Master's Thesis of International Studies

Analysis on PCT International Patent Application by Country and its Significance from 2000 to 2018

PCT 국제 특허출원의 국가별 분석 및 의의: 2000-2018년

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Abstract

Intangible property as well as tangible property have become pivotal components in the market economy and in the international digital era. Compared to tradable goods and services in the traditional economic system, the importance of intangible assets has gradually increased across the borders, where the ownership of Intellectual Property Rights (IPR) can directly lead to incentives for inventors. Along with the increase in the number of patent applications of new technology since 2000, the patent data can be used as one of the indicators reflecting the degree of technological development. Due to the territorial principle of patent rights, the inventors (firms or individuals) who seek for the enforcement of patent rights in foreign countries are required to submit patent applications, direct foreign applications (via a regional route or a national route) or Patent Cooperation Treaty (PCT) international applications, to the desired countries. Under the country-specific environment of IPR, "international patent" does not exist, but the procedures for foreign or international patent application are available for the initiation of the cross-border ownership of patent rights.

Each country has its unique feature of innovative activities and IP-related market structure, even though there have been cooperative efforts to harmonize the variety of domestic patent rules and regulations with an international standard driven by World Intellectual Property Organization (WIPO) and World Trade Organization (WTO). Accordingly, it is crucial to review the characteristics of countries indicating the noticeable activities of international patent applications not only from technological aspects but also from economic aspects. In this study, the data of international patent applications is selected and examined to present the innovation status of each country. More specifically, the pattern of international patent applications and its entry in the designated foreign country are interpreted in terms

of the international trade, particularly intensive and extensive margins of the potential exports, considering the circumstance that application and registration of patent rights are an essential prerequisite for the certain products (inventions) to be exported henceforth.

Therefore, to understand the complex dynamics of the global patenting behavior, first, the patent statistics is investigated from several different aspects: types of applicants, either residents or non-residents; types of application options, either a direct route or a PCT route; and types of offices, the Receiving Offices (RO) for initially filing PCT international applications based on the applicant's origin, and the designated offices for finally accepting the PCT applications, PCT national phase entry (NPE) at destination. Second, after dealing with the general trends of patent statistics since 2000, the data is focused on the linkage between the PCT international applications from the quantitative approach and PCT NPEs from the qualitative approach. The question of how the international patent applications are related to intensive margin and extensive margin is empirically approached by tracing the number of patents applied through the PCT system whether to enter the national stage. In addition, the result for simple regression analysis by year presents that the interaction between Gross Domestic Product (GDP) *per capita* and the number of PCT international applications is statistically significant and has the positive relationship. The simple regression analyses based on the aggregate data since 2000 are also statistically significant and indicate the positive relationships for the following three interactions between GDP *per capita* and intensive margin, between GDP *per capita* and extensive margin, and between GDP *per capita* and the total number of patents duplicated in multiple countries.

Keywords: Intellectual Property Rights (IPR), International Patent Application, PCT National Phase Entry, Intensive Margin, Extensive Margin

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List of Abbreviations

ARIPO	African Regional Intellectual Property Organization
CNIPA	China National Intellectual Property Administration
EAPO	Eurasian Patent Office
EM	Extensive Margin
EPO	European Patent Office
EUIPO	European Union Intellectual Property Office
GDPPC	Gross Domestic Product Per Capita
IB	International Bureau of WIPO
IM	Intensive Margin
IP	Intellectual Property
IPR	Intellectual Property Right
JPO	Japan Patent Office
KIPO	Korean Intellectual Property Office
NPE	National Phase Entry
PCT	Patent Cooperation Treaty
RO	Receiving Office
TRIPS	Agreement on Trade-Related Intellectual Property Rights
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Chapter I. Introduction

1.1 Purpose of Research

Intangible property as well as tangible property are a vital element in the market economy.[1] Compared to the conventional economic system dealing with goods and services for the trade, the significance of intangible assets has steadily increased in the international digital era, where the ownership of Intellectual Property Right (IPR) can unequivocally lead to incentives for inventors. The range of tradable items is expanded to copyrights of software programs, designs of smart phones, formula of pharmaceuticals, etc. Moreover, the share of intangibles in global value chain is higher than that of tangibles in the production of pharmaceuticals, chemicals, petroleum, computers and electronics.[2] In the era of "the fourth industrial revolution," the number of IT-related patents (the semiconductors, active solid-state devices, multiplex communications, and computer graphics) has noticeably

[1]Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee. 2008. "An Industrial Property Rights Strategy for Europe." Brussels, 16.7. COM (2008) 465 final, at p.3
[2]World Intellectual Property Report. 2017. "Intangible Capital in Global Value Chains." WIPO, at p.11.

increased since the mid-1990s.[3]

IPR is one type of exclusive property rights for the limited period of time, obtained from patents, trademarks, industrial designs, copyrights, and so forth, wherein the duration of IPR protection varies from country to country.[4] When inventors such as firms, individuals, governments or universities conduct the innovative activities, they seek for relevant IPR protection to prevent creative works or products from imprudent imitation and illegal duplication. When considering time and costs from filing international applications to granting IPR, the procedures for the IPR protection in the foreign countries are more complicated than those for domestic IPR protection. As a result, regarding the cross-border ownership of IPR, especially patent rights in this paper, the inventors take economic benefits such as marketability, productivity and profitability into account, when the patent registration of certain products is prioritized for the export to the foreign countries.

Due to the different scopes in domestic legislation, there have been cooperative efforts to harmonize various rules and regulations with an international standard, mainly implemented by two international organizations, World Intellectual Property Organization (WIPO) and World Trade Organization (WTO). Despite the efforts on international cooperation, the scope of patent rights varies by country in

[3]이지홍 임현경 정대영. 2018. 「4차 산업혁명과 한국의 혁신 역량: 특허자료를 이용한 국가 기술별 비교 분석, 1976-2015」. BOK 경제연구, 2018-01, 24, pp. 37-82.
[4]R.S. Khemani and D. M. Shapiro. 1993. "Glossary of Industrial Organization Economics and Competition Law." Fiscal and Enterprise Affairs, OECD.at p.49.

terms of protection and implementation. Furthermore, each country has its unique feature of inventive activities, patent-related market structure, and even national processes of Patent Cooperation Treaty (PCT) international applications. Consequently, it is crucial to review the characteristics of countries which have indicated the distinctive patenting patterns since 2000, reflecting the innovation degree in the high-technology industries.

Section II of this paper starts from briefly introducing the history of international treaties related to IPR, describing definitions and categories of IPR stipulated in international organizations and domestic legislation, and explaining features and processes of patent applications through the Paris routes (a direct national route or a direct regional route) and the PCT international route.

In Section III, the global trends of patenting behavior are observed by analyzing the statistical data of patent applications at an aggregate level: total patent applications based on Receiving Office (RO)[5] and country of origin (nationality of applicants); the number of PCT international applications; and the number of patents applied through the PCT system and entered in the national phase at destination and by origin.[6] The data is collected and arranged from two perspectives, some countries (Brazil, Mexico, India and Russia) receiving the great number of international patent applications, and other countries (mostly European countries such as Netherlands,

[5]WIPO. RO is the local patent office that inventors submit patent applications.
[6]WIPO Statistics Database.

Sweden and Switzerland) filing the most international patent applications.

In Section IV, the original PCT application at the international stage is traced with International Application (IA) number to the national stage, PCT National Phase Entry (NPE), by decomposing the whole assembled NPE data, eliminating the redundant data, and extracting the unique patent. After discussing the pattern from the initial international applications to the transferred NPE applications by country, the analysis is designed to interpret the number of PCT international patent applications linked to PCT NPEs in terms of intensive and extensive margins of the potential export flow. The intensive margin (IM) is measured by the unique number of NPE patents, and the extensive margin (EM) is calculated by the total number of duplicated NPE patents divided by the unique number of NPE patents. The calculated change by year of total intensive and extensive margins indicates the relatively great portion of IM and the small portion of EM in the international patenting trend. After the measurement of annual change in intensive and extensive margins, the evaluation focuses on the interaction between the number of PCT international applications as a dependent variable and Gross Domestic Product (GDP) *per capita* as an economic independent variable.

By using the simple regression methodology, first, the relationship between the number of PCT international applications and GDP *per capita* (GDPPC) is tested with 96 sampled countries by year from 2000 to 2017. While the data for the number of PCT international applications is derived from WIPO Statistics Database, the

separate data set calculated in Section 4.2 is used for the rest of regression analyses with 74 sampled countries. The results are statistically significant, and present the positive relationship, with regards to the interactions between IM and GDP *per capita*, between EM and GDP *per capita,* and between the total number of duplicated patents and GDP *per capita*.

In conclusion, Section V addresses major findings and implications of the paper. From the initial stage of the international patent application to the final stage that patents are transferred and absorbed in national application, the potential export flows in terms of intensive and extensive margins are implied by tracing the PCT international applications to PCT National Phase Entries.

1.1 Literature Review

It is widely accepted that patent data is the reflection of innovation driven by both firms and individuals, while the R&D expenditure data is mainly derived from large enterprises.[7] The implication of the critical relationship between the number of patents and R&D expenditures is that the patents can be used as an inventive indicator of different firms.[8] Considering the patent data as one of

[7]Jean O. Lanjouw, Ariel Pakes and Jonathan Putnam. 1996. "How to count patents and value intellectual property: Uses of patent renewal and application data." National Bureau of Economic Research. Working Paper 5741.
[8]Griliches, Zvi. December 1990. "Patent Statistics as Economic Indicators: A Survey."

innovation indicators, many studies have demonstrated the value of patents by the number of citations, the frequency of patent renewals, the size of patent family,[9] and the number of countries sharing the same patents applied and granted. Whereas the values of the invention itself and the applied patents are relatively low, the high value is put on the granted patents rather than the patents withdrawn or refused.[10]

With the advent of the PCT international patenting system responding to expectations in the globalization, the number of PCT international applications began to dramatically increase since 1985.[11] The PCT international application has been considered as a patent indicator, since the initial PCT international applications at filing offices are transferred to patent statistics at national or regional (designated) patent offices.[12] Filing patent applications at the appropriate patent office implies that the intention of an applicant is to sell (or export) a product with "the patent technology" in the specific market.[13] Thus, it is noteworthy to take both the initial submission of the PCT international application at the Receiving Offices and the

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Journal of Economic Literature, 24, 4, p.1661.

[9]OECD. "A patent family is defined as a set of patents taken in various countries to protect a single invention (when a first application in a country – the priority – is then extended to other offices."

[10]Guellec, Dominique, van Pottelsberghe de La Potterie, Bruno. 2000. "Applications, Grants, and the Value of Patents" *Economics Letters*, Vol.69(1), pp.109-114.

[11]Hariolf Gupp and Ulrich Schmoch. 1999. "Patent Statistics in the age of globalization: new legal procedures, new analytical methods, new economic interpretation." *Research Policy*, 377-396.

[12]Ulrich Schmoch. 1999. "Impact of International Patent Applications on Patent Indicators." Research Evaluation volume 8, number 2, pp. 119-131.

[13]Rainer Frietsch, Peter Neuhäusler, Taehyun Jung and BartVan Looy. September 2014. "Patent indicators for macroeconomic growth – the value of patents estimated by export volume." Technovation, Volume 34, Issue 9, p.546-558.

final destination of the PCT National Phase Entries at the designated offices into consideration.

The theoretical prediction in international trade is that innovation or technological development has impact on international trade which can generate economic growth. The technology transfer occurs from more innovative and advanced countries producing new items to less developed countries catching up the technology of production in the end, which can determine the pattern of international trade.[14] When it comes to exports in view of the role of IPR, there have been different positions toward strict IPR enforcement between developing and developed countries. From the perspective of developed countries, the strengthened IPR protection in developing countries raises the value of exports in patent-sensitive industries originated from developed countries.[15] The valid system for IPR protection in developing countries is desired to increase exports of technologically advanced products with the less concerns about infringement. Accordingly, the adequate IPR protection can be a key factor and the first step for export performances in the certain IP-intensive industries, such as software program, smart phones and electronic devices in the technology sector, and pharmaceuticals in the medical sector. From the point of view of developing countries, strong IPR regulations can cause the

[14]Krugman, Paul. 1979. "A Model of Innovation, Technology Transfer, and the World Distribution of Income" *Journal of Political Economy*, 87, 2, 253-66.
[15]Olena Ivus. 2010. "Do stronger patent rights raise high-tech exports to the developing world?" *Journal of International Economics,* 81 (2010): 38–47.

monopoly of certain corporations usually having headquarters in developed countries.[16]

Due to the different natures of patenting behavior, technology capacities and innovation environments from country to country, "country-specific understandings" should be supported from both national governments and international organizations.[17] Otherwise, the uncertainties in the enforcement of domestic patent laws might influence the inventor's decision to enter into those countries with the underestimated market potential. The strength of IPR national policies in an open economy is affected by market size, trading partners and R&D capacity.[18] Besides, the well-institutionalized protection of patent rights can lead to the expected benefits in international trade and FDI.[19]

In addition to the types of industries and the extent of IPR protection, the feature of exports in the international trading system can be described by the intensity and the variety of exported products. In regards to the economic theory in intensive and extensive margins of exports, the entry or the variety of exporting firms is defined as extensive margin, while the average volume or the intensity exported by

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[16]Maskus, K.E., Penubarti, M. 1997. "Patents and International trade: an Empirical Study." In: Maskus, K.E., et al. (Ed.), *Quiet Pioneering: Robert M. Stern and His International Economic Legacy*. University of Michigan Press, Ann Arbor, MI, pp. 95–118.
[17]Daniel Benoliel. 2017. *Patent Intensity and Economic Growth*. Cambridge University Press.
[18]Grossman, G.M., Lai, E.L.-C. 2004. "International Protection of Intellectual Property." The American Economic Review 94 (5), (2004): 1635–1653.
[19]Keith E. Maskus. 2000. "Intellectual Property Rights in the Global Economy" 11 Washington, D.C.; Institute for International Economics.

individual firm is explained as intensive margin.[20] The dimension of exports varies depending on intensive and extensive margins of trade across countries.[21] In the empirical literature with the evidence of the causal relationship between innovation measured by the number of patent applications in the technology field and exports related to the same technology field, the greater number of patent counts results in the more exports of highly valued products, presenting that the innovation has substantial effects on both intensive and extensive margins of exports in trade.[22]

[20]Ana M. Fernandes, Peter J.Klenow, Sergii Meleshchuk, et el. November 19, 2018. "The Intensive Margin in Trade." Inter-American Development Bank, IDB Working Paper Series, IDB-WP-973.
[21]Ibid.
[22]Wei-Chih Chen. 2013. "Then Extensive and Intensive Margins of Exports: The Role of Innovation." The World Economy, volume 36, issue 5, pp. 607-635.

Chapter II. Backgrounds

2.1 International Treaties related to Intellectual Property Rights

There have been various types of international treaties with regards to Intellectual Properties (IP), primarily arranged by the WIPO and the WTO. To begin with, the history of IP and its protection at an international level can be explained from the Paris Convention for the Protection of Industrial Property in 1883, abbreviated in the Paris Convention.[23] It is a milestone that the Paris Convention provides the fundamental principles for the internationally agreeable rules and regulations for IPR protection. Particularly, the Patent Cooperation Treaty (PCT) was established in 1979, providing international opportunities for firms and individuals.[24]

Main principles included in the Paris Convention are as follows: the Article 2 dealing with National Treatment for Nationals of Countries of the Union; the Article 4A to 4I covering Right of Priority as Inventors' Certificates in Patents, Utility Models, Industrial Designs, Marks; and the Article 4b addressing

[23]WIPO. Followed by Brussels Act in 1900, Washington Act in 1911, Hague Act in 1925, London Act in 1934, Lisbon Act in 1958, and Stockholm Act in 1967, the Paris Convention was amended in 1979 and entered into force in 1984.
[24]WIPO.

Independence of Patents Obtained for the Same Invention in Different Countries.[25] The Paris Convention has been known as one of the most momentous IP-related international treaties, since it firstly contributed to define the "right of priority" by allowing a patent applicant to claim priority within 12 months, in the case that an application is filed in other countries as well as the country of initial filing.[26]

There are several special agreements originated from the Paris Convention: Strasbourg Agreement Concerning the International Patent Classification (IPC)[27], the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure, Patent Cooperation Treaty (PCT), Patent Harmonization Treaty (PHT), Substantive Patent Law Treaty (SPLT), Patent Law Treaty (PLT), etc.[28] Focusing on one of the special agreements derived from the Paris Convention, the PCT with the Regulations and the Administrative Instructions was designed for the international patenting system to firmly secure the international protection of an applicant's invention and to unify international processes centered on the WIPO. In comparison with the Paris Convention which

[25]Article 2 and Article 4 of Paris Convention for the Protection of Industrial Property.
[26]Paris Convention for the Protection of Industrial Property.
[27]WIPO. 2019. Guide to the International Patent Classification. The main achievement of Strasbourg Agreement in 1971 was the adoption of the international classification system having eight technology sections with approximately 70,000 subdivisions. Each patent is categorized into the eight sections of the IPC code indicated by the capital letters: Human Necessities (A), Performing Operations and Transporting (B), Chemistry and Metallurgy (C), Textiles and Paper (D), Fixed constructions (E), Mechanical Engineering, Lighting, Heating, Weapons, and Blasting (F), Physics (G), and Electricity (H).
[28]WIPO.

allows application with "claim priority" in foreign countries after the first filing of local application within 12 months, the PCT offers a simple method for an international patent application with the extended period of "claim priority" to 30 months.[29] After filing PCT application within 12 months from the first day of an international application at a local office, international publication is conducted within 18 months from the first day of local filing, and effectively proceeded up to 152 Contracting States as of 2019.[30] After the establishment of Standing Committee on the Law of Patents (SCP) in 1998, the Patent Law Treaty (PLT) was adopted in 2000 for the unified national processes operated and authorized by domestic patent offices.[31] The PLT was adopted to allow efficient processes for inventors by providing 27 articles such as filing date in Article 5 and application in Article 6 for unifying national procedures of PCT international application.[32]

In 1967, the Convention Establishing the World Intellectual Property Organization, briefly the WIPO Convention, was formed to promote the development of "economic, social and cultural" parts of countries with innovation and creativity supported by an efficient international IP system.[33] Promoted from

[29]WIPO. PCT FAQs.
[30]The list of 152 PCT Contracting States as of 2019 is attached in Table A.1, Appendix A.
[31]WIPO.
[32]Patent Law Treaty. For details, the Article 5 deals with the specific criteria such as form or contents of application, translation requirements, fees, priority document if needed, and so forth.
[33]WIPO. Summary of the Convention Establishing the World Intellectual Property Organization.

the WIPO Convention, the WIPO became an UN-specialized organization with the intergovernmental function and objectives such as the international protection of IP and a guarantee of international cooperation by treaties.[34] The categories of IP under the WIPO system are divided into five: industrial properties including patents, trademarks, industrial designs, geographical indications; and copyrights. Depending on the types of IP, each international application is processed in different international systems: patents through the PCT system, trademarks through the Madrid system, and designs through the Hague system.[35] The WIPO stipulates patent rights as "a set of exclusive rights granted by law to applicants for inventions that are new, non-obvious and commercially applicable."[36]

Along with international agreements administered by the WIPO, the Agreement on Trade Related Industrial Property Rights (TRIPS) was introduced by the WTO in 1994 to resolve the problems of the Paris Convention, discussing the specific method to deal with the global infringement of IPR. With the absence of dispute settlement or legal mechanism under the WIPO system, the WTO is in charge of enforcing Member countries to abide by the IPR-related laws and regulations in the case of violation.[37] Consequently, countries seemed likely to rely on the General Agreement on Tariffs and Trade (GATT), pursuing the enforcement of IPR in the

[34]WIPO. 1998. Background Reading Material on Intellectual Property, at p.37-71.
[35]WIPO. 2004. Intellectual Property Handbook: Policy, Law and Use.
[36]WIPO. Glossary.
[37]WTO.

international manner.[38] In Part II of the Agreement on TRIPS, Standards Concerning the Availability, Scope, and Use of Intellectual Property Rights, the WTO defines eight sections of IP: Copyright and Related Rights, Trademarks, Geographical Indications, Industrial Designs, Patents, Layout-Designs (Topographies) of Integrated Circuits, Protection of Undisclosed Information, and Control of Anti-Competitive Practices in Contractual Licences.[39] Specifically for the patent, it is defined that "patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application."[40]

2.2 International Protection of Patent Rights

Due to the differences in definitions, laws and policies of IPR in an international organization as well as in a sovereign state, the cross-border protection of IPR is the complex issue. The idea of international protection of IPR, particularly patent rights in this paper, starts from understanding the different patenting environments by country and setting up proper strategies for IPR protection in foreign countries. As both influential providers and receivers of PCT international

[38]Chaudhry, Peggy E., and Michael G. Walsh. 1995. "Intellectual Property Rights." *The Columbia Journal of World Business,* 30.2 (1995): 80-92.
[39]Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), Annex IC.
[40]Article 27 of TRIPS.

patent applications, five Intellectual Property offices, so-called IP5, China National Intellectual Property Administration China (CNIPA)[41], European Patent Office (EPO)[42], Japan Patent Office (JPO)[43], Korean Intellectual Property Office (KIPO)[44] and United States of Patent and Trademark Office (USPTO) are main drivers of global patenting activities.[45]

One of the biggest patent markets and the longest IP histories, the U.S. defines the four types of IP: patents[46], trademarks and trade secrets are administered under the United States Patents and Trademarks Office (USPTO); and copyrights under the U.S. Copyright Office.[47] The European Union distinguishes the characteristics of IPRs between technical property rights including patents, and non-technical property rights including trademarks or geographical indications and

[41]CNIPA. The State Intellectual Property Office of China (SIPO) was renamed to CNIPA on 28 August 2018. The CNIPA deals with IPRs including patents, trademarks, geographical indications and layout designs of integrated circuits.
[42]EPO member states: Albania, Austria, Belgium, Bulgaria, Switzerland, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, UK, Greece, Croatia, Hungary, Ireland, Iceland, Italy, Liechtenstein, Lithuania, Luxembourg, Latvia, Monaco, North Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, Slovakia, Slovenia, San Marino, Turkey.
[43]The JPO handles IPRs by decomposing it into four parts: patents, utility models, designs and trademarks.
[44]The KIPO is responsible for the application and the registration of patents, utility models, trademarks and designs.
[45]Five IP offices. From 2006 to 2016, "the IP5 Offices together handle about 80 percent of the world's patent applications, and 95 per cent of all work carried out under the Patent Cooperation Treaty (PCT)."
[46]Intellectual Property Office. June 2013. "Intellectual Property Rights in the USA." The subdivision of patents is defined as "utility patent for innovations and technologies, design patent for new and original designs, and plant patent for distinct and new plant varieties."
[47]USPTO.

copyrights.[48] According to the research jointly conducted by the EPO and the European Union Intellectual Property Office (EUIPO),[49] the strict IPR regulations have been implemented in the Europe region to prevent illegal duplication of products and to protect IP-related industries, since it was found that IP-intensive industries are closely related to the generation of new employment and the increase in economic activities.[50] IPRs in the Republic of Korea (hereinafter Korea) can be divided into three categories of industrial property rights, copyrights and new IPR: the subdivisions of industrial property rights are patent rights, utility model rights, trademark rights, and design rights, wherein the design rights are viewed from patent and copyright approaches; subcategories of copyrights are copyright, neighboring right, design right; and new IPRs include trade secret, database, computer program and semiconductor.[51]

To deal with the concept of international protection of patent rights, it begins with "the principle of territorial privilege for jurisdiction," meaning that patent rights are territorial rights on the basis of the decision authorized in the

[48]EU Communication. 24 May 2011. "A Single Market for Intellectual Property Rights." Communication COM (2011) 287

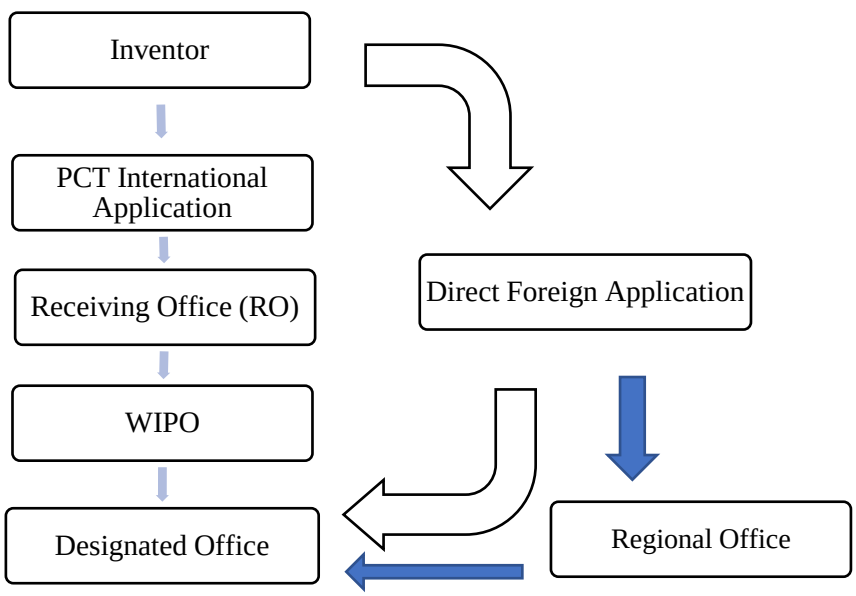
[49]While the EPO deals with patents, the EUIPO receives applications for trademarks and designs.

[50]A Joint Project between the European Patent Office and the European Union Intellectual Property Office. October 2016. "Intellectual Property Rights Intensive Industries and Economic Performance in the European Union." Industry-Level Analysis Report. Second edition.

[51]Investment Consulting Center of KOTRA. 2017. "Doing Business in Korea," Korea Trade-Investment Promotion Agency.

independent sovereign state. In other words, one domestic patent ownership is protected in one country unless the separate application is processed in the other country. Therefore, the individual procedures of each country are mandatory for the protection in the desired foreign countries, requiring for international cooperation to guarantee and implement the IPR protection in foreign countries in a decent manner. There are currently available three routes described in Figure 1, two direct foreign routes either a direct national route or a direct regional route, and a PCT international route for the cross-border ownership of patent rights.

Figure 1. PCT International Application and Direct Foreign Application



Note: Made by the author based on information provided by WIPO

The direct national route is that the inventor directly submits the patent applications to the designated offices in the desired foreign country. The process of the direct regional application is similar in the sense that the inventor directly applies the patent rights to the regional offices such as the European Patent Office (EPO) in the desired region. After filing direct applications to the regional patent offices, it provides the simplified application procedures for the inventors planning to apply patents in member countries by combining the applications in the integrated region. Distinctive from the direct foreign applications, the PCT international application is initially submitted to the Receiving Office (RO) and handled in the WIPO afterwards. However, when the inventor decides to proceed the PCT international application forward the entrance in foreign countries (PCT National Phase Entries), the domestic procedures in the Designated Offices are still required for the completion of applications after fulfilling the international requirements.

2.2.1 Direct National Application

The Paris Convention mentions that the direct application can be conducted by an inventor to foreign patent offices. In accordance with the Paris Convention, Article 4bis “Patents: Independence of Patents Obtained for the Same Invention in Different Countries” states that:

(1) Patents applied for in the various countries of the Union by nationals of countries of the Union shall be independent of patents obtained for the same invention in other countries, whether members of the Union or not.
(2) The foregoing provision is to be understood in an unrestricted sense, in particular, in the sense that patents applied for during the period of priority are independent, both as regards the grounds for nullity and forfeiture, and as regards their normal duration.
(3) The provision shall apply to all patents existing at the time when it comes into effect.

According to the Article 4 of the Paris Convention, patent rights are independent from country to country. Even though the patent is granted in one country, the inventor should go through the separate process for the patent rights in another country. Domestic characteristics of patenting activities can be observed from the direct applications submitted by domestic inventors including corporations, individuals, governments, institutions, universities, and so forth. As direct applications are open to both residents and non-residents, the statistics of direct applications comprises patent applications made by both domestic and foreign inventors. The applications filed by foreign inventors indicate the bilateral patenting flow from the applicant's nationality in one country to the patent filing office in another destination country.

There are several reasons why firms or individuals choose to proceed direct

patent application, rather than other options. First, regional and PCT applications take longer time to complete the whole procedures than the direct application. When an inventor who wants to register time-sensitive products (or inventions) in foreign countries, the direct route is preferred to obtain the ownership, especially in the presence of competitors in the market. Second, without the PCT membership, direct application is only option left for the patent applications in foreign countries. For instance, under the situation that Taiwan is not a PCT member country, inventors from Korea or the U.S. have only choice of direct foreign application to acquire patent rights in Taiwan. Similarly, Taiwanese inventors can apply patents only via direct route when seeking for patent rights in foreign countries. Along with Taiwan, Hong Kong is one of the most popular non-PCT Asian countries.[52] Filing PCT international application in the national stage to the patent office in China will provide the applicant with a subsequent opportunity to submit the application in Hong Kong.[53]

2.2.2 Direct Regional Application

Regional protection as well as national protection of patent rights can be sought through direct application to regional patent offices. Second method for

[52]WIPO.
[53]Ibid.

protecting patent rights in the regional system provides inventors with efficient opportunities allowing simultaneous applications to multiple counties in the integrated region such as African countries, the European Union and the Arab States. Moreover, all member countries of the Eurasian Economic Union (EAEU)[54] have the membership of the regional patent office, Eurasian Patent Office (EAPO).[55] As of 2019, regional patent offices are currently known as follows: African Intellectual Property Organization (OAPI), [56] African Regional Intellectual Property Organization (ARIPO),[57] Eurasian Patent Office (EAPO), European Patent Office (EPO), and Patent Office of the Cooperation Council for the Arab States of the Gulf (GCC Patent Office).[58]

When an applicant files the patent application to the EPO, for example, stating the designated countries in the European Patent Convention (EPC) contracting states such as France, Germany and Sweden, the applicant can guarantee the valid patent rights by paying the registration fees in the designated countries after

[54]EAEU member states: the Republic of Armenia, the Republic of Belarus, the Republic of Kazakhstan, the Kyrgyz Republic, and the Russian Federation.
[55]EAPO member states: Turkmenistan, the Republic of Belarus, the Republic of Tajikistan, Russia, the Azerbaijan Republic, the Republic of Kazakhstan, Kyrgyzstan, and Armenia
[56] OAPI member states: Benin, Burkina Faso, Cameroon, the Central African Republic, Chad, the Comoros, the Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Guinea, Guinea-Bissau, Mali, Mauritania, the Niger, Senegal, and Togo
[57]ARIPO member states: Botswana, Eswatini, Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mozambique, Namibia, Rwanda, Sao Tome and Principe, Sierra Leone, Somalia, Sudan, Tanzania, Uganda, Zambia and Zimbabwe
[58]GCC member states: the States United Arab Emirates, Kingdom of Bahrain, Kingdom of Saudi Arabia, Sultanate of Oman, State of Qatar, and State of Kuwait

the grant for the patent.[59] According to London Agreement entered into force on 1 May 2008, in the case that an applicant registers the patent in the individual country of the EPC contracting states, the submission of translation is not mandatory to validate the patent.[60]

Because of the complicated application system in the regional office, it is difficult to eliminate the double counting issue. If an applicant initially submits applications to the EPO and proceeds the patent registration in Germany, the number of patents could be counted twice, one in the EPO and another in Germany.

2.2.3 Patent Cooperation Treaty (PCT) International Application

Direct applications made by foreign inventor are rather "foreign application" from the bilateral aspect, while the PCT application is more likely to be considered as "international application" from the plurilateral aspect. The Article 2 of the Patent Cooperation Treaty, "Definitions of International Application," stipulates that:

> (i) "application" means an application for the protection of an invention; references to an "application" shall be construed as references to applications for patents for inventions, inventors' certificates, utility certificates, utility models,

[59]EPO.
[60]Article 1 of London Agreement.

patents or certificates of addition, inventors' certificates of addition, and utility certificates of addition; …

(vii) "international application" means an application filed under this Treaty;

The PCT international application process is comprised of two phases, international and national phases.[61] An international search and a preliminary examination are implemented during the international phase, and national and regional offices conclude the final decision on "the patentability of an invention" in accordance with domestic patent law during the national phase.[62]

With regards to international phase consisting of five stages, in the first stage, international application for patent or new invention within 12 months from the initial application is filed in the local patent office, so-called "Receiving Office" (RO).[63] For example, if an inventor in Korea, either Korean nationality or foreigners residing in Korea, prepares to obtain the patent rights in the PCT Contracting States such as the U.S., Japan, China, etc., the inventor should submit the patent application to Korean Intellectual Property Office (KIPO) as RO. In the second stage, the International Search Report (ISR) and written opinion are treated by International Bureau (IB) of the WIPO within 16 months from the initial filing.[64] The third stage

[61]WIPO.
[62]Ibid.
[63]Ibid.
[64]Ibid.

of the international publication within 18 months is the last stage of the automatic process. Once the inventor files the international application to RO, it is automatically proceeded to the third stage in the international phase. After the third stage, depending on the decision of the applicant, it is optional whether to process the further stage or not. The fourth stage is the publication of Supplementary International Search Report (SISR), and the final fifth stage is the operation of International Preliminary Examination to publish report on patentability.[65]

After the international phase, domestic PCT procedures in national phase are compulsory to acquire the patent rights in the desired countries. After the completion of all the processes required in the international stages, the applicant decides whether or when to enter the national phase in the elected or designated offices in the U.S., Japan, China, and so on, up to 152 Contracting States, so-called "Designated Office."[66] The PCT National Phase Entry (NPE) requires the applicant to pay national fees, prepare translations, and hire patent agents. The patents applied through the PCT system are proceeded in the designated offices for the official registration of patents in the future. While the international phase is regulated under the WIPO, the national phase is administered and controlled under the designated offices. That is, the patent granting authority relies on the decision of the designated office.

[65]WIPO.
[66]Ibid.

The PCT NPE procedures and the length of time from the national application to grants differ by country and by the type of industry. For example, while China National Intellectual Property Administration (CNIPA) requests 19 detailed rules including Patent Law of the People's Republic of China (CPL) and Implementing Regulations of the Patent Law of the People's Republic of China[67]. Compared to the national procedures in China, Mexican Institute of Industrial Property requires 12 simple rules including Mexican Federal Law on Administrative Procedures (MFL), Mexican Patent Provisions under the Industrial Property Law (MPL), and Mexican Patent Rules under the Industrial Property Regulations (MPR).[68]

The acquisition of patent rights is promoted in the WIPO-administered PCT system which is designed to provide the applicants with the simplified process of patent filings in multiple countries by reducing separate applications in jurisdiction of each country. However, whether to grant patent rights is solely determined by national and regional patent offices. The feature of PCT national stage applications varies depending on the rules and regulations of national offices.

[67]WIPO. 2019. PCT Applicant's Guide, National Phase, National Chapter, China National Intellectual Property Administration.
[68]WIPO. 2016. PCT Applicant's Guide, National Phase, National Chapter, Mexican Institute of Industrial Property.

Chapter III. Data

3.1 Data Description

Both IP Statistics Database Center and PATENTSCOPE are administered uder the WIPO, based on the data provided from national and regional patent offices.

3.1.1 WIPO Statistics Database

IP Statistics Data Center provides on-line data not only for patents, trademarks, industrial designs, utility models, and geographical indications at a national level, but also for patents under the PCT system, trademarks under the Madrid system, and industrial designs under the Hague system at an international level.[69] The national-level data is collected from domestic and regional offices, and the international-level data is accumulated via the application process regulated by the WIPO.[70] It is accurate that the international trend in patenting behavior is well predicted from the PCT international application data rather than direct application

[69]WIPO.
[70]Ibid. Available at https://www.wipo.int/ipstats/en/

data based on the sum of domestic and foreign inventive activities. In this research, the PCT international application data is mainly collected to analyze major countries representative with the active participation in patent filings under the PCT system.

Prior to the PCT international application data, the general patent data is sorted from IP Statistics Data Center and examined by certain countries with significant patenting activities over the period 2000-2018. Indicators could be chosen from total patent applications including direct applications and PCT National Phase Entries (NPEs), total patent grants for direct applications and PCT NPEs, patents in force, and so forth.[71] In addition to the indicators, there are several report types: total count including resident and non-resident counts by filing office and by applicant's origin, wherein total counts including resident and non-resident counts by applicant's origin are equivalent counts.[72] In this paper, the characteristics of each country are observed from two different perspectives, country as the origin of PCT international patent applications and country as the destination thereof.

Furthermore, the IP Statistics Data Center demonstrates the top 20 offices which receive the most patent filings for both direct applications and PCT NPEs in the period from 2004 to 2017.[73]

[71]WIPO.
[72]WIPO. "The concept of equivalent count is that an application filed at a regional IP office is counted multiple times according to the number of its members."
[73]WIPO. IP Statistics Data Center. Key Indicators.

Table 1. Top 20 Offices that Filed and Received the Most Patent Applications

	Direct and PCT NPEs at Designated Office		PCT NPEs based on the Designated Office		PCT Application by Country of Origin	
1	China	8,810,360	US	1,166,331	US	891,893
2	US	8,330,449	China	933,242	Japan	549,663
3	Japan	6,729,421	EPO	791,365	Germany	303,319
4	Korea	2,985,378	Japan	649,695	China	248,631
5	EPO	2,471,638	Korea	497,094	Korea	149,685
6	Germany	1,113,983	Canada	476,995	France	120,400
7	Russia	691,925	India	358,538	UK	93,352
8	Canada	678,886	Australia	317,483	Netherlands	74,772
9	India	569,491	Brazil	294,663	Switzerland	64,661
10	UK	462,846	Mexico	213,455	Sweden	62,309
11	Australia	456,784	Russia	164,419	Italy	46,660
12	Brazil	419,716	Singapore	113,362	Canada	45,518
13	France	301,400	Israel	79,020	Finland	33,472
14	Mexico	270,686	New Zealand	75,126	Australia	32,226
15	Hong Kong	214,528	Indonesia	60,607	Israel	26,880
16	Italy	172,963	Germany	51,128	Spain	23,142
17	Singapore	169,301	Norway	44,182	Denmark	21,436
18	Iran	164,377	Malaysia	44,048	Belgium	18,456
19	Indonesia	97,356	EAPO	37,417	Austria	18,434
20	Turkey	62,903	Thailand	36,349	India	18,128
	Total	35,174,391	Total	6,404,519	Total	2,867,896
	World	37,430,900	World	8,110,500	World	2,970,124

Data Source: WIPO Statistics Database

Note: The PCT application data is viewed from the nationality of the original applicant,

while PCT NPEs are collected from the destination countries in which the PCT applications are processed for the national steps. The numbers are cumulative counts over the period 2000-2017.

With the extended period over 2000-2017 and the expanded range of application types, the cumulative counts of total patent applications, PCT NPEs and PCT filings by applicant's origin in an order from the greatest number are described in Table 1. China, the EPO (Germany in the third column), Japan, Korea, and the U.S. are ranked in the list of top five in all three columns.

First column is set to explain the general trend in patenting behavior from the point of view at a national filing office (RO) regardless of filing routes or nationality of applicants. Total counts of patent applications are submitted through direction applications and Patent Cooperation Treaty National Phase Entries (PCT NPEs) counted from the sum of domestic and foreign inventors. Acknowledging the nature of IPR in five countries (China, the Europe, Japan, Korea and the U.S.) at the high level of overall innovation activities, the percentages of top 20 offices and top five offices out of world total applications are 94% and 78.3%, respectively.

Second column only presents that the counts of PCT NPEs, the number of patents entered in the national phase of PCT procedures and counted as national patents afterwards, are subtracted from the first column. Under the PCT rules that one unique patent can be duplicated and entered in multiple countries, the double counting issue will be discussed in Section IV. Top 20 offices and top five offices are popular countries as the popular destination of PCT international applications,

accounting for 79% and 49.8% of world PCT NPE applications, respectively. One regional office (EAPO) and four South East Asian countries (Indonesia, Malaysia, Singapore and Thailand) are positioned in top 20 countries receiving the high number of PCT NPEs. Compared to the list in the first column, offices in Israel, New Zealand, Norway, Malaysia, EAPO and Thailand are only ranked in the popular destination of PCT NPEs, showing the relatively less participation of other types of patent applications. Offices in France, Hong Kong Special Administrative Region (SAR), Italy, Iran and Turkey are not appeared on the list of designated offices of PCT NPEs, meaning that the number of direct applications is greater than that of PCT NPEs except for the Hong Kong SAR.

Third column is arranged to indicate the top 20 countries that file the highest number of PCT applications to all the Receiving Offices by country of origin. Even though the European countries (Sweden, Finland, Netherlands, Spain, Denmark, Belgium and Austria) are not listed in the top 20 countries with the great number of total patent applications, those countries appeared on the list of the top 20 countries with the highest number of PCT applications. The PCT applications by top 20 countries occupy 96.56% of the world applications, while those by top five countries (the U.S., Japan, Germany, China and Korea) account for 72.1% thereof. Twelve European countries including the United Kingdom are ranked in the list, accounting for 29.6%. The percentage is calculated to show how much the international patenting activities are dominated by certain countries.

The proportion of domestic and foreign applicants is different from country to country. However, differentiated from direct applications, the PCT applications are mostly submitted by domestic applicants initially to national offices. For instance, to specify the country's feature of PCT participation in China, out of total 48,904 PCT applications in 2017, 48,074 were submitted to the CNIPA by Chinese applicants, while 354 PCT applications to the EPO, 276 to the International Bureau (IB of the WIPO), and 114 to the USPTO.[74] In this sense, being representative of country-specific characteristics, the study does not pay much attention to the direct applications, but rather focuses on the offices filing the great number of PCT applications in Table 2. The data is observed from two perspectives, countries submitting the high number of PCT applications to the WIPO, and countries receiving the most PCT NPEs. While the simple counts of applications handled in the national offices can be approached from the quantitative approach, the feature of PCT NPEs can be analyzed from the qualitative approach in terms of the patent value and the efficiency of the PCT system.

3.1.2 PATENTSCOPE

PATENTSCOPE is the search system which offers full documents of

[74]The data is retrieved from WIPO IP Statistics Data Center.

patents for the convenience of patent attorneys, inventors, researchers and entrepreneurs.[75] The data coverage in PATENTSCOPE is different from the range of data available in IP Statistics Data Center, in the sense that PATENTSCOPE database is designed to provide the published information of patent applications.[76] Specifically, PATENTSCOPE covers the data including PCT international application (submitted via RO), PCT NPEs and national collection (from the designated office). Since each designated office voluntarily sends PCT NPE information to International Bureau (IB of the WIPO), there are unavoidable missing data which can lead to the misinterpretation.

Each IP office (the designated office) that deals with PCT NPEs sends the data containing office code, International Application (IA) number, national number, and entry date to the WIPO.[77] For instance, KR, office code consisting of the upper cases, means that the national office in the Republic of Korea, KIPO, has received PCT NPEs from many other countries and has sent the data to PATENTSCOPE. The PCT IA number is applicable to the record, submitted in "ST.10/C format (PCT, preamble followed by office code, four-digit year, and the six-digit number)."[78] For example, PCT/US1986/000947, when the US inventor filed an PCT international

[75]WIPO. September 28, 2018. PATENTSCOPE. The User's Guide.
[76]PATENTSCOPE. Available at https://www.wipo.int/patentscope/en/data/national_phase/procedures.html
[77]PATENTSCOPE.
[78]WIPO. PCT National Phase Information – Specification. Available at https://www.wipo.int/patentscope/en/data/national_phase/procedures.html

application at the USPTO in 1986, the patent can be traced by this IA number whether to enter the national phase in PCT Contracting States. Each patent can be traced with the IA number by decomposing the aggregate data of patents proceeded to the national stage originated from the PCT applications. National number is given by the designated office, when the PCT international application enters in the desired countries for the procedures in the national phase. The number, such as 1019870700058, is given by KIPO when entering a national phase in Korea.

Only 66 countries out of 152 PCT Contracting States provide the PCT NPE information for IB of the WIPO, and even the information offered by the U.S. is only available for a short period of time from December 2016 to December 2018.[79] The PATENTSCOPE data is collected since 2000 from top eleven countries (the U.S., China, the EPO, Japan, Korea, Canada, India, Australia, Brazil, Mexico and Russia) receiving PCT NPEs, 4,076,873 of the total number of 7,548,367.[80] Corresponding to the data in the second column of Table 1, the list of top eleven countries receiving the most PCT NPEs is the same in the PATENTSCOPE data. Three countries (Mexico, India and Russia) do not relatively apply the high number of patents through the PCT system but do receive the great number of PCT NPEs. The PCT NPEs out of national total applications account for the high ratio, 85.5% in Mexico (231,455 out of 270,686) and 70.2% Brazil (294,663 out of 419,716), compared to

[79]The data is attached in Table A.2, Appendix A.
[80]The data is attached in Table A.2, Appendix A, and also explained in Table 2.

the rest of countries receiving the greatest number of PCT NPEs.

3.2 Data based on Filing Offices and Country of Origins

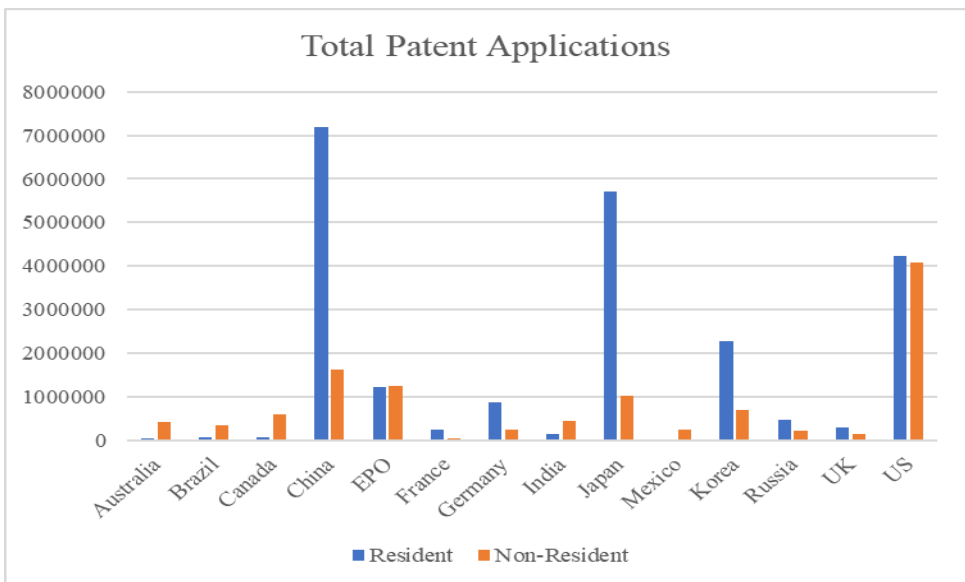
As previously discussed, the quantitative difference between resident and non-resident applicants is calculated by thirteen offices in the following Figure 2 out of twenty offices from the highest number of total applications in the first column of Table 1. The data is collected from one regional office, the EPO, and twelve national offices in Australia, Brazil, Canada, China, France, Germany, India, Japan, Mexico, Korea, Russia, the U.K., and the U.S. When indicators are selected by filing office, the counts indicate the location of the patent applications are initially submitted regardless of the applicant's origin or filing routes.

Resident applications are calculated from patent filings of resident inventors in local offices, while non-resident applications are conducted by foreign inventors residing outside the countries.[81] The number of resident patent applications indicates only the patenting activities of inventors in home countries. The relatively great gap between resident and non-resident applications is observed in three East Asian Countries (China, Japan and Korea). The almost equal

[81] WIPO. Data Description. The terminology is described in the website: "resident is used for filings made by applicants at their home office, and non-resident is used for statistics by office, abroad for statistics by origin."

distributions between resident and non-resident applications are shown in the EPO and the U.S. There are more non-resident applications than resident applications in five countries (Australia, Brazil, Canada, India and Mexico).

Figure 2. Total Patent Applications of Resident and Non-resident



Data Source: WIPO Statistics Database

Note: The patterns of resident and non-resident applicants are observed by thirteen offices with the highest number of total patent applications mentioned in the first column of Table 1. The numbers are cumulative counts over the period from 2000 to 2017.

In Korea, the types of applicants can be divided into four categories: domestic individuals (19.1% in 2007 and 19.8% in 2017), foreign individuals (0.7% in 2007 and 0.6% in 2017), domestic corporations (58.0% in 2007 and 57.9% in

2017), and foreign corporations (22.2% in 2007 and 21.8% in 2017).[82] Indicating the highest portion of domestic corporations, according to statistics in 2017 published by KIPO, top five domestic patent applicants are Samsung Electronics (5,471), LG Chemistry (3,635), LG Electronics (3,405), Hyundai Motors (2,909) and Electronics and Telecommunication Research Institute (2,064), and foreign applicants are Qualcomm (1,083), Huawei (608), Intel (574), Tokyo Electron (456) and Canon (423).[83]

After the general patenting pattern of each country is described by comparatively showing both resident and non-resident applications in Figure 2, only non-resident applications are focused and investigated with the statistics between PCT NPEs and direct applications to analyze the international and the bilateral trends of non-resident applications in Figure 3. Non-resident applications are submitted by applicants residing outside the country through two routes, a PCT route in the national stage and a direct route. While Direct applications to the IP offices in the home country made by non-resident applicants in the foreign country are more likely to show the bilateral relationship, due to the nature of PCT National Phase Entries, the identical patents can be entered in multiple countries, thereby indicating the international flows.

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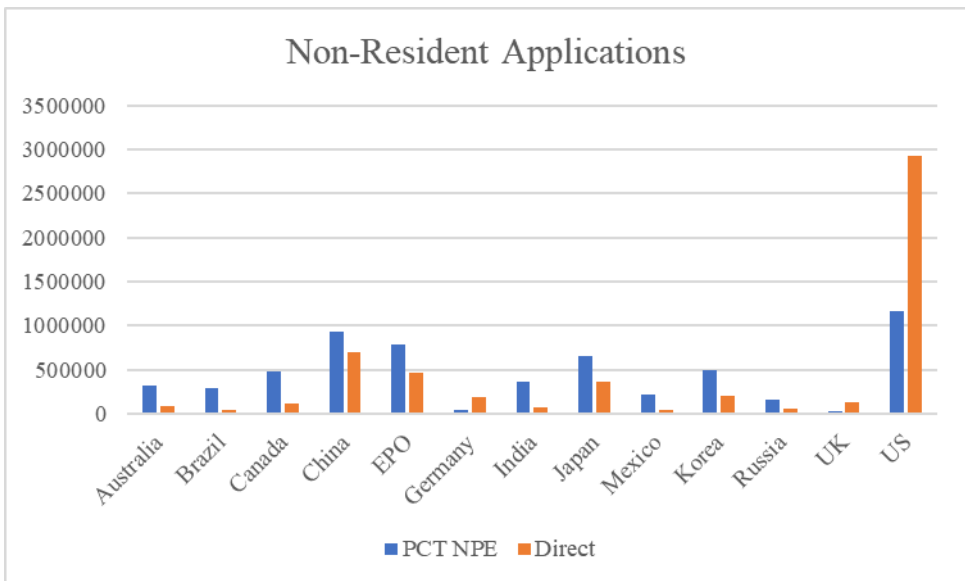
[82]특허청. 「2018 통계로 보는 특허 동향」p.62.
[83]특허청. 「2017 지식재산연보」
∗Electronics and Telecommunication Research Institute (한국전자통신연구원)is a government-owned enterprise.

Except for three countries (the U.S., Germany and the U.K.), most countries (Australia, Brazil, Canada, the EPO, India, Japan, Mexico, Korea and Russia) have received the greater number of PCT NPEs than that of direct applications. Since France and Netherlands do not provide the PCT NPE data, there could be the misinterpretation generated under the condition that a significant number of PCT applications from the U.S., Germany and the U.K. possibly entered in the national phase in France or Netherlands.

Figure 3. Non-resident PCT NPEs and Direct Applications by Filing Office



Data Source: WIPO Statistics Database

Note: The sum of PCT (left bar) and Direct (right bar) applications is equal to Non-Resident Applications (right bar) in Figure 2. To concentrate on the non-resident application pattern in each country, it is divided into two routes, the PCT NPE application and Direct application. The numbers are cumulative counts over the period from 2000 to 2017.

The Unites States shows the greatest difference between PCT NPEs and Direct applications, noticeably taking the highest proportion of direct applications worldwide. There can be several reasons presumed to explain the tendency in the U.S., based on the calculation shown in Figure 4. First, Taiwan is not a PCT member country and is the fourth foreign applicant submitting the high number of patent applications to the USPTO. Second, due to the market scale and the enforcement of IPR, multinational corporations prefer direct applications to the USPTO.[84] During the application period from on 1 January 2000 to 31 December 2015, separate information on the number of patents granted from the PCT international applications and from foreign applications in four countries (the U.S., the EPO, Japan and China) is provided by Korean Intellectual Property Rights Information Service (KIPRIS). Taking two examples of multinational corporations in Korea, the greater number of patents granted via direct applications than via PCT applications.[85]

The annual counts of patent applications by foreign origins from 2000 to 2015 are listed,[86] and five countries (Japan, Germany, Korea, Taiwan and

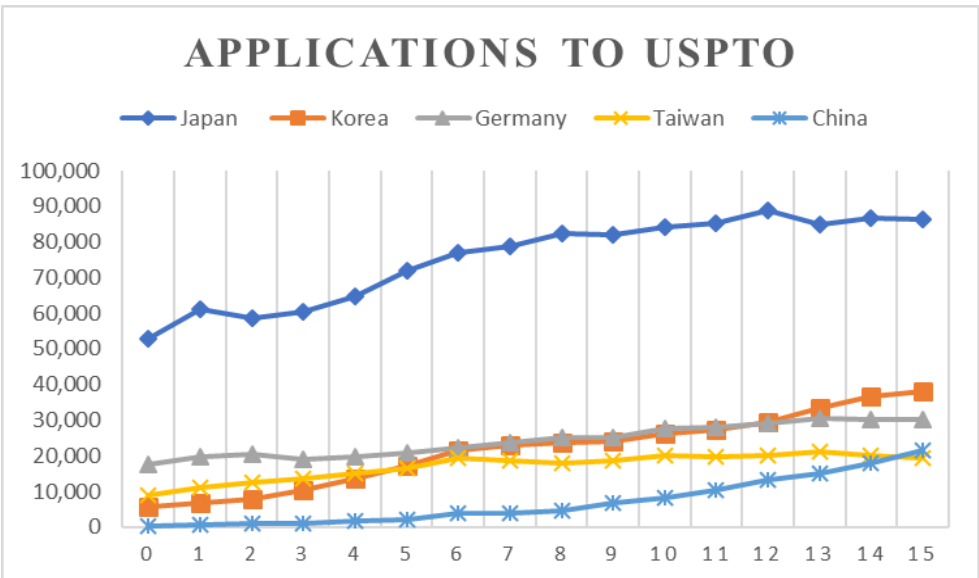
[84]특허청, 한국지식재산연구원. 2017.12. 「혁신경제 연구. 기술혁신형 기업의 해외출원 전략 연구

[85]Samsung Electronics and LG Electronics has presented the higher number of granted patents via direct foreign applications than via PCT applications. Samsung Electronics Co., Ltd. has patents granted through PCT NPEs (11,152) and foreign patents granted in the U.S. (52,916), the EPO (23,496), Japan (18,905) and China (38,763). LG Electronics INC. has patents granted through PCT NPEs (13,167), and foreign patents granted in the U.S. (15,269), the EPO (13,886), Japan (3,922), and China (30,013).

[86]The data is attached in Table B.1, Appendix B.

China) selected to describe the yearly change. In Figure 4, the number of patent applications submitted by Japan is remarkably high compared to the rest of countries. Japan, Germany, Korea and Taiwan are top foreign applicants and China shows the noticeable growth rate exceeding the number of patent applications made by Taiwan in 2015.

Figure 4. Patent Applications by Foreign Origin Filed in USPTO



Data Source: Patent Techonology Monitoring Team, USPTO

Note: The number of patent applications by foreign origin (Japan, Germany, Korea, Taiwan and China) is shown by year from 2000 to 2015.[87]

[87]Electronic Information Products Division, Patent Monitoring Team Report. May 2016. Number of Utility Patent Applications Filed in the United States, by Country of Origin, Calendar Year 1965 to Present. USPTO.

The top applicants of foreign origins are listed in an order from the highest number of cumulative applications filed to the USPTO during the period from 2000 to 2015: Japan (1,205,939), Germany (389,345), Korea (345,088), Taiwan (273,517), Canada (163,743), UK (159,609), France (141,505), China (112,303), Israel, Netherlands, Italy, Sweden, Switzerland, India, Australia, Finland, Belgium, Austria, Denmark and Singapore.[88] In addition to the cumulative number of applications, the distinctive feature is observed from the average annual growth rate in China (31.4%), India (23.03%), Korea (14.55%) and Israel (8.52%), while the grwoth rate in the rest of top 20 countries is less than 8%.[89]

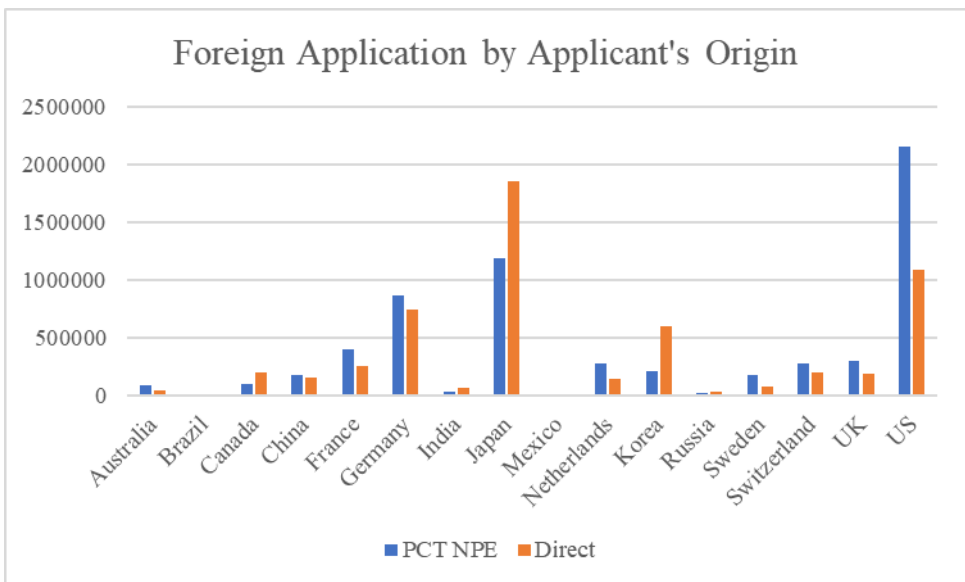
In contrast to indicators by filing office, indicators by country of origin allow the calcuation to trace the nationality of applicants who are in charge of patent filings abroad, regardless of the location of Receiving Offices. The country of residence or nationality of the first-named applicant is used to determine the origin of the applicant.[90]

As shown in Figure 5, applicants from Canada, India, Japan and Korea prefer direct foreign application over PCT international application. Especially, Japan presents the greatest number of overseas direct applications. Among five major countries (China, Germany, Japan, Korea and the U.S) in IP industries, three

[88]The rest of calculation is attached in Table B.1, Appendix B.
[89]The calculation is attached in Table B.1, Appendix B.
[90]WIPO.

countries (China, Germany and the U.S.) show the higher number of PCT NPE applications than that of direct applications. The European countries (France, Netherlands, Sweden and Switzerland) also have the prefernce on PCT applications to foreign direct applications.

Figure 5. Foreign Applications by Nationality of Applicants



Data Source: WIPO Statistics Database

Note: Base on the applicants' origin, the pattern of overseas patent appplications is shown by two different routes, the PCT NPE application (left bar) and the direct application (right bar).

Since direct foreign application is more likely to be involved in the bilateral relatioship between one country in which an applicant is originated and another country in which the patent application is filed, only PCT data is combined and

analyed to demonstrate the global patenting actitivites in Section IV, even with the limited data from Indonesia, Iran, Singapore, Turkey and the U.K., and no data provided from Brazil, France and Italy.[91]

Patent applications are submitted to local intellectual property offices in the same way irrespective of residents and non-residents. Particularly, it is hard to trace each application filed in certain countries such as China National Intellectual Property Administration China (CNIPA), Intellectual Property Office of Singapore and Natioanl Office of Intellectual Property of Vietnam. Dissimilar to the direct application relying on national officies, the PCT international application is primarily managed under the WIPO system. The initial application should be transferred to the WIPO, allowing the original patent to be traced whether the patents entered in the other foreign countries or not.

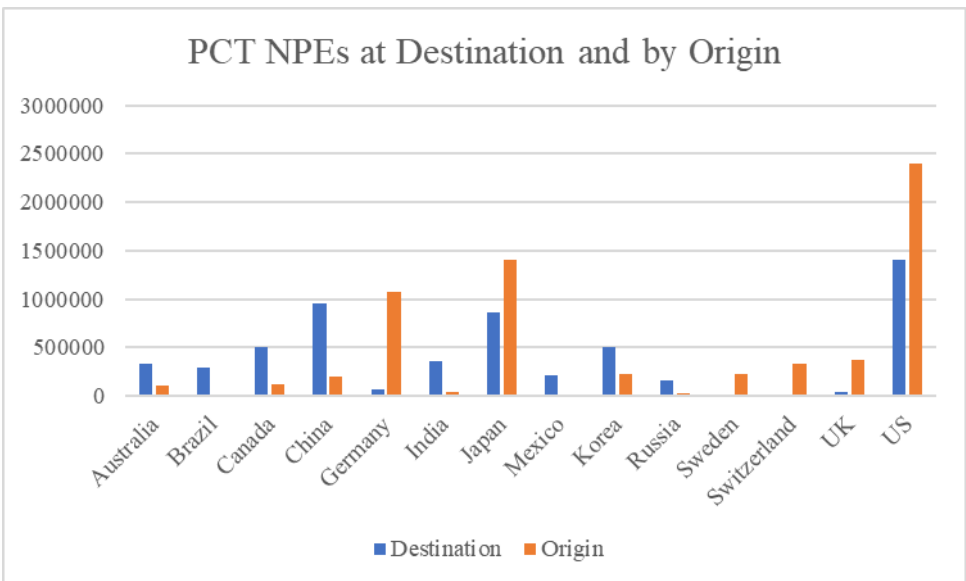
3.3 Country Data of PCT National Phase Entries

Cumulative counts of patent applications from 2000 to 2017 by country regarding PCT National Phase Entries are compared between a country at the designated office and an applicant based on nationality, in Figure 6.[92] The PCT

[91]WIPO.
[92]WIPO. 2019. "Patent Cooperation Treaty Yearly Review 2019, The International Patent System" at p.68-71. The statistics of PCT NPEs are provided in 2016 and in 2017 by

NPEs collected at destination countries are previously described in the first and second columns of Table 1. The PCT international applications are tranferred in regional or national offices and absorbed in the domestic patent statistics. In addition, the PCT NPEs by county of origin are initiated from the PCT international application in the third column of Table 1. After the completion of the PCT application, the inventors decide whether to proceed the national stage of the application or not. If so, one original patent application can be duplicated and expanded to multiple countries.

Figure 6. PCT NPEs at Designated Offices and by Country of Origin



Data Source: WIPO Statistics Database

designated offices and country of origins.

Note: Based on the cumulative statistics from 2000 to 2017, the feature of PCT NPE applications by country is described from two different perspectives, a country at the designated office receiving the most PCT applications for the national stage and a country based on the nationality of applicant who are filing the PCT application and entering the national phase.

The inventors from the U.S. file the greatest number of PCT NPE applications, followed by Japanese and German inventors. Whereas the inventors from Sweden, Switzerland and the U.K. apply the relatively high number of PCT NPEs, three countries receive the very small number of PCT NPE applications from foreign countries. In contrary to the European countries, seven countries (Australia, Brazil, Canada, India, Mexico, Korea and Russia) are popular destination countries that receive PCT NPEs.

Chapter IV. Results

4.1 Data Traced from PCT Application to PCT NPEs

In regards to the validity and the dynamics of international patent applications, it is valuable to examine the PCT patent data both in the international stage and in the national stage. The number of PCT international applications has frequently used for one of the reflective indicators of innovation. The simple number of PCT applications is approached from the quantitative analysis, while the PCT NPEs are viewed from the qualitative analysis. In this data set, the increased number of PCT applications can be explained as quantitative growth, and the number of increased patents entered in the national phase means the qualitative growth. If the PCT international application is proceeded further to the national phase entry, the number of duplicated patents entered in multiple countries can be calculated by merging all data received from the designated offices.

First, the data is arranged from top five countries (the U.S., Japan, Germany, China and Korea) that make the most uses of the PCT system and the rest of six countries (France, the U.K., Netherlands, Switzerland, Sweden and Canada) are also selected from the list with the greatest number of PCT international applications. The

number of PCT international applications by eleven countries accounts for 80.9% of the total PCT applications worldwide.

Table 2. The Number of Patents Traced from PCT Application to PCT NPEs

Country	PCT International Applications	Unique Number of NPEs	NPEs in Multiple Countries	Total NPEs Including Unreported
US	947,888	589,962	1,869,005	2,395,989
Japan	599,358	413,079	1,127,031	1,403,795
Germany	323,070	36,626	108,143	1,074,647
China	301,978	84,564	165,293	201,265
Korea	166,700	72,833	172,128	222,420
France	128,322	50,910	167,196	484,118
UK	98,979	62,450	220,386	370,428
Netherlands	78,898	13,011	41,019	337,819
Switzerland	69,223	7,092	24,172	327,780
Sweden	66,472	30,630	97,690	224,448
Canada	47,938	27,502	84,810	121,791
Total	2,608,804	1,388,677	4,076,873	7,164,500

Data Source: WIPO Statistics Database and PATENTSCOPE

Notes: (i) The cumulative statistics from 2000 to 2018 are designed to trace from the PCT international applications to the PCT national phase entries, available in WIPO Statistics Database.
(ii) Based on the WIPO Statistics Database, information on the number of PCT international applications is submitted from the Receiving Offices to the WIPO, and information on the number of total PCT NPE patents including the unknown applicants (the total duplicated NPEs including unreported patents) is provided from the designated offices to the WIPO.
(iii) In accordance with the data availble in PATENTSCOPE, each PCT national phase patent can be traced by the International Application (IA) number. After merging all the PCT NPE data (NPEs in multiple countries) collected in the designated offices, the redundant data is eliminated to figure out the unique number of patents (the unique number of NPEs).

Table 2 summarizes the number of PCT international applications in the

second column and the total number of PCT national phase-entered patents including the unknown applicants and the unreported patents the fifth column are provided by WIPO statistics database. The number of PCT international applications is counted from all Receiving Offices and one country of origin to indicate the country-specific feature in the same manner that explained in Table 1, except for the extended time period.

As mentioned in Section 3.1, the PCT NPE data entered for the future grants is volutarily offered by destination offices. The aggregate data from eleven countries (the U.S., China, the EPO, Japan, Korea, Canada, India, Australia, Brazil and Mexico) receiving the most PCT NPEs[93] is merged to trace back to the original PCT international application filed in Receiving Offices (RO). In short, the data setting is as follows: merging the aggregate PCT NPE data (5,784,815), based on the degisnated offices in eleven countries; sorting the aggregate data since 2000 (4,076,873) which is placed in the fourth column of Table 2, based on the applicants (the location of RO) by using the International Application (IA) number; and eliminating the duplicated IA number to extract the number of original patents added in the third colum of Table 2.

Since each designated office sends data to PATENTSCOPE by choice, the absense of data could be the cause of the inaccurate interpretation. However, even

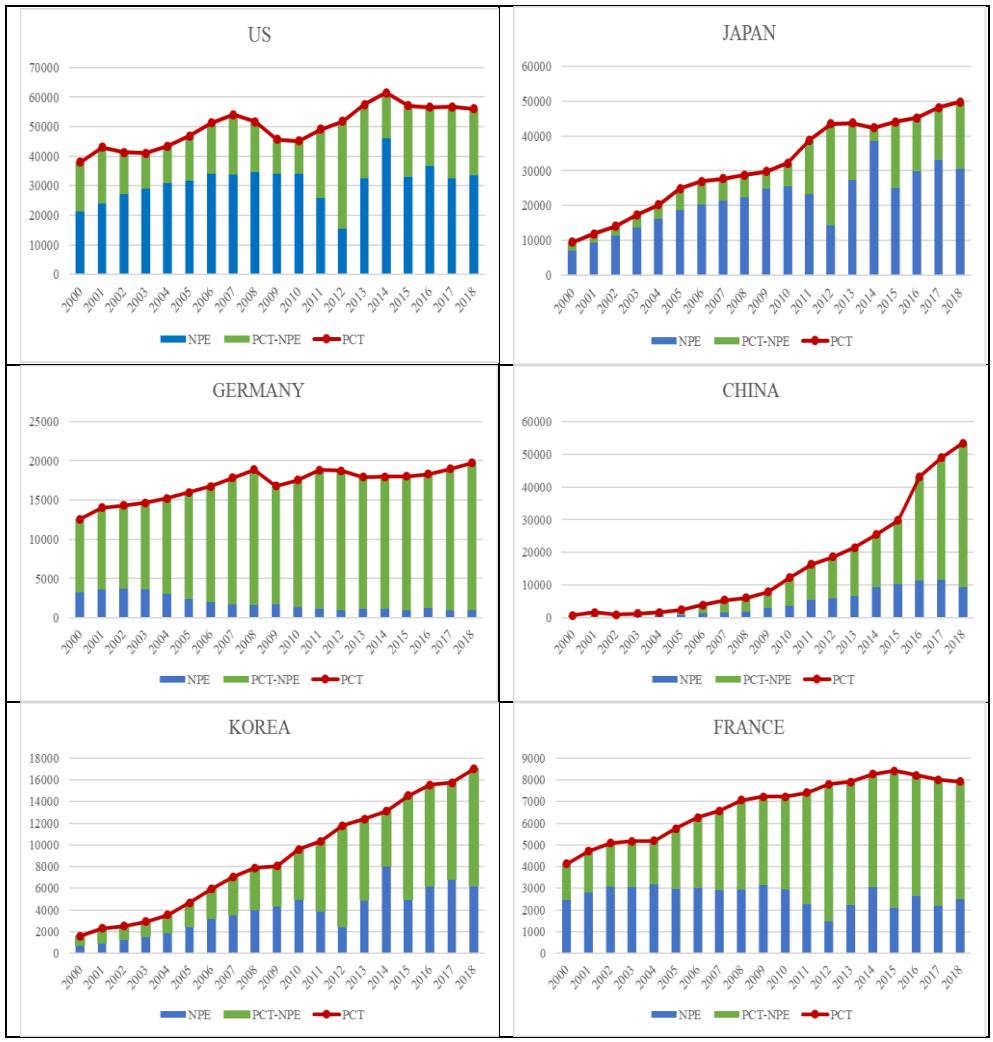
[93]The data source from PATENTSCOPE is attached in Table A.2, Appendix A.

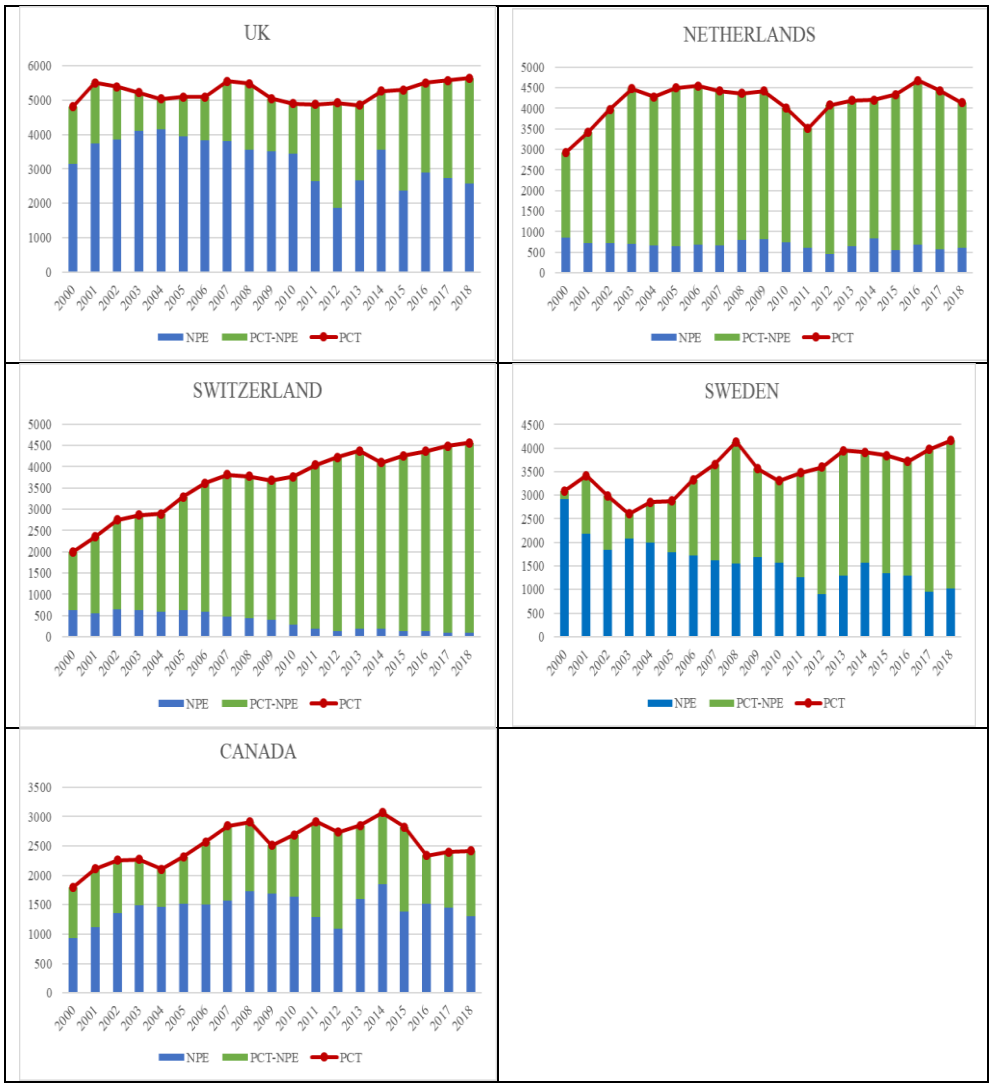
with the limited data, it allows to figure out how many PCT international applications are entered in the national phase and how many PCT NPE patents are duplicated. The following Figure 7 and Figure 8 are derived from the data in Table 2, second and third columns of Table 2 described in Figure 7 and third, fourth and fifth columns in Figure 8 to examine the yearly pattern in the PCT international applications and PCT NPEs.

As observed in Figure 7, China has shown dramatic increase in the number of PCT international applications and active participation in other IP-related works since 2000,[94] but it could be concluded as the quantitative growth in terms of the increased number of PCT international applications rather than the qualitative growth in terms of the conversion rate into the PCT National Phase Entries. In 2017, the PCT international applications filed from China is ranked in the second position, outnumbering the PCT applications conducted by Japan. Furthermore, it is expected to outweigh the volume of U.S applications in no loner than three years.[95]

[94]Joseph Calamia. July 2011. "China rising: international patent applications." IEEE Spectrum, Volume: 48, Issue:7, at p.68.
[95]WIPO. March 2018. "China Drives International Patent Applications to Record Heights; Demand Rising for Trademark and Industrial Design Protection." PR/2018/816

Figure 7. PCT International Application and PCT National Phase Entry





Notes: (i) Data Source is based on author's calculation, WIPO Statistics Database and PATENTSCOPE.

(ii) PCT means the number of PCT international application collected in the WIPO, and NPE means the unique number of PCT national stage patents originated from the PCT international applications and decided to enter the national phase, wherein the data is offered from the designated offices. PCT-NPE is the number of PCT national stage patents subtracted from the number of total PCT international applications, indicating that the remaining patents in the international phase.

However, not all PCT-applied patents are processed into the national phase for the patent registration in the desired countries. The original number of PCT NPEs out of total PCT international applications from China is 11,726 out of 48,903 (in 2017) and 9,448 out of 53,344 (in 2018), while the number from Japan is 33,116 out of 48,296 (in 2017) and 30,607 out of 49,706 (in 2018), and the number from the U.S. is 32,549 out of 56, 682 (in 2017) and 33,480 out of 56,000 (in 2018). In other words, the conversion rate from the PCT international application to the PCT NPEs in 2017 and in 2018 is as follows: 24% and 17.7% from China-origin applications, 68.6% and 61.6% from Japan-origin applications, and 57.4% and 59.8% from U.S.-origin applications.

The relatively high ratio of PCT national phase patents are observed in Canada, Japan, the U.K. and the U.S. In the case of Japan and the U.S., the increase in both the number of PCT applications and that of PCT NPEs can be interpreted as the balanced growth in quantitative and qualitive ways. Due to the lack of data, the low rate of proceedings from the PCT international application to PCT NPEs in three European countries (Germany, Netherlands and Switzerland) remains in the hands of PCT NPEs in France.

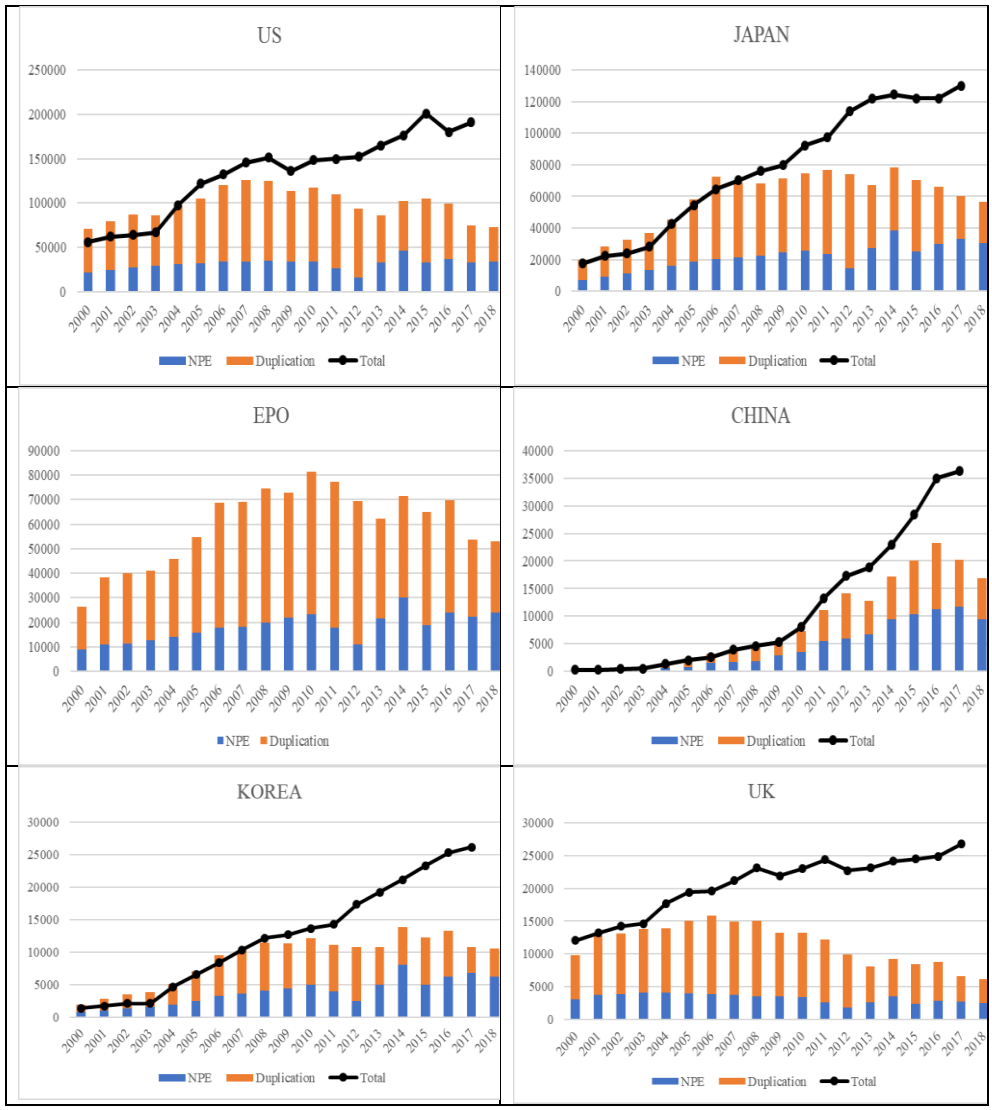
According to the WIPO statistics, two corporations with Chinese origin are ranked in the highest number of PCT international applications: Huawei Technologies Co., Ltd. (3,692 in 2015 and 4,024 in 2016) and ZTE Corporation (4,123 in 2015 and 2,965 in 2016). Two Chinese enterprises filed the greater number

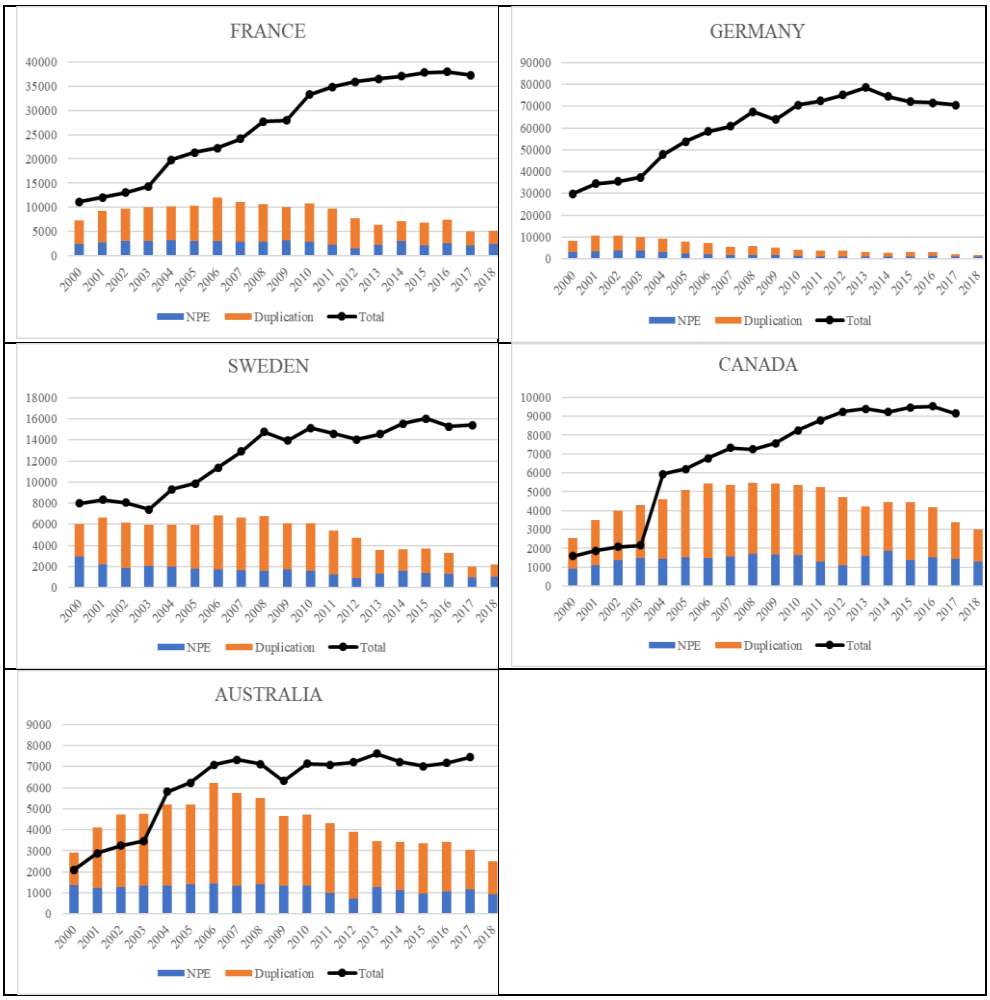
of PCT international applications than the U.S.-origin corporations, Intel Corporation (1,692 in 2015 and 2,637 in 2016), Qualcomm Incorporated (2,466 in 2015 and 2,163 in 2016) and Boe Technology Group Co., Ltd. (1,673 in 2015 and 1,818 in 2016). Along with two firms in China and three firms in the U.S., LG Electronics Inc. and Samsung electronics from Korea, Mitsubishi Electric Corporation from Japan, and Telefonaktiebolaget LM Ericsson from Sweden are ranked in top ten applicants in the PCT system over the period of recent five years, 2014-2018.

Described in Figure 8, even though one unique patent submitted for the PCT international application, the identical patent can be duplicated and expanded up to 152 independent patents in 152 Contracting States. The automatic and simultaneous filing in multiple countries is one of the valuable advantages of the PCT system. Based on the calculation of PCT NPE data from PATENTSCOPE, patents are duplicated and entered in national phase mostly less than 10 countries: 9.77% of patents is not duplicated at all; 16.13% is duplicated only once; 18.61% is duplicated twice; and 16.95% is duplicated three times.[96] The original number of patents entered in the national phase (NPE in Figure 7 and Figure 8) is repeated in Figure 8 to show the duplicated pattern of PCT NPEs.

[96]The rest of calculation is attached in Table A.3, Appendix A.

Figure 8. Tracing the Unique Number of PCT NPEs to the Duplicated Number of the Identical Patents Entered in Multiple Countries





Notes: (i) Data Source is based on author's calculation, WIPO IP Statistics Database and PATENTSCOPE.
(ii) The total counts of PCT NPEs in the EPO is not available.
(iii) NPE, the unique number of PCT national stage patents, is the same number in Figure 7 and repeated in Figure 8. Duplication indicates that the duplicated number of the unique patents entered in the national phases of multiple countries, based on the limited data from PATENTSCOPE. Total means the total number of duplicated patents including unknown applicants and unreported patents, based on the WIPO statistics database.

While the East Asian countries , Japan (copied 2.7 times), Korea (2.4 times) and China (1.9 times), represent the relatively low rate of duplication, the European

countries tend to duplicate the unique patent with the high rate, the U.K (copied 3.5 times), Switzerland (3.4 times) and France (3.3 times). The duplicated PCT NPE patents are initially applied to the EPO, then those can be transferred to the European Patent Convention (EPC) member countries.

With the less missing data, the conversion rate from the PCT international applications to the total number of duplications including unknown and unreported patents is calculated to explain the qualitative growth. According to the Average PCT National Phase Entries calculated in PCT Yearly Review 2019, the average duplication number from the original PCT application to the total number of PCT NPEs is the highest in Belgium (5.1), Switzerland (4.8), Denmark (4.4), the U.K. (4.1) and Netherlands (4.1), and the lowest in Korea (1.7) and China (1.0).[97]

4.2 Intensive Margin and Extensive Margin

From the perspectives of economic theory with regards to trade flows, intensive margin represents actual exports related to the value of goods, while the volume of extensive margin means the number of exports related to the variety of products. In this paper, shown in the equation (1), the intensive margin is measured

[97]WIPO. 2019. Patent Cooperation Treaty Yearly Review 2019, at p.59. "Applicants residing in Belgium and Switzerland initiated around five NPEs per PCT application, on average."

by the unique number of PCT NPEs, and the extensive margin is calculated from the duplicated number of PCT NPEs divided by the unique number of PCT NPEs.

$$\text{Duplicated number of NPE} = \text{Unique number of NPE} * \frac{\text{Duplicated number of NPE}}{\text{Unique number of NPE}} \quad (1)$$

$$ln[\text{Duplicated \# of NPE}] = ln[\text{Unique \# of NPE}] + ln\left[\frac{\text{Duplicated \# of NPE}}{\text{Unique \# of NPE}}\right] \quad (2)$$

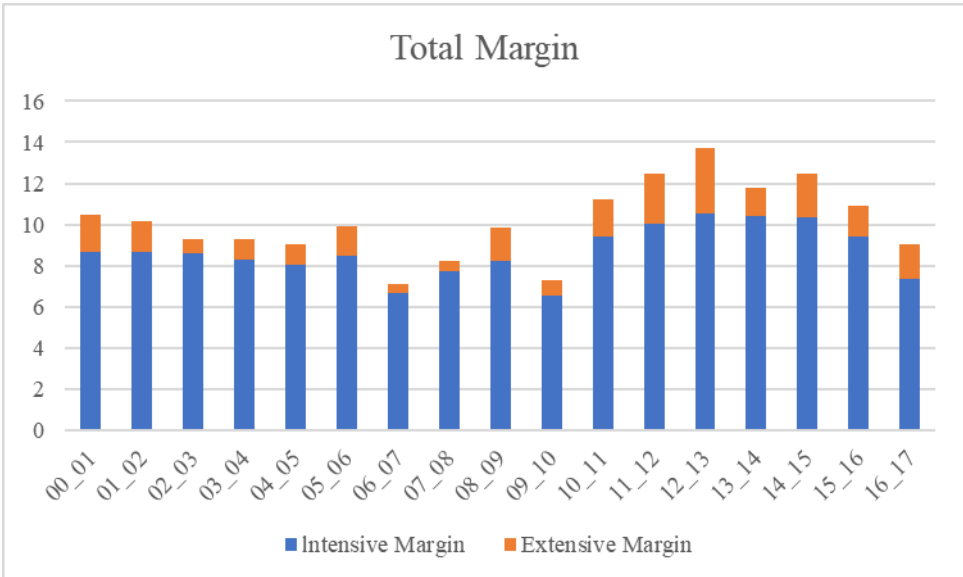
$$\triangle ln[\text{Total}]_{t-(t-1)} = \triangle ln[\text{Intensive Margin}]_{t-(t-1)} + \triangle ln\,[\text{Extensive Margin}]_{t-(t-1)} \quad (3)$$

As discussed in Table 2, the unique number of NPE means the original number of PCT-applied patents entered in the national phase, and the duplicated number of NPE indicates the number of unique patents expanded and entered in multiple countries for the national phase. After taking natural logarithm on both sides of the equation (1), the equation (2) is set up to calculate the annual change in intensive and extensive margins, described in equation (3). Total in the equation (3) stands for the duplicated number of PCT NPEs.

Figure 9 shows that PCT international applications linked to the national phase entrance relatively show the large portion of intensive margins and the small portion of extensive margins. When applying patent rights in foreign countries, it means that the potential export value of patent applications is preferred, rather than

the expanded range of the patent applications in multiple countries.

Figure 9. Intensive Margin and Extensive Margin



Notes: (i) Data is based on author's calculation and PATENTSCOPE.
(ii) Intensive and Extensive Margins are calculated based on equation (3). Intensive Margin is measured by the unique number of NPEs, and Extensive Margin is calculated from the duplicated number of NPEs divided by the unique number of NPEs.

In other words, the PCT international application plays a pivotal role in the intensive margin, the intensity of exports such as incentives from the granted patent rights, even though the PCT system is designed to provide the inventors with the convenient way for extensive margins, the expanded spectrum of the same export products (inventions) up to 152 countries.

4.3 Simple Regression Analysis

After the measurement of intensive and extensive margins, the evaluation focuses on the relationship between the number of PCT international applications as an innovation dependent variable and Gross Domestic Product (GDP) *per capita* as an economic independent variable. The yearly statistics over the period from 2000 to 2017 is calculated from 96 sampled countries to figure out the relationship between Gross Domestic Product *per capita* (GDPPC) in current US dollars[98] and the number of PCT international applications (PCT).

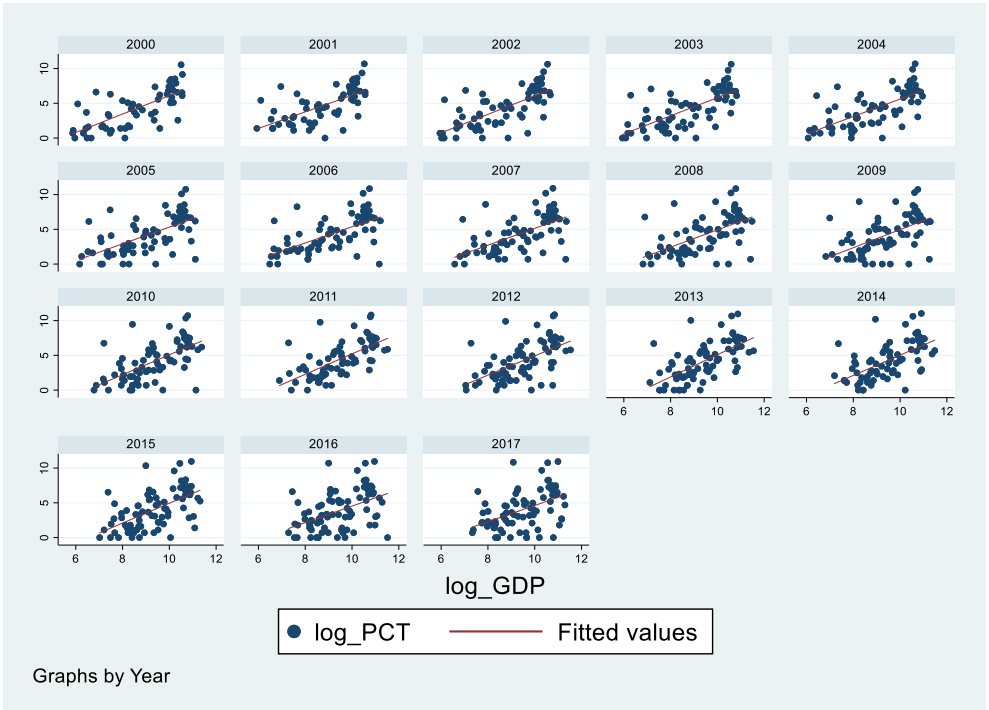
$$\log(PCT) = \alpha + \beta \log(GDPPC) \qquad (4)$$

Countries that have the available data for both GDP *per capita* and the number of PCT international applications are collected for the univariate simple linear regression model. In equation (4), log (*PCT*) is the logarithm of the number of PCT international applications, and log (*GDPPC*) is the logarithm of the GDP *per capita*. By using the OLS estimation, standard errors are robust with regards to heteroskedasticity.[99]

[98]The data is retrieved from World Development Indicators.

[99]The estimation result is attached in Table C.1, Appendix C.

Figure 10. Scatter Plot of Log of the Number of PCT International Applications against Log of GDP per capita



Notes: (i) Data is based on author's Calculation, World Development Indicators and WIPO Statistics Database.
(ii) From 2000 to 2017, by each year, it is found that the number of PCT international applications and the GDP *per capita* have the positive relationship after testing univariate simple linear regression model in equation (4).

Figure 10 provides an evidence of the linear positive relationship between GDP *per capita* and the number of PCT international applications by year. In other words, the higher the GDP *per capita* is, the greater the number of patents applied through the PCT system is. Nine countries (the U.S., Japan, Korea, the U.K., France, Germany, Sweden, Canada and Australia) except for China with the great number of

PCT international applications discussed in Table 1, are listed in the high-income countries, according to the World Bank Country Classifications in 2018.[100]

Different from the WIPO statistics data in Figure 10, the data set derived from PATENTSCOPE is used for the analysis in Figure 11 and Figure 12. Based on the aggregate data from 2000 to 2017, the sample of 74 countries is collected to test the interaction between Intensive Margin (IM) and GDP *per capita* (GDPPC) in equation (5) and between Extensive Margin (EM) and GDP *per capita* (GDPPC) in equation (6) by using the same simple regression methodology.

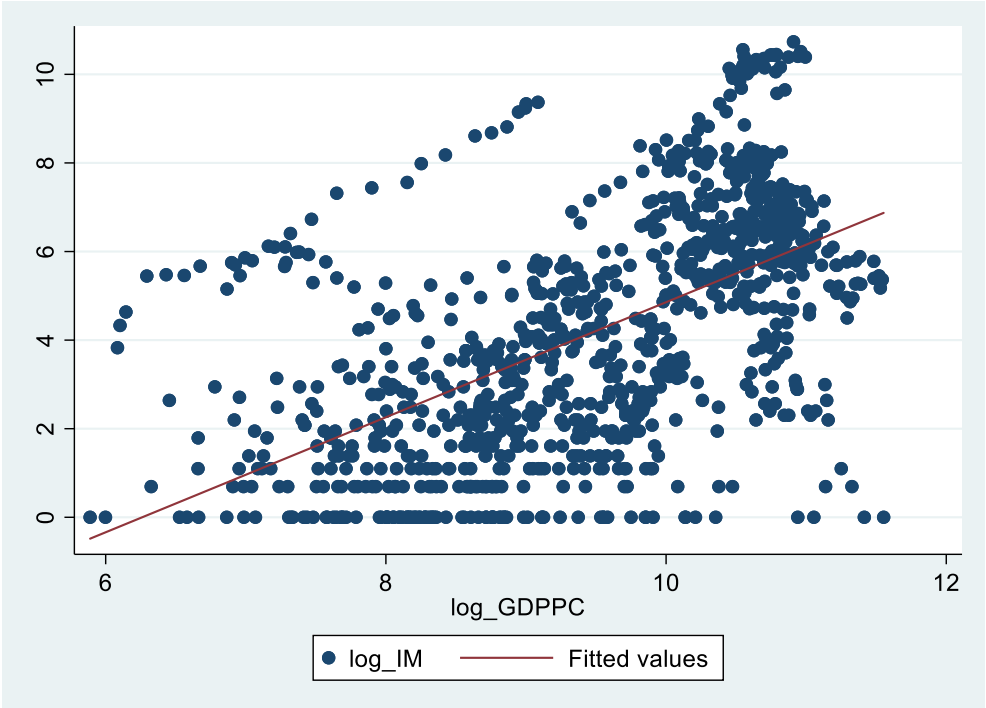
$$\log(IM) = \alpha + \beta \log(GDPPC) \qquad (5)$$

In equation (5), log (*IM*) is the logarithm of the intensive margin which is the original number of patents entered in the national phase, and log (*GDPPC*) is the logarithm of the GDP *per capita*. Standard errors are also robust with regards to heteroskedasticity with the OLS estimation. The simple regression with the dependent variable (IM) and the independent variable (GDPPC) has the statistical significance presenting that the increase in GDP *per capita* is associated with 1.29 increase in intensive margin.[101]

[100]International Monetary Fund (IMF). Available at https://www.imf.org/external/datamapper/NGDPDPC@WEO/OEMDC/ADVEC/WEOWORLD

[101]Calculation attached in Table C.2, Appendix C.

Figure 11. Scatter Plot of Log of Intensive Margin against Log of GDP per capita



Note: (i) Data is based on author's calculation, World Development Indicators and PATENTSCOPE.
(ii) With the cumulative statistics from 2000 to 2017, the positive relationship between Intensive Margin and GDP *per capita* is found by the simple regression analysis based on equation (5).

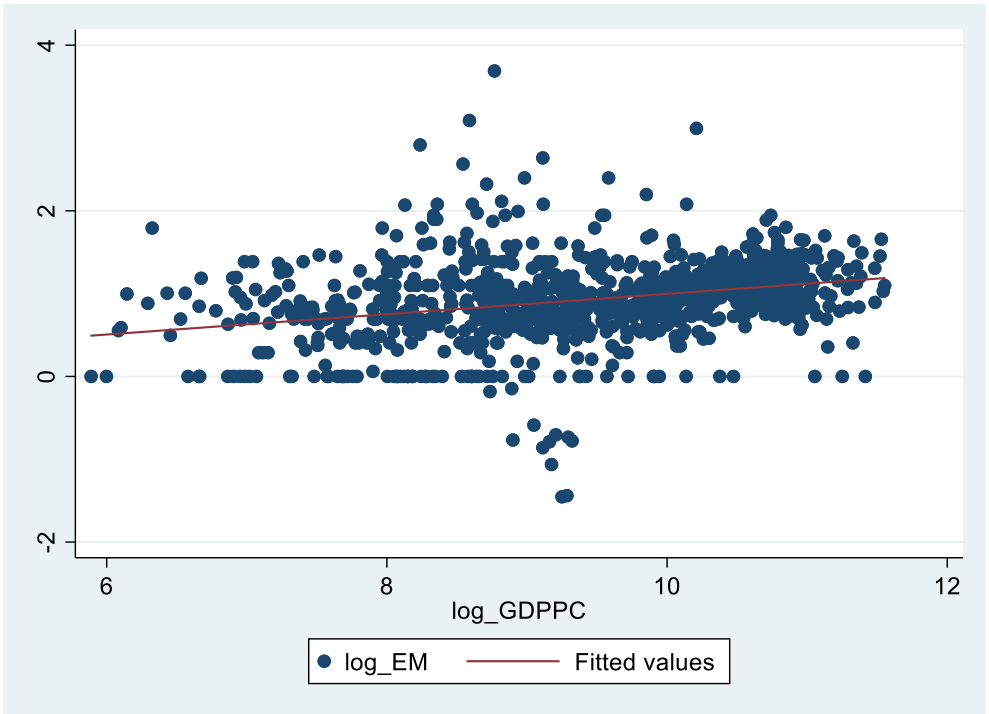
In equation (6), log (*EM*) is the logarithm of the extensive margin which is the number of duplicated patents divided by the unique number of patents, and log (*GDPPC*) is the logarithm of the GDP *per capita*. The OLS estimation is tested with robust standard errors to heteroskedasticity.[102]

[102]Calculation attached in Table C.3, Appendix C.

$$\log(EM) = \alpha + \beta \log(GDPPC) \qquad (6)$$

The simple regression with the dependent variable (EM) and the independent variable (GDPPC), representing the increase in GDP *per capita* is associated with 0.12 increase in extensive margin.

Figure 12. Scatter Plot of Log of Extensive Margin against Log of GDP per Capita



Notes: (i) Data is based on author's calculation, World Development Indicators and PATENTSCOPE.
(ii) With the cumulative statistics from 2000 to 2017, the relationship between Extensive Margin and GDP *per capita* is found by the simple regression analysis, based on equation (6).

The graph shown in Figure 12 with the weak positive relationship is not very representative because of the small R-squared value (0.0887), but the relationship is statistically significant with the zero p-value. Moreover, the relationship between GDP per capita and extensive margin is relatively weaker than the interaction between GDP per capita and intensive margin and the interaction between GDP per capita and the total number of duplicated PCT NPE patents.

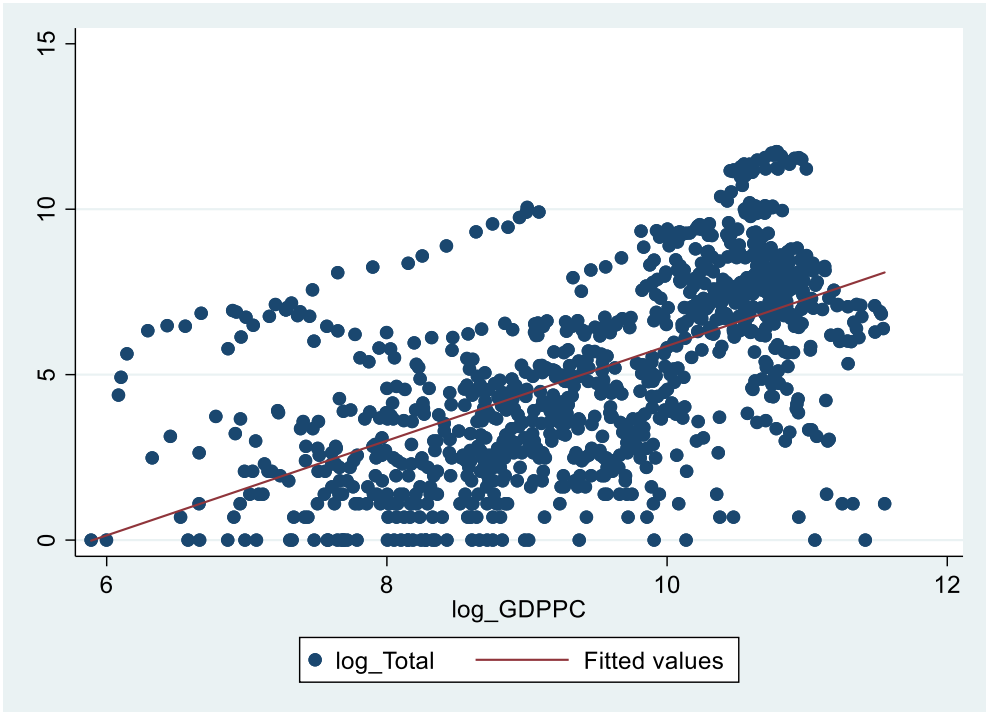
Finally, in equation (7), log (*Total*) is the logarithm of the total number of duplicated patents entered in the national phase, and log (*GDPPC*) is the logarithm of the GDP *per capita*.[103]

$$\text{Log}\,(Total) = \alpha + \beta \log\,(GDPPC) \qquad (7)$$

With the robust standard errors to heteroskedasticity, the OLS estimations also present that the positive relationship between the total number of NPE patents duplicated in multiple countries and GDP per capita, as shown in Figure 13. The increase in GDP per capita, the dependent variable. is associated with 1.43 increase in the total number of duplicated NPE patents, the independent variable. The coefficient is higher than other coefficients, 1.22 in equation (4) and 1.29 in equation (5).

[103]The OLS estimation table is attached in Table C.4, Appendix C.

Figure 13. Scatter Plot of Log of the Total Number of Duplicated Patents against Log of GDP per capita



Notes: (i) Data is based on author's calculation, World Development Indicators and PATENTSCOPE.
(ii)With the cumulative statistics from 2000 to 2017, the relationship between Extensive Margin and GDP *per capita* is found by the simple regression analysis based on equation (7).

The increase in GDP *per capita* has the greater impact on the growth in the intensive margin and the total number of duplicated NPE patents than in the number of PCT international applications. The increase in GDP *per capita* has the weakest impact on the growth in extensive margin among the tested variables.

Chapter V. Conclusion

It can be empirically explained that patenting activities abroad are related to export performance for the products requiring patent rights in advance. Policy implications can be suggested for the protection of patent rights and the role of innovation in terms of the export flows in the international trading system. When the PCT patent application in the international stage is transferred and finalized in the national stage, PCT NPEs, the initial application and the national entry in the foreign market can be interpreted as potential export flows regarding intensive and extensive margins.

The paper estimates the relationship between GDP *per capita* and patent-related variables such as the number of PCT international applications, the unique number of patents entered in the national phase measured as intensive margin (IM), the total duplicated number of NPE patents divided by the unique number of patents considered as extensive margin (EM), and the total duplicated number of NPE patents. It is found that there are the clear positive relationships between GDP *per capita* and the number of PCT international applications, between GDP *per capita* and IM, and between GDP *per capita* and the total number of duplications, and the weak positive relationship between the GDP *per capita* and EM.

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Appendixes

Appendix A: Patent Cooperation Treaty (PCT)

Table A.1: 152 PCT Contracting States as of 2019

Albania	Djibouti	Lesotho	Saint Kitts and Nevis
Algeria	Dominica	Liberia	Saint Lucia
Angola	Dominican Republic	Libya	Saint Vincent and the Grenadines
Antigua and Barbuda	Ecuador	Liechtenstein	San Marino
Armenia	Egypt	Lithuania	Sao Tome and Principe
Australia	El Salvador	Luxembourg	Saudi Arabia
Austria	Equatorial Guinea	Madagascar	Senegal
Azerbaijan	Estonia	Malawi	Serbia
Bahrain	Finland	Malaysia	Seychelles
Barbados	France	Mali	Sierra Leone
Belarus	Gabon	Malta	Singapore
Belgium	Gambia	Mauritania	Slovakia
Belize	Georgia	Mexico	Slovenia
Benin	Germany	Monaco	South Africa
Bosnia and Herzegovina	Ghana	Mongolia	Spain
Botswana	Greece	Montenegro	Sri Lanka
Brazil	Grenada	Morocco	Sudan
Brunei Darussalam	Guatemala	Mozambique	Sweden
Bulgaria	Guinea	Namibia	Switzerland
Burkina Faso	Guinea-Bissau	Netherlands	Syrian Arab Republic
Cambodia	Honduras	New Zealand	Tajikistan
Cameroon	Hungary	Nicaragua	Thailand
Canada	Iceland	Niger	The former Yugoslav Republic

			of Macedonia
Central African Republic	India	Nigeria	Togo
Chad	Indonesia	Norway	Trinidad and Tobago
Chile	Iran	Oman	Tunisia
China	Ireland	Panama	Turkey
Colombia	Israel	Papua New Guinea	Turkmenistan
Comoros	Italy	Peru	Uganda
Congo	Japan	Philippines	Ukraine
Costa Rica	Jordan	Poland	United Arab Emirates
Cote d'lvoire	Kazakhstan	Portugal	United Kingdom
Croatia	Kenya	Qatar	United Republic of Tanzania
Cuba	Kingdom of Eswatini	Republic of Korea	United States of America
Cyprus	Kuwait	Republic of Moldova	Uzbekistan
Czech Republic	Kyrgyzstan	Romania	Viet Nam
Democratic People's Republic of Korea	Lao People's Democratic Republic	Russian Federation	Zambia
Denmark	Latvia	Rwanda	Zimbabwe

Source: WIPO

Table A.2: PATENTSCOPE data accessed in February 2019

	Country	From	To	Count
1	ARIPO	30-Jun-96	05-Aug-08	1,077
2	Algeria	25-Apr-00	27-Dec-14	3,417
3	Armenia	15-Apr-18	20-Dec-18	3
4	Australia	04-Dec-97	27-May-18	343,389
5	Austria	27-Nov-80	14-Mar-19	3,351
6	Azerbaijan	21-Jan-16	21-Apr-17	28
7	Belarus	04-Jan-05	13-Aug-18	1,471
8	Belize	26-Aug-02	08-Feb-07	105
9	Bulgaria	05-Jan-04	18-Dec-07	1,252

10	Cambodia	26-Dec-17	26-Dec-17	1
11	Canada	31-Jan-90	21-Feb-19	626,856
12	China	02-Jan-94	17-Sep-17	667,979
13	Colombia	27-Dec-01	05-Feb-18	22,681
14	Costa Rica	10-Jun-01	27-Feb-19	7,093
15	Croatia	22-Apr-99	21-Mar-18	4,055
16	Cuba	02-Nov-09	23-Jun-11	299
17	Czechia	08-Nov-90	19-Feb-19	28,142
18	Denmark	06-Jan-98	14-Dec-98	31
19	Egypt	01-Jan-08	27-Feb-11	3,778
20	Eurasian Patent Office	01-Oct-96	26-Feb-19	43,772
21	European Patent Office	17-Apr-13	21-Mar-19	1,754,396
22	Finland	13-Jan-80	19-Dec-18	22,048
23	Georgia	14-Nov-99	27-Dec-18	3,116
24	Germany	12-Nov-80	18-Feb-19	243,536
25	Hungary	03-Jan-06	27-Jan-19	111
26	India	31-Jan-99	28-Dec-12	210,987
27	Indonesia	11-Jun-07	14-May-17	13,213
28	Iran	27-Oct-13	01-Dec-18	888
29	Israel	31-May-03	27-Feb-19	83,615
30	Japan	02-Apr-91	27-Feb-19	1,028,379
31	Kazakhstan	04-Jan-15	28-Jan-19	636
32	Kenya	05-Jan-98	11-May-06	237
33	Kyrgyzstan	19-Feb-97	05-Oct-05	213
34	Latvia	04-Jan-98	18-May-08	333
35	Lithuania	11-Apr-95	11-Aug-14	562
36	Malaysia	08-Mar-07	29-Sep-10	4,260
37	Mexico	23-Oct-92	18-Dec-18	243,393
38	Morocco	01-Jan-15	17-Feb-19	1,443
39	New Zealand	16-May-92	29-Nov-11	70,340
40	Nicaragua	05-Jul-17	28-Oct-18	179
41	Norway	20-Aug-80	13-Dec-18	74,571
42	Peru	05-Apr-10	06-Feb-19	7,939
43	Philippines	02-Jan-02	27-Dec-18	36,846
44	Poland	21-Nov-02	05-Dec-18	8,216
45	Republic of Korea	25-Jan-87	26-Dec-18	477,476
46	Republic of Moldova	02-Dec-93	18-Nov-18	620
47	Romania	05-Jan-90	27-Jan-08	3,927
48	Russian Federation	16-Jul-01	04-Dec-18	188,424
49	Saudi Arabia	01-Apr-15	01-Apr-15	1

50	Serbia	26-Sep-06	21-Jun-17	5,122
51	Singapore	31-Jan-16	31-Jan-19	19,886
52	Slovakia	13-Jan-93	26-Nov-08	13,265
53	Slovenia	09-Jan-01	21-Apr-05	218
54	South Africa	20-Dec-99	02-Apr-18	32,591
55	Spain	29-May-90	28-Jan-19	2,455
56	Sweden	15-Dec-82	12-Mar-19	2,252
57	Switzerland	07-Jul-08	13-Dec-18	598
58	Thailand	29-Sep-10	23-Dec-22	6,259
59	Turkey	19-Mar-96	17-Sep-17	14,256
60	Ukraine	13-Jun-05	11-Feb-19	14,972
61	United Arab Emirates	31-Aug-10	28-Feb-16	2,719
62	United Kingdom	31-Dec-1899	27-Feb-19	40,439
63	United States of America	14-Dec-16	03-Dec-18	1,137,833
64	Uzbekistan	01-Jan-01	22-Jun-06	946
65	Viet Nam	02-Apr-95	08-Apr-08	11,759
66	Yugoslavia/Serbia and Montenegro	08-Oct-96	21-Sep-06	4,112
	Total			7,548,367

Data Source: PATENTSCOPE

Table A.3: The Number of Duplications

Duplication	Frequency	Percent	Cumulative
0	641,684	9.77	9.77
1	1,059,610	16.13	25.9
2	1,222,068	18.61	44.51
3	1,113,472	16.95	61.46
4	849,855	12.94	74.4
5	598,974	9.12	83.52
6	421,246	6.41	89.93
7	302,448	4.6	94.54
8	221,247	3.37	97.91
9	98,020	1.49	99.4

10	23,562	0.36	99.76

Note: Author's calculation based on the data from PATENTSCOPE

Appendix B: Patent Applications by Foreign Origin Filed in USPTO

Table B.1: Cumulative Number of Patent Applications and Average Annual Growth Rate from 2000 to 2015

	Country	Number of Applications	Average Annual Growth Rate
1	Japan	1,205,939	3.56
2	Germany	389,345	3.84
3	Korea	345,088	14.55
4	Taiwan	273,517	5.63
5	Canada	163,743	4.84
6	UK	159,609	4.15
7	France	141,505	4.54
8	China	112,303	31.4
9	Israel	73,108	8.52
10	Netherlands	59,646	5.91
11	Italy	59,184	4.24
12	Sweden	54,479	4.40
13	Switzerland	53,927	6.10
14	India	51,932	23.03
15	Australia	50,155	5.19
16	Finland	38,575	5.46
17	Belgium	28,455	3.72
18	Austria	24,181	7.75
19	Denmark	23,962	7.25
20	Singapore	19,832	7.90

Note: Author's calculation is based on the data provided by the USPTO from 2000 to 2015.

Appendix C: Regression Analysis

Table C.1: Linear Regression Results for the Number of PCT International Applications and GDP per Capita

Linear regression				Number of obs	=	1,288
				F(1, 1286)	=	618.58
				Prob > F	=	0.0000
				R-squared	=	0.3444
				Root MSE	=	2.1859

log_PCT	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_GDPPC	1.223359	.0491875	24.87	0.000	1.126862	1.319855
_cons	-7.067883	.4490928	-15.74	0.000	-7.948918	-6.186848

Note: Author's Calculation is based on the data from World Development Indicators and WIPO Statistics Database.

Table C.2: Linear Regression Results for Intensive Margin and GDP per Capita

Linear regression				Number of obs	=	988
				F(1, 986)	=	392.88
				Prob > F	=	0.0000
				R-squared	=	0.3285
				Root MSE	=	2.2309

log_IM	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_GDPPC	1.298588	.0655148	19.82	0.000	1.170023	1.427152
_cons	-8.130117	.626727	-12.97	0.000	-9.359989	-6.900245

Note: Author's calculation is based on the data from World Development Indicators and PATENTSCOPE.

Table C.3: Linear Regression Results for Extensive Margin and GDP per Capita

Linear regression				Number of obs	=	988
				F(1, 986)	=	112.00
				Prob > F	=	0.0000
				R-squared	=	0.0887
				Root MSE	=	.47261

log_EM	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_GDPPC	.1227346	.0115973	10.58	0.000	.0999764	.1454929
_cons	-.2299394	.1167627	-1.97	0.049	-.4590715	-.0008074

Note: Author's calculation is based on the data from World Development Indicators

and PATENTSCOPE.

Table C.4: Linear Regression Results for the Total Number of Duplicated Patents and GDP per Capita

Linear regression — Number of obs = 988; F(1, 986) = 416.39; Prob > F = 0.0000; R-squared = 0.3519; Root MSE = 2.3336

log_Total	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_GDPPC	1.431063	.0701311	20.41	0.000	1.293439	1.568686
_cons	-8.444636	.6713027	-12.58	0.000	-9.761982	-7.12729

Note: Author's calculation is based on the data from World Development Indicators and PATENTSCOPE.

국문 초록

PCT 국제 특허출원의 국가별 분석 및 의의: 2000-2018년

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국제학과 국제지역학 전공
조유경

시장 경제와 국제적 디지털 시대에서 유형 자산 뿐만 아니라 무형 자산 또한 중요한 요소가 되었다. 무역가능한 상품과 서비스를 다루었던 전통적 경제 체계와 비교해서, 지적재산권의 소유권이 발명자의 인센티브로 직접적으로 이어지며, 무형 자산의 중요성은 국경을 넘어 점진적으로 증가했다. 2000년 이후 신기술 특허 출원 증가와 더불어, 특허 데이터는 기술 발전 정도를 반영하는 지표 중 하나로 사용될 수 있다. 속지주의 원칙에 따라, 해외에서 특허권 시행을 추구하는 기업 혹은 개인 등의 발명가는 (지역적 혹은 국내적 방식을 통한) 직접 해외 출원 혹은 PCT 국제 출원을 원하는 국가에 제출해야 한다. 이러한 지적재산권의 국가별 환경 하에서, “국제특허”는 존재하지 않고, 다만 국제 특허 출원 절차만이 국경을 넘은 특허권 소유를 위한 개시로 유효하다.

세계지적재산권기구와 세계무역기구를 중심으로 다양한 범위의 국내적 특허 규칙과 규정을 국제적 기준으로 조정하는 협력적 노력이 있었음에도 불구하고, 각 국은 혁신 활동과 지적재산 관련 시장 구조에 있

어서 고유한 형태를 지니고 있다. 따라서, 주목할 만한 국제 특허 출원 활동을 보이는 국가들의 특징을 기술적 · 경제적 측면에서 살펴보는 것이 중요하다. 이 연구에서는 국제 특허출원 데이터가 각 국의 혁신 정도를 반영하기 위해 선택되고 조사되었다. 더 구체적으로는 특허의 출원과 등록이 향후 특정 상품(발명)을 수출하기 위한 필수 전제조건인 상황을 고려하면, 국제 특허출원의 패턴과 해외 지정국으로의 진입이 각각 국제무역 중 특히 잠재적 수출의 내연적 · 외연적 확장으로 해석되었다.

그러므로 글로벌 특허 활동의 복잡한 역학을 이해하기 위해서는 첫째, 특허 통계가 출원인의 분류 (내국인 혹은 외국인), 출원 옵션 (직접 출원 혹은 PCT 출원), 그리고 특허출원 처리 관청 (출원인 국적에 근거한 PCT 국제 출원을 최초 수리하는 수리관청과 PCT 국제 출원의 국내단계 진입, 즉 수리관청에서 출원된 특허를 최종적으로 받아들이는 지정관청) 등 다른 측면에서 조사되었다. 둘째, 2000년 이후 특허 통계의 일반적 동향을 다룬 후, 데이터는 양적으로 접근한 PCT 출원과 질적으로 접근한 PCT 국내단계 진입의 연결에 집중한다. PCT 시스템을 통해 출원된 특허가 지정국가의 국내단계로 진입했는지 여부를 추적함으로써, 국제 특허 출원이 내연적 확장과 외연적 확장에 어떠한 관련이 있는지에 대한 질문을 실증적으로 접근하였다. 또한, 2000년 이후 연도별 단순회귀분석 결과, 1인당 국내 총생산과 PCT 국제출원의 상호 작용은 통계적으로 유의미하고 양의 관계가 있음을 증명하였다. 2000년 이후 합계 데이터의 단순회귀분석 결과 역시, 1인당 국내 총생산과 내연적 확장, 1인당 국내 총생산과 외연적 확장, 1인당 국내 총생산과 PCT 출원을 통해 다국으로 복제되고 확장된 총 출원 수의 상호 작용 모두 통계적으로 유의미하고 양의 관계가 있음을 증명하였다.

주제어: 지식재산권, 국제 특허출원, PCT 국내단계 진입, 외연적 확장, 내연적 확장

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