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Technological innovation activities in Turkey: the case of manufacturing industry, 1995–1997

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Abstract

This paper is based on the initial findings of a nation-wide survey of technological innovation activities of 2100 firms in Turkish manufacturing industry. Our findings show that the innovation activities are more widespread in the firms having large sizes of employment. In some sectors of manufacturing industry 60–80% of the firms undertake innovation activities. Improving the product quality and opening up new markets rank at the top of the main objectives of innovation activities. In-house R&D turn out to be the main sources of information assisting innovation activities. 51.2% of the firms that are engaged in innovation carry out joint R&D with consultancy firms, and 52.3% of the firms with which Turkish firms co-operate are in the EU countries. In the majority of the manufacturing sectors, more than 50% of the total sales are derived from technologically new and improved products. Only 19% of the firms have had patent applications with a return of very few patented inventions. A correlation analysis of basic indicators of innovation activities shows that, for instance, sales of new products, R&D expenditures, and firm sizes correlate only weakly.

Keywords: Innovation survey; Indicators of innovation activity; Correlation of indicators

1. Introduction

Turkey with a population over 65 million and the sixteenth largest GDP in the world has been undergoing a process of "catching up" on its course to competitiveness in global markets. The manufacturing industry in Turkey today is significantly different from what it was two decades ago. The structure of industry, product composition, organization of production at the individual firm level, and the behavior of markets have all been experiencing rapid changes from 1990s to the 2000s. It should be quite remarkable that the share of industrial products in the total revenues from export had been more than doubled from 1980s to 1990s (SIS, 1990), and about 80% of this export had been to the OECD countries (SIS, 1991). Efforts toward economic integration with the European countries have been continuing and one outcome is the entry to the European Customs Union in January 1996. Currently, the full membership of Turkey to EU is a much-debated question among the EU member countries and search for the resolution of barriers to entry is going on within the present government and other administrative circles in the country.

The telecommunications, textiles, construction, automotive and defense industries in Turkey have demonstrated significant progresses during the last two decades. Major firms have been increasingly taking part in joint industrial ventures with foreign companies and their exports of finished products to Europe is rapidly increasing. Equally interesting is the fact that many Turkish firms that are enhancing their technological capacities in high technology fields and undertaking R&D toward technological innovation are being awarded European Product Quality Awards in recent years.

Innovation in manufacturing industry and R&D are, of course, closely related and expenditures on industrial R&D are a measure of the emphasis placed on the development of industry. A recent survey on R&D in the government, higher education, and business sectors in Turkey indicates that the expenditures in manufacturing industry R&D, constituted by far the largest portion of total business enterprise R&D expenditures (SIS, 1997).

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The latter expenditures ranged between $174 million in 1990 and $310 million in 1997. The survey also shows that the share of manufacturing R&D in these sums turned out to be overwhelmingly high fluctuating between the minimum 92% and the maximum 95%, respectively in 1990 and 1997. When the data in the same survey is analyzed by sector of performance the R&D for the manufacture of television, radio and communications equipment and within that, especially R&D for transmitters, software and telecommunications constitute the main part of total business enterprise R&D performance.

In-depth studies on the organization of technology and technological R&D, its effects on the technology output and competitiveness of industry, the interface between technology and basic research particularly done in universities and research centers are becoming widespread in the developed countries in recent years (Mansfield, 1991). Turkey as a developing country is basically a big recipient but not the producer of technology. Probably due to this, studies concerning many features of technology as mentioned above are lacking in Turkey. Although one can find some quantitative (i.e. bibliometric, scientometric) studies on the development, growth trends and productivity of basic and applied research in some fields (Garfield, 1991; Uzun 1996, 1998), it is unfortunate that only preliminary studies on the role of S&T for development and the aspects of technology transfer are available (Dogrusoz, 1978).

In this paper we report briefly the initial findings of a nation-wide technological innovation survey in the manufacturing industry carried out, for the first time, by the State Institute of Statistics (SIS) in cooperation with the Scientific and Technological Council of Turkey (TUBITAK). In addition, an attempt is made to identify the basic indicators of innovation activities pertaining to the present manufacturing industry in Turkey and a simple correlation analysis based on these indicators is carried out. The overall objective is to gain insights into the present ststeof technology and technological innovation activities in the manufacturing industry in Turkey. The survey covers the data from a total of 2100 firms in the manufacturing industry for the period 1995–1997. It complies with the international standards set forth in the Oslo Manual of OECD for collecting innovation data (OECD, 1997a,b).

2. Method

The essence of the method followed in presenting the findings of the survey relies on various classifications of the data obtained. For ease of descriptions, the findings are presented in graphical and tabular forms. Various indicators have been designed to facilitate the discussions on the macro level characteristics of the innovation activities in the manufacturing industry in Turkey. Attempt is made to incorporate these indicators in a systems context and a correlation analysis is carried out to reveal the bivariate relationships between indicators.

3. Basic findings

3.1. Objectives of innovation

The reasons that the firms engage in innovation activities can be identified via their economic objectives in terms of products and markets, and how they rate a number of goals that process innovation can bring within reach. Fig. 1 gives a set of eleven objectives and their ratings on a semantic differential scale, which is widely used in literature to measure attitudes. The most conspicuous feature of this rating is that the largest blocks are (1) the objective of improving product quality, (2) opening up new markets, and (3) reducing unit labor cost. The rates of the last two of these objectives turned out to be almost equal.

3.2. Spread of innovation activities

One of the notable changes in the process of development of industry in Turkey has been the spread of innovation activities in recent years. Since the early 1980s, the number of firms practicing innovation has grown at an increased rate compared with its slow progress in the past decades. Fig. 2 gives the fraction of firms engaged in innovation activities by sector of performance. Some of the highlights that may be found through inspection of the figure are as follows: (i) on average, about 70% of the firms in the top three sectors, namely medical, precision and optical instruments; office, accounting and computing machinery; coke, refined petroleum products and nuclear fuel undertake innovation activities, while (ii) the six sectors that rank at the bottom of the list, i.e. sectors starting with fabricated metal products, and below, actually accounting for 51%of the total number of firms in manufacturing industry, has a corresponding average of about 10%.

Among the many factors hampering, or even completely blocking innovation activities in the manufacturing industry in Turkey are economical, e.g. cost are too high, appropriate financial sources are lacking, and perceived risks are excessive.

An aspect worth mentioning is the relationship between the spread of innovation activities and the firm sizes as measured by the number of employees. Fig. 3 gives the percentage of firms undertaking innovation vs firm size. Looking at the figure one can see at once that the spread of innovation activities tend to be strongly correlated with firm sizes as would be expected. One further corollary would be the comparison of sectors of

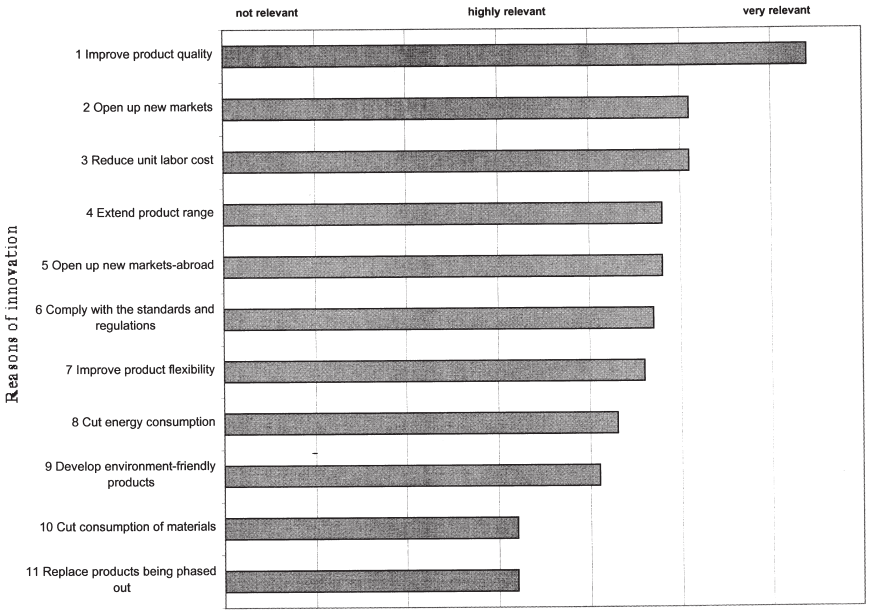

Fig. 1. Economic objectives of technological innovation activities.

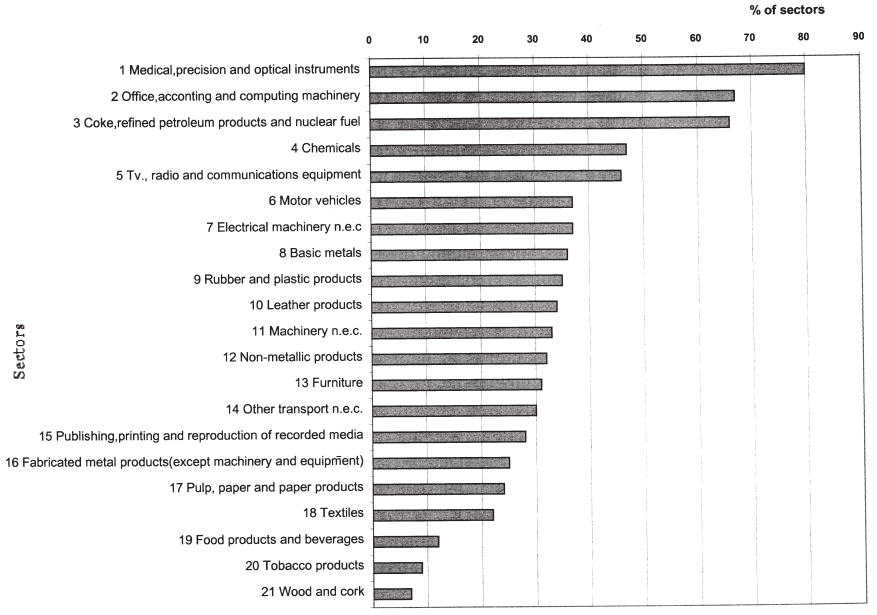

Fig. 2. Proportion of firms undertaking innovation by sectors (% of sectoral firms).

Fig. 2 with size groups of Fig. 3. Based on this, we can make an educated guess that top innovation sectors include large firms (probably with 1000 or more employees) while lowest innovation sectors have firms of low number of employees probably less than 50.

An important indicator of the priorities implicit in the "innovation system of Turkey" is the composition of expenditures by type of innovation activity (see Fig. 4). On average, the expenditures on innovative R&D within the firms are quite low (4.6% of the total), whereas expenditures for the transfer of technology through purchase of machinery for technological product and process innovation is outstandingly high (67.5% of total). Fig. 4 is a good indicator of the state of innovation system in Turkey where innovative R&D is low and technology purchase and transfer is very high. Therefore, one could hardly talk about the presence of a well-organized and reasonably efficient system of innovation in Turkey. Until recently, there was no central organization coordinating technological activities. With the creation of a new body called the Supreme Council of Science and Technology (SCST) working in cooperation with TUBITAK, the subject has started attracting some attention. It is hoped that SCST, charged with the formulation and

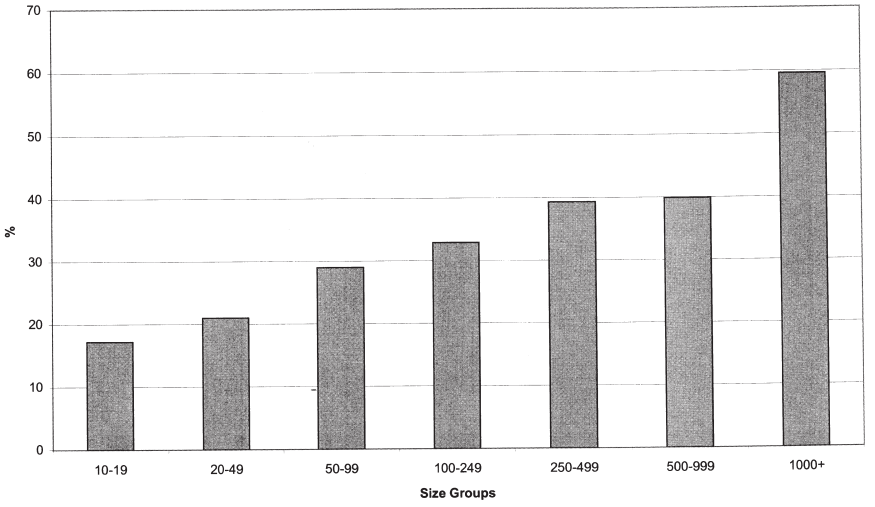

Fig. 3. Percentage of firms engaged in technological innovation by number of employees (size) in firms.

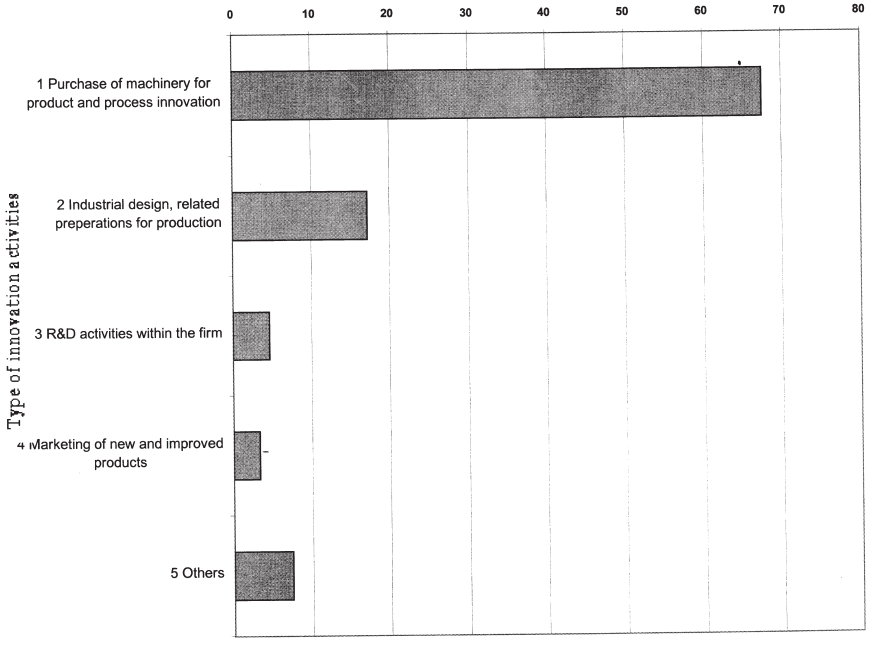

Fig. 4. Technological innovation expenditure by type of innovation activity (%).

implementation of national S&T policies, succeeds in enhancing the linkages within the network of public and private institutions supporting or undertaking innovation.

3.3. Sources of information for innovation

The innovation process is assisted by a variety of sources of information. Be it locally produced or transferred from sources elsewhere, information and its flow within the firms are essential for innovation activities and the development of technology at large. The sources of information include internal sources (within the firm or business group), external market sources, educational and research institutions, and generally available sources. Fig. 5 shows the main sources of information relevant for innovation activities in Turkey. On average, (1) in-house R&D shows up as the most important source of information and it is interesting to note that this is particularly so for the firms of small to medium size. Malerba et al. (1996) using the well-known Community Innovation Survey (CIS) data has found a similar result in this respect. These findings are not unexpected for the fact that the process of technology generation, product development, and even technology transfer activities demand R&D. Among the other major sources of innovation listed in Fig. 5 are (2) clients or customers, (3) fairs and exhibitions (4) suppliers of equipment, materials, components, and software. (15) Patent disclos-

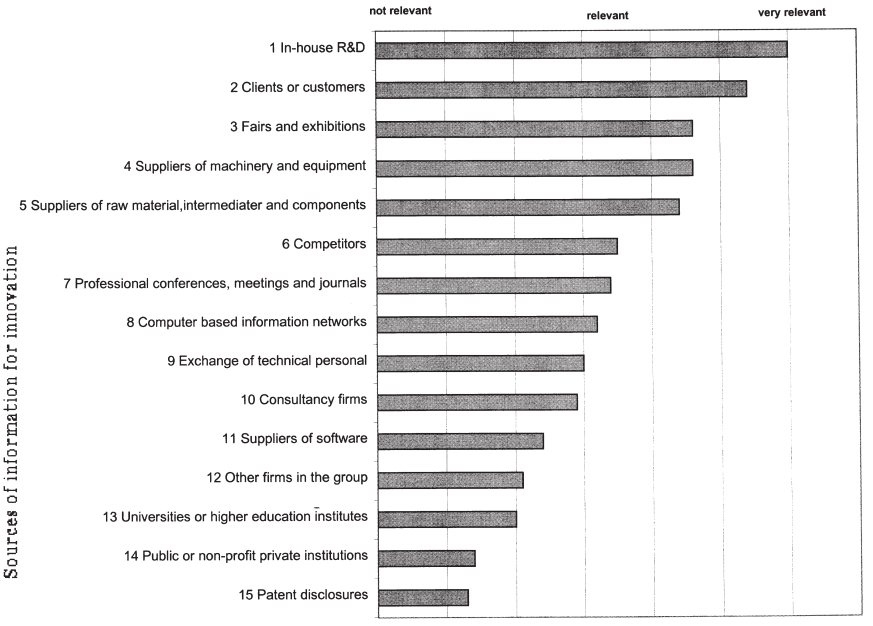

Fig. 5. Sources of information for technological innovation activities in Turkey.

ures, (13, 14) higher education institutes including universities, and other public or non-profit private institutions rank at the bottom of the list, a situation that prevailed, for example, in certain industries in Europe in 1990s (Albach et al., 1996).

3.4. Efforts of co-operation

It is usually held that co-operative enterprise activities can significantly contribute to firm innovation performance (OECD, 1997a,b). Firms co-operate to pool technical resources, achieve economies of scale and gain synergies from complementary human and technical assets. An innovation study in Norway, and Finland indicates that the share of new products in overall sales is higher among firms involved in co-operative projects (Smith et al., 1995).

Results of the present survey indicate that 51.2% of the firms engaged in innovation carry out joint R&D activities with consultancy firms; 46.9% with suppliers of equipment, raw materials and components; 39.6% with universities and other higher education institutes.

A classification of innovative firms in Turkey, according to the country of origin of the firms they co-operate shows that 89% of the firms co-operate with firms located at home; 52.3% are in EU; 17.2% are in the USA, and only about 8% are in Japan (Fig. 6). What is not shown in Fig. 6 is that 40% of these firms are of medium to large size having 250 or more employees, and only 18% are small firms in the category having employees between 10 and 250.

3.5. Impact of innovation

A partial indicator of the impact of innovative performance of the firms can perhaps be the rate of sales derived from technologically new or improved products (see Appendix A for definitions). Fig. 7 presents the percentages of new and improved products in sales by main economic activity. It is seen that for the sectors of (2) office, accounting and computing machinery; (11) machinery and equipment not elsewhere classified; (5) television, radio and communications equipment; (6) motor vehicles; (15) publishing, printing and reproduction of recorded media; (21) wood and cork the sales of new and improved products are over 50%. One unexpected result is that while (1) medical, precision and optical instruments sector is at the top of Fig. 2, the same group is now at the bottom, in terms of sales of new and improved products.

3.6. Patent applications

The number of national patent applications as the sum of resident and non-resident applications, in a sense, gives some idea about the size and power of the technology market in a country. Likewise, the number of patents applied for abroad by inventors in a country indicates the country's technology diffusion. Country shares in the European Patent Office (UPO) applications by priority year and by inventor for 1990–1996 show that Turkey (and also Iceland) ranks at the bottom with 0.01% (OECD, 1999).

Results of our survey show that, in Turkey, only 19%

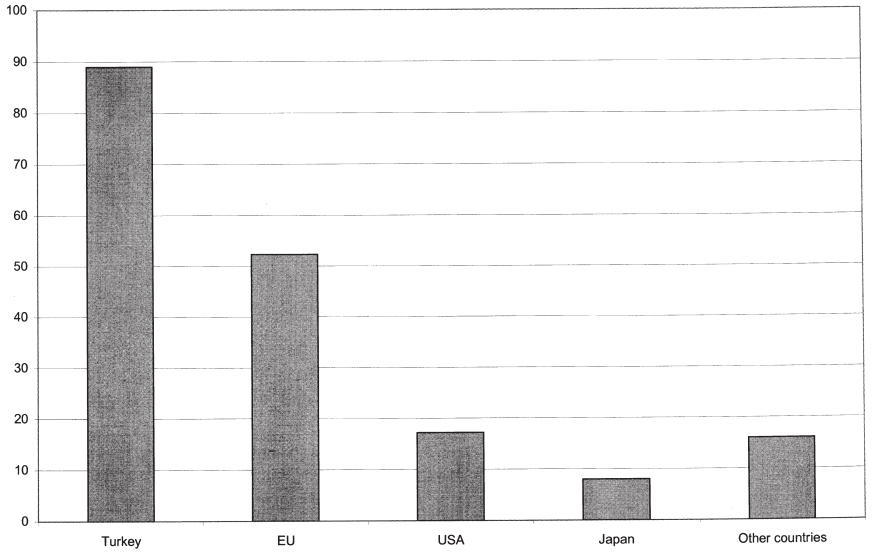

Fig. 6. Co-operation in technological innovation activity (%) with firms in different countries.

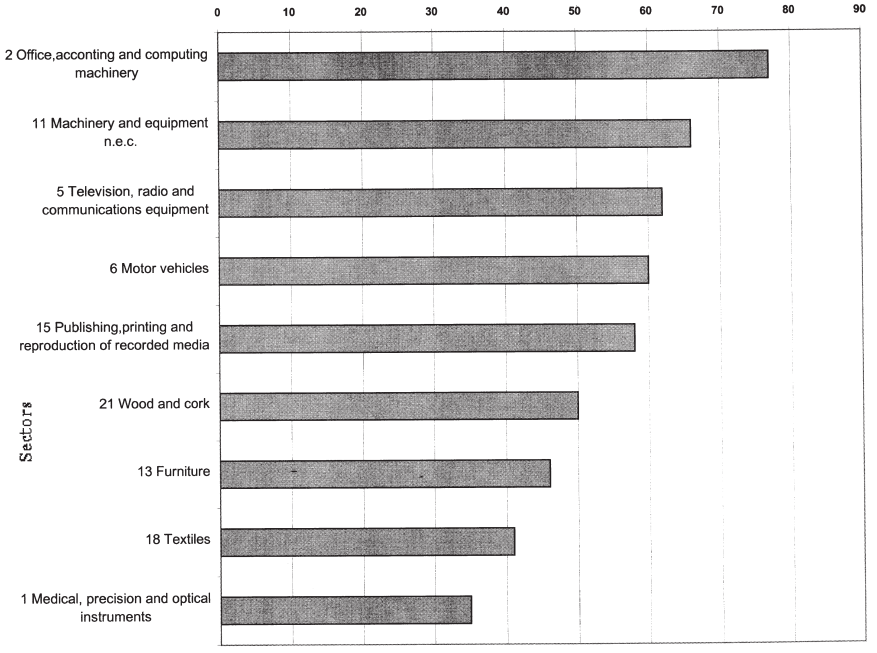

Fig. 7. Percentage share of new and improved products in sales by sectors.

of the firms engaged in technological innovation have had patent applications. Sixty-five and a half per cent of these applications were at home, 22.3% were in European countries, and 12.2% were in other countries. A breakdown of the patent applications by sector of performance indicate that 80% of the firms manufacturing leather products, and 66.7% manufacturing office, accounting and computing machinery have had patent applications.

4. Indicators of innovation activity

The basic indicators of a well organized, properly functioning system of technological innovation, is of course, the innovative R&D as a measure of input, and the count of patented inventions as a measure of technology output. Although there is substantial R&D efforts in certain sectors of technology in Turkey, the counts of patented inventions of these sectors are

Table 1
Indicators of innovation activity for major sectors

	Sector	(4) Sales of new products (%)[a]	(1) R&D expen. (%)[b]	(2) Firm size (%)[b]	(3) Researchers (%)[b]
2	Office, accounting and computing machinery	77	0.04	0.5	0.5
11	Machinery and equipment n.e.c.	66	12.3	17	18
5	TV, radio and computing equipment	62	32	41	61
6	Motor vehicles	60	19	27	15.8
15	Publishing, printing and reproduction of recorded media	58	1.2	1.5	0.7
21	Wood and cork	50	0.1	0.0	0.1
13	Furniture	46	0.2	0.4	0.3
18	Textiles	41	2.6	11	2.6
1	Medical, precision and optical instruments	36	0.4	0.9	1.0
	Totals		68	89	90
	Other sectors		32	11	10
	Overall total		100	100	100

[a] The figures are the averages over 1995–1997 (see Fig. 7).
[b] The figures for the sectors are the percentages of the column total (the third row from the bottom) for 1997.

presently too small to allow for an analysis of performance in terms of these indicators in a systems context. However, an attempt has been made to explore the main indicators of the innovation activities considered by the author are (1) R&D expenditures, (2) total employment of firms representing their firm sizes, (3) R&D researchers as inputs, and (4) the share of new and improved products in total sales as output indicators for the major sectors given in Fig. 7. Here it is assumed that economic impacts of innovation activities in terms of technologically new and improved products in total sales of manufacturing firms would be taken as output indicators. It should be noted that R&D researchers include those employees who are university graduates and are actively involved in R&D (17% of these researchers hold Masters or Ph.D. degrees), and technicians and other support personnel are included in the total employment (Table 1). The intangible indicators such as skills and creativity of employees in firms are also crucial in this respect but they are left out of the scope of the survey probably because of the difficulty in measuring them.

The set of the four indicators defined above has been

Table 2
Correlation matrix for measure of the innovation activity

		Sales	R&D	Firm size	Researchers
(4)	Sales	1.000			
(1)	R&D	0.3427	1.000		
(2)	Firm size	0.2872	0.852	1.000	
(3)	Researchers	0.3636	0.9514	0.9202	1.000

operationalized by expressing their values as percentages over the relevant manufacturing sectors in Table 1, and a simple correlation analysis based on these indicators is carried out using the software, the Statistical Package for Social Sciences (SPSS). The first point to be made with reference to this table is that the data therein is available only for short periods. The figures indicating the sales of technologically new products are the averages over the period 1995–1997 and the figures indicating the expenditures on R&D, researchers, and firm sizes representing the total employment are for the single year 1997.

The results of Table 2 are not eventually unexpected. The sales of new products aggregated for the sectors concerned are weakly correlated with other three indicators each with the correlation coefficient of about 0.3. Such a weak correlation between sales and firm sizes is quite contrary to our expectation that the larger the size of a firm the more its sales of new products, keeping in mind that the innovation activities were found to be more widespread within large firms. This may be attributable at the first place to the sample data, which is limited to a very short period of time. Patterns and practices of sales and behaviors of markets are also different in different manufacturing sectors, and there are many other factors that determine the observed variations in the amount of sales of new products. This point should be further investigated in the future.

5. Conclusion

Summing the results of the technological survey in Turkish manufacturing industry, we can say that: (1) more detailed surveys over longer periods are needed to gather data for exploring the mainstream of the technological activities in Turkey. Such studies would also serve, for the users (planners, decision makers, managers etc.) as tools for setting up S&T policies and information based decisions crucial in increasing competitive capacities of some strategic sectors in Turkey for global markets. (2) Basic scientific research done in universities and R&D in industry has developed quite considerably over the last decade. However, the built up of the technological infrastructure to utilize this

potential is still poor so that the industry in general could not make use of the knowledge generated in universities sufficiently. (3) Turkey has to rely basically on technology transfer in the development of industry. In the meantime indigenous technology development will accelerate as it develops its own technology generating capability. (4) Transferred technologies are maintained, adopted, improved and renewed with the support of the existing scientific and technological knowledge. (5) The case of Turkey can be considered quite safely as representative of many developing countries with strong commitment to technology and technological change. However, the lack of resources for innovation activities ties down the efforts of improving the existing innovation system.

Appendix A. Basic definitions (OECD, 1999)

Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). The minimum entry is that the product or process should be new (or significantly improved) to the firm (it does not have to be new to the world).

Technologically new product is a product whose technological characteristics or intended uses differ significantly from those of previously produced products.

A technologically improved product is an existing product whose performance has been significantly enhanced or upgraded.

Technological process innovation is the adoption of technologically new or significantly improved production methods. These methods may involve changes in equipment, or production organization, or a combination of these changes.

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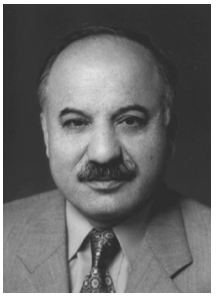

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