Vol. 03, No. 1 (2021) 53-64, doi: 10.24874/PES03.01.006

Proceedings on Engineering Sciences

www.pesjournal.net

THE NEW WORLD ORDER OF TECHNOLOGY AND INNOVATION: AN ANALYSIS OF HOW THE INVESTMENT ON INNOVATION BASED IN ARTIFICIAL INTELLIGENCE CAN MODIFY TODAY'S INDUSTRIAL PROTECTION MEANS

Giuliano Carlo Rainatto[1]
Orlando Roque Silva
Norberto Almeida de Andrade

Keywords:

Invention; Intellectual property; Artificial intelligence; Machine learning; WIPO

A B S T R A C T

There is no acceptable definition for artificial intelligence (AI), one of which is that it is a computer system capable of solving complex problems (World Economic Forum 2018). The WIPO AI report and the highest order fields AI was the starting point for the construction of this exploratory, statistical study with surveys of WIPO, UNESCO, World Bank databases. The dichotomous assessment of how artificial intelligence can modify the protection system of innovations and especially the that has been done to adapt innovation protection systems to the new adjacent possible (Tria et al, 2017) created by this new technology. The institutions studied do not yet have a definition of how to protect inventions generated by AI in all environments and Investments have been made to understand how to patent these inventions. To measure the return on investment in research and Development is the volume of patents granted by the technologies studied, Asian countries studied hold 57% of the total high technology publication, compared to the traditional western countries, and this shift from high technology studies migrating from 2003-2004 to the East, indicates a polarization of technology exclusivity impelling the beginning of the "possible" new world order.

1. INTRODUCTION

This article seeks to analyze how artificial intelligence can modify existing protection means, using the data presented by WIPO reports. These reports show us that there are 3 main fields of research using artificial intelligence, telecommunications, transport and medical technology.

The objective of understanding how artificial intelligence evolves in the volumes of patent applications and understanding how we can analyze the efficiency of countries in investing resources compared to the volume of results presented by innovation.

These objectives guided the studies and presented nominative results on the presented volume of

[1] Corresponding author:Msc. Giuliano Carlo Rainatto
Email: Giulianorainatto@yahoo.com.br

productions involving artificial intelligence, as well as the identification of a high volume of protection requests in the East.One way of evidencing the studies was through the use of the values used in R&D, their volumes of researchers influenced the research because they demonstrate the interest of the countries in innovating in the researched fields.

2. THE INNOVATION CYCLES AND ITS PERIODS

When we look for innovation, we soon think about how to protect it or how we can achieve financial results through individualizing the invention. Among the economists, who began their research on innovation waves and innovative ways, Kondratiev made his contribution by discovering the existence of innovation waves through historical series analysis, pointing out that every wave is related to a specific sector of innovation state-of-the-art technologies or systems.
His method was considered retrospective because it was an evolution in waves presented in the past, with durations of 50 years. In his attempt to find answers to future demands, he did not try to build an approach that would allow the construction of a model for forecasts. Another economist presenting waves, but of smaller amplitude, was Kuznets (Korotayev & Tsirel, 2010), who empirically found cycles of 15 to 30 years.

The first to highlight the works of waves was Schumpeter, who in his Business Cycles study named the waves of technological evolution as Kondratieff waves.

The cycle proposed by Kondratieff in his study showed that in the 1970s and 1980s there would be a wave of technological evolution in information and telecommunications. This cycle has been confirmed because information technology has evolved greatly since the 1980s (Yegorov, 2011) and, more recently, with the evolution of data storage and processing technologies such as big data, data mining and the artificial intelligence enhancement, driven quickly by the improvement of machine learning, deep learning algorithms.

This cycle that began in the 1980s and arrives today with the advance of artificial intelligence brings a challenge that has never been met before. Industrial and intellectual protection accompanies technological evolution since its inception (Hoovenkamp, 2016) in 1880 at the Paris Convention, but how to continue using protection methodologies when a machine demonstrates inventive activity independent of human action leading to the creation of something innovative?

This paradigm has been discussed by both protective sides, which are the patenting bodies governed by the World Intellectual Property Organization - WIPO, and also by the innovator side, on this account since the creation, the inventors want the exclusive exploitation of their inventions (World Economic Forum 2018).
Tria et al. (2017) states that "the introduction of a new idea expands the possibility of exploring new concepts and once introduced the new idea has to compete with other concomitant ideas". This statement gives us the idea that there is a near future when the evolution of technological maturity can lead us to a next new phase of innovations and inventions. The author reduces creation as the next "adjacent possible", meaning the next big step for invention or innovation lies in the maturity and knowledge of the technology that will be presented.

2.1 Modalities of protection of an invention

Patents have started to be disseminated in Greece (Dirpa, 2007), as the need to make clear who came up with each idea helped people denote protection for each invention. The first agreement related to patent protection was signed in Paris in 1883 (WIPO, 2019), there were signed agreements related to patents, trademarks, industrial designs and utility models (refers to the new utility of an existing product). It deals with agreements such as national treatment, that is, each signatory state to the agreement has the right under the convention. It was by agreeing on the right of priority where it was agreed that the invention is up to those who first present it to the regulators of industrial protection.

The Paris Convention, which was concluded in 1883, underwent to several revisions until its acts were finalized at the Stockholm Convention in 1979. One of the highlights adopted by the latest conventions is the Patent Cooperation Treaty (PCT), a system that can protect the inventions in the signatory countries of the agreement without the need to address to each country, the same is done by the office and origin of the applicant. As a result of this treaty, patents are now defined as:

“An official temporary title deed granted by the STATE by law to its proprietor or his successors (person or entity), who now has exclusive rights over the property, whether of a product, a manufacture process or improvement of existing products and processes, objects of patent. Third parties may exploit the patent only with the permission of the holder (license). During the validity of the patent, the holder is rewarded for the efforts and expenses expended in its creation. ” (Wilkinson & Bevir, 2007).

There are two types of protection, the invention patent which is the protection of an innovative construction of a product, which has never been seen before, and declared in the state of the art not compatible with anything in national and international searches. Or the utility model patent which is a presentation of a new way of protecting an invention that results in a functional improvement in its use or manufacture.

In addition to the patent there is the protection of a computer program. According to WIPO, "Computer program is the expression of an organized set of instructions in natural or coded language, contained in physical media of any kind, necessary for use in automated information processing machines, devices, instruments or peripheral equipment, based on digital or analog technique, to make them work in a manner and for a specific purpose "

The program is a set of instructions written in a specific language to be used by a computer to achieve a specific result, rights protection covers all expressions in the computer program. The rights related to computer programs are independent of registration, but their registration ensures greater security in the event of judicial demand, and the protection is not territorial but international in all 176 signatory countries to the Berne Convention 1886.

Software patenting law is not internationally harmonized, i.e. some countries recognize software patents and others adopt approaches that recognize software-assisted inventions.

From the 1970s, WIPO began to study software protection, including object code, source code, and documentation. In the mid-1980s, meetings were held to address the protection aspects of computer programs, treating them as copyright. (Wipo 2019) .Although there are several types of protection, none of them still adequately treat artificial intelligence products, limiting them to dealing with embedded artificial intelligence as part of a product whether tangible or not.

Artificial intelligence

According to the World Economic Forum (2018), there is no singular definition of artificial intelligence, some define it as a computerized system that exhibits behavior normally as a human intelligence, others define it as a rational system capable of solving complex systems and seeking to solve problems of the real world.

AI as machine learning, or ML, is an important tool in today's scenario that has grown exponentially since its deployment in the early 1950s at Dartmouth University at a conference on new computer ages proposed by John Maccarthy (NORDON 2019), 60 years later with vorticose growth we have a new era of computers where mathematical algorithms are governing digital market norms and behavior analysis of consumers.

Since the 1980s and 1990s humans have been tested against the evolving power of machines (Wipo 2018). The various man-machine disputes between Gary Kasparov and IBM's Deep Blue computer in 1996 mark the beginning of the application of artificial intelligence in increasingly complex environments, and more recently there have been a few more tests involving skin disease anamnesis history adopting a Google algorithm that was able to analyze 129,450 images of 2,032 different diseases, with clinical images that had already been biopsied, against some medical specialist with a different level of competence, resulting in a level of accuracy equal to the experts (Tull & Miller, 2018).

In the early 2011 (IBM, 2019), another tool was introduced to the world: the IBM-created Watson computer with 2880 processing cores, with over 100 algorithms analyzing issues with a high processing volume. The program chosen for the presentation was Jeopardy (a question and answer program), where the computer competed against event stars Ken Jennings and Brad Rutter, defeating both.

Artificial intelligence is starting to be a tool for companies to innovate in a staggering way, WIPO's 2018 report under the name "the history of AI" brings a glance of the artificial intelligence history in worldwide patent applications and listed 3 (three) important fields of study on innovation in artificial intelligence, such as telecommunications, transportation, and medical sciences. These 3 fields were selected to highlight the growth of the highest technology deposits studied today in the world.

Methodology

This paper considered a survey in the databases of WIPO, the World Bank, and UNESCO (UIS Statistics 2019) . The database scans were inherent to the article processes referring to the three fields that are being studied for surveys and improvement of the article with technical-theoretical basis. WIPO databases requested data on patent concessions from 2000 to 2017, as well as the granting of patents for the telecommunications, transport and medical sciences fields for the same years. In the World Bank repository, the R&D investment percentage data for each country in the research groups, as well as the GDP figures from 2000 to 2017. Unesco data served to list the number of researchers per million inhabitants in each research country.

Research Description

The countries were separated into groups based on the continents surveyed and their patent productions were added over the period 2000 to 2017. In group 1 Brazil was added because it is the country that publishes most patents in South America. These countries are the most patent publishers that could be analyzed using the methodology proposed.

Group 1 - Named AMERICAS, and includes the following countries, United States, Canada, Brazil.

Group 2 - Named ASIA, and includes the following countries, China, Japan and Republic of Korea.

Group 3 - Named EUROPEAN UNION and contains 28 countries of the European Free Trade Agreement, Austria, Belgium, Bulgaria, Cyprus, Croatia, Denmark, Slovakia, Slovenia, Spain, Estonia, Finland, France, Greece, Netherlands, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Czech Republic, United Kingdom, Romania, Sweden.

In a first evaluation the values of GDP and investments in research and development (R&D) of the countries belonging to the selected groups were surveyed. This data is important in identifying the amount that is being invested in research and development (Figure 1).

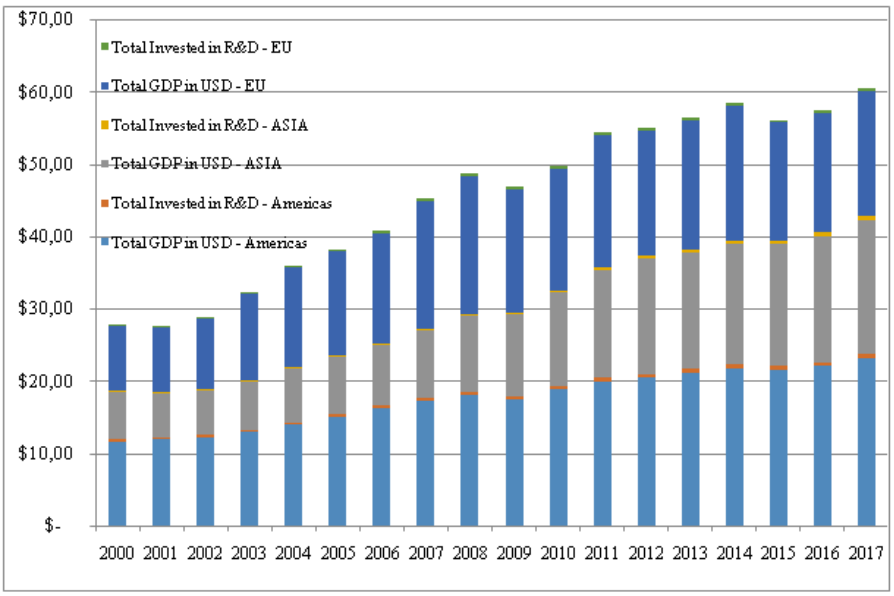

Figure 1. Total GDP by year and total R&D Invested. Source: Authors Research (2019)

Group 1 countries have a combined GDP of $ 23.18 trillion, with an R&D investment of $566 billion. Group 2 countries have a combined GDP of $ 18.54 trillion and a R&D investment of $ 474 billion, and finally Group 3 has a GDP of $ 17.25 trillion and a R&D investment of $ 352. billion dollars, all invested in 2017, according to data extracted from the survey.The technology fields were separated by patent volumes granted from 2000 to 2017 and were included to each research groups.

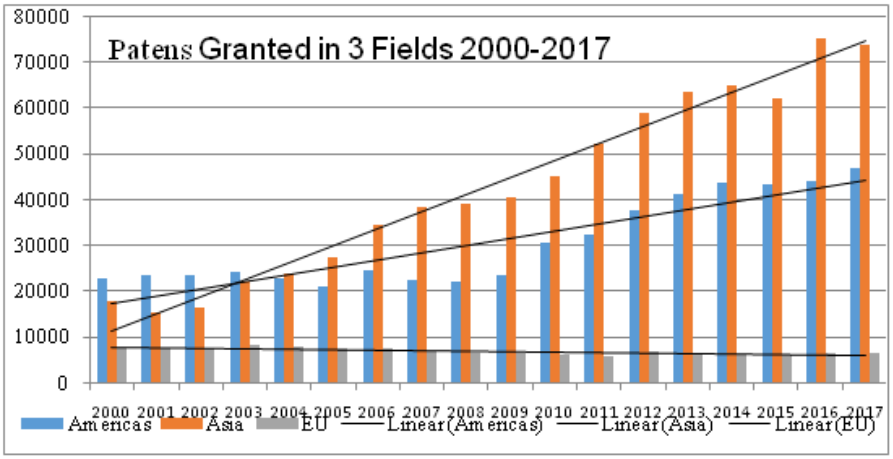

Figure 2. Total patents granted in 3 fields of study. Source: Authors Research (2019)

We can identify an increase of patents granted in group 2, compared to group 1, and, group 3 presented a decrease in patents volume granted in the 3 technological fields studied. An important analysis of the research was based on the efficient use of resources applied in research and development of technologies, calculating the approximate cost per high technology patent issued. By assessing this scenario, we have been able to evidence that Group 2 countries are being able to use resources more effectively in granting patents in general to countries in other groups.

In 2017 Group 1 obtained 348,378 total patents in all fields of study, and, in the three fields covered by this

research a volume of 47,164 patents were obtained. Group 2 obtained a total of 740,383 patents in 2017 and a total of 74,096 in the three fields of research. Group 3 obtained a total of 51,778 patents from all fields and 6,729 patents in the fields covered by the survey in 2017.

The different patent volumes found in all fields of study as well as the fields covered by this research led us to understand which factors are related and correlated so that this production has varied so much in the last 17 years. Statistical correlation was used in the following fields of study:

- Patents Granted x Total R&D Investment
- Total researchers x Total patents granted in the 3 fields of the article

Statistical studies lead us to the series of results shown in Figure 3.

Statistical Correlation

GROUP	**Patents granted x Total USD in R&D**	**Total Researchers x Total Granted 3 fields**
AMERICAS	0,87934421	0,658041074
ASIA	0,98786315	0,983171052
EUROPEAN UNION	-0,5083	-0,837777002

Figure 3. Statistical Correlation. Source: Authors Research (2019)

By analyzing the correlation, we can identify that in groups 1 and 2 there are strong correlations between the analyzed patent data that were granted, and the total volumes of resources invested in general research and development, i.e. in all existing research fields of WIPO and World Bank database. Correlation results obtained from data analysis of total researchers per million and patent grant volumes in the 3 (three) groups selected by the survey identified that in Group 2 the correlation is much stronger (0.98) than Group 1 data (0.65), demonstrating a very high possible investment in the high technology demands involving Artificial Intelligence.

The data from group 3 show a strong negative relationship between the granted patent volumes and the invested amount leading us to believe that the European Union acts strongly in basic science research where patents are not commonly used. Group 2 with strong correlations presented acts directly in the production of researches that are converted into patentable products or processes due to their strong indicators.

By analyzing the correlations and their dispersions and the data collected (Appendix) we have reached one of the crucial points of the research, how efficiently each country can achieve in producing patents, and in producing high-tech patents. The p-factor analysis was performed and we were able to identify levels of 0.0017, 0.0019, 0.0023 showing that the results identify a high significance of the data, showing them conclusive. All the analysis we understand that time affects the others years of investment, so the use of a long range of data minimize de Gap's that could be found on the measurement and return os patent production in these three specific fields.

Group 2 countries cost approximately $ 640,000 per high-tech patent, Group 3 costs approximately $ 6.81 million per high-tech patent, and Group 1 countries cost approximately $ USD 1.62 million per high technology produced patent (Figure 4).

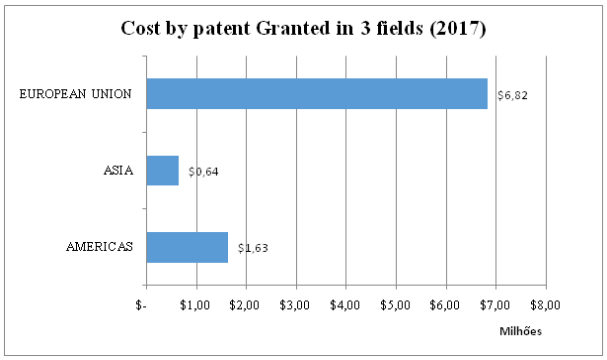

Figure 4 . Cost for high tech patents.
Source: Authors Research (2019)

The assessment of the importance of artificial intelligence in the three fields is latent, it can be identified that the first economy countries are acting strongly to be at the forefront of new technologies.

According to UNESCO (2018) the United States invests in research and development a total of 2.7% of its GDP, Japan invests 3.4%, China invests approximately 2% and Germany invests a total of 2.9%. These resource volumes are divided between government applications and investments by mostly private entities.

The Brazilian Profile of innovation is still slightly lower than the volumes presented by these countries, Brazil invests approximately 1.3% of the total GDP. This number may seem very close to the first economy countries, but the size of the Brazilian territory makes it difficult to approximate the volume of investments to be translated into innovations and future patents. We can see that in the fields identified as the next technology demands Brazil still has a very small volume of patents on the subject.

A discussion should be started at the academy, how to protect the inventions that artificial intelligence will produce and also, who is leading these technological innovations? How can we identify that this comes from a machine and not from the human mind? In this context of creation, intellectual and industrial protection must be modified to the point of being able to highlight and differentiate, in order to not be a plagiarism of creation itself.

Patents Evolution in the researched fields

Analyzing the innovation demands of major countries; the last 15 years have shown a shift in protection volume and speed. According to the World Intellectual Property Organization (WIPO), over the past 17 years, first economy countries have evolved their patent application volumes by numbers as seen in the Figures 5, 6, 7.

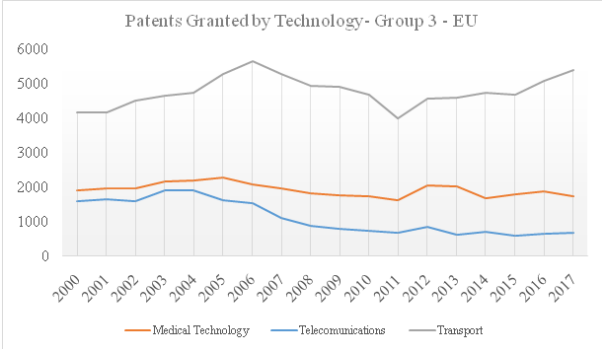

Figure 5. Group 3 patents granted by technology from 2000-2017.
Source: Wipo Statistics for researchers (2019)

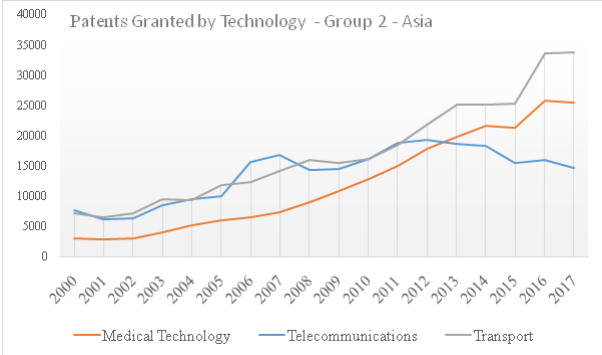

Figure 6. Group 2 patents granted by technology from 2000-2017.
Source: Wipo Statistics for researchers (2019)

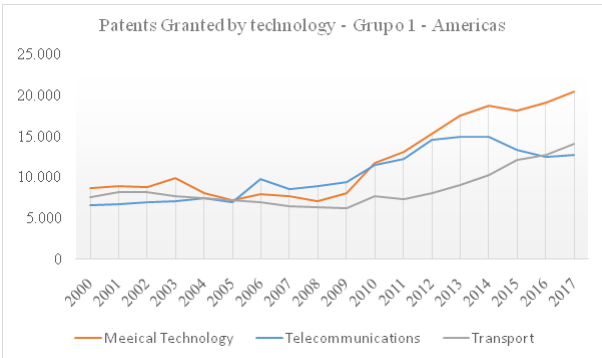

Figure 7. Group 1 patents granted by technology from 2000-2017.
Source: Wipo Statistics for researchers (2019)

The production of the researched groups showed a breaking point in the years 2003 - 2004, from there the countries of Group 2 (Asia), started to produce a higher volume of patents considered of high technology, compared to the evolution of the countries of group 1. (Americas) in patent volume. This patenting is justified around investments in areas related to research and development, education and infrastructure. These areas have had a broad vision for investment, but as the protection agencies have been working on the subject of high-tech patent protection involving I.A, it is an important focus to address.

3. DISCUSSION ON PROGRESS IN PROTECTION A.I's CREATIONS

The protection of inventions based on artificial intelligence has been discussed in all systems, in the EPO - European Patent Office (Veitengruber 2018) ML algorithms are the main issues because they understand that the algorithms are like computer source code that can be protected by copyright, being excluded from patent protection because they are mathematical processes, but with the human's inference in data programming, it returns to the discussion of its patentability (Conference EPO 2018). The protection agency also has some rules for patenting these new mixed protection systems, the so-called "Two Hurdle system", where they first wonder if AI contributes to the technical character of the invention, and then how AI or ML alters the technical effect that a patent promotes.

The United States Patent Office (USPTO) has an uncertainty in the implementation of patent sector 101, which defines the types of patentable items for this new AI protection modality, where the agency is still studying a sustainable solution for AI-based inventions, and also the validity of the patents generated by this innovation.

The Japan patent office (JPO) system indicates that inventors must comply with the protection criteria for patentability, within which an inventor's personality and creative process are necessary, but the challenge now is to provide sufficient evidence.

The rules of the Brazilian system provided by the INPI (National Institute of Intellectual Property, are provided in law 9.249 / 96 the so-called LPI - intellectual property law, having as a necessity the generation of an innovation, that is, the invention is not anticipated by any document providing for something similar to the current request. The second point to note is the inventive act, which is the simple fact that the new product is not easily reached for a patent protection technician, based not only on a simple combination of elements, but that the design has come out of something more complex than simply adjusting a product that can be obtained in previous documents. The third and last point is the industrial applicability, whether the product can be replicated or used in the economic concept of the word.

All systems follow the rules of the Paris convention that began in 1883 and have evolved to this day, with initial

descriptions of a worldwide patent and invention protection system administered individually by its regional offices and then worldwide by WIPO. WIPO is one of seventeen United Nations specialized agencies, whose mission is to lead the development of an international intellectual property system, and to govern a worldwide intellectual property protection system.

WIPO governs international patent cooperation treaties such as the Budapest Treaty, The Hague Agreement, the Lisbon Agreement, the Madrid Agreement, the Madrid Protocol, and the PCT.

4. CONCLUSION

We can list a great content that has been discussed in the protection agencies on how to protect inventions generated by artificial intelligence. Both WIPO and patent offices in each country have been taking steps to understand what was produced by humans and what was produced by the machine (A.I).

Artificial intelligence is much faster than human in analyzing the information available on the internet (Tull & Miller, 2018), but the demand for the protection of the invention follows the traditional process of protocol and identification of steps, one of them being inventiveness, which is the creation by the human being of a product with purpose and unique character and not reproducible by a qualified technician.

The work of addressing who owns the invention created by artificial intelligence continues at a steady pace, but while discussing, much has been evolved by algorithms that understand what is available on the network, i.e. what we discuss today may already be obsolete in terms of how protection should be done.

Ownership of the invention created by artificial intelligence may be who created the M.L algorithm, but when it evolves over the years taking advantage of information from other algorithms created by other people and generating a new invention who will own this new creation? Will you be a Co-op with the other programmers? Considering that a mathematical formula cannot be patented as an invention because it is an abstraction item not accepted by the protection agencies. We identified that there is a transition from what we can identify as new technologies, they involve a high investment to be generated, but resource efficiency is very important to increase the technological bases of the country. It is possible to identify the transition from the technology center of countries from west to east, where the number of patented products involving high technology is significantly larger than the volume produced in both the western and the European Union.

Analyzing the data obtained, we can conclude that 57% (Appendix 2) of the total volume of patents granted in 2017 belonged only to Group 2 and 37% of the same volume to Group1, and the resources devoted to R&D in Group 2, was $ 100 billion less than Group 1, which is a much lower cost to obtain a high-tech patent. These data show that since 2003, the production volumes of the high-tech fields in the Group 2 countries have been growing in more concessions than in the other groups, indicating a new high-tech world order.

There are limitations in exploring this article, where and how new demands will emerge, is as uncertain as when the next technological evolution will happen, but the certainty that Asian countries are investing in technology to be able to aim for market leadership on the global stage is evident.

A suggested analysis for future studies involves what has evolved in these selected countries, and that one can make a correlation to the fast growth of high-tech products, a study of volumes invested in education, or in other sectors on how they contributed to the increase in high technology production for these countries, also what was a determining factor for the countries of the European Union to reduce their production volumes so sharply.

References:

Dirpa (2017). *Manual para depositantes de patentes.* Rio de Janeiro.

Hovenkamp, H. (2016). *The Emergence of Classical American Patent Law. Arizona Law Review*, *58*(2), 263-306. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=116175714&lang=pt-br&site=ehost-live

IBM (2019). *IBM icons of progress. A computer called Watson.* Retrieved from: https://www.ibm.com/ibm/history/ibm100/us/en/icons/watson/ acessed in 09.02.2019.

Korotayev, A. V., & Tsirel, S. V. (2010). *A Spectral Analysis of World GDP Dynamics: Kondratiev Waves, Kuznets Swings, Juglar and Kitchin Cycles in Global Economic Development, and the 2008–2009 Economic Crisis*. Structure and Dynamics, 4(1).

Nordon (2019). *WIPO technology trends. Artificial intelligence*. Retrieved from: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055_exec_summary.pdf

Tria, F., Loreto, V., & Servedio, V. D. P. (2018). *Zipf's, Heaps' and Taylor's Laws are Determined by the Expansion into the Adjacent Possible*. Entropy, 20(10), 752. Doi: 10.3390/e20100752

Tull, S. Y., & Miller, P. E. (2018). *Patenting Artificial intelligence: Issues of obviousness, inventorship, and patent eligibility*. Rail - Journal of robotics, artificial intelligence &law.

UIS Statistics (2019). Unesco database. Retrieved from: http://data.uis.unesco.org/

Veitengruber, H. (2018*) Patenting Artificial Intelligence – Current Practice and Challenges. Ip for business*. Retrieved from https://ipforbusiness.org/epo-conference-patenting-artificial-intelligence-current-practice-and-challenges-now-available-online

Wilkinson, R., & Bevir, M. (Ed.) (2007). *The World Economic Forum. In Artificial intelligence collides with patent law*. Sage Publications Ltd.

WIPO database (2019). *Wipo statistics for researchers*. Retrieved October 7th, 2019, from https://www.wipo.int/ipstats/en/

WIPO (2019). *International IP protection of software.* Retrieved February 9th, 2019, from https://www.wipo.int/edocs/.../wipo_ip_cm_07_www_82573.doc.

World Bank database (2019*). World bank open data.* Retrieved from http://databank.worldbank.org/data/home.aspx

Yegorov, Y. (2011). *Long Economic Waves as innovation Cycles.* Simon Kuznets International Symposium, Kiev, Ukraine

Giuliano Carlo Rainatto
Instituto de Inovação Schumpeter,
São Paulo,
Brazil
giulianorainatto@yahoo.com.br

Orlando Roque Silva
Instituto de Inovação Schumpeter,
São Paulo,
Brazil
Orlandoroque@gmail.com

Norberto Almeida de Andrade
Instituto de Inovação Schumpeter,
São Paulo,
Brazil
Norbertofatecsp@hotmail.com

Appendix - Data of the research from 2000 – 2017

AMERICAS	GROUP	2000	2001	2002
% of GDP in R&D	AMERICAS	5,48679	5,69874	5,50588
Total GDp in USD	AMERICAS	$11.650.061.577.795,50	$11.877.573.452.974,50	$12.202.332.220.346,60
Total os USD in R&D	AMERICAS	$ 289.068.915.437,41	$ 299.891.712.205,74	$ 298.806.667.728,13
Total patents Granted	AMERICAS	172735	181646	177051
Efficiency / patent	AMERICAS	$ 1.673.482,01	$ 1.650.967,88	$ 1.687.686,98
Patents of 3 fields	AMERICAS	22833	23717	23819
Cost of patents	AMERICAS	$ 38.004.399.217,59	$ 39.128.029.669,52	$ 40.569.718.454,76
Total Researchers / million	AMERICAS	7419	7687	7802
Cost by research	AMERICAS	$ 96.567.343,70	$ 95.690.948,86	$ 91.475.034,18

ASIA	GROUP	2000	2001	2002
% of GDP in R&D	ASIA	5,97908	6,25324	6,34562
Total GDp in USD	ASIA	$ 6.660.499.656.190,09	$ 6.175.992.055.021,55	$ 6.194.686.348.663,78
Total os USD in R&D	ASIA	$ 165.080.329.630,37	$ 152.967.934.688,65	$ 153.431.515.774,45
Total patents Granted	ASIA	173894	172713	185495
Efficiency / patent	ASIA	$ 949.315,85	$ 885.677,02	$ 827.146,37
Patents of 3 fields	ASIA	17934	15603	16510
Cost of patents	ASIA	$ 16.345.003.873,01	$ 14.534.567.074,13	$ 14.539.283.912,46
Total Researchers / million	ASIA	7906	8546	8452
Cost by research	ASIA	$ 53.297.306,60	$ 51.272.872,80	$ 55.070.558,83

EUROPEAN UNION	GROUP	2000	2001	2002
% of GDP in R&D	EUROPEAN UNION	33,87912	34,64846444	34,39751333
Total GDp in USD	EUROPEAN UNION	$ 8.874.120.470.540,12	$ 8.974.833.619.316,01	$ 9.784.551.690.519,50
Total os USD in R&D	EUROPEAN UNION	$ 158.062.608.244,98	$ 160.485.431.591,80	$ 175.044.098.116,44
Total patents Granted	EUROPEAN UNION	60866	60034	59135
Efficiency / patent	EUROPEAN UNION	$ 2.596.894,95	$ 2.673.242,36	$ 2.960.076,07
Patents of 3 fields	EUROPEAN UNION	7629	7688	7801
Cost of patents	EUROPEAN UNION	$ 20.979.607.454,40	$ 21.448.969.124,91	$ 23.928.343.757,69
Total Researchers / million	EUROPEAN UNION	62907	63681	65724
Cost by research	EUROPEAN UNION	$ 59.202.806,59	$ 59.211.800,69	$ 62.767.053,89

AMERICAS	GROUP	2003	2004	2005
% of GDP in R&D	AMERICAS	5,52704	5,45754	5,48604
Total GDp in USD	AMERICAS	$12.908.946.212.649,70	$13.906.242.572.731,20	$15.097.628.386.115,70
Total os USD in R&D	AMERICAS	$ 315.716.453.376,69	$ 331.070.646.755,51	$ 358.760.242.823,59
Total patents Granted	AMERICAS	184361,3333	181143,3333	161761
Efficiency / patent	AMERICAS	$ 1.712.487,36	$ 1.827.672,27	$ 2.217.841,40
Patents of 3 fields	AMERICAS	24526	22973	21153
Cost of patents	AMERICAS	$ 42.106.893.116,14	$ 42.025.995.783,83	$ 46.277.299.528,72
Total Researchers / million	AMERICAS	8273	8401	8483
Cost by research	AMERICAS	$ 91.154.125,52	$ 97.408.852,61	$ 110.261.396,63

ASIA	GROUP	2003	2004	2005
% of GDP in R&D	ASIA	6,51482	6,77698	7,11508
Total GDp in USD	ASIA	$ 6.786.466.760.946,95	$ 7.535.376.504.036,03	$ 7.939.513.717.988,87
Total os USD in R&D	ASIA	$ 169.882.965.385,47	$ 189.003.421.964,74	$ 204.754.351.294,09
Total patents Granted	ASIA	203854	222620	249761
Efficiency / patent	ASIA	$ 833.356,06	$ 848.995,70	$ 819.801,14
Patents of 3 fields	ASIA	22164	24157	27752
Cost of patents	ASIA	$ 17.897.798.031,77	$ 20.423.183.673,30	$ 22.858.391.576,45
Total Researchers / million	ASIA	8888	9025	9842
Cost by research	ASIA	$ 59.849.746,86	$ 68.325.332,61	$ 70.233.719,00

EUROPEAN UNION	GROUP	2003	2004	2005
% of GDP in R&D	EUROPEAN UNION	34,58872	34,38445	34,95668
Total GDp in USD	EUROPEAN UNION	$11.905.537.456.650,90	$13.744.046.187.371,40	$14.373.017.705.822,50
Total os USD in R&D	EUROPEAN UNION	$ 213.073.212.334,46	$ 241.083.434.221,88	$ 251.112.345.074,04
Total patents Granted	EUROPEAN UNION	64088	62044	61168
Efficiency / patent	EUROPEAN UNION	$ 3.324.697,48	$ 3.885.684,90	$ 4.105.289,45
Patents of 3 fields	EUROPEAN UNION	8445	8061	7663
Cost of patents	EUROPEAN UNION	$ 28.595.631.519,70	$ 31.375.143.180,47	$ 32.360.406.848,25
Total Researchers / million	EUROPEAN UNION	65873	68815	73112
Cost by research	EUROPEAN UNION	$ 74.962.527,44	$ 82.453.719,26	$ 81.818.462,29

AMERICAS	GROUP	2006	2007	2008
% of GDP in R&D	AMERICAS	5,48681	5,61687	5,75627
Total GDp in USD	AMERICAS	$16.237.666.901.076,40	$17.313.920.190.162,10	$17.957.799.858.980,40
Total os USD in R&D	AMERICAS	$ 388.853.374.424,85	$ 422.706.671.151,25	$ 455.045.958.661,30
Total patents Granted	AMERICAS	191207	177688	178988
Efficiency / patent	AMERICAS	$ 2.033.677,50	$ 2.378.926,38	$ 2.542.326,63
Patents of 3 fields	AMERICAS	24675	22684	22244
Cost of patents	AMERICAS	$ 49.379.794.035,50	$ 52.240.883.499,06	$ 55.117.888.621,01
Total Researchers / million	AMERICAS	8644	8907	9219
Cost by research	AMERICAS	$ 119.014.008,36	$ 134.113.838,60	$ 142.392.697,53

ASIA	GROUP	2006	2007	2008
% of GDP in R&D	ASIA	7,47764	7,71293	7,9053
Total GDp in USD	ASIA	$ 8.294.306.455.464,06	$ 9.188.286.094.301,23	$10.634.434.366.845,10
Total os USD in R&D	ASIA	$ 214.830.269.165,63	$ 233.221.569.169,97	$ 265.801.175.895,61
Total patents Granted	ASIA	319975	356607	354179
Efficiency / patent	ASIA	$ 671.397,04	654.001,66	$ 750.471,30
Patents of 3 fields	ASIA	34532	38429	39396
Cost of patents	ASIA	$ 21.767.642.742,75	$ 24.413.752.922,50	$ 29.574.195.050,82
Total Researchers / million	ASIA	10343	10913	11090
Cost by research	ASIA	$ 75.764.258,61	$ 81.543.990,19	$ 95.473.041,52

EUROPEAN UNION	GROUP	2006	2007	2008
% of GDP in R&D	EUROPEAN UNION	36,15512	36,0629	36,97441
Total GDp in USD	EUROPEAN UNION	$15.331.362.327.432,40	$17.718.786.229.066,70	$19.056.303.793.648,90
Total os USD in R&D	EUROPEAN UNION	$ 271.174.947.008,58	$ 313.936.663.507,06	$ 344.828.312.943,36
Total patents Granted	EUROPEAN UNION	59704	56991	55403
Efficiency / patent	EUROPEAN UNION	$ 4.541.989,60	$ 5.508.530,53	$ 6.224.000,74
Patents of 3 fields	EUROPEAN UNION	7773	6997	6607
Cost of patents	EUROPEAN UNION	$ 35.765.704.977,15	$ 41.087.652.928,40	$ 44.570.930.232,07
Total Researchers / million	EUROPEAN UNION	75552	76763	81823
Cost by research	EUROPEAN UNION	$ 85.434.087,96	$ 97.204.586,62	$ 104.214.493,90

AMERICAS	GROUP	2009	2010	2011	2012
% of GDP in R&D	AMERICAS	5,85952	5,72996	5,70063	5,59203
Total GDp in USD	AMERICAS	$17.487.105.813.571,50	$18.814.467.185.792,20	$19.947.923.347.395,10	$20.486.162.709.938,70
Total os USD in R&D	AMERICAS	$452.261.727.729,35	$465.993.408.751,55	$492.340.135.016,87	$495.654.444.096,04
Total patents Granted	AMERICAS	189618	241985	248706	277804
Efficiency / patent	AMERICAS	$ 2.385.120,23	$ 1.925.711,96	$ 1.979.606,99	$ 1.784.187,57
Patents of 3 fields	AMERICAS	23647	30868	32483	37786
Cost of patents	AMERICAS	$ 56.330.148.211,33	$ 59.202.328.414,60	$ 63.461.819.728,35	$ 67.218.609.663,36
Total Researchers / million	AMERICAS	9157	9210	9542	9448
Cost by research	AMERICAS	$ 135.505.168,60	$ 149.685.214,86	$ 154.215.621,12	$ 150.386.657,48

ASIA	GROUP	2009	2010	2011	2012
% of GDP in R&D	ASIA	8,18675	8,31296	8,76377	9,14044
Total GDp in USD	ASIA	$11.235.020.060.841,90	$12.881.761.980.868,40	$14.911.423.703.055,30	$15.958.251.129.961,20
Total os USD in R&D	ASIA	$ 283.545.688.712,21	$320.838.189.438,04	$378.879.535.770,43	$ 410.899.627.580,82
Total patents Granted	ASIA	378470	426646	505156	605363
Efficiency / patent	ASIA	$ 749.189,34	$ 752.000,93	$ 750.024,82	$ 678.765,68
Patents of 3 fields	ASIA	40860	45344	52469	59175
Cost of patents	ASIA	$ 30.963.506.523,95	$33.930.680.583,83	$39.331.970.885,01	$ 39.889.424.644,10
Total Researchers / million	ASIA	10894	11324	11881	12372
Cost by research	ASIA	$ 138.659.303,69	$ 159.044.846,55	$ 185.943.336,29	$ 206.616.270,73

EU	GROUP	2009	2010	2011	2012
% of GDP in R&D	EUROPEAN UNION	40,23825	40,57095	42,4474	43,05593
Total GDp in USD	EUROPEAN UNION	$17.029.374.760.459,00	$16.915.430.864.410,50	$18.275.423.577.429,20	$17.226.191.806.660,40
Total os USD in R&D	EUROPEAN UNION	$ 329.588.790.358,84	$ 326.906.296.794,34	$ 361.120.067.031,72	$ 346.608.532.810,42
Total patents Granted	EUROPEAN UNION	66475	61808	53849	54465
Efficiency / patent	EUROPEAN UNION	$ 4.958.086,35	$ 5.289.061,23	$ 6.706.161,06	$ 6.363.876,49
Patents of 3 fields	EUROPEAN UNION	6758	6410	6073	7066
Cost of patents	EUROPEAN UNION	$ 43.390.747.437,40	$ 42.154.412.686,13	$ 42.229.142.741,59	$ 44.430.711.791,17
Total Researchers / million	EUROPEAN UNION	82267	84792	87575	88753
Cost by research	EUROPEAN UNION	$ 97.138.419,68	$ 93.523.784,34	$ 101.059.256,49	$ 93.592.025,33

AMERICAS	GROUP	2013	2014	2015	2016	2017
% of GDP in R&D	AMERICAS	5,63033	5,72209	5,73237	5,61403	5,297488824
Total GDp in USD	AMERICAS	$21.099.674.066.954,40	$21.779.220.707.219,60	$21.574.411.882.975,00	$22.030.169.201.223,30	$23.185.856.047.610,10
Total os USD in R&D	AMERICAS	$518.425.077.552,05	$541.176.703.300,54	$549.096.326.315,69	$560.585.238.716,00	$566.682.325.513,99
Total patents Granted	AMERICAS	304640	327176	324019	333668	348378
Efficiency / patent	AMERICAS	$ 1.701.762,99	$ 1.654.084,36	$ 1.694.642,37	$ 1.680.068,93	$ 1.626.630,63
Patents of 3 fields	AMERICAS	41292	43781	43510	44127	47164
Cost of patents	AMERICAS	$69.686.433.592,93	$71.247.368.690,86	$73.166.823.422,57	$73.286.322.089,92	$75.562.266.798,15
Total Researchers / million	AMERICAS	9600	9689	9523	9108	9134
Cost by research	AMERICAS	$152.820.987,60	$ 154.766.464,16	$161.256.183,90	$173.924.322,66	$173.865.649,14

ASIA	GROUP	2013	2014	2015	2016	2017
% of GDP in R&D	ASIA	9,4537	9,7101	9,55099	9,47651	9,5792
Total GDp in USD	ASIA	$16.031.727.796.282,50	$16.700.276.615.476,70	$16.787.782.002.171,70	$17.479.416.915.233,40	$18.534.192.929.873,70
Total os USD in R&D	ASIA	$415.544.544.909,13	$436.430.461.889,38	$428.705.172.495,67	$449.364.102.834,14	$474.422.320.383,75
Total patents Granted	ASIA	612097	590156	650547	716170	740383
Efficiency / patent	ASIA	$ 678.886,75	$ 739.517,11	$ 658.991,85	$ 627.454,52	$ 640.779,60
Patents of 3 fields	ASIA	63664	65301	62379	75478	74096
Cost of patents	ASIA	$42.056.707.082,14	$46.798.791.594,31	$41.569.746.538,83	$48.293.863.867,79	$48.504.655.957,17
Total Researchers / million	ASIA	12636	13282	13378	13529	13396
Cost by research	ASIA	$ 19.122.237,57	$ 232.185.279,43	$231.551.189,71	$232.867.014,74	$ 256.678.494,59

EUROPEAN UNION	GROUP	2013	2014	2015	2016	2017
% of GDP in R&D	EUROPEAN UNION	42,9539	42,86995	43,02909	41,00601	42,30168333
Total GDp in USD	EUROPEAN UNION	$17.960.675.458.117,00	$18.576.968.496.345,60	$16.366.177.835.313,40	$16.469.555.943.599,70	$17.254.832.313.632,70
Total os USD in R&D	EUROPEAN UNION	$363.597.115.637,13	$379.694.783.396,13	$334.729.137.766,13	$335.816.682.878,06	$352.988.653.702,52
Total patents Granted	EUROPEAN UNION	54880	53352	53601	53625	51778
Efficiency / patent	EUROPEAN UNION	$6.625.311,87	$ 7.116.786,31	$ 6.244.830,09	$ 6.262.315,76	$ 6.817.348,17
Patents of 3 fields	EUROPEAN UNION	6708	6257	6410	6702	6729
Cost of patents	EUROPEAN UNION	$46.959.629.543,61	$47.727.227.498,45	$42.393.995.591,54	$43.126.588.638,23	$45.778.257.157,64
Total Researchers / million	EUROPEAN UNION	91143	93959	95844	96498	95434
Cost by research	EUROPEAN UNION	$95.356.326,34	$ 98.102.580,75	$82.653.104,15	$ 81.506.192,70	$ 88.006.131,11

Appendix 2 - Patentes granted in 2017, from 3 fields of study in this article