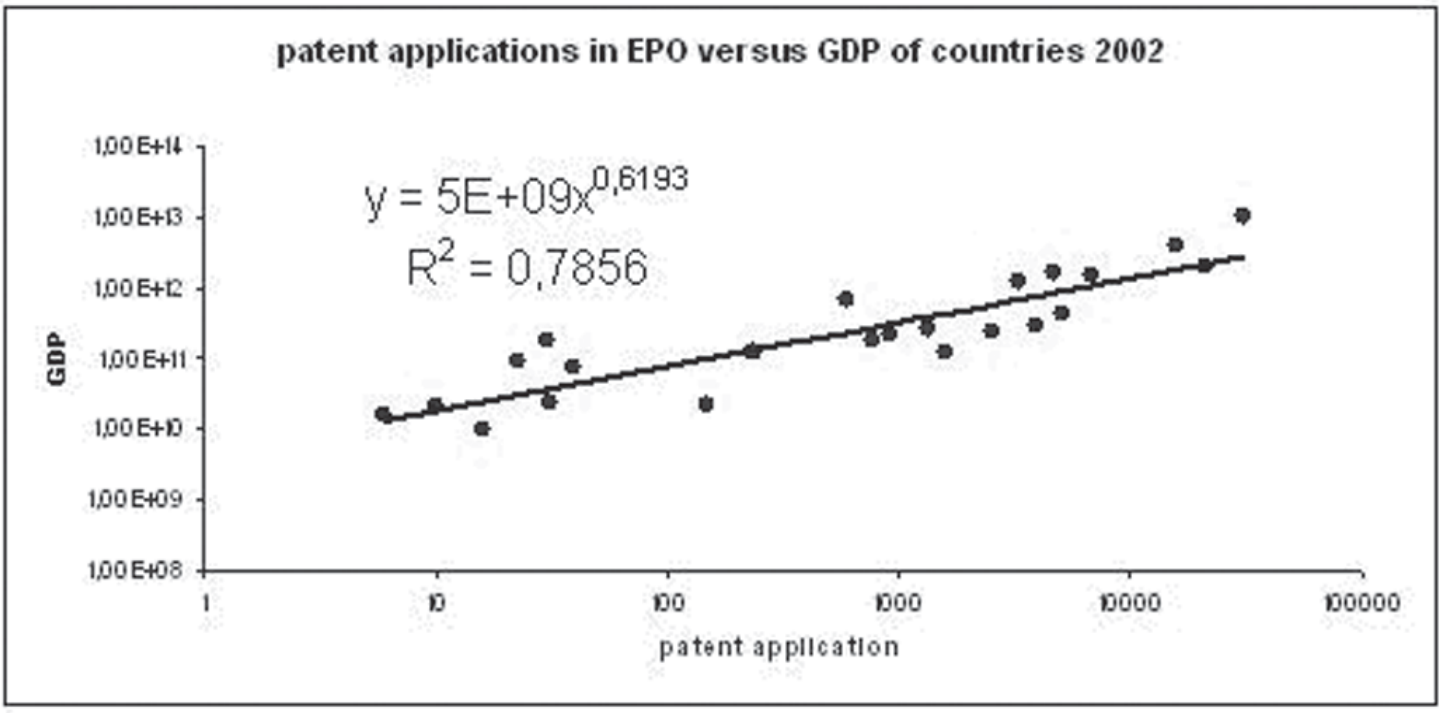


Figure 8. Patent applications in EPO versus GDP of countries in 2002 / Solicitudes de patentes ante la EPO versus el PIB de algunos países en el 2002.

the economy of countries and increase income raise the potential for new investments and innovations.

This relationship is a valuable exploration, it makes possible to predict one country's patent application quantity or innovation activity through analysing its GDP and vice versa.

The findings of study indicated that there is a weak correlation between the amount of patent applications and the size of population in the countries. The reason probably is that the money for science is more important than the number of people in not sufficient educated countries. The number of patent applications in the countries has a strong correlation with the number of publications in the SCI.

Acknowledgment

Special thanks to Setare (Sahar) Biglu

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Recibido: 22 de julio de 2010.
Aprobado en su forma definitiva:
15 de octubre de 2010

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