EVALUATION OF INNOVATION INDICATORS: THE TURKISH CASE AS A DEVELOPING COUNTRY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

AYŞEGÜL GÜNEL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN THE DEPARTMENT OF
SCIENCE AND TECHNOLOGY POLICY STUDIES

MAY 2009

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ABSTRACT

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May 2009, 93 pages

In knowledge society theory, wealth is created by production of knowledge and information which are basic sources of innovation. Innovation has vital importance for providing firms survival and competitive power together with enabling countries sustained economic progress and competitiveness. Because of its importance, measuring innovation becomes necessary for evaluating countries' performance and policymaking. First attempts to develop measurement framework for innovation was achieved by OECD via the Oslo Manual. Then, Latin American and Caribbean countries developed the Bogota Manual. As demonstrated by the Bogota example, industrial structures of developing countries including Turkey differ from the developed ones, which leads to failure of the methods used in developed countries for measuring innovation. In this thesis, the general innovation measurement concept and innovation systems in developing countries are discussed first in order for reflecting national capabilities of Turkey. Then, widely used innovation indicators of investment in R&D, human sources, patents and utility models, scientific publications and high technology exports are evaluated in terms of measurement scale, advantages and disadvantages and inadaptability together with offering basic alternative or complementary solutions when possible and with bringing out points to pay attention if they are bound to be used.

Keywords: Innovation indicators, innovation surveys, measuring innovation

ÖZ

YENİLİK GÖSTERGELERİNİN DEĞERLENDİRİLMESİ:
GELİŞMEKTE OLAN ÜLKE ÖRNEĞİ OLARAK TÜRKİYE

Günel, Ayşegül
Yüksek Lisans, Bilim ve Teknoloji Politikası Çalışmaları
Tez Yöneticisi: Doç. Dr. Teoman Pamukçu

Mayıs 2009, 93 sayfa

Bilgi toplumu teorisine göre zenginlik, yeniliğin (inovasyon) temel girdileri olan bilgi ve enformasyon üretimi yoluyla elde edilmektedir. Hayatta kalabilmek ve rekabet gücü kazanmak açısından firmalar için hayati önem taşıyan yenilik, sürdürülebilir ekonomik kalkınma ve rekabet gücü sağlaması yönünden ülkeler için de çok önemlidir. Bu sebeple, ülke performanslarının değerlendirilmesi ve politika tasarımı bakımından yenilik faaliyetlerinin ölçümü büyük önem kazanmıştır. Yenilik ölçüm çerçevesi ilk kez OECD tarafından Oslo Kılavuzu yoluyla tanımlanmıştır. Daha sonra Latin Amerika ve Karayip ülkeleri Bogota Kılavuzu'nu geliştirmiştir. Bu örnek, gelişmekte olan ülkelerin endüstriyel yapılarının gelişmiş ülkelerden farklı olduğu ve bu sebeple gelişmiş ülkelerde kullanılan yenilik ölçüm yöntemlerinin Türkiye gibi gelişmekte olan ülkelerde sorunlara sebep olacağını göstermektedir. Bu tezde, Türkiye'nin ulusal kapasite ve yeteneklerinin ortaya çıkarılabilmesi için öncelikle yenilik ölçüm kavramı ve gelişmekte olan ülkelerin yenilik sistemleri incelenmektedir. Sonrasında, yaygın olarak kullanılan yenilik göstergeleri (Ar-Ge yatırımı, insan kaynakları, patent ve faydalı modeller, bilimsel yayınlar ve yüksek teknoloji ihracatı) ölçüm çerçevesi, sağladıkları avantajlar, dezavantajlar ve uyumsuz oldukları noktalar açısından incelenip, mümkün olan durumlarda alternatif ya da tamamlayıcı çözümler sunulmakta; mevcut göstergelerin kullanılması zorunlu olduğunda ise dikkat edilmesi gereken noktalar vurgulanmaktadır.

Anahtar Kelimeler: Yenilik göstergeleri, yenilik anketleri, yenilik ölçümü

To My Parents

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor Assoc. Prof. Dr. Teoman Pamukçu for his guidance, advice and insight throughout the research. Correspondingly, I would also like to thank members of the Thesis Jury, Assoc. Prof. Dr. Erkan Erdil and Prof. Dr. Erol Taymaz for their suggestions and comments.

The technical assistance and support of Mr. Can Çetin and Mr. Hadi Tolga Göksidan are sincerely acknowledged.

I am grateful to my parents, Ms. Nejla Günel and Mr. Mehmet Günel and my dear friends, Ms. Selcan Zeren, Ms. Yasemin Aslan, Ms. Çilem Selin Akay, Ms. Işık Erten Özmen, Mr. Mehmet Atasoy, Ms. Özge Barışeri, Ms. Sibel Paksoy, Ms. Dilşad Keskin and Ms. Zeynep Akar Güngör for their invaluable support and encouragements.

Lastly, I would like to thank the Scientific and Technological Research Council of Turkey (TÜBİTAK) for their precious support.

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CHAPTER 1

INTRODUCTION

Throughout decades human beings have faced many milestones that once man dreamed became indispensable part of one's lives. Starting from natural philosophers whose thinking way affected human society in the following periods, invention of printing press became a turning point which accelerated dissemination of knowledge. Toffler (1980) alleges that the world has been shaped by three waves of technological transformation. The first was agricultural revolution and the second was industrial revolution. Industrial revolution was based on revolution in power by means of steam power and energy dependent machinery which concluded in mechanization of industry. Following the industrial revolution, information revolution is the third technological transformation which surrounds us and indicates a new way of living. Vonnegut (1969) and Bell (as cited in Preston, 2001) also claims the existence of a third revolution namely information revolution. Daniel Bell who has significant contributions in this area named the emerging new social order after information revolution as "the post-industrial society" in the year of 1973 (as cited in Preston, 2001) and he later used the term "information society" which was adopted by many scholars.

Information society theory acknowledges "information" as a basic resource in technological, economic, occupational, spatial and cultural aspects (Webster, 2002). Bell also propounded that changing role of knowledge and information was the base of fundamental change in social and industrial structures (Preston, 2001). Depending of this idea, the term of "knowledge economy" arises as an economic counterpart of information society where wealth is created by production of knowledge and information. As a result, it is clear that knowledge is a thing to be marketed in today's world (Capurro, 1996). It is done by **innovation** where technology and science-based theories play a primary role in present-day industry. Innovation differs from invention in that invention is developing a new idea whereas innovation is the commercial application of that idea on the market.

Innovation has the central importance for firms' survival in rapidly changing competitive environment by changes and developments on products, services and manufacturing processes. It does not only provide competitive advantage for firms or individuals, but also for countries. Innovation is very important for increasing the wealth of nations and improving the quality of life. It is the centre for economic progress and very critical to accelerate or sustain economic growth for countries. (Freeman and Soete, 1997).

Since positive effect of innovation on economy is widely accepted, content of this economic impact has become very important. Studies on innovation from economic perspective have changed the definition and scope of innovation in time. So, understanding of innovation comprehensively rises. This is done by measuring innovation which enables policymakers to design more effective policies and to monitor their impact over time (Goedhuys et al., 2005).

During 1980's and 1990's statistical measurement gained importance and in 1992 it was concluded in a standardized manual on technological product and process innovation by OECD (Organization for Economic Co-Operation and Development) namely Oslo Manual. The Oslo Manual prepared a baseline for the Community Innovation Survey (CIS) carried on European Union (EU) member states in order for comparing innovation performances of countries. In 1997 the Oslo Manual was revised comprising also service sector. Lastly in the year of 2005, third edition of the Manual was published expanding the content including organizational and marketing innovation. During these years it was continued to apply CIS repeated every four years also enriching its content. Using outcomes of CIS, reports on innovation activities of countries have been published by international organizations like OECD. In the year of 2000, the EU developed an index namely European Innovation Scoreboard (EIS) evaluating the innovation performances of member states depending on a composite indicator. The methodology of this annual scoreboard changed in years and included also candidate countries and world's leading countries.

These studies set an example for non-OECD and non-EU countries like Malaysia, Thailand, South Africa and Latin American countries and they conducted their own innovation surveys most of which depending on Oslo Manual (Polcuch et al., 2005). Latin American and Caribbean countries prepared a new manual, the Bogota Manual, considering different characteristics of innovation in their region in the year of 2001.

Taking the Latin American example into account, industrial structure of developing countries differs from developed ones which leads to failure of the methods used in developed countries. As an example, some indicators for developing countries become meaningless for developed countries since they provide countrywide access for these indicators like internet access. Actually, this leads to misunderstanding since developed and developing countries were evaluated in the same framework like in EIS. On account of these reasons, some parts of internationally used innovation indicators are not suitable for Turkey as a developing country.

This study aims at evaluating widely used innovation indicators by defining what and how they measure, advantages and disadvantages of using these indicators in general and inadaptability of substantial part of these indicators particularly in order to measure and reflect national capabilities of Turkey. It is an indispensible fact that most of innovation indicators investigated in this study are being used and going to be used mostly for benchmarking country performances. It may not be possible to change this picture in the near future in international arena. However, it is possible to determine a set of national innovation indicators to assess Turkey's performance. This study prepares a base for such kind of future studies by bringing out points to pay attention if the present innovation indicators are bound to be used and by offering basic alternative or complementary solutions when possible.

In order for obtaining the intended objectives, it is needed to provide concept integrity firstly. So, the thesis starts with basic definitions and frameworks. Innovation and the notion of innovation are defined from the historical perspective revealing changes and development of the concept beginning from Schumpeter's approach. It is given by models of innovation in six generations starting with black box to linear model and ended by innovation milieu based on networking and linkages. Following, open innovation model is defined to emphasize the complex nature of innovation. Along with defining the national innovation system and emphasizing the importance of innovation for firms and other actors in the system, the requirement of measurement emerges. Measurement in national level is critically important for a country in order for monitoring innovation performance of the country and developing policies for competitiveness. Because of these reasons it is necessary that measurements be objective and the indicators enabling measurement allow comparison between countries. This is obtained by standardized manuals. The Oslo and the Bogota Manuals are also explained in the chapter followed by surveys they guide: the Community Innovation Survey and the surveys conducted in Latin American and Caribbean countries. The chapter ends with comparison of these two surveys in content.

Differences in coverage of innovation surveys in developing countries arise from different characteristics of innovation environment in those countries. Because of this, Chapter 3 defines innovation systems in developing and emerging countries in detail. There are many factors affecting innovation caused by economic instability in the country and/or unconsciousness about innovation by firms. These factors are investigated in the chapter and characteristics of innovation are exposed. Because of the difference of technical change definition in developed and developing countries the “learning” concept is developed and the term of *National Innovation System* in industrialized countries is defined as *National Learning System*. However, it is not fair to generalize all developing and emerging countries in the same category. The countries have different learning capabilities depending on their characteristics and infrastructures and hence innovation is perceived differently. Because of these distinctions, all countries follow different paths for development.

After defining the innovation systems in developing countries, the Turkish case is taken and evaluated as developing country example in the Chapter 4. Firstly, indicators’ role on policy formulation and assessment is considered. Next, STI formulation of Turkey is described. Then, mostly used internationally comparable innovation indicators under the headings of input, output and performance indicators are given. Performance indicators depending on Community Innovation Survey output are not discussed in this section since they do not provide comparison between years and even countries. Instead, research and development expenditures, science, technology and innovation human resources, patents, scientific publications and high-technology exports are examined in terms of reflecting Turkey's capability. Each indicator is explained with general discussions and advantages and/or disadvantages of using these indicators for Turkey are discussed in this chapter.

Finally, the study is concluded with summing up and general evaluation proposing points to pay attention while using innovation indicators and alternatives.

CHAPTER 2

MEASURING INNOVATION

As it is mentioned in the previous chapter, knowledge is the ultimate key to create new values from the ideas and connect them to the market thorough new goods or services or thorough new ways of design, production and/or delivery which is called innovation (Soete, 2006). More detailed and worldwide accepted definition of innovation is "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (Oslo Manual 3rd edition, 2005).

Although knowledge's being created, nurtured and used for competitive advantage gained importance after widespread use of information technologies, the generation and exploitation of knowledge has long been accepted as essential for the economic growth (Arundel et al., 2006). The first person who is very influential in explaining economic development by innovation was Joseph Schumpeter in the year of 1934. He revealed a process called "creative destruction" defining new technologies' replacing the old in the innovation process. Schumpeter defined "radical innovation" creating major disruptive changes, and "incremental innovation" continuously advancing the process of change. In Schumpeter's view there were five types of innovation (Oslo Manual 3rd edition, 2005):

- *Introduction of a new product*
- *Introduction of a new method of production*
- *Opening of a new market*
- *Development of new sources of supply for raw materials or other inputs*
- *Creation of new market structures in an industry.*

Schumpeter's theory of innovation was developed by Neo-Schumpeterian economists and continued to develop and expand suitable with economic conditions. However, models to explain innovation mostly deals with product and process innovation different from the Schumpeter's approach. Marinova and Phillimore (2003) focus on six generations of models:

- **First Generation – The Black Box Model:** It leans upon Solow's Total Factor Productivity Model (1957) which alleges that determinants of economic growth are technological progress together with, but separated from labor and capital. However, technology seems like a black box and the only thing that counts are its inputs and outputs, not the innovation process itself. This model also becomes identical with R&D components of innovation.

- **Second Generation – Linear Models:** After the 1960s the black box of innovation is opened and the innovation process draws attention. However, the process is defined as 'technology/science push' model first and linear 'need pull' model afterwards. Rothwell and Zegveld (as cited in Marinova and Phillimore, 2003) define step sequences as follows which are now accepted as away from reality:

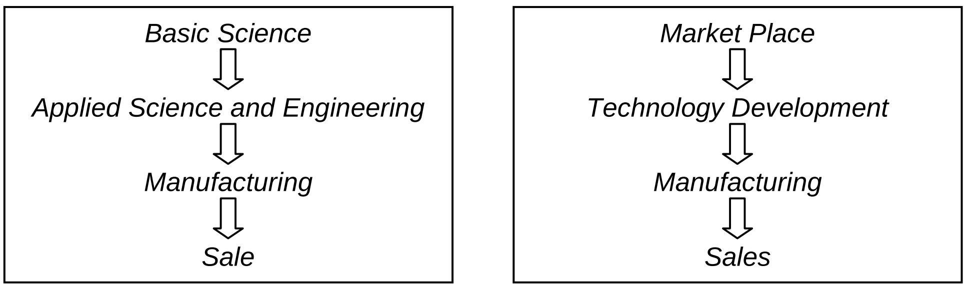


Figure 2.1 "Linear technology/science push" and "need pool" models of innovation.

Source: Rothwell and Zegveld as cited in Marinova and Phillimore, 2003

- **Third Generation – Interactive Models:** Because of linear models' being so simple and away from being explanatory, the interactive models are developed containing complex interactions in the process. It is defined by Rothwell and Zegveld (as cited in Marinova and Phillimore, 2003) as stages below:

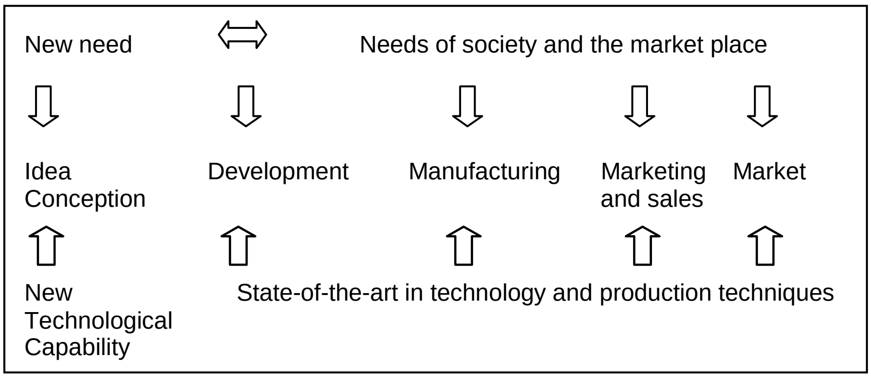


Figure 2.2 Interactive model of innovation

Source: Rothwell and Zegveld as cited in Marinova and Phillimore, 2003

- **Fourth Generation – Systems Models:** Innovation is not necessarily made only in-house. On the contrary it requires interaction and cooperation with firms forming a network. The most important system model is recognized as the National Innovation System.

- **Fifth Generation – Evolutionary Models:** Evolutionary model of technological change challenges traditional economic theory of market equilibrium and complete information. In order for innovation to occur in a market economy imperfections are required and innovation is done under uncertainty. The main feature of this model is how decisions are made and how the participants interact to produce innovation.

- **Sixth Generation – Innovative Milieu:** This model is based on networking and linkages, but in the framework of regional clusters of innovation. Innovation milieu explains the success of small and medium-sized enterprises by their supporting network operation. It also emphasizes on innovative firms in the same territory have a similar culture in knowledge developing and different ones have a different pattern.

It is seen that innovation is a complex process where different actors are involved in different stages of knowledge creation. This idea leads to the paradigm of **Open Innovation** which is developed by Henry Chesbrough in the year of 2003. Chesbrough (2006) defines Open Innovation as “use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". This means that the source of useful knowledge creating research and development is not solely the firm itself, as well as the other firms. Similarly, the knowledge is distributed not only inside the firm but also outside the firm by licensing and the similar. Visual representations of both models are shown in the figures 2.3 and 2.4.

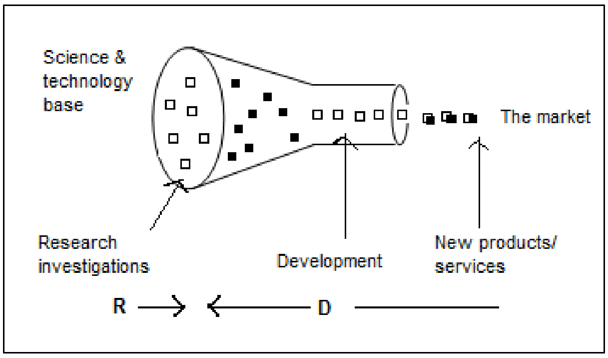


Figure 2.3 The closed innovation model

Source: Chesbrough, 2006

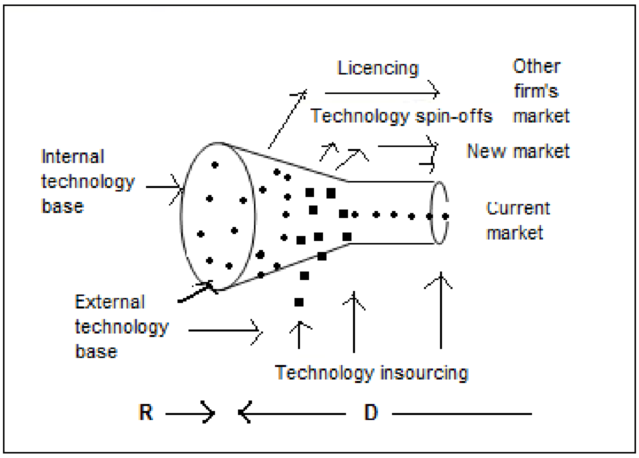


Figure 2.4 Open innovation model

Source: Chesbrough, 2006

It is seen that there is an important public dimension to innovation (Smith, 2006). It is a social activity performed in an environment comprising of competitors, suppliers, public authorities, and so on. According to studies of OECD (National

Innovation Systems, 1997), overall performance of an economy do not depend highly on specific institutions, but much on how they interact with each other on knowledge creation and use. All these actors and their interaction form a system called “National Innovation System” (NIS). Although the idea of NIS was first introduced by Christopher Freeman in 1987, the first person using the expression “National System of Innovation” was Bengt-Åke Lundvall. In 1992, Lundvall defined it as *“... the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state.”* (as cited in Freemen, 1995). Taymaz (2001) classifies the institutions of NIS in six groups as firms, research institutes, scientific and educational institutes, financial institutes and policymakers.

Along with understanding the importance of innovation for firms and nations, measuring innovation becomes necessary. Measuring occurs at two levels: firm and national level. Firm level measurement is subject to organization’s self control. Although it is done by benchmarking, efficiency estimation and similar purposes, there is no standard common technique. Measuring innovation at the national level is very important in that technological innovation is believed to be one of the main drivers for sustained economic growth (Grupp and Mogee, 2004). However, it can be said that national level measurement rises with the framework of NIS. NIS’s efficiency is provided by public policy as well as institutions’ interaction. So, the key level of measurement is to help in the formulation of public policy (Sloan, 2005). In order for policy development and monitoring their impact, national level of measurement is required.

2.1. Standardized Manuals

Beginning from 1960s, the OECD has been involved in measuring science and technology. The OECD was formed in the year of 1961, and following year the Directorate for Scientific Affairs was involved in the problem of measuring research and development systematically (Arundel et al., 2006). In 1963, the *Proposed Standard Practice for Survey of Research and Experimental Development*, namely the **Frascati Manual** was discussed and accepted in Frascati, Italy. The first version of the manual tried to handle the problem of measuring resources devoted to research and experimental development (R&D). Within years the manual was revised and the 6^{th} edition was published in the year of 2002.

The success of the Frascati Manual gave rise to a series of similar methodological and statistical guidelines which are referred as to *Frascati Family* (Arundel et al., 2006). These are the manuals for measuring technological balance of payments, patents, innovation (the Oslo Manual), human resources devoted to science and technology (the Canberra Manual) and the similar.

The **Oslo Manual** is a standard guideline developed jointly by Eurostat – Statistics Office of the European Commission and the OECD. The Manual covers instruction for collecting and interpreting innovation data which forms the CIS. Since measuring innovation has been a new and developing term, the Oslo Manual has attracted attention from not only OECD members, but also non-OECD countries.

Beginning from 1992 non-OECD countries started to conduct innovation surveys similarly including Latin American countries. Sometime later, they started to discuss adapting the Oslo Manual for Latin American countries. As a result of intense work, the **Bogota Manual** arose.

Similarly, the African countries dealt with conducting their own innovation survey and developed **NEPAD Methodological Study** for this purpose. However, since it is not easy to reach reliable and comparable information on African countries, the NEPAD study will be skipped and the Oslo and Bogota Manuals will be investigated in detail.

2.1.1. The Oslo Manual

The Oslo Manual – *Guidelines for Collecting and Interpreting Innovation Data* is very important on defining a measurement framework for innovation which does not have a long history. This section presents summary information on content of the Manual stressing on important characteristics of innovation for measurement purposes.

The Oslo Manual was first published in the year of 1992. Focus point of the first edition was technological product and process innovation in manufacturing. The first guideline in defining innovation environment and measurement became really influential and it became a basis for large scale innovation surveys such as the CIS organized by EU and Australian and Canadian surveys.

Outcomes of the first CIS necessitated revision of the Manual. For this reason, second edition was published in 1997. The second edition similarly limited the definition by technological product and process innovation. However, it broadened the cover of industries including services together with updating the definition and methodology taking the survey results into account. Since this version of the Manual met the needs of countries in a better way, non-OECD countries also started to apply innovation surveys. At the same time discussions to extend the definition of innovation and methodological concepts have been continued. The third and the most recent edition which comes up as a result of collaborative study of the OECD and Eurostat experts, was published in 2005.

As a comprehensive guideline, the Oslo Manual starts with innovation theory, definitions and classifications. However, the third edition expands the measurement framework in three important ways as stated in the presentation of Manual (Oslo Manual 3rd Edition, 2005):

First, it places greater emphasis on the role of linkages with other firms and institutions in the innovation process. Variety and structure of an enterprise's links to sources of information, knowledge, technologies, practices and human and financial resources have an important role on the innovation activity of the enterprise. Although the structure of the linkages differs from passive sources of information in the form of embodied and disembodied knowledge to technology co-operation, they are the sources of knowledge and technology in the innovation activity. After the innovation activity successfully completed it is spread by same channels. Diffusion is the indicator of economic impact of the innovation. Because of the importance of knowledge flows and diffusion evaluation of linkages expanded in the third edition of the Oslo Manual.

Second, it recognizes the importance of innovation in less R&D-intensive industries, such as services and low-technology manufacturing. This edition modifies certain aspects of the framework (such as definitions and relevant activities) to better accommodate the services sector. Since sector coverage of the Manual is bounded with business enterprise sector, other sectors such as public sector are out of scope of the Manual. So the coverage of the Manual is manufacturing, primary industries and the services sector. One significant change in the third edition is putting aside the word “technological” with the concern of technological may mean “using high-technology plant and equipment” especially for the service sector.

Third, the definition of innovation is expanded to include two additional types of innovations, organizational innovation and marketing innovation. One of the starting points of developing a guideline is that it is not enough to determine whether firms are innovative without knowing how they innovate and what types of innovation they implement. For this reason, excluding organizational and marketing innovation would be inadequate for understanding the relation of innovation to economic growth. Types of innovation defined in the Oslo Manual third edition (Oslo Manual 3rd Edition, 2005) are as follows:

- **Product Innovation:** It is the introduction of new or significantly improved good or service. For goods, it includes significant improvements in functional characters like technical specifications, components, materials or new use of product with changes to technical specifications. For services, it includes significant improvements in the way they are provided, the addition of new functions or introduction of new services.

- **Process Innovation:** It is the implementation of a new or significantly improved production or delivery method including significant changes in techniques, equipment or software. Process innovations are implemented aiming at decreasing unit cost of production or delivery, increasing quality, and producing or delivering new or significantly improved products.

- **Marketing Innovation:** it is the implementation of a new marketing method. These types of innovations involve significant changes in product design, packaging, product placement, product promotion or pricing. In order to increase firm’s sales, addressing customer needs better, opening up new markets, newly positioning a firm’s product on the market are intended by marketing innovations.

- **Organizational Innovations:** It is the implementation of a new organizational method in the firm’s business practices, workplace organization or external relations. Organizational innovations are implemented in order to increase firm’s performance by reducing some sort of costs, improve workplace satisfaction, reduce cost of supplies or gain access to non-tradable assets as non-codified external knowledge.

The innovation measurement framework from the perspective of a firm is shown in Figure 2.5. This is somehow the visualization of NIS shaped by institutional framework and infrastructure. The institutional framework generates an appropriate innovation environment or hinders innovation activities and efforts of the firm. Although there are no institutional obstacles for innovation, innovation is not performed in case of lack of demand. Demand is the core factor for firms to perform innovation together with facilitating from the policymaking and educational perspective. Under these convenient conditions firms innovate interacting with other firms and public research institutions. Innovation measurement is constructed on this framework in the Oslo Manual. It tries to measure innovation in the firm, linkages with other firms and research institutions, the role of demand and the institutional framework.

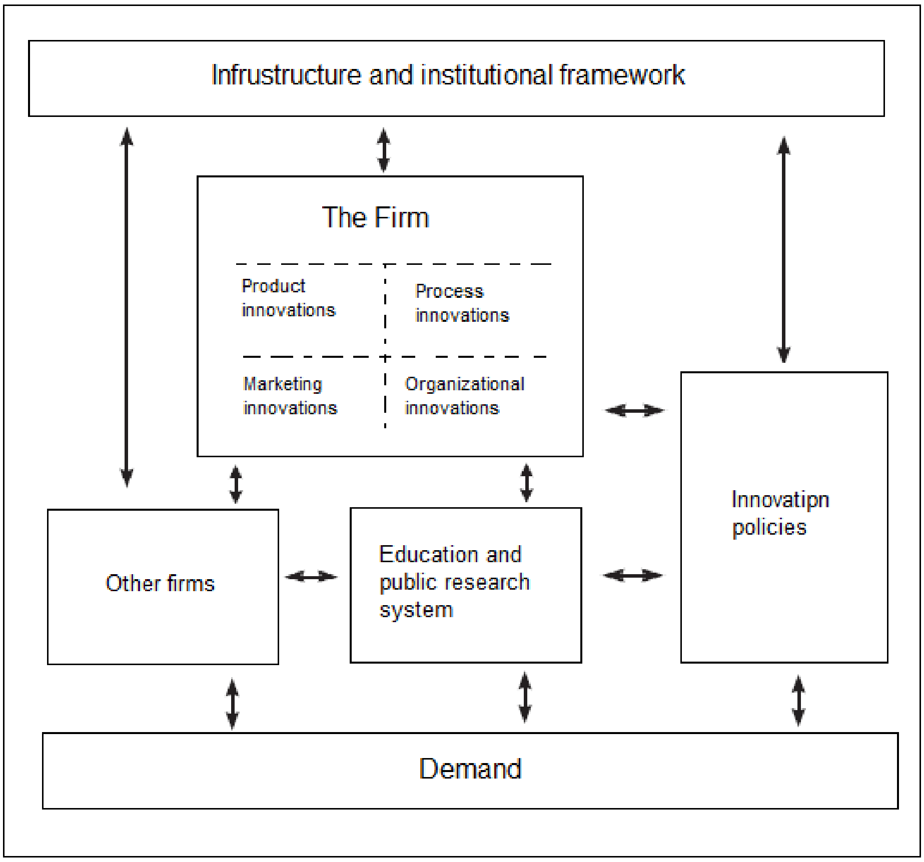


Figure 2.5 The innovation measurement framework

Source: Oslo Manual 3rd Edition, 2005

Going from macro framework to details, key issues to provide data are classified as following in the Manual (Oslo Manual 3rd Edition, 2005):

- Innovation activities and expenditures which include all scientific, technological, organizational, financial and commercial steps which lead, or are intended to lead, to the implementation of innovations. These activities are classified as *successful*, *ongoing* or *abandoned*.

- Factors influencing innovation includes cost factors, lack of skilled personnel or knowledge, market factors and institutional factors. These factors may slow down innovation activities or may cause not starting at all. Identifying them is very important for understanding the innovation process and for formulating innovation policy.

- The innovating firm which has introduced innovation although it is not successful and the impact of innovation such as effects on sales and market share to changes in productivity and efficiency. Impact is very important since innovation is a driver force for international competitiveness.

- Linkages in the innovation process are an important development of the Manual as mentioned above. These include government laboratories, universities, policy departments, regulators, competitors, suppliers and customers.

After defining what to measure, the Oslo Manual presents survey methodology for statistical measurement bearing being a continuous process of innovation in mind. This part includes some basic concepts from data collection to result estimation which is very important for obtaining internationally comparable data for benchmarking purposes.

One of the important features of the third edition of Oslo Manual (2005) is appending an annex on innovation surveys in developing countries together with characteristics of innovation and methodological issues in developing countries. UNESCO Institute for Statistics coordinated the preparation of the annex. Latin American experience was followed up taking the document including their contributions as a base. It may not be suitable for all developing countries since it was prepared based on innovation surveys conducted on Latin American countries taking structural differences of the region into account. However, including a section on developing countries in the Oslo Manual shows that they are aware of different characteristics of innovation in developing countries and also not being able to capturing them by current guidelines. This is a promising progress for defining innovation not only in developed countries but also in developing countries and also encouraging efforts to measure innovation by taking Latin American and Caribbean studies seriously. Content of this annex in the Oslo Manual will not be investigated here since it will be a focus point of Chapter 3.

2.1.2. The Bogota Manual

As a result of comprehending the importance of innovation and its impact on economy, the first edition of the Oslo Manual draw attention from all over the world. Non-OECD countries also started to conduct innovation surveys in the light of the Oslo Manual. In 1995 Chile conducted and innovation survey and it was followed by neighboring countries in the region (Polcuch et al., 2005). However, they realized that all studies and examples available were describing the innovation activities conducted in developed countries. However, in Latin American countries the characteristics and scope of the processes of technological change was unknown. As a result of this, Latin American countries started a project of "Standardization of Technological Innovation Indicators in Latin America and the Caribbean" undertaken by the Ibero-American/Inter-American Network of Science and Technology Indicators (RICYT). Within the scope of the project a workshop was held in Cartagena, Colombia in 1996 where a statement was made on "*the need and simultaneous difficulty of establishing indicators that describe the processes of technological innovation in Latin America.*" In which the characteristics of the indicators were defined as (Bogota Manual, 2001):

- *Indicators should collect and describe the specific characteristics of technological innovation processes observed in the region*
- *On the other, the indicators constructed should allow comparative analysis of the status and dynamics of innovation processes at a global or international level.*

A series of workshops followed the Cartagena workshop where RICYT, the Colombian Institute for the Development of Science and Technology (COLCIENCIAS), Organization of American States (OAS), the Ibero-American Program of Science and Technology for Development (CYTED), the Colombian Observatory of Science and Technology (OCYT) were involved in. As a result of intense work, the Bogota manual – Standardization of Indicators of Technological Innovation in Latin American and Caribbean Countries emerged in the year of 2001.

As stated in the Bogota Manual (2001), it draws inspiration from the Oslo Manual. However, because of different characteristics of the countries in the region, the

Oslo Manual was interpreted in need of designing “specific tools and procedures that will make possible to identify the specific regional characteristics of firms in the region and their scientific/technological systems, to allow the construction of indicators capable of interpreting these changes and differences” (Bogota Manual, 2001). The Oslo Manual provides what to be measured by enabling internationally comparisons. On the other hand, the Bogota Manual guides on how these measurements are used through capturing distinctive aspects of innovation in the region covering firms’ technological efforts. This indicates that the two manuals provide complementary approach for the region.

The Oslo Manual consolidates the term of innovation and draws framework for purpose of measurement, and then introduces methodology for data collection and measurement. Since it is revised based on survey applications in time, it proposes alternative ways of methodology instead of asserting the only mandate. On the other hand, the Bogota Manual has a more specific point focusing on innovation measurement in Latin American and Caribbean countries. It uses the Oslo Manual as a model and states differences and discussions on particular parts of methodology and application. Moreover, the Bogota Manual propounds questionnaire in the light of discussions since they aimed at deriving innovation indicators for the region.

Taking the conceptual framework into account for adapting the Oslo Manual, the Bogota Manual (2001) approaches the discussion in three ways: *approach*, *definition* and *aspects of measurement* which are discussed below:

- **Approach:** This section deals with the Oslo Manual approach in terms of conceptual framework; research priorities such as technology diffusion, information sources and obstacles; firms, science and technology institutions, diffusion and absorption and conditions for innovation under the heading of innovation factor. Where the Bogota Manual extends these discussions are “Business goals and innovation” and “Conceptions of technical change”.

    - *Business goals and innovation* aims at identifying the goals of innovation by approaches of competitiveness, business strategy and the dynamic interaction of the critical strategic elements. The term of *competitiveness* in this context is not bounded with productivity; rather it involves exogenous factors such as rate of exchange, the tax system, the availability and quality of infrastructure, the specific characteristics of markets in which a firm is operating, the availability and price of input, salary levels, and labor legislation which affect the competition in the NIS. *Business strategy* emphasizes endogenous nature of technological change. This approach takes its roots from Schumpeter's view of "the businessman innovates in pursuit of the monopolistic profit that motivates and perpetuates his innovative efforts" and Kaldor's view of "technological change is indissolubly linked to capital accumulation". Lastly, *complex interaction and investment* stresses on innovation decisions are made strategically depending on characteristics of the firm and hence investment is made for competitive advantage.

- o *Conceptions of technical change* covers technical change from historical perspective in terms of Schumpeter's and Kaldor's view, neo-classical view and evolutionary view. Schumpeter introduces the differences between inventiveness, innovation and diffusion together with defining types of innovation. Kaldor questions the conception of being technological change's exogenous and states the way in which the growth of capital intensity translates into productivity gains are determined by business technological dynamism. Neo-classical theory contributes the discussion by defining market failure which affects technical change. The evolutionist extends the discussion as uncertainty, externalities and dynamic returns determine the development of technical change.

- **Definitions:** In this section Oslo Manual's technological product and process innovation, innovation activities and innovative firm definitions are covered. Since third edition of the Oslo Manual was published after the Bogota Manual, the review excludes the organization and marketing innovation. The significant difference affecting definitions is that traditional definition of technical change is more significant in developed countries and ability to absorb technological knowledge is more restricted. Since characteristics and point of view in developing countries differ from developed countries, the Bogota Manual expands the definition of innovation including “technological effort” and the concept of *Innovating Activity Management (IAM)* is introduced. In this framework innovation definition includes marketing and organizational innovation and innovation activities include innovation efforts together with R&D. Innovation efforts involve design, acquisition of embodied and disembodied technology, marketing and training.

- **Aspect of Measurement:** This section corresponds to aims, sources, obstacles of innovation and innovation indicators emphasizing impact and diffusion indicators in the Oslo Manual. Contributions of the Bogota Manual on this part for developing countries emerges three consequences for methodology consistent with affects of globalization and economic openness:

> ***1.*** *The necessary inclusion of organizational aspects in innovation analysis, since organizational modernization seems to be a crucial mechanism in reconversion.*
> ***2.*** *The need to consider the decision to innovate as an investment decision: investment conditions are decisive for the accumulation of the capabilities required by reconversion efforts (such as organizational modernization and investment aimed at incorporating technical change), in which context innovation takes place.*
> ***3.*** *The importance of accounting for the impact of innovative activities in terms of the goals of firms, such as productivity or competitiveness increases.*

Remaining issues following pre-mentioned approaches are related to structure of developing counties. The following section investigates this specific matter widely. With concerns of avoiding repetition, approaches for developing countries will be included in Chapter 3 and review of the Bogota Manual will continue with operational concerns.

The second part of the Bogota Manual is about indicators and measuring. Mainly statistical methods for data collection and indicator selection are explained. International statistical concerns of data collection are also valid in the Bogota Manual such as obtaining standardized and high-quality data. This part continues with indicators classifications and concluded with a wide list of indicators and sample forms for survey.

2.2. Innovation Surveys

Although the nature of innovation, even the definition and the scope of innovation has been changing and becoming mature as a result of practices in time, there are some concepts as R&D and human resources which are indispensible factors for conducting innovation. These both are inputs to the innovation and it is possible to obtain data by surveys leaded by the Frascati Manual for a long time. Although such kind of data somehow enabled holding view on innovation activities before 1990s, developing the Oslo Manual prepared a base for innovation surveys. Purpose of innovation surveys are summarized by Guellec and Pattinson (2006) as following:

- Although R&D has an important impact on economy, much technological innovation does not result from R&D as in the services sector.
- Output of innovation activities are as important as input to the innovation. Because of this, output indicators are to be measured.
- At the firm level, knowledge of the conditions of innovation activities need to be improved since R&D surveys mostly gives aggregate data. This information includes motivations, factors making firms innovative, and links.

Because of need for measurement and information on innovation activities, the European Union (EU) member states started to conduct Community Innovation Survey since 1993.

As mentioned in the previous section, the Oslo Manual affected the developing countries such as Singapore, Taiwan, Malaysia, Thailand, South Africa and Latin American Countries and they conducted innovation surveys based on the Oslo methodology (Polcuch et al., 2005).

2.2.1. The Community Innovation Survey (CIS)

The Community Innovation Survey (CIS) started as a survey on innovation activities of EU member states in the year of 1993. The first one was a pilot survey jointly initiated and implemented by Eurostat and DG Enterprise under the aegis of the European Innovation Monitoring System (EIMS), part of the Innovation Programme (EU Cordis, 2002). The survey is implemented every four years and mini CIS surveys are implemented by several countries at the two-year point between the main surveys (Arundel, 2005).

With the guidance of CIS1, CIS2 was carried out in 1997/1998, and CIS3 in 2000/2001 with some exceptions. CIS4 was implemented on 25 Member States, Candidate Countries, Iceland and Norway with the observation period 2002 to 2004 and the reference period of 2006. The frequency of the survey was increased in 2004 to a full survey every four years and a reduced survey every two years after the main one. CIS 2006 was conducted by 27 Member States, Candidate Countries, Iceland and Norway based on the reference period 2006, with the observation period 2004 to 2006. (Eurostat).

CIS is prepared based on Oslo Manual. From 1997 to 2005 the second edition, and beginning from 2005 the third edition has been used as a guideline. Every country collects their own data via statistical offices and the Eurostat collects aggregated and micro data from countries (Eurostat).

The questionnaire of CIS 2006 conducted in Turkey is given in Appendix A. Turkey applies CIS surveys proposed by the Eurostat with some minor changes. Because of being innovation a new concept for Turkish firms some explanatory information is added together with changing slightly questioning styles in order for enabling better understanding by firms. Moreover, it is asked for some additional information such as differentiating between Turkey and abroad taking the effect of innovation in terms of entering new markets or facing economic uncertainty as a factor hampering innovation arising from the structure of Turkey. However, Turkey applies the mandatory parts of the survey not the optional parts. Because of this the Turkish survey is narrower in terms of organizational and marketing innovation. Networking of relationship, factors affecting organizational and marketing innovation are missing in Turkish survey. Moreover, there are general problems related to CIS such as innovation surveys' concerning of measurement of input and output rather than the actual progress, focusing on innovative or innovating firms and discarding potentially innovators for developing countries (Tandoğan et al., 2009). As mentioned in Section 2.1.2, the Bogota Manual was developed concerning these factors.

2.2.2. Latin American and Caribbean Innovation Surveys

In Latin America, Chile, Mexico, Colombia, Venezuela and Argentina were the first to conduct innovation surveys between 1995 and 1997. Following them, Uruguay, the State of San Pablo, and Brazil carried out innovation surveys mainly based on the Oslo Manual. However, the Latin American countries do not only aim at identifying characteristics of innovative firms, but also non-innovative and potentially innovative firms making an effort (Annlo, 2006). As a result, the Bogota Manual was developed intending to develop a standardized regional survey for Latin American and Caribbean countries as explained in Section 2.1.2.

The regional survey is formed of a basic common questionnaire defining standards for comparison where each country adapts according to their country-specific features including (Annlo, 2006):

- **Industrial classification:** International Standard Industrial Classification (ISIC) codes or conversion into ISIC is advised to use to be able to compare within industrial sectors. ISIC three digits is preferred since variance is really high when two digit used.
- **Size:** Considering numbers of employees, value of production or sales and the similar factors, defining a range of sizes are recommended again for comparative purposes between countries. However, there is no common size criterion for the region.
- **Time Periods:** The concern of covering more than one year is also valid for the region. However, it is not possible to say all countries carry on their surveys at the same time. Because of this, using the same reference period would enable comparison among countries.
- **Monetary Values:** Questions whose answers require monetary units are mostly confusing for the respondents. For instance, questions asking about utility do not generally specify whether it is operational or gross.

Moreover, it should be stated whether the unit is expected in constant term or current term. In order for comparison, a standard converter should be defined into US dollars and purchasing power parity.

- **Qualitative Information:** When the qualitative scale is used, the answers have a wide range affected from cultural factors and interviewer's approach. Besides, increasing number of options in the answers gets it difficult to rank. So, regrouping options into general common themes is suggested.
- **Filters:** some questions and methods to gather information changes from country to country. For example, in Argentina only firms engaged in R&D are asked about staff in charge of execution where in Colombia, the question is asked every innovative firm. Because of this, firm types are suggested to specify which require managing the filters carefully in the survey forms.
- **Multinational Enterprises:** In order for comparison between countries in the region the definition of multinational enterprise should also be specified.

The Bogota Manual includes the List of Indicator; Standard Common Form which is a complex form including quantitative and qualitative dimensions providing the basis for surveys taken every five or six years; and Basic Form to collect quantitative data which is suggested to conduct yearly or every two years. The Standard Common Form is given in Appendix B. Since the Latin American and Caribbean countries apply the Basic Form in one or two years, and the Standard Common Form in five or six years, the latter is much more comprehensive. It comprises group of questions under the headings of Firm Identification, Economic Performance, Innovation Activities, Innovation Funding, Innovation Results, Innovation Goals, Sources of Innovation Information, Relationship with National System of Innovation, and Factors Affecting Innovation.

Firm Identification includes questions of communication information and firm's activities. Most of the questions in this part exist in the CIS; however, it includes extra questions on age of the firm and period of foreign investment. Economic Performance part is comprised of questions like production, market share, export and import, employment and the similar. Most of the detailed questions about economic activities of the firm do not exist in CIS; however, this group of questions is recommended to be obtained from other surveys if possible rather than including in the survey itself.

The core of the survey, Innovation Activities tries to define types of innovation and innovation efforts in the region as explained in the Manual. Unavoidably, R&D and training exist in this part like in the Oslo Manual. There are also questions on organizational and marketing innovation although expressed differently. Innovation activities characterizing the developing countries such as embodied and disembodied technology acquisition, activities related to industrial engineering like quality control and design are discrepancies of Latin American and Caribbean surveys compared to CIS. Acquisition of embodied and disembodied technology like hardware, licenses and consultancy are emphasized as innovation efforts which is very important for developing countries.

Innovation Funding part in the Latin American and Caribbean surveys is very similar to the one in the CIS defining the source of finance in innovation. Similarly, Innovation Results part is designed to obtain effects of innovation as in CIS. However, CIS only asks for acquisition obtained as a result of innovation where Latin American and Caribbean surveys also asks for reasons to innovate in terms of market goals, cost reduction, product, quality, and production improvement and their relationship to public policies in the part of Innovation Goals.

Source of information for innovation and cooperation are very important both for developed and developing countries. As a result of this, questions to obtain information on these factors are similarly exists in both surveys. However, the Latin American and Caribbean surveys investigate cooperation's in terms of NIS framework.

Lastly group of questions proposed by the Bogota Manual is related to factors effecting innovation by negative and positive means. CIS elaborates the factors in negative meaning as the factors preventing innovation and classifies these factors as cost, knowledge, market and not needing innovation. In the Latin American example, they are classifies according to their economic impact in micro, meso and macro approach including risk of innovation and/or imitation, physical infrastructure, institutional framework and etc. Although negative effects are evaluated together with positive effects, this is a very important part in defining the reasons hampering innovation activities in order for developing policy formulations to encourage innovation especially in developing countries.

As it is mentioned before, innovation has vital importance for firm's survival and existence in competitive environment. In global world, entering in this contest is also possible by innovation for countries. Because of this, understanding the concept of innovation is very important. This chapter starts with definition and scope of innovation. Then internationally used standard guideline for measurement of innovation, the Oslo Manual is investigated. Next, the Bogota Manual proposing complementary information on innovation activities in developing countries is analyzed. After defining the measuring framework from different perspectives, the most common innovation survey, the Community Innovation Survey is taken into consideration. The innovation survey conducted in Latin American and Caribbean countries taking its roots from the Bogota Manual is also investigated comparing its context to CIS. Considering recent application provides illustrating the macro view. However, it is not complete to evaluate Turkey before evaluating characteristics of innovation in developing countries.

CHAPTER 3

INNOVATION SYSTEMS IN EMERGING AND DEVELOPING COUNTRIES

Developing the Bogota Manual and innovation surveys by Latin American and Caribbean countries is the result of Oslo Manual's not capturing some important aspects of innovation for developing countries and limiting the relevance and usefulness of the surveys (Goedhuys et al., 2005). This is explained by structure and comprehension of innovation and innovation environment in emerging and developing countries differs from the developed countries and in order for better measurement, these differences should be clarified in a systematic way.

There are lots of factors affecting enterprises' deciding of innovation, conducting innovation activities and hence characteristics of innovation in developing countries.

Deciding for innovation and starting innovation by enterprises are affected by the market conditions and the enterprise itself in developing countries. Developing countries face macroeconomic uncertainty, high firm turnover, lack of physical infrastructure, institutional fragility, lack of entrepreneurship, lack of public policy instruments for support and business start-up, risk-averse nature of firms more than the developed countries. Some countries have traditional economic systems like China where major government S&T policies and programs have an impact on innovation instead of private enterprises. State-owned firms have an important position in some countries where innovation is discouraged by lack of competition. Market size and firm size are relatively small and multinational companies reduce innovation decision-making power since the needs are met by technology transfer from abroad. Competition is mostly obtained by cheap labor which causes informal organization of innovation (Polcuch et al., 2005).

Together with macro factors preventing or affecting innovation, sectorel structure of the market is very important on innovation activities. If a limited number of firms operate at a sector, they may not need innovation since the market is shared among them. Moreover regional differences in a country like digital divide prevent diffusion of knowledge.

Looking from the supply side, in emerging economies, fewer resources are devoted to innovation, and R&D funding and execution are mostly made by government. Linkages between science and technology actors are absent which causes less flow of information. Moreover, deficiency of human capital and tacit knowledge is a remarkable barrier for innovation (Polcuch et al., 2005).

Under these circumstances, innovation is mostly defined as minor or incremental changes in developing countries as the first South African innovation survey reveals that 86% of innovations are incremental. Another important characteristic of developing countries is that acquisition of embodied knowledge constitutes both product and process innovations. However, organizational innovations are critically important for developing countries since it affects positively the performance of the enterprise and provides the ability of absorbing new technologies incorporated in machinery and other equipment. Moreover, the sector on which innovation mostly emerge is the agriculture sector instead of industry in developing countries. (Oslo Manual 3rd edition, 2005).

After defining the concept of innovation and innovation climate in developing and emerging countries, it comes to NIS conception in these countries. As explained in Chapter 2, the idea of NIS rises with the analysis of technical change at the national level for growth and economic development (Viotti, 2001). However, there is a difference in notion of technical change between developed and developing countries. In industrialized countries the process of technical change is driven by innovation which is a privilege for these countries whereas in industrializing countries the process of technical change is mostly characterized by absorption and improvement of innovation (Viotti, 2001). The analysis of technical change requires a new concept to illustrate the framework of NIS in developing countries. This concept is designated as **learning** which is defined as "the process of technical change achieved by *diffusion* (in the perspective of technology absorption) and *incremental innovation* by Viotti (2001). Lall (2003) also emphasizes the term of learning and gives features of technological learning in developing countries as summarized below:

- Technological learning is described as a conscious and purposive process instead of being automatic and passive. Firms using a given technology precede different learning curves depending on their capabilities and hence reach different levels.
- Firms cannot reach full information on technical alternatives. Instead, they operate with hazy knowledge of technologies they are using.
- In order for obtaining necessary capabilities, firms need to learn learning itself. New or emerging firms may benefit from foremost firms, but learning process is time consuming and they are inefficient while learning.
- Inevitable firms face uncertainty. However, learning is path-dependent and cumulative. That is why they may choose to collect new information, learn from the experience and imitate other firms.
- The learning process is technology specific. However, technology requirements differ from embodied to tacit and etc. because of this reason, acquired capabilities may not transferable to another.
- Different technologies have different spillover effects and they have potential for further technological advance.
- Capability building occurs at all levels not necessarily on the R&D stage. On the contrary, some R&D is just needed for efficient absorption.
- Technological development takes place to different paths from know-how which is attaining a minimum level of operational capability to know-why which is understanding of the principals of the technology. Certainly, aiming at deeper technological capability involves higher cost, risk and duration. However, know-why makes firms to select the technologies they need better.
- Technological learning requires externalities and interlinkages with for example suppliers, competitors, customers. Interaction with them and also different sectors provides information flows which form clusters assuring collective learning for the whole group.
- Technological interaction occurs between countries together with within country. For developing countries, important technology is an important source for learning. However, all technology import is not conductive to indigenous learning.

After defining features of technological learning in developing countries, it is now possible to pass through the term of National S&T learning. It is used for “the learning process happening at all levels of national economies from the level of individual residents to the level of firms, industries, sectors, and governments, by which countries absorb and disseminate existing S&T knowledge as well as generate and process new S&T knowledge at the global technological frontier” (Soubbotina, 2006). As a consequence, the definition of National Innovation System for developing and emerging countries becomes **National Learning System (NLS)**. Viotti (2001) presents a simplified model comparing NIS and NLS in terms of technical changes. It is seen that technical change process led by innovation is peculiar to developed countries. However, in developing countries, technical change is defined as absorption and improvements of innovations of developed countries. In industrialized countries, an interactive relationship is observed between incremental innovation, innovation and diffusion. In developing countries however, technical change is achieved by diffusion and incremental innovation. Because of this, learning by absorption and incremental innovation are the characteristics of NLS.

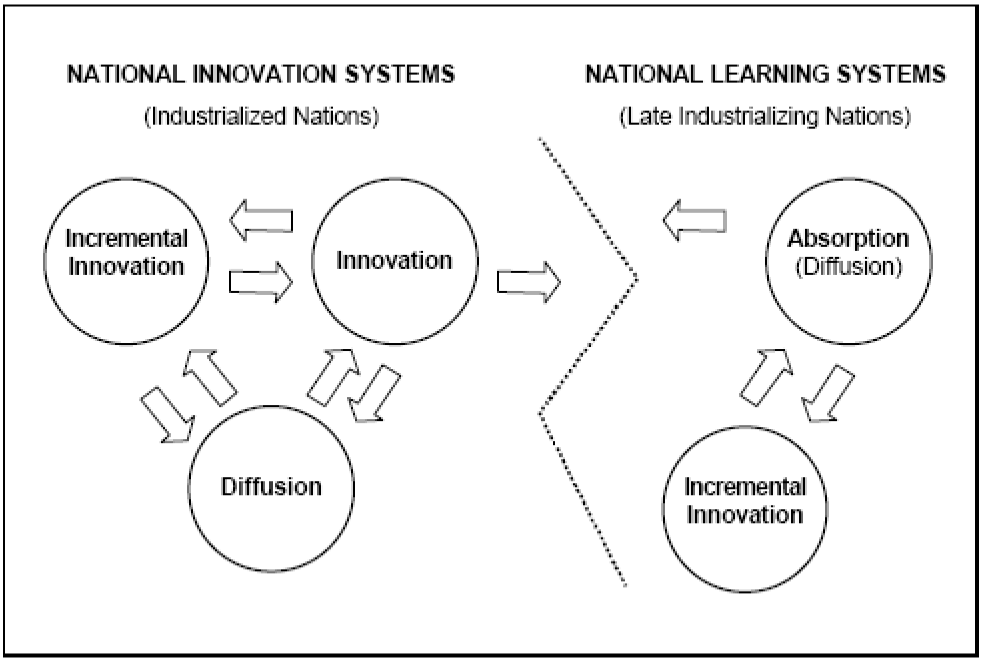


Figure 3.1 National Innovations System versus National Learning System

Source: Lall, 2003

Although it is possible to collect developing countries under the framework of learning systems, developing countries have very different characteristics from each other depending on their economic and social development, structural features and even geographical locations. However, it would be inappropriate to classify them taking these characteristics into account or by using some general indicators like Gross National Income since the subject point is technical change. One approach to classify developing countries is using their S&T capabilities as proposed by the World Bank (Aubert, 2006). Using a weighted composite indicator constituting of S&T capabilities like R&D capacity, human capital and high technology exports, the table below is obtained:

Table 3.1 Country classification depending on their S&T capabilities

S&T Proficient Countries	S&T Developing Countries	S&T Lagging Countries
Brazil	Benin	Burundi
China	Chile	Gabon
India	Colombia	Guatemala
Hungary	Egypt	Iraq
Mexico	Macedonia	Mali
Singapore	Pakistan	Nepal
Slovenia	Turkey	Uruguay
South Africa	Venezuela	Vietnam

Source: Aubert, 2006

Another classification is presented by Lall (2003) creating six general models of national S&T learning given in Table 3.2. One dimension of technological learning is government S&T policies in terms of encouraging active or passive S&T learning strategies. The other aspect is the access to foreign S&T knowledge sources since learning from foreign sources is very important in developing countries. Intersection of these two dimensions forms five major models as: traditionalist slow learners, creative isolated learners, passive FDI-dependent learners, active FDI-dependent learners, Autonomous learners and creative cooperative learners.

Table 3.2 Models of national technological learning

Quality of Government S&T Policies	Mode of Access to Foreign Sources of S&T Knowledge			
	Isolated	**FDI-Dependent**	**Autonomous**	**Cooperative**
Passive S&T Learning Strategy	Traditionalist Slow Learners	Passive FDI-Dependent Learners	NA	NA
Active S&T Learning Strategy	Creative Isolated Learners	Active FDI-Dependent Learners	Autonomous Learners	Creative Cooperative Learners

Source: Lall, 2003

The category in which national S&T learning is very slow is the traditionalist slow learners including least developed Sub-Saharan Africa. Countries reached a certain level of learning capacity and attracting FDI, but on low value-added industries are classified as passive FDI-dependent learners like Mexico and Philippines. Active FDI-dependent learners are one step ahead comparing to passive FDI-dependent learners. Example of this category can be Ireland and Singapore. Active learners from foreign sources without relying on FDI like Korea and Japan form the group of autonomous learners. Example of creative isolated learners and creative cooperative learners are Russia and the United Kingdom respectively depending on their attitude towards cooperation.

Together with this classification Soubbotina (2006) defines path for technological learning based on their learning capabilities as seen in Figure 3.2. The most rationale transitions are presented by Soubbotina (2006) as following:

- *From slow-learning traditionalism to passive and active FDI-dependent learning*
- *From passive FDI-dependent to more active FDI-dependent or autonomous*
- *From active FDI-dependent to autonomous and creative-cooperative*
- *From autonomous to creative-cooperative*
- *From creative-isolated to autonomous and creative-cooperative learning*

However, it is not possible to suggest a standard development path since it is also a policy implication. However, this is out of scope for this study and hence will not be elaborated here.

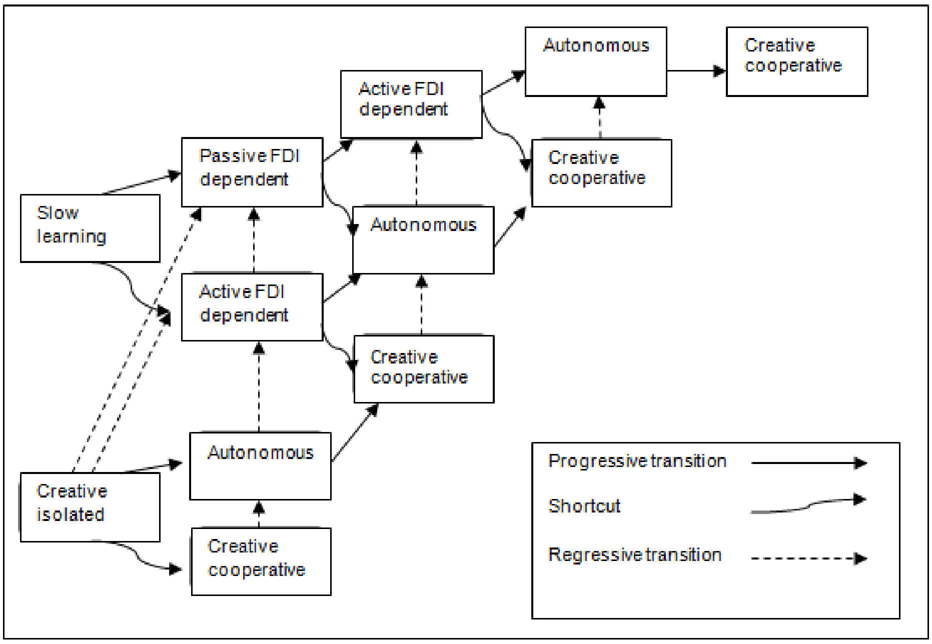


Figure 3.2 National Paths of Technological Learning

Source: Soubbotina, 2006

Evenson and Westphal (1995) make a similar classification using the technological capability indicators. These indicators are listed as following:

1. Real growth (1965 – 1990)
    - GDP per capita
    - GDP: Aggregate/Agriculture/Industry/Services
2. R&D intensity (R&D/GDP – 1990)
    - Aggregate: Public/Private
    - Agriculture: Public/Private
    - Industry: Public/Private
    - Services: Public/Private
    - Science/GDP (1990) : Public/Private
3. S&E intensity (S&E/GDP – Index)
4. Invention indicators

- Invention /S&E (number of inventions per scientists and engineers engaged in R&D)
- Invention import share
- Invention export share

5. Intellectual property rights
    - International recognition
    - Domestic use

Countries are classified in 4 groups depending on these indicators: OECD industrialized, recently industrialized (Greece, Portugal and Spain) and 2 groups of developing countries in 6 synthesized levels of technological development as given below. Examples for each group in developing country classes are given in the parenthesis.

Level-1 developing countries:

- Traditional technology (Yemen, Laos)
- First emerge (Nepal, Ethiopia)
- Islands of modernization (Sri Lanka, Kenya)

Level-2 developing countries:

- Mastery of conventional technology (Malaysia, Turkey, Colombia)
- Transition to NIC-hood (India, Thailand, Mexico)
- Newly Industrialized (NIC)-hood (Korea, Taiwan)

In Level-1, countries which are not successful in achieving basic level of technological capabilities exist. Level-2 countries cannot wholly expand and improve their capabilities although they have basic capabilities. As a result of this, values of indicators like public and sector investment in R&D, number of scientists and engineers, patent indicators increase from traditional technology group the NIC-hood group. R&D in the common sense is not observed in Level-1 countries. Their innovation activities are mostly defined as design, engineering and etc. however, R&D intensity is comparably high in agriculture sector. It is also observed in Level-2, but formal R&D is important for Level-2 countries which enables them to advance more easily.

It is seen that although there is a classification of a general “developing countries”, structure and technological capability of countries in this group are very different from each other. This indicates that measuring these capabilities would be different from each other. Although there are examples of measurement like suggested by the Bogota Manual, all indicators should be evaluated bearing these country-specific features in mind.

CHAPTER 4

EVALUATION OF EXISTING INNOVATION INDICATORS: THE TURKISH CASE

As explained in detail in the previous chapters, policy formulation for competitiveness is made based on R&D and innovation indicators and in return, success of these policies and the overall performance of the NIS or NLS are evaluated using these indicators as illustrated in the figure below:

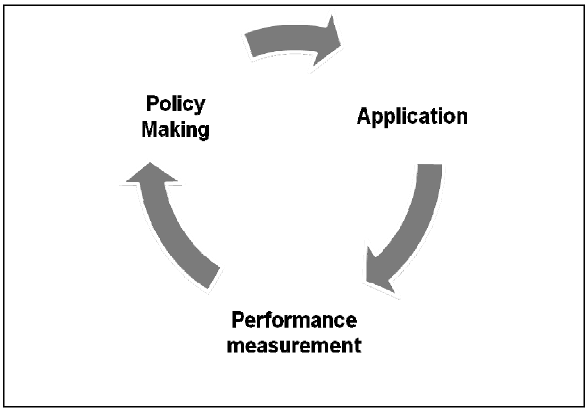


Figure 4.1 Performance measurement cycle in NIS/NLS

Countries evaluate their performances considering their needs by yearly (or one in two years) data collection and also these data are used for benchmarking to other countries which is the idea behind developing standardized manuals. However, definition and/or content of the same data may change from year to year which causes break in series. Moreover, although countries use the same guideline for data collection and analysis, like the Oslo Manual, there may be differences in the quality of data between countries. These differences are mostly caused by definition, classification and measurement of the indicators which ends up misuse of indicators. (Freeman and Soete, 2007). Some countries benefit from this misuse, but for other countries it causes problems. These are the major drawbacks of measurement observed in any kind of statistical data processing independent from STI measurement, however it is not taken into consideration while using these data most of the times. When comes to innovation, there is also the awareness aspect. Since innovation is a recent term compared to R&D, it is not possible to enable units under survey to understand the same concept especially in less industrialized countries. Difference between concepts of technical change and innovation between developing and developed countries were examined in the previous chapter. In this case, the conceptions are so different that, it is totally inconvenient to compare developing and developed countries. All these problems related to measurement of data, and STI data specifically, should be bear in mind while using data for analysis, monitoring and benchmarking purposes.

After stating the problems and remarks related to macro level of measurement in general, indicator-wise examination will be made for Turkey. Turkey as a developing country faces many problems in the concept of innovation like other developing countries although being an OECD member. Turkey has population more than 70 millions, Gross Domestic Product per capita is 10 436 USA Dollar in current prices in 2008 with a 13% growth rate whereas the growth rate of the previous year was 21.8% which is an indication of the global economic crisis (Source TurkStat). Turkey's economy has affected from crises many times which cause increase in inflation and interest rates in the past. Considering main economic sectors, service sector comes the first; industry and agriculture following respectively in considering contribution to GDP growth. Although having high population, age structure of Turkey differs from the European countries. 35 % of the population is under 20 years old corresponding nearly 25 million of young population. This shows the potential of Turkey in STI human resources when canalized by accurate policies.

Coming to science, technology and innovation policy framework of Turkey, there is the *Supreme Council for Science and Technology (SCST)* as a highest level advisory body in policymaking. The SCST is chaired by the Prime Minister and convenes regularly twice a year since 2004. Beginning from 1983 in which the SCTS was founded, 18 meetings were held with related ministers (National Defense, Economy, National Education, Health, Agriculture and Rural Affairs, Industry and Trade, Energy and Natural Resources, Environment and Forestry), chairmen of the Council of Higher Education, Turkish Atomic Energy Authority, Union of Chambers and Commodity Exchanges of Turkey, General Director of Turkish Radio and Television, a member from university designated by the Council of Higher Education, Undersecretaries of State Planning Organization, Treasury and Foreign Trade and the president of the Scientific and Technological Research Council of Turkey (TÜBİTAK). TÜBİTAK is the secretariat of the SCST and responsible for (TÜBİTAK):

- Advising the Government in formulating ST&I policies of Turkey
- Promoting, funding and monitoring academic R&D
- Promoting, supporting and monitoring industrial RTD & innovations & fostering academia-industry cooperation
- Running R&D institutes to perform RTD activities in line with national priorities
- Operating facilities providing assistance & technical service to R&D activities
- Discovering talents and supporting scientists of the future
- Awarding annual prizes, serving as incentives for scientific excellence
- Organizing and running international S&T cooperation
- Promoting science literacy & publishing popular science books & magazines and scientific journals

At the 10th meeting of SCST, in the year of 2004, Turkish Research Area was adopted as illustrated in Figure 4.2.

Objectives of the TRA are defined as:

- To increase the quality of life in Turkey
- To find solutions to social and economic problems
- To increase the competitiveness power of our country
- To improve and disseminate science and technology culture in our society

Targets of the TRA are:

- To increase GERD
- To boost the demand for R&D
- To improve the quality and quantity of R&D personnel

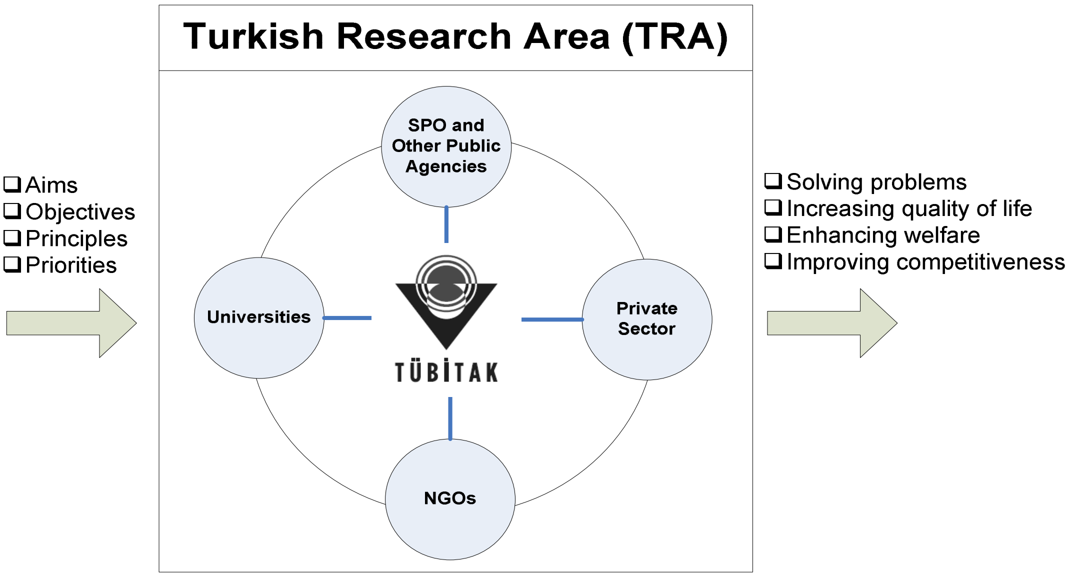


Figure 4.2 Turkish Research Area

Source: TÜBİTAK

In the National S&T Strategy two significant targets have been established for the year 2013:

- to increase GERD to 2% during the period from 2005 to 2013.
- to raise the number of full-time equivalent R&D personnel up to 150,000 in 2013.

It is seen from the policy framework that Turkey is attempting to develop the NIS/NLS in recent years and in order to reach targets established, allocated sources are increasing. However, as being a developing country, most of the assumptions discussed in Chapter 3 are valid for Turkey.

In order to assess the effectiveness of these policies, measurement is critically important for Turkey. Innovation indicators are evaluated as input, output and performance indicators. STI indicators which are inputs to the Turkish innovation/learning system will be investigated by R&D expenditures and human resources. Outputs of the system classified as scientific publications, patents and high-tech. exports. Innovation performance of the overall system is expressed by Community Innovation Survey related indicators. Turkey conducts the CIS consistent with EU countries since 1995-1997 period which corresponds to CIS2. CIS questionnaire conducted by Turkey in 2006 was discussed in Chapter 2 and compared to Latin American & Caribbean surveys in terms of content. It is known that CIS is a survey applied every 3 or 4 years and asks about numerical values like total turnover and number of employees taking the last year as a reference. Because of this, it is not possible to make a comparison for a country on the timescale. Moreover, because of being a new concept compared to R&D, the survey scope changes every term which also becomes trouble in terms of comparison. Because of these reasons CIS-related indicators will not taken into consideration in this Chapter for Turkey.

4.1. Input Indicators

4.1.1. Investment in R&D

R&D, defined as "*creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications*" in the Frascati Manual (2002) is a key element in the knowledge-based economy. It is regarded as one of the main drivers of enterprises' internal capabilities and agreed on being contributor to economic growth even though it is not necessary for growth (Bordt et al., 2006).

The factor which enables measuring R&D in the national level is "intramural expenditures" which is defined as "all expenditures for R&D performed within a statistical unit or sector of the economy" and somehow ""extramural expenditures" defining "payments for R&D performed outside the statistical unit or sector of the economy" as stated in the Frascati Manual (2002). Although R&D expenditures enable countries to monitor their performance by measuring annually, it is not proper to use these data for benchmarking purposes between other countries. As stated in the Frascati Manual (2002), using R&D in monetary terms is biased because of differences in price levels between countries and over time. Since current exchange rates' not reflecting the balance of R&D prices between countries and in times of high inflation general price indices' not reflect trends in the cost of performing R&D, purchasing power parities (PPP) and the implicit gross domestic price (GDP) index are used. However, instead of reflecting the real amounts, opportunity cost of the resources devoted to R&D is reflected in this way.

Although R&D has an important role on countries' development, the important factor for a country to advance is innovation. R&D is mostly part of innovation activities although all innovation activities need not contain R&D as in the case of organizational innovation. Acquisition of disembodied technology, know-how and other activities in the content of innovation is very important especially for developing countries. It is also evident from the results of CIS that, more firms innovate than perform R&D even in the Europe where the innovation policy focuses on R&D as being the source of inventions in the science-push or linear model of innovation. (Arundel, 2007). As mentioned in Chapter 2, the linear model of innovation is inadequate for explaining the complex nature of innovation. Rosenberg (as cited in Forbes and Wield, 2002) alleges that even in the developed countries like US, 80% of industrial R&D is defined as improving new products instead of inventing. Moreover, industries, except from some science-based ones as pharmaceuticals, are able to use innovation as the core of firm without doing in-house R&D in the classical sense.

Arundel (2007) also emphasize the fact that R&D indicators' being used for innovation measurement is caused by dominance of supply-side R&D support programs in innovation policy as the target of increasing R&D expenditures in Gross Domestic Product (GDP) to 3% in Europe being devoted in the Lisbon Agenda. This is an implication of the "myth" of *more technology is always good* which drives trying to solve problems using sophisticated techniques instead of doing cheaply (Forbes and Wield, 2002).

Being the case in developing and emerging countries diffusion of technology and skills especially for small and medium-size enterprises is an important aspect of innovation which cannot be captured by R&D indicators (Arundel, 2007). Because of these reasons, industrializing countries need to follow a different path for sustainable development. A striking example for this development path is the South Korea which is referred as "catch-up model". Defined as late-industrialized country, Korea increased its productivity by changing of production methods, layouts and etc. Then, started borrowing foreign new technologies and concentrated on effective use of these technologies. The characterization of innovation by adaptation rather than creativity enabled hampered repeating the same process of technological development performed earlier by developed countries. Lastly, Korea came to the stage of assimilating the knowledge/technology generation mechanism having more knowledge-based and technology-intensive industry (Suh, 2000). Revealed by the South Korean example, non-R&D activities in the form of technology transfer and the similar are all innovation which captures the potential of the country. In this point, public policy comes up by awareness and pushing the industry towards aimed level of development.

In Turkey, the Turkish Statistical Institute (TurkStat) is responsible for collecting, evaluating, analyzing, and publishing national statistics including STI data. R&D survey in higher education sector, government sector and business enterprise sector are conducted separately each year compatible with Frascati Manual and Eurostat recommendations. In higher education sector and government sector census is conducted and on industrial sector survey is conducted by sampling. The contents of the survey in industrial sector is all enterprises receiving R&D support from TÜBİTAK and other institutions, the biggest 500 enterprise by turnover announced by Chamber of Industry in Istanbul, all enterprises in technopolices and a sample taken from enterprises of 20 and higher employees which are not known of conducting R&D. On government sector the survey is conducted by post and on higher education sector by register information like Ministry of Finance, Higher Education Council and etc. for public universities and face-to-face interviews for private universities.

Keeping in mind drawbacks of R&D data and, R&D expenditures data particularly, Turkish case is to be examined through time-series data. Firstly, Gross Domestic Expenditure on R&D (GERD) as a percentage of GDP indication of R&D intensity is given in Figure 4.3 below:

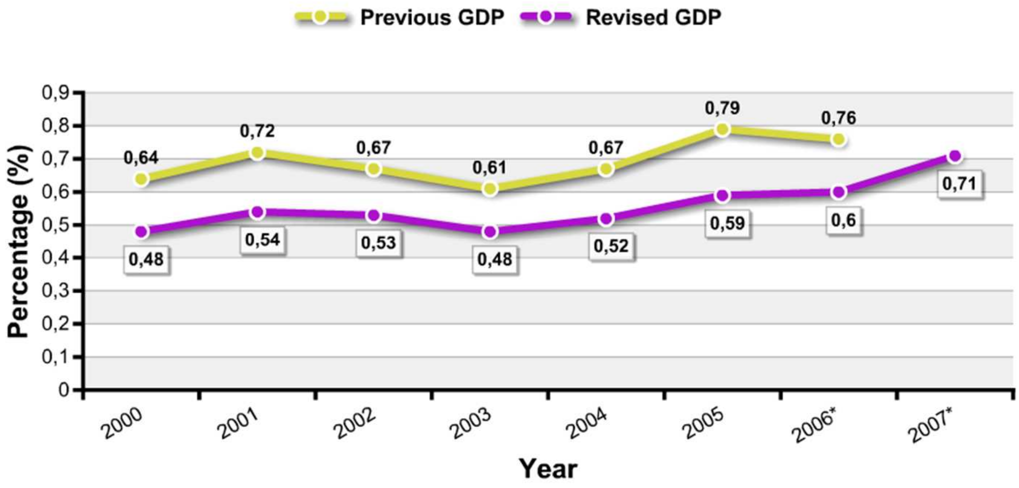


Figure 4.3 GERD Intensity in Turkey

Source: TurkStat

In Figure 4.3 two series exist one of which is calculated by revised GDP based on 1998 and the other is old one based on 1987. Since the definition and content of GDP changed, the value of R&D intensity changes which causes misunderstanding. Moreover, in the years of 2006 and 2007 calculated by revised GDP, gross salaries are used for calculation of R&D labor cost in higher education sector which causes break in the series. This also creates problems in comparisons with other countries. Moreover, some military institutions and institutions like education and research hospitals and municipals are not included in the survey. In universities, only researchers are included in the survey and number and expenditures of technicians and other support personnel is skipped. Similarly, vocational training schools are not counted. There are also problems with including income obtained from revolving fund for researchers at universities and earnings gained from R&D and innovation projects of national sources like TÜBİTAK and international sources like EU. TurkStat is working on improving measurement framework together with scholars working on this topic and with stakeholders using these data, but it is not possible to change all at once. So, while using R&D data, all the problems mentioned above should be considered.

Taking the one-year data as a snapshot and comparing it to another country or countries also creates problems since the structure and past trends of the country are ignored. So, these indicators should be given by growth rates which enable tracking the trends. However, this may be a bias for developed countries for their industries' working nearly full capacity. A developing country may increase its R&D expenditures twofold in a short time since it has not reached saturation level, but it is not possible in developed countries.

The R&D intensity data is affected by changes in the value of GDP such that R&D expenditures increases by years, but if the GDP growth rate in these years is greater than that of GERD, the value of GERD in GDP appears to be decreased. Because of this reason, R&D expenditures in monetary unit should be taken into consideration together with GDP although it does not allow comparison to other countries without using the PPP values. The figure given below reveals rate of changes in both GERD and GDP.

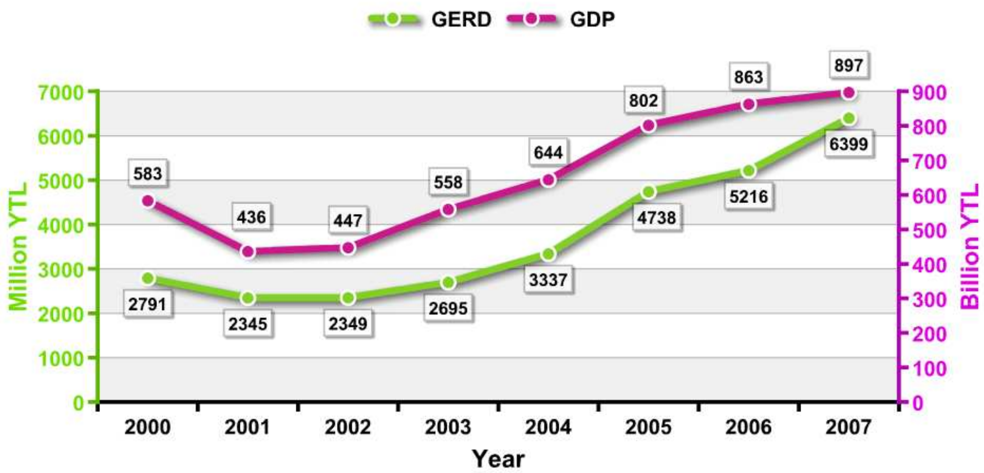


Figure 4.4 R&D expenditures versus GDP in Turkey (2008 constant prices)
Source: TurkStat

Another indicator widely used for comparison between countries is R&D expenditures per capita as shown in Figure 4.5:

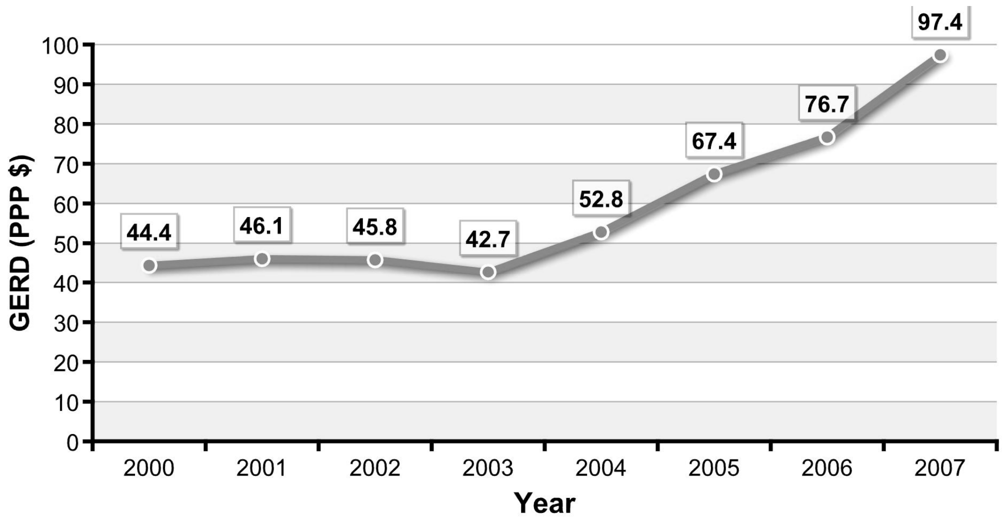


Figure 4.5 GERD per capita population in Turkey

Source: TurkStat

Although having a population over 70 million is a potential for Turkey for development, not being able to use this potential together with other structural problems becomes a disadvantage for Turkey as a high populated country. Although R&D expenditures are for the benefit of whole country and have the potential of having profit for the economy, the only part of the population performing these expenditures is mostly R&D personnel/researchers. So, taking R&D expenditures per researcher or per R&D personnel puts forward a more realistic figure. Precisely, it would not be appropriate to use this indicator instead of “per capita population” but it will show the picture of R&D performing from the perspective of performers. Becoming low of this indicator compared to other countries presents two results: one is conducting small number of R&D activities compared to other countries or spending less depending on the quality of the research which is not easy to separate from each other without knowing the system in the country.

Composition of R&D spending is also an important indicator for revealing the structure of the system in the country. GERD by sector of performers in Turkey is given in the Figure 4.6. It is known that GERD performed by business enterprise sector is higher than that of government and higher education sector in all industrialized countries. However, in Turkey highest education sector have a higher share which reveals that R&D is conducted mostly in the universities in the form of basic research.

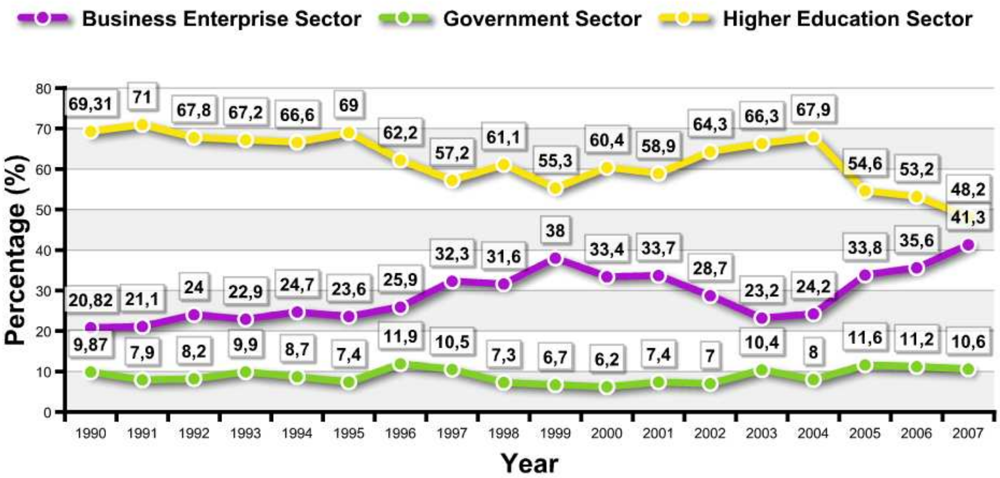


Figure 4.6 Percentage of GERD by performance sectors

Source: TurkStat

GERD by source of funds is also an important indicator. Figure 4.7 gives the yearly data of percentage of GERD by source of funds. A similar pattern is observed in the figure different from developed countries which are caused by structure of Turkish system, not the indicator. However, it is seen that in recent years the situation has started to change slightly.

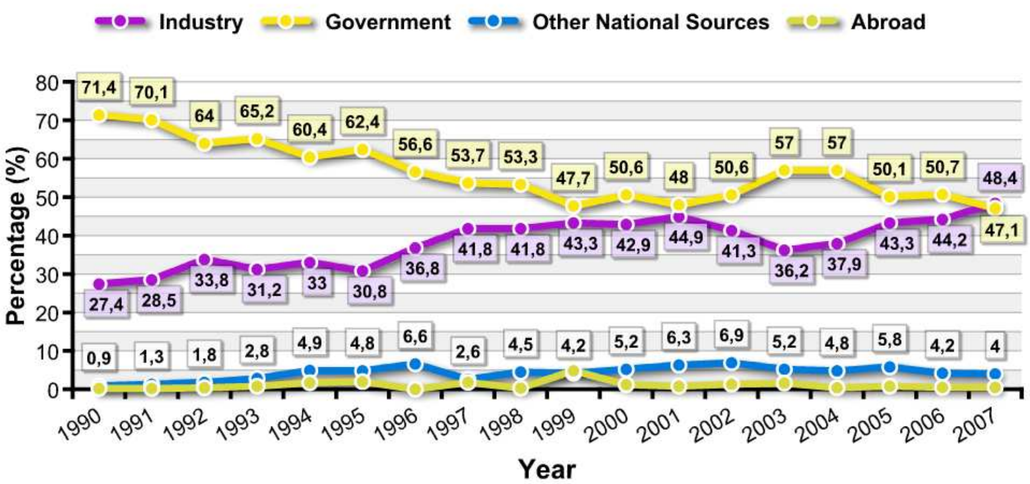


Figure 4.7 Percentage of GERD by source of funds

Source: TurkStat

Percentage of GERD by sector of performers and source of funds are given in the figures above. However as mentioned before, yearly decreasing or increasing of each sector need not be caused by real decrease or increase. All the sectors may increase/decrease their values, but one of whose growth rate can be much above/below the others. So the monetary values should be taken into consideration while interpreting.

Since innovation is conducted by business enterprise sector which is the main driver of economic growth, composition of business enterprise sector R&D expenditures by activities is very important. Composition of R&D expenditures in business enterprise sector by International Standard Industrial Classification of Economic Activities (ISIC Rev. 3.1) in 2007 is given in the Table 4.1. Although such a detailed data are not used for benchmarking between countries, it is useful to see the sectorel distribution. It is seen that in 2007 68% of R&D is conducted by manufacturing sector and 31% is conducted by the service sector which seems to be including low-tech. R&D.

Table 4.1 Composition of R&D expenditures in business enterprise sector by ISIC

ISIC Rev. 3	Description	%	ISIC Division	Description	%
01-02-05	**Agriculture, Hunting, Forestry and Fishing**	**0.14%**	34	Motor vehicles, trailers & semi-trailers	28.27 %
10-14	**Mining and Quarrying**	**0.34%**	35	Other transport equipment	3.06%
15-37	**Manufacturing**	**68.19 %**	36-37	Manufacturing n.e.c.; Recycling	0.67%
15-16	Food products, beverages & tobacco	1.87%	**40-41**	**Electricity, Gas and Water Supply**	**0.16%**
17-18-19	Textiles, textile products, leather & footwear	1.32%	**45**	**Construction**	**0.39%**
20-21-22	Wood, pulp, paper, paper products, printing & publishing	0.40%	**50-99**	**Service Sector**	**30.73 %**
23-24-25	Chemical, rubber, plastics & fuel products	8.03%	50-55	Wholesale & retail trade; repairs, hotels & restaurants	2.37%
26	Other non-metallic mineral products	1.73%	60-61-62-63-64	Transport and storage; communication	3.41%
27	Basic metals	0.86%	65-66-67	Financial Intermediation	5.76%
28	Fabricated metal products, except machinery & equipment	0.95%	70-74	Real estate, renting & business activities	18.27 %
29	Machinery & equipment n.e.c. (not elsewhere classified)	8.12%	75	Public administration and defense; compulsory social security	0.27%
30	Office, accounting & computing machinery	0.13%	80	Education	0.03%
31	Electrical machinery & apparatus n.e.c.	1.84%	85	Health and social work	0.16%
32	Radio, television & communication equipment	9.82%	90-91-92-93	Other community, social and personal service activities	0.25%
33	Medical, precision & optical instruments	0.60%		**Total**	**100%**

Source: TurkStat

Lastly, it would be incomplete to finish this part without monitoring quality of R&D. Focusing on the quantity of R&D expenditures rather than the content of R&D will be a mistake (Forbes and Wield, 2002). This is somehow done by presenting success stories by amount of export as a result of R&D or import prevented by R&D, increase in employment and so on. However it is not possible to measure this indicator in the national context to see the whole picture. Moreover, evaluation of public R&D funds is a hot topic to see the impacts of these funds. Industrialized countries are working on developing methodologies for evaluation. It is also spoken in Turkey, but studies have just started. After proceeding and obtaining results, it will be very beneficial for defining future strategies.

4.1.2. Human Resources

As regarded by all scholars, human capital is core of technological development. Since technology is embodied in human, human capital is accepted as driver for technological advance (STEP, 2002). Rapid technological changes increase need of skills for competitiveness especially in developing countries calling for more skills, higher level of skills and different skills (Lall, 1999). Development and diffusion of knowledge are done by highly skilled human resources in science and technology which is defined by the OECD Canberra Manual as following:

...people who fulfill one or other of the following conditions:

- *successfully completed education at the third level in an S&T field of study;*
- *not formally qualified as above, but employed in a S&T occupation where the above qualifications are normally required.*

People working in the S&T activities but having low skills like secretariat in R&D department are also included in the human resources for S&T according to the Canberra Manual. This brings the classification by the standard international classification by the International Standard Classification of Occupations (ISCO). According to ISCO basic definitions by occupation in the Frascati Manual (2002) is given below:

> ***Researchers*** *are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned.*
>
> ***Technicians and equivalent staff*** *are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers. Equivalent staff performs the corresponding R&D tasks under the supervision of researchers in the social sciences and humanities.*
>
> ***Other supporting staff*** *includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects.*

Since the definition of human resources here concentrated on science and technology, the problems discussed in the previous section are also valid here. In Turkey, not including technicians and other support personnel in the survey on higher education sector causes underestimation. R&D human resources are measured as headcount and Full Time Equivalent (FTE- person-year spent on R&D) approach. There are problems in calculating FTE since it is not asked by survey. A study in this topic is expected to start in coordination with TurkStat. Another problem in survey content is PhD students who are not working but receiving scholarship from TÜBİTAK. Although PhD studies are a part of R&D according to the Frascati Manual, PhD students are not calculated in R&D human resources data. Scholarship given by TÜBİTAK do not also included in R&D expenditures. Till developing methodologies to count these missing values, the R&D personnel and researchers number will be underestimated.

There is also non-technological innovation notion which is very important for especially developing countries that S&T human resources do not cover it. This kind of data are captured by CIS, however CIS is applied on enterprises chosen by sampling. Because of this, data obtained from R&D surveys are widely used.

R&D human resources data for Turkey are given in Figures 4.8 and 4.9. The first one illustrates R&D personnel per 10,000 total employment. Headcount data is not comparable alone, that is why it is divided by total employment.

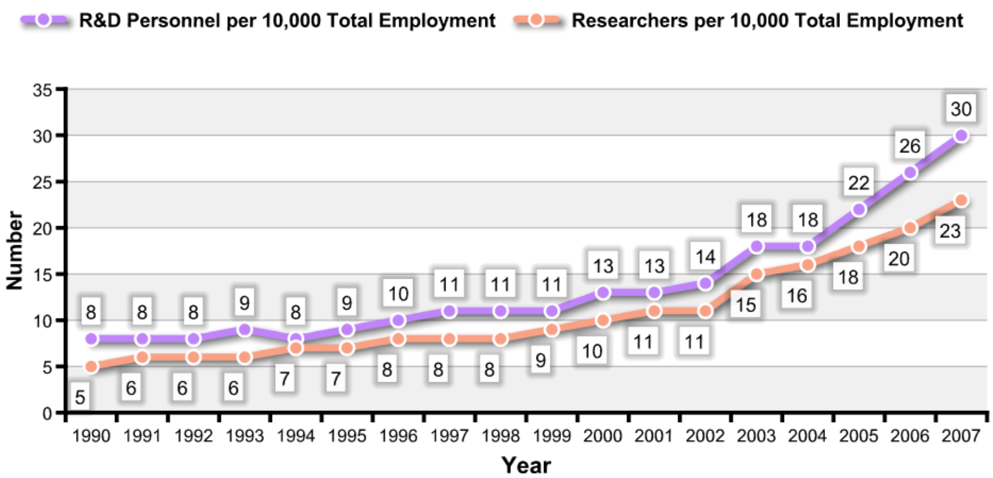


Figure 4.8 R&D human resources per 10,000 employment

Source: TurkStat

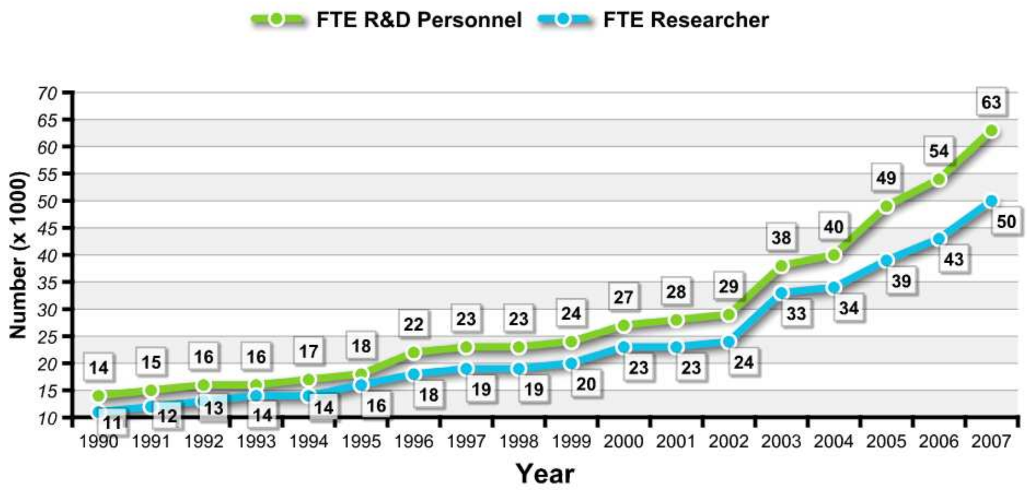


Figure 4.9 FTE R&D personnel and researchers

Source: TurkStat

Although human resources data are very important for measuring innovation, problems as experienced in R&D expenditures like definition change, break in the series cause misleading interpretation. For example, when looking at the figures, it seem like there is a sharp increase in R&D human resources in 2003. However, this is caused by the change in the definition of full time equivalent R&D personnel and researchers that TurkStat uses in surveys. This makes it difficult to compare the values of 2002 and 2003.

It is known that technological innovation increases the demand for highly educated and highly skilled workers because they have a comparative advantage in helping companies implement new technologies effectively (Siegel et al., 1999). The human resources indicators enabling this contribution are science and engineering graduates. Moreover, post secondary and non-tertiary education is also important for educating technicians and equivalent staff. However, although the number of students graduated from these schools gives the potential in technological aspects, all of them need not be involved in these processes. Because of this, these indicators are not enough alone. There is also non-technological innovation which is very important in developing countries. It is not possible to separate disciplines in education potential for this kind of innovation like in technical areas. However, gross enrollment ratio in tertiary education and youth education attainment level are used for revealing potential.

Recently, internalization of R&D caused by competition between countries give rise to “brain drain” and “brain gain” notions. Industrialized countries are competing to each other to attract skilled labor especially in developing countries. However, it is not easy to measure the size of outgoing human capital although it is very important for developing policies. A similar conception which is very popular is mobility of doctorate holders. Industrialized countries are performing studies for measuring and tracking this data, however it is not appearing studies related to this topic in Turkey in the near future.

Human resources cannot be fully evaluated without interaction and knowledge diffusion between scientists, engineers and other actors involved in innovation. Innovation surveys give information on innovation cooperation. But, there are also studies like network analysis obtained by case studies in limited sectors or small ranges.

4.2. Output Indicators

4.2.1. Patents and Utility Models

Patents and utility models are powerful tools for avoiding the risk of infringement for individuals or firms. Therefore there has been always a tendency for applying to national and international patent offices especially in developed countries.

“*A patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem* (WIPO, Frequently Asked Questions). Utility models are very similar to patents and sometimes referred to as "petty patents" or "innovation patents" (WIPO, Protecting Innovations by Utility Models). Although utility models are rights granted to protect invention, its definition varies between countries. In Turkey, utility models are granted for all products which comprise of technical development and can be patentable except chemicals and processes. World Intellectual Property Organization (WIPO) defines differences between patents and utility models as following:

- *The requirements for acquiring a utility model are less stringent than for patents. While the requirement of "novelty" is always to be met, that of* *"inventive step" or "non-obviousness" may be much lower or absent altogether.*

- *The term of protection for utility models is shorter than for patents.*
- *In most countries where utility model protection is available, patent offices do not examine applications as to substance prior to registration. This means that the registration process is often significantly simpler and faster, taking, on average, six months.*
- *Utility models are much cheaper to obtain and to maintain.*
- *In some countries, utility model protection can only be obtained for certain fields of technology and only for products but not for processes.*

Since utility models are much cheaper and easier compared to patents, they are mostly suitable for SME’s. However, some inventors apply for utility model instead of patent although their invention can be patentable since patenting procedure is very long, costly and have short term economic value of the invention (Yalçıner, 2000).

Patents are regarded as tools for providing incentives for innovation, contribution to technology diffusion, and hence affecting economic performance (Patents and Innovation: Trends and Policy Challenges, 2004). Moreover, patents are used as innovation output indicators by international organizations like OECD, EU and the others. However, whether they have a similar function in developing countries like Turkey is a matter of dispute. Patents indicate a positive fraction of output from R&D (Connolly, 2003). As it is known, R&D and innovation are quite costly processes. Patents and utility models provide inventors to return their R&D expenditures by licensing, but it is not enough to stimulate R&D especially in developing countries.

When comparing innovation performances of different countries, patent statistics are used at international level like applications to European Patent Office or grants given by United States Patent and Trademark Office. However, as Pretnar (1990) stresses taking out patents on foreign markets has no real sense for enterprises from less developed or developing countries.

Protecting inventions by patenting provides inventors to hold the right of monopoly and to produce new technologies by motivating R&D activities. Moreover, publication of all details of patented invention helps diffusion of knowledge of the latest technique which invention comprises (Yalçıner, 2000). However, although patents bring many advantages for firms or individuals, they have many disadvantages.

First of all, although patents are good indicators of new technology creation, they do not measure the economic value of these technologies (Hall et al., 2001). Most of them have no industrial applications or many inventions cannot be patentable.

Second, industrial structure of a country is an important factor affecting patent application, i.e. being very high of patenting in the US is mainly caused by higher concentration of high-tech manufacturing sector across the country. (Pro-Inno Europe, IPR)

Next, strict patent protection is alleged to have negative effect on developing countries, because most innovation in developing countries may actually be imitation (Schneider, 2005). Lower protection helps imitation of foreign technologies; it reduces the market power of foreign firms and benefits domestic consumers (Chen et al., 2005). At this point, technology diffusion gets important. Import can embody innovation inexistent in the country and it may provide insight from this innovation by technological diffusion promoted by trade (Schneider, 2005). A study conducted by Connolly (2003) indicates that high technology imports in developing countries increases significantly imitation and innovation and contributes more in growth than domestic technology. So, in developing countries technological activity consists of learning to use imported technologies efficiently. Protecting inventions by patenting provides inventors to hold the right of monopoly and to produce new technologies by motivating R&D activities. Moreover, publication of all details of patented invention helps diffusion of knowledge of the latest technique which invention comprises (Yalçıner, 2000). However, although patents bring many advantages for firms or individuals, they have many disadvantages.

Nevertheless, as Griliches (1990) alleges, patent statistics are the unique source for analysis of the process of technical change with the help of availability, accessibility and details given by data. Although it is not easy to obtain economic value of patents, they provide a wide range of information and are used as innovation output measures. Moreover, when patent counts are used as a science and technology indicator for the first time by National Science Foundation of US, they showed that the US should pay more attention to Japan as a competitive industrial power (Grupp and Mogee, 2004).

Patents are instruments for firms to practice technology and enable measuring firm's technological competence since they show commitment to R&D and technology although indirectly. Other things being equal, one would expect the firm having (more) patents to be better able to develop new products, processes, or services based on this technology (Breitzman and Mogee, 2002).

Lall and Albaladejo (2001) states that complex engineering, electronics and similar sectors require high degree of tacit knowledge (technology-specific skills, experience, learning, information and organization needed to be competitive) in technological activities. That is why copying is very difficult and expensive in these sectors which causes patent applications' being low. However, in industries like fine-chemicals and pharmaceuticals, it is easier for rivals to copy products. As a result, patents are vital for sustaining the large and risky R&D expenditures needed for product innovation.

There is also the term of "sleeping patent" used by dominant firms to block entry into the market like in the Xerox case which was alleged to have taken out patents over inferior technologies in order to block entry and protect its dominant position (Weeds, 1999). These kinds of instances prevent other firms in the sector doing R&D, and hence taking patents which is an unwanted situation for a developing country.

As seen from the discussions above, patents and utility models are indicators on which there is a huge dispute. Some scholars support using them as output indicators, but some object this idea. However, patent applications to and grants given by European Patent Office (EPO), United States Patent and Trademark Office (USPTO), and number of triadic patent families which are defined as a set of patents filed simultaneously at the EPO, USPTO and the Japanese Patent Office (JPO) are used to making comparisons among countries. They are shown for Turkey in the figures below:

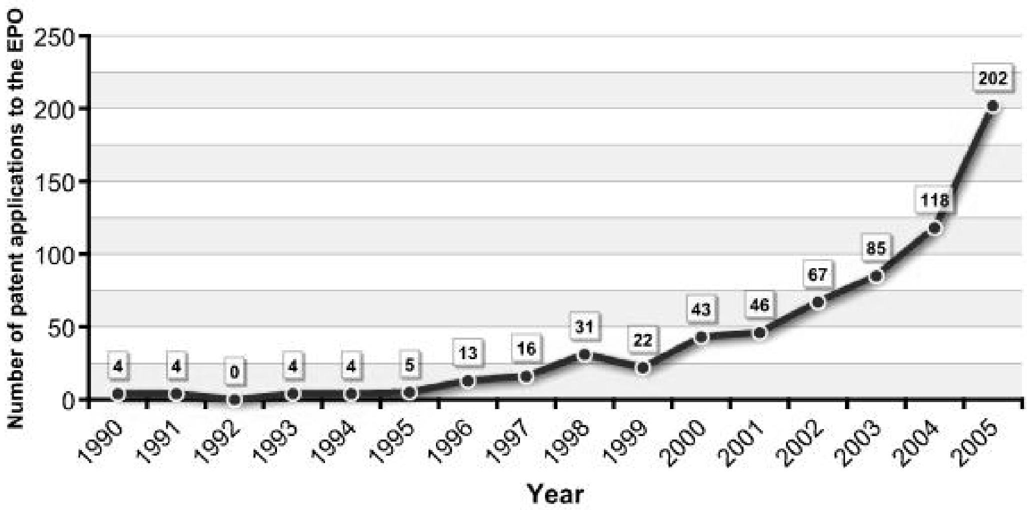


Figure 4.10 Number of patent applications to the EPO (priority year)

Source: OECD, Main Science and Technology Indicators: MSTI, 2008/1

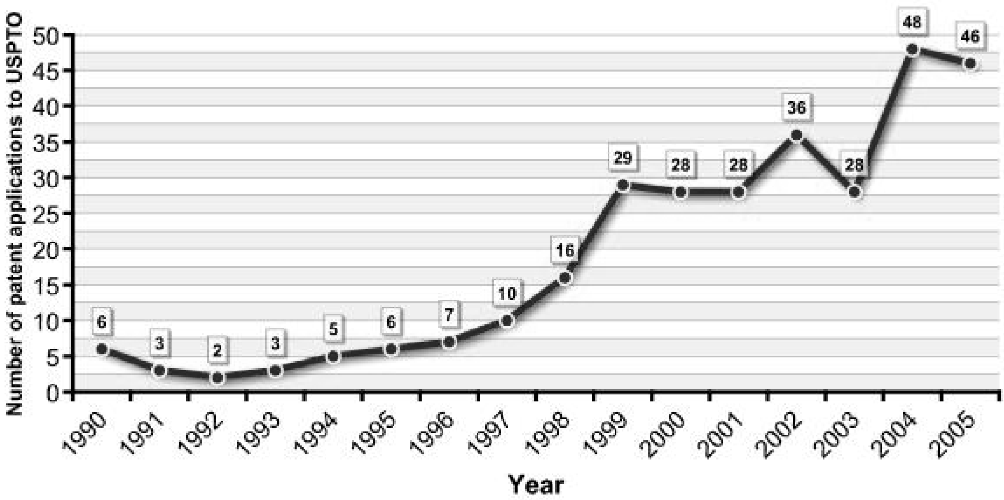


Figure 4.11 Number of patent applications to USPTO (filing year)

Source: OECD, Main Science and Technology Indicators: MSTI 2008/1

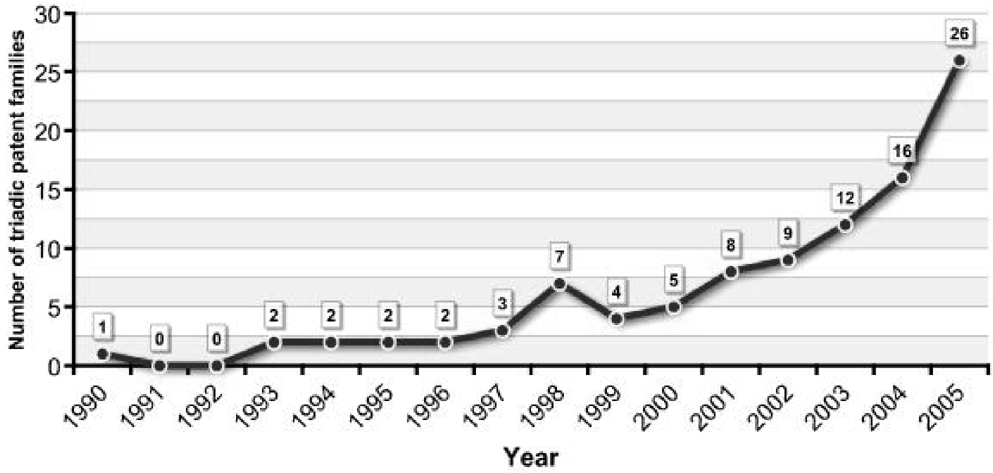


Figure 4.12 Number triadic patent families (priority year)

Source: OECD, Main Science and Technology Indicators: MSTI, 2008/1

It is seen from the figures that although number of application in EPO, USPTO and triadic patent families increase rapidly in recent years, the patent numbers are still low. EPO applications are higher compared to USPTO and triadic patent families. There are some reasons for increasing like increased public awareness of patent protection, will for increasing technological capabilities and seeing the Europe as new market, and financial support mechanism of TÜBİTAK both for domestic and international patent applications. When the EPO applications are investigated it is seen that US, Germany and Japan are in far ahead. When it comes to USPTO applications, US, Japan, Germany, Korea and China are top five. However there is a bias towards USA since USPTO is national patent office of US. In triadic patent families US, Japan and Germany have the share of nearly 75 % of all OECD applications. As the case in USPTO applications from the USA, EU countries have the advantage of marketing in EPO. Since Turkey does not have such a benefit, Turkey seems to drop behind automatically. While comparing the number of applications to and grants given by international patent organizations, numbers are given by per million population. Although these indicators are used reflecting a country's general performance, the group of people potential to take patents are researchers or R&D personnel. So instead of using per million population, they should be given as per researcher enabling more fair comparison.

Another remarkable aspect of patenting is that number of patent applications increase when the number of R&D personnel is high as illustrated in the figure below depending on a study published by Eurostat (Felix, 2008):

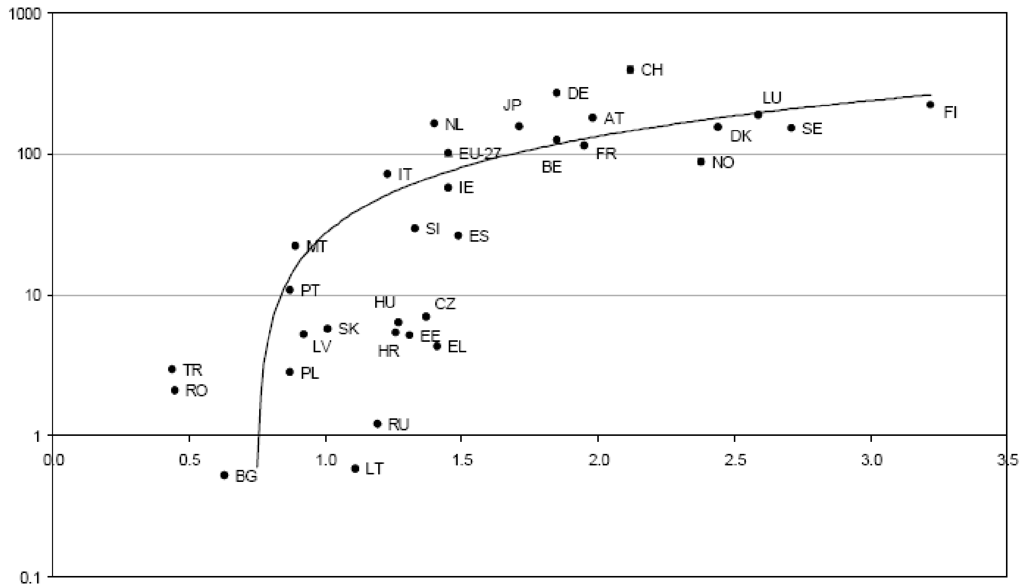


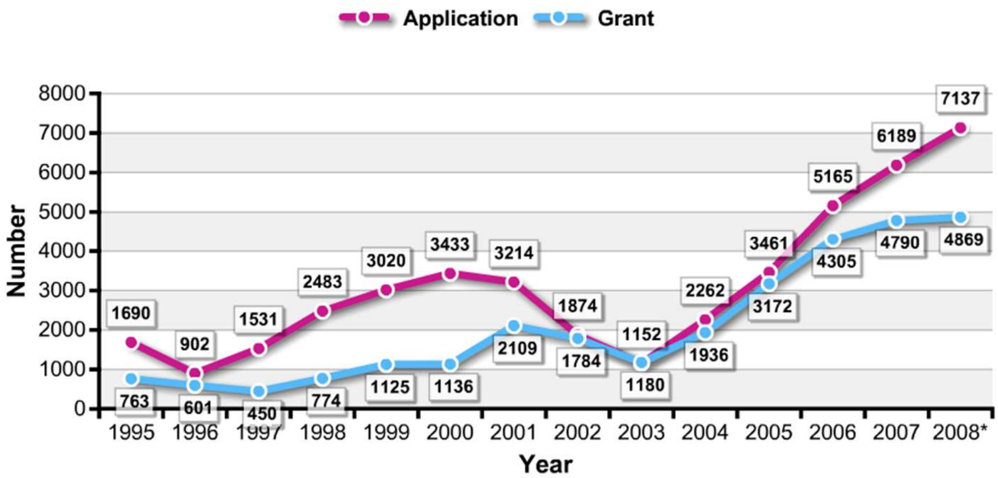
Figure 4.13 Correlation of patent applications to EPO per million inhabitants (log scale) and R&D personnel as share of total employment (2005)
Source: Eurostat

It is seen from the figure that there is a logarithmic correlation between EPO patents per million inhabitants and R&D personnel as a share of total employment. This means that the higher the number of R&D personnel, the higher the number of EPO patent applications for selected countries. Turkey again falls behind industrialized countries because of EPO patents are taken. The same thing applies to R&D expenditures and especially business enterprise R&D expenditures and patents. This indicates that using these indicators together as innovation indicators are misleading especially for developing countries like Turkey.

There is also problem in doing R&D and taking patents and/or utility models by multinational companies. Although they operate in many countries, their R&D centers are mostly in their home countries which are mostly developed ones.

Although they produce in a developing country like Turkey, they mostly do not take patents in the country.

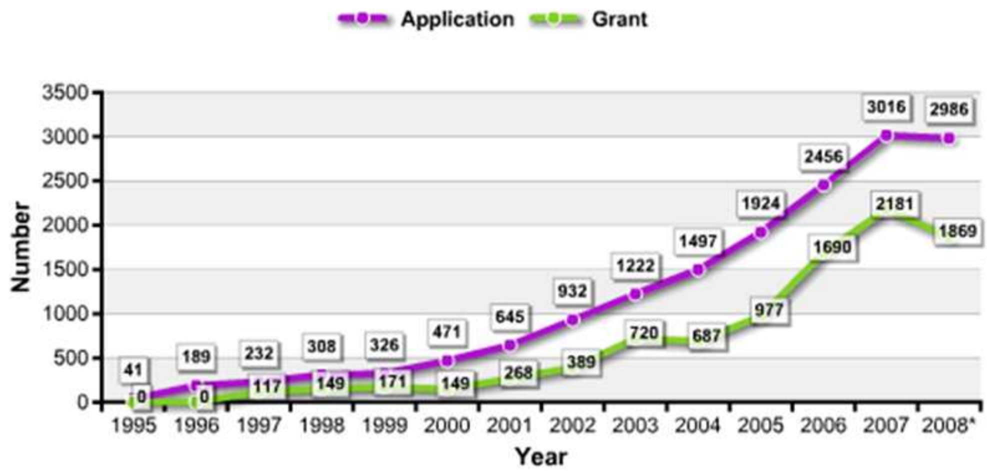
Coming to national indicators, patent and utility model application and grant numbers are given in the figures below:



* By January 22, 2009

Figure 4.14 Patent applications to Turkish Patent Institute (TPI) and grants given by TPI

Source: TPI



* By January 22, 2009

Figure 4.15 Utility model applications to TPI and grants given by TPI

Source: TPI

It is known that for a country which does not have trade relationships with some countries, there is no purpose of taking out patents in those countries if they are not planning in the future either. Because of this reason, investigating of patent applications and grants in national patent offices is more reasonable. Patent and utility model applications from both domestic sources and abroad via PCT (Patent Cooperation Treaty) and grants given by TPI are shown in Figure 4.14 and Figure 4.15. It is seen that number of applications and patent have an increasing trend in recent years. As mentioned above, TPI and TÜBİTAK made an agreement on a new support mechanism for national, international, and triadic patent applications in the year of 2006. In this context, predefined amount of cost of national patent applications to TPI and international patent applications under some circumstances is paid by TÜBİTAK. Although it is a new program, its effects are visible by Figure 4.14. By this support program, patent applications are expected to increase significantly in the near future. This is again an external factor affecting behavior of researchers. When the patent data are taken for analysis, this factor should be taken into consideration.

It is also known that patents and utility models are mostly taken by firms and individuals in firms. Therefore, patent and utility model applications per R&D personnel in business enterprise sector will provide more reasonable results of innovation capability of country’s researchers in terms of intellectual property.

4.2.2. Scientific Publications

In order for defining research quality and efficiency of countries, production and quality measurement and evaluation of academic research units have an important role on providing sources on continuing scientific researches and academic promotion (ULAKBİM, 2007). Scientific publications are powerful tools for transferring knowledge into production. Because of this, they are used as innovation output indicators.

Scientific publications are produces by mostly universities and they measure extend and depth of country’s research. However, since they are written at universities they may not be shared with private enterprise sector which is expected to use these publications as inputs for their production. Because of lack of cooperation between university-business enterprise sector and government sector, valuable outcomes may become useless. Because of this, they do not give any information on whether knowledge it contains transferred into application.

Writing and issuing publications in some disciplines are easier than some other. For example a scientist studying medicine has mostly more publications than a scientist studying social sciences. Moreover, in some discipline like Economics it is possible to change the assumptions and produce a new publication using the same methodology.

In spite of these disadvantages, university staffs are always in a competition to produce more publications and publish them in respectable journals since academic prestige and opportunity to promote they provide. However, number of journals is not a sufficient indicator alone since considerably number of publications are not used and transferred into application. Because of these, citations are mostly used as innovation indicators. It seems to be a positive contribution to science and country's knowledge stock to increase the number of publications and citations; however improper exploitation also appears in this area. Scientists sometimes form citation networks in which they only cite each other. They do not use any other scientist's study that is not in the network. This is certainly not ethical and hence decreases confidence. While using scientific publication and citation numbers as innovation output indicators of a country, all of the negative factors should be taken into consideration.

There are also measurement problems related to scientific publications. Although all of them are registered materials, it is not such easy to obtain standard indicators from them. Countries, apply different methodologies and tools to collect data which cause problems for comparison. One of the research platforms for searching in the wide database of sciences, social sciences, arts and humanities is *ISI Web of Knowledge.* Data obtained from ISI database for Turkey is given below:

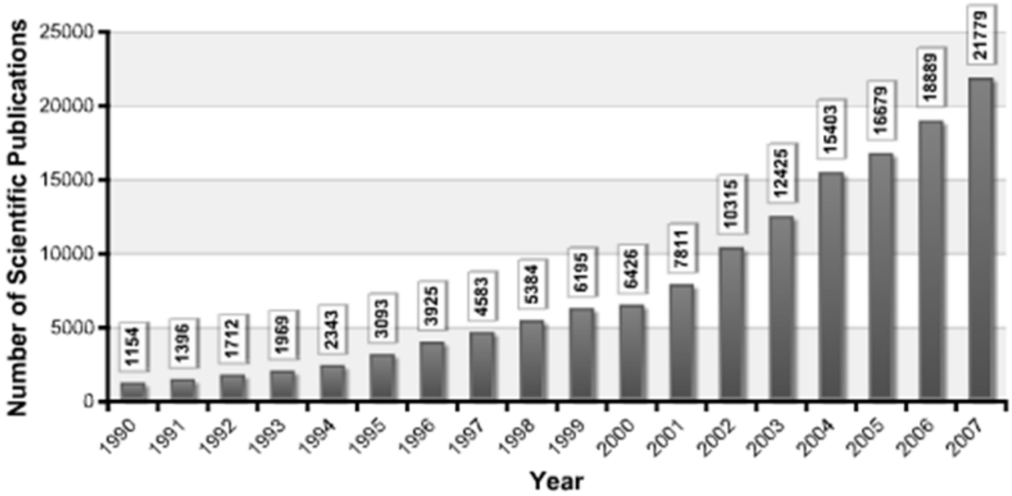


Figure 4.16 Scientific Publication originated from Turkey

Source: Thomson's ISI Web of Science (Database: SCI-EXPANDED, SSCI, A&HCI)

It is seen that number of publications originated from Turkey increases rapidly by years. As it is mentioned using of publication constraints to promote in universities and increasing the number of universities and hence academic personnel in universities increased this number strikingly. However, this indicator does not provide country wise comparisons since it depends on country's size. Because of these reasons, scientific publications per million population is used ad in Figure 4.17:

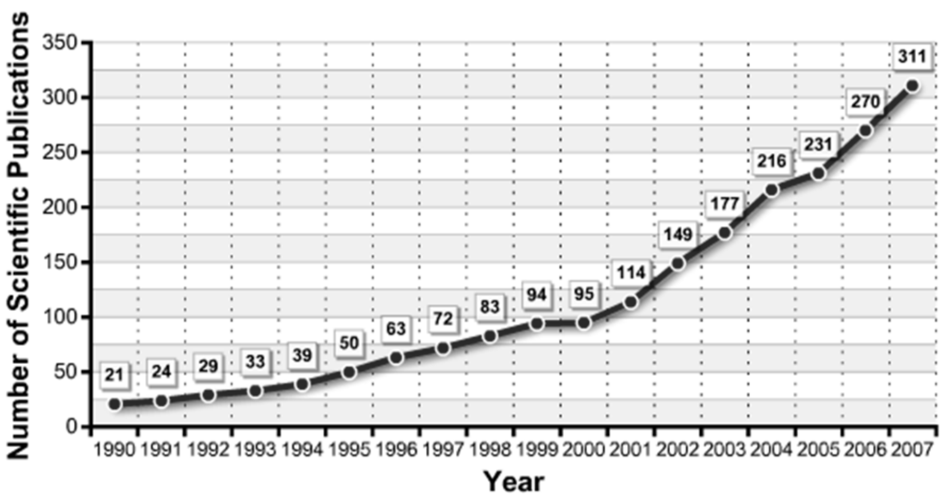


Figure 4.17 Scientific Publication per million population

Source: Thomson's ISI Web of Science (Database: SCI-EXPANDED, SSCI, A&HCI)

It is possible to compare country performances by using data in Figure 4.17, but there is a drawback of using this indicator that scientific publications are mostly produced by academic staff and nearly half of the population of Turkey is comprised of young people and children which are not capable of doing academic studies. Because of this, scientific publications per academic staff and even per sum of professors, associate professors and assistant professors would give a literal measurement.

As mentioned above, number of scientific publications is not enough to define scientific output without citation information. However, citation data obtained from the Internet is not reliable. Therefore, it is not used in this section. There is also missing information on citation networks which give interaction of researchers in and outside of the country. Citation analysis is done on a limited discipline or geographical area within projects; however, obtaining national indicators is not easy and logical since different disciplines mostly do not cooperate except from interdisciplinary studies.

4.2.3. High Technology Exports

High technology defines firms and industries whose products or services embody advanced technologies with the ability of high value added production which contribute to countries' economy by fostering competitiveness (Seyoum, 2004). Aerospace, electrical and electronic equipment, chemical products, pharmaceuticals are all regarded as high-tech. products. Many countries are trying to develop high-tech. sectors by investigating huge money in this sector. Industrialized countries like USA who has 19-26% of world share in high tech sector do not want to lose their shares, where other countries are trying to compete with them in this sector (Seyoum, 2004). Not only industrialized countries, but also developing countries want to take place in this developing sector. However, there is a debate on whether high technology exports are as it is seen especially for developing countries.

Although the World Bank has many studies on high-tech. exports, they claim that high-tech. is not always associated with high value added, high wages and rapid growth (World Bank, Science, Technology and Innovation – Key Issues). They start from the fact that since policymakers view high-tech as the only way for competitiveness, they devote enormous resources to develop this sector in the country. However, developing and emerging countries have an option obtain value added by strengthening low and medium technology sectors and trying to develop a few niche products and industries from them. For example, although computers are high-tech. products, assembling computers are not. Moreover, the World Bank claims that some sectors classified as low-tech. may include medium or high-tech activities which results in wrong classification.

Forbes and Wield (2002) also alleges that viewing high technology as always better than low is a myth with an alternative of developing “well-known” and well-used” technologies focusing on quality issues rapid turnaround of parts production, smaller inventories and shorter product life with a different factory layout. Instead of trying to develop high tech industries from the mature ones, they would better to try reorganization and transformation of those industries.

Certainly there are developing and catching up countries making a name in high-tech. exports like Korea and Singapore; however, Mani’s study (2000) shows that only a few countries achieved having a high share in high tech exports, but remaining are far behind.

High technology exports of Turkey are given in the table below:

Table 4.2 High Technology Export of Turkey

High Tech. Export (1000 USD)	2003	2004	2005	2006	2007
Aerospace	529,643	599,587	369,954	665,528	811,792
Pharmacy	229,723	301,903	334,655	371,632	418,749
Computers – Office machines	28,683	36,378	49,203	62,334	117,799
Electronics – Telecommunications	1,976,798	2,909,234	3,18,.830	3,120,135	2,791,908
Scientific instruments	127,234	170,176	194,195	240,521	328,911
Total	2,892,081	4,017,278	4,133,837	4,460,150	4,469,159
Share in Total Export (%)	6.1	6.3	5.6	5.2	4.1

Source: Undersecretariat for Foreign Trade

It is seen that Turkey's share in high-tech export has been decreased since 2001. However, higher shares are results of television and telecommunication exports like Beko and Vestel. Considering the electronics and telecommunication sector, Turkey ranks the first with 36 % export in the world (Türkoğlu, 2008). However, it is just a choice for competitiveness with other countries. All countries need not concentrate on high technology production, even though do, they do not have to export their products. Because of these factors, high technology exports are not good indicators for innovation. Instead, medium-high technology production and exports are better indicators especially for developing countries.

There is also an important indicator of technology balance of payments which is not calculated for Turkey measuring international transfers of technology: licenses, patents, know-how and research, technical assistance. Unlike R&D expenditure, these are payments for production-ready technologies. In globalizing world, these indicators have an important role on innovation measurement. (STI Scoreboard, 1999). TurkStat is preparing for measuring Technology Balance of Payments in the near future, but for now no prediction is available for comparing with other countries.

CHAPTER 5

CONCLUSION

Innovation which is roughly defined as the first introduction of an invention on the market has the central on providing competitive power to both firms and countries by increasing quality of life ant contributing into wealth of nations. It is done by changing and/or development of products, services and manufacturing processes. Although there is an accurate definition of innovation, is structure changes and gets wider according to social, economic and infrastructural characteristics of countries. Because of importance of innovation for both firms and countries, measurement of innovative activities is very important especially in industrialized countries. However, as the scope of innovation changes from region to region, measurement scope is not expected to be same. In this study, I tried to answer the questions of whether internationally used innovation indicators are adequate for Turkey as a developing country; if not what are the incompatibilities with widely used ones and what can be done to overcome these problems systematically. The novel contribution of this study is going from the general framework of measurement and evaluating particular indicators in terms of relevance for Turkey. There are many studies investigating innovation indicators and benchmarking between countries, but this study does not aim at explaining current situation in innovation in terms of technological development. It tries to define whether these indicators are reliable for capturing technological developments or the factors behind those technologies.

In order for evaluating indicators, the innovation environment should be defined carefully both in developed countries and developing countries. Therefore, it is started by definition of innovation. Since innovation is a recent concept compared to R&D, the definition and content of innovation changes in time from simple to more complex with changing economic and technological conditions. This naturally generated a cycle in which macro policies are made on innovation outputs which emerge measuring concept. Measuring needs to be done systematically enabling international comparisons whose framework is defined by studies of international organizations like OECD. As a result of these studies, the

Oslo Manual - Guidelines for Collecting and Interpreting Innovation Data developed by OECD and Eurostat is developed. The Oslo Manual defines innovation in four types as product, process, marketing and organizational innovations and methodological framework for measurement these types in its third edition. The Oslo Manuals outlines and guides the Community Innovation Survey in Europe. However, these studies attracted attention of developing countries in different regions that they developed their own guidelines to capture different characteristics of innovation in their regions. Regional manual of Bogota in Latin American and Caribbean countries is a striking example for developing countries. The Bogota Manual takes its inspiration from the Oslo Manual as proposed in the beginning of studies. However, surveys guided by the Bogota Manual extends innovation framework for adapting in the region. They include activities of acquisition of embodied and disembodied technology like hardware, licenses and consultancy as innovation efforts. This is very important for Oslo Manual's focusing on only innovative firms in the classical sense.

Later on, innovation systems in developing and emerging countries are defined in detail which leads different measurement methodologies. Economic instability, public policies, not understanding the importance of innovation affects firms starting and conducting innovation activities. The main difference is caused from the definition of innovation in terms of technical change achieved by diffusion which is called "learning". The learning concept forms the National System of Learning different from National System of Innovation. National Learning Systems are defined as the process of learning by absorption and incremental innovation. However, this process is not achieved in all developing countries in the same manner. Technological capabilities of countries draw different illustrations from each other in the way of development. Because of these differences measurement framework differs from country to country.

After defining characteristics of innovation and factors triggering innovation from the concept of technical change, Turkey example is evaluated. Turkey has both advantages and disadvantages considering its characteristics. However, in recent years political commitment in the policy framework is very important for advance in science, technology and innovation. Turkey is investigated in terms of input indicators which are investment in R&D and human resources and output indicators of patents and utility models, scientific publications and high technology exports.

As it is known R&D is a key element in knowledge-based economy. Therefore, indicators like R&D expenditures and R&D intensity are used for measuring innovation. However, R&D is just a part of innovation and even in developed countries innovation is more important than R&D. Moreover, for developing countries it is more important to choose the problems cheaply instead of doing by sophisticated and expensive methods. There is also diffusion of knowledge and skills term of innovation which is discarded by R&D in developing countries. There are also problems caused from measurement process such as changing the definition and concept of the indicator such as revising GDP and using gross salaries for calculation of higher education sector labor cost in R&D expenditures. Moreover, some institutions are not covered in the survey together with some kind of expenditures. These factors all cause underestimation of R&D expenditures. In order for illustrating absorption of R&D expenditures, 'R&D expenditures per R&D personnel or researchers' is recommended to use together with R&D per capita. There are also deficiencies in terms of investment in R&D for Turkey which are focusing on quality of R&D instead of quantity and assessment of public R&D funds for evaluation policies.

Next, human resources in STI is discussed because of its role in development and diffusion in knowledge. R&D human resources is very important for transferring this knowledge into technology, but problems related to R&D surveys affects also human resources data. There are breaks in series caused from definition and content changes. R&D human resources data is incapable of capturing innovation types like organizational innovation and potential of Turkey not in the R&D concept, but also application notion. So, engineers and post secondary and tertiary education graduates are recommended to use together with gross enrollment ration. Nonetheless, brain drain and brain gain concepts which are very popular now, are not covered by current measurement framework.

After input indicators, output indicators are examined beginning from patent indicators. Patens are easily accessed sources of information, but there are many discussions on them to use as innovation indicators especially for developing countries. For developing countries, strict patent protection is alleged to have negative effect since technology is learned by diffusion. Moreover, there is lack of public awareness in developing countries. It is also proved that there is positive correlation between patents and R&D personnel. As a result, it is recommended that patent data is given per R&D personnel in order for obtaining productivity.

Next, scientific publications are discussed enabling transferring knowledge into production. However, because of lack of cooperation between industry and the academia this knowledge cannot be applicable in the industry. Moreover, publication information is not enough without citation information which is not easy to measure.

Lastly, the output indicator of high-technology exports is examined. It is alleged that high technology exports are just a choice to develop, and there are other ways for competitiveness for developing countries. If it is bound to be used medium and high technologies should be evaluated together.

Although indicators in this study are mostly criticized, it is known that most of them are going to be used for evaluating performance of Turkey. An extension to this study can be defining the national set of innovation indicators independent from the present indictors, but using experiences of present measurement framework. It is a study in which many experts from different institutions should be involved. However, this study provides inputs to that study while providing remarks for available indicators.

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APPENDIX A: COMMUNITY INNOVATION SURVEY 2006 QUESTIONNAIRE CONDUCTED BY TURKEY

Part 1. General Information about the Enterprise

1.1. Name of enterprise:

1.2. Is your enterprise part of an enterprise group?

- o Yes – Specify the name of the enterprise group and in which country the head office of your group is located?
- o No

1.3. Source of capital: Domestic capital (%):

Foreign capital (%):

1.4. Total turnover of the enterprise in 2006:

1.5. Number of employees of your enterprise in 2006: (February/ May/ August/ November)

1.6. In which geographic markets did your enterprise sell goods or services during the three years 2004 to 2006?

- o Local / regional within Turkey
- o National
- o Europe
- o All other countries

Part 2. Product (good or service) innovation

2.1. During the three years 2004 to 2006, did your enterprise introduce:

- o New or significantly improved goods
- o New or significantly improved services

2.2. Who developed these product innovations?

- o Mainly your enterprise or enterprise group
- o Your enterprise together with other enterprises or institutions
- o Mainly other enterprises or institutions

2.3. Were any of your goods and service innovations during the three years 2002 to 2004:

- o New to your market? (Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets))

- Only new to your firm? (Your enterprise introduced a new or significantly improved good or service that was already available from your competitors in your market)

2.4. Using the definitions above, please give the percentage of your total turnover in 2006 from:

- Goods and service innovations introduced during 2004 to 2006 that were **new to your market**
- Goods and service innovations introduced during 2004 to 2006 that were **only new to your firm**
- Goods and services that were **unchanged or only marginally modified** during 2004 to 2006 (include the resale of new goods or services purchased from other enterprises)

Part 3. Process innovation

3.1. During the three years 2004 to 2006, did your enterprise introduce:

- New or significantly improved methods of manufacturing or producing goods or services
- New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services
- New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing

3.2. Who developed these process innovations?

- Mainly your enterprise or enterprise group
- Your enterprise together with other enterprises or institutions
- Mainly other enterprises or institutions

Part 4. Ongoing or abandoned innovation activities:

4.1. Did your enterprise have any innovation activities to develop product or process innovations still ongoing by the end of 2006? (Yes/No)

4.2. Did your enterprise have any innovation activities to develop product or process innovations that were abandoned during 2004 to 2006? (Yes/No)

Part 5. Innovation activities and expenditures

During the three years 2004 to 2006, did your enterprise engage in the following innovation activities:

5.1.1. Intramural (in-house) R&D (Yes/No)

5.1.1.1. If yes, did your firm perform R&D during 2004 to 2006:

- Continuously?
- Occasionally?

5.1.2. Extramural R&D (Yes/No)

5.1.3. Acquisition of machinery, equipment and software (Yes/No)

5.1.4. Acquisition of other external knowledge (Yes/No)

5.1.5. Training (Yes/No)

5.1.6. Market introduction of innovations (Yes/No)

5.1.7. Other preparations (Yes/No)

5.2. Please estimate the amount of expenditure for each of the following four innovation activities in 2006 only. (Include personnel and related costs)

- Intramural (in-house) R&D:
- Acquisition of R&D (extramural R&D):
- Acquisition of machinery, equipment and software:
- Acquisition of other external knowledge:

5.3. During the three years 2004 to 2006, did your enterprise receive any public financial support for innovation activities from the following levels of government? (Include financial support via tax credits or deductions, grants, subsidized loans, and loan guarantees.)

5.3.1. Local or regional authorities (TÜBİTAK, KOSGEB, TTGV and etc.) (Yes/No)

5.3.2. Central or regional government institutes (municipality etc.) (Yes/No)

5.3.3. The European Union (EU) (Yes/No)

5.3.3.1. If yes, did your firm participate in the EU 6th Framework Programme for Research and Technical Development (2003-2006) (Yes/No)

5.3.4. Other international institutions (Yes/No)

Part 6. Sources of information and co-operation for innovation activities

6.1. During the three years 2004 to 2006, how important to your enterprise's innovation activities were each of the following information sources?

Information Source	Degree of importance			Not used
	High	Medium	Low	
Internal 6.1.1. Within your enterprise or enterprise group	O	O	O	O
Market Sources 6.1.2. Suppliers of equipment, materials, components, or software 6.1.3. Clients or customers 6.1.4. Competitors or other enterprises in your sector 6.1.5. Consultants, commercial labs, or private R&D institutes	O O O O O	O O O O O	O O O O O	O O O O O
Institutional Sources 6.1.6.Universities or other higher education institutions 6.1.7. Government or public research institutes	O O	O O	O O	O O
Other Sources 6.1.8. Conferences, trade fairs, exhibitions 6.1.9. Scientific journals and trade/technical publications 6.1.10. Professional and industry associations	O O O	O O O	O O O	O O O

6.2. During the three years 2004 to 2006, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions? (Yes/No)

6.3. Please indicate the type of co-operation partner and location

Type of co-operation partner	Turkey	Europe	USA	Other	No Cooperation
6.3.1. Other enterprises within your enterprise group	O	O	O	O	O
6.3.2. Suppliers of equipment, materials, components, or software	O	O	O	O	O
6.3.3. Clients or customers	O	O	O	O	O
6.3.4. Competitors or other enterprises in your sector	O	O	O	O	O
6.3.5. Consultants, commercial labs, or private R&D institutes	O	O	O	O	O
6.3.6. Universities or other higher education institutions	O	O	O	O	O
6.3.7. Government or public research institutes	O	O	O	O	O

6.4. Which type of co-operation partner did you find the most valuable for your enterprise's innovation activities? (Give corresponding letter)

Part 7. Effects of innovation during 2004-2006

7.1. How important were each of the following effects of your product (good or service) and process innovations introduced during three years 2004-2006?

Effects	Degree of observed effect			Not relevant
	High	Medium	Low	
Product oriented effects				
7.1.1. Increased range of goods or services	O	O	O	O
7.1.2. Entered new markets or increased market in Turkey	O	O	O	O
7.1.3. Entered new markets or increased market abroad	O	O	O	O
7.1.4. Improved quality of goods or services	O	O	O	O
Product oriented effects				
7.1.5. Improved flexibility of production or service provision	O	O	O	O
7.1.6. Increased capacity of production or service provision	O	O	O	O
7.1.7. Reduced labour costs per unit output	O	O	O	O
7.1.8. Reduced materials and energy per unit output	O	O	O	O
Other Effects				
7.1.9. Reduced environmental impacts or improved health and safety	O	O	O	O
7.1.10. Met regulatory requirements	O	O	O	O

Part 8. Factors hampering innovation activities

8.1. During the three years 2004 to 2006 were any of your innovation activities or projects:

8.1.1. Abandoned in the concept stage (Yes/No)

8.1.2. Abandoned after the activity or project was begun (Yes/No)

8.1.3. Seriously delayed (Yes/No)

8.2. During the three years 2004 to 2006, how important were the following factors for hampering your innovation activities or projects or influencing a decision not to innovate?

Factors	Degree of importance			No effect
	High	Medium	Low	
Cost factors				
8.2.1. Lack of funds within your enterprise or group	O	O	O	O
8.2.2. Lack of finance from sources outside your enterprise	O	O	O	O
8.2.3. Innovation costs too high	O	O	O	O
Knowledge factors				
8.2.4. Lack of qualified personnel	O	O	O	O
8.2.5. Lack of information on technology	O	O	O	O
8.2.6. Lack of information on markets	O	O	O	O
8.2.7. Difficulty in finding cooperation partners for innovation	O	O	O	O
Market factors				
8.2.8. Market dominated by established enterprises	O	O	O	O
8.2.9. Uncertain demand for innovative goods or services	O	O	O	O
8.2.10. Economic uncertainty in the country	O	O	O	O
Reasons not to innovate				
8.2.11. No need due to prior innovations	O	O	O	O
8.2.12. No need because of no demand for innovations	O	O	O	O

Part 9. Intellectual property rights

9.1. During the three years 2004 to 2006, did your enterprise:

- 9.1.1. Apply for a patent (Yes/No)
- 9.1.2. Register an industrial design (Yes/No)
- 9.1.3. Register a trademark (Yes/No)
- 9.1.4. Claim copyright (Yes/No)

Part 10. Organizational and marketing innovations

10.1. During the three years 2004 to 2006, did your enterprise introduce:

- 10.1.1. New knowledge management systems to better use or exchange information, knowledge and skills within your enterprise or to collect and interpret information from outside your enterprise (Yes/No)
- 10.1.2. New methods of workplace organization for distributing responsibilities and decision making *(i.e. first use of a new system of employee responsibilities, team work, decentralization, integration or de-integration of departments, etc)* (Yes/No)
- 10.1.3. New methods of organizing external relations with other firms or public institutions *(i.e. first use of alliances, partnerships, outsourcing or subcontracting, etc.)* (Yes/No)

10.2. How important were each of the following effects of your enterprise's organizational innovations introduced during the three years 2004 to 2006?

Factors	Degree of effect			No effect
	High	Medium	Low	
Reduced time to respond to customer or supplier needs	O	O	O	O
Improved quality of your goods	O	O	O	O
Reduced costs per unit output	O	O	O	O
Improved employee satisfaction and/or lower employee work load	O	O	O	O

APPENDIX B: STANDARD COMMON FORM FOR LATIN AMERICAN AND CARIBBEAN INNOVATION SURVEYS SUGGESTED BY THE BOGOTA MANUAL

Firm Identification

1) Firm identification number (sample)
2) Tax identification number (standardized in the country)
3) Firm name
4) Address, city, state/department
5) Telephone number and fax number
6) E-mail
7) Web site
8) Name of the firm's chief executive
9) Name and position of the interviewee
10) Telephone number and fax number
11) E-mail
12) 3 or 4 digit ISIC classification of the firm
13) Identify the 3 main products of the firm and its sales share
14) Year of the firm was set up in the country
15) Specify number and location of the firm's establishments
16) Specify if the firm belongs to a national conglomerate
17) Percentage composition of firm capital
    a) National
    b) Foreign (specify country of origin)
18) Multinational firm subsidiary
19) Period of greatest foreign investment
    a) During the last 10 years
    b) Between 10 and 20 years
    c) More than 20 years
20) Specify type of ownership: co-operative, governmental, family, worker share, other.

Economic Performance

(Where possible, the following indicators are to be obtained from other surveys.)

21) Sales value of products manufactured by the establishment and products
manufactured by third-parties.
22) Sales share (value) of innovated products during the last 20 years[1].
23) Market share.
24) Production value.
25) Total export value.
26) Exports share (value) of innovated products over the last 20 years.
27) Gross earnings value, operating profit value and pre-tax profits.
28) Total employment by qualification level (number of employees).
    a) Basic education
    b) Technical training
    c) Graduate studies
    d) Post-graduate studies
29) Average monthly salary according to levels of qualification (basic education, technical training, graduate studies and post-graduate studies).
30) Percentage distribution of employees (production and administration).
31) Value distribution of the payroll (production and administration).
32) Specify percentage labor turnover according to levels of qualification (basic education, technical training, graduate studies and post-graduate studies).
    a) Less than 1 year
    b) Between 1 and 3 years
    c) Between 3 and 8 years
    d) Over 8 years
33) Value of imports:
    a) Inputs
    b) Machinery and equipment
    c) Other
34) Value of investment:
    a) Gross
    b) Machinery and equipment
35) Productive asset value.
36) Utilized installed capacity (%).
37) Average cost of a representative product.

[1] This period is not defined as it depends on how frequently surveys are taken. The selected period should allow for the construction of temporal series

Innovation Activities

38) Does the firm engage in any of the following innovative activities? If the answer is YES, rate from 1 to 7, 1 being the highest. Choose 0 for activities the firm does not carry out.

a) R&D
b) Embodied technology acquisition
c) Disembodied technology acquisition
d) Training
e) Organizational change
f) Design
g) Marketing

39) Specify percentage of resources allotted to the following innovative activities:

a) R&D
b) Embodied technology acquisition
c) Disembodied technology acquisition
d) Training
e) Organizational change
f) Design
g) Marketing

40) Determine which special units or departments exist in the firm and the number of employees in each.

Unit – laboratory – department	*Existence*	*No. of employees*
R&D		
Design		
Quality control		
Engineering		

Research and Development (R&D)

41) If the firm has conducted research and development projects during the last 20 years, state number of employees working on R&D, average monthly salary and time devoted to these tasks.

Level of qualification	*No. of employees*	*Time devoted (%)*	Average monthly salary
Basic education			
Technical training			
Graduate studies			
Post-graduate			

42) How much has the establishment invested in in-house R&D?

a) Staff costs
b) Equipment
c) Buildings
d) Inputs
e) Other

43) How much has the firm invested on external R&D contracts?

44) What results have R&D projects yielded?

a) New products
b) Prototypes
c) New processes
d) Pilot plants
e) Patents
f) Publications in indexed or international journal

Innovation efforts

Embodied technology

45) What volume of the firm's investment in capital goods has led to technological change and new products and processes during the last 20 years?
46) What is the country of origin of this technology?
47) How much has the firm invested in hardware over the last 20 years? (Specify if used for production or administration).

Disembodied technology

48) How much has the firm invested in licenses or technological transfer agreements such as patents, brands, industrial secrets over the last 20 years?
49) What is the country of origin of this technology?
50) How much has the firm invested in consultancies over the last 20 years?
51) Specify areas of application of consultancies:

a) Production
b) Productive system organization
c) Product design
d) Firm management
e) Finance
f) Marketing and distribution

52) What is the country of origin of the consultant or the consultancy firm?

53) How much has the firm invested in software over the last 20 years? (Specify if used for production or administration).

54) What is the country of origin of the software?

Training

55) If the firm has implemented technological training programs during the last 20 years, state the objectives of these programs:
   a) Innovation and improvement of productive processes.
   b) Product development, improvement and design.

56) Specify the average number of training hours received under those programs.

57) Has the firm implemented management and administration training programs during the last 20 years?

58) Indicate the areas the programs addressed:
   a) Managerial
   b) Administrative skills
   c) Information technologies
   d) Industrial security
   e) Quality control

59) State the average number of training hours received under these programs.

60) State the firm's investment in technological and managerial training, as well as the number of trained employees according to level of qualification (basic education, technical training, graduate studies, post-graduate studies).

	Technological training	***Managerial training***
Expenditure (per year)		
Number of trained employees by level of qualification: • Basic education • Technical training • Graduate studies • Post-graduate studies		

Organizational modernization

61) Has the firm implemented organizational modernization programs during the last 20 years? (Specify which.)

62) Has the firm implemented programs to modernize production processes and management during the last 20 years? (Specify which.)

63) Has the firm implemented quality control and assurance programs during the last 20 years? (In which areas?)

64) Has the firm implemented environment management programs during the last 20 years? (In which areas?)

65) How much has the firm invested in organizational modernization activities? (Differentiate each category.)

Design

66) Specify the investment made by the firm in product design, industrial processes and industrial engineering over the last 20 years.

Marketing

67) Has the firm implemented new forms of distribution and marketing during the last 20 years?

68) Has the firm undertaken efforts relating to marketing of innovated products during the last 20 years?

69) Specify expenditure incurred in marketing activities.

Innovation Funding

70) State percentage of funds used by the firm to perform innovative activities according to funding sources.

    a) Own resources
    b) Related firm resources
    c) Parent firm resources
    d) Other firm resources
    e) Government
    f) Commercial banking
    g) International co-operation

Innovation Results

71) Has the firm introduced new or improved products in the marketplace during the last 20 years?

72) These products are new for:

    a) Your firm
    b) The national market
    c) The international market

73) Does innovation affect the main product features?
74) Has the firm introduced new or improved processes in the plant during the last 20 years?
75) Is innovation central to the process?
76) Has the firm undergone organizational innovations during the last 20 years? (If so, indicate which.)
77) Has the firm introduced marketing innovations during the last 20 years? (If so, indicate which.)
78) Specify percent distribution of resources (human and financial) allotted to innovation of products, process and organization (including marketing).
79) What impact has the introduction of process, product and/or organizational innovations had on the following concerns?
    a) Profitability
    b) Cash flow
    c) Market share
    d) Competitiveness
    e) Productivity
    f) Environmental impact
    g) Service quality
    h) Labor relations
80) What impact has the introduction of process, product and/or organizational innovations had on the firm's economic performance?
    a) Increase in sales and exports due to new and improved products
    b) Cost reduction due to process innovation
    c) Change in the use of production factors (labor, raw material and input, energy, fixed capital).
81) Have product, process and/or organizational innovations had any positive impact on any of the following concerns?
    a) Water
    b) Atmosphere
    c) Soil
    d) Landscape
    e) Waste Products
82) Has the firm requested patents either in its country or in foreign countries during the last 20 years? (If so, specify countries.)

83) Has the firm obtained patents either in its country or in foreign countries during the last 20 years? (If so, specify countries.)

84) Has the firm licensed technologies during the last 20 years? (If so, specify countries.)

85) Does the firm have certified processes? If the answer is YES, state the entity (and country) that issued the certification and the corresponding date.

86) Does the firm have certified products? If the answer is YES, state the entity (and country) that issued the certification and the corresponding date.

Innovation Goals

87) Rate the main five goals pursued by the firm throughout the innovation from 1 to 5, 1 being the highest.

a) Market goals:
   - Maintaining the current market
   - Widening the current market
   - Opening new markets

b) Cost reduction goals:
   - Unit labor cost
   - Material consumption
   - Energy consumption
   - Decrease rate of return
   - Inventory reduction

c) Quality associated goals:
   - Enhancing product quality
   - Improving work conditions
   - Lessening environmental impact

d) Product associated goals:
   - Replacing obsolete products
   - Widening current line of products
   - Opening new lines of products
   - Introducing environmentally sound products

f) Production associated goals:
   - Production flexibilization
   - Deadtime reduction
   - Improving environmental management (cleaner or ecoefficient production)

g) Opportunity exploitation:
   - Public policies
   - New scientific and technological knowledge
   - New materials

Sources of Innovation Information

88) Rate the main five sources of information (in-house and external) used by the firm from 1 to 5, 1 being the most important.
    a) In-house R&D department
    b) Production department
    c) Sales and marketing department of
    d) Other department
    e) Executives of the firm
    f) Other related firm
    g) Parent firm (if the firm is multinational)
    h) Customers (national or foreign)
    i) Competitors
    j) Suppliers (national or foreign)
    k) University, research or technological development center (national, international, public, private)
    l) Consultants, experts (national or foreign)
    m) Fairs, lectures, shows
    n) Magazines and catalogues
    o) Databases

Relationship with the National System of Innovation

89) Indicate the frequency with which your firm contacts the different agents of the NSI by type of object of the co-operation or association agreements reached during the last 20 years. Also, specify the degree of satisfaction with each agent (totally satisfactory, adequate, inadequate, totally unsatisfactory).

Type of co-operation agreement objects:

- Essays, analysis and metrology
- Technological and market information search, processing and analysis
- Seminars and training courses
- R&D projects

- Product and process design
- Organizational change consultancy
- Technical help for technological or environmental problem-solving
Agents or institutions are:
- Public and private universities
- Public and private research and technological development centers
- Technical training institutions
- Test laboratories
- Intermediation bodies
- Suppliers
- Related firms
- Parent firm
- Other firms
- Consultants

Object / Agent	Tests	Information	Training	R&D	Design	Technical Assistance	Organizational change consultancies	Degree of satisfaction
University								
Technological center								
Technical training institute								
Laboratories								
Intermediation entities								
Suppliers								
Related firms								
Other firms								
Parent firm								
Consultants								

90) For each co-operation and association object, indicate how much the firm has invested during the last 20 years and in what percentage the proposed goals have been achieved and the assigned schedule and budget been complied with.

Object	Tests	Information	Training	R& D	Design	Technical assistance	Organizational change consultancies
Investment							
Objective achievement %							
Schedule compliance %							
Budget compliance %							

Factors Affecting Innovation

91) Rate the following factors affecting innovation positively, neutrally, or negatively:

a) Business or microeconomic factors:

- Innovation capabilities
- Availability of trained employees
- Resistance to change
- Labor defection
- Risk of innovating
- Payback period
- Innovation costs

b) Mesoeconomic or market factors:

- Market size
- Market structure
- Marketing
- Sector dynamism
- Consumer response to new products and processes
- Opportunity to co-operate
- Technological opportunity
- Technological dynamism
- Need to innovate
- Funding costs
- Funding availability
- Risk of imitation

c) Macro or metaeconomic factors:

- Information on markets
- Information on technologies
- Laws, regulations, standards, taxes
- Public institutions
- Science and technology institutions
- Physical infrastructure
- Copyright system
- Labor laws and regulations
- Quality of basic worker training
- Training costs
- Training center quality
- Availability of training centers