An analysis of relation between resident and non-resident patents and gross domestic product: Studying 20 countries

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Abstract— Recently, regarding to the occurrence of global challenges including economic recession, continental changes and public consequences, human’s creativity and inventions (Patent) are essential to find out sufficient solutions in future. Also, country of origin is used to categorize Intellectual Property (IP) data by resident (domestic) and non-resident (foreign) patent. In addition, Gross Domestic Product (GDP) is an important subject in macroeconomic, which refers to the market value of all final goods and services produced and is correlated with criteria and standards of life. Therefore, according to importance of subjects as resident and non-resident patents and GDP, this paper tries to rationalize and analyze the trend between them through regression method to find out the effect of each type of patent on GDP. In fact, this method is applied and analyzed for 20 countries around the world (the data from the years 1980-2007) as case studies and all countries are classified into 3 classifications as Developed, Mid-Developed and Developing Countries based on the relation between resident and non-resident patents and GDP. At the end, the findings show USA and Japan are developed countries based on each relation.

Keywords- Resident Patent; Non-Resident Patent; Gross Domestic Product; Regression Method

I. INTRODUCTION

Regarding to the occurrence of global challenges including economic recession, continental changing and general consequences of policies (such as security, health and food), human’s creativity and invention are essential to find out acceptable solutions in future. Moreover, due to increasing growth of knowledge as an impetus for innovation and economy, intellectual property (IP) plays a vital role in simulating and assessing creativity and innovation to patent in the modern economy. Furthermore, the index Gross Domestic Product is subjected to macro-economy and this index is correlated with criteria and standards of mankind’s life [1].

Patent is an exclusive right which is given by law to the inventors for their inventions in a limited period of time (usually for 20 years). The patent holder has the legal right to exclude others from commercially exploiting the invention for the duration of this time. In the subject patent, the terms Resident (domestic) and Non-Resident (foreign) are defined based on the country of origin and all IP data and information are categorized by these two terms. As a matter of fact, the residency of the first person who registers an invention in the IP documents (that is Patent and Trademark application) is used for categorizing the IP data and information by the country of origin. A resident filing in the IP data refers to an application filed by an applicant at his national IP office. For example, an application filed by an applicant resident of Japan at the IP office of Japan, is considered as a resident filing for the IP office data of Japan; similarly, a non-resident filing refers to an application registered by an applicant at a foreign intellectual property office. For instance, an application filed by a French resident applicant at the IP office of China, is considered as non-resident filing for the data of China’s intellectual property office [2].

Furthermore, Gross Domestic Product (GDP) is one of the measuring scales of economy, which defines the value of all final produced goods and services in the certain period of time in a country which it is measured by the currency of that country. In this definition, final goods and services mean those which are in the end of the production’s chain and they are not purchased for other production or services [3].

According to the importance of subjects as Patent and GDP, some researches have considered examining and analyzing the relation between them. In this regard, a research examined the trend between patent and economic growth for Japan and South Korea. They found that the logarithms of GDP and the number of patents are co-integrated and it may be a two-way causality between the growth of GDP and the growth of the number of patents. But, at last, they realized that the growth of GDP causes the growth of the number of patents and did not find any evidence of reverse causality [4]. In addition, another study tried to find out the effective variables on firm market value and in this regard, it was assessed by variables such as assets value, quality of R&D stock and Patent [5]. Moreover, it was found out that there is a quantitative relationship, which can be expressed as G=kF(lgP)N, where G is per capita GDP, F gross expenditure on R&D as % of GDP, P patent applications, N
Internet users per 10,000 inhabitants, and k a constant ranging from 0.4 to 1.2 in most countries[6].

According to the terms above and literature review, this research tries to study and analyze the relationship between different types of patent as resident and non-resident one and the economic index GDP to specify the effect of these two types of patent on GDP. In this regard, at first different regression equations (about 9 equations) are used to estimate the relationship between the variables resident and non-resident patent and GDP. Finally, the method is applied for about 20 different countries around the world (the data from 1980 to 2007) and they are classified based on type of their regression equation and patterns.

II. RESEARCH METHODOLOGY

In this research, with regard to literature review and the importance of subjects patent from the point of residency and non-residency (as an impetus for innovation) and GDP (a scale for measuring the macro-economy), we aim to examine and analyze the relation between them and specify the effect of these two types of patent on the GDP. Therefore, a research methodology including some steps as follows is conducted:

a. Studying theoretical aspects and literature review: firstly, this article studied the theoretical aspects and literature review related to the patent (resident and non-resident) and GDP

b. Using the regression method to estimate the relation between types of patent and GDP: in this step, the regression method including some equations is used to specify the relation between resident and non-resident patent (as independent variables) and GDP (as the dependent variable).

c. Applying previous step for some countries as case studies: based on previous step, the regression method is applied for the relation between resident and non-resident patent as independent variables and GDP as the dependent variable of some countries to study and analyze the relation between these two variable in different case studies.

d. Classifying different countries based on type of the relation: at the end, considering the type of relation and trend between the number of the resident and non-resident patents and GDP of each country, they are classified.

III. THE REGRESSION METHOD

In statistics, regression analysis includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed[7]. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables — that is, the average value of the dependent variable when the independent variables are held fixed. In all cases, the estimation target is a function of the independent variables called the regression function. The performance of regression analysis methods in practice depends on the form of the data generating process, and how it relates to the regression approach being used. Since the true form of the data-generating process is in general not known, regression analysis often depends to some extent on making assumptions about this process. These assumptions are sometimes (but not always) testable if a large amount of data is available. Regression models for prediction are often useful even when the assumptions are moderately violated, although they may not perform optimally. However, in many applications, especially with small effects or questions of causality based on observational data, regression methods give misleading results[8].

Based on literature review and regression method, the variables number of patents (including both resident and non-resident patent) and GDP are considered as independent (X) and dependent(Y) variable respectively. Therefore, this research uses different types of equations such as the linear, polynomial (upper than binominal), power, exponential and logarithmic to estimate the relation between these two dependent and independent variables. Moreover, for deciding on the best estimating equation among the equations above, the value R-squared which shows the accuracy of an estimating equation is used.

All statistical software packages perform least squares regression analysis and inference. Simple linear and multiple regressions which use the least squares method can be performed in Microsoft Excel spreadsheets.

IV. CASE STUDIES

Based on the accessibility to data, this article has used the data between years 1980 to 2007 for the variables of the number of patents (resident and non-resident) and GDP from the information internet database of World Intellectual Property Organization (WIPO) [9] and International Monetary Fund [10] respectively. Furthermore, some countries around the world (about 20 countries) are chosen based on their importance in the continents to study and analyze the relationship between the variables mentioned. Therefore, we classify all these countries regarding to the type and pattern of two variables (the variables of number of patents: resident and non-resident patent and amount of GDP).

A. The relationship between number of resident and non-resident patents and amount of GDP

In this section, based on the importance and progression of Japan in both patent and GDP, it was firstly decided to perform the regression method for that country in details and according to the followed method, other case studies are examined and analyzed and just results are shown.

“Fig. 1” shows the variety types of estimated regression which are passed through the data of patent(variable x) and GDP(variable y) from Japan by distinguished lines and names. In addition, this relation is shown mathematically by types of equations and their R-squared in table I. Based on examining and analyzing both “Fig. 1” and table I, it is realized that the
equation polynomial with four monomials is the best one for estimating the relation between patent and GDP data of Japan. Also, it is clear that every mathematical chart has its unique features and pattern and based on these, it is understood that in this equation there are almost 3 peaks (one minimum in 1985 and one maximum in 2001). This proves that Japan had two major fluctuations about GDP acquired from patents in two different periods during about 22 years. During the years from 1985 to 1990, we can see an increasing trend of patents number, although with declining or even negative growth of GDP. According to this, it is realized that whether the creativity and invention subjects were not paid attention in Japanese policies during this decade or they were implemented and exploited after this decade. It is noticeable that about the year 2000, GDP captured from patents is reached to its maximum and after this time we can see a declining growth either in GDP and patent.

As you have observed in figure 1 and table I, the relation and the pattern between all number of patents and GDP for Japan studied and analyzed as a sample. Now, here we study and analyze this relationship and pattern for Japan in the other way and more accurately. In fact, in order to study and analyze the effects of resident and non-resident patent on GDP, we study the relation and the pattern of each of them separately. Figure 2 shows these relations. It is noticeable that here we did not discuss in details about estimating the best regression equations. Therefore, we examine the relation between the variables resident, non-resident and all patents with GDP of Japan as a sample. In figure 2 you can see that for each relation between the variables resident, non-resident and all patents with GDP, three estimated charts are drawn (by distinguished colors). By observing figure 2, you understand that the pattern of chart of the relationship between resident patent and GDP is so close to the chart of the relationship between the whole patents and GDP, while the chart of relationship between non-resident patent and GDP is different and it is located with a large distance to two other charts. Moreover, not only this chart has the large distance, but also it has different pattern, since it has more peaks. Consequently, we can conclude that the resident patents in Japan had bigger and greater effects on the GDP rather than the non-resident ones. As a result, we can conclude that Japan is a more developed country from the point of its resident patents, rather than its non-resident ones.

### TABLE I. ESTIMATED EQUATIONS BETWEEN PATENT AND GDP FOR JAPAN

<table>
<thead>
<tr>
<th>Types of Equation estimated for Japan</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>0.761</td>
</tr>
<tr>
<td>Exponential</td>
<td>0.827</td>
</tr>
<tr>
<td>Polynomial</td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>0.761</td>
</tr>
<tr>
<td>Linear</td>
<td>0.844</td>
</tr>
<tr>
<td>Linear</td>
<td>0.865</td>
</tr>
<tr>
<td>Linear</td>
<td>0.865</td>
</tr>
<tr>
<td>Linear</td>
<td>0.872</td>
</tr>
<tr>
<td>Logarithmic</td>
<td>0.746</td>
</tr>
</tbody>
</table>

As you can see in Table I, the best regression equation for Japan is the exponential equation with \( R^2 = 0.827 \). This equation shows a strong relationship between resident patents and GDP. Other equations, such as the linear, polynomial, and logarithmic equations, have lower \( R^2 \) values, indicating a weaker relationship.

**Figure 1.** Estimated charts between patent and GDP for Japan

**Figure 2.** The comparison of estimated regression charts for three relations as resident, non-resident and all patents with GDP of Japan

**B. Classifying 20 countries based on the relation between both resident and non-resident patents with GDP**

Regarding to the regression method and estimated equations which have been used for Japan as a sample, now we are to study and analyze the relationships between the variables resident patents with GDP and non-resident patents with GDP for 20 countries around the world, which are shown in Figures 3 and 4 with tables II and III. It has to be mentioned that we only classify the results not in details.

1) **Classifying 20 countries based on the relation between resident patent and GDP**

In figure 3 you can see that the countries Japan, USA, Germany, and southern Korea have a considerable growth and development in both resident patent and GDP rather than other countries around the world and thus they have separated themselves from others and are known as developed countries.
(X≥50000, Y≥300000). Moreover, the countries such as France, England and China have a few growth and development in resident patent, but have gain a great GDP which based on that, we name them as Mid-developed countries(10000≤X<50000, 10000≤Y<300000). At the end, the countries such as Canada, Italy, Spain, Israel, Australia, Sweden, India, Netherland, Egypt, Malaysia, South Africa, Singapore, Turkey are actually in the low level of resident patent and GDP, which lead them to be known as developing countries(X<10000, Y<10000). Table II shows these developed, Mid-developed, and developing countries with considering the number of resident patents and GDP.

TABLE II. CLASSIFYING 20 COUNTRIES BASED ON THE RELATION BETWEEN RESIDENT PATENTS AND GDP

<table>
<thead>
<tr>
<th>Types of Countries</th>
<th>Variables</th>
<th>The Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed</td>
<td>X≥50000, Y≥300000</td>
<td>USA, Japan, Southern Korea, Germany</td>
</tr>
<tr>
<td>Mid-Developed</td>
<td>10000≤X&lt;50000, 10000≤Y&lt;300000</td>
<td>France, England, China</td>
</tr>
<tr>
<td>Developing</td>
<td>X&lt;10000, Y&lt;10000</td>
<td>Canada, Italy, Spain, Israel, Australia, Sweden, India, Netherland, Egypt, Malaysia, South Africa, Singapore, Turkey</td>
</tr>
</tbody>
</table>

2) Classifying 20 countries based on the relation between non-resident patent and GDP

In figure 4, you can see the charts of 20 countries based on the relation between the number of non-resident patents and GDP. It is obvious that America has dramatically grown and developed based on non-resident patent and GDP which this is the result of large amount of people who move to this country for the education and investment, and more accurately it can be mentioned that the number and effect of resident and non-resident patents are approximately equal in this country. Although, Japan has less development in this area rather than America, but however it has a better growth in comparison with other countries. So, here we know America and Japan as developed countries(X≥50000, Y≥300000). Furthermore, in this chart by considering less growth of the countries like France, England, Germany, Australia, Canada, southern Korea, China and Singapore rather than developed countries (America and Japan), we name them as Mid-developed countries (10000≤X<50000, 10000≤Y<300000). This is considerable that southern Korea and Germany were known as the developed countries due to the relation between resident patent and GDP, but here they are known as mid-developed counties which it shows that their resident people are more active and successful in the point of economy and invention. Finally, countries such as Italy, Spain, Israel, Sweden, India, Netherland, Egypt, Malaysia, South Africa, Turkey are located in a very low level of relationship of non-resident patent and GDP, and as a result, they are known as developing countries( X<10000, Y<10000). Table III shows the developed, mid-developed, and developing countries based on the relation between non-resident patent and GDP.

TABLE III. CLASSIFYING 20 COUNTRIES BASED ON THE RELATION BETWEEN RESIDENT PATENTS AND GDP

<table>
<thead>
<tr>
<th>Types of Countries</th>
<th>Variables</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed</td>
<td>X≥50000, Y≥300000</td>
<td>USA, Japan</td>
</tr>
<tr>
<td>Mid-Developed</td>
<td>10000≤X&lt;50000, 10000≤Y&lt;300000</td>
<td>France, England, China, Southern Korea, Germany, Canada, Australia, Singapore</td>
</tr>
<tr>
<td>Developing</td>
<td>X&lt;10000, Y&lt;10000</td>
<td>Italy, Spain, Israel, Sweden, India, Netherland, Egypt, Malaysia, South Africa, Turkey</td>
</tr>
</tbody>
</table>

V. CONCLUSION

The main purpose of this paper was examining and analyzing the trend and relation between types of patent as resident and non-resident one(independent variables) with GDP(dependent variable). Actually, for conducting this purpose, the trends and relations between them were realized and estimated through regression method including different equations as Exponential, Linear, Logarithmic, Polynomial (upper than 2) and Power one and the best one was selected by considering the R-squared value. Also, some countries(20 ones) over the word were chosen as case studies to examine and analyze the relation between mentioned variables. For the relation between resident patent and GDP, countries were classified as Developed Countries “USA, Japan, Southern Korea, Germany”, Mid-Developed “France, England, China” and Developing Countries “Canada, Italy, Spain, Israel, Australia, Sweden, India, Netherland, Egypt, Malaysia, South Africa, Singapore, Turkey”. Finally, for the relation between Non-resident patent and GDP, countries were classified as Developed Countries “USA, Japan”, Mid-Developed “France, England, China, Southern Korea, Germany, Canada, Australia, Singapore” and Developing Countries “Italy, Spain, Israel, Sweden, India, Netherland, Egypt, Malaysia, South Africa, Turkey”. As a conclusion, USA and Japan are developed countries whether based on the relation between resident or non-resident patent and GDP.

REFERENCES

[9] www.wipo.int/
Figure 3. The chart of 20 countries based on the relationships between resident patents and GDP.

The chart of 20 countries based on the relationships between non-resident patents and GDP.