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Global Leadership in Production of Patents

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Abstract: Among all countries, USA, China and Japan appear with the largest level in the production of patents; the generation of patents reflects a significant part of the economical development of a country, and also this activity is intrinsically related to the intellectual capital of an organization. This study focuses on the statistical comparison of this activity for the cluster of countries with the highest production of patents (based on annual data) for the period 2005-2010; a nonparametric statistical method was selected (whose justification is explained) to perform the comparisons, and a diagram of parameters is shown to facilitate the comprehension of the factors involved in this process.

Key words: production of patents; annual growth rate of patents; box-plot; Friedman test
JEL code: O30

1. Introduction and Background

The production of patents can be viewed as a process that provides successful strategies to promote new standards in economic development; the patent represents a structure to protect the intellectual property. The business organizations and/or enterprises from countries with low-income economies are facing another challenge to their competitiveness through an invasion of technology originated from countries like United States of America (USA), China and Japan, whose leadership in the generation of patents are present in this period of global competence.

Technology has always been the changing force for mankind (Close, Humphrys and Ruttenbur, 2000); The main factors affecting the production of patents are the governmental policies (non-bureaucratic decisions that reflect allocating resources (grants) to support research), the technological tools (computer labs, physical, chemical and biological labs, networking infrastructure, etc.) and as well as the social environment (collegiality, collaboration and culture of the people doing (and/or supporting or advising) research, see Figure 1; where the intellectual capital represents the knowledge of the researchers or investigators that are responsible of the research projects.

Talking about technological tools, for example Cisco Systems is one of the largest corporations of e-Learning users that explains its compromise with the e-Learning's components; whose "components" can include content delivery in multiple formats, management of the learning experience, and a networked community of learners (online-learning), content developers and experts (intellectual capital); where e-Learning provides faster learning at reduced costs, increased access to learning, and clear accountability for all participants in the learning process.

In today's fast-paced culture (social environment) organizations that implement e-Learning provide their

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work force with the ability to turn change into an advantage (Kirschner and Paasa, 2001). In this context the differences between e-Learning, and online-learning should be noted: e-Learning represents the whole category of technology-based learning, while online-learning is synonymous with web-based learning; in order to be more precisely, online-learning is in fact a component of e-Learning. Thus, we can sketch a definition of e-Learning as a delivery process of knowledge, through different electronic media technologies including internet (Pena-Sanchez, 2010), intranet (Clyde, 1999), extranet, satellite broadcast, audio/video tape, interactive TV, CD ROM, etc.

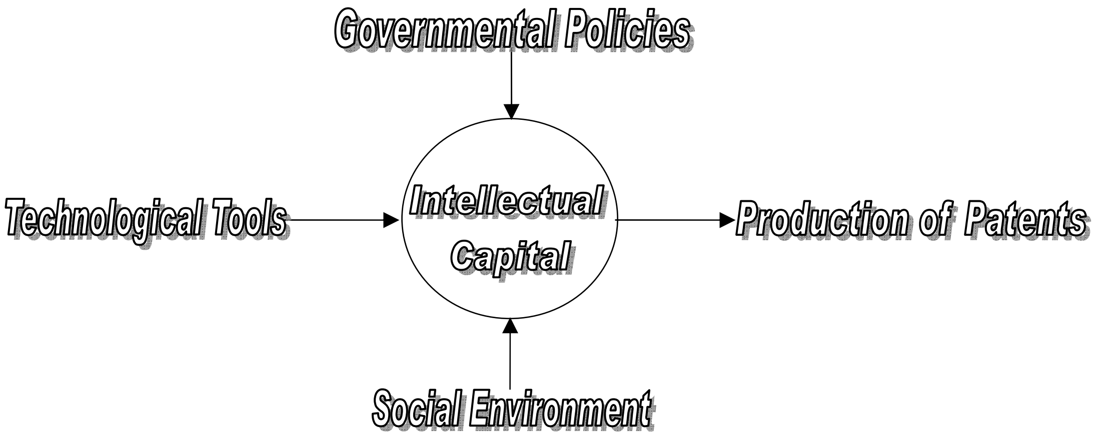

Figure 1　Diagram of Parameters for the Production of Patents

The availability in e-Learning helps us increase access to training and ensure that it is immediately relevant and cost-effective. Some advantages of online-learning include: Anywhere, Anytime, Anyone: e-Learning is available 24 hours a day, around the world. Organizations can distribute training and important information (Glauser, 1984) to multiple locations easily and conveniently, allowing employees to access training at their convenience (Pena-Sanchez, 2007).

Since geographical and time barriers are virtually removed, e-Learning is no longer limited to a few people who can travel to a seminar or conference. E-Learning can occur throughout organizations and e-collaborative individuals, accelerating the transfer of knowledge (intellectual capital), and transforming learning from an isolated example of qualified development into a powerful tool for managerial decisions.

2. Objective

The main objective of this article is to examine the generation of patents (resident regional applications) for the period 2005-2010 among the three countries (USA, China and Japan), which are the largest producers of this activity highly related with the economic development.

3. Research Hypotheses

About the production of patents for the three countries (USA, China and Japan) during the period 2005-2010, Japan shows a significant different average number of patents (ANP) with respect to the other two countries; then, the research (alternative) hypothesis can be specified as

H_{A1}: Japan $_{ANP} \neq$ USA $_{ANP} \neq$ China $_{ANP}$

For this case its corresponding null hypothesis is

H_{01}: Japan $_{ANP}$ = USA $_{ANP}$ = China $_{ANP}$

About the annual growth rate of patents for the three countries (USA, China and Japan) during the period 2005-2010, China shows a significant different average annual growth rate (AAGR) measured in percent with respect to the other two countries; then, the research (alternative) hypothesis can be specified as

H_{A2}: China $_{AAGR} \neq$ USA $_{AAGR} \neq$ Japan $_{AAGR}$

Then, in this case its corresponding null hypothesis is

H_{02}: China $_{AAGR}$ = USA $_{AAGR}$ = Japan $_{AAGR}$

Calculating Percent Growth Rate:

The percent change from one period to another is calculated from the formula indicated inside Table 1.

Table 1 Components of the Formula for Calculating Percent Growth Rate (GR)

$GR = [(V_{Present} - V_{Past}) / V_{Past}] \cdot 100$	
Component	Concept
GR	Growth Rate measured in percent
$V_{Present}$	Present value or the value at end of period
V_{Past}	Past value or the value at beginning of period

Source: http://www.ehow.com/how_4532706_calculate-growth-rate-percent-change.html.

4. Data, Methodology and Results

This research is supported by secondary type data from various sources: journal articles and technical reports, such as the publications from the World Intellectual Property Organization (WIPO).

Table 2 Number of Patents Resident Regional Applications per Country, 2005-2010

Country	Year					
	2005	2006	2007	2008	2009	2010
USA	207,867	221,784	241,347	231,588	224,912	241,977
China	93,485	122,318	153,060	194,579	229,096	293,066
Japan	367,960	347,060	333,408	330,110	295,315	290,081

Source: http://www.wipo.int/ipstats/en/wipi/.

Table 3 Annual Growth Rate (%) of Patents per Country, 2006-2010

Country	Year*				
	2006	2007	2008	2009	2010
USA	6.70	8.82	-4.04	-2.88	7.59
China	30.84	25.13	27.13	17.74	27.92
Japan	-5.68	-3.93	-0.99	-10.54	-1.77

Note: *The Annual Growth Rate for year 2005 depends on 2004, which is not available.

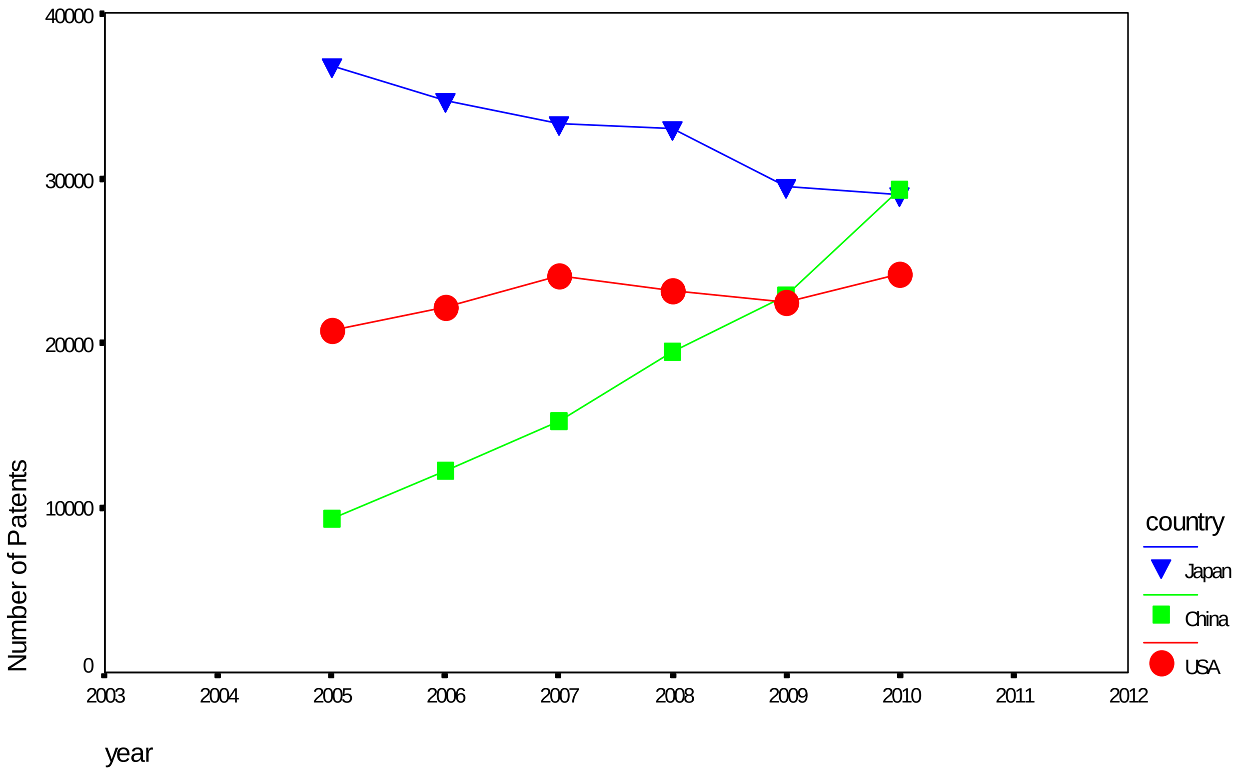

Figure 2 Number of Patents per Country, 2005-2010 (see Table 2)

From Table 2, for the year 2006 in the case of China, its percent annual growth rate was calculated according to the formula previously described:

China $GR_{2006} = [(V_{2006} - V_{2005}) / V_{2005}] \bullet 100$

China $GR_{2006} = [(122{,}318 - 93{,}485) / 93{,}485] \bullet 100$

China $GR_{2006} = 30.84$

An identical procedure was used to calculate all the values in Table 3. One consideration in determining whether a parametric or a nonparametric (Pena-Sanchez, 2005) method should be used is the set of assumptions about the population probability distributions from which the data was obtained. For example, in order to use the analysis of variance (ANOVA), which is a parametric technique (Cooper and Schindler 2008), the “response” variable must be normally distributed for each population. Moreover, two other required assumptions are: the observations represent independent random samples from the populations (Factors) under study; and the variance of the response variable must be the same for such populations, this last assumption is called “homoscedasticity”.

In order to avoid any risk imposed by the parametric techniques if their assumptions are not valid (Levene test for Homogeneity of Variances (p-value = 0.009, which implies to reject H_0 at alpha = 0.05) for data on Table 2), we decided to use a nonparametric statistical method to test the null hypotheses: the analysis was performed via the Friedman test (Conover, 1999), where the treatments are the “countries” and we have been using the “year” as the blocking factor; the results of this test are shown in Table 4.

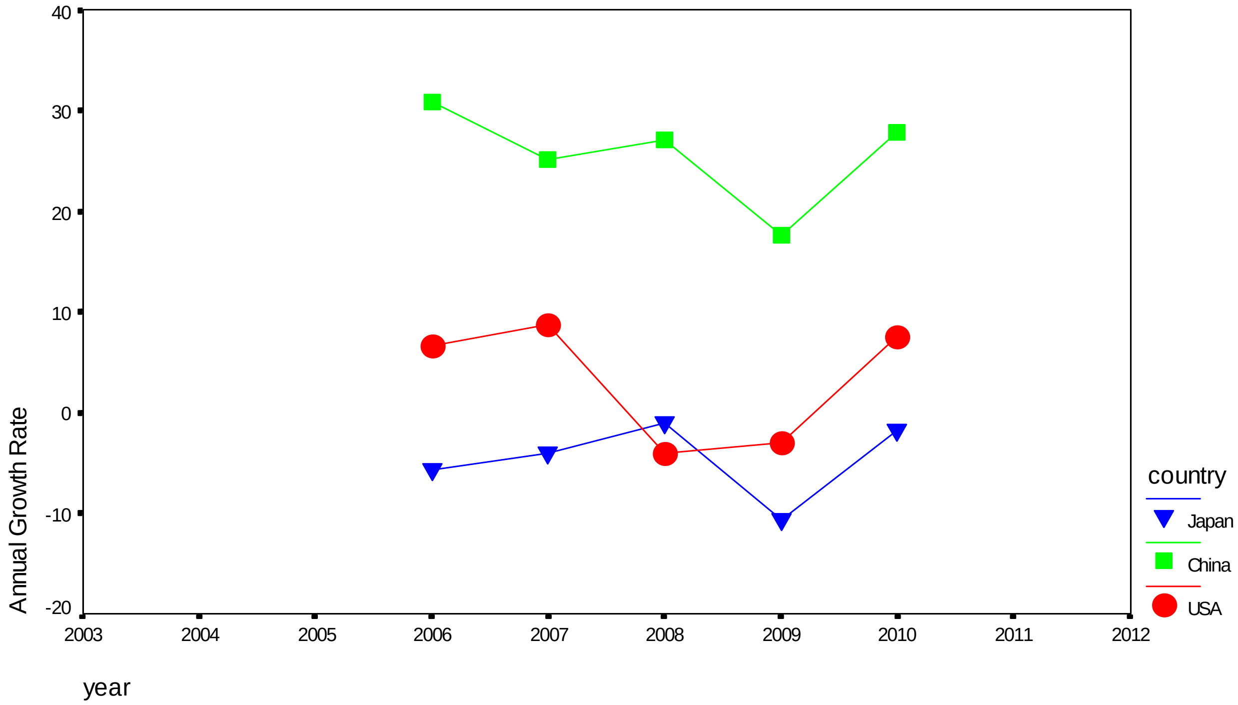

Figure 3 Annual Growth Rate (%) of Patents per Country, 2006-2010 (see Table 3)

Table 4 Friedman Test for the Three Countries USA, China and Japan

Variable at Ho	Cases (n)	Degrees of Freedom	Chi-Square	p-value
Number of Patents	18	2	36.0000	< 0.001
Annual Growth Rate	15	2	22.5333	< 0.001

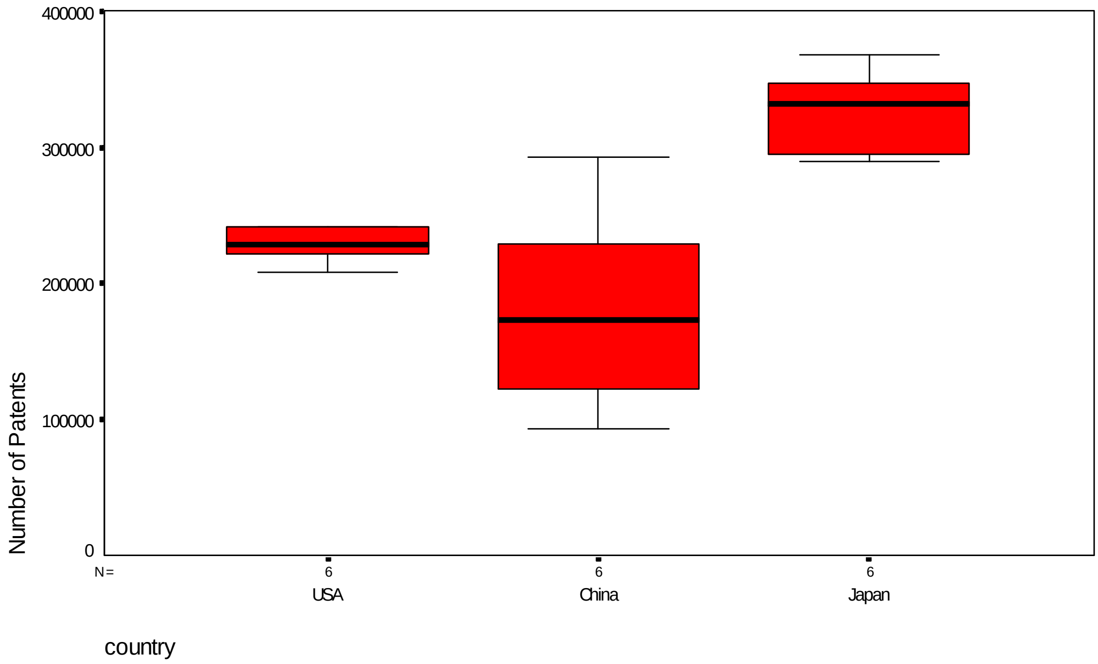

Figure 4 Box-Plots for the Number of Patents per Country, 2005-2010

In descriptive statistics, the box-plots are graphical representations of numerical data sets; the box-plots are nonparametric tools: Display differences between groups of numerical data without making any assumption of the underlying statistical distribution; this tool helps to identify outliers and to indicate the degree of variability (dispersion) and skewness in the data. The box-plot is a graphical display of a five number summary: The minimum value, the first quartile (25th percentile), the second quartile (50th percentile) also known as the median (the horizontal line that splits the box is at the median), the third quartile (75th percentile) and the Maximum value.

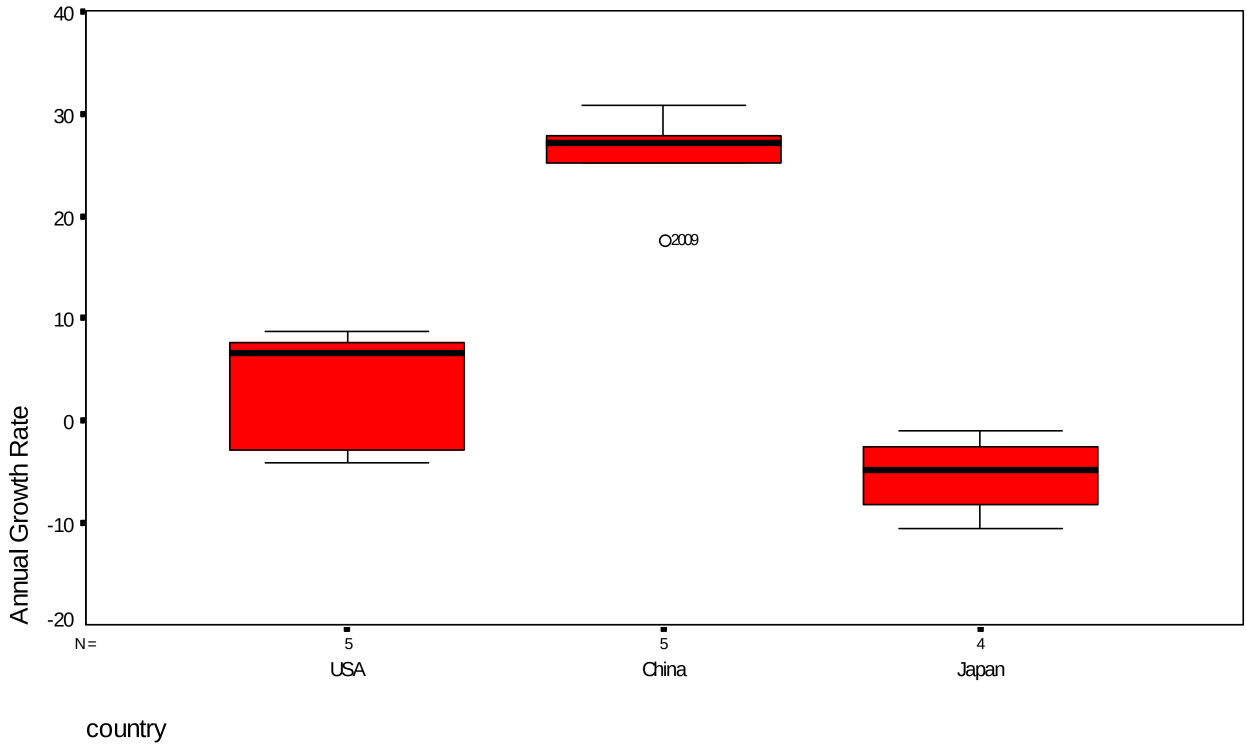

Figure 5 Box-Plots for the Annual Growth Rate (%) of Patents per Country, 2006-2010

5. Directions for Further Research

These findings should influence public (governmental) and private authorities responsible of research and development programs to design less bureaucratic and collaborative strategies that really motivate the generation of patents. As educators and researchers, we all should seek the most effective and efficient tool (Jones and Madden, 2002) for basic academic competences, as well as for collaborative tasks (McEntee and Pena-Sanchez, 1997).

It is hoped that this paper will foster more research into the relationships (Hilton, 1999) between governmental policies, technological tools, social environment, intellectual capital and the generation of patents (see Figure 1); so that more effective and efficient decisions will occur both in public and private organizations whose agendas include research and development (Sitkin, Sutcliffe and Barsios-Choplin, 1992); for example, the organizational culture (Deem, Barnes, Segal and Preziosi, 2010) as part of the social environment plays a critical factor in the motivational aspect.

6. Discussion and Conclusions

We have been trying to explain through Figure 1 the description of the main factors involved in the generation of patents. One the contributions of this article is precisely Figure 1, which is presented as a diagram of "parameters"; this diagram enables a research team to identify and review signal factors (technological tools), control factors (governmental policies), and noise factors (social environment) that affect the intellectual-capital's ideal activity. This result in creating an understandable and well-defined intellectual-capital function in terms of a measurable objective: the production of patents.

Thus, from Figure 1 we can view that the production of patents can be transformed in a sustainable process (Rusinko, 2005).

It is clear that China has been planning a policy to stimulate its technological development to pass from being a poor economy to one of maquila or maquiladora based economy, and subsequently to be positioned as one of a technological innovation (Wang, Ahlstrom, Nair and Hang, 2008) with high levels of incomes.

From a global point of view, the group conformed by USA, China and Japan is the cluster of countries with the largest production of patents; below this cluster appears South Korea (Republic of Korea), whose registration of patents is enumerated as 131,805 for the year 2010, below South Korea appears Germany with 47,047, and downward is the Russian Federation during the same year 2010 with 28,722 registered resident regional patents (WIPO, 2011).

Our conclusion supported by a nonparametric (Conover, 1999) statistical method through the Friedman test (p-value < 0.001 on Table 4 permits the rejection of both null hypotheses) is that the average annual growth rate (AAGR) measured in percent for production of patents in China exceeds the averages reached by USA, and Japan during the period 2005-2010. Thus, in terms of the number of patents: the leadership corresponds to Japan (Figures 2 and 4); but in terms of the percent annual growth rate: the number 1 is China (Figures 3 and 5).

About the linear long-term trend of the data in Figure 2, Japan shows a decreasing tendency, which is also reflected in Figure 5 with a decreasing annual growth rate; while the opposite behavior is shown by China with an increasing tendency about the production of patents.

From 2005 until 2008, USA appears in the middle position between China and Japan, later on during 2009 and 2010 China was exceeding to USA; then, we can understand the pressure from above and from below according to the data in Figure 2; thus, this pressure may be transferred to organizations and their researchers in the form of competitiveness; at this point will be very relevant to define an appropriate methodology for the distribution of economic resources to support to those researchers that have a compromise with the generation of patents that really represent tangible benefits.

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