1. INTRODUCTION

1.1 Intellectual Property - Outline

1.1.1 Intellectual Property - Definition

Human beings are different from other living beings in terms of the imagination that they apply using their minds to resolve all the conscious/subconscious problems. Everything unique done by human beings (e.g. printing press, combustion engine, transistors, semiconductors, chips, DNA drugs and all such innumerable inventions and innovations), which have helped living beings advance technologically in their lives is an indication of the technological progress and advancement made by humans since their inception on earth. As these are innovations and inventions, they need to be protected and legally enforced at every possible level. Such is the high relevance and importance of these intellectual property frameworks that an international organization WIPO (World Intellectual Property) has formulated and manages more than 18 international treaties regarding intellectual property.

1.1.2 Subjects protected under IP regime

As indicated above, intellectual property (IP) includes and covers rights related to all possible human mind innovations, which may be in the form of any of the following:

a) Copyrights (artistic, bookish, fictitious and technical work)
b) Related rights (presentations of performers and announcements)
c) Industrial property (discoveries, industrial design, commercial names/marks & partial opposition)

1.2 Copyright

1.2.1 Definition

A legal protection offered to creative authors, performers for their creations (referred to as works) are a copyright.

1.2.2 Type of works covered under copyright

Copyright protection offers protection to creative performers for their contributory works such as books, rhymes, acts, plays, encyclopedias, articles, journals, movies and television shows, vocal compositions, architecture, images, paintings, programs, structures and statues. However, they do include works which are considered abstract ideas. They are focused only on protection of ingenious human thoughts. For instance, if any person takes an image of a particular object, it gets automatically his copyright. Nobody has the legal authority and permission to make copies of the same and do any sort of sales without the person's approval.

1.2.3 How to protect works under Copyright?

Any work created by a performer/artist automatically becomes his/her copyright. There are no such legal and mandatory requirements of registering your work to obtain legal protection on copyright. However, there is an optional mechanism to register your work(s) and obtain legal protection over your copyrighted work.

1.3 Related Rights

1.3.1 Definition

Related rights (often referred to as neighboring rights) are intellectual property protections offered to the following cadres of people: -

a) Performers (such as artists, anchors, etc.) who actually give performance in their works.
b) Vocal composers, producers

1.3.2 Copyrights versus Related Rights

The difference between copyright and related rights is basically in the segment of the people category which is being protected by the two different intellectual property rights. While copyright would protect an artist of a

painting, related rights will be responsible for protection of organizations displaying that painting.

1.3.3 Rights granted in related rights?

These related rights are territorially restricted in nature, i.e. every country has its own set of rights provided to the set of people covered under related rights protection. However, there are several well known treaties and acts such as TRIPS and WIPO Performances and Phonograms Treaty (WPPT) which address this issue. Some of the rights which are governed by WPPT are imitation, circulation and presentation rentals rights. These rights are in general, rights of enforcing prohibition of imitation and circulation to vocal composers and producers. Similar rights are granted to the broadcasting organizations and phonogram producers.

1.3.4 Need for related rights

Performers deserve legal intellectual property protection for their original work. While vocal and music producers require protection for their innovative, techno-financial assets, broadcasters require it for their expertise, skills and organizational abilities enhancement and avoid breach of privacy.

1.4 Trademarks

1.4.1 Definition

A signage or a graphical symbol which helps people identify and distinguish particular good, service or brand(s) from other products/services in the similar segment is a trademark. Consider for example “HP” for “Hewlett Packard” or “Lenovo”.

1.4.2 Different type of signs used as trademarks

The most important and essential thing for a valid trademark is its uniqueness as compared to other existing brands/trademarks. It should be such that people recall a particular product/service/brand just upon listening or looking at the corresponding trademark. In this regard, trademarks may

constitute possible individual (Lenovo/Nikon) or multiple words (Bharat Petroleum), numbers (9/11), abbreviations (HP/YSL/3M), diagrams (IndianOil logo) and pictorial graphical representations (Coca Cola), smells, sound, songs, tunes, colors.

1.4.3 Type of trademarks

Trademarks may be of mainly two types, namely certification marks and collective marks. While certification marks help identify and differentiate products and services conform to certified standards (such as ISO), collective marks help in differentiating services/products provided by a particular group/union (such as CA for Institute of Chartered Accountants or CPA for Society of Certified Public Accountants). Further, there is also Service marks, which are specifically related to service as compared to any product.

1.4.4 Importance of trademarks

Trademarks are a pivotal component of intellectual property for any organisation. They help in building consumers recall, identify and relate to particular set of goods/services, act as brand differentiators, are crucial assets and help grow the business. Organizations continuously use their trademarks to advertise and market their products/services/brand and try to gain supremacy within the consumers' mindset. Many organizations earn a lot of royalties through the trademark licensing activities.

1.4.5 How to protect your trademark from illegal use?

Most popular and effective methodology adopted to protect illegal infringement and usage of trademarks is to have it registered with territorial patent and trademark office. As indicated, trademarks are protected only in jurisdictions/geographies where they are legally registered. The same trademark can be used by any producer/service provider in other locations where there is no protection granted to that particular organization. For this, every country maintains a "TRADEMARK REGISTER" for registering the trademarks in their respective jurisdictions. However, it is not a mandate to have your trademarks registered in order to obtain protection. A less trusted mode of protection is also offered to unregistered trademarks.

1.4.6 Protection offered by trademarks

As other intellectual property rights, trademarks also provide its registered beneficiary exclusive rights to stop others from using trademark symbol without permission and provide franchisee or licenses to selected third party providers for using the trademarks to sell goods/services.

1.5 Geographical Indications

1.5.1 Definition

A sign to indicate the geographical origin of a particular product is a geographical indication. It helps in relating that product with certain qualities/attributes based on the originating geographical place. For instance, “Darjeeling” for tea grown in India, and “Swiss wine” for wine of Switzerland is some of the well known geographical indications. Geographical indications are not restricted for usage in beverages/agri-products. Even products like “Swiss watches” from Switzerland indicate presence of geographical indication.

1.5.2 Trademark versus Geographical Indication

Trademark is a sign for an organisation to differentiate itself from other organizations. On the other hand, geographical indication separates and indicates the location of origin of a particular product/service.

1.5.3 Protection of Geographical Indication

Various national laws and regulations provide mechanisms for protection of geographical indication such as “consumer protection”, “unfair competition protection”, etc. Special sanctions and order from the court help prevent the illicit usage and recovery of fines, penalties and damages.

1.6 Industrial Designs

1.6.1 Definition

Intellectual property right related to artistic and decorative facet of an object is an industrial design. It could be shape, visual colors, sketch or pattern of lines. Major usage of industrial design is in wristwatches, ornaments, electronic devices, automobiles, designs and luxurious products.

1.6.2 Protection of industrial designs

- Many countries have their own industrial design law under which any new/original industrial design should be duly registered. This leads to issuance of a “registration certificate” which indicates legal protection to any industrial design. In some cases depending on the nature and strictness of law and type of industrial design, it can also be protected under copyright act as a “Work”.
- While some countries allow for parallel usage of industrial design and copyright act, others allow and provide for selection of any one of the two. Once selected, the beneficiary/applicant is deprived of usage of the other protection.

1.6.3 Protection provided by industrial designs

Again acting as an intellectual property infringing right, industrial design prohibits illicit imitation of design without permission/approval of the registered applicant. Further, applicant is granted the right to decide and provide licenses to people (of his/her choice) to use the industrial design.

1.6.4 Need for protection of industrial designs

A lot of commercial value and increased marketing activities are created and put in place with the help of attractive and visually appealing industrial designs. They help in generating good ROI (return on investment), increase and build market competition and promote development of creativity in a technologically driven world market.

1.7 Patents

1.7.1 Definition

A restricted right granted by law/ patent and trademark office to a person/organization (referred to as inventor/assignee) for an invention (carried out and presented in the form of a product, process, methodology or a solution to an existing technological problem) is considered as a patent. Examples of patents range from electric fans to vehicle movement, communication, mobile phones and innumerous products around us.

1.7.2 Type of inventions protected by patents

For any invention to be granted and protected by a patent, it must satisfy the general criteria of novelty, utility, non-obvious and statutory requirements (collectively referred to as NUNS).

a) Novelty: An invention should have some attribute/characteristic which is not disclosed any time before being disclosed in the invention. That means that the invention should be different from prior art.
b) Utility: Invention to be patentable should have industrial applicability. E.g. obtaining a patent on production of >100% efficient vehicle is not possible as the idea is not implementable by any person ordinarily skilled in the art.
c) Non-obvious: Invention should not be easily deducible by any person who has little knowledge about that particular domain.
d) Statutory requirements: The invented matter must be a component of popularly called “patentable subject matter” under the laws of that particular jurisdiction. Generally, “natural discoveries, science theories, mathematical formulas, animal and plant varieties, medical treatment methodologies and business methods” are not “patentable subject matters” in most of the countries.

1.7.3 Invention Protection – Methodology

There are two methods of protecting an invention: -

a) Patent: Rights protected in a particular jurisdiction wherein the protection is sought. These rights are provided on disclosure of full technology to the masses regarding the invention by the inventor(s).
b) Trade Secrets: This provides for keeping certain information (which is critical to sustaining of your business) highly confidential and prevent it from being disclosed to the people.

1.7.4 Process of obtaining a patent for an invention

The process to obtain a patent for protecting your invention is a well-structured methodology. It begins with filing a patent application in a particular template at the desired patent and trademark office of a jurisdiction. The patent application needs to disclose all the information pertaining to the invention, namely: “title”, “field of technology”, “background and prior arts”, “drawings”, “detailed description” and “claims” of the invention, sufficient for any person skilled in the art to understand and enable it without fail. After filing of the patent application, it is generally published i.e. brought into the public domain. Post that, examination of the patent application starts which results in patent examiner judging and deciding at a technical and legal level, the possibility of granting a patent to the invention’s assignee(s).

1.7.5 Rights of a patent owner

A person holding a valid patent for an invention, has legal rights to prevent others in that particular jurisdiction from “making, using, offering for sale, importing or selling the invention” without his/her approval. Even, he/she has all the rights to allow and license parties to use inventions on certain terms and conditions. He/she can even sell his invention to any third party, who becomes the new assignee in that case.

1.7.6 Patent Protection – How extensive is it?

The protection offered by a patent is limited and restricted to the country/jurisdiction where the patent is being granted. For example, a patent granted in United States protects inventor/assignee from barring others to use its invention **only** in United States. With the development of several geographical collaborated regions, similar types of patent offices have also

opened up. For instance, “European Patent Office” (EPO) and “African Regional Industrial Property Organization” (ARIPO) are regional IP organizations/bodies which grant regional patents providing protection in all the member countries of these respective organizations. To elaborate a little further, EPO granted patents hold valid and provide protection in around 40 countries which agreed to be a member of European Patent Convention.

Further, there is an international level organization (World Intellectual Property Organization), which administers and manages multiple treaties. “Patent Cooperation Treaty” also referred to as PCT, allows assignees to file their patent applications in multiple countries simultaneously and seek protection in all the desired locations/potential markets. However, WIPO is not responsible for granting any patents. This is the responsibility of national patent offices.

1.7.7 Need for protecting inventions with patents

To incentivize individuals and inventors, motivate them further into innovating, enhancing the quality and standard of human life are some of the major reasons which compel and encourage inventors to obtain patents for their respective inventions. Patents promote further inventiveness by allowing future inventors to have a base of knowledge about existing technological advancement.

1.7.8 Types of Patent Applications

Generally, there are three types of patent applications filed by inventors/assignees. They are:

- National Patent Application
- International PCT Application
- European Patent Application (commonly referred to as Regional Patent Application)

1.7.8.1 National Patent Application

This is a form of regional and jurisdiction specific patent protection. When a decision to file a patent for protecting an invention is taken at the national level, firstly a patent application is drafted and filed at the respective patent office. This filed application is commonly referred to as “priority patent application”. Generally, the application gets published in the public domain after certain time duration (18 months for United States). A patent examiner from the corresponding patent office examines the patent application to judge it on the various criterions of patentability. After doing a thorough prior art search, a patent is granted to the inventor(s)/assignee(s) if all criterions are fulfilled satisfactorily.

1.7.8.2 International Patent Application

It can be either under Paris Convention or under PCT (governed by World Intellectual Property Organization i.e. WIPO).

The Paris Convention patent application type is generally filed when assignee(s) wants to protect and enforce their inventions in multiple countries. A time duration of 12 months from priority date is given to file their patent applications in different countries covered under the Paris Convention Treaty.

PCT patent applications through WIPO provide an intermediate route for priority patent applications to enter into national patent applications of different and multiple countries. It is a means to provide the applicant considerable time to decide all the countries that he/she would like to seek protection of his/her invention in.

1.7.8.3 European Patent Application

This is a regional patent application filed under the European Union to seek protection with the help of a single patent application under more than 40 countries. It is the responsibility and at the discretion of the applicant to select all the countries that it might like to seek protection in. These patent applications are granted by European Patent Office and published in any of the three official languages, i.e. English, French & German. These patent

applications provide same level of legal protection and enforcement capabilities as any other national patent application. Generally, it is effective to consider filing and pursuing a European Patent Application when protection is looked upon and sought in at least 4 European countries.

2. LITERATURE REVIEW

2.1 Invention, Technology & Invention Relationship

Innovative performance refers to companies' performance in terms of the actual introduction of inventions into the markets (Freeman and Soete, 1997) [16].

Inventive performance is generally companies' achievements in terms of sketches, ideas, models of new products, devices, systems and processes (Freeman and Soete, 1997 [16]; Ernst, 2001 [15]). Raw patent counts and its corresponding citations are used as actual measures of inventive performance. Accomplishment of companies with respect to combination of research capabilities, R&D input and output are referred to as technological performance.

An "indicator" is a collection and group of specifics and/or interpretations which inform analysts and decision makers about significant information about the original event/study of interest. For science and technology, the indicators are specifically referred to as "Science and Technology Indicators" (henceforth STI). In order to validate the importance of an indicator, it is essential to understand and analyze the background of the indicator and try to relate its relevance and importance with respect to it. The literature review section aims to address the important dimensions and indicators that have been used to indicate technological development.

It has been argued in the past that the quality of patented inventions differs from patent to patent. Further, the likelihood and possibility of patent inventions at a given quality varies at both organizational and industrial level (Scherer, 1965) [30]. In the recent times, there is a lot of debate on patent quality and how to use it to measure innovation, technological & entrepreneurship development. The objective of having a high patent quality is to avert the uncertainty of lower incentives in innovating, promoting entrepreneurship, employment and growth.

There are many indicators to study the technology output of different countries. These indicators can be in terms of product/technology & financial/market. Some of them are as follows:

Measure	Advantage	Disadvantage
New Product Development (NPD)	Measurement of actual implementation	No guarantee of success of all products
Patent applications	Measurement of technological progress	All patents not put into industrial utility
Patent citations	Highlights importance of patents	Self-citation of patent by same assignee
Process innovations	Measures rate of improvement in processes and methods being practiced in the organization	Dilemma for innovators
Idea/Invention disclosures	Measures rate of idea generation	Seldom realization and conversion of ideas
Ratio of sales of new products to R&D expenditure	Indicator of R&D efficiency	Establishing baseline difficult
Total R&D expenditure	Easy to calculate and monitor	No direct relation to indicate innovation efficiency
New markets entered	Indication of radical innovation	Approximately 50% of new products launched succeed
Number of employees in R&D (or focus on R&D within the organization)	Indicates focus within organization (easy to measure)	No direct relation to indicate innovation efficiency

Table 2.1: Indicators of Science and Technology (*Source: Measuring Innovation part 1: Frequently Used Indicators; URL:* http://www.innovationmanagement.se/2013/02/15/measuring-innovation-part-1-frequently-used-indicators/)

Out of the above, patent based indicators are the most frequently used ones to determine the technological progress of countries in a comparative manner. The scientific studies and publications on determinants and indicators of innovative/inventive activities use patent data at different hierarchy levels (i.e. at country or at firm level). This is due to the fact that there is a very close and innate relationship between innovation and patents. The various patent indicators used by economists/ policy makers are comparable and homogenous to the other Science and Technology Indicators (STI) such as R&D expenditure, references in the scientific publications, Science Citation Index, etc.

Several works has been done in the past to contribute towards defining and measuring the technological and economic value of patented inventions. Technological, inventive and innovative performances have been analyzed in the past in terms of new product developments, patent counts and citations and R&D input. However, using them in a multi-dimensional situation, either individually or combination helps in measuring innovative performance in wider perspective.

The current literature on the innovation measurement highlights various interesting perspectives on the above mentioned indicators. Below is a brief outline of information on the above indicators used in the literature to assess the technological progress.

2.1.1 Announcement of New Products

Various literature works have used announcement of new products as an indicator of innovative capability. The data source in these literature works have been mostly plurality of sources and databases. For instance, in a study involving 250 companies (based in United States), the authors applied a combined indicator of which one part was a statistical degree related to announcement of new products in Dialog's NPA+ database (Hitt et. al, 1996) [23]. The work that there is a positive correlation between announcement of new products and number of patents at the industrial level and not at the individual companies' level is indicated in the work of Devinney (1993) [12],

which indicated that patent intensity explains only about less than 3% of variance in new product announcements of individual firms.

However one of the problems with this approach is that it is based on companies' press releases and corresponding marketing departments. There is no or little screening undertaken by the database operators and administrators themselves. On the other hand, patents in particular, are screened for their original contribution both during the filing/prosecution duration and post grant duration by company attorneys/engineers. Therefore, careful screening of the information is necessary with announcement of new products as compared to any other indicators in order to avoid major problems with results' validity.

2.1.2 Patents

Like most other indicators, patent measure for a long time, in reality has been usage of raw patent counts. The same has been subject to a long-time debacle over its shortcomings and biased nature (Archibugi, 1992 [5]; Cohen and Levin, 1989 [11]; Dosi, 1988 [13]; Griliches, 1998 [20]). Difference in patenting behavior of large and small companies, importance and valuation of different patents and consideration as being a part of the overall path from research to innovation are some shortcomings that appear from work discussed in the literature. Raw patent counts are accepted as one of the many suitable indicators for researchers to assess the innovative/inventive performance in terms of new processes, products and technologies (Aspden, 1983 [7]; Acs and Audretsch, 1989 [1]; Bresman et al., 1999 [8]; Freeman and Soete, 1997 [16]; Cantwell and Hodson, 1991 [10]; Griliches, 1998 [20]; Patel and Pavitt, 1995 [27]; Pavitt, 1988 [28]). Arundel and Kabla (1998) [6] and Lerner (1994) [24] admit that patents can be used in high tech sectors also. These works suggest that lesser the patents used for wider cross-sectional analysis in their tendency to patent, better is the patents' reflection on the companies' performance (Ernst, 2001) [15].

2.1.3 Patent Citations

Lots of researchers utilize patent citations as an indicator of companies' inventive performance increasingly. In comparison to raw patent counts (a purely quantitative measure), patent citations also incorporate a determination of the patents' quality. Patents generally have both, backward and forward patent citations. While backward patent citations (commonly referred to as prior art) are cited in all patent applications having certain degree of similarity in technical aspects of claims, forward patent citations occur when a patent application is cited by other patent applications in later filed patent applications. Higher number of forward patent citations and lower number of backward patent citations generally indicate and highlight the impact, importance, strength and value of a patent. Although many researchers have been critical about usage of patent citations without appropriate knowledge of interpretation of citations report (Bettels and Michel, 2001) [25], huge amount of quantitative data analysis of patents & its citations is being used in economics (Harhoff et al., 1999 [21]; Rosenkopf and Nerkar, 2001 [29]; Stuart, 2000 [31]). Validating the usage of patent citations as inventions/innovation quality indicator in terms of correlation between importance and number of citations is also studied (Albert et al., 1991) [3].

2.1.4 Research & Development Inputs

The literature and work done in the past has usually taken R&D expenditure (or spending) as an indicator of the organizations' efforts with the hope of generating an output. R&D inputs have actual and true correlation with R&D output in the form of patents (Griliches, 1990, 1998) [19, 20]. Efforts in R&D also provide insights into innovative and technical competencies of various organizations (Duysters and Hagedoorn, 2001) [14]. So, it is visible that organizational R&D efforts are affected by the R&D expenditures incurred by organizations (Nelson and Winter, 1982) [26]. Future allocations of R&D resources are very much dependent on the effectiveness of the R&D inputs at the earlier stages. The actual R&D efforts indicate to a large extent, the previous successes which form an integral component of skills developed by companies in creating the futuristic R&D strategy.

2.1.5 Statistical Association of New Product Announcements, Patents and R&D

As indicated by the above analysis and understanding of different indicators from various studies, it is quite intriguing to develop a better understanding of the association between the different indicators. Majority of the earlier conducted studies use only one single indicator out of the many prevalent, however quite a number of studies and conducted literature work use plurality of indicators to report correlation between indicators. However, the literature working and using only/more than one indicator seems to reflect a somewhat different representation when it grills down to understanding the plausible association between new products, patent counts/citations and R&D inputs.

Katila and Ahuja (2001) [2] conducted a study of chemical industry at an international level and reported a statistical correlation of approximately 0.845 between patent counts and R&D inputs. Duysters and Hagedoom (2001) [14] found a correlation of little above 0.5 between patent counts and R&D intensity of organizations operating in the international computer domain. Measuring the innovation in a sampled manner for 150 semiconductor firms, Stuart (2000) [31] reported a high correlation of 0.798 between raw patent counts and their citations. On the other hand, Nerkar and Rosenkopf (2001) [29] reported low correlation value of around 0.3 between patent counts and citations while analyzing a sample of optical disk companies.

Hitt et al. (1996) [23] set a substantial value of 0.5 correlation between R&D intensity and new product announcements. Although far from being closer to the true value, Brouwer and Kleinknecht (1999) [9] reported correlation existing between patenting activity and sales of innovative and new products in the markets by various organizations.

3. RESEARCH METHODOLOGY

Tae K.R and Yoo J.H (2011) [B1], in collaboration with Korean Intellectual Property Office (KIPO) conducted a study on understanding the various patenting indicators which could be used for measuring the technological innovative capabilities of OECD member countries till 2007.

The current research extends the contribution of the above mentioned authors till 2013. To perform the research and analysis, the following approach was adopted:

1. The data for 30 member countries of OECD till 2013 was taken from multiple sources, namely WIPO Statistics and OECD Patent Databases.
2. The data was analysed on the verge of multiple distinct indicators. Some statistical analysis is carried out to understand the holistic advantages of these indicators.
3. An amalgamated indicator (*Source: Tae K.R and Yoo J.H, 2011 [B1]*) is used to rank the same 30 countries and judge their relative technological competence.
4. One of the distinct indicators, namely triadic patent families are taken and analysed in greater detail, both at the global and regional (i.e. North America, Europe and Asia Pacific) level. Further, patenting trends of ICT domain are analysed using the most widely accepted classification format, International Patent Classification (IPC) taken from WIPO IPC Database.
5. The research concludes with the comparison of these member countries on a timeline basis, i.e. 2007 vis-à-vis 2013.

4. DATA ANALYSIS

4.1 Data Collection Techniques & Sources

The data for carrying out the research work is obtained from secondary data sources, namely:

- World Intellectual Property Office (WIPO) Statistics
- Organisation for Economic Co-operation and Development (OECD) Statistics for Science and Technology Indicators
- Thomson Innovation Patent Database
- Relecura Patent Database

Existing literature talks and discusses about count of patent applications, their granted family members and corresponding citations. However, the same are not sufficient and do not incorporate all the aspects of patenting. The current research aims to look at the relatively less studied aspects of previous researches and proposes a new patent indicator to understand the patenting performance at the national level.

4.2 Proposition of Distinct Patenting Indicators

The various dimensions were segregated and divided into three broad categories:

- Conception
- Management
- Utilization

Fu and Yang (2010) [17] elaborated and explained a process wherein patents (innovative capacity) are related to resulting in economic outcomes (true performance) for the country. Also, other studies conducted by Global Competitiveness Report (2007) [18] and World Competitiveness Yearbook (2005) [32] inform and explain about the internal environmental conditions under which any country develops, monitors and utilizes the patents to generate economic assets (rents). The top level hierarchy of distinct factors have been taken from the above mentioned frameworks. The hierarchical framework is represented as below:

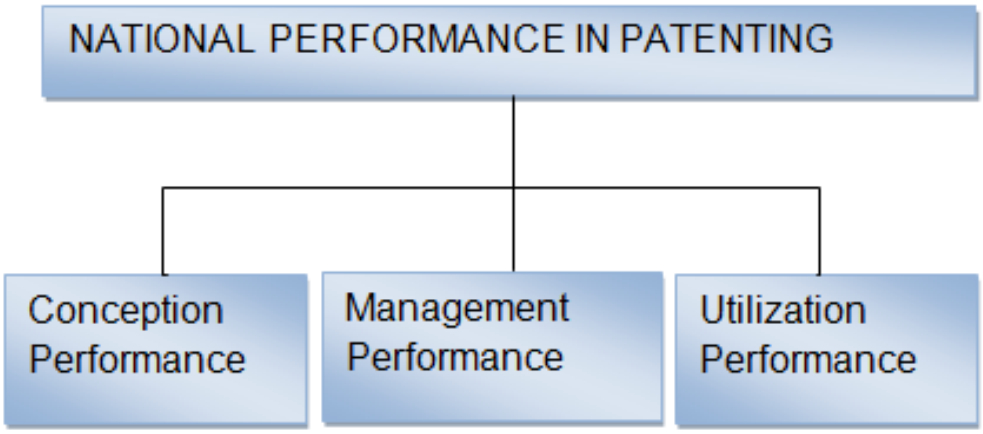


Figure 4.1: 1st level hierarchy of Performance Indicator (*Source: https://www.indiaenvironmentportal.org/*)

The above mentioned three dimensions are divided into:

- Quality: to understand the relative relevance and benefits of core technologies over peripheral ones (Hirschey and Richardson, 2004) [22].
- Quantity: to take technological stocks into account. Certain level of technology has to be developed and reach at a certain level before the same can be put into industrial utility (Archibugi and Coco, 2005) [4].

Each of the qualitative and quantitative dimensions is further divided into actual and comparative aspects. Comparative aspect is used to indicate the relative competence of each country with comparison to other countries, while actual aspect is used to indicate the extent of potential of individual country in each domain.

Based on the above rationale and explanation, a final set of individual indicators are proposed as indicated below.

Level 1	Level 2		Indicator
Conception	Quantity	Actual	Foreign and domestic Patent application count
		Comparative	Foreign and domestic Patent application count/ 10K Inventors
	Quality	Actual	Triadic patent application count
		Comparative	Triadic patent application count / 10K Inventors
Management	Quantity	Actual	Count of patent examinations
		Comparative	Patent examinations count/ Number of patent examiners
	Quality	Actual	PCT international search report count
		Comparative	PCT international search report count / Number of patent examiners
Utilization	Quantity	Actual	Enforced patents
		Comparative	Enforced patents / Firms in knowledge-based industries
	Quality	Actual	Value-added within knowledge-based industries
		Comparative	Value-added within knowledge-based industries / Firms in knowledge-based industries

Table 4.1: Distinct Indicators and their significance in patenting performance measurement (*Source:* https://www.indiaenvironmentportal.org/)

Each of the above mentioned distinct indicators plays a key role and provides a different view of the information regarding patenting dimension of any country:

a) "*Foreign and Domestic Patent Application Count*": This indicator highlights information and describes about the number of patents created by inventors of a particular country. Foreign patent applications are ones which are filed in countries apart from inventor's original country. Eg. Indian inventors filing their patent applications in United States.

b) "*Foreign and Domestic Patent Application Count/ 10K inventors*": gives information about relative innovative capabilities of inventors of one country with respect to other countries.

c) "*Triadic Patent Application Count*": shows the number of patents (having potential of being granted at USPTO, EPO and JPO), developed and filed by country's inventors.

d) "*Triadic Patent Application Count/ 10K inventors*": shows the relative comparison of one country's performance in triadic patent application filing trend vis-à-vis other countries' inventors.

e) "*Count of patent examinations*": gives information about the efficiency of patents examined and managed by respective country's patent examiners. Data for this indicator analysis is taken from data available from OECD patent statistics database.

f) "*Patent examinations count/ Number of patent examiners*": Number of patent examinations conducted by one country's examiners vis-à-vis the same count by other country's examiners. Analysis of this indicator is done post the data available from OECD patent statistics database.

g) "*PCT International Search Report Counts*": Analysis is conducted from the data available from WIPO Statistics. It helps in understanding the competitive intensity of national examiners.

h) "*PCT International Search Report/ Number of patent examiners*": helps in understanding the relative competence levels of patent examiners of different countries.

i) "*Enforced patents*": indicates the strength and number of patents which are currently valid and used in a country.

j) "*Enforced patents/ Firms in knowledge based industries*": indicates relative strength of one country in terms of its usage of patents in industry as compared to another.

k) "*Value added within knowledge based industries*": brings into light the profitability levels generated using patents by a country's firms.

l) "*Value added within knowledge based industries/ Firms in knowledge based industries*": It's a relative parameter of comparison between different countries' ability and potential of generating revenue from their national patent portfolio.

INDICATOR	DATA SOURCE	YEAR
Foreign and domestic Patent application count	WIPO Statistics	2013
Foreign and domestic Patent application count/ 10K Inventors	WIPO Statistics, OECD STIs (Science & Technology Indicators	2013
Triadic patent application count	OECD STIs	2013
Triadic patent application count / 10K Inventors	OECD STIs	2013
Count of patent examinations	WIPO Statistics	2013
Patent examinations count/ Number of patent examiners	WIPO Statistics	2013
PCT international search report count	WIPO Statistics on Paris Convention Treaty (PCT)	2013
PCT international search report count / Number of patent examiners	WIPO Statistics on PCT	2013
Enforced patents	WIPO Statistics	2013
Enforced patents / Firms in knowledge-based industries	OECD structural & demographic business statistics; WIPO Statistics	2013
Value-added within knowledge-based industries	OECD structural analysis database	2011
Value-added within knowledge-based industries / Firms in knowledge-based industries	OECD's structural and demographic business statistics	2011

Table 4.2: Sources of data collection for proposed distinct indicators

INDICATOR		MEAN	S.D.	MIN	MAX
1	Foreign and domestic Patent application count	37546	76836	33	379416
2	Foreign and domestic Patent application count/ 10K Inventors	90	132	6	595
3	Triadic patent application count	840	2319	0	9786
4	Triadic patent application count / 10K Inventors	2.5	2.7	0	9.5
5	Count of patent examinations	1026	1222	7	5991
6	Patent examinations count/ Number of patent examiners	0.084	0.050	0.023	0.138
7	PCT international search report count	692	2445	100	11671
8	PCT international search report count / Number of patent examiners	8.4	4.4	2.5	27.5
9	Enforced patents	255165	342699	326	1657355
10	Enforced patents / Firms in knowledge-based industries	4.6	5.3	0.15	17.6
11	Value-added within knowledge-based industries	653	1876	0.78	6084
12	Value-added within knowledge-based industries / Firms in knowledge-based industries	370	570	2.5	2750

Table 4.3: Statistical analysis of distinct indicator(s) (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB and http://www.wipo.int/ipstats/en/*)

4.3 Patenting Performance of Countries & Regions

4.3.1 Triadic Patent Families

Triadic patent families at OECD are the one that are filled by the US Patent and Trademark office (USPTO), the European Patent office (EPO) and Japan Patent Office (JPO) to protect the inventions. Indicators on triadic patent families, in statistical analysis, expand the international comparability of patent-based data.

Earliest priority data, country of inventor's residence and fractional tally are the criteria for counting triadic patent families. There is a lag in availability of information and priority date, especially for USPTO grants, due to which the latest year for which triadic patent families are available for analysis is 1999.

4.3.1.1 Number of triadic patent families and growth rate

The count of triadic patent families has increased exponentially since mid-2000s. In 2013, nearly 53,000 families were estimated by the OECD. They have grown at an average rate of 5.9% a year from 2000 to 2005 but dropped at a rate of 2.99% a year till 2013.

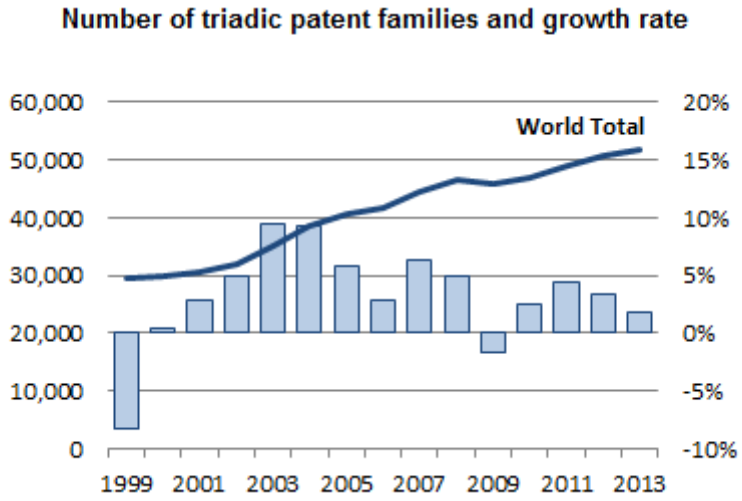


Figure 4.2: Number of triadic patent families and growth rate (*Source: Created by author based on data retrieved from* [*http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*](http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB))

4.3.1.2 Share of countries in triadic patent families 2013

Also, same kind of treads is witnessed at the country level from mid-2000. Jointly United States, European Union and Japan, reports approximately 90% of triadic patent families, with 31.5%, 29.75 and 28.75% shares respectively. Nevertheless, contrasting trends have been seen in OECD countries. Although, a steady growth rate has been seen in most countries, Finland, the United Kingdom and the Netherlands showed a decline.

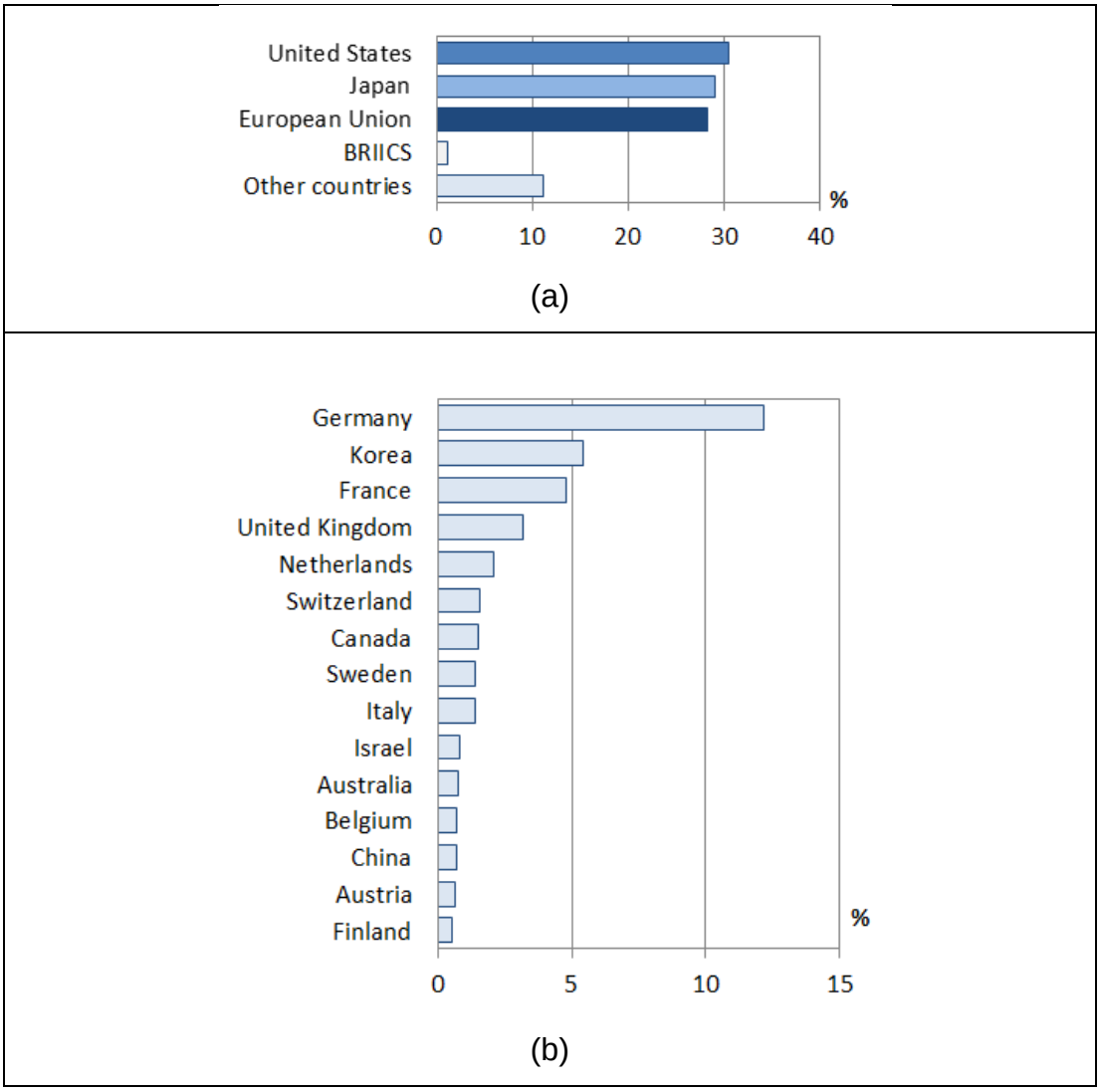


Figure 4.3: Share of countries in triadic patent families (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

Asian countries have shown an outstanding growth. Germany is Europe's strongest performer in terms of invention and stands in the third place. Korea gained eight relative positions as compared to its ranking in 1999 and now ranks at fourth position, ahead of France and United Kingdom. This improvement was also witnessed in India and China, with a growth of 268 and 32.9% respectively between 2003 and 2013.China is amongst top 15 patenting countries now.

If the triadic patent families are normalized by the total population then Japan, Switzerland, Sweden, Germany and the Netherlands are the most inventive countries in 2013. In term of population, Japan has maximum

patent families (119), ahead of Switzerland (109). Finland, Israel, Korea, United States have ratios above the average OECD patent families per million habitants.

Most countries' inclination towards patent has amplified since 2003. But Belgium, Finland and the Netherlands are the exceptions. China and India are amid the lowest patenting tendency, with less than 0.298 triadic patent families per million populations, but this percentage is growing swiftly.

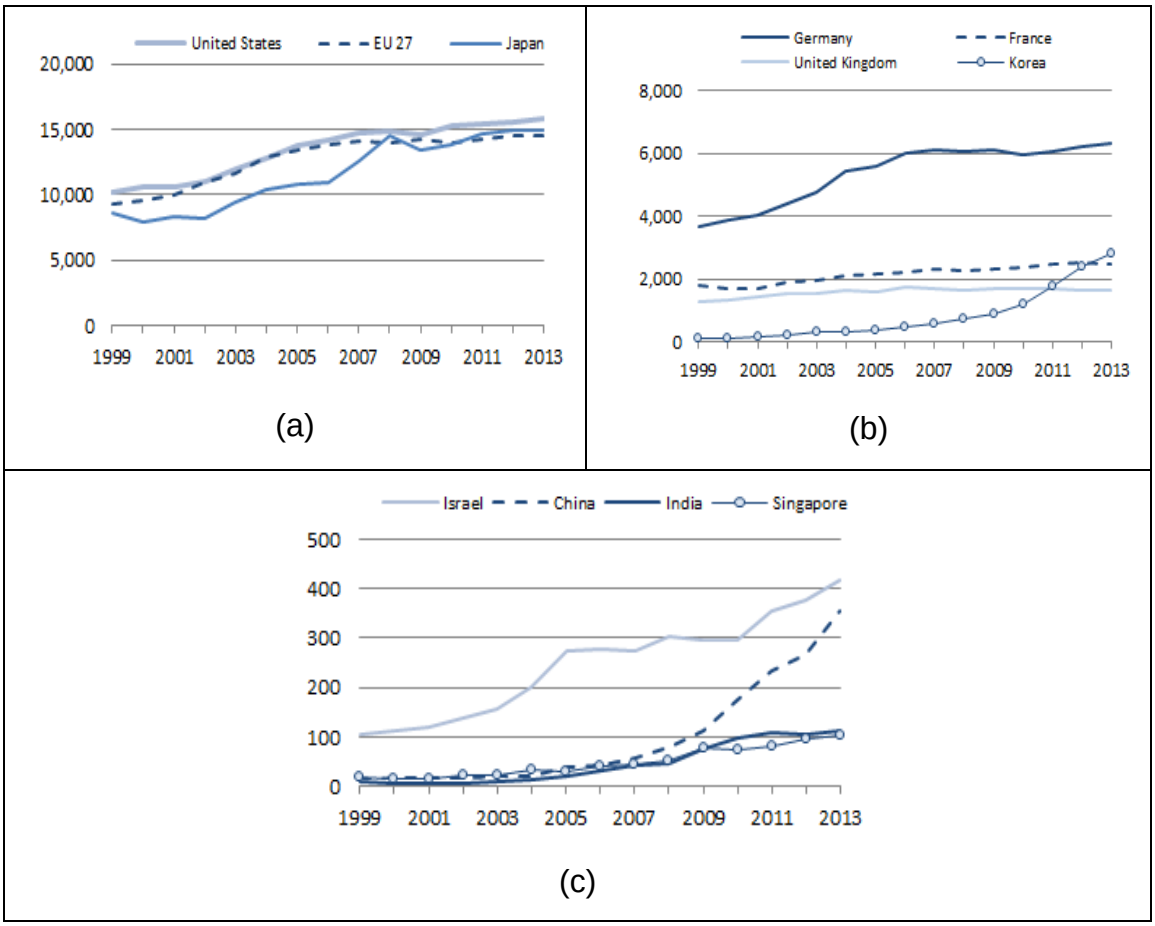
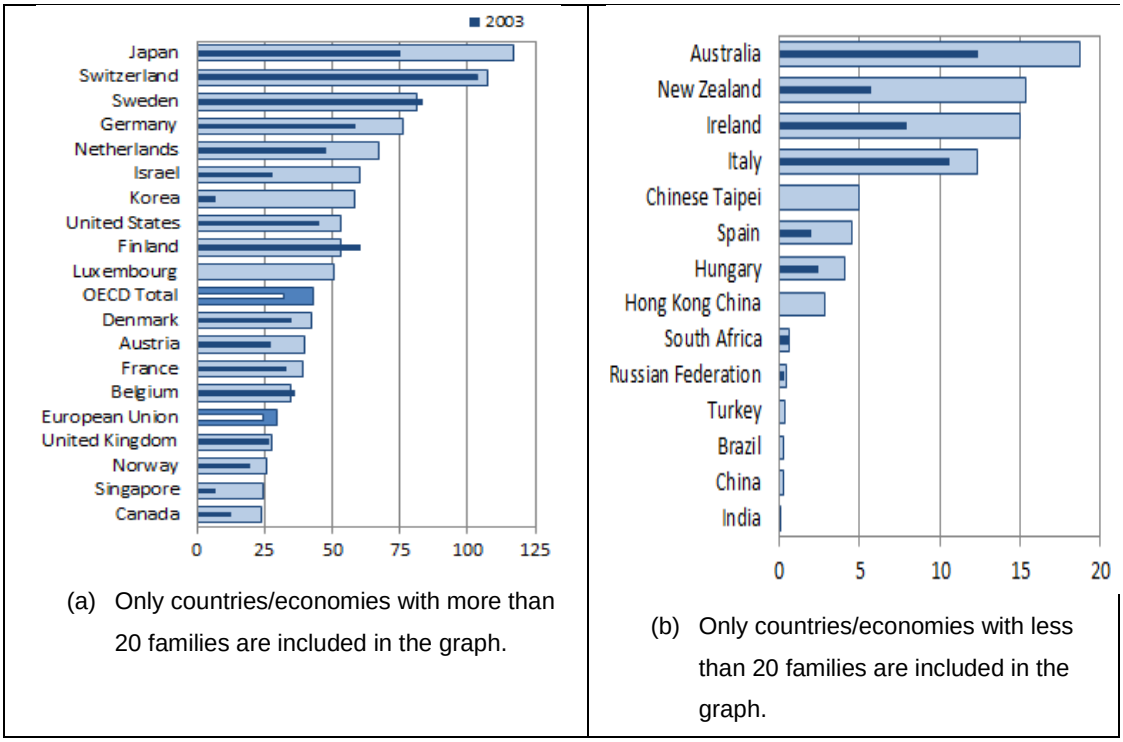


Figure 4.4: Trends in triadic patent families (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)



(a) Only countries/economies with more than 20 families are included in the graph.

(b) Only countries/economies with less than 20 families are included in the graph.

Figure 4.5: Triadic patent families per million population (*Source: Created by author based on data retrieved from* [*http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*](http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB))

4.3.1.3 Ratio of triadic patent families to industry financed GERD

Gross Domestic Expenditures on R&D (GERD) is basically an OECD nomenclature to define the total expenditure incurred on research and development within the domestic boundaries of any country in a given period of time.

The main OECD region's patent intensity has a steadier pattern than the other three major regions, in which Japan has had the maximum patent intensity, when peak was observed. Earlier, it had similar patent intensity to that of the European Union. On the other hand, United States' patent intensity is beneath the OECD average. This is due to the fact that there is a great upsurge in industry-financed R&D as compared to triadic patent families, specifically in the late 2000. The patent families in European Union increased at a slower speed than the R&D expenditure. In contrast, in Japan the rate of increase in triadic families was more rapid than the R&D expenditure by industry sector.

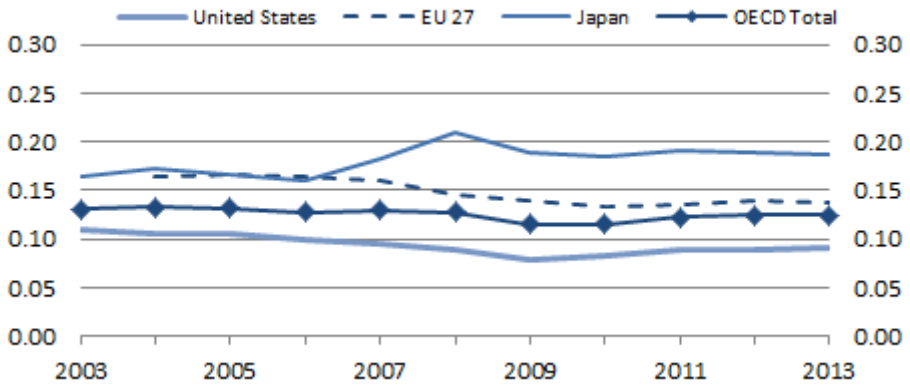


Figure 4.6 (a): Ratio of triadic patent families to industry financed GERD

(*Source: Created by author based on data retrieved from*

http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB)

Germany, France, the Netherlands, Switzerland and the United Kingdom were at the top most level in terms of patent intensity (above OECD average), from 1995 to 2005. The Netherlands gained the top position with more than 260 patent families per billion USD of R&D expenditure. Korea is soon catching up. Korea's triadic patent families' growth is four times higher that R&D expenditure.

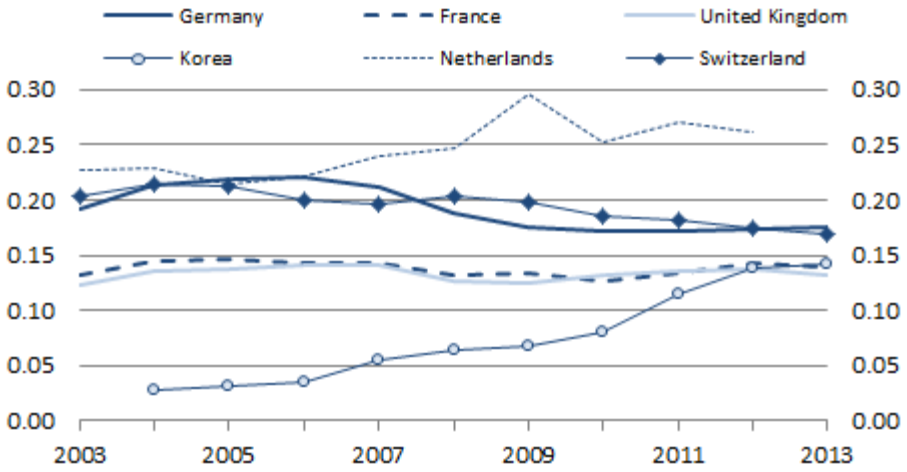


Figure 4.6(b) Ratio of triadic patent families to industry financed GERD

(*Source: Created by author based on data retrieved from*

http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB)

The stable levels of patent intensity were maintained by Canada, France, Germany and the United Kingdom from 2003-2013. Conversely, a sturdy decrease in this indicator was seen in Denmark, Finland, Israel and Sweden since mid-2000 because of the less number of triadic patent families originating from them in contrast with the R&D expenditure spent.

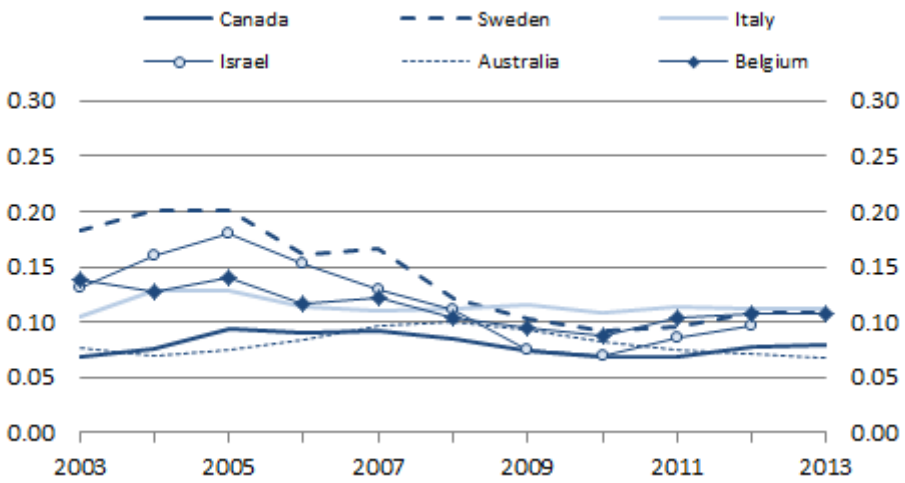


Figure 4.6 (c): Ratio of triadic patent families to industry financed GERD

(*Source: Created by author based on data retrieved from* [*http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*](http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB))

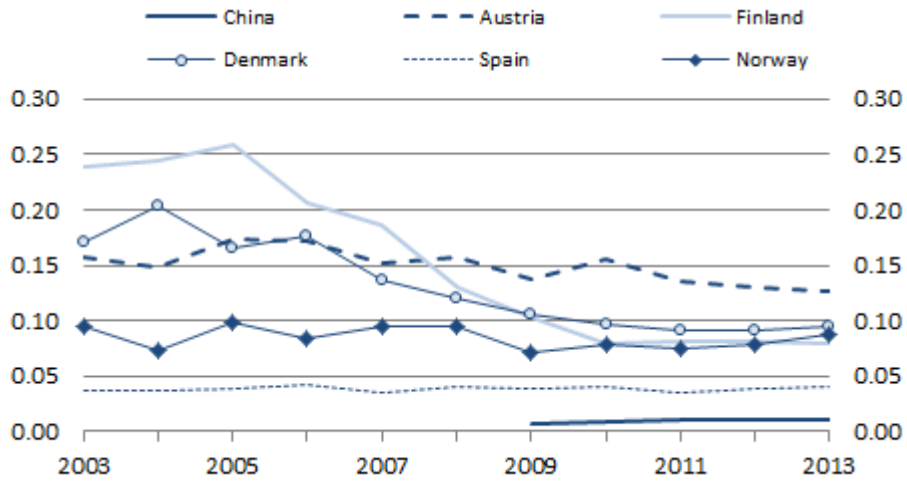


Figure 4.6 (d): Ratio of triadic patent families to industry financed GERD

(*Source: Created by author based on data retrieved from* [*http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*](http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB))

4.4 Patenting Activity at Regional Level

A broader scope of analyses to acknowledge the issues concerning the regional aspect of invention can be drawn by evaluating patent data by regions.

Innovation activities are not evenly dispersed throughout the country. Few regions are highly innovative while the rest show very little innovation. By analyzing patents by regions, the concentration of inventive activities throughout the country can be calculated. For instance, if the numbers of patents filed under PCT (Patent Co-operation Treaty) are broken down by region then inventive regions, that are significant source of the world's knowledge, can be pointed out.

The PCT offers a flexibility to file a single international application at a single patent office to gain patent rights in a large number of countries. Additional 18months are offered to the applicants to decide whether he wants to file a national or regional (e.g. EPO) patent, and if they want to file then they get 30 months of the priority date. So, cause of international element, PCT application count is considered as an alternative indicator of countries' inventive activities.

The PCT process is progressively used for patent applications, with approximately 146 000 patents entitling the EPO for the priority year 2013. This growth is strongly linked with the amount of contracting states, which has doubled since the mid-1990s.

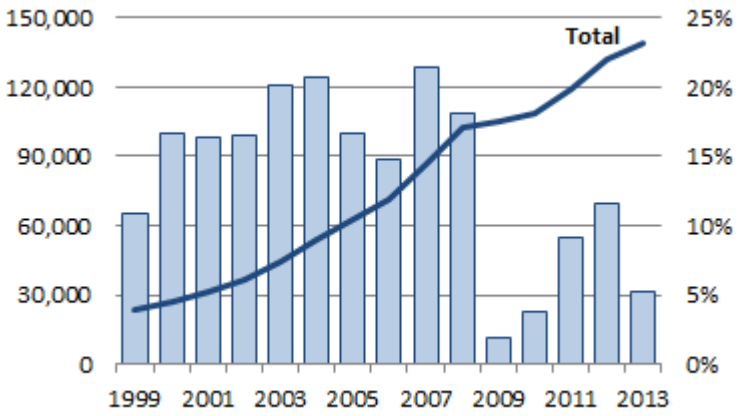


Figure 4.7: Filed patent applications & growth rate at PCT (*Source: Created by author based on data retrieved from* [*http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*](http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB))

Inventive activities are focused in small number of regions within countries. This degree of concentration in most of the countries is much higher than population. If OECD countries are considered then Switzerland has the lowest concentration ratio as compared to regions of large countries like Canada, Australia and Turkey.

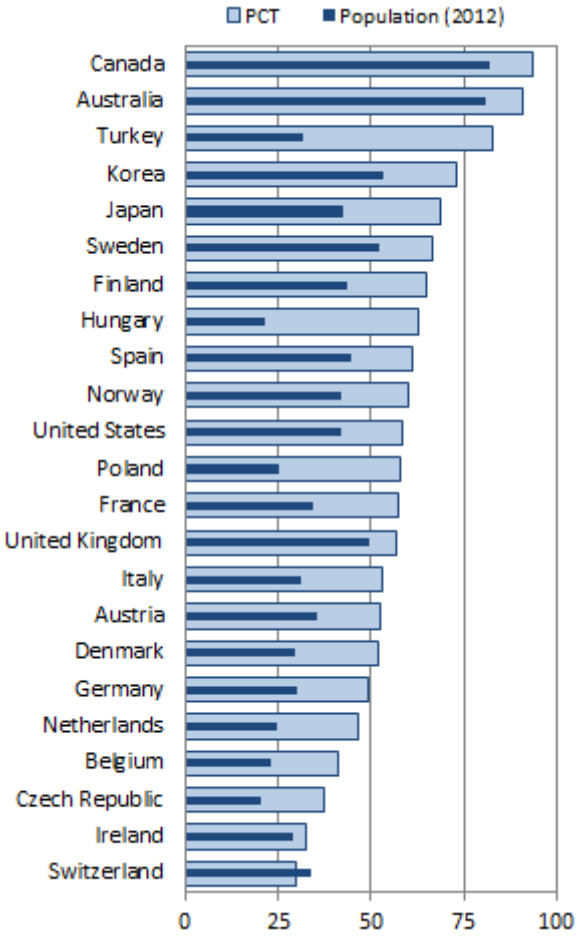


Figure 4.8: PCT regional level geographic concentration index (*Source: Created by author based on data retrieved from* [*http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*](http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB))

4.4.1 North America

In United States, only few regions are responsible for most of the PCT fillings. From 2003 to 2005, approximately 22.5 percent PCT patent applications were filed and applied by inventors residing in California (indicating the high level of inventiveness existing within that region of United States). The US Bureau of Economic Analysis (BEA) defined the regions of San Jose, Oakland and San Francisco which go in front with over 15900 applications in which 11.9% PCT applications were filled by the residents of US. The BEA regions accounting for 9.9% and 8.7 % PCT fillings are New York/Newark/Bridgeport and Boston/Worcester/Manchester, respectively. Almost 11% of all the PCT fillings are represented by these regions.

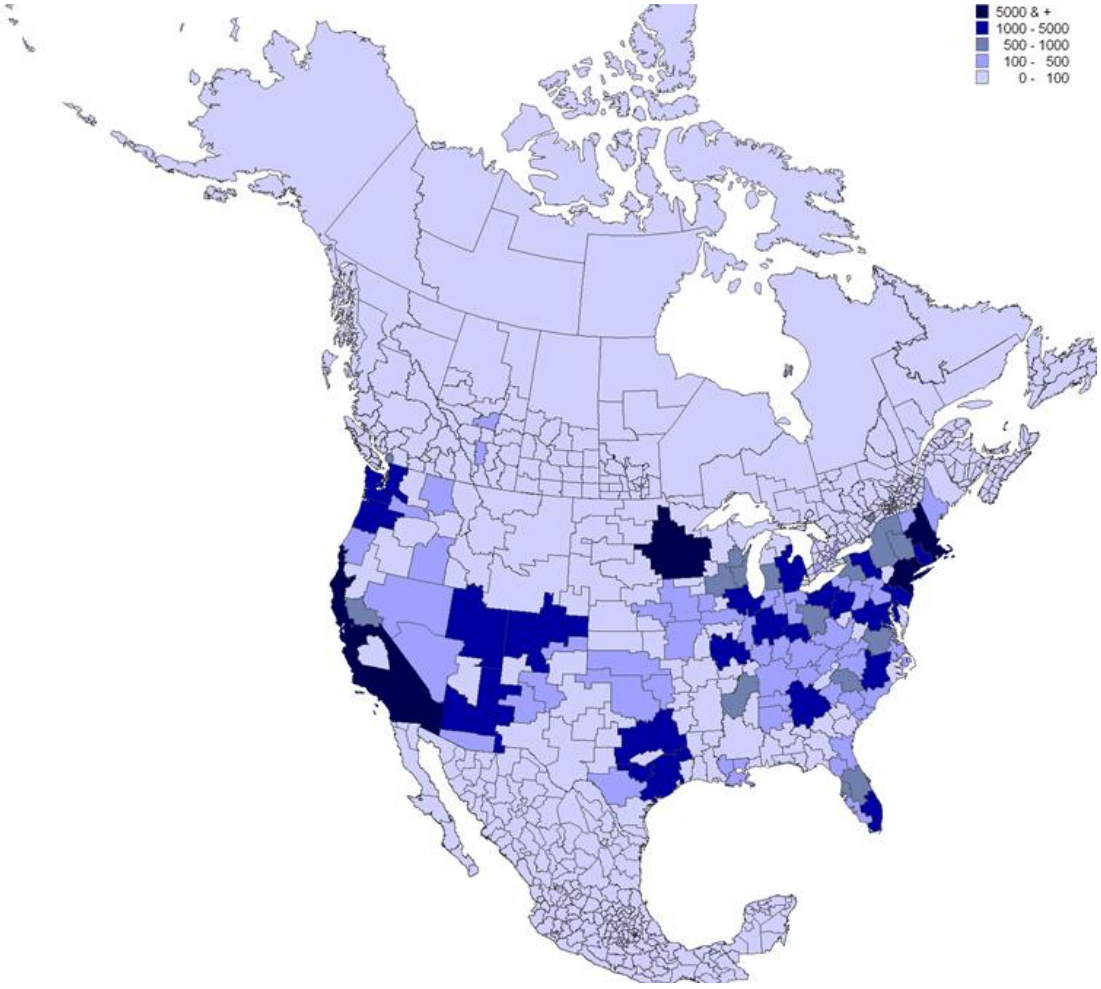


Figure 4.9: PCT Applications filed at North America (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

4.4.2 Europe

Most of the patenting activities in Europe are localised at the central regions like Nordic countries and United Kingdom. With nearly 5500 PCT fillings in 2011-2013, Noord-Brabant in Netherlands occupies the top position. This characterizes 4.5% PCT fillings in European Union and accounts for more than half in the Netherlands. Sttugart, Munich, Dusseldorf and region of Rhein-Main represent the top five inventive regions from Germany in the European Union. The regions just outside the top five are Stockholmslan and Paris.

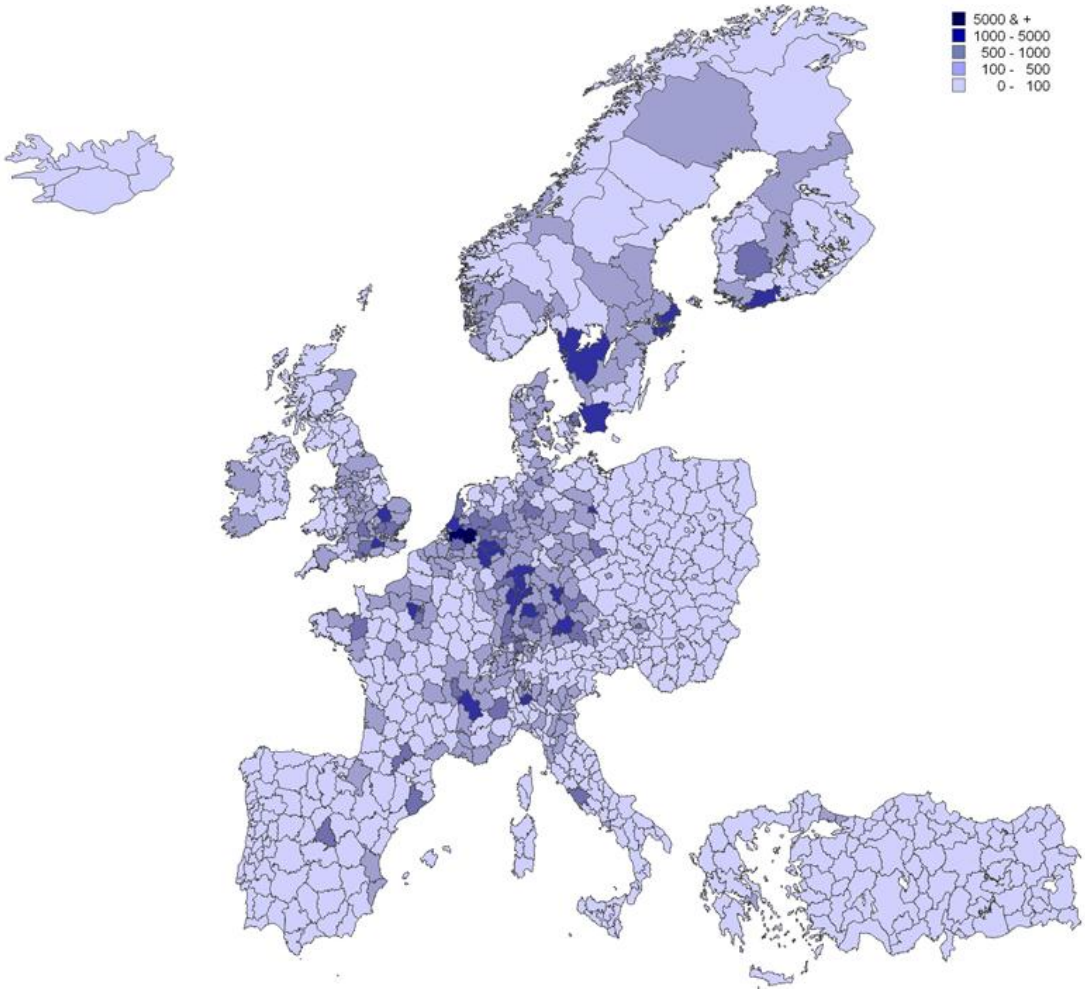


Figure 4.10: Filed PCT applications in Europe (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

4.4.3 Asia Pacific

PCT fillings originated from Japanese inventors (Tokyo, Kanagawa and Osaka) are the major patent application filling regions, representing half of the PCT fillings in Japan and nearly 8.2% of the PCT applications worldwide in 2011-2013. Tokyo ranks first in the world with 4.7% PCT fillings.

In Korea, Seoul and province of Gyeonggi-do are the regions that rank fifth worldwide in 2011-2013 with over 4900 PCT applications.

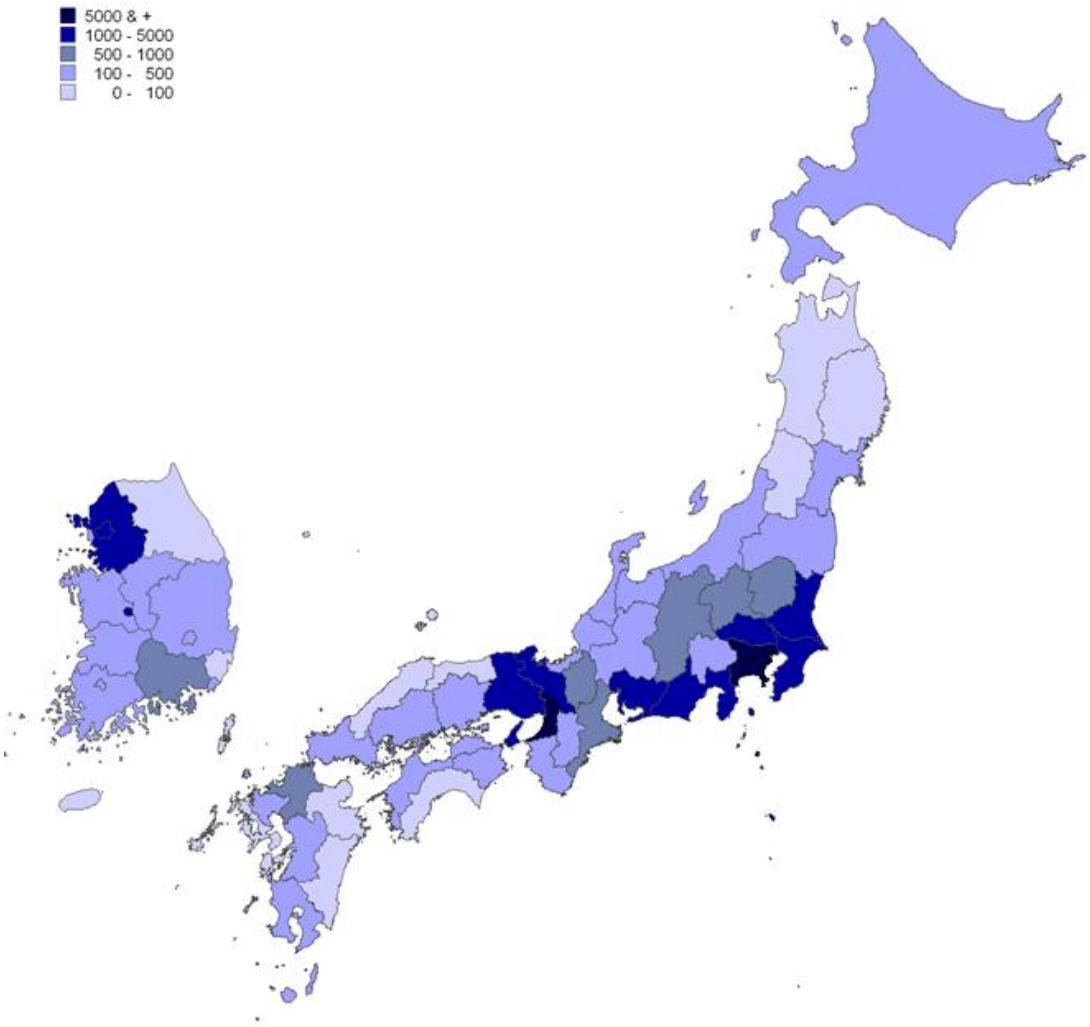


Figure 4.11: Filed PCT Applications in Japan/Korea (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

In Australia, Sydney and Melbourne are the most inventive regions, accounting for 53.9% of patent applications.

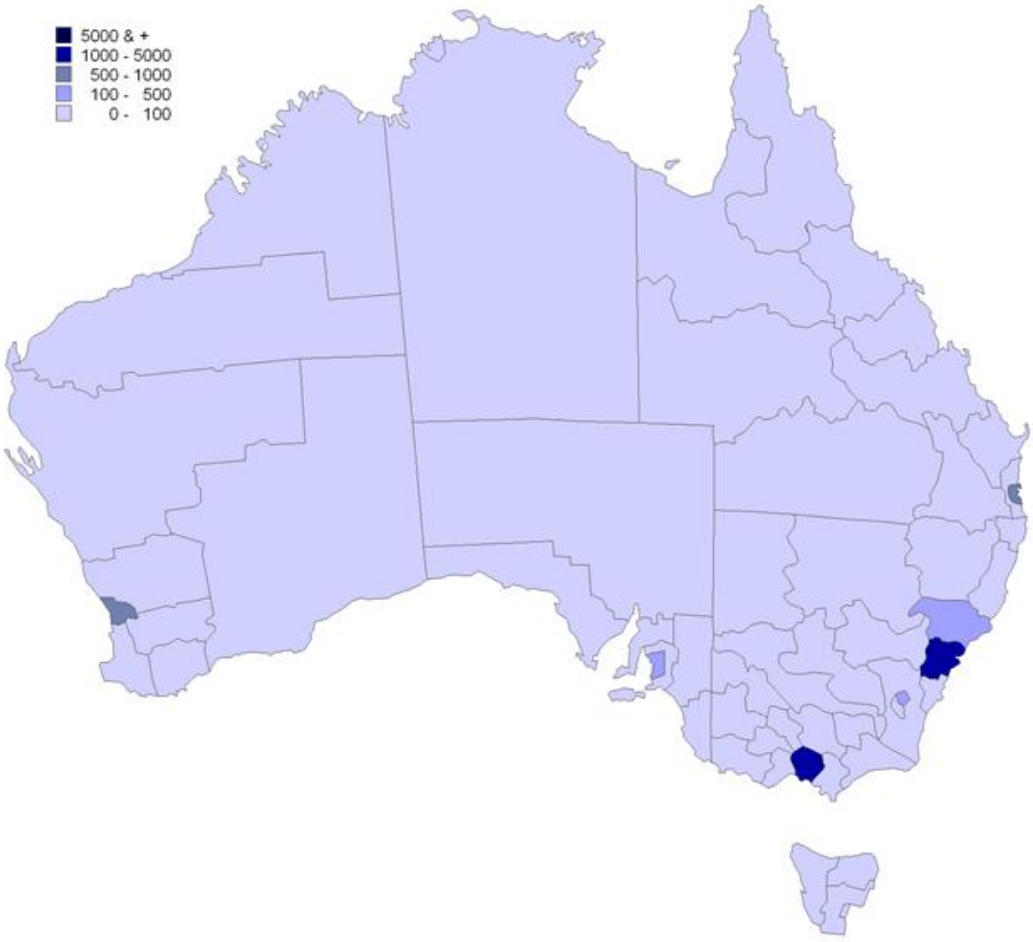


Figure 4.12: Filed PCT Applications in Australia (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

Among emerging countries, Guangdong (China) is the top ranking region with 2400 PCT applications in 2011-2013, leaving behind Beijing and Shanghai. In India, Maharashtra (mainly Mumbai), Karnataka (Bengaluru) and Andhra Pradesh (Hyderabad) are the most inventive regions.

4.5 Patenting New Technologies (in ICT)

International Patent Classification (IPC) system has been used for identifying and analysing patents in Information and Communication Technologies (ICT). Each patent is attributed with one or more classification codes during the examination process. However, the patent classification system has not yet included specific codes or categories for emerging technologies, which creates difficulty in identifying the patents associated with these technologies.

Based on the following IPC codes, the ICT-related patents can be classified into four categories as:

Field of Technology	IPC Classes & Definitions
Telecommunications	**G01S** - Radio direction-finding; radio navigation; determining distance or velocity by use of radio waves; locating or presence-detecting by use of the reflection or reradiation of radio waves; analogous arrangements using other waves **G08C** - Transmission systems for measured values, control or similar signals **G09C** - Ciphering or deciphering apparatus for cryptographic or other purposes involving the need for secrecy **H01P** - Waveguides; resonators, lines or other devices of the waveguide type **H01Q** - Aerials **H01S 3/00** - Lasers, i.e. devices for generation, amplification, modulation, demodulation, or frequency-changing, using stimulated emission, of infra-red, visible, or ultra-violet waves **H03B** - Generation of oscillations, directly or by frequency-changing, by circuits employing active elements which operate in a non-switching manner; generation of noise by such circuits **H03C** - Modulation **H03D** - Demodulation or transference of modulation from one carrier to another **H03H** - Impedance networks, e.g. resonant circuits; resonators **H03M** - Coding, decoding or code conversion, in general **H04B** - Transmission **H04J** - Multiplex communication **H04K** - Secret communication; jamming of communication **H04L** - Transmission of digital information, e.g. telegraphic communication **H04M** - Telephonic communication **H04Q** - Selecting (switches, relays, selectors ; wireless communication networks)
Consumer Electronics	**G11B** - Information storage based on relative movement between record carrier and transducer **H03F** - Amplifiers **H03G** - Control of amplification **H03J** - Tuning resonant circuits; selecting resonant circuits **H04H** - Broadcast communication **H04N** - Pictorial communication, e.g. television **H04R** - Loudspeakers, microphones, gramophone pick-ups or like acoustic electromechanical transducers; deaf-aid sets; public address systems **H04S** - Stereophonic systems

Computers, Office Machinery	**B07C** - Postal sorting; sorting individual articles, or bulk material fit to be sorted piece-meal, e.g. by picking **B41J** - Typewriters; selective printing mechanisms, i.e. mechanisms printing otherwise than from a forme; correction of typographical errors **B41K** - Stamps; stamping or numbering apparatus or devices **G02F** - Devices or arrangements, the optical operation of which is modified by changing the optical properties of the medium of the devices or arrangements for the control of the intensity, colour, phase, polarisation or direction of light, e.g. switching, gating, modulating or demodulating; techniques or procedures for the operation thereof; frequency-changing; non-linear optics; optical logic elements; optical analogue/digital converters **G03G** - Electrography; electrophotography; magnetography **G05F** - Systems for regulating electric or magnetic variables **G06** - Computing; calculating; counting **G07** - Checking-devices **G09G** - Arrangements or circuits for control of indicating devices using static means to present variable information **G10L** - Speech analysis or synthesis; speech recognition; speech or voice processing; speech or audio coding or decoding **G11C** - Static stores **H03K** - Pulse technique **H03L** - Automatic control, starting, synchronisation, or stabilisation of generators of electronic oscillations or pulses
Other ICT	**G01B** - Measuring length, thickness or similar linear dimensions; measuring angles; measuring areas; measuring irregularities of surfaces or contours **G01C** - Measuring distances, levels or bearings; surveying; navigation; gyroscopic instruments; photogrammetry or videogrammetry **G01D** - Measuring not specially adapted for a specific variable; arrangements for measuring two or more variables not covered by a single other subclass; tariff metering apparatus; transferring or transducing arrangements not specially adapted for a specific variable; measuring or testing not otherwise provided for **G01F** - Measuring volume, volume flow, mass flow, or liquid level; metering by volume **G01G** - Weighing **G01H** - Measurement of mechanical vibrations or ultrasonic, sonic or infrasonic waves **G01J** - Measurement of intensity, velocity, spectral content, polarisation, phase or pulse characteristics of infra-red, visible or ultra-violet light; colorimetry; radiation pyrometry **G01K** - Measuring temperature; measuring quantity of heat; thermally-sensitive elements not otherwise provided for **G01L** - Measuring force, stress, torque, work, mechanical power, mechanical efficiency, or fluid pressure **G01M** - Testing static or dynamic balance of machines or structures; testing of structures or apparatus, not otherwise provided for **G01N** - Investigating or analysing materials by determining their chemical or physical properties **G01P** - Investigating or analysing materials by determining their chemical or physical properties

	G01R - Measuring electric variables; measuring magnetic variables **G01V** - Measuring electric variables; measuring magnetic variables **G01W** - Meteorology (radar, sonar, lidar or analogous systems, designed for meteorological use) **G05B** - Control or regulating systems in general; functional elements of such systems; monitoring or testing arrangements for such systems or elements **G08G** - Traffic control systems **G09B** - Educational or demonstration appliances; appliances for teaching, or communicating with, the blind, deaf or mute; models; planetaria; globes; maps; diagrams **H01J** - Electric discharge tubes or discharge lamps **H01L** - Semiconductor devices; electric solid state devices not otherwise provided for

Table 4.4: Definitions of IPC Classifications considered for ICT application patents analysis (*Source: http://web2.wipo.int/ipcpub/#refresh=page*)

The number of patents in the ICT sector indicates a steady growth from mid 2000s to 2013, having 4.9% as an average rate per year from 2003. In the year 2013, more than 65000 ICT-related patent applications were submitted and filed under PCT. The inventions under the ICT sector have been surging with respect to total number of PCT applications. Hence, on an average, the ICT-related patents dominate the countries' patent index.

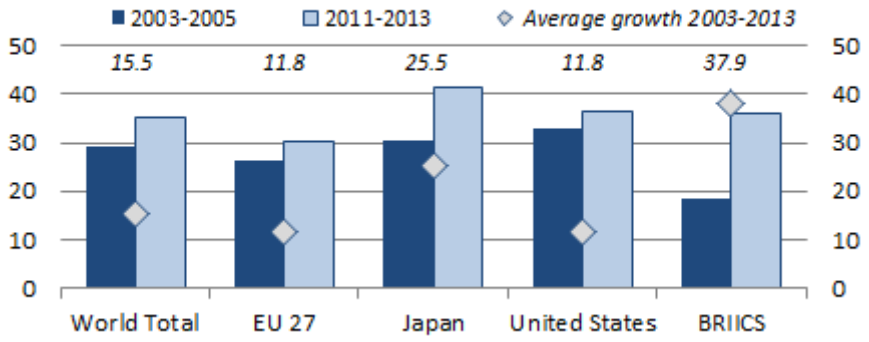


Figure 4.13: ICT patents share in total patents (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

Considering the duration 2003-2005, out of the total patents considered by different countries, the portion belonging to the ICT-related patents increased by five percent in 2011-2013. However the situation in the BRIICS countries was different where ICT related patents formed 37.9% percent part of the total mass (almost 1/3rd of the entire chunk), making the proportion double

than before. The technological advance patent index showed that the countries Finland, China, Finland, Japan, Singapore, the Netherlands and Korea consisted of a large number of ICT-related patents as compared to all other countries.

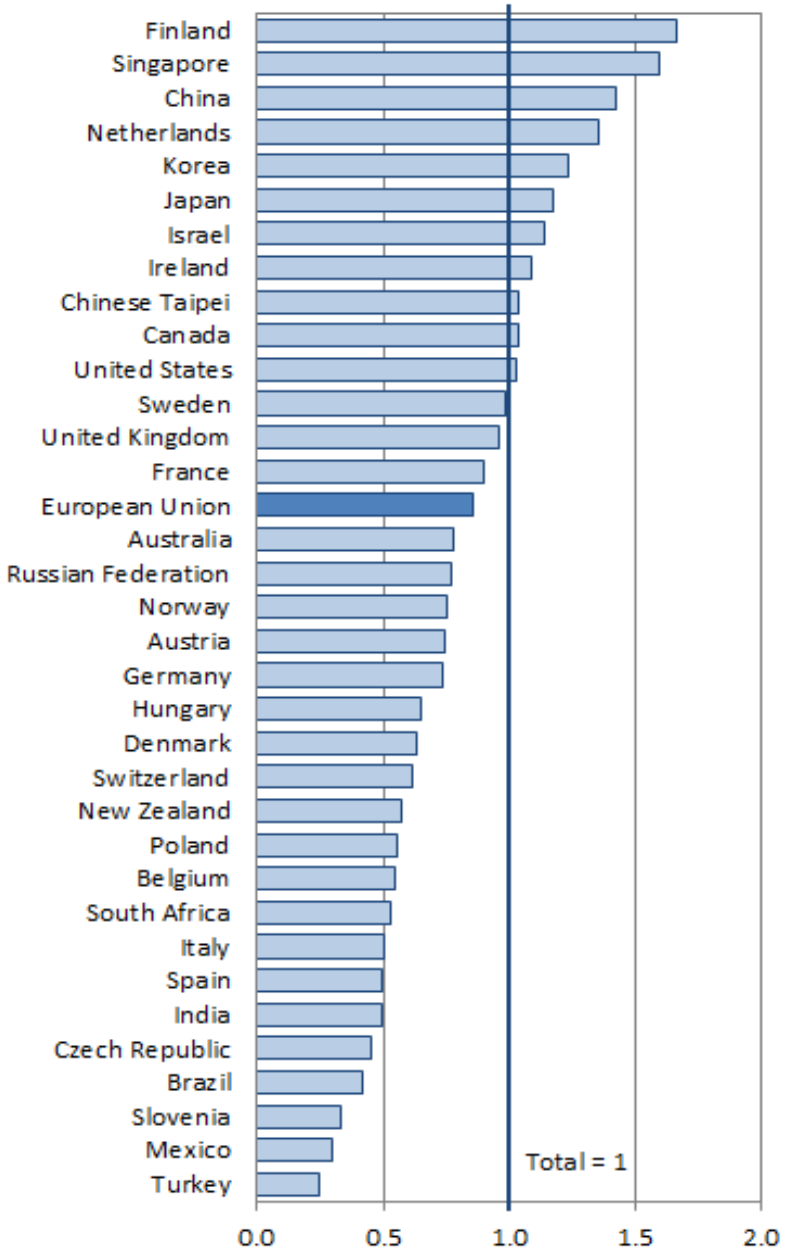


Figure 4.14: Share of country's ICT patents relative to ICT share in total patents (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

In the year 2013, The United States (35%), Japan (18.6%), Germany (8.3%), Korea (6%) and China (5.5%) were the front runners in filing ICT-related patents under the PCT. During the year 2013, China with above 2300 patents and Korea with more than 2500 patents have become the top contributors of ICT-related patents.

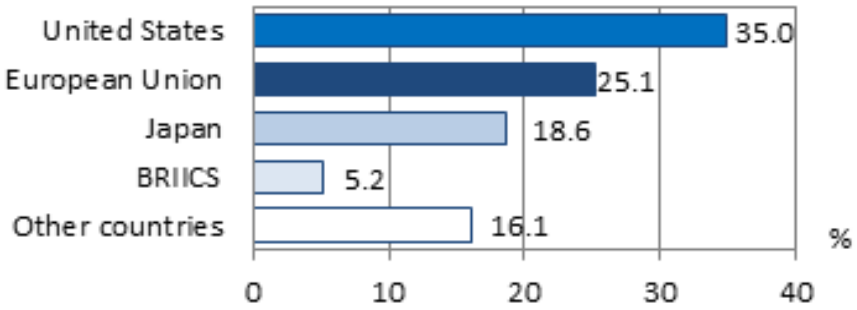


Figure 4.15: Share of economies in ICT patents (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

With 7.9 percent of the ICT-related PCT filed patents, Tokyo has become a chief region crediting itself to nearly 9700 ICT patents. Following Tokyo, there are San Francisco/Oakland/San Jose and New York/Bridgeport/Newark of United States. Below these, with 4700 ICT-related patents, Seoul in Korea stands on fourth position. While in the European landscape, France, the Netherlands and Germany are leading in ICT patenting. Crediting itself with 55.7% of the ICT-related inventions in China, the city of Shenzhen has now entered the top fifteen ICT-related patenting regions.

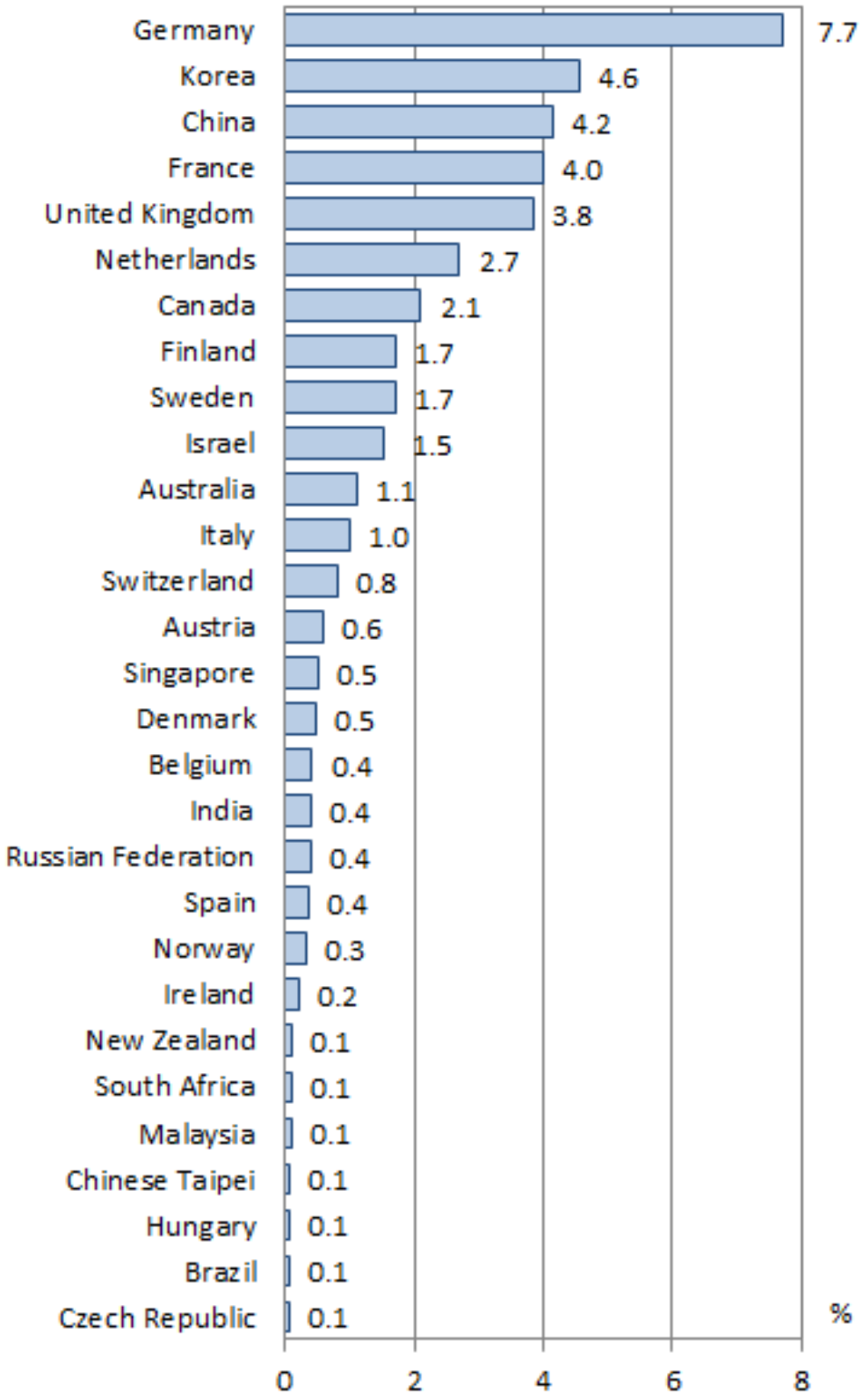


Figure 4.16: Share of countries in ICT patents (*Source: Created by author based on data retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*)

4.6 Amalgamated Indicator

Let

A_i = value of i^{th} actual distinct indicator

B_j = value of j^{th} comparative distinct indicator

W_i = weight assigned to i^{th} actual indicator

W_j = weight assigned to j^{th} comparative indicator

The following steps were used by Tae K.R and Yoo J.H (2011) to devise an amalgamated indicator and use it for ranking 30 international countries:

1. All the actual distinct parameters values are considered after doing the square roots of their true values. This is done with the aim of decreasing the gaps between the respective values of each actual indicator. Values obtained for the comparative indicators are used without any mathematical formulation.
2. The values obtained in the above step are further recalibrated to obtain the normalized values (X_i and X_j).
3. Recalibrated values (X_i and X_j) are multiplied by their respective weights (W_i and W_j).
4. The values obtained in step 3 are summed up for each respective national entity to obtain the total score (Z).

$$\boxed{Z = 100 \times [Sum(X_i \times w_i) + Sum(X_j \times w_j)]}$$

Where,

$$\boxed{X_i = \frac{(\sqrt{A_i} - Min)}{(Max - Min)}}$$

And

$$\boxed{X_j = \frac{(B_j - Min)}{(Max - Min)}}$$

The authors used Analytical Hierarchy Process (AHP) to determine, assign and add relative importance to each distinct indicator in consultation with more than 40 patent experts/consultants (they adopted a sample methodology to identify the experts and consultants). To derive and reach to

a final weight for each distinct indicator, the weighting values were multiplied in an upstream style till the topmost hierarchical level of that indicator. The final weights as assigned to each indicator after following the above mentioned methodology were as follows:

Indicator	Weighting value
Foreign and domestic Patent application count	0.06
Foreign and domestic Patent application count/ 10K Inventors	0.10
Triadic patent application count	0.04
Triadic patent application count / 10K Inventors	0.10
Count of patent examinations	0.08
Patent examinations count/ Number of patent examiners	0.10
PCT international search report count	0.07
PCT international search report count / Number of patent examiners	0.05
Enforced patents	0.07
Enforced patents / Firms in knowledge-based industries	0.13
Value-added within knowledge-based industries	0.06
Value-added within knowledge-based industries / Firms in knowledge-based industries	0.14

Table 4.5: Weights assigned to distinct indicator using AHP (*Source: https://www.indiaenvironmentportal.org/*)

Although countries such as New Zealand, Australia, Canada, Spain, Mexico, Poland, Norway, Hungary and Turkey are well ahead in terms of number of domestic patent applications, they are way behind and rank lower on the composite patent indicator assessment.

Other countries such as Luxembourg, Denmark, Ireland, Netherlands, Belgium, Austria and Switzerland remain uncompetitive on the domestic applications count, but score higher on the composite indicator assessment.

RANK	COUNTRY	PATENT PERFORMANCE INDICATOR SCORE (2013)	PATENT PERFORMANCE INDICATOR SCORE (2007)	PERCENTAGE CHANGE
1	Japan	104.6	74.6	40.28
2	United States	85.1	54.1	57.30
3	Netherlands	67.2	52.2	28.73
4	Switzerland	61.0	51.0	19.60
5	Germany	55.9	45.9	21.70
6	Korea	48.3	38.3	26.10
7	Australia	46.4	26.5	75.09
8	Canada	46.0	25.9	79.15
9	United Kingdom	44.5	36.4	24.25
10	Finland	43.5	25.7	69.26
11	France	40.7	34.5	17.97
12	Denmark	38.4	30.4	26.31
13	Austria	36.5	30.7	18.89
14	Ireland	36.1	36.0	0.27
15	Sweden	35.7	34.5	3.47
16	New Zealand	34.2	22.0	55.45
17	Belgium	32.6	24.0	35.83
18	Norway	32.4	22.4	44.64
19	Italy	32.0	24.2	32.23
20	Luxembourg	29.4	21.1	39.33
21	Spain	29.2	19.2	52.08
22	Iceland	26.9	15.7	71.33
23	Czech Republic	25.7	16.9	52.07
24	Hungary	25.2	15.2	65.78
25	Greece	16.6	14.6	13.69
26	Portugal	15.9	12.7	25.19
27	Mexico	15.7	12.9	21.70
28	Slovak Republic	14.1	12.1	16.53
29	Poland	11.5	9.0	27.77
30	Turkey	11.2	10.5	06.66

Table 4.6: Ranking of OECD member countries on amalgamated indicator

(*Source: Created by author based on data retrieved from* *http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB* *and* *http://www.wipo.int/ipstats/en/*)

4.7 Conclusions

An amalgamated indicator proposed by Tae-Kyu Ryu and Yoo-Jin Han (2012) has been used to assess the 30 countries in order of their patenting performance and find the differences in their ranking based on data obtained in 2013 vis-à-vis 2007 (data for earlier conducted study). Some of the findings as observed after the comparison of 2013 ranking with 2007 rankings are as follows: -

a) While Japan, United States, Germany, Netherlands, Switzerland and Korea have been able to maintain their respective positions in 2013 on the amalgamated indicator rankings, United States has progressed at a tremendous rate (57.30%) followed by Japan (40.28%) amongst these countries.
b) Some countries such as Canada (79.15%), Australia (75.09%), Iceland (71.33%), Finland (69.26%), Hungary (65.78%), New Zealand (55.45%) and Spain (52.07%) have shown a significant improvement and radical pace towards enhancing their patenting activities from 2007 to 2013.
c) Countries such as Turkey (6.66%), Sweden (3.47%) and Ireland (0.27%) have not changed much on the amalgamated patenting indicator score.
d) Other countries have shown a considerable improvement in their individual patenting scores on the amalgamated indicator and have a score improvement in the range of (10-30%).

While analysing the triadic patent applications and PCT filed applications, the trend although showing an enormous increase in early 2000s, slowed down at most regional patent offices around 2005. While triadic patent applications grew at a steady rate of 3.5% YOY from 2008 to 2013, PCT patent applications grew at 6% during the same tenure. China was an exception, reporting the national patent application filings grow at a constant rate of around 22.3% every year for last 10 years.

4.8 Limitations

1. Research has been carried out based on secondary data available at various patent databases (i.e. WIPO, OECD, Thomson and Relecura). For the research, no primary data collection has been done.

4.9 Future Scope

1. As done for patenting analysis at a global, regional and national level for triadic patent applications and PCT filed applications, similar kind of in-depth analysis can be conducted for all the other mentioned individual indicators.

5. BIBLIOGRAPHY

B1. John Hagedoorn and Myriam Cloodt, 2002. Measuring Innovative Performance: is there an advantage in using multiple indicators? Research Policy 32 (2003) 1365–1379.

B2. Tae-Kyu Ryu and Yoo-Jin Han, 2012. Indicator for Evaluating National Patent Performance: Comparative Analysis among the 30 OECD countries. Journal of Intellectual Property Rights, Vol 17, pp 103-110.

B3. WIPO Statistics on Patents, URL: http://www.wipo.int/ipstats/en/

B4. OECD Science and Technology (Patent) Statistics, URL: http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB.

B5. Leif Denti. Measuring Innovation part 1: Frequently Used Indicators; URL: http://www.innovationmanagement.se/2013/02/15/measuring-innovation-part-1-frequently-used-indicators/

6. REFERENCES

1. Acs, Z.J., Audretsch, D.B., 1989. Patents as a measure of innovative activity. Kyklos 4, 171–180.
2. Ahuja, G., Katila, R., 2001. Technological acquisition and the innovative performance of acquiring firms: a longitudinal study. Strategic Management Journal 22, 197–220.
3. Albert, M.B., Avery, D., Narin, F., McAllister, P., 1991. Direct validation of citation counts as indicators of industrially important patents. Research Policy 20, 251–259.
4. Archibugi C and Coco A, Measuring technological capabilities at the country level: A survey and a menu for choice, Research Policy, 34 (2) (2005) 175-194.
5. Archibugi, D., 1992. Patenting as an indicator of technological innovation: a review. Science and Public Policy 6, 357–358.
6. Arundel, A., Kabla, J., 1998. What percentage of innovations are patented? Experimental estimates in European firms. Research Policy 27, 127–142.
7. Aspden, H., 1983. Patent statistics as a measure of technological vitality. World Patent Information 5, 170–173.
8. Bresman, H., Birkenshaw, J., Nobel, R., 1999. Knowledge transfer in international acquisitions. Journal of International Business Studies 30, 439–462.
9. Brouwer E. and Kleinknecht A., 1999. Innovative output and a firm's propensity to patents: an exploration of CIS micro data. Research Policy 28, 615 – 624.
10. Cantwell, J., Hodson, C., 1991. Global R&D and UK competitiveness. In: Casson, M. (Ed.), Global Research Strategy and International Competitiveness. Blackwell Scientific Publications, Oxford, pp. 133–182.
11. Cohen, W.M., Levin, R.C., 1989. Empirical studies of innovation and market structure. In: Schmalensee, R., Willig, R. (Eds.), Handbook of Industrial Organization, vol. 2. Elsevier, Amsterdam, pp. 1059–1107.

12. Devinney, T.M., 1993. How well do patents measure new product activity? Economic Letters 41, 447–450.
13. Dosi, G., 1988. Sources, procedures, and microeconomic effects of innovation. Journal of Economic Literature 26, 1120–1171.
14. Duysters G and Hagedoorn J, 2001. Do company strategies and structures converge in global markets? Evidence from the computer industry. Journal of International Business Studies 32, 347 – 356.
15. Ernst, H., 2001. Patent applications and subsequent changes of performance: evidence from time-series cross-section analyses on the firm level. Research Policy 30, 143–157.
16. Freeman, C., Soete, L., 1997. The Economics of Industrial Innovation. Pinter, London.
17. Fu X and Yang Q G, (2010), Exploring the cross-country gap in patenting: A stochastic frontier approach, Research Policy, 38 (7) 1203 – 1213.
18. Global Competitiveness Report (WEF, Geneva), 2007
19. Griliches, Z., 1990. Patent statistics as economic indicators: a survey. Journal of Economic Literature 28, 1661–1697.
20. Griliches, Z., 1998. R&D and Productivity: The Econometric Evidence. The University of Chicago Press, Chicago.
21. Harhoff, D., Narin, F., Scherer, F.M., Vopel, K., 1999. Citation frequency and the value of patented inventions. Review of Economics and Statistics 81, 511–515.
22. Hirschey M and Richardson V J, Are scientific indicators of patent quality useful to investors? Journal of Empirical Finance, 11 (1) (2004) 91-107.
23. Hitt, M.A., Hoskisson, R.E., Johnson, R.A., Moesel, D.D., 1996. The market for corporate control and firm innovation. Academy of Management Journal 39, 1084–1119.
24. Lerner, J. (1994), “The Importance of Patent Scope: An Empirical Analysis”, RAND Journal of Economics, 25(2): 319-333.
25. Michel, J., Bettels, B., 2001. Patent citation analysis: a closer look at the basic input data from patent search reports. Scientometrics 51, 185–201.
26. Nelson, R., Winter, S., 1982. An Evolutionary Theory of Economic Change. Harvard University Press, Cambridge, MA.

27. Patel, P., Pavitt, K., 1995. Divergence in technological development among countries and firms. In: Hagedoorn, J. (Ed.), Technical Change and the World Economy: Convergence and Divergence in Technology Strategies. Edward Elgar, Aldershot, pp. 147–181.
28. Pavitt, K., 1988. Uses and abuses of patent statistics. In: van Raan, A.F.J. (Ed.), Handbook of Quantitative Studies of Science and Technology. Elsevier, Amsterdam, pp. 509–536.
29. Rosenkopf L and Nerkar A., 2001. Beyond local search: boundary – spanning, exploration, and impact in the optical disk industry. Strategic Management Journal 22, 287 – 306.
30. Scherer, F. M. (1965). “Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions”, American Economic Review, 55(5): 1097-1125.
31. Stuart, T.E., 2000. Inter-organizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry. Strategic Management Journal 21, 791–811.
32. World Competitiveness Yearbook (IMD, Lausanne), 2005.