PATENTS AND INNOVATION IN PHARMACEUTICAL INDUSTRY IN TURKEY: THE COMPARISION OF PATENT SYSTEM WITH SOME SELECTED COUNTRIES

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ABSTRACT

PATENTS AND INNOVATION IN PHARMACEUTICAL INDUSTRY IN TURKEY: THE COMPARISION OF THE PATENT SYSTEM WITH SOME SELECTED COUNTRIES

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The aim of this thesis is to make policy recommendations for Turkey in order to facilitate innovative activities resulting in more patent applications in pharmaceutical industry through comparing her with the selected countries; USA, EU, Japan, India, China and Korea. The comparison is performed in terms of the patent, research and development (R&D) expenditures and basic research. This study begins with firstly indicating the relationship between patents and innovation in sector basis. When it is looked at this relationship patents are the most necessary tool for pharmaceutical industry. Therefore, in the main part of the thesis the patents and innovations in pharmaceutical sector are analyzed mostly. However, this analysis is not done in all aspects but it is done in terms of research and development expenditures and basic research. Patent is mainly a result of research and development activities. Besides, basic research is also effective in making innovations and so in patent system. Because of these reasons, the relationship between patents and innovations in pharmaceutical industry are covered in terms of these two aspects-R&D expenditures and basic research-. These relationships are analyzed in country level. In this thesis, in order to see the right route for Turkey and give some advises to Turkish patent and innovation system especially in pharmaceutical industry Turkey is compared with USA, EU, Japan, China, India and Korea. The reason to take USA, EU and Japan is that, these countries are developed countries, the biggest patent offices in the world are in these countries and the number of patent applications is the highest in the offices of these countries. On the other hand, China, India and Korea are taken as subject to the comparison because these countries are developing countries like Turkey and the development levels of these countries are not too higher than Turkey. In this thesis, through comparing Turkey with the selected countries, some policy recommendations are done for Turkey and this thesis may open door to further studies on the patent and innovation system of Turkey especially in pharmaceutical industry.

Key Words: patent, innovation, research and development, basic research, pharmaceutical industry

ÖZ

TÜRKIYE'DE İLAÇ SEKTÖRÜNDE PATENT VE İNOVASYON: PATENT SİSTEMİN SEÇİLMİŞ BAZI ÜLKELERLE KARŞILAŞTIRILMASI

ÖZDEMİR TUNCER, Elif

Yüksek Lisans, Bilim ve Teknoloji Politikası Çalışmaları Bölümü
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Bu tez çalışmasının amacı Türkiye'yi Amerika Birleşik Devletleri, Avrupa ülkeleri, Japonya, Hindistan, Çin ve Kore ile karşılaştırarak patent-araştırma geliştirme faaliyetleri için yapılan harcamalar ve patent-temel araştırma ilişkileri dikkate alınarak Türkiye'nin ilaç sektöründe daha fazla inovasyon yapması ve daha fazla patent başvurusunda bulunması için Türkiye'ye politika önerilerinde bulunmaktır. Bu tez çalışması, sektörel bazda patent-inovasyon ilişkisini irdeleyerek başlar. Bu analiz sonucunda patentin en fazla ilaç sektöründe önemli rol oynadığı sonucuna varılır. Dolayısıyla bu tezin ilk bölümünde ilaç sektöründe patent-inovasyon ilişkisi çalışılmıştır. Fakat bu çalışma sadece araştırma-geliştirme harcamaları ve temel araştırma açılarından ele alınmıştır. Patent temelde Ar-Ge faaliyetlerinin bir sonucudur. Bunun yanı sıra, temel araştırma da inovasyonda ve dolayısıyla patent başvurularında etkilidir. Bu nedenle patent-inovasyon ilişkisi Ar-Ge harcamaları ve temel araştırma açılarından ele alınmıştır. Bu ilişki ülkeler bazında dikkate alınmıştır. Bu tezde, Türkiye'ye yol göstermek ve bir takım önerilerde bulunmak için Türkiye'de ilaç sektöründe patent ve inovasyon faaliyetleri Amerika Birleşik Devletleri, Avrupa ülkeleri, Japonya, Hindistan, Çin ve Kore ile karşılaştırılmıştır.

Amerika Birleşik Devletleri, Avrupa ülkeleri, Japonya'nın seçilmesinin nedeni bu ülkelerin gelişmiş ülkeler olması, dünyanın en büyük üç patent ofisinin bu ülkelerde olması ve dünyada en yüksek patent başvuru sayılarının bu ülkelerde olmasıdır. Diğer yandan, Çin, Hindistan ve Kore'nin seçilmesinin nedeni bu ülkelerin gelişmişlik düzeyi olarak Türkiye'ye yakın olmasıdır. Bu tezde seçilen ülkelerle kıyaslanarak, Türkiye'ye birtakım politika önerileri yapılmıştır ve bu tez özellikle ilaç sektöründe patent ve inovasyon ile ilgili başka çalışmalar yapılmasına kapı açabilir.

Anahtar Kelimeler: patent, inovasyon, araştırma-geliştirme, temel araştırma, ilaç endüstrisi

Eşim ve biricik kızım için…

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CHAPTER 1

INTRODUCTION

In a globalized competitive environment, in order to guarantee their sustainability, growth and increase their profitability all enterprises need to have the ability to utilize knowledge and information in a creative way and, thus to be innovative. Technological improvements, changes in the need of customers, competition, etc urge firms to differentiate their activities, i.e. to make innovations. In order to succeed innovation, firms have to be open to R&D activities and scientific improvements. However, being innovative is not enough and firms need to protect their innovations from imitations to make return from these innovations. In this respect, patent is seen as the most important tool for the protection of innovations.

The R&D activities, basic research, patents and innovations all have tight relationship with each other. Basic research leads to R&D activities and R&D activities lead to innovations and these innovations are protected by patents. Patents lead to more basic research and more R&D and innovations accordingly. Each of these affect the others positively, if one is absent it is difficult to do others. However, the degree of relationship between these aspects differs from industry to industry. In some industry these relationships are too tight in some the level of their relationships is weak. The pharmaceutical industry is the industry where these relationships are the tightest. The reasons behind this are; the investments in this sector are too risky, this sector has high R&D expenditures and the innovations in this sector mostly depend on recent scientific research. Because of the high R&D costs and the risky investments patent is a very crucial instrument for this industry.

In Turkey, the number of patent applications of pharmaceutical industry is too low and this shows that there is no enough innovations in this industry. n this study, it is aimed to give some policy recommendations for Turkey in order to increase innovations and number of patents in the pharmaceutical industry by comparing her with some selected countries. To reach this aim, the relationships between patents, innovation, R&D and basic research are studied and through these the situation of pharmaceutical industry in Turkey is analyzed via the comparison of Turkey with some developed and developing countries.

In order to define more clearly, this study is organized around four research questions: First question aims to find out the relationship between patent and innovation in different sectors. Second question is directed to see whether R&D expenditures have affects on innovation and so in the number of patent applications. Third question aims to see the effects of basic research on innovation and patents.
Fourth question investigates the data obtained from TUBITAK-TEYDEB and TUIK which are related to the R&D activities of pharmaceutical firms.

With the results of the first question it is seen that patent and innovation has the tightest effect in pharmaceutical industry. The beginning point of this thesis is shaped by this finding. Second question finds out that R&D expenditures is very high in pharmaceutical industry and since the costs of R&D is very high in this sector patents are very crucial. With the third question the tight relationship between basic research, innovation and patents in pharmaceutical industry is seen. The result of fourth question clears the general situation of pharmaceutical industry in Turkey as not developed enough.

Through the comparison of Turkey with the selected countries, it is found out that Turkey is behind the selected countries in terms of R&D expenditures, basic research and patent applications in pharmaceutical industry. Therefore, it is needed for Turkey to take over some policies in order to make progress in pharmaceutical industry.

In this thesis as selected countries three developed and three developing countries are chosen. As developed countries, USA, EU-27 and Japan are taken because they are the triadic patent families and most of the R&D and basic research in the world are done in these counties. On the other hand, as developing countries China, India and Korea are taken because they are developing countries like Turkey and they are a step further than Turkey in terms of innovative capacity and so they may be as samples for Turkey to show path for innovative activities.

In the second chapter of this study, the relationship between patent and innovation is mentioned both with theoretical background and the empirical background. Firstly, the concepts of patent and innovation is introduced and secondly the theoretical background of the relationship between patent and innovation is explained in sector-basis. Lastly, the empirical background of the relationship between patent and innovation is explained in sector-basis. The main focus of this relationship is the pharmaceutical sector.

In the third chapter of this study, the relationship between patents and research and development expenditures is studied. Firstly, the theoretical comments on the relationship between patents and research and development and the empirical studies done on the relationship between patents and research and development expenditures are mentioned. Secondly, the characteristics of pharmaceutical industry and the research and development process of this industry is provided. This is followed by the subject the importance of patents for pharmaceutical. Fourthly, the comparison of R&D expenditures in Turkey, in US, in EU, in Japan, in India, in China in and Korea and patent protection in these countries are mentioned. The historical background of patent system in Turkey is explained.

In the forth chapter of this study, the relationship between patent and basic research in the seven countries is analyzed. In order to do this firstly, the relationship between basic research and innovation is introduced and secondly empirical studies done about the relationship between basic research and industry innovations are explained. Thirdly, the interaction between basic research and universities are studied and fourthly the relationship between basic research and patents are analyzed and from these subjects the comparison of basic research in Turkey, in US, in EU, in Japan, in India, in China in and Korea and patents in these countries are studied.

In the fifth chapter, the general situation of pharmaceutical industry in Turkey is tried to be explained by using the data from TUIK and TUBITAK-TEYDEB.

In the last chapter, some concluding remarks are made and the differences between Turkey and the counties which are subject to this study is summarized and some policy recommendations are made to Turkey.

CHAPTER 2

PATENT AND INNOVATION

2.1. Patent System

2.1.1. What is patent

A patent is a legal property right to an invention, which is granted by national patent offices. A patent gives its owner sole rights (for a certain duration) to exploit the patented invention; at the same time it discloses the details of the patent as a way to allow broader social use of the discovery (Oslo, 3rd edition:OECD).

Human beings have many rights which are earned by birth or after the birth. Patent right is one of these rights that depends on the request of people (Yalciner, 2000). The patent system is designed to encourage inventions that are useful to society by granting inventors absolute right to make profit from their inventions for 20 years. But patents cannot protect each and every person who conceives an invention. Hence an invention must fulfill certain criteria to be patentable. Patentability refers to the substantive conditions that must be met for a patent to be held valid. As patent laws are different in different countries, the patentability criteria also vary from country to country. The invention must satisfy the requirements under the context of a national or multinational body of law to be granted a patent. Although the patentability criteria differ from country to country depending on the law of the land, there exists some common criteria (Yalciner, 2000, *www.trizsite.com*). These patentability criteria are industrial application (EU), novelty and inventive step (EU). In US, instead of industrial application, utility; and for inventive step, nonobviousness is used. The inventive step means that patented invention should not be obvious to a person skilled in the relevant art.

Economists define the inventive step by the threshold below which the reduction in costs for process innovations or the degree of quality improvement for product innovations would be sufficient for the patent to be granted (Encaoua et al., 2006). The traditional test of non-obviousness at the patent offices is based on three technical scopes. The first one is the scope and contents of prior art, the second is the differences between the prior art and patent claims and the last one is the level of ordinary skills in the relevant art. However, in the US commercial success, failure of others and long felt need as a set of secondary economic factors have been emphasized recently by the US Court of appeals for the federal Circuit (Hunt, 1999). In order to provide industrial application criteria, the invention should be useful. If something has no use for the society or the world, if something is harmful to the mankind, then that is not patentable. Non-obviousness is the third criteria to evaluate the patentability of an invention. The invention should be non-obvious to anybody having ordinary intelligence and knowledge on the subject matter. If the invention is obvious to anybody having ordinary intelligence and knowledge on the subject matter then it is not qualified for a patent (www.trizsite.com).

Patents are a double-edged sword, with a positive and negative side. They often contribute to enhancing incentives to invent, to disclosing and trading technology, but they also generate costs to society in terms of monopoly rents and barriers to access and use knowledge. Without patent protection, competitiveness might be sufficient to compensate innovators in certain circumstances. For example, when secrecy is a feasible means of protection and the cost of imitation is high or first mover advantages and network externalities are important, patents may not be necessary. However, patents could still play a positive role for fostering disclosure and market transactions over technology (licenses). Industry specific conditions prevail in that matter (Encaoua, et al., 2006).

There are some tools needed to be defined in order to understand the patent system better. These are (OECD, 2004):

Patent subject matter: It is the domain of knowledge that can be patented. Its definition must be based on careful examination of when it is efficient for society to offer patent protection in addition to other legal or market-based means of protection.

Patenting requirement: It is the height of the inventive step required for a patent application to be granted. In other words, it is the extent of the contribution made by an invention to the state of the art in a particular technology field. The higher that contribution, the more selective the process thus the lower the number of patents granted. On the other hand, too high a requirement would discourage innovations which are still necessary for technological breakthrough to translate into actual products and processes.

The breadth of patent: It is the extent of protection granted to patent holders against imitators and follow-on inventors. Patentees not only obtain exclusive rights on their own inventions but they also have rights on the inventions which are deemed functionally equivalent and to a certain extent on improvements of their inventions. Patents that are too broad allow their holders to preempt the future. However, patents that are to narrow discourage research that feeds into follow-on inventions.

2.1.2. The Objectives and Functions of patents

Economic objectives of IPR system is firstly to promote inventions in knowledge creation and business innovation by establishing exclusive rights to use and sell newly developed technologies, goods and services. Secondly it aims to promote widespread dissemination of new knowledge by encouraging rights holders to place their inventions and ideas on the market (Markus, 2000). Patents encourage investments in innovation and enhance the dissemination of knowledge (OECD, 2004). The aims behind protecting innovations by patents are; to recognize intellectual inventions, to encourage innovation and R&D functions, to reward the innovators and to disseminate knowledge through explaining all the steps in R&D functions (Yalciner, 2000).

There are two functions of patents. These are monopoly function and knowledge function. Patents give the monopoly right to patent holder by preventing others to produce, sell or market the subject of patent. In order to have this right, patent holder has to explain all the information related to the subject matter of patents to the public. This information is composed of all the information that is needed to produce or apply the subject matter of patents by others. This is the knowledge function of the patents. Through the first function-monopoly function- of patents, patents holder are motivated to innovate more, through the second function-knowledge function- the initial point of R&D activities are created and the transformation of the initial point of innovations to higher point become easier and quicker (Yalciner, 2000).

2.2. Innovation

2.2.1. What is Innovation

An innovation is "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (Oslo, 3rd edition:OECD).

Innovation activities include all scientific, technological, organisational, financial and commercial steps which actually lead, or are intended to lead, to the implementation of innovations. The minimum requirement for an innovation is that the subject matter of innovation must be new to the firm. There are four types of innovation. These are product innovations, process innovation, marketing innovation and organisational innovation (Oslo, 3rd edition:OECD):

A product innovation "is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics”

A process innovation “is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software”.

A marketing innovation “is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing”.

An organisational innovation “is the implementation of a new organisational method in the firm’s business practices, workplace organisation or external relations”.

2.2.2. The Objectives and Factors of innovation

There are many reasons for enterprises to engage in innovation activities. The objectives of enterprises are mostly related with products, markets, efficiency, quality or the ability to learn and to implement changes. The factors competition, demand and markets lead enterprises to innovate. In order to expand or diversify product portfolio and increase or avoid a decline in market share, improve quality, flexibility or efficiency or reduce costs enterprises focus on innovation (Oslo, 3rd edition:OECD).

The ultimate reason behind innovation is to improve firm performance, for example by increasing demand or reducing costs. A new product or process can be a source of market advantage for the innovator. In the case of product innovation, the firm can gain a competitive advantage by introducing a new product, which allows it to increase demand and mark-ups. In the case of productivity-enhancing process innovations, the firm gains a cost advantage over its competitors, through depending on the elasticity of demand, the firm can gain higher market share and increase its profits. For organisational innovations, factors like customer relations, operational efficiency or improving the capture and sharing of knowledge are the main the motives (Oslo, 3rd edition:OECD).

Innovation can also improve performance by increasing the firm's ability to innovate. For example, improving the capabilities of production processes can make it possible to develop a new range of products, and new organisational practices can improve the firm's ability to gain and create new knowledge that can be used to develop other innovations (Oslo, 3rd edition:OECD).

2.2.3. Measurement of Innovation

Innovation can be measured by science and technology indicators. These indicators are resources devoted to R&D and patent statistics. Patent statistics are increasingly used in various ways as indicators of the output of research activities. The number of patents granted to a given firm or country may reflect its technological dynamism. The drawbacks of patents as innovation indicators are well-known. Many innovations are not patented, and some are covered by multiple patents; many patents have no technological or economic value, and others have very high value (Patent Manual: OECD, 1994).

The ability of enterprises to appropriate the gains from their innovation activities is an important factor affecting innovation. If, for example, enterprises are unable to protect their innovations from imitations by competitors, they will have less incentive to innovate. Policy plays a central role in the design of legal methods of protecting innovations. There are some methods of formal and informal protection. These are (Oslo, 3rd edition:OECD):

- Patents.

● Registration of design.
● Trademarks.
● Copyrights.
● Confidentiality agreements and trade secrecy.
Informal methods:
● Secrecy that is not covered by legal agreements.
● Complexity of product design.
● Lead time advantage over competitors.

Patent data, both applications and grants, function as an intermediate output indicator for innovation activity and also provide information on the innovative capabilities of the enterprise (Oslo, 3rd edition:OECD).

All innovations should be new either to the firm, to the market, or to the world. By definition, all innovations must contain a degree of novelty. Since one of the requirements to grant patents is novelty there is a close relationship between innovation and patents. This relationship can be seen in the theoretical comments on the effects of patents on innovation and in the studies done about these effects. Below, the theoretical and empirical backgrounds of the effects of patents on innovation are explained in details.

2.3. Theoretical and Empirical Background of the Effects of Patent System on Innovation

As it is mentioned before, to grant patents, novelty, non-obviousness and industrially applicable characteristics are needed. Therefore, it can be interpreted that patents are given to innovative products.

Many inventions are done as a result of technical progress. Technology has an increasing importance in our society and our economy. Technology is a key force of change. With the increased relevance of technology, the importance of patents has raised. Patents bring competitive advantages.

Since the end of World War 2, many nations have opted for privatization and deregulation. Tariff barriers around the world have fallen, the market economy which increases efficiency in resource allocation and encourages the adoption of best practice technologies, has proved to be the most favorable environment for entrepreneurship and technical innovation. Patent system appears more than ever to large industrial firms an essential instrument in securing investments in R&D (Sideri and Giannotti-Gnnaio, 2003). Therefore, there is a close relationship between patents and innovation.

In the past, in order to measure this closeness, some surveys and empirical studies are made. Some scholars, economists, scientists, etc study on the subject-the effects of patents on innovation- in general and on different industries. Some of them state that patents do not have any effects on innovation. On the other hand, some point out that they have negative effects on innovation. Some scholars and economists made empirical studies about the subject. Some reached the result that in some sectors patents are advantageous to firms, in some they have no effect on innovation and in some sectors they have negative effects on innovation. In this chapter, firstly, theoretical comments about the positive effects of patents are mentioned; secondly, the theoretical comments about the negative effects of patents are explained. Lastly, empirical studies done about the topic is revealed.

2.4. Theoretical Comments on the Positive Effects of Patents on Innovation:

Patents play an increasing role in innovation and economic performance. The recent evolutions in innovation processes, the economy and the patent regimes made business and public research organisations use patents. The advances in science and technology have created new waves of innovation especially in information and communication technology and biotechnology. In OECD economies, the importance of innovation as a driver of competitive advantage has grown over the last decade. Innovation becomes central to business strategy. Firms in wide range of industry sectors see innovation and R&D as means of their competitive advantage (Mairesse and Mohnen, 2003).

Since the ICT and the Internet has accelerated the availability of information on new technologies, secrecy becomes a less viable strategy. Competitors can access these codified information easily and so they can imitate in a shorter time (OECD, 2004).

In the long run, only technological progress can make a nation richer and more productive than others. A recent branch of economist, the endogenous or “Neo-Schumpeterian” growth theory, asserts this thesis by validating the relevance of discoveries, inventions, innovations and competitiveness as suggested by non-economists (Sideri and Giannotti-Gnnaio, 2003).

Innovation and technological change create winners and losers. In a competitive and innovative economy, a new invention typically makes obsolete a previous one and activates a process of substitution. Such a process is called as “creative destruction” by Joseph Shumpeter. The patent system which plays an important role in establishing a balance between the interests of innovators and those of imitators, plays an important role in smoothening the excesses of the “creative destruction” (Sderi, Giannotti-Gennaio, 2003).

When patents enhance market entry and firm creation, they have positive impact on competition. Through the patent protection small companies assert their rights against larger ones (Gans et al., 2002). For instance, some economist argue that for the business method invention patents, if patent right facilitates entry into the industry by new and innovative firms, competition benefits from the monopoly rights given by the patent rights. In addition to this, innovation in business methods will benefit from the incentive created by a patent (Hall, 2003).

Because of the globalization, the number and variety of potential competitors has increased notably. Therefore, innovative companies have been demanding enhanced legal protection including patents. For example, in the US R&D in SMEs grew almost twice the rate of R&D in large firms during the 1990s. Increased venture capital supported this trend to the advantage of the activities for new technology-based firms since such firms often have few assets other than their intellectual property and need patent protection to attract venture capital. Their participation in the innovation network of other firms is enabled by their ability to license their patents. The growing technological complexity of products and processes, increased technological opportunities created by recent scientific advances, rapid technological change, more competition and higher costs and risks of innovation are forcing firms to work in greater collaboration (OECD, 2004).

The use of the patent system has evolved and now aims not only to protect a particular invention, but can also be used for a variety of strategic reasons, such as to reserve as wide a part of a given business sector or technology domain as possible. It can also be used to reinforce a lead time by delaying the market entry of a competitor. Once informed that a patent is pending or has been granted, a competitor would have to be very careful before making a product which could infringe on the patent (OECD, 1997).

Many economist view the patent system as a necessary evil. With the patent system, short term monopoly right to the use of an invention is traded off in return for two things. These are the incentive to create innovation and early publication of information about the innovation and its enablement. They argue that without patent system fewer innovations would be produced and those that were produced would not be kept as much as possible to protect return from misappropriation (Browny and Hall, 2003).

A patent system serves as an inducement for the needed investments to develop and commercialize inventions and it also enables the orderly exploration of the broad prospects opened up by particularly novel inventions (Mazzoleni and Nelson, 1998).

Patents can also be used for blocking certain technical areas. A patentee enjoys a legal monopoly over the patent term. However, he should accept competition from other firms using the same invention or building or improving on it. The competitors might use new patents to protect such improvements but these competitors need the patentee's authorization to add to a patented technology (OECD, 1997).

Public is benefited from patents since patents provide an incentive to develop and commercialize inventions with substantial utility. Without patent protection, innovators that produce intellectual property may not be able to appropriate sufficient benefits of their innovation to justify their creative effort because IP is particularly susceptible to misappropriation and free riding. The problem is acute when innovator entails substantial fixed costs and the imitator copy the invention cheaply. Through patent rights, granting exclusive rights to innovator eliminates this problem. In addition, patents facilitate commercialization of the invention that they protect. Patent rights make it easier for inventors to develop relationship with others who invest in the further work needed to commercialize the invention. Public disclosure of scientific and technical information is part of the consideration that the inventor gives the public and such disclosure can stimulate further scientific progress (OECD, 2006).

Patents reward creators and inventors for innovation, promote access by business and the public to science, technology and culture. They protect the inventions that business exploits as a result of research and development. Patents are incentive to research and development and to innovation. The first policy objective of patents is thus the creation of new technology, both by stimulating local (national) scientific research (applied to industry) and technology transfer from abroad in order to improve the national technological base. An efficient patent system is expected to contribute to innovation in three respects (OECD,1997):

1- A patent grants the right of exclusive use of an invention for a certain period of time to the inventor so it allows recovery of initial investment (in particular R&D) costs. For this reason, the patent system acts as a stimulus for research and innovative activities.
2- The period of time during which exclusive use is granted to the inventor creates a favorable economic environment for the development of the invention towards marketable products.
3- The patent system establishes a framework for the collection, classification and dissemination of the world's largest store of technological information.

The diffusion of technology is the second policy objective of patents. This explains why the patent term is limited and non-renewable. It also explains the requirement that the invention and in particular its industrial application (or "embodiments") be disclosed fully in the application. In the same vein, patents are published and patent documentation (both existing and expired patents) constitutes an excellent source of technological information – the number of patents published each year world-wide exceeds 1.5 million. For a number of countries, patent documentation is viewed as an essential basis for transfer of technology and as a way to accelerate R&D efforts. Thus, researchers have access to the latest technological information from all countries and can build upon this universal intellectual "bank" of specialised knowledge (OECD, 1997).

For R&D activities, firms are mostly focusing on their competencies but they also acquire complementary technologies from other firms, universities and government labs. As a result, all forms of collaborations increase. Collaborations can be facilitated by the expansion of market for technology that allow for formal, market-based exchanges of knowledge via patent licensees. Licensing provide another channel by which patented technology can be disseminated and utilized at a price negotiated by buyer and seller. In the development of technology transactions, patents play important role. Through patents, markets for technology exist. These markets are very important for the circulation of knowledge. If the patents by public research organisations are encouraged, the commercialization of inventions derived from publicly funded research increase (OECD, 2004).

Table 1: The Patent System Viewed by a Two-Handed Economist

Effects on	**Benefit**	**Cost**
Innovation	1. creates an incentive for research and new product/process development; 2. encourages the disclosure of inventions	1. impedes the combination of new ideas & inventions; 2. raises transaction costs for follow-on innovation
Competition	facilitates the entry of new (small) firms with a limited asset base or difficulties obtaining finance	creates short-term monopolies, which may become long-term in network industries, where standards important

Source: Hall, 2003

The benefits and costs of patents on innovation and competition are explained in the view of economists by Table 1. Patents have both benefits and costs on innovation and competition.

Patent granting motivates the inventor to innovate, raises welfare and creates a temporary monopoly with its attendant dead-weight loss. This result is mitigated by two observations. First of them is that inventors are motivated by a variety of factors apart from financial factors. The second is that an innovator is often creative in securing returns to their inventions even in the absence of a patent by bringing it to the market speedily and by secrecy. As a result of these observations, a patent system is expected to be an important incentive system when considerable funds are needed to develop an invention as in the case of pharmaceuticals or complex modern information technology and when it is difficult to keep the innovation secret or imitation is easy (Hall, 2003).

Once an invention is known, it can be used by others with no additional R&D cost. Therefore, the costs of innovation decrease. By giving some temporary exclusionary rights to inventors, the government delegates the R&D decision and leaves the responsibility of recovering R&D investment in the hands of the inventor. The assignment of costs is made to users rather than to tax payers. In addition, in order to implement a patent system the government does not require sensible economic information that is only privately known such as R&D cost and private value of invention thus avoiding adverse selection problems. In addition, patents favor the diffusion of knowledge due to their disclosure requirements which means the costs of replication may be lower for a patented invention than for an invention kept secrecy (Encaoua et al., 2006).

Different from excluding competitors from the market, patents serve other purposes that should also be taken into account when evaluating the relevance of patent as a policy instrument. Patents are used as an argument in negotiations for cross-licensing agreements, as a signaling mechanism for shareholders, banks, venture capitalists, competitors or customers. They also contribute to social welfare by facilitating the diffusion of knowledge through information disclosure and by allowing the development of markets for technology. Although, an invention can easily be kept secret, as in the case of process innovations, granting patent might be socially beneficial for the diffusion of knowledge even if it is not necessary as an incentive to innovate. These other private and social motives for patenting that may lead to social welfare gains seem to differ across technology fields and to a large extent economic theory falls short of addressing them (Encaoua et al., 2006).

In the current debate, there are at least four different broad theories about the purposes patent serve. These are; the anticipation of patents provides motivation for useful invention**-invention motivation-.** Patents on invention induce needed investments to develop and commercialize them-**induce commercialization-**. Patents are society's award to individuals who disclose their inventions-**information disclosure**-. Patents enable the orderly exploration of a broad prospect-**exploration control-**(Mazzoleni and Nelson, 1998).

Theory one-patents motivate innovation: The most familiar theory, invention motivation theory, is that the granting of patents increases the supply of useful inventions and that the cost of patents is the restriction on access to completed inventions that the holding of a patent creates (Mazzoleni and Nelson, 1998).

The costs to society of granting patents stem from the monopoly on the technology that the patent awards. In some cases, especially in pharmaceuticals, firms charge very high prices for their patented pharmaceuticals. There are some examples that firms charge high prices to their products. For example; the Bell telephone patents were an important part of the package of elements that enabled AT&T to establish the near monopoly of telephone service which they held for many years. Light bulb patents enabled GE and Westinghouse to prevent entry into the light bulb business. There is the static cost associated with patent-protected monopoly position (Mazzoleni and Nelson, 1998).

The assumption of the Theory 1 is that patents are needed to provide firms with the requisite incentive to invent. This justifies the costs of temporary monopoly (Mazzoleni and Nelson, 1998).

Theory 1 presumes either that if there were no patent protection, there would be no invention or more generally that absent a patent system, incentives for invention would be too weak to reflect the public interest. The prospect of a patent enhances invention incentives. Theory 1 assumes that the stronger the patent protection the more inventing incentives are (Mazzoleni and Nelson, 1998).

Theory 2: Patents induce disclosure of inventions: Patents encourage and provide a vehicle for disclosure and more generally generate quick and wide diffusion of the technical information underlying new inventions. This theory focuses on the commercially oriented inventors and assumes that they can appropriate some returns from a new process and product simply by using or producing it while keeping the relevant information secret to prevent rapid imitation. The disclosure of inventions may be interesting when it is assumed that an inventor cannot exploit all possible uses of the invention. Therefore, the publication of a patent attracts the attention of parties who can make use of the invention (Mazzoleni and Nelson, 1998).

Under theory 2 patents are not necessary to induce investment. Rather, patents encourage disclosure and more generally provide a vehicle for a quick and wide diffusion of the technical information underlying new inventions. The focus in this theory is on disclosure (Mazzoleni and Nelson, 1998).

Theory 3: Patents induce the development and commercialization of inventions: Some inventors may not have desire or capability to carry their inventions to the market. For example, the large share of Dupont's product innovations were based on inventions bought from smaller firms (Mueller, 1962).

Similarly in the 1920s GE bought and developed many inventions made by private inventors or small firms. As it is seen, holding patent by the initial inventor may be necessary for licensing agreement (Reich, 1985).

It was argued that a company would be unlikely to engage in development of a university invention unless it had proprietary rights. If the universities held strong patent rights they would be in a position to sell such licenses. If there were no patents or if the government held them with a commitment to non-exclusive licensing, companies would be unlikely to invest in the necessary development work (Mazzoleni and Nelson, 1998).

Many versions of theory 3 are connected to theory 1. If a first stage inventor is in the game for profit and knows that profiting will require handing–off the invention to another organisation for development, then expectations of a patent may be necessary to induce an initial inventing. But the emphasis on theory 3 is on the facilitation of the hand-off. According to theory 3, the possession of a patent gives the original patent holding organisation-a university or a small firm- incentive to push out its inventions to firms that can develop and commercialize them (Mazzoleni and Nelson, 1998).

Theory 4: Patents enable orderly development of broad prospects: Initial discovery or invention is seen as opening up a whole range of follow-on developments or inventions. Many university inventions are of this sort (Kitch, 1997).

In theory 4, an initial discovery or invention is seen as opening up a whole range of follow-on developments or inventions. Under this theory, holding of a broad patent on a prospect opening invention permits the development of the full range of possibilities to proceed in an orderly fashion (Mazzoleni and Nelson, 1998).

Table 2 : A catalog of patent theories

	Variants	Issues
Theory 1	**A.** more inventing is better i. inventors as a group do more inventing ii.new inventors are drawn in who cannot themselves directly exploit their inventions **B.** more inventing may be worse	in many industries, the prospect of a patent does not seem significantly to increase incentives for inventing
Theory 2	**A.** patents induce disclosure rather than secrecy **B.** patents induce licensing of inventions for uses the inventor cannot directly exploit	But patents also enable the patent holder to restrict use
Theory 3	**A.** a variant or an extension of theory 1 with the patent coming early in the process i. induces and enables development to be funded ii. stops invention races	But many inventions are developed and commercialized without a patent University patents may restrict access to science and technology that otherwise would be in the public domain
Theory 4	A. absent a controlling patent, there will be races	But the presence and enforcement of a broad patent limit the parties who have motivation to work a prospect

Source: Mazzoleni and Nelson, 1998

Table 2 shows the four patent theories about the purposes that patent serve. In the theory one, patents lead to more innovations. In the theory 2, patents encourage disclosure and so they provide diffusion of technology and with the theory 3 the main focus is on licensing activities and lastly theory 4 focuses on patents as a motivating force for follow-on inventions. All these theories summarize the objectives of patenting activities. However, as seen in the Table 2 there are some drawbacks of these theories. All advantageous situations may have drawbacks but he main issue is to try to eliminate or minimize these drawbacks.

There is no such a question that whether which of these theories is correct. The question can be where do different theories apply? The variants of these theories are important to identify the domains of applicability (Mazzoleni and Nelson, 1998).

In the past decade, IP has become a more highly recognized component of economic value to the point that companies concentrate on creating intellectual assets to the virtual exclusion of all else, the so called “pure IP” company. Many high- tech companies at the stock exchange have market capitalization that depends in large part upon the ability to monetize and defend patents. The economic significance of patents depend on many factors like its scope, the length of its term in respect to the stream of revenues, its defensibility, and the uncertainty related to it. An increase in patent scope is associated with an increase in the firm's value (Sideri, Giannotti-Gennaio, 2003).

The trade-off between the patent breadth and patent length depends on the characteristics of industries such as the innovativeness of industries. Broad patents allow the patentee to set a higher market price for the patented product while patents with longer lives allow the patentee to obtain revenues for longer time period. Larger breadth makes it more difficult to imitate or improve upon the protected invention whereas increasing the duration of patent protection enhances the incentives to imitate or to improve the invention. However, the effects patent breadth and length differ according to whether an innovation is isolated or as a part of sequence of innovations building on each other. In the case of isolated patents, short and broad patents are optimal because they avoid socially wasteful costs to develop substitutes (Gallini, 1992).

However, licensing could be an alternative way to avoid the development cost of such substitute products. When the cost for developing a substitute is close to the R&D, cost of the original innovator, the previous result is reversed when licensing is allowed, in this case long and narrow patents are optimal. But if the cost of developing a substitute is low again short and broad patents are optimal (Maurer and Scotcmer, 2002).

In the sequential innovation setting the aim is to design a patent system to increase the rate of innovation. In a cumulative setting, lagging breadth alone does not provide sufficient incentives for R&D. Lagging breadth offer protection only against imitators but not against future innovations (O'donoghue, 1998).

A specified rate of innovation can be achieved by one of the following patent regimes. Either a long statutory patent life combined with a narrow leading breadth or short statutory patent life combined with a broad leading breadth. Increasing the inventive step may impede the appearance of a useful improvement of the basic invention, while increasing the leading breadth has not such a negative impact, as long as the patent holder of the basic invention accepts to enter into a licensing agreement (Denicolo and Zanchettin, 2002). These two patent regimes depend on the rate of arrival of innovative ideas. If the arrival of innovative ideas if low, long patent life and narrow patent breadth is optimal or vice versa (O'donoghue, 1998).

The strength of patentability requirements also affects innovation in different aspects. Strong patentability requirements provide higher incentives to innovate either by extending the effective life of patents, that is the length of market incumbency for the inventor or by increasing the quality of the successive innovations (O'donoghue, 1998 and Hunt, 1999).

Strength of the nonobviousness is another important factor affecting innovation. This requirement for granting patents depends on the structure of industries. If the industries innovate slowly, the reduction in the non-obviousness requirement encourages innovation more than in industries that innovate rapidly. In rapidly innovating industries where each product builds on others, welfare is more likely to be enhanced by having a high hurdle for obtaining a patent (Hunt, 2001).

In the long run, increasing the patentability requirement leads to longer effective patent lives for inventions reaching the threshold by delaying its substitution in the market by an improved technique. In addition, it leads to a higher average profit flow from a patented discovery. There exists a U-shaped relationship between the patentability requirement and the rate of innovation. The rate of innovation first is positively affected by patentability requirement to a point and but beyond that point the rate decreases (Hunt, 1999).

In the case of sequential innovation, increasing the standard of patentability can increase R&D as firms go after the larger innovations although the overall cost of obtaining a patent has risen (O'donoghue, 1998).

If the size of innovations is endogenous, the rate of innovations is positively related to the patentability requirement. Not only a stringent patentability requirement extends the effective life of patents but it also induces firms to pursue more ambitious R&D projects. The optimal patentability requirements increase with the arrival rate of innovative ideas. Higher standard for protection does not lead to a decline of the rate of innovation in rapidly innovating industries. In such industries patentability requirements may encourage larger and riskier inventions that are socially desirable (O'donoghue, 1998).

Patents should be used in order to encourage firms to engage projects with low certainty of commercial success, as inventions with more certain gains would be implemented even in the absence of patent protection. In industries that innovate slowly, reductions in the patentability requirement are more likely to encourage innovation (Merges, 1992).

Inventors may work on their discoveries for a variety of reasons. One of these reasons is the financial reward earned from inventions. Inventors concern about the possibility that others may imitate their discoveries. If an invention can be imitated quickly, the inventor will soon be forced to compete with other suppliers, who did not incur the development costs, he or she bore. This competition will reduce possibly even eliminate the profits an inventor can earn from his or her discovery. In such an environment, a discovery not protected by a patent gives the inventor only a fleeting advantage over his or her competitors. Obtaining a patent can reduce this competition because it gives the inventor a temporary monopoly to produce his or her invention. Thus, by helping to ensure a reasonable economic return to inventive activity, patents provide an important incentive to engage in research and development (Hunt, 1999).

The advantages of patents differ from industry to industry and patents work differently in different industries. In some industries, it is very crucial to apply for patents but in some industries it is not necessary to apply for patents. For example; in biotechnology, companies especially start-up companies benefited greatly by having chance to obtain patent protection. In pharmaceutical industry it is crucial to have patents. The main reason of this is that, this industry is a strongly research-oriented branch of the industry. On the other hand, the vast majority of patents given to pharmaceuticals are directed to new chemical compounds, formulations or processes which are characterized by the presence of certain chemical elements (Gans et al., 2002 and Mandi, 2003) In addition to these, in pharmaceutical industry the costs of R&D is too high and so it is necessary to obtain patents in order to make return from the inventions.
Pharmaceutical industry is the only industry where there is a big confidence that patents are a good measure of innovative success. In this industry, it is possible to make perfect reverse-engineering in almost all medical and pharmaceutical innovations and these innovations can be easily replicated with a small fraction of investment of required for the research and clinical testing. (Schroth and Szalay, 2007 and Sereno, 2010).

In biotechnology, chemicals and pharmaceuticals where R&D investments are considerable patents matter more as an incentive mechanism. In these sectors innovations may be difficult to be protected with other mechanism (Lévêque and Ménière, 2006).

The introducing and strengthening patent system increase patenting and strategic uses of patents. However, it is less clear that these changes result in an increase in innovative activity although they may redirect such activity toward things that are patentable or not subject to being secret within the firm. The increase in innovation due to patent is especially in pharmaceuticals, biotechnology and chemicals. Patents in these areas are easy to define since they are based on molecular formulas and so easy to enforce. (Hall, 2003)

However, it is not clear that in other industries patents are totally necessary. For example, in software and services patent protection is very new. In different countries these are still not subject to patent protection. In consumer electronics, patents are widely shared among competitors through cross licenses while patents on chemical compounds are normally not licensed to others and exclusivity is closely guarded (Gans et al., 2002 and Lehman, 2003).

2.5. Theoretical Comments on The Negative Effects of Patents on Innovation:

Patents can hamper innovation when it limits access to essential knowledge as may be the case in emerging technological areas when innovation has a marked cumulative character and patents protect “foundational inventions”[1]. Too broad a protection on basic inventions can discourage follow-on inventors if the patent holder refuses access to under reasonable conditions. This situation is mostly valid for new technologies especially for genetic inventions (Bar-Shalom and Cook–Degan, 2002, OECD, 2003a).

Firms might choose not to patent because of its costs, complexity and levels of protection. They might also hesitate to engage in joint international research ventures because of uncertainties in the assignment of patent rights among prospective partners. They might refrain from foreign research investments due to problems in enforcement or awarding of patent rights. (OECD, 1997)

[1] Foundational invention: invention within a nonprofit organization that supports charitable activities in order to serve the common good.

When imitating is as costly as inventing and when firms have economic and technical means for protecting their inventions, there is no need for further legal protection (Encaoua, et al., 2006). Patents may enhance technology diffusion as patenting means disclosure of inventions which might otherwise be kept secret. Industrial surveys show that reluctance of firms to patent their inventions is due to the fear of providing information to competitors (OECD, 2004).

Patents create static distortions corresponding to the classical deadweight loss that results from inefficient monopoly pricing. The market reward from a patented good is not directly linked to the R&D cost needed to develop it. Inventors cannot fully capture the social value of their invention. Patents may provide insufficient incentives for inventors to develop socially valuable inventions because of positive spillovers of their ideas to other researchers. Patent races create some duplication of resources (Encaoua, et al., 2006).

Competition is one of the areas affected from patents. As a patent gives its holder exclusive rights that creates a temporary monopoly, the patent holder can set a higher market price than the competitive price and can limit the total volume of sales (OECD, 2004). In most cases, there will be some consumers willing to buy the product at the competitive price, but unwilling to pay the higher price charged by the patent holder (Hunt, 1999).

Two situations might arise in the absence of patent protection: Either all firms invest in R&D or only one firm invests and the others imitate. In contrast, patent protection allows one of the firms to block entry to subsequent markets and delay subsequent innovations. The pace of innovation would be lower in the presence of patents, as an effect of complementarity, given that it is only in the absence of patent protection that all firms would be allowed to stay in the market and invest in R&D (Encaoua et al., 2006).

Patents with low social value or even illegitimate patents (not sufficient) can have a detrimental effect on innovation and competition (Encaoua et al., 2006).

The characteristics of patents and patentability requirements are among the parameters of patenting that affect innovation.

Overall excessively weak and narrow patents might deter business investment in R&D, as it becomes too easy for an imitator to undercut the inventor's market price. They may also encourage secrecy at the expense of publicity and harm markets for technology and so hinder diffusion of technology. On the other hand, excessively strong and broad patents may open door to undesired strategic behavior by patent holders who may use their titles to appropriate revenue from existing inventions marketed by other firms (OECD, 2004). The net effect of raising the patentability threshold on the pace of innovation has short term and long term effects. Short term effect is negative. Increasing the patentability requirement lowers the probability that an invention qualifies for a patent, thus reducing the short term incentive to innovate (Hunt, 1999).

Breadth of patents can be a parameter that should be considered while analyzing the effects of patents on innovation. Broad patents may be more harmful than encouraging innovation, as they may distort incentives and allocation of research funds. Broad patents increase the rents accruing to inventors. They increase the social cost of imperfections in the management of the patent system. They tend to skew the reward distribution associated with research. Large breadth makes research resemble more a "winner takes all' game. This causes duplication and concentration of R&D efforts in some areas at the expense of investment in other areas where the return is lower (Encaoua et al., 2006).

There are some costs of holding patents. One of them is the holding of a broad patent by one firm in some cases deters other firms from trying themselves to invent in the neighborhood (Scotchmer and Green, 1990 and 1995).

In many industries, making the best product or using the most advanced process may require using ideas developed by many different people. Some of those ideas will be patented, so using them requires the consent of the patent owner. While developers and users of technologies have an incentive to reach an acceptable licensing arrangement, the cost of doing so is sometimes quite high. In some cases, an acceptable arrangement is not reached and the parties may resort to litigation. Two notable examples of this kind of failure include the airplane and the radio in the early years of the 20th century. In both instances, several companies obtained patents covering important aspects of these highly valuable inventions. Unfortunately, they were unable to reach a satisfactory cross licensing arrangement, and this failure precluded the manufacture of the most advanced aircraft or radios in the U.S. These impasses were broken by the intervention of the U.S. government during the First World War. In the case of aircraft, a successful system of cross-licensing was established, and it continued after the war. In the case of radio, patent rights were essentially suspended for the duration of the war. After the war, the U.S. Navy encouraged the formation of the Radio Corporation of America, which soon held rights to virtually all the important radio patents and a near monopoly position in the emerging industry (Hunt, 1999).

It is necessary to look at the negative effects of patents in different industries, because these effects differ from industry to industry. In industries with cumulative or sequential technology where each innovation builds on the last it is impossible to get the incentives right unless there is enough information to enable contracts to be written before the first invention. By paying licensing fees to the earlier inventors, the incentives to develop follow-on innovation in these industries are reduced (Scotchmer, 1991 and Green and Scotchmer, 1995). When the innovation is sequential-an invention follow up on the previous one- patent protection may impede access to the knowledge embedded in previous invention and slow down technological progress. Scotchmer (1991) and Green and Scotchmer (1995) and Hunt, 1999 argue that this is true for software related industries. Software firms are better off when they are imitated by competitors because imitation increases the probability of competitors achieving further innovations from which they can in turn benefit at later stages: "When innovation is sequential and complementary, standard reasoning about patents and imitation may get turned on its head. Imitation becomes a spur to innovation, while strong patents become an impediment". They conclude that even if the initial rents earned by an innovator in the absence of patents may be lower than with patents, the benefits that accrue to him when he is allowed in his turn to build around the next innovation made by a competitor may outweigh the current loss. Their result strongly relies on the complementarity assumption according to which the probability of subsequent inventions is higher when more firms enter the market with new ideas, an assumption that is justified insofar as the existence of different lines of research increases the probability of discovery (Bessen and Maskin, 2002)

2.6. Empirical Studies done about the Effects of Patents on Innovation

There are many empirical studies done about the effects of patents on innovation. The importance of patents for innovation is studied in different countries and in different industries. In this chapter, firstly, the importance of patents for different industries is mentioned and secondly, some studies are covered to explain whether patents are necessary for innovation or not.

In a series of surveys conducted in the US, EU and Japan in the mid-1980 and 1990s, respondent companies reported patents as being extremely important in some industries and their importance can be negligible in other industries. In biotechnology, drugs and chemical to a certain extent, in machinery and computers industries, patents have pivotal role. In other industries, patents are reported as playing secondary role as means of protection for their inventions as they tend to rely on alternative means such as secrecy, market lead, advance on the learning curve, etc (Levin et al., 1987 and Nelson and Walsh, 2000).

Another empirical study was done in 1973 using data from 27 firms. From their study they reached a conclusion that 60 percent of pharmaceuticals R&D, about 15 percent of chemical R&D, about 5 percent of Mechanical engineering R&D and a negligible amount of electronics R8D were dependent on patent protection (Taylor and Silberstone, 1973).

In another study, two questions were answered. One of them is “to what extent would the rate of development and commercialization of inventions decline in the absence of patent protection” and the second question is “to what extent do firms make use of the patent system and what differences exist among firms and industries and overtime in the propensity to patent”. To find out the answers of these questions an empirical study based on data obtained from a random sample of 100 US manufacturing firms is conducted. These 100 firms were from twelve industries excluding small firms. From each firm an estimation of the proportion of its inventions developed in 1981-1983 that would not have been developed if it could not have obtained patent protection is obtained. In addition to this, it is obtained an estimation of the proportion of inventions commercially introduced in 1981-1983 that would not have been commercially introduced if it could not have obtained patent protection. These estimates are combined in order to produce industry-wide estimates. The results show that patent protection was judged to be essential for the development or introduction of 30% or more of the inventions in only two industries which are pharmaceuticals and chemicals. In other three industries, petroleum, machinery and fabricated metal products patent protection was estimated to be essential for the development and introduction of about 10-20% of their inventions. In the remaining seven industries which are electrical equipment, office equipment, vehicles, instruments, primary metals, rubber and textiles, patent protection was estimated to be much more limited importance. Indeed, in the office equipment, motor vehicles, rubber and textile industries firms are unanimous in reporting that patent protection was not essential for the development or introduction of any of their inventions during this period (Mansfield, 1986). This figure is illustrated in Table 3.

Table 3: Percent of developed or commercially introduced inventions that would not have been developed or commercially introduced if patent protection could not have been obtained, twelve industries, 1981-83

Industry	Percent That Would Not Have Been Introduced	Percent that would not have been developed
Pharmaceuticals	**65**	**60**
Chemicals	**30**	**38**
Petroleum	**18**	**25**
Machinery	**15**	**17**
Fabricated metal products	**12**	**12**
Primary metals	**8**	**1**
Electrical equipment	**4**	**11**
Instruments	**1**	**1**
Office equipment	**0**	**0**
Motor vehicles	**0**	**0**
Rubber	**0**	**0**
Textiles	**0**	**0**

Source: Mansfield, 2007

In 1981, a data for 48 product innovations to conduct a survey to find out whether innovation depends on patents is used. It is found out that 90 percent of pharmaceutical innovations, 20 percent of chemical, electronics and machinery innovations would not have been introduced without patents (Mansfield et al., 1981).

Similar results based on a previous survey where US manufacturing firms were asked what fraction of inventions they would not have developed in the absence of patents between 1981 and 1983 were obtained. It was found such fraction to be high for pharmaceuticals (%60) and chemicals (%40) and very low for other sectors Mansfield, 1986).

All the patentable inventions are not patented. In some cases, firms rely on trade secrets because technology is progressing so rapidly and so they are afraid of their inventions to be obsolete before a patent issue. To see this figure a study is done by Mansfield in 1986. The aim of the study was to find out the percentage of patentable inventions that were patented in 1981-1983.

The industries taken into account are the industries where according to Table 3 patents seem more important and the industries where patents are seen less important.

Table 4: Percentage of Patentable Inventions That Were Patented, Twelve Industries, 1981-83

Industry	**All firms**
Industries (Pharmaceutical, Chemical Petroleum, Machinery and Fabricated Metal Products) where patents are relatively important	**84**
Industries (Primary Metals, Electrical Equipment, Office Equipment, Instruments, Motor Vehicles, Rubber, and Textiles) where patents are relatively unimportant	**66**
Individual industries	
Pharmaceuticals	**82**
Chemicals	**81**
Petroleum	**86**
Machinery	**86**
Primary Metals	**50**
Electrical Equipment	**83**
Office Equipment and Instruments	**75**
Motor Vehicles	**65**
Other'	**85**

Source: Mansfield, 1986

As it is seen from the Table 4, the percentage of patentable invention that were patented is over 80% in the first group, pharmaceutical, chemical, etc. and over 60 percent in the second industry group. Although the industries in the second group seldom regard patent protections as necessary to the development and commercial introduction of an invention, they still patent their inventions. In each of these industries as seen in Table 4, at least half of the patentable inventions were patented. The reason seems to be that, the prospective benefits of patent protection, including whatever delay is caused prospective imitators and the use of patents as bargaining chips, are judged to exceed its costs. If it is true, it is perfectly reasonable for the firm to take out a patent whether or not the invention would have been introduced without patent protection (Mansfield, 1986).

At the Federal Trade Commission and Antitrust Division of the Department of Justice (FTC\DOJ) Hearings, representatives from pharmaceuticals industry stated that patent protection is indispensable in promoting pharmaceutical innovation for drug products. Patent protection prevent rival firms from free riding on the innovating firms' discoveries, patents can enable pharmaceutical firms to cover their fixed costs and recoup their high levels of investment in R&D efforts. Representatives from biotechnology industry explained that many biotechnology companies conduct basic research to identify promising products and then partner with a pharmaceutical company to test and commercialize the product. They need patent protection to attract investment from capital markets and to facilitate inter-firm relationship such as licensing and joint venture which are necessary for commercial development of their inventions (www.ftc.gov).

In 1950s, firms in the US were studied in order to see the importance of patents. The study reached the conclusion that aside from pharmaceuticals, firms in most industries reported that patents were neither effective nor necessary for enabling them to appropriate returns from their R&D (Scherer et al., 1959).

A same study was done for the firms in UK in the 1970s. The same result was reached that aside from pharmaceuticals; patents have no importance in other industries Taylor and Silberstone, 1973).

In a wide range of high-tech industries, firms rated a head start, establishment of effective production sales and service facilities, and rapid movement down the learning curve as much more effective as patents in enabling them to profit from their R&D. However, pharmaceuticals and fine chemical industries are exceptions. A number of industries which do little R&D and where technological advance is relatively slow, also reported that patents were not effective for them. These studies may miss the interests of small firm in an industry where there are several large ones with deep pockets and strong market positions may not be able to make much advantage out of a head start or timely establishment of an effective production and sales program. Perhaps for those firms, patents are more important than they are for large and established firms either as means to appropriate returns through licensing or as means to maintain control of the technology while a production and sales capability is established. Nor do these studies get at the question of whether the prospect of patents motivates firms and other organizations outside of a particular industry to undertake inventions which would be used inside that industry. This class of inventors which are called as industry outsiders is likely to lack the complementary assets needed to appropriate the returns from innovation by being first to market or by rapidly moving down the learning curve (Mazzoleni and Nelson, 1998). Jewkes et al. (1969) have documented the importance of such outsiders to technical advance in a number of industries. For them the prospect of a patent may be essential if there is to be incentive to invent.

The collection of small and medium sized firms in the American biotechnology is a striking example of enterprises that would not have come into existence without patent protection (Mazzoleni and Nelson, 1998).

In the 20^{th} century there made some surveys about the patent and innovation. The Carnigie-Mellon and Yale surveys demonstrate clearly that patents are not among important means to appropriate returns to innovation except perhaps in pharmaceutical industry.

The Yale Survey 1983 and Carnegie Mellon survey indicate that US manufacturing companies tend to use private appropriation mechanism, such as exploitation of lead time, the use of complementary sales, manufacturing and service capabilities, in addition to secrecy and patents to capture and protect the competitive advantage provided by innovation. Patents appear to be relatively effective in industries such as drugs and medical equipment, special purpose machinery, computers and auto parts (Levin et al., 1987 and Cohen et al., 2000)

By using data from Carnegie Mellon Survey, it is understood that additional payoffs obtained from patented invention relative to an unpatented invention differs largely across industries, and is positive only in few manufacturing industries which are those where inventors patent mostly drugs, biotech, medical instruments, machinery, computers, and industrial chemicals (Encaoua et al., 2006).

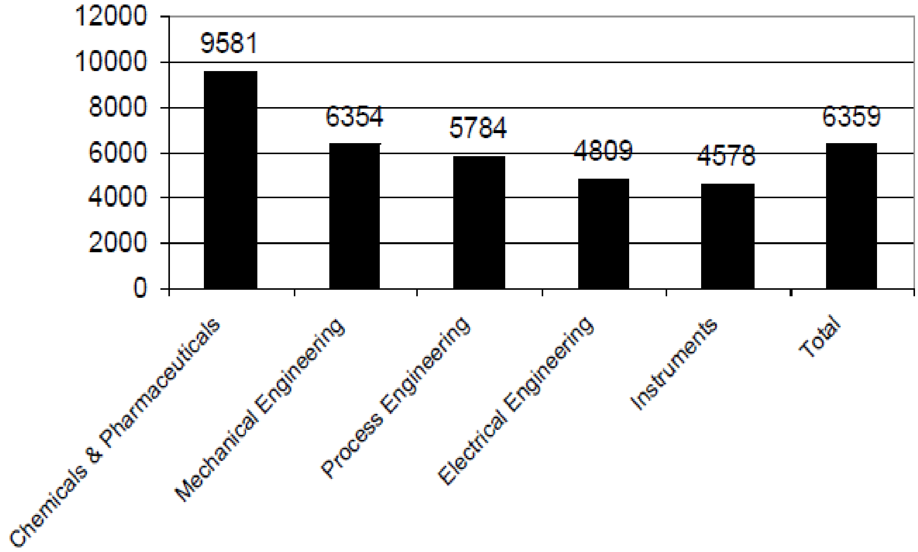


Figure 1: Average patent value by technological class

Source: PatVal, 2005: A survey of 9,017 European patents granted by the European Patent Office in 1993-1998)

Figure 1 indicates the value of patents for different sectors. It highlights important differences between different fields. In this figure it is seen that patent is important in pharmaceuticals and chemicals the most. In other sectors, its importance is not as much as in pharmaceutical sector.

The patent premium[2] and its effect on R&D in various sectors are provided by Arora et al. (2003). They find that patent premium is positive in sectors for biotechnology (20% and 34% of the value of unpatented innovation), medical instruments (14-22%) and drugs and medicines (5-11%). This means that on average it is profitable to patent innovations in these sectors.

However, increasing the patent premium does not increase R&D much except in pharmaceuticals and biotechnology (Arora, et al., 2001) Patents have an important positive impact on incentives to innovate in biotechnology.

[2] Patent premium: is the proportional increment to the value of innovations realized by patenting them

A %10 change in R&D premium induces a %10,6 increase in R&D expenditures (Lévêque and Ménière, 2006)
In contrast, patents do not play important role in other industries. In the studies mentioned below it is shown that patents do not have much effect on innovation and R&D.

An aggregate data across 60 countries for the 1960-90 period is obtained by Park and Ginarte (1997). From this data it is found out that the strength of the IP system is positively associated with R&D investment in the 30 countries with the highest median incomes, G-7 and other developed countries mostly in Europe. In other countries, the relationship is also positive but not significant. However, their estimates are cross-sectional and not corrected for reverse causality between doing R&D and having patent system.

In one of the studies of Hall and Ziedonis, (2001) semiconductors industry is studied. This industry doubled its patenting-R&D rate after the creation of the CAFC and other changes to patent legislation in 1982. Interview evidence suggested that the increase was due to the fact that inventions in this industry use technology which is covered by hundreds of patents held by a number of firms, and those firms increasing feared litigation and preliminary injunctions if they fail to have cross-licensing agreements in place. Negotiating such agreements was greatly facilitated by having a large patent portfolio of your own, so several firms, large and small were engaged in defensive drives to increase their patenting rate. This had little to do with encouraging innovation.

In Japan in 1980 the effect of patent on innovation is studied. The statutory change that allowed the multiple claims per patent had the effect of increasing patent scope in Japan according to Japanese firms and patent attorneys. They find out that this change to patent system had a very small effect on R&D activities in Japanese firms (Sakakibara and Branstetter, 2001).

The effects of patents on innovation in Canada were studied. A type of firm-level survey evidence on innovation was used as in the PACE survey. It was found that the relationship between patent and innovation is strongly going from innovation to patent use than from patent use to innovation. Firms that innovate take out patents but firms make intensive use of patents do not produce more innovations (Baldwin, et al., 2000).

A recent survey of the American manufacturing sector shed some light on the current industrial view of patents as one of the instruments to protect innovation rents. The study showed that secrecy ranked first (over patents, lead time, sales and service or manufacturing complexity) among 14 of the 43 industries surveyed as a method for product innovation protection, and 28 out of 43, or 65 per cent, for process innovation protection (Cohen et al., 1996). Similarly, in a 1994 survey of German small and medium-sized enterprises with in-house R&D activities, only one third of the respondents said they used patents to protect their intellectual property. Another third relied on secrecy, pointing to the high cost of litigation. The last third answered that they introduced innovations faster than their competitors, the life-cycle of their products being on average not much longer than the time required for a successful patent application in Europe (about 2.5 to 3.5 years) (Fest, 1996).

Another survey, carried out in France in 1991 by the Industry Ministry, also revealed limited and uneven recourse to patents: only 10 per cent of innovating firms regarded patents as a very important source of innovation (Guellec et al., 1996)

Sawyer (2008) indicates that surveys of companies show that most inventions are not patented instead they rely on their first-to-market advantage, on trade secrets or on complementary products and services. However, in pharmaceuticals the situation is opposite. In this industry, patent protection increases innovation. He explains that the costs of getting, enforcing and defending a patent are much more than the profits earned from it. For instance, in 1999 the total profits from patents in all US public firms except pharmaceuticals was about $3 billion, but their litigation costs associated with those patents were $12 billion. As it is seen there is a huge difference between profits and costs of patents in industries except pharmaceutical industry.

Researchers in Europe and Japan obtained similar result (Hall, 2003). The result of PACE survey of large European firms, accounting for more than 75% of the patenting in Europe is reported that in US and Europe firms rate superior sales and service, lead time, secrecy as far more important than patents in securing the returns to innovation. Patents are usually reported to be necessary primarily for blocking and defensive purposes. (Arundel, 2001)

Table 5: Literature Review Table

Author	Country	Methodology	Main Finding
Levin et al., 1987 and Nelson and Walsh, 2000	US, EU and Japan	Interview with companies	Patents are important mostly in biotechnology, drugs and chemicals
Mansfield, 1986	US	Two main questions are asked to 100 companies in tweleve industries on the percentage of inventions introduced and developed without patents	The percentage of inventions that would not be introduced and developed is the highest in pharmaceutical industry
Taylor and Silberstone, 1973		Data from 27 firms	The R&D in pharmaceutical industry is mostly dependent on patent protection
Mansfield et al., 1981		Data for 48 product innovations	90% of pharmaceutical innovations would not have been introduced without patent protection
Mansfield, 1986	US	A question asked manufacturing firms what fraction of inventions would not have been developed in the absence of patent	60% of pharmaceuticals and 40% of chemicals would not have been developed in the absence of patents
Mansfield, 1986		Ask firms in twelve industries the percentage of patentable inventions that are patented	In pharmaceuticals, chemical, petroleum 84% of patentable inventions were patented
FTC\DOJ		Explanation of	Patents are indispensable

Hearings		pharmaceutical companies	for innovations in pharmaceutical industry
Scherer et al., 1959	US	Data from firms in US	Except in pharmaceutical industry, patents are not necessary for other industries
Taylor and Silberstone, 1973	US	Data from firms in US	Except in pharmaceutical industry, patents are not necessary for other industries
Cohen, et al., 2000 and Levin, et al., 1987		Carnigie-Mellon and Yale surveys	Patents are not important to appropriate returns except in pharmaceutical industry
Levin et al., 1987 and Cohen et al., 2000	US	Survey done for US manufacturing companies	Patents are relatively effective in industries such as drugs and medical equipment
Encaoua, et al., 2006		Carnegie Mellon Survey	Additional payoffs obtained from patented invention is positive in mostly in drugs, biotech, medical instruments
PatVal, 2005			Patent is valuable mostly in chemicals and pharmaceuticals
Arora et al., 2003			Patent premium is positive in biotechnology and medical instruments, drugs and medicines
Sakakibara and Branstetter, 2001	Japan		Patent has very small effect on R&D activities
Baldwin, et al., 2000	Canada	PACE survey	The relationship between patent and innovation is going from innovation to patent
Guellec et al., 1996	France	Survey	Only 10% of innovating firms regarded patents as an important source of innovation
Sawyer, 2008		Survey	Most inventions are not patented except the inventions in pharmaceuticals

From all the studies above, it is seen that patent stimulates innovation differently from one sector or one technology to another and so there is not a universal effect of patents on innovation. In other words, patents do not have positive effects on innovation in all industries. From the studies mentioned, the net effect of patents on innovation is seen mostly and obviously in pharmaceuticals. Therefore, it can be stated that patents are very critical and important for innovation mostly in pharmaceuticals industry. The importance of patents for pharmaceuticals is due to the fact that in this industry there is huge amount of R&D expenditures and it is very easy to imitate any drug compound. Therefore, for investors in order to make return from their inventions they need a mechanism which protect them from imitators. One of the mechanisms is patenting the inventions. Otherwise, the investors in the pharmaceutical sector do not have incentive to make innovations and so the rate of innovations in this sector decreases automatically. However, patenting innovations motivate investors to make more inventions and so patents in pharmaceutical sector spur innovations.

Because of the importance of patents in pharmaceutical sector, in the other chapters of this study, the patent system in pharmaceutical industry in different countries, US, Europe, Japan (the countries where patent system is the strongest in the world), Turkey as a developing country and India, Latin America and China as developing countries like Turkey is worked on.

CHAPTER 3

THE RELATIONSHIP BETWEEN PATENTS AND RESEARCH AND DEVELOPMENT ACTIVITIES

3.1. Theoretical Comments on the Relationship Between Patents and Research and Development

In the literature, the relationship between patents and R&D has enormous attention. The main reason behind this is that innovative activity at the firm level is important for firms in order to improve their performance and also in the advanced economy it is the main driving force of growth process (Gurmua and Perez-Sebastian 2007).

Patents stimulate firms to undertake R&D investments to discover new products by granting market power and thus return on the investments. Generous patent system is likely to stimulate innovation strongly. In order to obtain benefits, if a patent is granted, firms may need to invest in R&D to transform the patent into a more commercial innovation (Montalvo, 1997).

Patents protect the inventions that business exploits as a result of R&D efforts. The main goals of patent system are to promote the creation and diffusion of technology by providing an inventor with limited monopoly over a technological solution in exchange of a full disclosure of invention. Even though they are often combined with other forms of protection, patents have traditionally been considered as one of the main incentives for R&D (OECD, 1997).

3.2. Empirical Studies done on the Relationship between Patents and Research and Development Expenditures

An empirical study which aims to measure the relationship between patents and R&D expenditures is done by Gurmua and Perrez-Sebastian (2007). They use various models for the analyses of longitudinal patent data. In particular a semi parametric generalization of a negative binomial-beta regression model is used. The result of the study shows that although results are sensitive to different estimation methods, the contemporaneous relationship between patenting and R&D expenditures continues to be strong and accounting for 60% of the total R&D elasticity.

An econometric study is performed by Evenson and Kanwar (2001) to see the relationship between R&D investment and the strength of a country's patent protection. In this study they utilize a cross-country panel of 32 countries over the period 1981-1990. As a result of this study, they find that there is a strong positive association between R&D investment expenditures of countries and their intellectual property protection.

Another empirical study is done by Scherer (1980). Scherer (1980) makes a survey of 27 British companies operating in research-oriented industries in order to see the relationship between R&D and patents. From the survey he finds that in the absence of patent protection, R&D expenditures would be reduced by %64 in pharmaceuticals, by %25 in specialty chemicals, by %5 in basic chemicals and by %5 in machinery and mechanical components industries. This survey shows the importance of patents in industries which are high risky and which have high R&D costs.

From the empirical studies it is interpreted that patent is a necessary tool for research and development activities and vice versa. In particular, industries such as pharmaceuticals that produce products as a result of R&D need patent protection more than other industries because these industries invest more in R&D activities and R&D process is a costly process. In order to compensate their costs of R&D, firms apply for patents.

3.3. The Characteristics of Pharmaceutical Industry and Research and Development Process in the Pharmaceutical Industry

The pharmaceutical sector is a high-technology and knowledge-intensive industry. The industry has a two-tier structure. The largest firms account for the majority of the R&D investment in the industry and hold the majority of patents. A large number of smaller firms manufacture off-patent products or under license to a patent-holder. The pharmaceutical industry is heavily regulated. Few aspects of the industry are unaffected by regulatory controls (OECD, 6 Feb. 2001).

In pharmaceutical industry the R&D expenditures is too much (Danzon and Towse, 2003). The investment cost of pharmaceuticals is greatly high and the distribution of earnings on marketed pharmaceuticals is greatly skewed making investment in pharmaceutical industry highly risky (Grabowski and Vernon, 1994).

In addition to the high cost of R&D in pharmaceuticals, the R&D process is also too long. The importance of patents to pharmaceutical firms in appropriating benefits from innovation is because of the characteristics of the pharmaceutical R&D process (Grabowski, 2002). The R&D process for new drugs is risky and costly. Only a few chemical entities ever receive marketing approval. Among these only a few are commercially successful (OECD, 6 Feb. 2001).

The full R&D process from synthesis to approval involves undertaking successive trials of increasing size and complexity. The pre-clinical and clinical testing phases generally take more than a decade to complete (Joseph, 1995). The initial phases of developing a new drug often involve large-scale screening of many molecules in order to identify a compound with potential therapeutic benefits. The initial phases are followed by in-vivo experiments on animals. If the compound is promising, a patent will be sought in this stage. If a product is patented, the compound passes through a series of human clinical trials (OECD, 6 Feb. 2001).

There are 5 major phases in the R&D process of a new drug. These are (Sereno, 2010):

1- Discovery
2- Pre-clinical research
3- Clinical trials
    a- Phase 1
    b- Phase 2
    c- Phase 3
4- Regulatory review and approval
5- Market lunch

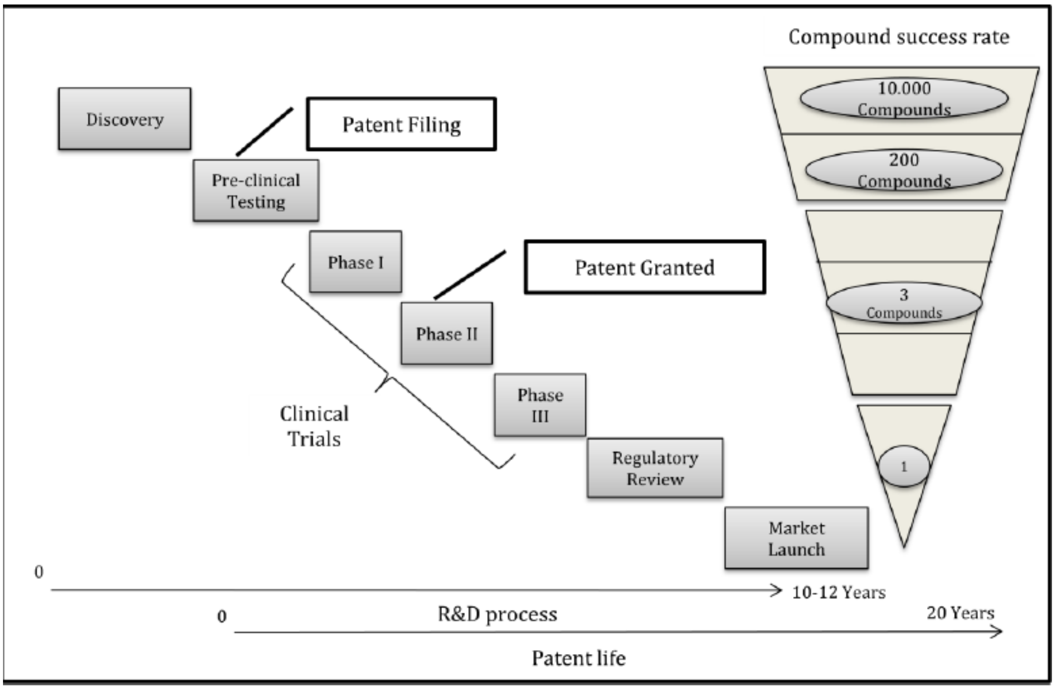


Figure 2: 5 major phases in the R&D process of a new drug

Source: Sereno, 2010

The patent applications are mostly done in the pre-clinical period. This means there become significant loss in patent life since until market approval there are different phases to be passed (Sereno, 2010). As it is seen from the Figure 2, R&D process takes generally 10-12 years to pass all the phases and to reach the market and the patent life is 20 years. This shows that there is a loss of nearly 10-12 years in the patent life.

In addition to being long, R&D process in pharmaceutical industry is also very costly. It takes several hundred million dollars to discover, develop and gain regulatory approval for a new drug (Grabowski, 2002). Grabowski and Vernon (1992b) estimate that the total R&D costs in the early 1980s in the United States amounted to $231 million for each new product brought to market. Evidence from empirical research indicates that nominal pharmaceutical company R&D costs rose from an average of $231 million in 1987 to $359 million per new drug in 1990 (OECD, 6 Feb. 2001).

As it is seen R&D in pharmaceutical industry has high cost. One of the reasons behind this is that most of the new drug candidates fail to reach the market. The reasons of this failure are toxicity, carcinogenicity, manufacturing difficulties, inconvenient dosing characteristics, inadequate efficacy, competitive factors, etc. Only 1% of the compounds examined in the pre-clinical period make it into human testing. Only 20% of the compounds entering clinical trials survive the synthesis to market approval (Joseph, 1995).

Pharmaceutical R&D is also a high-risk venture. Most of the few drugs that are approved will face competition from rival's products. "The combination of high up-front R&D costs, potential competition on final sales, and a lengthy development period serve to make pharmaceutical R&D a higher risk business than other industries" (OECD, 6 Feb., 2001).

Research has found that 75 percent of drug company profits come from just 10% of all drugs. For some major firms, three products account for 70 – 80 % of total pharmaceutical sales (OECD, 6 Feb. 2001).

The ability of research-based companies to continually develop new chemical entities with superior chemical properties and to market these drugs in a profitable way makes them to make profit continually (OECD, 6 Feb. 2001).

3.4. The Importance of Patents in Pharmaceutical Industry

Patents are generally considered as necessary to encourage R&D, particularly in an R&D intensive industry such as pharmaceuticals (Danzon and Towse, 2003). Pharmaceutical industry is the industry that has high R&D costs, long development period to market a product and there is high uncertainty in this industry. Only a small proportion of compounds which are developed by pharmaceutical firms can obtain market approval. All these reasons make patents a crucial tool for pharmaceutical industry.

Patents of chemical compounds play a crucial role in terms of stimulating developments of new drugs (Scherer, 1980). Patent protection is fundamental for ensuring a continuing flow of innovative new drugs and pharmaceutical industry is more reliant on patent protection for innovation than other industrial sectors (OECD, 6 Feb.2001). Therefore, patents are widely and consistently used in pharmaceuticals relative to most other economic sectors (Levin, et al., 1987).

The pharmaceutical industry is characterized by substantial investment in R&D and in pharmaceutical industry there is a continuous flow of new innovations. Almost all R&D of the industry is carried out by large multinational firms. This R&D is funded primarily from the profits flowing from exclusive rights granted to a patent holder during a patent's life time. These exclusive rights can lead to substantial market power and wide margins between price and cost (OECD, 6 Feb. 2001)

The importance of patents in pharmaceutical industry is also shown itself in imitation of drugs. In pharmaceutical industry while cost of innovations is too high, cost of imitation is too low in contrast. Except in bio-technology it is very easy and inexpensive to imitate pharmaceuticals. If there were no patent protection, imitators would free ride on the innovator's approval and duplicate the compound for a small fraction of the originator's costs. The imitation costs of any pharmaceutical compound are extremely low relatively to the innovator's costs for discovering and developing a new compound (Grabowski, 2002)

Through the imitation of drugs, generic drugs are produced. The development costs of generic compounds are relatively modest. They should only show that they are bio-equivalent to the pioneering brand to receive market registration. This process only takes a few years and costs to one to two million dollars (US Congression Budget Office, 1998).

When generically equivalent copy products could enter freely to the market in the absence of patent protection, competition would force prices to down to marginal cost. Marginal cost would cover the expenses of copy products that incur only production and distribution costs with negligible R&D expenditures. Generic firms do almost not engage in R&D activities. However, marginal cost would not afford to cover the R&D costs of innovator firms. Hence free entry and resulting marginal cost pricing are incompatible with sustained incentives for R&D. Therefore, the purpose of patents is to bar entry of copy products for the term of patent and thus recoup the R&D expenditures in order to preserve incentives for future R&D (Danzon and Towse, 2003). In addition, in the absence of patent protection, incentives for R&D investment and margins on pharmaceutical products would decline (OECD, 6 Feb., 2001).

As it is seen, patent is very important and crucial tool for pharmaceutical industry. Therefore, countries should have a well-structured patent protection. For instance, Grabowski (2002) mentions that without a well-structure patent protection neither the research in pharmaceutical industry nor generic industry would be able to grow and prosper.

Although patent protection is seen as a very important tool because of the high cost of R&D, economic theory views patent protection as second best way to pay R&D. The first best way is all consumers whose marginal benefits exceed marginal cost should use the product but since patents permit pricing higher than marginal cost some consumers forego the product even though their marginal benefit exceeds the marginal cost (Danzon and Towse, 2003).

However, with large fixed costs of R&D, the first best solution is not possible, marginal cost pricing to consumers would generate inadequate revenue to sustain innovation unless there is no other subsidies such as government subsidizes R&D. Thus a patent system, which enables innovator firms to charge prices above marginal cost, is generally viewed as the best practical approach to funding R&D in industrialized countries (Danzon and Towse, 2003). Since pharmaceutical industry have enormous amount of fixed R&D costs, patent is the best way to fund R&D expenditures. In pharmaceutical industry, if the price of products is the same as marginal cost, nobody might make innovations in this industry. Because as mentioned before, in this sector there is high R&D costs and in order to compensate these costs and make return from investments, the price of invented products has to be higher than marginal cost. Therefore, patent is still the best way to make return from investments in pharmaceuticals and it is the main tool to make incentives to innovate more in the sector.

As a result, there is a high relationship between patents and R&D expenditures. In the pharmaceutical sector, R&D investment is the main process to make innovations. Therefore, high R&D investment may lead high rate of innovations. Countries have to pay enough attention to R&D

investments of the firms and they have to have necessary policies to encourage firms to invest in R&D.

R&D investment reaches to its importance that it deserves by EU. EU gives a fund 17.5 billion avro in order to support research and innovation activities of SME in the 6th framework. 7th framework continues to support the innovation activities with its more than 50 billion budget (www.cordis.europa.eu).

Besides, countries have to have strong patent protection policies since there is a tight relationship between R&D investment and patent protection. If any country is lack of one of these, it cannot be successful in both of them. R&D investment cannot be effective and efficient without a strong patent protection and it is directly related to patent protection. Grabowski (2002) indicates that in particular, countries that wish to encourage R&D investment and innovation have industrial policies that feature strong patent protection policies. These policies motivate industries like pharmaceuticals and biotechnology to undertake the long costly and risky investment that characterize the innovative process in these industries

The main discussion of this thesis is the comparison of the patent protection of Turkey, US, EU, Japan, India, China and Korea in terms of R&D expenditures and basic research publications. In this chapter, the relationship of R&D expenditures and patent protection in Turkey, US, EU, Japan, India, China and Korea is discussed.

3.5. The Comparison of R&D Expenditures in Turkey and in Some Selected Countries and Patent Protection in these Countries

In Turkey, while the increasing rate of R&D investment is more than OECD countries, the share of R&D investment in GDP is still low. Within OECD countries the increasing rate of R&D investment is around 2%, in Turkey it is 10, 6% in 1995-2004. On the other hand, R&D investment in Turkey is

0.67%. This shows that Turkey has long way to take in terms of R&D investment (OECD, 2007).

Turkey has low level of R&D intensity in economic activities and Turkey needs to develop new product and process and reach to the foreign technologies easily. (OECD, 2001).

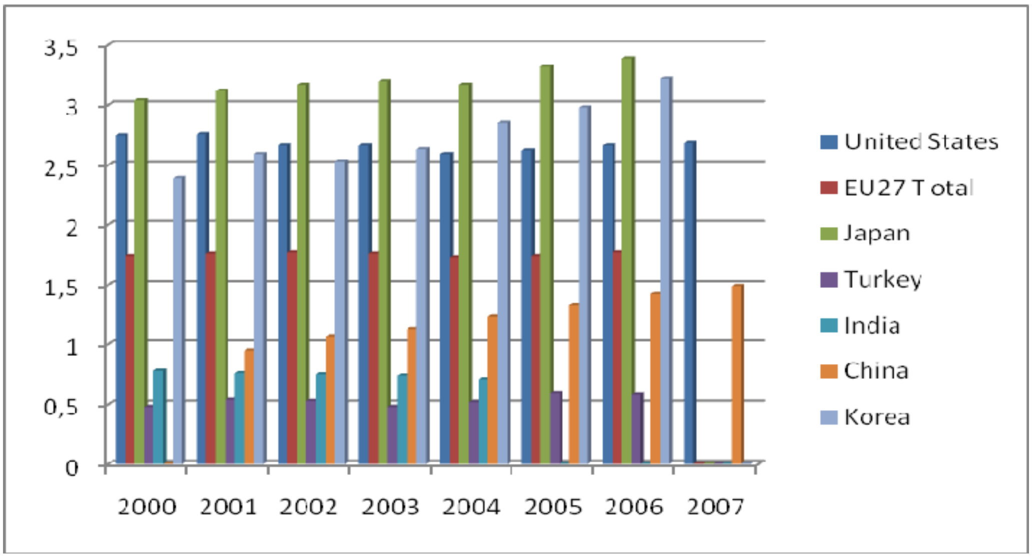


Figure 3: Gross domestic expenditure on R&D As a percentage of GDP

Source: OECD 2009

Figure 3 shows the percentage of R&D expenditures in GDP. This indicator is effective in comparing countries in terms of R&D expenditures because it is not affected from the size of countries.

In EU in total this R&D intensity is **1.73** in 2004, **1.74** in 2005 and **1.77** in 2006. R&D expenditures in EU decreases in 2001 and 2002 and it even decreases slightly after that. If the current negative trend continues, by 2010 Europe's R&D intensity will have declined to its mid-1990s (European Commission, 2007).

In US, the R&D intensity is **2.59** in 2004, R&D intensity in US increases from 2004 to 2007.

In Japan R&D expenditure as a percentage of GDP is **3.2** in 2004, and it also increases from 2004 to 2007. As it is seen, in Japan R&D intensity is more than in US and in EU in total.

In Korea, R&D intensity is **2.85** in 2004, **2.98** in 2005 and **3.22** in 2006. Although Korea is a developing country it has big share of R&D expenditures in GDP. R&D intensity in this country is also higher than in US and EU in total. The increase in R&D intensity in Korea is higher than other countries mentioned here.

R&D intensity in EU-27 remains at a lower level than in most of the other major world economies such as the US, Japan and South Korea. In these countries, and in spite of some minor, short-term fluctuations, the trend over the past decade has been much more positive, outpacing Europe's performance in R&D intensity growth (European Commission, 2007).

In China, R&D intensity shows an increase from 2004 to 2007. China as one of the new emerging economies is rapidly catching up other world leader economies. If current trend continues, it is expected that China will catch up EU by 2009 in terms of R&D intensity (European Commission, 2007).

In India, R&D intensity is more than **1.70** until 1997 and it is **1.71** in 2004. The data for the years after 2004 is not available.

In comparison to countries mentioned above, in Turkey, in 2004 R&D intensity **is 0.52.** In 2005 it increases to **0.59** and in 2006 it is **0.58.** As it is seen, the R&D intensity increases from 2004 to 2006. This shows that Turkey engages in R&D activities more than earlier years. In recent years, the R&D activities in Turkey have increased. The reason behind this may be the subsidies by government have increased. For example, TUBITAK, TTGV, Industry and Trade Ministry, DTM, BAP, EUFP6 and EUFP7, KOSGEB support R&D projects done by private firms in Turkey. Public R&D and innovation funds increase from year to year. For example, in 2004 it was 543 billion TL, in 2005 it increased to 969, 6 billion TL, in 2006 it was 1.256,8 billion TL and in 2007 it increased to 1.259,2 billion TL (www.tubitak.gov.tr). There is a clear increase in the public funds to R&D and innovations activities in Turkey.

Another reason behind the increasing R&D intensity may be some legal issues. For instance, the 5746-the Support of Research and Development Activities Law (Arastima Gelistime Faaliyetlerinin Desteklenmesine Hakkinda Kanun)- numbered law, 5084-the Support of Incentives to Investments and Employment Law (Yatirimlarin ve Istihdamin Tesvikine Yonelik Kanun)-numbered law and 5510-Social insurances and General Health Insurance law(Sosyal sigortalar ve genel saglik Sigortasi)-numbered law, etc. These laws provide some tax opportunities and some legal degradation and incentives to private firms. These policies make private sector engage in R&D activities. In addition to these, private sector begins to have R&D culture and they begin to learn how to make R&D and so the number of R&D projects begins to increase.

Another important point is that in order to make R&D more and effectively, there is usually a need to have university-industry collaboration especially in the sectors that are more R&D-intensive such as pharmaceutical industry. In recent years, in order to have university-industry collaboration, some technology transfer offices are built in the university campuses in order to have interaction easier. Knowledge or technology transfer within the same campus is more effective and less costly. Besides, as mentioned before illegal interaction between scientists and industry is more used than other sources to share knowledge. For this reason, the distance between university and industry is important and technology transfer offices provide this too.

All these give incentives to private sector to engage in R&D activities and so R&D expenditures has increased in recent years.

Overall picture in Figure 3 indicates that R&D intensity in Turkey is less than developed countries, US, EU27 and Japan. Unfortunately, it is also less than developing countries which are China, Korea and India. Although Korea is a developing country its R&D intensity is more than US, EU27. Therefore, it may be thought that Korea is on the path of reaching the developed countries in innovations. Japan is the leading country in R&D intensity.

Historically Turkey has made limited investments, as a percentage of GDP in research and development (including environmental innovation). More emphasis though was put on R&D after 2005, as more ambitious objectives for investment were set - although lower than the EU Lisbon target (OECD, 2008)

The sectors engaging in R&D activities are also important parameters in terms of evaluating a country's performance in innovations. Figure 4 shows the share of business enterprise sector, public sector and university in R&D expenditures.

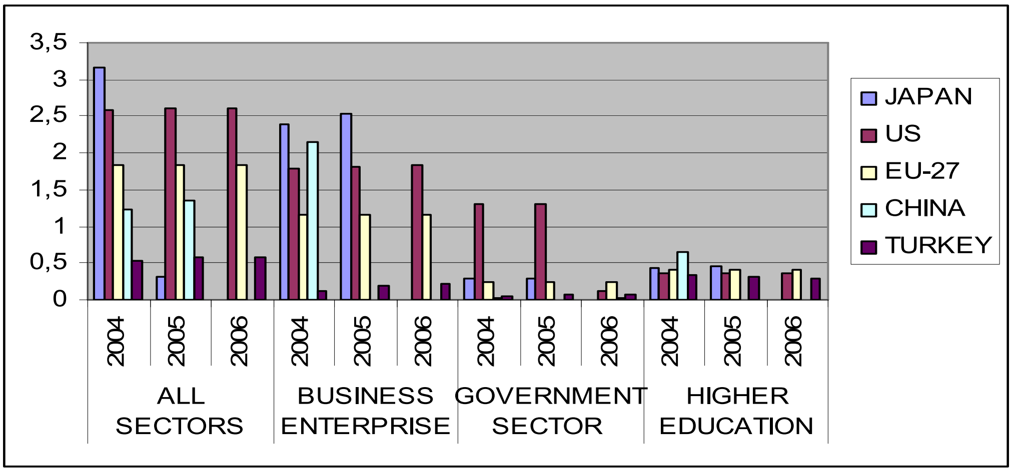


Figure 4: R&D expenditure as a percentage of GDP, by sector of performance

Source: eurostat, 2009

In Turkey, the percentage of R&D expenditures in GDP is the lowest in government sector. In business enterprise sector it is modest and in higher education sector it is the highest. In other words, the breakdown of R&D intensity within Turkey of 0.13 comes from the business enterprise sector, while 0.04 from the public sector and 0.35 from higher education sector. This shows that the most R&D activities are engaged in higher education sectors, universities, etc.

In EU, Japan, USA and China, the breakdown of R&D intensity comes mostly from business enterprise sector and then from higher education sector and at lowest rate from government sector. Because in the USA, Japan and EU the driving force of economic development is the business enterprise sector which develop their own technology (w3.gazi.edu.tr).

Figure 4 shows that in Turkey, business enterprise sector do not engage in R&D activities enough. The business enterprise sector in developing countries pays more attention to engage in R&D activities than manufacturing. However, in Turkey business enterprise sector still do not give enough importance to R&D activities (w3.gazi.edu.tr).

There should be some reasons behind why private sector has low share in R&D expenditures in Turkey. One of these reasons may be private sectors are not motivated enough to make R&D activities. They do not make effort to engage in R&D activities since these activities are costly. In order to give incentives to private sector there should be some policies that support them to make R&D and so innovations. There may be some government subsidies to help private sector. The relationship between university and private sector should be provided and there should be some legal tax discounts if private firms do R&D. Although in Turkey the mentioned subjects are tried to be done, they are still at the beginning stage and Turkey has long way to achieve all these in a good level. The share of private sector is very important to make innovations. If it is looked at developed countries the economic driving force of them is private sector and this sector has high share in R&D expenditures. The most effective way to make innovations is to use theoretical knowledge from university and put this knowledge into practice in private sector and so there can be more innovations. The role of university in innovations may be to search for theoretical base, the role of private sector may be to make innovations through using knowledge from universities and the role of government may be to support private sector that engage in R&D activities. With this system an effective and efficient way to make innovations may be achieved.

Lall (1998) summarizes R&D activities in Turkey very well. She says “Turkish industry had practically no tradition of conducting R&D, preferring to rely passively on imported technologies. Only 13 per cent of national R&D is financed by the private sector. The government offers fiscal incentives for industrial R&D in 1989, only 13 firms applied for these incentives. Private R&D is far below levels in the advanced NIEs, and too low to support sustained industrial competitiveness in advanced European markets. The lack of technological activity has led to a significant brain drain of the best Turkish technical graduates. The need for technology support is particularly pressing for the large number of SMEs that dominated Turkish industry and that tend to lag in technology. The large amount of general R&D in Turkey, financed by the central government, takes place in public research institutes and universities. This R&D has had few linkages to the productive industrial sector, and private industry has been avoided to collaborate with the public laboratories. The pattern of public R&D doesn’t match national industry’s technological needs. The technology infrastructure is generally inadequate to current industrial needs, and even more so to the demands of a more dynamic export structure. The metrology, standards, testing and quality system has been unable to provide the services needed by exporters, raising their costs, constraining technology development and reducing their ability to compete internationally” (Lall and Teubal, 1998).

As Lall (1998) Indicates Turkey is usually depended on imported technology and private sector is not sufficient enough to make R&D and to provide sustainable competitiveness to Turkey. As she explains most of the R&D is done in universities and the link between university and industry is too weak. In addition to these technology infrastructure is not adequate to fulfill the demands of the country.

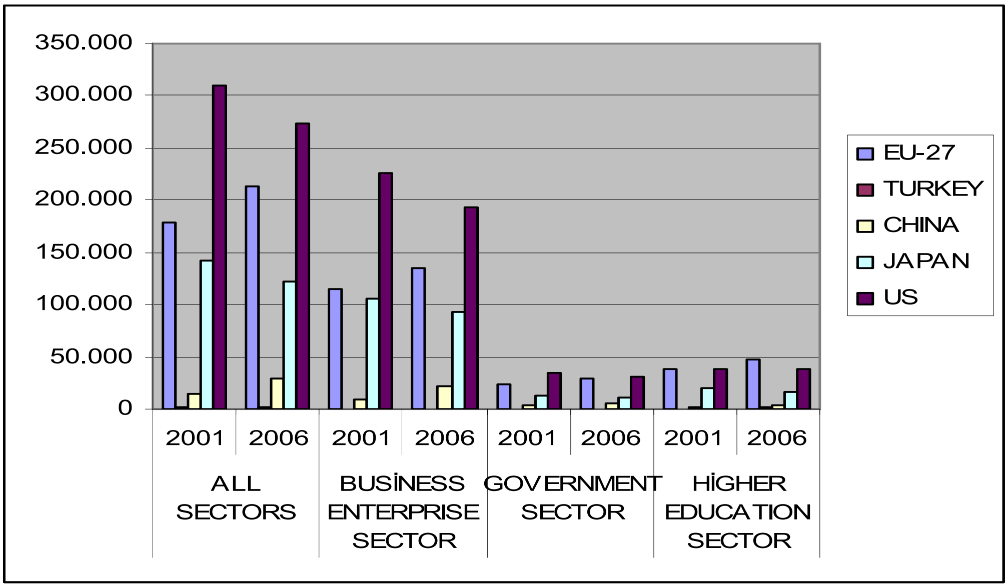


Figure 5: R&D expenditure in EUR million and average annual growth rate (AAGR), by sector of performance, EU-27 and selected countries, 2001–2006

Source: eurostat, 2009

In 2006, R&D spending amounted to more than EUR 2.432 million in Turkey. Between 2001 and 2006, R&D expenditure increases at an average annual rate of 15.7%. On the whole, as seen from the Figure 5 higher education is the most important sector investing in R&D in Turkey. However, the average annual growth rate is more in business (17.9%) and government sector (26.9%) than in higher education sector (12.6%). As the average annual growth rate refers to increase in the value of an individual investment or portfolio over the period of a year, the increase in AAGR in business sector is a good sign of making investment in the right sector. This indicates that Turkey is on the right path as other developed countries in making investment in R&D through the right sector. However, Turkey still has low R&D investment than developed and some developing countries such as China, India and Korea and has long way to use business sector to make R&D investment enough and to make more innovations. In Turkey, there are some problematic areas that make R&D investment low. These are; added values of scientific studies are low, the lack of coordination between researchers, the low number of innovation activities, brain migration, the dependence of R&D activities to the foreign countries, the lack of R&D support to SME and the lack of information about IPR (Kok, 2005).

After the Japan and USA, China becomes the country that makes the most R&D investment in 2001-2006 with its 16, 5% average annual growth rate. In US, Japan and China, the share of business sector is the most in the R&D investment. As mentioned before, business sector is the most important sector investing in R&D in innovative countries.

The important tendency among OECD countries is that the portion of business sector in the R&D expenditures and funding is increasing more than government sector (www.turktrade.org.tr). In the developed countries, business sector is the main driving force of growth.

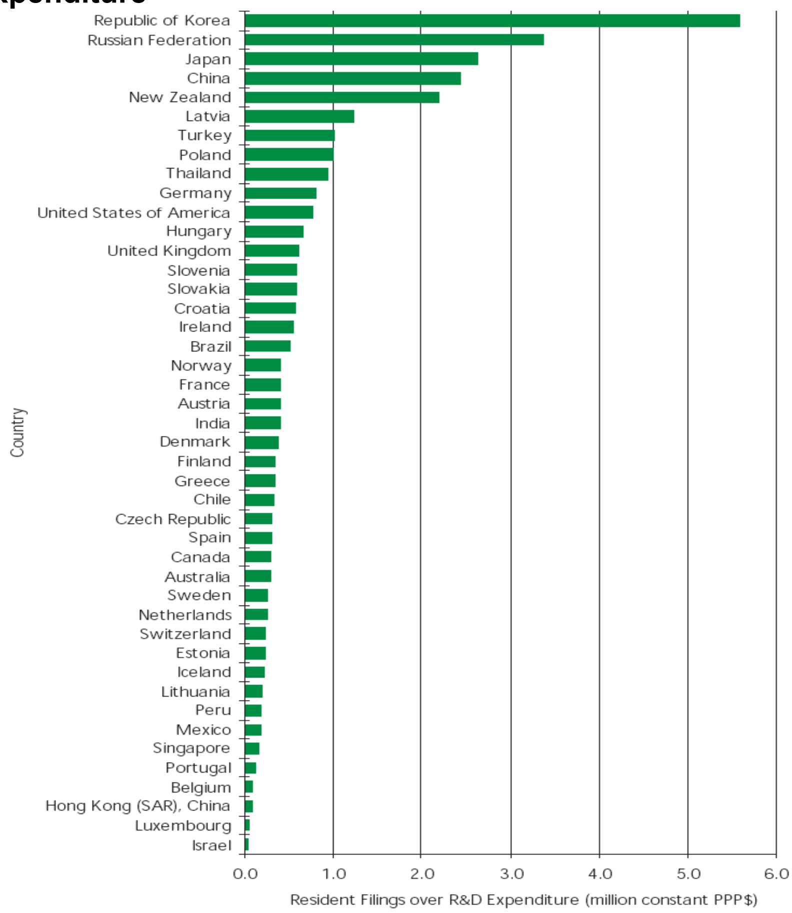
3.6. Patents and R&D Expenditures

The R&D expenditures increase directly proportional with the development level of countries (www.turktrade.org.tr).

The relationship between development level and R&D is related to the factors like monetary deepness, IPR protection, the resources funded by government and the quality of research enterprises (Lederman and Maloney, 2003]. Therefore, in the developing counties, since there is no enough IPR protection, technical and monetary resources, R&D investment are limited (www.turktrade.org.tr).

Patent statistics are usually viewed as an indicator of R&D output. There is a strong positive correlation between the number of patents and industry-financed R&D expenditures (R2 = 0.99). The more a country spends on R&D, the higher the propensity of that country to patent (OECD, 2008). Countries with a high level of R&D investment tend to have high resident filings to R&D expenditure ratio (patent intensity).

Table 6: Resident Patent Filings Per Research And Development Expenditure



Note: Research and development expenditure are in millions of constant US dollars, based on purchasing power parities and lagged by 2 years to derive the resident filings to R&D ratio.

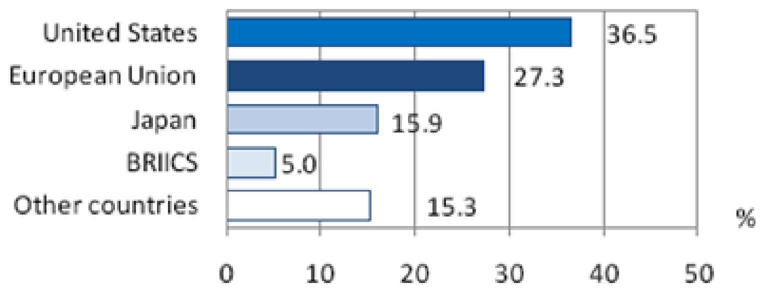
Source: WIPO Statistics Database

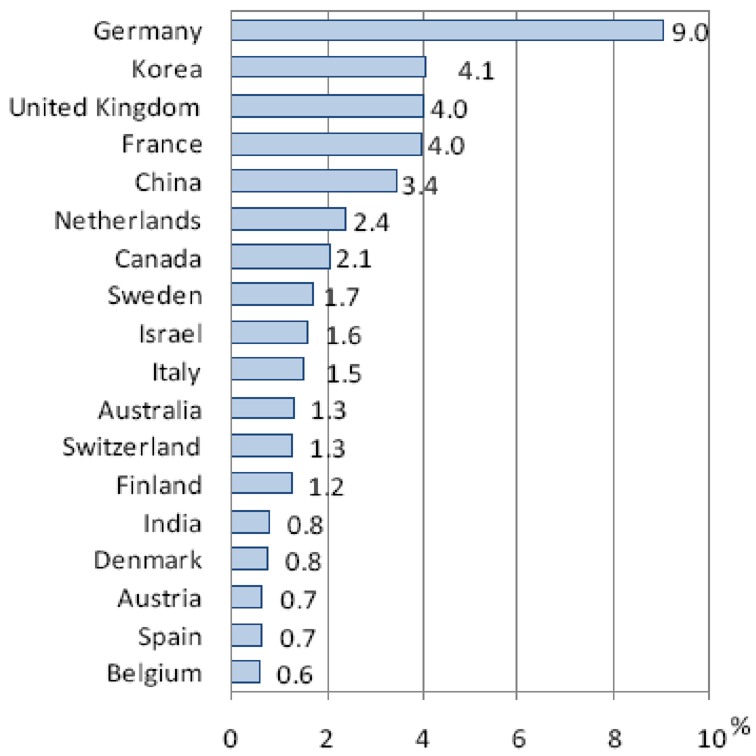
Table 6 shows that The Republic of Korea, Japan, China and New Zealand have a high patent intensity. The number of resident patent fillings in these countries is more than other countries per R&D expenditure. Turkey is also in a good level in terms of patent intensity. However, this must be because R&D expenditure is low in Turkey and this may lead to high patent intensity. The USA has lower patent intensity than Turkey. This does not mean that resident fillings in the USA are too low. This means R&D expenditures in the USA is higher than Turkey and so the patent intensity becomes lower than in Turkey. India has the lowest patent intensity than the countries mentioned here.

In the previous section in Figures 3,4 and 5, R&D expenditures of US, EU27, Japan, Korea, India, China and Turkey is analyzed. Turkey is compared with other countries. Since the R&D expenditure in Turkey is the least among the countries mentioned, it may reach a conclusion that the number of national patents in Turkey is also too low. Since the R&D investment is the most in the pharmaceutical industry, lack of R&D expenditures shows lack of investment in pharmaceutical industry.

Patents statistics also reflect the inventive performance of countries, regions and firms like R&D expenditures, as well as other aspects of the dynamics of the innovation process (OECD, 2008).

The United States, Japan and the European Union demonstrate similar inventive performance, contributing to almost 90% of total triadic patent families in 2005. Patenting activity is concentrated in a set of countries such as the United States, Japan, Germany, Korea, France and the United Kingdom. Among these, Japan has the highest ratio of patent families per population (OECD, 2008).





BRIICS :Brazil, China, India, Indonesia, Russian Federation and South Africa

Figure 6 : Share of countries in high-technology manufacturing industries, 2005

Source: OECD, 2008

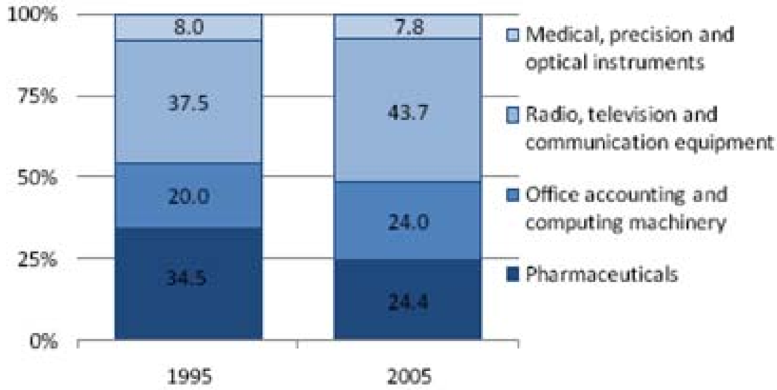


Figure 7: Share of high technology patenting by industries

Source: OECD, 2008

As it is seen from the Figure 6, the United States is the leader in patenting activities in high-technology industries in 2005, with 36.5% of all patents relating to this field. The European Union and Japan followed with 27% and 15%, respectively. Korea is in the rank after Germany with 4.1% of patents in the high technology field. China has the proportion of 3.4% of patents and India has 0.8% of patents in the high technology field. However, Turkey is not among the countries that have some proportion of all patents in the field of high technology.

In the figure 7, pharmaceutical sector is seen among the high technology field. Therefore, the data of countries related to percentage of patents for high-technology industry is also applicable for pharmaceutical industry. Therefore, Turkey has no place in the patenting activities in pharmaceutical sector in 2005.

In order to see the situation of Turkey better, it is beneficial to look at the legal issues about patent protection and the number of patent applications in Turkey.

3.7. Legal Issues about Patent System in Turkey

Turkey has made considerable progress in patenting activities in the past decade. Over the past years, some incentive programs have been introduced to facilitate R&D activities. Patent is one of the economic instruments for inventors to keep control of their inventions and ensure return on their investments in R&D (Dereli and Durmusoglu, 2008). Therefore, patent is a sign of technological status of countries and is important for protection of innovators economically.

In Turkey, TPI (Turkish Patent Institute) has been established on June 24, 1994 as responsible authority to receive, examine, search and register patent applications (www.tpe.gov.tr).

In Turkey, Invention Patent Law has been adopted in 1879 at Ottoman time and stayed in force until 1995. It is known as the only law which lived longest in the World without having been changed. According to the 3rd matter of the Invention Patent Law, pharmaceuticals and pharmaceutical manufacturing method were out of patent protection (Acar, Yeğenoğlu, 2004).

After 29 October 1923, the first attempt of Turkey about protection of IPR occurred in 1930. In 1930, Turkey participated to The Hague text of the "Paris Convention which creates a common protection on industrial property" (www.tpe.gov.tr).

From the year 1930, Turkey became a member of Paris Convention. This convention establishes a Union for protection of industrial property rights. The Convention adopts 4 main principles;

- Minimum requirements for protection,
- Non discrimination,
- Territorial effect, and
- Priority.

One of these principles is the priority principle. According to this principle, any patent application file in any of the member states has priority right if it is filed in other countries in one year. The period of the priority right is twelve months for patent applications. In addition, in the Paris Convention brings the minimum conditions (requirements) needed to grant patents in the member states. (http://www.wipo.int/treaties/en/Show/Results).
In the year 1967, WIPO has been established in order to promote the protection of IP throughout the world. The protection is provided through cooperation among states and in collaboration with other international organizations (www.wipo.int).

In 1976, Turkey signed the WIPO Convention. Since the aim of WIPO is to promote the protection of IP throughout the world, it is important the make all procedures related to IP easier. For this reason, WIPO aims to harmonize national legislation in the IP field (www.wipo.int).

Turkey became a party to London Act of Paris Convention in 1956. Additionally became a party to the Articles of 13^{th} to 30^{th} of Stockholm Act in 1976. Lastly became party to the Articles of 1^{st} -12^{th} of Stockholm Act of Paris Convention on 1^{st} of February 1995 (www.tpe.gov.tr).

On 24 June 1994, Turkish Patent Institute (TPI) has been established as being autonomous in financial and administrative issues. TPE works on behalf of Industrial and Trade Ministry. The main aims of TPI are (www.tpe.gov.tr):

- to contribute to Turkey's technological development,
- to create competition environment
- to make progress in R&D activities
- to provide documents to knowledge related to intellectual property to the public

This was very important milestone in development of Intellectual and industrial Property Rights in Turkey. Until the establishment of TPI, Turkey adopted some of the international conventions but did not make any progress in IPR in practice. The main and substantive improvements in the IPR system in Turkey began with establishment of TPI.

On 1st of January 1995, World Trade Organization (WTO), which is a global international organization dealing with the rules of trade between nations, has been established. Although WTO is a new organization its trading system was old. Since 1948, the General Agreement on Tariffs and Trade (GATT) had provided the rules for this system (www.wto.org).

Turkey has participated in WTO was in 25 February 1995. With this participation, Turkey became a member of Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. TRIPS agreement which was negotiated in the Uruguay Round of GATT in 1994 sets down minimum standards for all different forms of intellectual property, especially requirements that member nations' laws must meet for IP regulation. The main elements of protection is defined, the rights to be conferred and permissible exceptions to those rights are explained in the agreement. These standards are set by requiring the main convention of WIPO, Paris Convention for the Protection of Industrial Property (Paris Convention) and the Berne Convention for the Protection of Literary and Artistic Works (Berne Convention). The main substantive provision in these conventions became obligations under TRIPS agreement. Thus, the TRIPS Agreement sometimes referred to as a Berne and Paris-plus agreement (www.wipo.int)
Turkey, after its participation to the TRIPS agreement, put into practice the laws related to IP in accordance to the standards to the agreement. With the TRIPS agreement, patents began to be granted in all "fields of technology," and must be enforceable for at least 20 years (www.wto.org).

The TRIPS Agreement has an important principle which aims intellectual property protection to contribute to technical innovation and the transfer of technology. Producers, users and the public should benefit, and economic and social welfare should be enhanced (www.wto.org).

Trade-Related Aspects of Intellectual Property Rights (TRIPS) is expected to have the greatest impact on the pharmaceutical sector and access to medicines. International conventions or agreements prior to TRIPS did not specify minimum standards for patents and pharmaceutical patents. However, the TRIPS Agreement now requires all WTO members, with few exceptions, to adapt their laws to the minimum standards of IPR protection thus the pharmaceutical patent protection (www.wto.org).

Until 1995, the applications of pharmaceutical patents were not accepted. However, after the WTO's establishment convention, Turkey was one of the members of this convention. In the 8th paragraph of the Article 70th, It is obligatory to receive the filings of product patents applications for pharmaceuticals for all country. However, different transition periods have been assigned to the member states according to their development level. Developed member states had one year transition period to implement applicable changes to the obligations mentioned in TRIPS agreement. However, developing countries had more 4 years transition period, and the least developed countries had 10 years transition period to complete adoption of changes (www.wto.org).

In the Section 7, article 3 of the TRIPS agreement, mentions the data exclusivity and data protection of the pharmaceutical patent. This article is below:

"Members, when requiring, as a condition of approving the marketing of pharmaceutical or of agricultural chemical products which utilize new chemical entities, the submission of undisclosed test or other data, the origination of which involves a considerable effort, shall protect such data against unfair commercial use. In addition, Members shall protect such data against disclosure, except where necessary to protect the public or unless steps are taken to ensure that the data are protected against unfair commercial use” (www.wto.org).

In Turkey, on 1st January 1995, the patents applications for pharmaceuticals began to be accepted. There are mainly two kinds of patents. These are: (Yalçıner, 2004)

1- product patents
2- process patents

The product patents covers the new drug active ingredient. These are product patents.

The process patents covers the new processes used for producing a drug. (Yalçıner, 2004).

In Turkey, patent protection of pharmaceuticals began on 1st of January 1999 (Yalçıner, 2004). After the TRIPS agreement, in order to implement changes to the national law, Turkey adopted some laws and some decree-laws in the pharmaceutical patent field. The relationship between Turkey and European Union is based on Association Council decision on March 6, 1995. According to this decision, an important step is achieved in the path of Turkey’s full membership to EU. This was adopted by European Parliament on 13th December 1995. On 1st of January 1996, Customs Union between Turkey and EU started. According to Customs Union, the import of drug matters which are the raw materials used in the formulation of medicines and drugs are not charged customs duty (anonymous, 2001).

According to Association Council decision, it was decided for Turkey to adopt necessary IPR legislation. In addition to this, a decision is taken for Turkey to adopt the legislation for granting pharmaceutical patents before 1st of January in 1999 (anonymous, 2001).

The Invention Patent Law adopted in 1879 during Ottoman time has been changed by the Decree Law 551 adopted on 24th of June 1995. With this Decree Law 551, new regulations have been adopted for patent rights. Finally with the Decree Law 566, it was adopted to accept patent applications related to pharmaceuticals on 1st of January 1999 instead of 1 January 2000.

However, in accordance with Turkey's commitments to the EU for the customs union, with the 566 decree law which is published in the 22nd of September 1995 and in the 22412 numbered official gazette, this period was shortened and the pharmacy became subject matter of patents in the 1st of January in 1999. (Acar and Yeğenoğlu, 2004) Therefore, patents in pharmaceutical industry are exercised 1 year earlier. The legislation does not contain pipeline protection for pharmaceutical products. The Turkish Patent Institute accepts applications for pharmaceuticals (www.turkey-now.org).

Turkey began to accept pharmaceutical patent applications in the 1st of January 1995 and these patents began to be granted on 1st of January in 1999. Patent law in Turkey, came into force in June 1995. According to this law, duration of patent protection is 20 years starting from the filing date. Duration of R&D is within this period. If the product is marketed lately, 15 years protection is defined. With the Supplementary Protection Certificate (SPC), 5 more years can be added to patent protection. However, this additional period is not in force in Turkey. The drugs that are authorized or are applied to authorize before the 1st of January 1999 are out of patents. This means patents are given to new products (www.tpe.gov.tr).

After the establishment of Turkish Patent Institute, during the period of one and half year, 2 laws, 6 Decree Laws, 14 Regulations, 2 notifications entered into force (www.tpe.gov.tr).

In the 1st of January 1996, with the 7th of July in 1995 and 4115 numbered law approved by TBMM, Turkey attended to Patent Cooperation Treaty (PCT). This convention gives opportunity to countries to apply with a single international patent to many PCT members in the same time. This application can be done by citizens of member countries of PCT or people inhabit in these member countries. These applications can be done to national offices to member countries or if wanted to WIPO (www.wipo.int).

As it is seen, patent protections policies did not change until 1995 and this shows that Turkey has not used patent system until 1995. The main developments in the patent system have been made after 1995. In comparison to USA, EU, Japan, China, India and Korea Turkey was too late to integrate patent protection into its legal structure. Therefore, patent applications in Turkey and patent applications of Turkey under PCT, EPO or USPTO are still too low. In the Figure 8 the number of patent application of Turkey to the triadic patent families is shown. However, Turkey has very low applications in total.

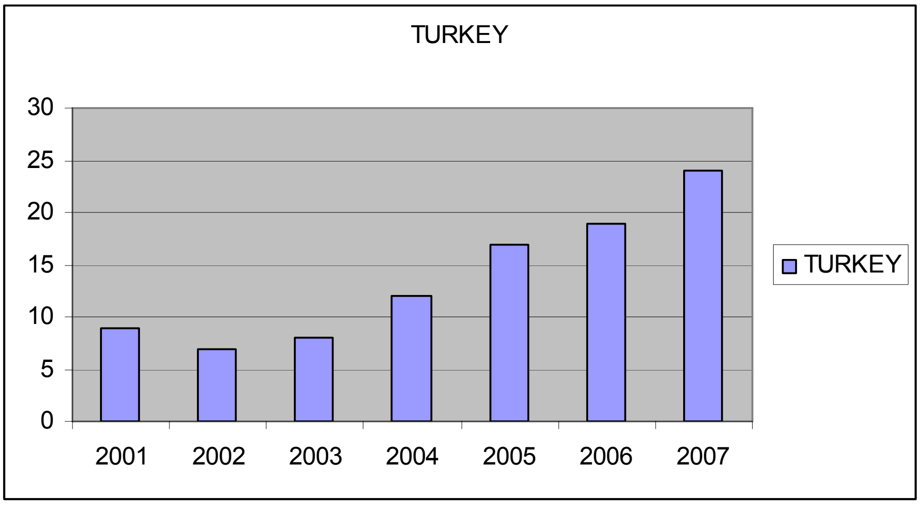


Figure 8: The Application of Turkey to the Triadic Patent Family in 2001-2007

Source: OECD, Science and Technology Basic indicators, 2009/1

However, USA, EU, Japan and Republic of Korea are leader countries in terms of patent applications worldwide. The EPO, JPO, KIPO and USPTO are among the largest IP offices in the world in terms of the volume of patent applications they handle. The following figure shows the role played by the Four Offices in the patenting activity (WIPO, 2008).

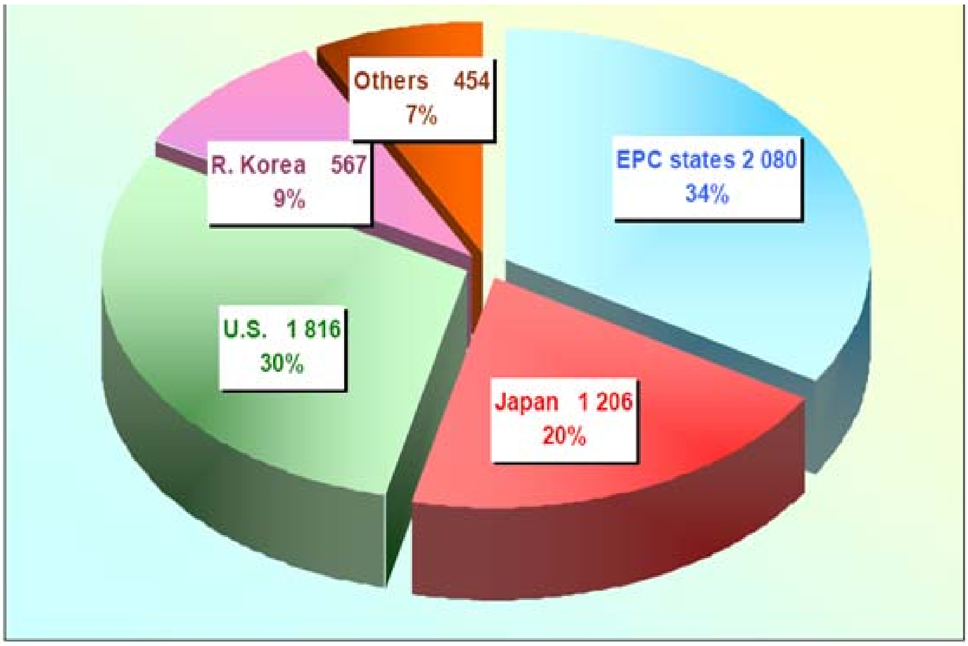


Figure 9: Patents in force in 2007 (in thousands)

Source: www.jpo.go.jp

The number of patent applications is the most in EPC states, it is followed by the US and Japan. After these three, Republic of Korea comes. Since EU, USA and Japan have high technology infrastructure it is not surprising for them to be leader in patent applications. However, Korea is a developing country and it is interesting to see it in the fourth place in terms of the number of patent applications. This figure shows that Korea is an innovative country and makes R&D as much as developed countries.

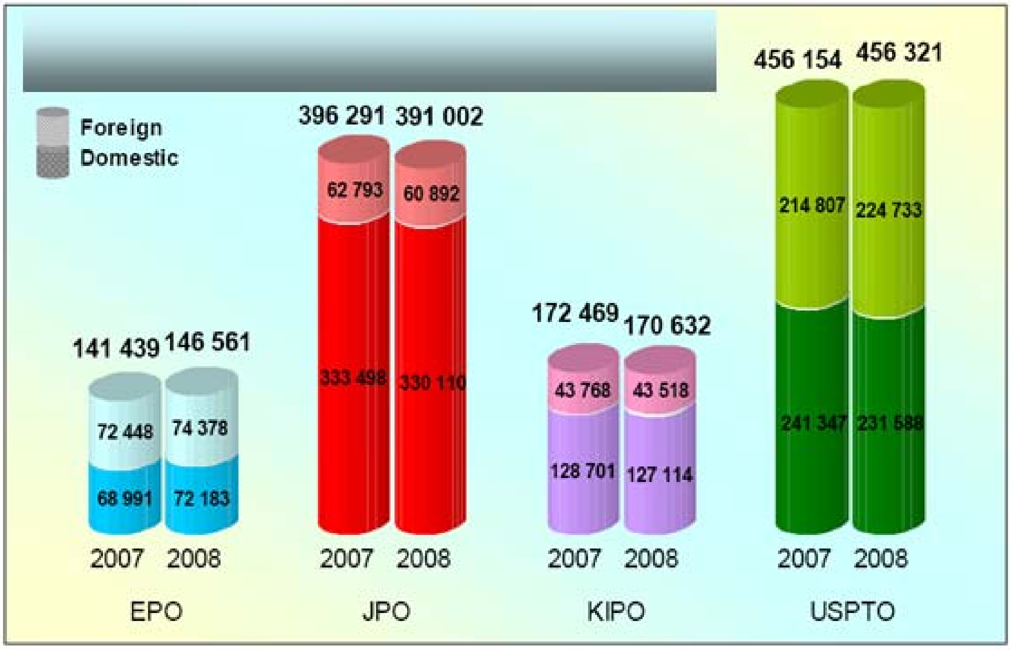


Figure 10: Domestic and Foreign Applications Field

Source: www.jpo.go.jp

EPO: European Patent Office **JPO:** Japan Patent Office **KIPO:** Korean Intellectual Property Office **USPTO**: United States patent and Trademark Office

Except in EPO, in JPO, KIPO and USPTO domestic patent applications are more than foreign patent applications. For example, in JPO there is a big gap between domestic and foreign patent applications. Domestic patent applications are almost 85% and foreign application is only 15% of all applications. In KIPO, the gap between domestic and foreign patent applications is high. The percentage of domestic patent applications is almost 75% and the rest is foreign applications. Both in Japan and Korea domestic innovations are more and so domestic applications are much more than foreign applications. In USPTO the percentage of domestic and foreign applications are near to each other. However, this does not mean that US is not innovative, in contrast she is too innovative but since the number of patent applications is much more than other countries, the gap between domestic and foreign patent applications is small. As the number of patent applications within a nation increases the gap between domestic and foreign patent applications may become smaller. In EU the number of domestic and foreign patent applications is near each other. Since EU consists of many countries this figure is also normal and it does not mean that EU countries are not innovative. EU in total is innovative and has a high number of patent applications.

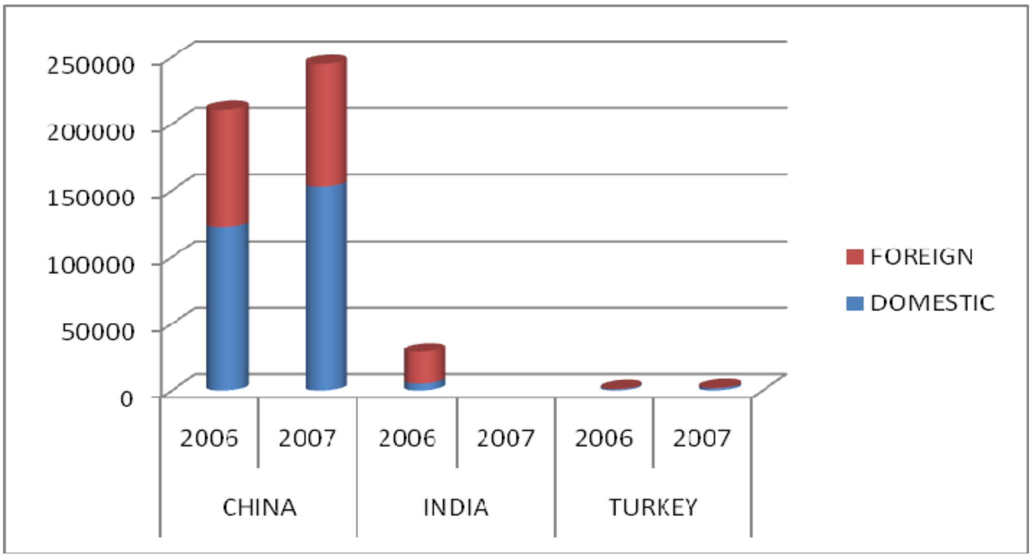


Figure 11: Domestic and Foreign Applications Filed

Source: WIPO Statistics Database, 2009

According to Figure 11 in China and in Turkey domestic patent applications are more than foreign patent applications. However, in India foreign patent applications are much more than domestic patent applications. In total the number of patent applications is the least in Turkey. This shows Turkey is not an innovative country and other countries may not see it valuable to apply to Turkey for patent applications. The legal issues associated with patent applications may also lead to this situation. Patent system integrates in Turkey very late and firms are not enough informed about the patent system.

Although in Turkey, domestic patent applications are more than foreign applications; this is not valid in all sectors. In high-technology sector foreign patent applications is much more than domestic patent applications. This shows that Turkey is not good at making innovations in high-technology sector and it does not have appropriate technology infrastructure to make R&D and so to make innovations in this sector.

In order to see the situation of Turkey in terms of patent applications clearly, it is important to look at these applications in sector basis. When the patent applications are analyzed, it can be seen that national corporations do not benefit from patent enough but multinational corporations benefit from patent system especially in pharmaceuticals and chemicals (Soyak, 2002). In the national pharmaceuticals industry, as the rate of foreign capital increases, the national R&D expenditures decrease seriously (www.insancilsol.com).

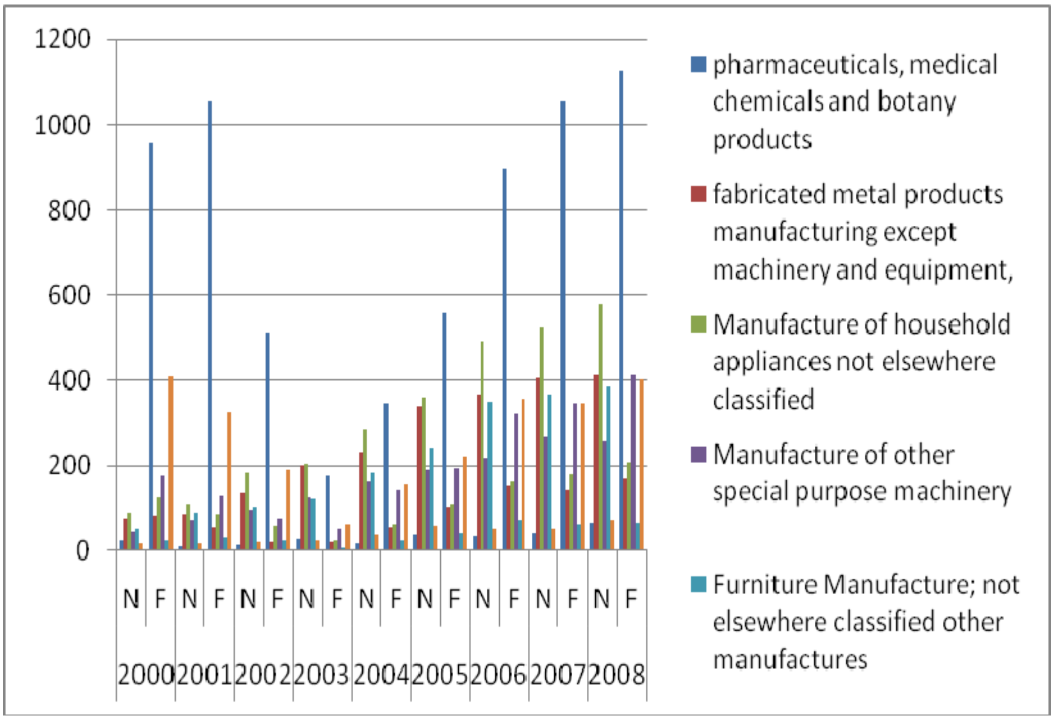


Figure 12 :The number of patent applications by the field of industry

Source : TPI

In Turkey as it is seen from the Figure 12 the national patent applications in pharmaceutical industry is too low. Most of the applications are done by foreign pharmaceutical companies. Therefore, it may be interpreted than national firms in Turkey do not engage in R&D activities in high-technology industries such as pharmaceutical industry and so they do not have innovations in this industry. First of all, Turkey adapts patent protection to its legal system too late. Therefore, the industry does not enough informed about the patent system and are not used to apply for patents. Secondly, Turkey usually prefers to import technology from foreign countries. It also does not have strong technology infrastructure to make R&D. For instance, the graduates in Turkey prefer to go abroad so Turkey cannot use these brains in its innovation system. Government subsidies and legal regulations are not enough to motivate private sector to make R&D. Besides, the university-industry collaboration is still very weak. All these reasons may make Turkey not use its resources effectively to make R&D and so innovation.

CHAPTER 4

THE RELATIONSHIP BETWEEN PATENTS AND BASIC RESEARCH

In a global and competitive environment, countries need to make progress to protect themselves from competitors and keep themselves in a competitive environment. In this respect, the relationship between science and technology is an important parameter since science-based technologies play an important role in modern economies. This relationship can be effectively supported by some quantitative indicators such as publication and patent data. With these data, the dynamics of the interaction of science and technology and the professional move of academic and industrial researchers between institutions can be analyzed and the situation of countries around the world in terms of science can be interpreted.

In order to have modern economies, the education system of the countries should be strong enough to create a culture of focusing on making progress in every field of society. To form such a culture, people in countries should be qualified enough to produce original ideas and put these ideas in life. These original ideas refer to scientific knowledge. Basic knowledge is mostly produced in universities and put into practice in R&D laboratories. Scientific research is one of the generators which put countries in a developed level and lead them to innovate. Most of the innovations are based on basic research. Therefore, basic research and innovations have close relationship. In this chapter, the relationship between basic research-innovations, basic research-universities and basic research-patents is provided in order to see the role and importance of basic research in the countries.

4.1. The Relationship Between Basic Research and Innovation

In the recent years, there has been big interest on R&D within industry. Through R&D activities firms innovate and make technological improvements. Research done by Acs et al. (1992), Mansfield (1991) and (1992) and Jaffe (1989) indicate that technological change in the important segments of the economy has been based on basic research.

Basic research named also as fundamental research or pure research, is defined as experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying phenomena and observable facts, without any particular application or use in view (www.arc.gov.au). Basic research can be thought of as arising out of curiosity without any commercial aim. However, in the long term it is the basis for many commercial products and applied research. The substantial proportion of R&D undertaken in universities and government research laboratories is sector-based rather than being curiosity driven (Bryant, 2001). Basic research is mainly carried out by universities and public research institutions. Basic research is the dominant activity in university sectors, applied R&D dominates R&D in government laboratories and experimental development dominates the business sector (Bryant, 2001).

The basic research mainly provides theoretical and empirical findings and new types of instrumentation which are necessary for the development of products and processes but it does not provide the invention itself (Mansfield, 1995). In order to make innovations basic research is used by firms.

Basic research often stimulates and enhances the power of R&D done in industry (Nelson and Rosenberg, 1994). It can be thought as expanding technological opportunities available to society (Klevorick et al.,1995). Outputs of academic patents disseminate via open science are useful not only to industry, but also feed into future academic research (Sampat, 2006).

In the long period, basic research is one of the sources of firms to make innovations and to produce commercial products. Because of this, science and industry are tightly bound. Researchers and government scientists spend much of their time attending to commercial interests (Simon, 2009).

4.2. Empirical Studies done about the Relationship between Basic Research and Industry Innovations

There are some empirical studies to measure the relationship between academic research and industry innovations. One of these studies is done by Mansfield (1991). Mansfield (1991) studies the data obtained by 76 firms in manufacturing industries. He finds out that about 11% of their new products and about 8% of their new processes could not have been developed without recent academic research. These percentages differ from industry to industry. In some industries basic research is much more important in order to make innovations than in other industries. For example, pharmaceutical industry is the most important industry for human health. Therefore, it needs the most R&D to fulfill the needs of people to produce new drugs. Therefore, for pharmaceutical industry basic research is crucial to make innovations.

A considerable proportion of industrial innovations in high-technology industries such as drugs, instruments and information processing are directly based on recent academic research (Mansfield, 1995).

Table 7: The Percentage of New Products and Processes Based on Recent Academic Research, Seven Industries, United States, 1975-85

Industry	Percentage that Could Not Have Been Developed (without substantial delay) in the Absence of Recent Academic Research		Percentage that Was Developed with Very Substantial Aid from Recent Academic Research[a]	
	Products	Processes	Products	Processes
Information processing	11	11	17	16
Electronics	6	3	3	4
Chemical	4	2	4	4
Instruments	16	2	5	1
Pharmaceuticals	27	29	17	8
Metals	13	12	9	9
Petroleum	1	1	1	1
Industry mean	11	9	8	6

Source: Mansfield, 1991

As it is seen from the Table 7, the percentage of new products and processes based on recent academic research is the highest in pharmaceutical industry. New products or processes could have been developed without academic research but it would have been much more expensive and time consuming to do so (Mansfield, 1991a).

The relationship between academic research and industrial innovations is also illustrated by Marsili (1999). He draws a summary table to show the patterns within and differences across industries. The table is based on the statistical analysis of the Pace survey of European industrial managers, US R&D data, employment patterns in the different industries and patent citations. Through this survey, Marsili classifies industries in terms of the contribution of academic research to innovation in each sector.

Table 8: The Role of Academic Research in Different Industries

Contribution of academic research	Development activities engineering disciplines (mainly tacit)	Research-based activities basic and applied science (mainly codified)
Very high	Computers	Pharmaceuticals
High	Aerospace	Petroleum
	Motor vehicles	Chemicals
	Telecommunications and electronics	Food
	Electrical equipment	
Medium	Instruments	Basic metals
	Non electrical machinery	Building materials
Low	Metal products	Textiles
	Rubber and plastic products	Paper
Relevant scientific fields[a]	Mathematics, computer science, mechanical and electrical engineering	Biology, chemistry, chemical engineering

Source: Marsili, 1999

Table 8 in conformity with Table 7, indicates that contribution of academic research is very high in pharmaceuticals, in other industries such as petroleum, chemicals and food its contribution is high and on basic metals and building materials it is medium.

The study done by Mansfield (1991) is replicated by Beise and Stahl (1999) in Germany with a much larger sample of 2300 manufacturing firms. They find that approximately 5% of new products sales could not have been developed without academic research. They show that academic research has a greater impact on new products than new processes. They also find out that large firms are more likely to draw from universities than small firms.
Another empirical study is done by Nelson (1986). He make surveys of research managers and finds out that university research is an important source of industry innovations especially in biological sciences.
Jaffe (1989) makes a study to see the knowledge spillovers from universities through modifying the “knowledge production function” introduced by Griliches (1979). As a result of his study, he finds out that corporate patent responds positively to commercial spillovers from university research. Patent activity increases both in the presence of high private corporate expenditures on R&D and as a result of research expenditures undertaken by universities.

Gibbons and Johnston (1974) indicates that 36% of the information which contributed to the development of an innovation and which was obtained from outside the firm during the innovation has its origins in basic research.

4.3. Basic Research and Universities

The role of universities in the innovation process has increased over time since the development of new products or technologies depends increasingly on scientific research (Martin and Nightingale 2000). This is because the importance of multi and interdisciplinary R&D and the relationship between basic research and industrial application increases. Important innovations in high technologies such as telecommunication technology and biotechnology are drawn from basic research (Mansfield, 1995).

As mentioned before, the basic research is mainly done in universities. Therefore, the transfer of knowledge from universities to industry is an important aspect to benefit from basic research. New knowledge generated by public research is transferred to the industry by publication of research papers, R&D contracts or R&D-cooperation with private companies (Beise and Stahl, 1998).

Academic patenting is more about boosting research and transferring technology to industry than about making a profit (www.wipo.int). In addition to this, since universities have less incentive to keep research secret, there are spillovers from universities to firms (Jaffe, 1989). The spillover between universities and industry can be achieved through research parks and technology transfer offices (TTO).

There are two main spillovers between university and industry. These are geographical spillovers and spillovers across sectors and industries. Geographical spillovers imply that firms are located near research centers, other firms and universities (Martin and Nightingale, 2000). The new growth theories suggest that differences in growth rates may result from increasing returns to knowledge. One of the sources of these returns may be geographical concentrations of knowledge or agglomerations that provide a means to facilitate information searches, increase search intensity and ease task coordination. Therefore, location may lead to higher rates of technological advance and economic growth (Feldman, 1999) Research collaboration within a country is strongly influenced by geographical proximity. If the distance is long, collaboration is low because research collaboration often demands face to face interaction (Katz, 1994). Significant amount of total flow of spillovers originates from other firms. Firms benefit from R&D efforts of other firms that are in close technological proximity. Since the knowledge spillover may cross firms geographical location of firms becomes significant (Jaffe, 1986).

In seeking to understand the localization effects on economic activity, some empirical studies have classified agglomeration economies into localization economies or urbanization economies. Since the interest here is on localization effects, in this section only it is focused on localization economies. Localization economies are knowledge spillovers external to firms but internal to industry. Local industry agglomeration may increase innovations by providing industry specific complementary assets and activities that may lower costs of supplies to the firm. Thus, industries in which complementary assets are important may more likely be concentrated geographically and realize more innovative productivity (Feldman, 1999).

Factors such as geographical proximity and the nature of contractual relationship between public researchers and private firms have very important effect on the efficiency with which information is transferred from public to private sectors (Cockburn and Henderson, 1998).

Firms which are located closely to public research institutions have more incentive to work with these institutions since the cost of travelling between collaborators is low. Moreover, informal communication between scientists of private firms and public institutions is more in the same area. These firms that are located in the area where academic research is done are more likely to have opportunity to apply the findings of research earlier than distant firms (Martin, 2000 and Beise and Stahl, 1998) Therefore, more collaboration between nearby partners than between more distant ones should be observed (Beise and Stahl, 1998).

There are some empirical studies done to see the relationship between universities and industry. For instance, Cohen et al. (1998) discuss efforts by industry and policy makers in order to make university research more reliable for industry. They show growing ties between universities and industry. University research parks are designed to commercialize university technology. These research parks are very crucial to provide coordination between university and industry. Through technology transfer offices and research parks the university-industry collaboration increases. The main functions of TTOs are summarized by Figure 13.

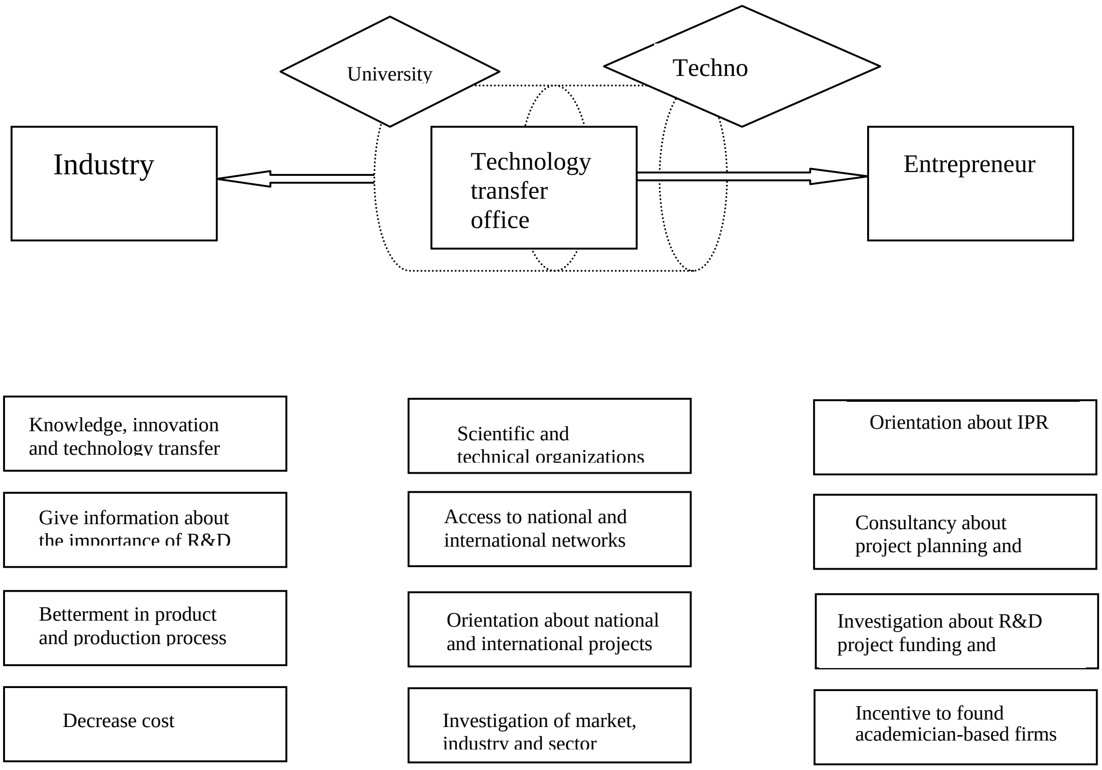


Figure 13: The Functions of Technology Transfer Offices

Source: The Presidency of Turkish Republic Government Control Institution Research and Examination Report (2009)

Techno parks behave as households of TTO. As it is seen from the Figure 13, TTO function between university and techno parks. These offices provide knowledge flow from university to industry or firms. Their main aim is to commercialize the results of academic research effectively and quickly. In other words, they provide coordination between researchers and entrepreneurs and industrialists. The technology produced in university should be turn into products through right mechanism. TTO are the main mechanism that provides this.

The main functions of TTO as shown in Figure 13 are; to transfer knowledge, information and innovation, to give information about the importance of R&D

projects through this they facilitate innovations, to make technical and scientific organizations so that firms can be aware of new technologies and scientific developments, to give information about the Intellectual property rights and the ways to use these rights so that firms can protect their inventions from imitations, etc. In summary, TTO both stimulate coordination between university and industry and facilitate R&D projects and innovations within industry through making organizations in order to provide knowledge, technology and information flow from university to industry and giving necessary information about the scientific and technological improvements and rights of firms.

Meyer (2003) defines three types of technology transfer modes in universities. These are direct mode, mediated mode and intermediary mode. In the direct mode, technology transfer takes place between academic investor and interested third party. In this mode, there is no technology transfer office. In the mediated mode, the research is utilized by technology transfer office because the university or related organizations owns the IPR. In this mode, there is technology transfer office. Lastly, in the intermediary mode, university does not own IPR to the invention but the technology transfer is involved as a facilitator of transfer. Figure 14 schematizes these three modes (Meyer, 2003).

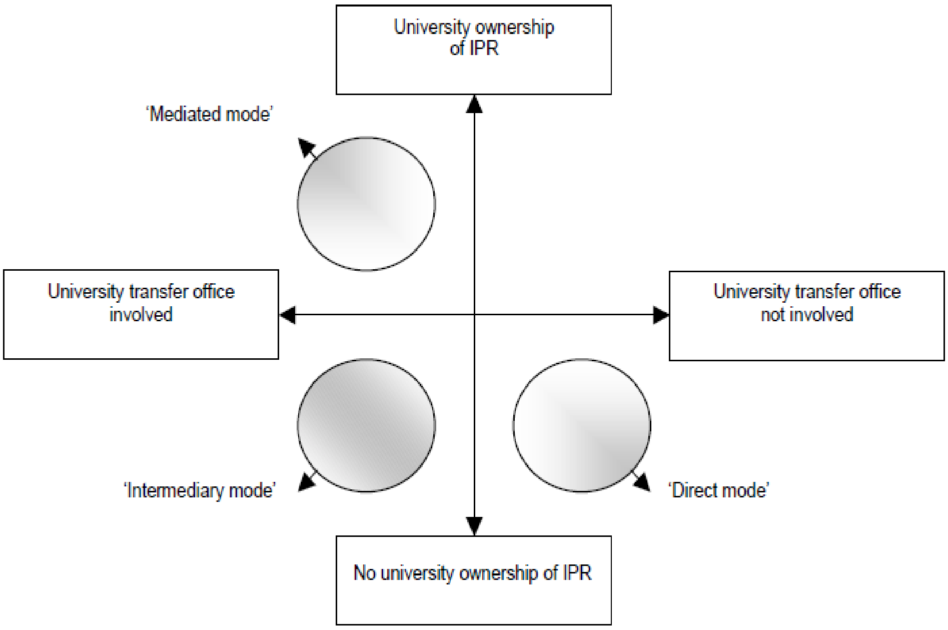


Figure 14: Different Technology Transfer Modes

Source: Meyer, 2003

As it is shown from the Figure 14, in the direct mode there is no university technology office and the university does not own the IPR. This leads to quick and direct knowledge transfer from university to firms. Moreover, the coordination between academicians and entrepreneurs or industrialists becomes easier and quicker so that innovations in the firm level can be done faster. On the other hand, in the mediated mode, since IPR is owned by university, research done in university is utilized by technology transfer office. From this office, result of research is transferred to firms and so it is commercialized in the firm level. The transfer of knowledge in this mode is slower than in the direct mode. Lastly, in the intermediary mode, the university does not own IPR and technology transfer office is used to transfer research result from university to industry and this result is commercialized in the industry. The transfer of technology in this mode may be faster than in the mediated mode since university does not own IPR in this mode.

Meyer-Krahmer and Schmoch (1998) uses a combination of European Patent Office data and survey of universities on their linkages with industry and they find out two-way interaction between universities and industry. The most important forms of interaction between universities and industry are collaborative research and informal contacts. Collaborative research involves a bi-directional flow of knowledge and informal discussion is preferred to publications for contacts (Martin and Nightingale, 2000). Technology transfer is seen to be most effective within informal communication networks (Beise and Stahl, 1998). Informal communication leads to mutual trust and trust raise the propensity to co-operate in R&D projects since cooperation increases the risk of know-how leaking out (Granovetter, 1985).

Mansfield (1998) makes a study to see the time delay from academic research to industrial practice. He finds out that the time delay has shortened from 7 years to 6 years. He suggests that increasing links between academic research and industrial practice may be a result of academic work toward more applied and short-term work and of growing efforts by universities to work more closely with industry.

Spillovers between universities and industry are common among research-related activities. The productivity level of industry not only depends on research effort but also on the general pool of knowledge accessible to it (Griliches, 1994).

Firms with higher R&D expenditures have more tendencies to receive knowledge spillovers from public research (Beise and Stahl, 1998). High-technology industry such as pharmaceutical industry has high R&D costs and so they need more knowledge transfer from public research or universities.

Klevorick et al. (1995) explains the importance of university research for R&D intensive industries, such as pharmaceutical industry. He finds out that firms in these industries mainly utilize findings from applied sciences. For instance, Mansfield (1991) makes a study in USA. He finds out that 11 per cent of all product innovations, and 9 per cent of all process innovations developed in research intensive industries such as drugs, metals, etc. in 1975 to 1985 could not have been realized without the respective results from university research.

To sum up, university research causes industry R&D. For this reason, the knowledge and technology transfer between university and industry is very crucial. This interaction is the most crucial for high-technology industries such as pharmaceutical industry, biotechnology, etc. The innovations in these industries mostly depend on basic research. Therefore, a state that improves its university research system will increase local innovation by attracting industrial R&D and augmenting its productivity (Jaffe, 1989).

4.4. The Relationship between Basic Research and Patents

When a patent is granted, a public document is created which includes extensive information about the inventor, technological antecedents about the invention. Apart from these, the document contains “references” or “citations”. What citation a patent must include is determined by patent examiner. The citations serve the legal function of delimiting the scope of the property rights conveyed by the patent (Jaffe et al., 2001).

As mentioned in the previous sections, basic research has tight relationship with industry innovations. There is strong evidence that in recent years, science has become increasingly important for innovations. This is evidenced in the number of citations in patents to scientific work (European Commission, 2007).

In practice, research discoveries are not able to enter the marketplace in their laboratory forms. This process is achieved by patents and patents provide the transition of technology to the marketplace (Kirschenbaum, 2002).

Without patents, since the measure of scientist's success lies in publishing findings in peer-reviewed journals, companies are unable to keep the basic research technology underlying their product development hidden from others to preserve their competitive edge (Kirschenbaum, 2002).

In recent years, empirical observations show that technology can increasingly be related to science. For example, Narin et al. (1998) find out that patents increasingly refer to papers of scientific journals.

A study done by Geuna and Nesta (2006) using data on university-invented patents from Belgium, France, Finland, Germany and Italy shows that technological areas where patenting is most frequent are mostly related to biotechnology and pharmaceuticals.

Jaffe (1989) investigates the role of universities in the innovation process in the USA. He finds out that knowledge from scientific research significantly influences the number of patents applied by firms in the same state.

Jaffe (1989) also makes a study to measure geographical spillovers in the US employing a three-equation model involving patenting, industrial R&D and university research. He examines the relationship between patents assigned to corporations in 29 US states in 1972-1977, 1979 and 1981, industrial R&D and university research by using patents as proxy for innovative output. From this study, he finds out that there are spillovers from university research and industrial patenting.

Patents also play important role in universities. Universities as the main source of basic research has complex obligations because their goals are especially to create and disseminate knowledge regardless of whether their activities are profitable in private sector or not. Many universities view the number of patents, licenses and disclosures in addition to royalties and sponsored research as the outputs of their commercialization. Universities use resources to attract industry funding and by using this funding they make further research. Many universities have willingness to engage in such activities and private sector is looking more carefully at university intellectual property. Commercial activities include industry-sponsored research and royalties as well as numbers of invention disclosures, licenses and new patent applications. Biological sciences and engineering are more important to licensing activities than physical sciences (Thursby and Kemp, 2002).

Throughout much of the 20th century, universities were reluctant to become directly involved in patenting and licensing activities because of fears that such involvement might compromise their commitments to open science and their institutional missions to advance and disseminate knowledge to disseminate knowledge. Therefore, many universities avoided patenting and licensing activities (Sampat, 2006).

However, in the wake of Bayh-Dole Act, the number of universities involved in patenting and licensing activities has increased. Internal technology transfer offices are set up to manage licensure of university patents. The main goal of the Act is to promote the technology transfer from publicly funded academic research projects to the business sector (Sampat, 2006).

With Bayh Dole Act, the interests of universities change and if the research done by researchers worth to be commercialize, they are patented. In other words, with the Bayh Dole Act the relationship between universities and industry become tighter. The process of commercialization of university research is as follows: First the research is conducted in university with or without the intention of creating a commercializable innovation. If a faculty member believes that results of research are commercializable, he or she undertakes a formal process of disclosure of the results to the university's technology transfer office. This office evaluates the innovations for patentable or commercial potential. If the innovation is seen as commercializable TTO seeks to find private sector firms as licensees of the technology (Thursby and

Kemp, 2002). This Act gives universities the right to seek patents for the results of their research. The Act gives not only universities but also individual investors incentive to be on the lookout for patentable inventions by giving opportunity to universities the share of patent royalties with individual investors (Sampat, 2006).

The Bayh Dole Act also provides the usage of patent system to promote the utilization of inventions arising from federally supported research and development. It promotes commercialization of technology and it makes it possible to make scientist to benefit from patented inventions. The Act requires that the inventors receive a share of royalties from the sales of inventions (Kirschenbaum, 2002).

The Bayh Dole Act and the patent protection give companies incentives to invest in developing basic research into real world applications.

4.5. The Comparision of Basic Research in Turkey and in Some Selected Countries and Patents in these Countries

As mentioned before, the relationship between science and technology can be effectively supported by some quantitative indicators such as publication and patent data. In the recent years, in order to find out the place of countries around the world in terms of science and to compare the scientific characteristics of countries, 3 criteria are accepted. These are: the number of publications that are published in the international scientific journals, publications that are published in the journals which are searched by scientific indexes and citation numbers of the scientific publications (Ak and Gulmez, 2004)

In the Table 10 the number of articles, compositions and notes that are published in countries which are subject to this thesis and their impact factor are given.

Table 9: The number of publications between 1981-2007

COUNTRY	PUBLICATION NUMBER	CITATION NUMBER	POPULATION	PUBLICATION NUMBER PER MILLION CAPITA	CITATION NUMBER PER MILLION CAPITA	IMPACT FACTOR
EU-27	6.736.583	92.284.710	499.723.500	13500	184700	13,70
USA	6.634.586	137.391.957	307.212.123	21600	447200	20,71
JAPAN	1.493.226	18.321.818	127.078.679	11800	144200	12,27
CHINA	639.834	3.267.114	1.338.612.968	500	2400	5,11
INDIA	457.769	2.340.776	1.166.079.217	400	2000	5,11
SOUTH KOREA	237.216	1.458.882	48.508.972	4900	30100	6,15
TURKEY	120.562	548.547	76.805.524	1600	7100	4,55

Source: ULAKBIM

As it is seen from the Table 9, there is a direct relationship between the development level and publication number of countries. Among the selected countries, Turkey has the least publication number. The 92% of all publications in Turkey belongs to government universities, foundation universities, GATA and Staff schools, 4.5% belongs to corporations associated with Health Ministry, 3.5% belongs to other government corporations and public institutions (www.ulakbim.gov.tr).

When it is looked at the publication number per capita, USA has the highest publication number per capita and it is followed by EU-26 and then Japan. There is also a parallel relationship between publication number per million capita and development level. However, this parallel relation is not valid for India and China because their population number is too high. It does not lead to right interpretation to compare their publication number per million capita with other countries. Since these countries have too high population, the publication number per million capita for them is too low. This ratio does not mean they are weak at science and have low development level. Turkey has high publication per million capita than China and India. However, because of the interpretations made above, it does not mean Turkey is better than China and India in scientific research and development. Except from China and India Turkey has the least publication number per million capita. This shows that Turkey is not in a good place in the world in terms of scientific research.

Citation number is also a parameter to measure whether a publication is important, precious or not. It also tells us the scientific place of countries around the world. If the citation number of an article is high, it provides respectability to the scientist who owns the article and the journal that publish the article. Today, scientific performance of scientists is measured by the citation number their articles have. High citation number also leads other scientists to be aware of the articles that have high citation number. As a result, there is a direct relationship between the citation number and the quality of publications.

In the Table 10, the citation number and citation number per million capita for selected countries is provided. In terms of citation number USA is in the first place and it is followed by order of EU-27, Japan, China, India and South Korea. Turkey has the least citation number. This shows that the publications in Turkey are not seen as important and precious and their quality is weak. The citation number per million capita is also the highest in USA and then EU-27 and Japan. In China and Korea, there is a same situation as in publication number per million capita. Since they have high population, citation number per million capita for them is too low. This low ratio does not mean that their publications are not valuable and weak. In Turkey, citation number per million capita is the lowest than other selected countries except from China and India. This means publications in Turkey are not seen as worth to be cited.

Apart from publication number and citation number, impact factor of publications is also a measurement to find out the situation of scientific development of countries and the quality of the publications in these countries.

Impact factor is defined as a quantitative measure of the frequency with which the 'average article' published in a given scholarly journal has been cited in a particular year or period. It is generally used in citation analysis. Impact factor can be formulazed as follow (http://www.library.tudelft.nl):

Impact factor: the number of current year citations in a given journal/ the number of items published in that journal during the previous two years

The impact factor is a measure of importance of scientific journals. From the Table 9, the importance of scientific articles of the countries shown can be compared with each other. In USA the impact factor is highest and so it can be interpreted that articles or notes that are published there, are very important and are preferred more than the articles in other countries. The impact factor in USA is followed by EU-27. Japan follows EU-27 with 12,27 impact factor. Japan is also in a good position in term of impact factor of their publication because the impact factor there is near to EU-27 and USA which are the most developed countries and the strongest countries in terms of science and technology in the world. As a developing country, South Korea has 6.15 impact factor. For a developing country this number is not bad. This shows that South Korea is good at scientific research and their publications may be preferable. Scientific research may open doors to technological development and innovations. South Korea has made too much improvement in technology and innovations. China and India follow South Korea with 5,11 impact factor. Turkey has 4,55 impact factor. Within the selected countries publications in Turkey has the least impact factor. This shows that the publications in Turkey are not preferred to be cited like the publications in selected countries. This may lead to interpretation that published articles in Turkey are not very successful and valuable.

As it is seen the publication number, citation number and impact factor in Turkey is too low. It is interpreted that the Turkey is not developed enough in science and publications in Turkey are not valuable enough and have low quality. However, these should not be the only reasons. There may be some other reasons behind the low number of publications and citations in Turkey. These reasons can be the migration of graduates to foreign countries, the time limit of academicians to make research, the languages that are used to publish articles, etc. Graduates of Turkey who want to make academic career mostly prefer to go abroad and so potential researchers do not contribute to Turkish scientific performance. Most of the academicians in Turkey focus on education and because of the burden of lectures and students they have limited time to make scientific research. The number of articles in Turkey which are written with foreign languages may be low. This leads to less citation to these articles.

Among the selected countries Turkey has the least publication and citation number. However, this does not mean that Turkey is always in the same place in terms of publication. In the figure 15, the trend of the publication number of Turkey from 1997 to 2009 is given.

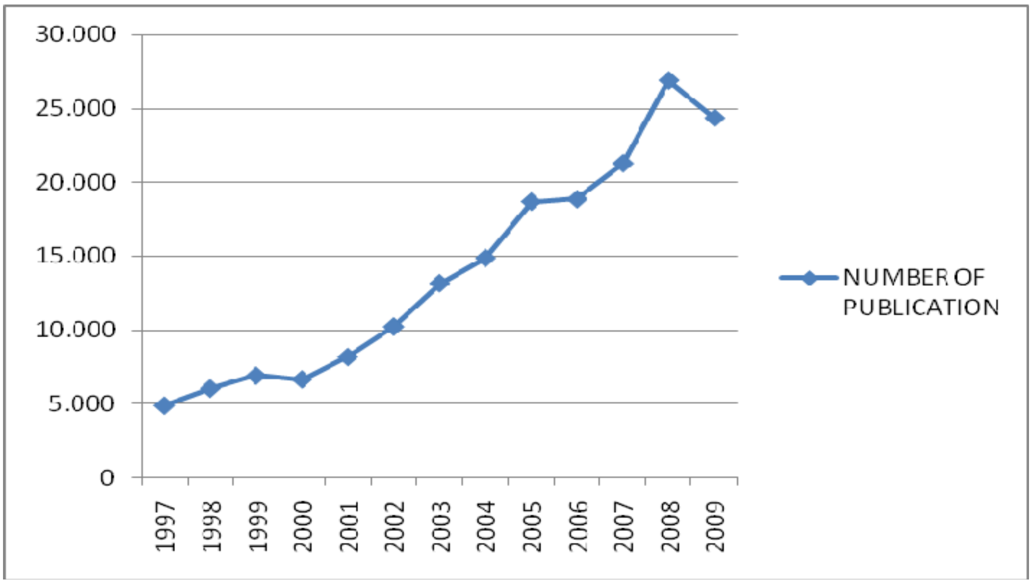


Figure 15: The Number of Publication Between 1997-2009 (Turkey)

Source: ISI, Web of Science, 2010

Figure 15 shows that the number of publication in Turkey has increased from 1997 to 2008. There is a very little decrease in 2009 but this fall is not too much and it is negligible. This is a good sign that the publication in Turkey increases from year to year. There may be some reasons behind this rise. One of these reasons may be that the publication number of the articles of any academician is taken as a criterion to advance in career in the recent years. Moreover, the Council of Higher Education (YOK) has begun to look at the publication of articles of any academician in international journal in associate professorship exams. In addition, after the 1983 the number students who go abroad for master and doctorate program has increased. When these students come back to home, the number of publications in Turkey has increased (Ak and Gulmez, 2004). The incentive programs driven by TUBITAK, TUBA, etc for international publication also have contribution in the rise of publications of Turkey.

The subject of this study is to see the number of patent applications in pharmaceutical sector. In order to see the development of countries in pharmaceutical sector, it is beneficial to see the number of publications in this sector. In the Table 10, the number of basic research in pharmaceutical sector is given.

Table 10:The number of publications in pharmaceutical and pharmacy between 1981-2007 in Turkey

COUNTRY	PUBLICATION NUMBER	CITATION NUMBER	POPULATION	PUBLICATION NUMBER PER MILLION CAPITA	CITATION NUMBER PER MILLION CAPITA	IMPACT FACTOR
EU-27	221.857	3.349.872	499.723.500	443,96	6703	15,10
US	189.632	3.687.058	307.212.123	617,26	12.001	19,44
JAPAN	74.608	847.046	127.078.679	587,10	6.665	11,35
CHINA	14.572	83.344	1.338.612.968	1,08859E-05	6,22615E-05	5,72
INDIA	9.801	62.901	1.166.079.217	8,40509E-06	5,39423E-05	6,42
SOUTH KOREA	7.873	50.703	48.508.972	162,3	1045	6,44
TURKEY	4.600	26.500	76.805.524	5,98915E-05	345	5,76

Source: ULAKBIM

Table 10 shows that Turkey has also the least number of publications in pharmaceutical and pharmacy. Turkey is also very weak in basic research in pharmaceutical industry. Meyer-Krahmer and Schmoch’s (1998) study shows that in pharmaceuticals, the links between industry and university is direct and often visible. Therefore, since the contribution of basic research in high-technology industries such as in pharmaceuticals to innovations is very high, the low number of publications leads to low number of innovations in this industry.

In the pharmaceutical and pharmacy, the publication number per million capita is the highest in USA and Japan follows USA. EU-27 is in the third place. Although South Korea is a developing country, it is on the right path to catch the developed countries in innovations and scientific research. China and India has the least publication and citation number per million capita since they have high number of population. Turkey, except China and India has the least publication number per capita. This situation is nearly the same with citation number per million capita.

It is necessary to see whether Turkey is always in the same place in terms of publication number in pharmaceuticals and pharmacy. In the Figure 16, the trend of the number of publication of Turkey in this sector is provided.

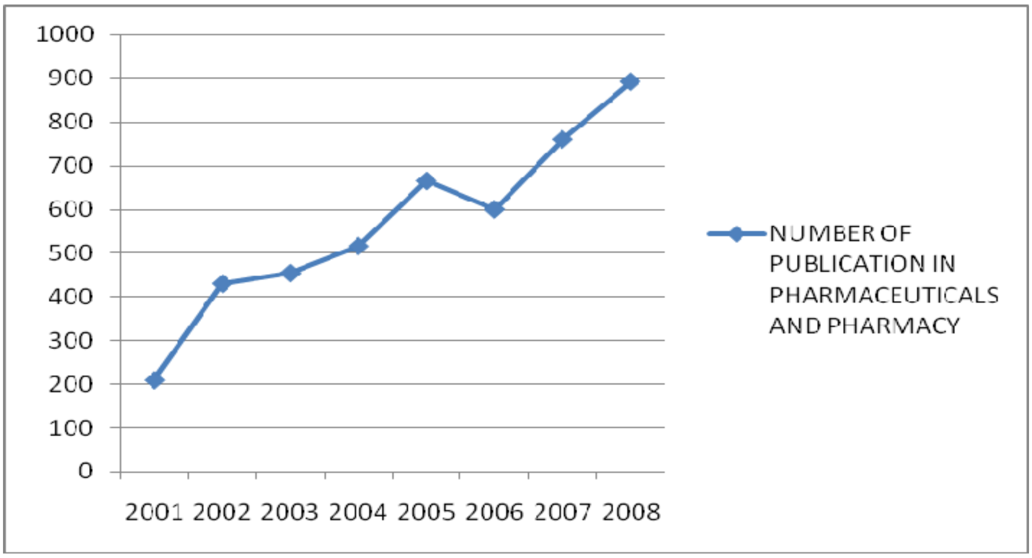


Figure 16: The Number of Publications in Pharmaceuticals and Pharmacy (Turkey)

Source: ISI, Web of Science, 2009

The number of publications of Turkey in Pharmaceuticals and Pharmacy has and increasing trend from 2001 to 2008. In 2006 it decreases but this decrease can be negligible. In general the publication number has increased from year to year. This shows that Turkey has made progress in the pharmaceutical sector in terms of scientific research too. The reasons behind this rise may be the same with the reasons of the rise in publications in general.

Although the publications of Turkey has a increasing trend both in general and in pharmaceutical sector as seen in Figures 15 and 16, Turkey still has low number of publications in general and in pharmaceutical industry. Since science and technology has close relationship, the low performance in science leads to low performance in technology. Technological improvements, innovations are close to each other and so if a country is not good at making technological improvements; it is not good at making innovations either.

Science, technology, innovations are all related to each other. They behave as one of the legs of a chair. If one is absent the others cannot exist easily. All these are related to patents because without innovation, it cannot be talk about patents and without science it is difficult to make technological improvements especially in industries which have high R&D such as pharmaceutical industry, biotechnology, etc.

As the number of publications of Turkey is low in pharmaceutical industry, it can be interpreted that the number of innovations in this sector is also low. This leads to low number of patent applications in pharmaceutical industry. Expenditures by universities on research have significant and positive influence on patent activity (Acs et al., 1991). As mentioned before, in pharmaceutical industry, innovations are directly related to basic research. Therefore, the less the number of basic research the less the number of innovations and so patent applications.

It is necessary to see the situation of the firms in the pharmaceutical industry in Turkey closely in terms of R&D expenditures, patents in order to see the path Turkey is going on. In order to make some policy recommendations to Turkey, it is crucial to analyze the current situation of pharmaceutical industry. In chapter 5, some data related to R&D activities and patent applications of the pharmaceutical firms are analyzed closely.

CHAPTER 5

THE STILIST FACT OF TURKISH PHARMACEUTICAL INDUSTRY

With this thesis, it is aimed to see the relationship between patent-innovation, patent R&D activities and patent-basic research. Through these topics, the main focus is on pharmaceutical industry. In the previous chapters, the innovations, R&D, basic research in pharmaceuticals are covered in general. In this chapter, it is tried to analyze the situation of the firms in pharmaceutical industry in Turkey in terms of R&D activities and patent applications in detail. To analyze these firms, R&D data from Turkish Statistical Institute (TUIK) and The Scientific and Technological Research Council of Turkey (TUBITAK)-Technology and Innovation Funding Programs Directorate (TEYDEB) and patent data from Turkish Patent Institute (TPI) are used.

It will be beneficial to closer look at the pharmaceutical industry in Turkey. How many firms in this sector do business in Turkey, how many of them are national and how many are foreign-based, what do they produce, etc are tried to be answered first. Therefore, in the first part of this chapter, the pharmaceutical industry in Turkey is explained in general and in the second part the R&D and patent of the pharmaceutical firms are analyzed.

5.1. Pharmaceutical Industry in Turkey in General

Pharmaceutical industry is one of the industries which has high added value to Turkish economy. This industry has high rate of production and export. With the Good Manufacturing Practices which came into effect in 1984, this industry increases its technological development and reach to the statues of EU countries

There are 300 pharmaceutical firms in Turkey. Out of this, 53 have production foundation. In this sector 42 firms are foreign-capital and 14 of them are producers the others are either contract manufacturers or importers. In the Turkish pharmaceutical industry nearly 80% of raw materials are imported (http://www.ieis.org.tr/asp_sayfalar/index.asp?sayfa=215&menuk=12).

Turkey is an importer in pharmaceutical industry. In the Figure 17, this can be seen easily.

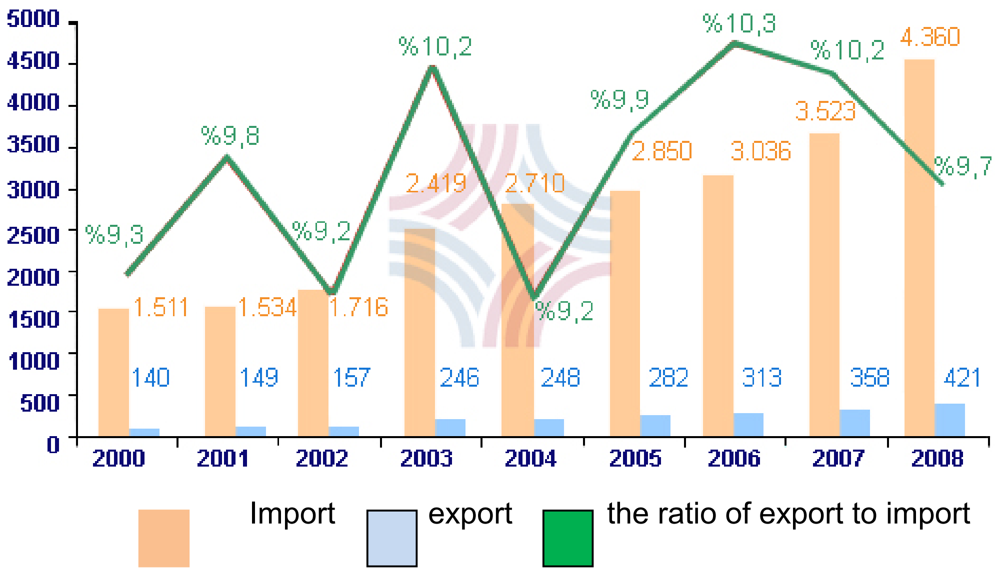


Figure 17: Foreign Trade

Source: IEIS, 2009

As it is seen in the Figure 17, the import of Turkey increases from year to year and it reaches to 4,36 billion dollar. On the other hand, export also increases and it becomes 421 million dollar in 2008, but its rise is smaller than import rise. In all years export is less than import. The ratio of export to import is very low. However, from 2004 to 2007 this ratio increases but in 2008 it decreases to 9,7%.This means the foreign trade of Turkey is not as it is wished for a country. The ideal situation is that export is always more than import. This situation in Turkey is vice versa. There should be some regulations to convert this situation to opposite.

To know the situation of countries in the world in pharmaceutical industry would be beneficial in order to see Turkey's place around the world better. The 65% of new drugs are marketed first in USA. 46% of the world drug sells and 45% of the world R&D expenditures in this sector belong to USA, too. USA is followed by EU and Japan. 31% of world drug sells and 41% of the world R&D expenditures in pharmaceutical sector are done by EU. Japan follows EU by sharing 9, 3 % of the world drug sells and 13% of the world R&D expenditures (Schweitzer, 2007).

In Turkey, the drug sells and R&D expenditures in pharmaceutical industry is too low. On the other hand, Turkey has nearly 76 million populations and so its heath expenditure is too high. For this reason, it is very important to produce drugs in house and decrease dependence to foreign countries. In order to produce original drugs Turkey need technological infrastructure and researchers and needs to make R&D. It is a very difficult process to produce original drugs. Producing generic instead of original drugs is also very beneficial to the economies of countries and they also provide added value to the economies. In the Turkish pharmaceutical sector mostly generic products are produced.

As it is known, in order to produce generic drugs, the patent protection of the original product should finish. The factor matter of the generic drug should be the same with the original drug. There should be a bio-equivalence between generic drug and original drug.

The costs of producing original drug are too high and time-consuming. However, it is less costly to produce generic drugs. For producing generic drugs there is no need to make clinical tests, etc. Since it is less costly, producing generic drugs becomes attractive for countries. With the generic drugs, the prices of original drugs decrease and so this leads firms to search for new drugs. Through this, there will be development in the health sector. Generic drugs production also leads to increase in treatments.

In Turkey, most of the pharmaceutical firms produce generic drugs. In order to produce generic drugs, firms also need to make R&D but not as much as in producing original drugs. In the next part of this chapter, to see the general picture of pharmaceutical industry in Turkey, the R&D expenditures and R&D intensive of pharmaceutical firms who make R&D project applications to TUBITAK-TEYDEB and the R&D data from TUIK are analyzed.

5.2. Data on R&D Projects of Pharmaceutical Firms applied TUBITAK-TEYDEB

In Turkey, there are some incentive programs driven by government sector or private sector to support R&D activities of industry. TUBITAK-TEYDEB works as one of these government institutions. Firms in any sector can apply to TUBITAK for their R&D projects. If the projects are seen as R&D project by committee within the TUBITAK, these projects are granted.

Pharmaceutical firms are among the firms who apply to TUBITAK-TEYDEB for their R&D projects. There are 20 pharmaceutical firms who apply to TUBITAK and whose R&D projects are accepted. First application of pharmaceutical firms began in 2000. Therefore, R&D data related to these firms are taken from 2000.

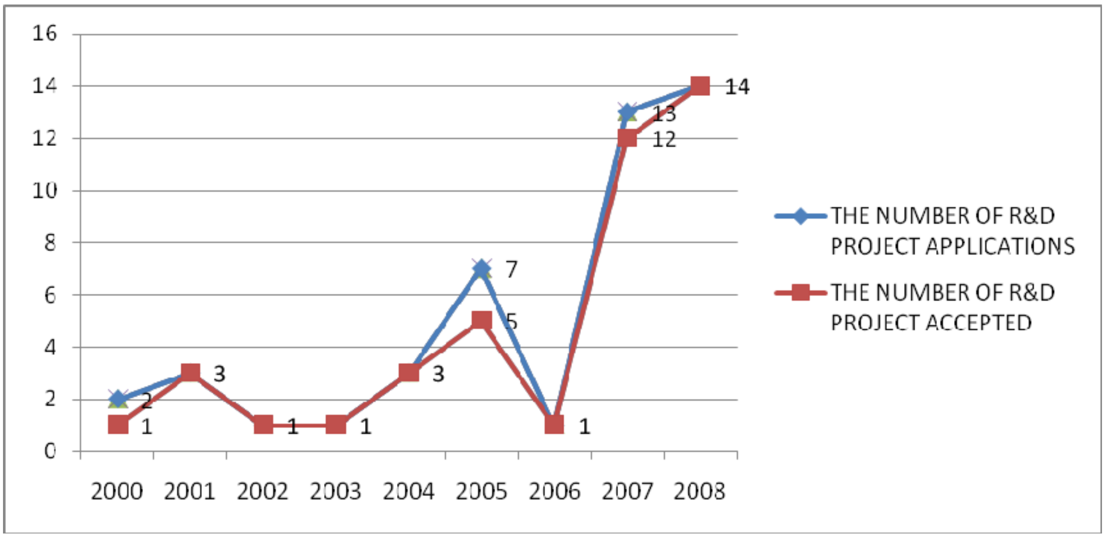


Figure 18: The Number of R&D Projects Applications and The Number of Accepted R&D Projects (TUBITAK-TEYDEB)

Source: TUBITAK-TEYDEB data

As it is seen from the Figure 18, the number of R&D projects done by pharmaceutical firms is not straight until 2006. However, after 2006 there become big increase in the R&D project applications and the number of project accepted. This shows that in 2000-2006 firms do not engage in R&D activities too much and may not be aware of the incentives programs well. After 2006, firms may become more conscious about the incentives programs and R&D activities and they begin to make more R&D activities.

The R&D expenditures of the R&D projects accepted by TUBITAK-TEYDEB are shown in the Figure 19.

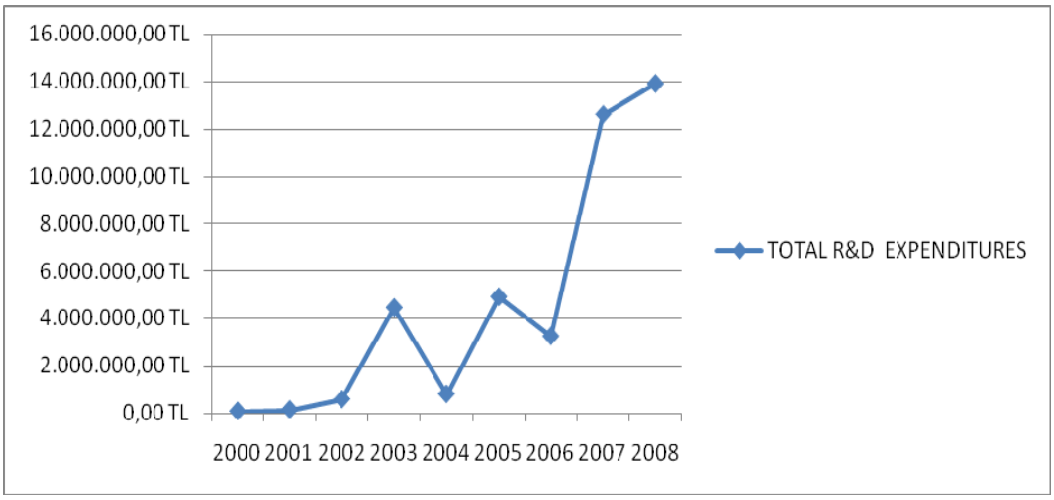


Figure 19: Total R&D Expenditures of the R&D Project Accepted by TUBITAK-TEYDEB

Source: TUBITAK-TEYDEB data

As shown in Figure 19, the R&D expenditures follow the same path with the number of project accepted. After 2006, the R&D expenditures increases too much in parallel with the number of R&D projects accepted.

There may be many reasons behind the increase in R&D expenditures of pharmaceutical firms. Pharmaceutical industry is an industry that needs the most R&D activities among other industries. In a competitive environment, firms in the pharmaceutical sector have to make progress continuously and in order to provide this; they have to engage in R&D activities. R&D activities of pharmaceuticals in Turkey increase after 2006. This shows that pharmaceutical firms begin to be aware of the importance of R&D in their market and so R&D culture begins to be existed among them. When firms begin to have R&D culture, they try to hire more R&D personnel. In parallel with the increase in R&D personnel, R&D activities of the pharmaceutical firms increase. The main concern here should be the qualifications of R&D personnel. These personnel should be expert in their subject and should have enough education in the area they work for.

In Turkey, in the recent years, firms have founded R&D centers. To take certificate for these centers they have to fulfill some conditions. First of all, they have to hire minimum 50 full time R&D personnel and they have to engage in R&D activities within the country. These lead firms to hire R&D personnel and to do R&D activities. Through these, R&D activities of firms increase.

In the R&D activities, the coordination between universities and industry is very crucial and important. Universities are the center of scientific and technological research. The research results can be commercialized through industry. Therefore, the coordination between university and industry should be provided. In the recent years, in order to provide university-industry coordination, there have founded some techno parks in Turkey. These are founded aiming to increase the coordination between university and industry, to prevent brain emigration to foreign countries and to increase development level of Turkey. There are 23 techno parks in Turkey which are announced in the website of Industry and Trade ministry of Turkey. (http://www.sanayi.gov.tr/webedit). There were only 2 techno parks in 2002 in Turkey. This number increases from year to year. This is a good sign of giving importance to R&D activities and university-industry relationship.

The increase in R&D activities of pharmaceutical firms in Turkey may also be related to R&D incentives. For R&D activities there are some government incentive programs. TUBITAK, Technology Development Foundation of Turkey (TTGV), Industry and Trade Ministry of Turkey, Small and Medium Enterprises Development Organization (KOSGEB), EU Framework Programs, all give incentives to R&D projects. In addition to these, there are some tax incentives for R&D activities and patent application incentives for the firms. These are, the 5746-the Support of Research and Development Activities Law (Arastima Gelistime Faaliyetlerinin Desteklenmesine Hakkinda Kanun)-numbered law, 5084-the Support of Incentives to Investments and

Employment Law (Yatirimlarin Ve Istihdamin Tesvikine Yonelik Kanun)-numbered law and 5510-Social Insurances and General Health Insurance law-(Sosyal Sigortalar ve Genel saglik Sigortasi)-numbered law, some tax incentives which decreases 80% of income tax of R&D personnel, which decreases 40% R&D expenditures from income tax of firms, firms which make R&D in techno parks are exempt from income and corporate taxes, etc. all these incentives give firms opportunity to do more R&D activities.

The increase in R&D culture, R&D centers, techno parks, university-industry coordination, R&D incentives and tax incentives for R&D activities all may increase the R&D expenditures of pharmaceutical firms applied to TUBITAK-TEYDEB. These can be generalized to the pharmaceutical firms in Turkey.

The trend of R&D projects and expenditures of pharmaceutical firms is increasing. However, are they in good level? Of course, no. The R&D expenditures of the pharmaceutical firms are too low. In pharmaceutical industry huge amount of R&D activities are needed to make any drug. Since R&D expenditures of the firms in this industry is low, it may be interpreted that the firms do not produce new drugs enough and do not engage in R&D activities enough.

As it is seen from the Figures 18 and 19, although pharmaceutical firms taken as a sample in this thesis make progress in term of R&D, they do not engage in R&D activities sufficiently. There may be some reasons behind this. First of all, pharmaceutical industry may not be taken as an important industry for economy. If the population of Turkey and the added value of this sector are thought there should be some special regulations for this industry. However, in Turkey there is no special interest to this sector. The R&D activities of this sector are too low.

Pharmacy faculties are important parameters for pharmaceutical industry. They make research about drug raw materials, investigate for physical, chemical and biological characteristics of these raw materials and they also make research about how to produce qualified drug. Therefore, the number of these faculties and the education in these faculties are very crucial and important for R&D activities in this sector. However, the number of pharmacy faculty in only 12. If the population of Turkey is thought this number is too low.

As mentioned before techno parks are founded in order to provide coordination between university and industry. Among the 23 techno parks, only 3 are founded in the university campuses which have pharmacy faculty. Therefore, the number of techno parks which aim to coordinate university and pharmaceutical sector is too low.

In Turkey, mostly generic drugs are produced. Generic drugs should be bio-equivalent with original drugs. To measure whether generic drug is bio-equivalent with original drugs, bio-equivalence studies are done. There are only 3 institutions in Turkey which make bio-equivalence tests and give bio-equivalence certificate. These are; Erciyes University, Hakan Cetinkaya Good Clinical Practice Center, Ege Uaniversity Drug Development And Pharmacokinetic Practice Center and Yeditepe University Good Clinical Practices Center. Since this number is too low, bio-equivalence tests sometimes are done abroad. This is not a preferable situation and it is a costly process. If the bio-equivalence tests are all done in Turkey their costs would be less and less time consuming.

The percentage of R&D expenditures and export of the firms to the net total sales are the parameters that show the performance of the firms in terms of innovation and foreign trade. In order to see the performance of 20 pharmaceutical firms applied to TUBITAK-TEYDEB the ratio of the R&D expenditures and export to their net sales turnover from the year 2000 to the year 2008 are shown in the Table11.

Table 11: The Percentage of R&D Expenditures and Export in Net Sales Turnover- 20 Pharmaceutical Firms Applied to TUBITAK-TEYDEB in 2000-2008

YEAR	NET SALES TURNOVER	TOTAL R&D EXPENDITURES	EXPORT	PERCENTAGE OF R&D EXPENDITURES IN NET SALES TURNOVER	PERCENTAGE OF EXPORT IN NET SALES TURNOVER
2000	118.761.157,00	840.811,00	3.330.669,00	0,707984851	2,804510401
2001	242.169.033,00	2.642.186,00	7.694.108,00	1,091050316	3,177164274
2002	700.987.066,00	7.501.498,00	19.019.153,00	1,070133582	2,713195995
2003	530.036.092,00	6.291.332,00	16.481.190,00	1,186962944	3,109446743
2004	604.876.170,00	9.991.009,00	35.696.970,00	1,651744522	5,901533532
2005	679.469.084,00	9.715.570,00	15.822.357,00	1,429876683	2,328635308
2006	1.021.745.619,00	5.739.948,00	52.391.072,00	0,561778577	5,127604271
2007	1.289.246.264,00	20.999.382,00	22.517.409,00	1,62881077	1,746556079
2008	1.485.155.891,00	14.376.805,00	132.331.254,00	0,968033395	8,910260182

Source: TUBITAK-TEYDEB data

As shown in Table 11, the percentage of R&D expenditures in net sales turnover does not show a steady trend from 2000 to 2008. However, it becomes more than 1% in general but this a very small figure. It may be interpreted that pharmaceutical firms do not engage in R&D activities enough and they do not allocate enough capital to R&D activities.

In contrast to the percentage of R&D expenditures in net sales turnover, the percentage of export in net sales turnover is high. It either does not show a steady trend but it increases to nearly 9% in 2008. This is a good sign for foreign trade of the firms but this figure is not enough for the economy of the firms and thus the country.

As the data taken from TUBITAK-TEYDEB may help to see the figure of pharmaceutical firms, data taken from TUIK also may help to get information of some pharmaceutical firms in Turkey. Both these data do not show all of the pharmaceutical firms and so they may not show the situation of pharmaceutical firms in wholly, but they may assist to make interpretation about these firms in general.

5.3. R&D Data on Pharmaceutical Firms in Turkey

The data taken from TUIK consists of in average 20 pharmaceutical firms and these are the firms which make either R&D or take grants from any government sector. Although 20 firms is very low to get enough information about the general situation of pharmaceutical firms in Turkey, since these firms are the firms who make R&D and since the number of pharmaceutical firms which make R&D in Turkey is also low, data taken from TUIK may be thought to be enough to give the general situation of pharmaceutical industry in Turkey in terms of R&D expenditures.

The data related to R&D activities of pharmaceutical firms are available from 2003 in TUIK.

Table 12: Average R&D Expenditures of Pharmaceutical Firms Between 2003-2008

YEARS	AVERAGE R&D EXPENDITURES
2003	1.732.123,63
2004	1.676.673,41
2005	2.181.134,95
2006	2.221.305,33
2007	3.061.568,22
2008	3.522.124,58

Source: TUBITAK-TEYDEB data

As it is seen from Table 12, the R&D expenditures of the pharmaceutical firms are not straight and it increases obviously after 2006. This trend is the same with the trend seen from the data taken from TUBITAK-TEYDEB. The reasons behind this rise are mentioned above.

The number of researcher personnel and R&D personnel are important parameters to see whether there are enough personnel to do R&D. Researcher personnel refers to the personnel who is responsible to run the R&D projects. Among the researcher personnel the number of these personnel with doctoral standard is important. Personnel with doctoral standard are seen as more qualified in their subjects that other personnel and they may also be good at using basic research in practice. In the Table 14, the percentage of personnel with doctoral standard to total researcher personnel and percentage of R&D personnel to total personnel are given.

Table 13: The Percentage of Researcher Personnel with Doctoral Standard to Total Researcher Personnel

YEARS	RESEARCHER PERSONNEL WITH DOCTORAL STANDARD	TOTAL RESEARCHER PERSONNEL	PERCENTAGE OF PERSONNEL WITH DOCTORAL STANDARD TO TOTAL RESEARCHER PERSONNEL
2003	10	129	7,75%
2004	11	148	7,43%
2005	16	134	11,94%
2006	10	140	7,14%
2007	21	298	7,05%
2008	37	315	11,75%

Source: TUIK Data

As seen in the Table 13, the number of researcher personnel and researcher personnel wirh doctoral standard in 2008 are the most. This shows that in the recent years, firms begin to make more R&D projects and the personnel begin to improve themselves in their subjects and they begin to have tendency to make basic research and use these in R&D projects. However, the percentage of personnel with doctoral standard to total researcher personnel is still too low since 2003. This percentage should be increased because in pharmaceutical industry, basic research is very crucial to produce drugs and this basic research may be best provided from the inside researchers with doctoral standard.

The number of R&D personnel and the percentage of R&D personnel to total personnel are given in the Table 14. These information is available only for 2006-2008.

Table 14: The Percentage of R&D Personnel to Total Personnel

YEARS	TOTAL R&D PERSONNEL	TOTAL PERSONNEL	PERCENTAGE OF R&D PERSONNEL TO TOTAL PERSONNEL
2006	313	40046	0,78%
2007	397	36194	1,10%
2008	460	37404	1,23%

Source: TUIK Data

As seen in Table 14, the total number of R&D personnel increases from 2006 to 2008 although the number of total personnel decreases in 2007 and it increases not much in 2008. The rise in total personnel is a good sign that pharmaceutical firms begin to engage in R&D more than before. However, the percentage of R&D personnel to total personnel is too low. This shows that although the number of R&D personnel increases this rise is not enough and the number of R&D is still too low in compare to total personnel and this means that R&D activities are not in good level.

As the R&D activities in pharmaceutical industry are very costly, it is important to know the financial sources of the firms which engage in R&D activities. If there is financial support from outside of the firms such as government sector, private sector or abroad, firms are more motivated to do R&D. The more funding from other sources the more R&D activities the firms engage. In the Table 15, the financial support of R&D activities of pharmaceutical firms are given.

Table 15: **Financial Sources of R&D Activities of Pharmaceutical Firms, 2003-2008**

YEARS	TOTAL R&D EXPENDITURES	FINANCIAL SUPPORT FROM GOVERNMENT	FINANCIAL SUPPORT FROM PUBLIC ECONOMIC ENTERPRISES	FINANCIAL SUPPORT FROM PRIVATE SECTOR	FINANCIAL SUPPORT FROM ABROAD
2003	27.713.978	173.358	0	0	0
2004	28.503.448	228.111	0	0	0
2005	41.441.564	300.844	20.000	132.777	0
2006	39.983.496	752.671	0	279.224	0
2007	67.354.501	2.850.719	0	0	535.247
2008	81.008.865	1.256.926	0	0	0

Source: TUIK Data

As it is seen from the Table 15, there are 4 kinds of financial support to R&D projects of pharmaceutical firms. These are; financial support from government, financial support from public economic enterprises, financial support from private sector and financial support from abroad. As it is shown in Table 15, the R&D activities of the pharmaceutical firms are mostly funded by government sector but the support from government cover very small percentage of R&D expenditures of the firms. The support of government sector and private sector should be increased. The government should encourage government sector, public economic enterprises and private sector to support R&D activities of pharmaceutical firms and should give incentives to the firms to benefit from funding abroad.

As firms make R&D and as a result of their R&D activities as they produce new drugs, they need to protect themselves from imitations. Besides, they need to make return from their innovations. In order to fulfill these needs, firms apply for patents. In this respect, it may be interpreted that there is a parallel relationship between patents and R&D expenditures. In pharmaceutical industry, the R&D expenditures are higher than in other industries and so the relationship between R&D expenditures and patents is tighter. In order to see this relationship, it may be beneficial to see the number of patent applications of pharmaceutical firms in Turkey.

Table 16: **The Number of Patent Applications in Turkey in 2003-2008**

Years		The number of patent applications	
	National	Foreign	Total
2003	28	176	204
2004	18	346	364
2005	36	558	594
2006	35	899	934
2007	40	1056	1096
2008	67	1126	1193

Source: TPI

In Table 16, the number of national and foreign patent applications to TPI is given from the year 2003 to the year 2008. Both the national and foreign patent applications increase from year to year. This shows that the R&D activities increase from year to year in Turkey and in other countries. However, there is a huge difference between the number of national and foreign patent applications. National patent applications are too below the foreign patent applications. This may be interpreted that pharmaceutical firms in Turkey do not make enough innovations and so the number of patent applications in pharmaceutical sector is too low. Besides, firms are not informed enough about the patent system and patent system in Turkey improves very soon.

As it is seen the R&D expenditures, R&D personnel and the number of patent applications in Turkey is not in goo level. There should be some regulations to make improvements in these subjects. In the next chapter of this thesis, some policy recommendations are made to show a route to follow for pharmaceutical firms in Turkey.

CHAPTER 6

POLICY RECOMMENDATION TO TURKEY

In a global environment, in order to compete with other countries and have strong economy, countries need to have ability and knowledge to improve technologically. Through the technological improvements, country can gain importance and make progress. In this respect, R&D activities and science are important inputs of technological improvements. On the other hand, patent and innovation are the outputs of technological improvements. Therefore, technology, science, R&D, innovations and patents are all related to each other.

The data related to R&D expenditures, scientific publication, patents and innovations can tell us much about the performance of countries in the globalized world. These data usually differ from industry to industry. In some industries these aspects may have little importance but in some industries they are very crucial. In the industries such as pharmaceutical industry, biotechnology, etc that provide high added value to economy, R&D activities, scientific publications and patents are the main cores of technological development. The main focus of this thesis is on pharmaceutical industry.

In the previous chapters of this thesis, the data related to R&D expenditures, scientific publication, patents are analyzed for Turkey and some selected developed and developing countries mainly in pharmaceutical industry and the situation of Turkey is compared with these countries. It is reached a conclusion that, although Turkey has an increasing trend in terms of R&D activities, scientific publication and patents in pharmaceutical industry, it is not in sufficient level and Turkey has long way to catch these countries. In this chapter of the thesis, some policy recommendations are made for

Turkey, to increase its speed to make progress in pharmaceutical industry in order to adapt the global competitive environment.

In Turkey, in pharmaceutical industry, the R&D expenditures, scientific publications, patent applications are too low. These causes Turkey not to get benefit from pharmaceutical sector which bring high added value to economy. In order to be innovative and make progress in this sector there are some actions to be done.

In pharmaceutical industry, in order to produce any drug, huge amount of R&D activities should be performed. This industry is the only industry that needs the most R&D activities. In order to increase R&D activities, first of all firms should have enough infrastructure and capital to do R&D. They should hire qualified R&D personnel and have enough laboratories and supplies, etc. If the pharmaceutical firms do not have enough capital, some funding programs or some other opportunities such as credits, debts should be provided by governments and business sector. Since R&D is a risky and costly process it is necessary for government or business sector to share these risks with innovate firms. The funding programs and tax incentives may be increased and there may be some extra special incentives for pharmaceutical firms. The innovations done by these firms may be gone under priority areas.

R&D activities are directly related to the degree R&D culture the firms possess. To engage in R&D activities sufficiently, R&D culture is an important aspect. If firms have this culture, they make much effort to do R&D. The diffusion of R&D culture may be provided through making information programs which focus on the importance of R&D, information and knowledge sharing and bringing the firms in the same sector together in order to give them opportunity to share their ideas with each other.

Science is one of the parameter that contributes innovations in pharmaceutical sector. Most of the innovations in this sector are based on the recent scientific studies. In pharmaceutical sector, the main sources of science are pharmacy faculties. In these faculties the researches about drugs are performed. The number of these faculties is too low and this number should be increased. In order to make R&D, the conditions of laboratories of these faculties should be improved and all necessary supplies should be provided.

The transfer of knowledge and information from university to industry is very crucial in order to commercialize scientific results produced by universities. In this respect, there should be tight relationship between university and industry. This can be the most effectively satisfied by techno parks. Techno parks have vital importance for the coordination of university and industry. As in every field of economy, among techno parks there is also competition. Since techno parks are managed by Industry Ministry, the Ministry should encourage more competition between techno parks through revealing the data about R&D activities and R&D personnel number and the number of patent applications, etc of these techno parks. This practice encourages techno parks to make technological improvements. Moreover, the number of techno parks in Turkey is not enough. In order to get the highest benefit from techno parks for pharmaceutical industry, the number of techno parks within the universities which have faculty of medicine and faculty of pharmacy should be increased. It is costly to found techno parks and in the foundation process they need financial support. Therefore, government should fund techno parks and make effort to raise the number of them.

There are firms which have innovative ideas and want to put their ideas in practice through techno parks but do not have enough capital. For these firms there should be some funding programs driven by government or private sector. If there no support is provided to these firms, they may coordinate with foreign firms and put their ideas in life abroad. This is a loss for Turkish economy and the aim here should be to prevent brain migration and to benefit from smart brains within Turkey.

The education system of Turkey is also an important parameter in the development level of pharmaceutical industry. If the education system is improved enough and if there are sufficient supplies and laboratories in universities, the scientific research can be done easier and more research may be performed. In Turkey, the condition of universities should be improved and enough supplies should be provided in order to make scientific research. Since these conditions are not well enough many graduate students go abroad for master and doctorate programs. These students contribute to foreign economies with their scientific studies and scientific publications. Turkey should provide these students sufficient conditions for education and keep them in home. Through this, the number of scientific studies increase and the number of scientific publications also increases.

Most of the innovations in pharmaceutical industry have their roots in basic research in other words basic research is an important input of innovations in pharmaceuticals. The number of scientific research in this field is very low in Turkey. This number is critically important and should be increased. Turkey can succeed this through keeping qualified researchers in Turkey and motivate students to attend to doctorate programs thus to make basic research.

In Turkey, the main focus of pharmaceutical industry is producing generic drugs. These drugs should be bio-equivalent with original drugs. The bio-equivalence tests should be performed for each generic drug. There are only 3 laboratories in Turkey that do these tests. Since these laboratories are not enough, bio-equivalence tests are mostly made abroad. In addition to this, most of the raw materials for drugs are imported. Therefore, in can be interpreted that Turkey is dependent to foreign countries in producing generic drugs. More research should be done to find out raw materials of drugs in house and the number of laboratories should be increased. Government and private sector should give support in order to fulfill these needs.

In pharmaceutical industry, since it is very costly and time-consuming to produce any drug, there should be some regulations to protect innovators to make return from their inventions. Patents are the main tool that protect innovations from imitations and thus provide innovators to earn benefit from their findings. They also play important role in spurring innovation and encouraging the disclosure and commercial development of inventions. However, the number of patent applications in pharmaceutical sector in Turkey is too low. This shows that the importance of patents may not be known well among pharmaceutical firms and it is costly to apply for patents. There should be some information programs that focus on the importance of patents and patent procedures. Moreover, there is only one patent incentive program which is driven by TUBITAK and TPI. This is not enough to motivate firms to make more patent applications. The number of these incentive programs should be increased and there should be some special funding for patent applications pharmaceutical firms.

Lastly, motivation is an important tool for people to make them show more performance in their specialty field. Therefore, for researchers this situation is the same. If they are motivated more in terms of money or any other appreciation methods, they may be more productive. There are some prize incentives for scientific researchers in Turkey. These prizes may be improved for researchers in pharmaceuticals.

All these recommendations can be done through some governmental regulations and policy improvements. If these suggestions are put in life, the R&D activities, the number of scientific publications and the number of patent application thus innovations in pharmaceutical industry may raise automatically. Turkey may catch a level of competing in this sector in the world.

CHAPTER 7

CONCLUSION

In a globalized world, the competitiveness is a focal point of the nations. In the competitive environment, nations need to be innovative in order to live long and be among developed countries. To be innovative it is essential to engage in R&D activities and use scientific knowledge. To make return from inventions, it is needed to protect inventions. Patent is the main tool to protect inventions. Therefore, there is close relationship between R&D expenditures, innovation, basic research and patents.

The strength of interrelation between R&D expenditures, innovation, basic research and patents differ from industry to industry and it is the tightest in pharmaceutical industry.

In the pharmaceutical industry, the cost of R&D is too high and so innovation in this industry is very costly. Therefore, it is very crucial to protect the innovations in the pharmaceutical sector and patent protection is the most preferable tool for this protection need.

The starting point of this thesis study is to analyze the situation of pharmaceutical firms in Turkey in terms of patents, R&D and basic research. This analyze is done by comparing Turkey with three developed countries which are the triadic patent families USA, EU and Japan and three developing countries, India China and Korea.

At first, the R&D expenditures in pharmaceutical sector in Turkey is analyzed and compared with the selected countries mentioned above. It is found out that Turkey has the lowest R&D expenditures than these selected countries. This means there is not enough R&D activities done by pharmaceutical firms in Turkey.

Secondly, the basic research performance of pharmaceutical sector in Turkey is compared with the selected countries. The number of publications in pharmaceutical is the lower in Turkey than in the selected countries.

As mentioned before, patents are very significant tool for pharmaceutical industry. The empirical studies show that the need for patents to protect innovation is the highest in pharmaceutical sector. Patents have direct relationship with R&D expenditures, innovation and basic research in pharmaceutical industry. If R&D expenditures increase the number of patent application also increases. This situation is vital for innovation and the number of publications.

In Turkey, all R&D expenditures, the number of publication and patents are too low in pharmaceutical industry. This shows that Turkey is not strong enough in pharmaceutical sector. The innovation in this sector is too low and this is a big loss for Turkish economy because pharmaceutical sector is a sector that has high added value. Therefore, it is very crucial to pay close attention to this sector and to innovate in this sector. For these reasons some policy recommendations are made for Turkey.

This thesis gives some policy recommendations for Turkey to be innovative in pharmaceutical industry through comparing Turkey with three developed and three developing countries in terms of R&D, basic research and patent applications. Some significant policy recommendations are given in chapter 6 of this thesis. The main objectives of Turkey should be to provide infrastructure and capital for pharmaceutical industry in order to engage in R&D activities. To do R&D firms need to hire qualified R&D personnel. Besides, science is an important parameter to do R&D. thus scientific knowledge should be well used by firms in their innovation activities. In addition, patent system should be strengthened and firms should be aware of how to use this system. These are the main things to be done to improve in pharmaceutical sector in Turkey.

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APPENDICES

Appendix A: Gross domestic expenditure on R&D as a percentage of GDP

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Australia	..	1,48	..	1,53	..	1,61	..	1,47	..	1,51	..	1,69	..	1,78	..	2,01	..
Austria	1,44	1,42	1,44	1,51	1,55	1,6	1,7	1,78	1,9	1,94	2,07	2,14	2,26	2,26	2,44	2,46	2,56
Belgium	1,58	..	1.66 |	1,65	1,67	1,77	1,83	1,86	1,94	1,97	2,08	1,94	1,88	1,87	1,84	1,88	1,89
Canada	1,57	1,62	1,68	1,73	1,7	1,65	1,66	1,76	1,8	1,91	2,09	2,04	2,03	2,05	2,01	1,94	1,89
Czech Republic	..	..	..	..	0.95 |	0,97	1,08	1,15	1,14	1,21	1,2	1,2	1,25	1,25	1,41	1,55	1,53
Denmark	1,61	1,64	1,72	..	1,82	1,84	1,92	2,04	2,18	..	2,39	2,51	2,58	2,48	2,45	2,46	2,54
Finland	2.00 |	2,1	2,14	2,28	2,26	2,52	2,7	2,86	3,16	3,34	3,3	3,36	3,43	3,45	3,48	3,45	3,47
France	2,32	2,33	2,38	2,32	2,29	2,27	2.19 |	2,14	2,16	2.15 |	2,2	2,23	2,17	2.15 |	2,1	2,1	2,08
Germany [1]	2.47 |	2,35	2,28	2,18	2,19	2,19	2,24	2,27	2,4	2,45	2,46	2,49	2,52	2,49	2,48	2,54	2,53
Greece	0,32	..	0,42	..	0.43 |	..	0,45	..	0,6	..	0,58	..	0,57	0,55	0,58	0,57	0,57
Hungary	1,04	1,03	0,95	0.87 |	0,71	0,63	0,7	0,66	0,67	0,78	0,92	1	0,93	0.88 |	0,94	1	0,97
Iceland	1,15	1,32	1,33	1,37	1,53	..	1,83	2	2,3	2,67	2,95	2,95	2,82	..	2,77	..	..
Ireland	0,92	1,02	1,16	1,25	1,26	1,3	1,27	1,24	1,18	1,12	1,1	1,1	1,17	1,24	1,26	1,32	1,36
Italy	1.19 |	1,15	1,1	1,02	0,97	0,99	1.03 |	1,05	1,02	1,05	1,09	1,13	1,11	1,1	1,09	1,14	..
Japan [2]	**2,78**	**2,72**	**2,65**	**2,6**	**2,71**	**2.81 |**	**2,87**	**3**	**3,02**	**3,04**	**3,12**	**3,17**	**3,2**	**3,17**	**3,32**	**3,39**	**..**
Korea [3]	**1,84**	**1,94**	**2,12**	**2,32**	**2,37**	**2,42**	**2,48**	**2,34**	**2,25**	**2,39**	**2,59**	**2,53**	**2,63**	**2,85**	**2,98**	**3,22**	**..**
Luxembourg	..	..	..	..	..	..	..	..	..	1,65	..	..	1,66	1,63	1,57	1,66	1,64
Mexico	..	..	0,2	0,27	0,28	0,28	0,31	0,34	0,39	0,34	0,36	0,4	0,4	0.43 |	0,46	..	..
Netherlands	1,96	1,89	1,91	1.95 |	1,97	1.98 |	1,99	1,9	1,96	1,82	1,8	1,72	1,76	1,78	1,74	1,73	1,73
New Zealand	0,97	1.00 |	1,01	..	0,95	..	1,09	..	1	..	1.14 |	..	1,19	..	1,16	..	..
Norway	1,62	..	1,7	..	1.69 |	..	1,63	..	1,64	..	1,59	1,66	1,71	1,59	1,52	1,52	1.57 |
Poland	0,74	0,76	0,76	0,7	0.63 |	0,65	0,65	0,67	0,69	0,64	0,62	0,56	0,54	0,56	0,57	0,56	..

Portugal	0,54	0,58	0,58	0,56	0,54	0,57	0,59	0,65	0,71	0,76	0,8	0,76	0,74	0,77	0,81	1	1,18
Slovak Republic [4]	2,1	1.76 |	1,35	0.89 |	0,92	0,9	1.07 |	0,78	0,65	0,65	0,63	0,57	0,58	0,51	0,51	0,49	0,47
Spain	0,82	0.86 |	0,86	0,79	0,79	0,81	0,8	0,87	0,86	0,91	0,91	0,99	1,05	1,06	1,12	1,2	..
Sweden [5]	2,67	..	3.11 |	..	3.26 |	..	3,48	..	3,61	..	4,17	..	3,85	3,62	3.80 |	3,74	3,63
Switzerland	..	2,58	..	..	..	2,65	..	..	..	2,53	..	..	..	2,9	..	..	..
Turkey	**0,39**	**0,36**	**0,33**	**0,27**	**0,28**	**0,34**	**0,37**	**0,37**	**0,47**	**0,48**	**0,54**	**0,53**	**0,48**	**0,52**	**0,59**	**0,58**	**..**
United Kingdom	2,06	2.01 |	2,04	2	1,94	1,86	1,8	1,79	1,86	1,85	1,82	1,82	1,78	1,71	1,76	1,78	..
United States [6]	**2,71**	**2,64**	**2,52**	**2,42**	**2,51**	**2,55**	**2,58**	**2.61 |**	**2,66**	**2,75**	**2,76**	**2,66**	**2,66**	**2,59**	**2,62**	**2,66**	**2,68**
EU27 total	**..**	**..**	**..**	**..**	**1,67**	**1,66**	**1,67**	**1,67**	**1,72**	**1,74**	**1,76**	**1,77**	**1,76**	**1,73**	**1,74**	**1,77**	**..**
OECD total	2.18 |	2,14	2,09	2,04	2.06 |	2,08	2,1	2,13	2,17	2,21	2,25	2,22	2,22	2,19	2,23	2,26	..
Brazil [7]	..	..	..	0,85	0,8	0,72	..	..	..	0,94	0,96	0,91	0,88	0,83	0,97	1,02	..
Chile	..	..	..	..	..	..	..	..	..	..	..	0,68	0,67	0,67	..	..	..
China [8]	**0,73**	**0,74**	**0,7**	**0,64**	**0,57**	**0,57**	**0,64**	**0,65**	**0,76**	**0.90 |**	**0,95**	**1,07**	**1,13**	**1,23**	**1,33**	**1,42**	**1,49**
Estonia	..	..	..	..	..	..	..	0,57	0,69	0,61	0,71	0,72	0,77	0,86	0,93	1,14	1,12
India [9]	**0,77**	**0,79**	**0,71**	**0,65**	**0,63**	**0,65**	**0,72**	**0,73**	**0,76**	**0,78**	**0,76**	**0,75**	**0,74**	**0,71**	**..**	**..**	**..**
Israel [10]	2,5	2,57	2,68	2,68	2,62	2,8	3,07	3,21	3,69	4,45	4,76	4,75	4,44	4,41	4,51	4,53	4,74
Russian Federation	1,43	0,74	0,77	0,84	0,85	0,97	1,04	0,95	1	1,05	1,18	1,25	1,28	1,15	1,07	1,07	1,12
Slovenia	..	..	1,6	1,76	1,55	1,31	1,29	1,36	1,39	1,41	1,52	1,49	1,29	1,42	1,46	1,59	1,58
South Africa [11]	0,84	..	0,61	..	..	..	0,6	..	..	..	0,73	..	0,8	0,86	0,92	0,95	..

1 *The data for Germany cover unified Germany from 1991 and western Germany only until 1990.*

2 *Series for Japan adjusted until 1995.*

3 *In Korea, social sciences and humanities are excluded from the R&D data.*

4 *For the Slovak Republic, data before 1994 refer to the Research and Development Base (RDB) and cover the whole activity of institutions and not only R&D. Defence R&D was totally excluded until 1997 and only partially included thereafter.*

5 *Until 2005, R&D data for Sweden excluded R&D activities of State and local governments; SMEs were not fully covered, and prior to 1993 the surveys in the Business Enterprise, Government and Private Non-Profit sectors excluded R&D in the social sciences and humanities.*

6 *For the United States, capital expenditure is not covered and R&D conducted by state and local governments is excluded.*

7	*For Brazil, data for the business enterprise sector are collected through innovation surveys with very low response rates and are likely to be underestimated. Data for the government sector and the higher education sector are estimated using budgetary information and are probably underestimated as well.*
8	*Before 2000, data for the business sector in China covered large and medium-sized enterprises only, hence the R&D data were underestimated.*
9	*The higher education sector and the small-scale industry sector of India are only partially covered. Data for 2003-4 and 2004-05 were estimated by applying sector-wise growth rates for the period 1998-99 to 2002-03.*
10	*Defence excluded. For technical reasons, this database uses Israel's official statistics, which include data relating to the Golan Heights, East Jerusalem and Israeli settlements in the West Bank.*
11	*Due to the lack of a comprehensive business register in South Africa, R&D expenditure may be underestimated by 10% to 15%.*

Source: OECD, 2009 (OECD Factbook 2009: Economic, Environmental and Social Statistics)

Appendix B: R&D expenditure as a percentage of GDP, by sector of performance,

	All sectors			Business enterprise sector			Government sector			Higher education sector		
	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006
EU-27	1.83 s	1.84 s	1.84 s	1.17 s	1.16 s	1.17 s	0.24 s	0.25 s	0.25 s	0.40 s	0.40 s	0.40 s
BE	1.87	1.84	1.83 p	1.29	1.25	1.24 p	0.14	0.15	0.16 p	0.41	0.41	0.41 p
BG	0.50	0.49	0.48	0.12	0.10	0.12	0.33	0.32	0.31	0.05	0.05	0.05
CZ	1.25	1.41	1.54	0.79	0.91	1.02	0.26	0.26	0.27	0.18	0.23	0.25
DK	2.48	2.45	2.43 p	1.69	1.67	1.62 p	0.17	0.16	0.16 p	0.61	0.60	0.63 p
DE	2.49	2.48	2.53 p	1.73	1.72	1.77	0.34 i	0.35 i	0.35 p	0.41	0.41	0.41 p
EE	0.86	0.93	1.14 p	0.34	0.42	0.51 p	0.11	0.10	0.15	0.39	0.38	0.46
IE	1.24	1.26	1.32 p	0.81	0.82	0.89 p	0.09	0.09	0.09	0.33	0.34	0.34
EL	0.55 e	0.58	0.57 e	0.17 e	0.18	0.17 e	0.11 e	0.12	0.12 e	0.27 e	0.28	0.27 e
ES	1.06	1.12	1.20	0.58	0.60	0.67	0.17	0.19	0.20	0.31	0.33	0.33
FR	2.15 b	2.12	2.09 p	1.36 b	1.32	1.32 p	0.37	0.37	0.36 p	0.40 b	0.40	0.38 p
IT	1.10	1.09	:	0.52	0.55	0.54 p	0.20	0.19	0.19 p	0.36	0.33 b	:
CY	0.37	0.40	0.42 p	0.08	0.09	0.09 p	0.13	0.13	0.12 p	0.13	0.16	0.18 p
LV	0.42	0.56	0.70	0.19	0.23	0.35	0.08	0.10	0.11	0.15	0.23	0.24
LT	0.76	0.76	0.80	0.16	0.15	0.22	0.19	0.19	0.18	0.41	0.41	0.40
LU	1.63	1.57	1.47 pe	1.43	1.36	1.25 e	0.18	0.19	0.19 p	0.02	0.02	0.04 p
HU	0.88 b	0.94	1.00	0.36 i	0.41 i	0.48 i	0.26 bi	0.26 i	0.25 i	0.22 i	0.24 i	0.24 i
MT	0.54 b	0.54 p	0.54 p	0.35 b	0.35 p	0.34 p	0.01	0.03	0.03	0.17	0.16	0.18
NL	1.78 pe	1.74 pe	1.67 pe	1.03 p	1.02 p	0.96 p	0.26 i	0.24 i	0.24 i	:	:	:
AT	2.22	2.43 e	2.49 e	1.51	1.64 e	1.66 e	0.11	0.12 e	0.13 e	0.59	0.64 e	0.65 e
PL	0.56	0.57	0.56	0.16	0.18	0.18	0.22	0.21	0.21	0.18	0.18	0.17
PT	0.77 e	0.81	0.83 e	0.28 e	0.31	0.35 e	0.12 e	0.12	:	0.28 e	0.29	:
RO	0.39	0.41	0.45	0.21	0.20	0.22	0.13	0.14	0.15	0.04	0.06	0.08
SI	1.42	1.46	1.59	0.95	0.86	0.96	0.28	0.35	0.39	0.18	0.24	0.24
SK	0.51	0.51	0.49	0.25	0.25	0.21	0.16 i	0.15 i	0.16 i	0.10	0.10	0.12
FI	3.45	3.48	3.45	2.42	2.46	2.46	0.33	0.33	0.32	0.68	0.66	0.65
SE	3.62 i	3.80 b	3.73	2.67 i	2.81 b	2.79	0.11 i	0.18 b	0.17	0.83	0.79 b	0.76
UK	1.71	1.76	1.78	1.07	1.08	1.10	0.18	0.19	0.18	0.42	0.45	0.46
IS	:	2.77	:	:	1.43	:	:	0.65	:	:	0.61	:
NO	1.59	1.52	1.52	0.87	0.82	0.82	0.25	0.24	0.24	0.47	0.47	0.46
CH	2.90	:	:	2.14	:	:	0.03 i	:	0.02 i	0.66	:	:
HR	1.13	1.00	0.87	0.47	0.41	0.32	0.24	0.24	0.23	0.42	0.35	0.32
TR	0.52	0.59	0.58	0.13	0.20	0.21	0.04	0.07	0.07	0.35	0.32	0.30
CN	1.23	1.34	:	0.82	0.91	:	0.28	0.29	:	0.13	0.13	:
JP	3.17	3.32	:	2.38	2.54	:	0.30	0.28	:	0.43	0.45	:
RU	1.15	1.07	:	0.80	0.73	:	0.29	0.28	:	0.06	0.06	:
US	2.58 i	2.61 pi	2.61 pi	1.78 i	1.82 pi	1.83 pi	0.31 i	0.31 pi	0.29 pi	0.37 i	0.37 pi	0.37 pi

CN, JP, RU and US: source OECD-MSTI.

Flag 'i'
DE: includes other classes.
HU: incomplete breadown of R&D expenditure by sector of performance.
SK: defence excluded (all or mostly).
SE: underestimated or based on underestimated data.
SE, CH and US: federal or central government only.
US: excludes most or all capital expenditure.

Source: Eurostat, 2009

Appendix C: The number of patent applications by the field of industry in Turkey

	2000		2001		2002		2003		2004		2005		2006		2007		2008	
	N	F	N	F	N	F	N	F	N	F	N	F	N	F	N	F	N	F
pharmaceuticals, medical chemicals and botany products	22	959	11	1056	15	513	28	176	18	346	36	558	35	899	40	1056	67	1126
fabricated metal products manufacturing except machinery and equipment,	77	84	86	55	135	19	200	21	231	56	340	105	367	153	405	142	413	170
Manufacture of household appliances not elsewhere classified	89	123	112	87	185	57	205	25	285	63	359	110	493	163	522	179	578	206
Manufacture of other special purpose machinery	43	178	71	127	96	75	124	50	163	142	191	194	218	321	266	345	258	411
Furniture Manufacture; not elsewhere classified other manufactures	53	24	91	29	105	22	121	7	185	22	242	41	351	73	368	63	385	65
Main chemicals products	16	409	16	324	20	192	23	62	38	156	59	221	52	358	51	348	72	401

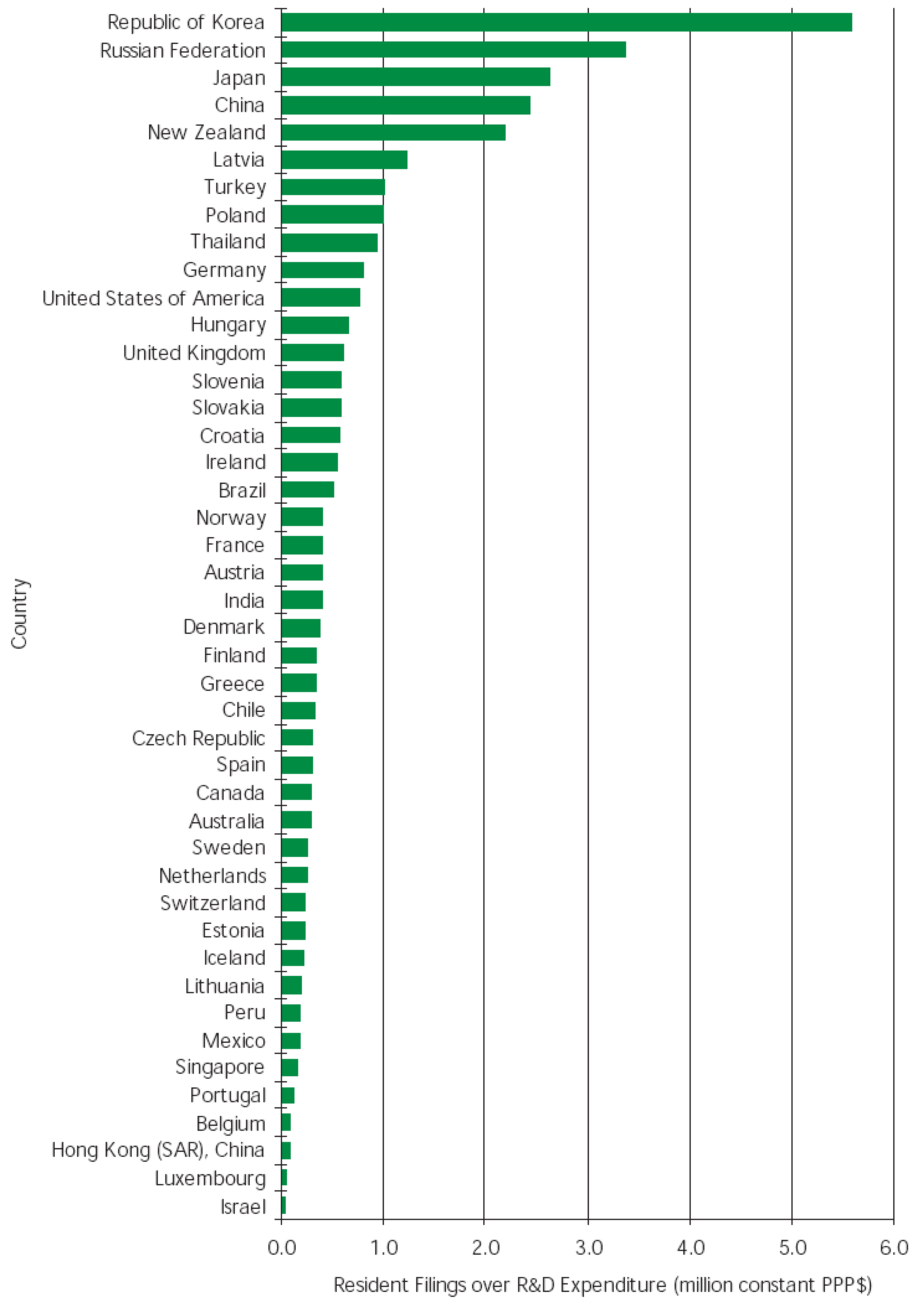
Source: TPE

Appendix D: The Application of Different Countries to the Triadic patent Family in 2001-2007

	2001	2002	2003	2004	2005	2006	2007
Almanya	5662	5513	5720	6022	6014	6090	6146
Fransa	2188	2213	2254	2402	2410	2427	2468
İngiltere	1587	1627	1634	1633	1635	1650	1645
Hollanda	1180	1053	1046	1051	1012	1010	1024
İsviçre	806	806	834	880	890	896	898
İtalya	716	718	703	765	757	766	756
Macaristan	31	28	41	44	38	41	42
Türkiye	**9**	**7**	**8**	**12**	**17**	**19**	**24**
Çek Cumhuriyeti	15	16	16	15	16	17	19
Polonya	10	14	10	16	15	14	18
Yunanistan	6	8	12	9	14	14	14
Portekiz	6	6	7	7	11	11	12
Slovak Cumhuriyeti	2	2	5	3	4	4	4

Source: OECD, Science and Technolgy Basic indicators, 2009/1

Appendix E: Patent fillings per Research and Development Expenditures



Source: www.wipo.org