Influence of Current and Investment R&D Expenditures on Number of Patent: A Case Study of Turkey

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Abstract

The aim of this study was to examine the correlation between the number of patent and research and development (R&D) budget, within the current and public investment of R&D expenditure in Public Private(Commercial) and Higher Education sectors in Turkey . For this purpose, correlation between patent execution in Turkey in the years of 1995-2012 and Public, Commercial and Higher Education sector 's current and investment R&D budget expenditures were analyzed using linear regression model. E-View 6 software program was used for statistical purposes. It was found that there was a positive correlation between R&D expenditure related to public sector and number of patent than other sectors when it was examined among the Public, Commercial and Higher Education sectors.

Key Words: R&D, Patent, Current Spending, Investment Spending, Innovation.

1. Introduction

R&D assets are long term and low rate of return investments. The governments had to take precautions to protect property rights due to high cost of R&D activities, long terms, unknown results and availability of R&D activity's results to be replicated by other businesses or sector (Durmuş, 2008: 290). Among these precautions, the patent regulation has an important place. On the other hand, because knowledge is a public good (Romer, 1990), R&D activities are quite important for public sector. Today's modern economy is increasingly managed by new technology and innovation comparing to physical capital. With the help of high innovation, in other words the economy that having more products with original patent, countries become more independent and more competitive (Prodan, 2005: 6). Schumpeter stated (1950) that innovations are the primary functions of the capitalist system that keeps it in motion. Innovation process has a positive effect on economical growth. This process starts with a creative idea, develops R&D activity and results with a product. Patent applications in this process (Papadakis, 1993; Holbrook, 1992; Prodan, 2005). As a result innovation becomes the basic asset of protecting intellectual and industrial rights.

One of the most important factor that indicate development level of countries is industrial property rights. In globalizing word, it became an obligation to protect industrial property rights because of international competition. Besides, the issues related to separation process of products are the reasons that today's nations care about industrial property rights and they try hard to protect them. At this point, the government makes patent laws as one of its major obligations to regulate the market aiming the protection of intellectual and industrial property rights. The first attempt to protect industrial property rights in the world was the first patent law put in order in Venice in 1474. The importance given to industrial property rights was increased between the 16-19th century by many countries especially United Kingdom and USA. These countries built their own industrial property systems (http://www.turkpatent.gov.tr/dosyalar/yayinlar/faaliyet/FR07.pdf, 22.03.2013). During this 200 years of process, USA started the official patent licensing in 1790, and France in 1791. Many countries issued patent regulations following years (http://patent.nedir.com/#ixzz2PCf0nltn, 02.04.2013).

In Turkey the first official attempts concerning to protect industrial property rights was began with Alamet-i Farika Regulation in the late 19th century. After this date, there were serious regulation efforts to improve national legislation. The importance of international trade and collaboration became significant; therefore serious steps were taken towards joining international settlements. The first international settlement was 'Paris Convention' in 1883. Turkey was involved this convention in 1925. Paris Convention is recognized as the constitution of industrial property rights. This convention assures to protect industrial property rights internationally. Important developments were experienced in the field of industrial property between 19.-20th centuries. Some settlements were signed to provide international integration and several organizations were organized to lead the industrial property rights system.

Madrid Protocol (1989) on international registry of industrial property, Lahey (1925) on International Protection of Industrial Designs, Lizbon (1958) on International Protection of Geographical Landmarks and Patent Cooperation Treaty (1970) are the examples of international integrations signed in 20th century. The World Intellectual Property Organization (WIPO-1967), Europe Patent Office (EPO-1973), World Trade Organization (WTO- 1995) and Office for Harmonization in the Internal Market (OHIM- 1996) are the significant international organizations leading new applications in industrial property and providing consistency among nations. Due to Turkey's given importance to industrial property and with the effect of globalization, Turkey becomes a member of the several international organizations. Turkey has gained a respectable place in international industrial property system. When Turkey became a member of World Trade Organization, WTO's contracts got affected and a new era started in the field of industrial property system (http://www.turkpatent.gov.tr/dosyalar/yayinlar/faaliyet/FR07.pdf, 22.03.2013).

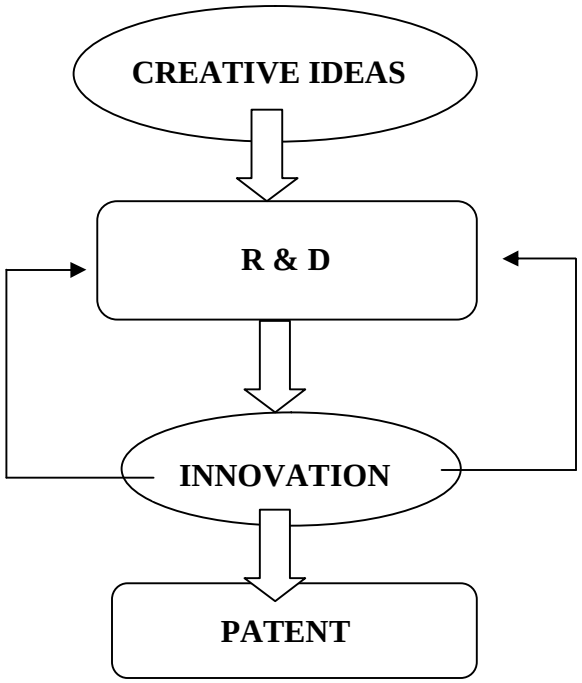
In historical process, patent that is a basic factor within industrial and intellectual property is affected by R&D budget directly in innovation process. For this reason, in many empirical study, correlation between two factors are tried to examine using different econometric methods for different nations. These studies showed that relation between R&D activities aiming to improve cumulative knowledge and human culture and patent has one thing in common. They share the unsuccessful attempts effect on public budget and they both need government intervention against market fluctuations. The aim of this study was to discover the correlation between patent number of Turkey and R&D budget. This study is important and also different from other studies, because it examines the R&D budget within three sections –higher education, trade, public-. Besides, it evaluates each R&D spending (expenditure) item in two categories –current and investment- and analyses the correlation among the number of the patent and those item. The main purpose was to determine what type of R&D expenditure has a strong correlation with the number of the patent. For this reason, next section will discuss the concept of patent.

2. Concept of Patent

Information is the most important factor determining competitive power and development level of communities in nowadays economy. Invention that come up with used information and creativity is also the basic of competition besides it is one of the biggest source of income in developed countries. So, information is a necessary source for communities and it is the most important reality of the life. R&D activities of long process is made for solutions to technical problems. Saving patent right provides the legal monopoly right for the owner of innovation and it enables to block benefit of others from his/her innovation without permission (Kaya, 2009: 20).

In this context, patent is a document show that right of use or production belonging to specific a new device, or tool or process was given for a long time (Griliches, 1990: 1662). This definition since classical economists (like Adam Smith and David Hume) include an application to protect of property right as one of government's basic tasks. Thus, the government protects property of creator idea or innovation by patent in innovation process and it helps to end up with product.

Figure 1: Innovation Process



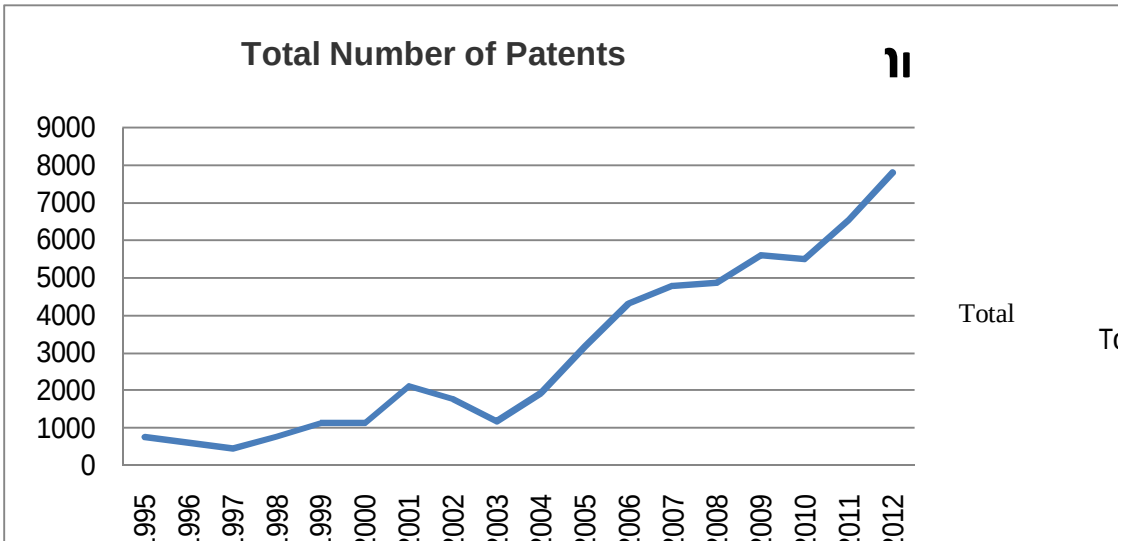
Source: Kaya (2009)

Within the innovation process and as a result of high R&D budget (see in figure 1) (OECD, 2008: 181) patent is called as "finding document", "nationally document" or "discovery document". Moreover, it is explained as a formal document governmentally certificated that show production or sale rights of a commercial invention belong to a firm or a person. Similarly, it can be identified a document show that a particular property right has been given to its inventor by an authorized organization. Inventors themselves can sell, use or can import given property right. But a person don't get right for produce, use, sell or import of invention by patent. Patent include intellectual property category like trademarks, copyrights and business secret. Patents also present to inventors economic promotions provided a monopolist saving for the innovation (U.S. Code Title 35: Patents, 154).

To get patent for an invention, it must fit certain criterions defined in law. First, nature of patent must be worth the protection. Most of patent application involves inventions. Heuristic and mental movements as mathematical algorithms, natural events, abstract idea and natural law don't available for patents (Ben-Yehuda, 2000). Then, innovation must pass the novelty test. Innovations must be unique and patent is given for innovations passed the novelty test for a year so that it sell or put up for sale within one year, it use in favor of trade or public or announce it as an innovation (Pressman, 2002). If an idea has been announced to even a small group before it issue within further a year, it fails to pass the novelty test. As a last criterion, patent must be helpful worth waiting for. Most of innovations generally slog to pass helpfulness level. The last and probably the most unclear criterion is clarity criterion. This criterion involve to must prove it wasn't created by a person had a common experience (Christ, 2005).

Innovations on industrial field are basic factors effected economic development. Innovations usually are developments that new products and new methods insure to reflect to economy. Beside patent insures, legal protection to innovations, it also serves as a promotion to be found innovations and novelties. Patent prompts to be formed of search and progress activities in the whole fields of technology. And it takes a very important role in spread of technical information (http://www.tpe.gov.tr/dosyalar/taslaklar/Patent_Kanun_Taslagi_Gerekçe.pdf, 29.03.2013). According to Turkish Patent Institute's data, patent registry score was 763 in 1995 and this figure rise up 7816 in 2012 (See in Figure 2).

Figure 2: Patent Registry in Turkey.



Source: http://www.tpe.gov.tr/portal/default2.jsp?sayfa=136

3. R&D Budget

According to Arrow (1962), R&D has public welfare feature and it creates positive external impacts. The market economy will be demonstrated a reason for R&D investments in public within invention and research investments. But, questions about how to invest and how much it will cost have a certain difficulties for policy makers that want to take a decision connecting with measurable data (Arrow, 1962). In this direction, R&D budget are one of important circles within production chain beginning with creative idea for patent creation. As we mentioned before R& D creates positive externality which is a sort of market failure needs government intervention. Also it can be said that R&D budget are a public good in a sense due to they created information externality. In this context, in a lot of developed and developing country, R&D budget have a very important part in both total and public R&D expenditure. R&D budget evaluates basically within framework of three sectors. In this framework arising from Public, Private (commercial) and Higher Education, R&D budget are classified and defined by Turkish Statistical Institute.as follows:

Public Sector: Whole public institutions.

Private Sector: This category includes industries and service attempts worked on private sector with 20 or further personnel.

Higher Education: It covers whole state universities and foundation universities and research institutes.

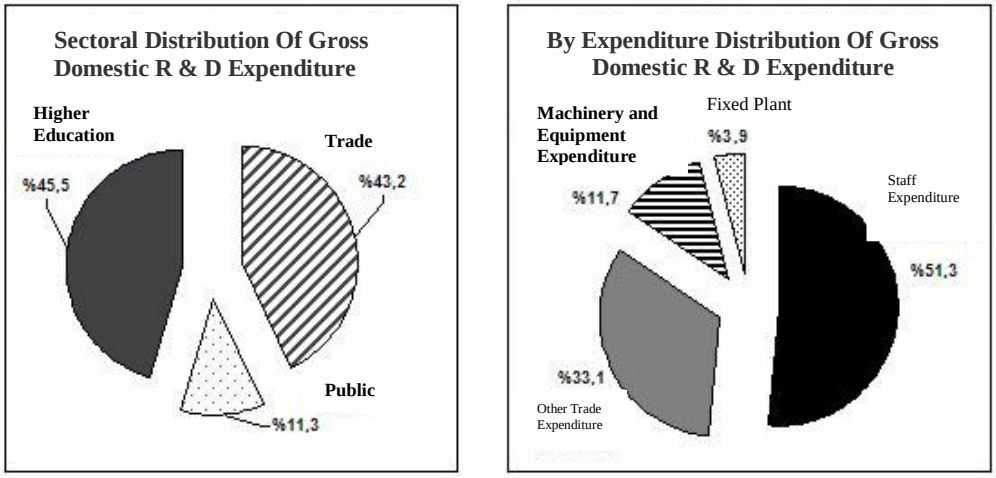
In the consideration of these definitions according to results of R&D activities research in 2011 build upon public corporations, foundation universities and questionnaire results in commercial sector and budget and personnel lists of state universities, in Turkey in 2011 Gross domestic R&D budget increased %20, 4 by previous year and it was calculated 11154 million Turkish Liras. Gross domestic R&D budget in Turkey takes up %8,6 in gross domestic product. This proportion calculated as %8,4 in 2010. Gross domestic R&D budget was spent by higher education in %45.5; by commercial part in %43.2 and by public part in %11.3 (See Table 1).

Table 1: R&D Budget Distribution

	Current Prices (TL)	Purchasing Power Parity(1)	U.S. Dollar(2)
Gross domestic R & D Expenditure	11 154 149 797	11 100 865 642	6 652 537 043
Gross domestic R & D Expenditure/GDP(3)(%0)		8,6	
Per capita gross domestic R & D Expenditure(4)	149,3	148,6	89

(1) Purchasing power parity in 2011 (1 U.S. Dollar = 1.005 TL)
(2) Import-weighted average U.S. dollar exchange rate in 2011 (1 U.S. Dollar = 1,5767 TL)
(3) GDP Value in 2011 = 1 298 062 003 649 TL
(4) Population of Turkey as of 31.12.2011 = 74 724 269
Source: (http://www.tuik.gov.tr/PreHaberBultenleri.do?id=10931 26.05.2013).

Figure 3: R&D Budget Distribution According to Sectors and Groups.



Source: TUIK, 2013.

4. The Literature Review Related to Correlation between Patent and R&D Budget

Patent represents intellectual and industrial property. And so, it is an important factor for literature. For example innovation, took an important part in Wealth of Nations because of its technological advantage (Nelson, 1981: 1030). R&D and patent literature developed from growth models. The Romer Model ,is the first one. Information production and overflow driven model by Romer (1986) is assumed that in production and investment process, is produced information. And it is assumed that when a new production is a matter this producted information is used as a free input in production stage in parallel with externality and as a result of this committed new production is done with lower cost. In this context Young (1991) tested Romer Model (1986). It was assumed that developed country produced high-tech product and underdeveloped country produced low-tech product in Young's application. In trade relation based upon comparative priority between mentioned two country, it was seen that developed county specialized in high-tech product and underdeveloped country specialized low-tech product. Thus, it is concluded that developed country specialized high-tech product has a higher growth rate than underdeveloped country because high-tech product has the higher learning potential (Young, 1991:390).

For this reason progress of reaching to the standards of developed countries depends on their performance on human capital, knowledge, technological improvements and R&D. It can be said that government policies increasing the cumulative knowledge and support R&D activities have positive effect on economic growth (Rivera-Batiz & Romer, 1991: 1-47). Grossman and Helpman developed Romer's Theory of knowledge as a public good and they mentioned two important feature of R&D. First, every R&D project develops a new design for a new product. This new design brings a monopoly position to his designer. Secondly, every R&D project contributes to existing cumulative knowledge. This capital storage will be used by next generations as a collection of ideas and methods (Özer, Çiftçi, 2008: 221).

The correlation between R&D spending and patent analyzes began with definition of patent as a innovation criteria in research finding's estimation (Holbrook, 1992; Papadakis, 1993; Hingley, 1997). As it seen, patents have consider as a criteria of R&D success for a long time. In the researches by Scherer (1965) and then Griliches (1984) they stated that patent's data used for economical searches with full scale. Pakes and Griliches (1984) claimed patent procedure was a R&D procedure's pause process from spent to achievement and therefore it serves as an output variance of R&D investments. There are important other searches that examine relation between R&D budget and patent output. Hausman, Hall and Griliches (1984) have extent the studies by Pakes and Griliches. They have formation an econometric relation model between R&D budget and patent number. In this way they have researched the effect of R&D expenditure by firms on patent number by using panel data and time series analysis. They found that there was a positive correlation between patent number and R&D budget. Czarnitzki and Hussinger (2004), have analyzed the public sector R&D budget effects on R&D spending in private sector. Czarnitzki and Hussinger have found that there is a positive correlation between public finance and patent requests. Prodan (2005) analysis showed that the increase of R&D expenditure in business sector increased the number of patent applications more than increase of R&D on general.

Hall, Jaffle and Trajtenberg (2001, 2005) using Patent References Data Files have determined an important positive correlation exist between a patent's reference and its monetary value. The monetary value of patents is measured with marketing value of a foundation's participation share. To determine marketing value of participation share they are benefited from the foundation's R&D investments (Hall, Jaffle, Trajtenberg, 2005).
Unlike other studies the aim of our study is to examine the relation between investment and current R&D expenditure in terms of higher education, commercial and public sector and patent application.

5. Data and Methodology

In this study, the correlation will be analyzed between patent application for Turkey in 1995-2012 and Higher Education, Public and Private Sector 's current and investment R&D expenditure (expenditure values are deflated by using GDP deflator) via linear regression model (used e-Views 6 program). The annual data used this study belong to Turkish Statistical Institute. R&D spending in analyze categorized in two ways as investment and current. Current spending consist of labor costs and other current costs. Labor costs involve costs connected with annual wages and salaries or premium payments, holiday payments, contributions to retirement fund, other social security payments and extra pays as payroll taxes. Other current costs include free materials by statistical unit for one year to support to R&D studies, consumption kits and equipments. The investment spending is annual gross expense with which permanent asset for R&D program. When they are spent, they must report in term truly and they must record as a factor of amortization. R&D spending, including all amortization prices with building, foundation and equipment are out of scope. This approach is proposed due to two reasons. If amortization (i.e. payment is rendered to finance for exist assets) insides current expenditures, adding capital expenditure it elicit double count. In government sector normally any award is got for amortization of permanent assets. Consequently, unless amortization rules out of scope even a nation inside matching among sectors can't be compared and unless total sectors build upon a base, totals with a national serial can't be collected (http://www.tuik.gov.tr/VeriBilgi.do?alt id=8).
In consideration of these definitions, R&D spending consisted of current and investment spending (like Kondo's (1999) and Prodan's (2005) studies) will be used in model as variable, and patent applications as a output. Besides, based on Prodan's (2005) and Kondo's (1999) due to studies logarithmic model have a worse performance than linear model this research go on with linear regression model.

Table 2: Results of Regression Analyze

Models	Explanatories
Public	
$P=\beta_1+\beta_2$ GCE$+\beta_3$GIE$+u_i$ P=949.218+0.0056GCE+0.001GIE (5.66) (4.13) (3.12)	R^2=0.96 Adjusted R^2=0.95
Commercial	
$P=\beta_1+\beta_2$ BCE$+\beta_3$BIE$+u_i$ P=901.021+0.001BCE+0.002BIE (4.55) (4.38) (4.55)	R^2=0.95 Adjusted R^2=0.94
Higher Education	
$P=\beta_1+\beta_2$ HCE$+\beta_3$HIE$+u_i$ P=572.550+0.0000013+0.00000076 (2.80) (2.91) (2.66)	R^2=0.94 Adjusted R^2=0.93

Table 2 shows the regression models of each sector. In model "P" represents patent applications, "GCE" government current R&D expenditure, "GIE" R&D investment expenditure, "BCE" commercial current R&D expenditure, "BIE" commercial R&D investment expenditure, "HCE" higher education current R&D expenditure and "HIE" higher education R&D investment expenditure.

In the direction of regression outcomes, it was found that the most effective sector on patent application is public sector. In public sector, while raise of one unit in public current R&D increases 0.0056 unit patent application, raise of one unit in public investment R&D increases 0.001 unit patent application. In commercial sector, beside of the effect are lower than public sector's effect, basic differentiation is that the investment R&D expenditure in private sector have higher effect on patent application than current R&D expenditure. When a raise of one unit in commercial current R&D expenditure increases 0.001 unit patent application, a raise of one unit in commercial investment R&D expenditure increases 0.002 unit patent application.

And higher education sector have the lowest effect in all sectors. In this direction, when a raise of one unit in higher education current R&D expenditure increases 0.0000013 unit patent application, a raise of one unit in higher education investment R&D increases 0.00000076 unit patent application. (There aren't any heteroscedasticity and autocorrelation problem of regression prediction in each three sectors. This result is found with Breusch-Godfrey Serial Correlation LM test and Breusch Pagan Godfrey Heteroscedasticity tests. The outcomes are showed on appendix tables).

5. Conclusion

Patent provides technologically advantage to the economies and because of its this feature it gets an important part in innovation procedure. In this study, where the correlation among patent applications and Public, Commercial and Higher Education current and investment R&D expenditure has been investigated, in the case of Turkey as an individual country in the period of 1995 to 2012.

In consideration of this examination it shows that the most important contribution to patent application has been made by public current R&D expenditure. When it is considered that current expenditure involve annual wages and payments and free materials to support R&D studies and consumption necessaries and equipment, in public sector R&D staff have the more positive effect to patent application than other sectors. In this direction, it must consider that rising trend of public R&D expenditure can cause to the more positive developments in patent application number. Come to commercial sector, even though the effect of R&D spending to patent application is lower than public sector, the basic variation due to commercial sector investment R&D expenditures have the more positive effect to patent application than current R&D expenditure.

In this point, annual gross expenses with permanent assets used R&D programs of statistical entities in commercial sector have the more positive effect to patent application. As a result R&D policy in Turkey must be built on public and commercial (private) sectors. Also higher education sector must have been encouraged by public sector by using fiscal policy instruments for rising patent performance.

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APPENDIX:

Table 1: Results of Heterskedasticity Test:

Equation 1:

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.044274	Prob. F(2,15)	0.9568
Obs*R-squared	0.105634	Prob. Chi-Square(2)	0.9486
Scaled explained SS	0.062772	Prob. Chi-Square(2)	0.9691

Equaiton 2

F-statistic	1.306675	Prob. F(2,15)	0.2998
Obs*R-squared	2.670718	Prob. Chi-Square(2)	0.2631
Scaled explained SS	2.965807	Prob. Chi-Square(2)	0.2270

Equation 3:

F-statistic	0.671338	Prob. F(2,15)	0.5257
Obs*R-squared	1.478837	Prob. Chi-Square(2)	0.4774
Scaled explained SS	1.189585	Prob. Chi-Square(2)	0.5517

Table 2: Results of Lm Serial Correlation Tests:

Equation 1:

F-statistic	2.754251	Prob. F(2,13)	0.1006
Obs*R-squared	5.357161	Prob. Chi-Square(2)	0.0687

Equation 2:

F-statistic	1.487343	Prob. F(2,13)	0.2620
Obs*R-squared	3.351824	Prob. Chi-Square(2)	0.1871

Equation 3:

F-statistic	7.758512	Prob. F(2,13)	0.0061
Obs*R-squared	9.794375	Prob. Chi-Square(2)	0.0075