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What do patent data reveal? The case of Turkish manufacturing industries*

Ummuhan Gökovalı
Department of Economics, Muğla University, Kötekli, 48000 Muğla, Turkey

Abstract

This paper investigates the innovative capabilities of the Turkish economy by using a new Turkish patent data set for the period 1985-1999. The technological composition of the granted patents is presented by making a distinction between resident and non-resident applicants. The so-called auto-sufficiency and revealed technological advantage indices are calculated to determine whether the sector under consideration is self-sufficient in terms of generating its own technology. Finally, resident applications/grants are grouped according to their sources of innovations (i.e., academics, individuals, public and private corporations) in order to ascertain the innovative capabilities of each sub-group.

1. Introduction

There is great consensus about the importance of technological capabilities in shaping the direction and rate of long run economic growth and the development level of a country. Science and technology (S&T) activities are of the utmost importance insofaras the crucial phenomenon of technological capability is concerned. While research and development (R&D) activities constitute the major input into S&T activities, it is

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generally agreed that patenting is one of their most salient outputs in terms of indicating the rate and direction of technological progress.

The legal basis upon which intellectual property rights (IPRs) are created is exceptionally important for the productivity of S&T activities. Specifically, the protection of patent rights has a decisive influence on economic interactions. First, the efficient protection of patent rights encourages not only R&D activities, but also product or process innovations, which in turn enhances economic growth and international competitiveness.[1] Second, efficient protection as such provides a legal impediment against infringement and copying so that incentive-generating returns can be appropriated from investment in R&D activities. Third, a strong legal basis facilitates technology transfer by forming a reliable ground for foreign firms that are prone to produce and/or exchange their product and process innovations.

In order to make efficient analyses that reveal the linkages between technological activities and economic variables, it is crucial to find robust indicators for S&T activities. The best practice is to make use of patent and R&D statistics together in order to discern the dynamics of technological processes. As in the case of most developing countries, technology-related data sets in Turkey are either lacking or inappropriate for comprehensive and informative analyses. Thus, it is no surprise that the technology literature in Turkey has remained a relatively infertile domain of research.[2] The major contribution of this paper is the introduction of a new patent data set to uncover the micro-dynamics of technological processes in the Turkish economy. However, lack of comprehensive and detailed R&D data in Turkey forces us to be content with the patent data at hand.[3] Even though patent data do not fully conform to R&D activities, the former may be used alone due to the strong positive correlation between the two. Wherever there is a lack of pertinent data on R&D, the conventional (and inevitable) practice is to have recourse to patent data alone (Hall *et al.*, 1984; Pavitt, 1985; Griliches, 1990). It is on this ground that patent data is used as the major

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[1] In this regard, many studies have elaborated on the contributive links that run from the protection of patent rights to inventions and innovations, and from the latter to growth and competitiveness: e.g., Fagerberg, 1988; Dosi *et al.*, 1990; Patel and Pavitt, 1995; Lach, 1995; Pianta, 1995; Eaton and Kortum, 1995, 1996; Gould and Gruben, 1996; Evenson, 1997; Archibugi and Michie, 1998; Hollanders *et al.*, 1999; Cohen *et al.*, 2000.

[2] Some studies offer detailed analysis of the relationship between technology and various economic variables for Turkey. See, for example, Kırım (1990), Taymaz (2001), Pamukçu (2003), Soyak (2003), and Özçelik and Taymaz (2004).

[3] Systematic collection of R&D data in Turkey began in 1993 (Taymaz, 2001: 157).

input in the current analysis, which is the first attempt to analyze technological micro-dynamics by using Turkish patent data.[4]

The raw data pertaining to the Turkish manufacturing industries (comprising 22 sectors) and covering the period 1985-99 comes from the Turkish Patent Institute (TPI). TPI uses the International Patent Classification (IPC) system, which is different from that of the conventional sectoral classification systems, such as the International Standard Industrial Classification (ISIC). Therefore, the first task is to accord the patent data with ISIC. Once this task is accomplished, the micro-dynamics of technological capability may be discerned for the Turkish economy.

Section 2 provides an outlook of patenting activities in Turkey in comparison with the world patent applications and grants classified according to income levels of the countries. Further, Turkish patent applications and grants are grouped according to their technology levels as defined by the OECD (1996) to reveal the technological composition of resident and non-resident grants separately.[5] In section 3, the so-called auto-sufficiency index (ASI) and revealed technological advantage (RTA) index are calculated at sectoral levels. These indices are constructed to indicate whether the sector under consideration is self-sufficient in terms of generating its own technology by resident initiative. Section 4 decomposes patent applications and grants by residents into four groups; namely, individuals, academia, public and private sectors in order to detect their degrees of innovativeness. The inertia of academic institutions in this regard may be considered to constitute a crucial warning about the need to improve cooperation between university and business in Turkey. Section 5 presents the concluding remarks.

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[4] For a comprehensive review of the patent literature, see Griliches (1990). The problems with patent data include the following: i) all inventions are not patented, ii) all inventions are not patentable, and iii) patented inventions are different from each other in terms of the quality and the magnitude of the inventive output associated with them (Griliches, 1990). Furthermore, the propensity to patent varies across countries, sectors and firms, which creates problems especially in conducting comparative analyses (OECD, 1994).

[5] The raw IPC-based data is converted into 4 digit-sectors according to ISIC Rev. 2 with MERIT and Yale Technology Concordance (YTC) in order to enhance the reliability of the data. Following OECD's (1994) 'fractional count' procedure, IPC codes in the same application are equally weighted while concording them to ISIC. Spearman's rank correlation test (Newbold, 1995) is carried out to compare results of MERIT and YTC, and findings suggest that they do not produce different results at 1% significance level. See Verspagen *et al*. (1994) and Johnson and Evenson (2001) for detailed information on MERIT Concordance and YTC, respectively.

2. Patenting activities

In this section, applications/grants and their distribution among residents and non-residents is presented for Turkey and compared with world patenting activities grouped according to the income level of the countries. Then, the technology composition of patent grants is investigated based on the Yale Technology Concordance (YTC). YTC distinguishes between the industry of manufacture (IOM) and the sector of use (SOU). MERIT and YTC-IOM assign inventions to industries where they are produced, whereas YTC-SOU assigns inventions to sectors where they are used.[6]

2.1. Patenting activities in Turkey in comparison with world patenting activities

Patents, being one form of IPRs, are legal devices for the protection of technical inventions developed by firms, institutions or individuals. Over the last two decades, the use of patents has continually increased. This surge in patenting led to the investigation of the globalization trend of technological activities, especially by firms. Empirical findings suggest that although the global exploitation of technology (patents taken in foreign markets are used as indicators) increased in the 1980s, the global generation of technology (the share of patents originating from nationally and foreign-controlled firms as a percentage of total national patenting is used as an indicator) did not increase *pari passu* (Archibugi and Michie, 1995). Patel and Pavitt (1991) and Kumar (1996) give further evidence that there is no globalization trend for technological activities in the 1980s.

Table 1 reports percentage shares of applications and grants for Turkey as well as world-patenting activities of different income levels in terms of applications and grants, in which the distinction between resident and non-resident has already been made by the World Intellectual Property Organization (WIPO). The patent data are grouped according to the World Bank "classification of economies by income and region, January 2000" and reported for five-year intervals beginning from 1985 to 2000. Applications and grants are grouped into low-, middle-, and high-income countries. The reported data include all patent

[6] MERIT concordance results will not be presented here; however both MERIT and YTC-IOM concordances yield similar results in terms of the technological composition of sectors as well, hence, technological composition of sectors based on YTC-IOM applies more or less to that of MERIT concordance.

applications and grants, and in some cases, utility model certificates (UMCs) known also as petty patents.[7]

Overall worldwide patenting activities (not reported in the table due to space considerations) reveals that in contrast to a slight increase in worldwide resident applications from 670,451 in 1985 to 908,117 in 2000, worldwide non-resident applications sharply increased from 184,782 in 1985 to 8,531,295 in 2000. The same trend is observable in terms of granted patents as well. Whereas resident grants slightly increased from 177,915 in 1985 to 298,491 in 2000, non-resident grants rose from 92,171 in 1985 to 375,897 in 2000. These figures are in accordance with those of Archibugi and Michie (1995), and reveal that the global exploitation of technology that was prevalent in the 1980s is continuing in the 1990s.

One general observation for patenting activities worldwide as well as for Turkey is that grant-to-application ratios (for all patents as well as for the residents and non-residents) declined drastically within the last decade. This is most probably due to the fact that both data are arranged according to the application date, and the grant date follows the application date with a time lag; hence, it is natural for those ratios to have a declining trend towards the end of the period of observation.

Table 1(a) demonstrates the distribution of Turkish patents between residents and non-residents along with grants-to-applications ratios for benchmark years along the 1985-99 periods. UMCs are also included in the Turkish patent applications and grants beginning in 1995, when a new decree-by-law entered into force concerning the protection of patent rights in general and UMCs in specific (TPI, 1997). Resident share in applications and grants (number of applications rose from 190 in 1985 to 592 in 1999; whereas number of grants slightly decreased from 49 in 1985 to 33 in 1999) decreased in 1999 in comparison to that of 1985; while the reverse is true for the share of non-residents' applications and grants (number of non-resident applications rose from 578 in 1985 to 2753 in 1999; similarly the number of non-resident grants increased from 331 in 1985 to 522 in 1999—not reported in the table due to space considerations). It is evident from the table that the share of non-residents is invariably far higher than that of residents in all applications as well as

[7] For the descriptions of the data and for more details see:
http://www. wipo.org/ipstats/en/publications/b/notes/i/codes.htm (WIPO, 2002a).
Data from 1995 to 2000 is obtained from the WIPO home page:
http://www.wipo.org/ipstats/en/ (WIPO, 2002b) and data from 1985 to 1990 is kindly sent from this organization via electronic mail. For the year 2000, data includes UMCs for Australia, Slovenia, Thailand and Yugoslavia and for the years 1995, 1990 and 1985 data includes UMCs only for Australia.

Table 1
Proportions of Applications and Grants for Residents and Non-residents, 1985/2000

	Applications (%)		Grants (%)		Grants/Application (%)	
Year	Residents	Non-Residents	Residents	Non-Residents	Residents	Non-Residents
a. Turkey						
1985	24.7	75.3	12.9	87.1	25.8	57.3
1990	11.1	88.9	6.9	93.1	42.2	71
1995	12.0	88.0	13.3	86.7	36.4	32.2
1999	17.7	82.3	5.9	94.1	5.6	19
b. Low-income countries						
1985	33.8	66.2	20.8	79.2	3.4	13.0
1990	31.9	68.1	55.2	44.8	12.2	9.9
1995	4.5	95.5	34.2	65.8	0.8	1.6
2000	1.3	98.7	44.6	55.4	0.3	0.4
c. Middle-income countries						
1985	82.0	18.0	80.6	19.4	37.5	9.0
1990	82.5	26.3	86.9	7.8	48.4	4.4
1995	19.3	80.7	53.7	38.5	7.1	5.1
2000	4.4	94.9	57.0	43.0	1.8	1.4
d. High-income countries						
1985	49.2	50.8	36.3	63.7	15.5	27.2
1990	39.4	60.5	35.3	64.4	10.6	19.3
1995	31.2	68.6	34.4	65.3	10.6	20.1
2000	16.2	83.8	42.4	57.6	5.1	7.0

Notes: For Table 1 (b), (c), (d); entries in the first two columns pertaining to applications and grants, respectively, may not sum to unity because of the irregularities in the original data obtained from WIPO database. Patent data for Turkey for the year 2000 was not available at the time of the study; hence, data for 1999 is presented for Turkey.
Source: Turkish patent data are taken from the Turkish Patent Institute and world patent data from the WIPO Database (see footnote 7)

grants for Turkey. The grant-to-application ratio is again higher for non-residents than residents along the period except for the year 1995.

As it is observable from the Table 1(a), performance of the residents is desperately weak as far as their patenting activities are compared to those of the non-residents for Turkey. When the figures from Table 1(a) and Table 1(c) are evaluated together, it is evident that Turkish resident patenting activities are not in accordance with Turkey's classification as a middle-income country by the World Bank. Figures reveal that the share of resident patenting activities in middle-income countries constitutes a high portion of total patenting activities, both in terms of applications and grants. This is not the case for Turkey. The percentage of non-resident

grants for Turkey is very high compared to that of the countries considered. Low patenting activities in Turkey suggest that Turkey seems to belong to the low-income country group in terms of technological activity, although Turkey is included in the middle-income country group by the World Bank.

There may be at least two reasons for Turkey's low resident patenting activities compared to other middle-income countries. Firstly, firms may be reluctant to apply for patent protection in Turkey. The innovation activities survey for the manufacturing industries (conducted by the State Institute of Statistics for the 1998-2000 period) indicates that firms are indeed reluctant to apply for patent protection in Turkey. The highest propensity for applying for patent protection comes from firms active in the following sectors: electronic equipment (40%), followed by furniture (36%) and coke, refined petroleum products and nuclear fuel (33%). Firms from the tobacco products and office, accounting and computing machinery sectors did not apply for patent protection at all in the period considered. On the other hand, the highest percentage of firms not applying for patent protection comes from firms active in wood and cork (91%) and other transport equipment (90%). The most important reason for not applying for patent protection is lack of information. Especially firms that are active in coke, refined petroleum products and nuclear fuel (100%), tobacco products (71%), publishing, printing and reproduction of recorded media (60%) report that they do not apply for patent protection due to lack of information.[8] The innovation survey reveals that the patenting propensity among Turkish firms is very low.

Secondly, as Albuquerque (2000) states, resident patenting activities underestimate the technological activities of developing countries. Albuquerque (2000) discusses the problems arising from the use of resident patents as indicators of S&T activities of developing countries. Firstly, he argues that developing countries could make minor modifications to foreign technologies that cannot be directly turned into patenting activity. Although they learn about how to use, adopt and modify foreign technology, many of these improvements are not patented. That is, the learning activity occurs without obtaining patents. Hence, "domestic patent statistics do not capture a big share of relevant local technological activities in developing countries" (Albuquerque, 2000: 1048). Secondly, domestic patent statistics as a measure of technological change also do not capture technology transfer mechanisms

[8] In 12 sectors out of 22 sectors, firms indicate that lack of information is the first reason for not applying for patent protection. The other reasons for firms not to apply for patent protection are that firms considered patent protection as unnecessary and that patent provides insufficient protection (SIS, 2004).

as do capital goods imports and technology licensing (Albuquerque, 2000: 1048). The third problem is related to the fact that domestic patent statistics under-represent technological improvements in developing countries. If this is the case, then patenting activities in Turkey will underestimate the technological development level of Turkey. This could be the second reason why Turkey seems to belong to the low-income country group in terms of patenting activities, even though Turkey belongs to the middle-income country group according to the World Bank income classification.[9]

If resident patenting is taken as the sole indicator of inventive activity and technology creation in a country, then Turkey's technological infrastructure appears to be at stake.[10] At the other side of the same coin, intensity of non-resident patenting may well indicate significant levels of technology transfer in embodied or disembodied forms. Therefore, the Turkish economy is not only dependent on foreign technology, but may also be an important technology market for non-residents, open to global exploitation of technology as indicated by the increasing share of non-resident applications and grants over the years.

Table 1(b) shows the proportion of applications and grants for residents and non-residents in benchmark years for low-income countries. The proportion of resident applications in total applications for low-income countries has been decreasing while the reverse is true for non-resident applications. In terms of granted patents, the percentage of resident grants is usually below the percentage of non-resident grants. The share of resident grants increased from around 21% in 1985 to 45% in 2000 for low-income countries.

Table 1(c) shows the proportion of applications and grants for residents and non-residents in benchmark years for middle-income countries. The share of resident applications and grants declined, while the share of non-resident applications and grants increased over the years. The grants-to-application ratio of residents is always higher than that of non-residents.

Table 1(d) shows the proportion of applications and grants for residents and non-residents in benchmark years for high-income countries. Residents have a decreasing share of applications whereas the

[9] Nevertheless, one should be cautious while placing a country strictly into one of these country groups.

[10] One of the limitations of the study is that we confine our comments only to patent applications and grants due to the lack of the available data on the economic values of patents. Hence, one should be cautious about the interpretation of the patent data by itself. In another context, data on economic values of patents can be generated and employed in an analysis to give information that is more concise about the technological level of Turkey.

reverse is true for non-residents. On the other hand, resident grants increased their share, while the reverse is true for non-residents. High-income countries have always had smaller residents' share compared to that of non-resident for applications and grants. Grants-to-applications ratios are higher for non-residents than that of residents for high-income countries.

As can be seen from the Table 1(a, b, c, d), the increasing share of non-resident applications over the years for all income levels is even more pronounced for low-income and middle-income countries. The share of non-resident applications increased to as much as 99% for low-income and 95% for middle-income countries as of 2000. These figures suggest that global exploitation of technology in the 1990s is still continuing at a rapid pace, as suggested by Archibugi and Michie (1995) in the 1980s. Although global exploitation of technology is taking place at all income levels, this is more remarkable for the low- and middle-income countries, as revealed by the higher share of non-resident applications in these countries compared to that of high income countries as of 2000. Firms undertake costs and efforts to apply patent protection in the expectation of compensation by trading the disembodied invention, blocking competitors, or preventing other firms from invading their own third markets.

2.2. Technology composition of Turkish Patent Grants: YTC-IOM and YTC-SOU

In this section, the technology compositions of Turkish resident and non-resident patent grants are compared based on their concordance by YTC-IOM and YTC-SOU. Technology composition of the sectors are classified into three groups (low, medium, and high technology) according to their technology levels based on R&D intensities (OECD, 1996). Table 2 presents shares of resident and non-resident grants according to the technology levels of the sectors concorded by YTC-IOM.

Table 2

Patent Grants (% Shares of Sectors):
Technology Levels, 1985/99, YTC-IOM

	1985			1990			1995			1999		
	APG	RG	NRG	APG	RG	NRG	APG	RG	NRG	APG	RG	NRG
Low	27.0	32.2	26.2	25.6	27.3	25.3	25.5	32.4	24.4	23.5	33.8	22.8
Medium	50.2	42.5	51.3	47.3	46.3	47.5	46.0	40.8	46.8	40.7	47.0	40.3
High	22.8	25.3	22.5	27.1	26.4	27.2	28.5	26.8	28.8	35.8	19.2	36.9

Notes: APG refers to all patent grants, RG to resident patent grants, and NRG to non-resident patent grants; *Source*: Turkish Patent Institute.

All patent grants (APG) according to their IOM mostly belong to the medium technology class (41-50%). However, medium-tech sectors have been losing their dominant shares over time. This decline is quite proportionally matched with the rising share of the high-tech sectors (from 23% in 1985 to 36% in 1999). Low technology sectors have relatively more stable shares of about 25%.

The share of resident patent grants (RG) in low-technology levels has been quite steady over time. Roughly 34% of residents have had grants for patents with low-tech compositions for the year 1999; the same shares for medium and high technology sectors are about 47% and 19%, respectively. The decreasing share of high-tech resident grants is almost matched by the rising share of medium-tech grants over the years. Taymaz (2001) gives evidence for the technological composition of manufacturing production by using the same definition of technology groupings as used in this study. Low- and medium-technology taken together constituted 93% of manufacturing production in 1990, but declined to 88.5% in 1997, which is more or less in accordance with the technological distribution of resident patent grants accounted for by low- and medium-tech shares taken together as of the 1990s. However, while Taymaz (2001: 76) finds that these shares are declining over the years for manufacturing production, resident patenting activities are increasing their share in low- and medium-tech sectors. Resident patenting activities in low- and medium-tech taken together increased from around 74% in 1990 to 81% in 1999.

While high-tech NRGs have risen from 23% in 1985 to 37% in 1999, medium-tech NRGs have fallen from 51 to 40%. The shares for low-tech NRGs, on the other hand, are 26 and 23%, respectively. In this period, a subtantial increase in high-tech NRA occurred due to the boom in the share of pharmaceuticals in 1995, which is when the right to patent in pharmaceuticals became effective in Turkey. Following a new decree-by-law, patenting was allowed in pharmaceuticals in 1995.

Based on YTC-SOU, Table 3 presents shares of resident and non-resident grants according to the technology levels of the sectors. The SOU values exhibit an important difference with respect to the IOM values. The dominance of medium-tech sectors in IOM vanishes in the case of SOU. As far as the SOU of APG is concerned, low-, medium- and high-tech sectors have had quite stable shares, which have eventually reached almost identical values in 1999. Similar interpretations are valid for NRG since they constitute APG, by and large.

The share of medium-tech RG has been relatively stable over the years. Towards the end of the period, a rise in the share of low-tech RG is observed along with the fall in the share of high-tech RG. The shares of

low- and medium-tech RG are almost the same (42%) in 1999, whereas the share of high-tech RA is 16%.

In sum, the IOM values demonstrate that the majority of patent applications belong to medium-tech sectors followed by high-tech sectors. The SOU values, however, indicate an even distribution in general. This points to a seeping-through process, whereby technologically more sophisticated sectors provide low-tech ones with technological spillovers. For instance, it is highly likely that there exist spillovers from electric machinery, electronics, instruments, and computer and office machinery to the sectors with low-tech compositions. Consequently, it is reasonable to assert that Turkish manufacturing industries, which are populated by medium- and low-tech sectors, exhibit a high degree of technological heterogeneity.

Table 3
Patent Grants (% Share of Sectors):
Technology Levels, 1985/99, YTC-SOU

	1985			1990			1995			1999		
	APG	RG	NRG	APG	RG	NRG	APG	RG	NRG	APG	RG	NRG
Low	35.0	34.0	35.1	37.1	32.8	37.7	33.8	33.0	33.9	31.3	41.6	30.7
Medium	36.9	40.6	36.4	32.4	41.5	31.3	35.5	40.8	34.8	32.4	42.2	31.8
High	28.2	25.4	28.5	30.5	25.7	31.0	30.7	26.2	31.3	36.3	16.2	37.5

Note: See Table 2 for abbreviations
Source: Turkish Patent Institute.

3. Auto-sufficiency index and revealed technological advantage

This section presents auto-sufficiency indexes (ASIs) and revealed technological advantages (RTAs) computed for the Turkish manufacturing industries for benchmark years. ASI is the ratio of 'the number of patents granted to residents' to 'the number of total patents granted in Turkey'. In this respect, ASI is an indicator of self-sufficiency in terms of technology generation by residents.[11]

In Table 4, ASI values are reported at aggregate levels by using both the MERIT concordance and YTC (IOM and SOU). Both concordances

[11] However, Banerjee *et al*. (2000) argue that ASI is a measure of technological autarchy rather than self-sufficiency. For the biotechnology sector in several countries, they calculated ASIs with the highest values for the Soviet Union (0.9) and Japan (0.8), and lowest values for England (0.2) and Hungary (0.2).

yield roughly similar results. Until 1999, averages for the manufacturing industries as a whole seemed to be relatively stable.[12] However, one must also keep in mind that ASI, at the aggregate level, does not fully capture the improvements in S&T activities for a disaggregated level.

Besides the ASI, 'modified' revealed technological advantage (RTA) is calculated as the ratio of 'the share of resident patents in all patents in sector *i*' to 'the share of resident patents in all patents for the manufacturing industries as a whole' (RTA index = $(RG_i/APG_i)/(RG/APG)$, where RG and APG refer, respectively, to resident patent grants and all patent grants issued by the TPI, and *i* refers to the sector under consideration). In another way, modified RTA is the ratio of ASI for each sector to the ASI for total manufacturing industries (ASI_i/ASI).

Table 4
ASI: Manufacturing Averages, 1985/99

Year	MERIT	YTC-IOM	YTC-SOU
1985	0.11	0.13	0.11
1990	0.07	0.15	0.11
1995	0.13	0.13	0.12
1999	0.06	0.06	0.06
Manufacturing Average, 1985-99	0.11	0.13	0.11

Source: Raw data from Turkish Patent Institute.

The RTA index values reported in Table 5 were not calculated with respect to the total world patents. They are, indeed, resident-based ratios that reveal the relative patenting propensity of sectors (technological strengths/weaknesses) in comparison with that of the Turkish manufacturing industries as a whole.[13] Table 5 below presents the top five sectors in terms of RTA indexes in the selected years.[14]

[12] There is a break in the general trend in 1996, when Turkey signed the Patent Cooperation Treaty (PCT). The adaptation to PCT procedures took some time in Turkey. Hence, there was a sharp decrease in NRG beginning from 1996.

[13] Due to the lack of external Turkish patent data, only patents granted by the Turkish Patent Institute are used. For this reason, comparative analysis of patent data for a set of developing countries based on external patenting is not possible. We rely on Soete (1981: 641) in modified RTA index calculations: "[O]ne can look at the number of patents originating from various foreign countries in one particular country. To the extent that all patents have undergone a similar screening treatment, most of the international comparability problems disappear".

[14] One should be cautious about the interpretation of RTA, since the index is based on a low number of resident patent grants.

Table 5
RTA Index: Top Five Sectors, 1985/99

Sectors	MERIT	Sectors	IOM	Sectors	SOU
		1985			
Wood & furniture	8.8	Food, beverages & tobacco	2.9	Computer & office machinery	2.5
Other transport	5.7	Computer & office machinery	1.7	Food, beverages & tobacco	2.3
Computer & office machinery	3.4	Other Industrial Products	1.7	Other Machinery	1.9
Metal Product	2.8	Metal Product	1.6	Motor Vehicles	1.8
Other Industrial Products	2.6	Motor Vehicles	1.5	Other Industrial Products	1.6
		1990			
Rubber & plastic	3.7	Motor vehicles	1.9	Motor vehicles	2.1
Other industrial products	3.4	Metal products	1.8	Other machinery	2.1
Metal products	3.1	Computer & office machinery	1.7	Metal products	1.8
Wood & furniture	3.1	Other industrial products	1.6	Computer & office machinery	1.5
Motor vehicles	2.7	Other machinery	1.5	Wood & furniture	1.5
		1995			
Wood & furniture	4.8	Petroleum & petroleum products	2.6	Wood & furniture	2.4
Petroleum & petroleum products	3.3	Ferrous basic metals	2.2	Motor vehicles	1.9
Metal products	3.2	Wood & furniture	1.9	Metal products	1.6
Motor vehicles	2.5	Metal products	1.9	Instrument	1.7
Other transport	2.2	Motor vehicles	1.8	Other machinery	1.7
		1999			
Rubber & plastic	5.8	Petroleum & petroleum products	3.2	Other machinery	2.5
Wood & furniture	4.9	Metal products	2.0	Petroleum & petroleum products	2.0
Textiles	3.5	Other machinery	1.9	Food, beverages & tobacco	1.9
Petroleum & petroleum products	3.4	Non-ferrous basic metals	1.9	Metal products	1.7
Metal products	2.4	Paper, printing & publishing	1.9	Other industrial products	1.6

Source: Turkish Patent Institute.

In terms of generating their own technologies through resident initiatives, 'computer and office machinery' and 'other industrial products' were relatively more self-sufficient during the second half of the 1980s, as can be observed in Table 5. However, these two sectors seem to have somewhat lost their leading positions within the last decade.

Similarly, motor vehicles and the wood and furniture sector were other prominent patent grantees until 1999, when they had lost their importance. As far as the newly promising sectors are concerned, 'other machinery' and 'petroleum and petroleum products'[15] are to be noted for their apparent rise relatively recently. Above all, however, one sector occupies an outstanding leadership position as the most traditional and promising grantee of patents among its resident counterparts. This is the metal products sector.

Taymaz (2001: 185) presents the sectoral distribution of R&D expenditures in 2-digit manufacturing industries for the 1991-97 period. The machinery and equipment (38) sector, followed by chemicals (35), constitute a high portion in R&D expenditures in total manufacturing industries and their ranking does not change much over the 1990s. The share of machinery and equipment (38) was 63% in 1991 and increased to around 68% in 1997, while the same shares for chemicals (35) were 12% in both 1991 and in 1997. The share of R&D expenditures for the textile sector (32) decreased while that of stone clay and glass products (36) with basic metals (37) increased as of 1997. The machinery and equipment sector increased its R&D share to 83%, while the chemicals sector decreased its share to 6% for the year 1999. The other sectors do not have an R&D share that is above 3% of the total (SIS, 2004).

The innovation survey indicates that the following sectors have relatively more innovative activity than other sectors in the 1998-2000 period: these are office, accounting and computing machinery (3825), electrical machinery (3831), other transport equipment (3849), and machinery sectors (3829). Textiles (32), furniture (33), publishing and printing (34), on the other hand, in general have relatively less innovation activities for the same period. R&D intensities of sectors and innovation survey results are more or less in accordance with the RTA index values based on patent data with the exceptions of wood and furniture (33) and other industrial products (39) sectors**,** which have relatively higher RTA index values. Motor vehicles (3843), metal products (3810) and computer and office machinery (3825), which have relatively higher RTA indexes in 1990, belong to machinery and equipment sectors (38). The petroleum and petroleum products (353+354) sectors, which recently have gained importance according to RTA index, are also in accordance with the rising share of R&D expenditures of the chemicals sector in general.

As a conclusion to this section, it is to be noted that 'petroleum and petroleum products' and 'metal products' are low tech-sectors, whereas

[15] Petroleum refineries and manufacture of miscellaneous products of petroleum and coal (353-354).

'other machinery' is 'medium-tech' (OECD, 1996). Modified RTA indicates that sectors that are characterized by low and medium technology have relatively higher indices compared to manufacturing industries as a whole for Turkey. Being in an inferior position, Turkish residents specialize in low and medium technology sectors in their own market.

4. Resident applicants and grantees: Academia, public and private corporations, and individuals

This section presents a closer look at patent applications by and grants to residents in Turkey for the period 1985-98.[16] Rather than grouping resident applications/grants into sectoral distributions, residents are grouped into four broad categories and investigated in terms of their share in patent applications/grants over the years. Resident applications and grants are arranged in accordance with the so-called 'fractional count' as suggested by OECD (1994). Table 6 shows resident applications and grants for four broad categories: academic institutions, including universities and the Scientific and Technical Research Council of Turkey (STRCT stands for TÜBİTAK), private corporations, public corporations, and individuals.

The most salient inference from Table 6 is that the highest shares belong to individuals, followed by private corporations for the entire period. The average share of individuals is 66% in applications and 57% in grants, whereas the share of private corporations is 29% in applications and 38% in grants in the period. Shares in both applications and grants are prominently decreasing for individuals, and increasing for private corporations over time.[17] Considering the negligibly small share of public corporations along with the rather modest share of academia, it is plausible to assert a noteworthy shift from individuals to private corporations in terms of patenting activities over time. This development is in line with the development trend of any country. That is, as corporate financing of R&D is increasing, one would expect to see the same increase in their patenting behavior; furthermore, as more competition is taking place among corporations and increasing the bills of financing of R&D, one would expect that the share of individuals in applications and grants to decrease. The data reveal that this is the case for Turkey.

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[16] For this section end-period is 1998 rather than 1999; since granted resident patents is very low for 1999, which would yield unreliable results in terms of distribution of patent grants among resident initiatives.

[17] Although not reported in Table 6, it is to be noted that grants-to-applications ratios are about 46% and 30%, respectively, for private corporations and individuals, as period averages.

Table 6
Resident Applications and Grants, 1995/98

	1985		1990		1995		1998		1985-98	
Applications	Count	Share (%)	Count	Share (%)	Count	Share (%)	Count	Share (%)	Count	Share (%)
University & STRCT	2	1.6	3	2.2	6	2.9	21	4.0	125	4.0
Private corporations	24	19.0	24	17.8	49	23.3	203	38.7	903.5	29.2
Public corporations	0	0.0	3	2.2	1	0.5	5	1.0	20.5	0.7
Individuals	100	79.4	105	77.8	154	73.3	296	56.4	2047	66.1
Total	126	100.0	135	100.0	210	100.0	525	100.0	3096	100.0
	1985		1990		1995		1998		1985-98	
Grants	Count	Share (%)	Count	Share (%)	Count	Share (%)	Count	Share (%)	Count	Share (%)
University & STRCT	1	2.1	1	1.8	2	2.6	1	0.7	40	3.7
Private corporations	10	21.3	11	19.3	24	31.2	87	60.4	416.5	38.2
Public corporations	0	0.0	1	1.8	1	1.3	0	0.0	9.5	0.9
Individuals	36	76.6	44	77.2	50	64.9	56	38.9	625	57.3
Total	47	100.0	57	100.0	77	100.0	144	100.0	1091	100.0

Source: Raw data from Turkish Patent Institute.
Notes: The number of applications and grants used in Tables 1(a) and 6 may not be equal to each other because while Table 1 uses to total number of residents applications and grants, Table 6 uses only resident applications and grants that can be categorized as one of four broad categories. Some of the resident applications and grants do not have any information concerning the distribution of patent applications/grants among resident initiatives.

The evidence for universities and STRCT indicated that there is not an increasing trend in patent applications and grants. This is contrary to our expectations. One would expect reasonably high patenting propensities for universities and the STRCT. These institutions are viewed as the places where scientific and theoretical contributions come from. However, this is not the case in Turkey. This is most probably due to the weak links between academia and business. Another reason may be that there are relatively fewer incentives for patents in academia compared to those in the private sector. To be sure, inventions are adapted to production in private corporations, but not in academia.

Distribution of R&D expenditures across the different institutional sectors shows a mixture of patterns compared to that of patenting activities over the years. The higher education sector is the foremost performer of R&D in Turkey, although its share shows a declining trend

from around 70% in 1990 to 61% in 1998[18]. The greater involvement of the higher education sector in R&D expenditures is in contrast to the low patenting activities of this sector, as Table 6 reveals. The business enterprise sector is the second largest performer of R&D expenditures and its share has increased from 20.4% in 1990 to 31.6% in 1998. The evolution of R&D expenditures of the business enterprise sector runs parallel to the patenting activities of the sector. The share of public corporations in R&D expenditures decreased from around 10% in 1990 to around 7% in 1998, which is not comparable to the extremely low patenting activities of this sector.

5. Concluding remarks

Patent applications and grants in Turkey are examined in detail for the 1985-1999 period. The contribution of this study relies on the according of the raw patent data into sectors by means of two distinct concordances; namely, MERIT Concordance and YTC (IOM and SOU). Similar concordance results found from MERIT and YTC eliminate the possible data problems coming from a developing country such as Turkey. Considering that there is no detailed sectoral R&D data or innovation surveys in a time series perspective for Turkey, this study is one of the first to shed light on not only patent-related technological dynamics in Turkey, but also on the evolution of technological dynamics in general.

Making a distinction between residents and non-residents in terms of patent applicants and grantees has revealed Turkey's backwardness in technology generation through domestic resources. This aspect of resident patenting activities in Turkey seems to be more in accordance with the experience of low-income countries rather than that of middle-income countries. What is more critical is that Turkey is not only unable to increase her patenting activities in general, but her innovative activities also appear to be concentrated mostly in the low and medium technology sectors. The share of resident patent grants in low and medium technologies taken together increased from about 75% in 1985 to about 81% in 1999. In addition, the findings of the modified RTA index has revealed that the metal products sector (low-tech), other machinery (medium) and petroleum and petroleum products (low-tech) are traditional and still promising leaders in terms of patenting activities.

In producing merely modest levels of her own technology essentially in the low and medium technology industries, Turkey appears to depend

[18] Data for 1990 is from SIS (1997) and data for 1998 is from SIS (2005).

mainly on foreign technology. This technological aspect of the Turkish manufacturing industries should be considered as a crucial warning to policymakers. Long-term growth and international competitiveness as well as their 'sustainability' are a matter of technology creation at home. Of course, dynamic processes, like technology-related activities, cannot be duly shaped by mere reliance on freely operating market forces. Therefore, S&T policies should be carefully designed so as to i) encourage technology production by domestic initiatives, ii) construct a rigorous technological infrastructure that is conducive to rapid adaptation and adoption of transferred technology, and iii) take precautionary steps to reverse its ongoing specialization in technologically inferior industries. What is further needed is a fertile ground on which efficient cooperative links can be nurtured especially between academia and business. It is, indeed, in this way that painstaking scientific efforts can be fruitfully converted into private returns. Unfortunately, Turkey's performance in this respect is also quite unsatisfactory.

Truly competitive edges in the international arena are acquired through getting acquainted with high technology activities that exhibit particularly superior aspects in general. In the first place, spillover effects from high technology to low and medium technology industries are more intensive. Besides, high-tech industries inherently possess a higher learning potential, by way of which they adapt to altering market conditions much more rapidly. Therefore, technology policies in Turkey should aim at shifting S&T activities towards more technology-intensive processes. Consequently, ul Haque's (1995: 22) warning should never be forgotten: "As is frequently observed, it matters a great deal today whether a country specializes in the production of potato chips or micro chips".

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Özet

Patent verileri ne göstermektedir? Türkiye imâlat sanayi örneği

Bu çalışma, 1985–99 dönemleri arasında Türkiye'deki patent verilerini kullanarak, Türkiye Ekonomisi'nin yenilik kapasitesini incelemektedir. Tescil edilmiş patentlerin teknoloji bileşenleri yerleşik ve yerleşik olmayan başvuru sahiplerine göre ayrıştırılmıştır. Sektörlerin kendi teknolojilerinin geliştirmede yeterli olup olmadıklarını ortaya koymak için 'auto-sufficiency' ve 'revealed technological advantage' olarak adlandırılan indeksler hesaplanmıştır. Son olarak, yerli patent başvuru ve tesciller yeniliğin kaynağına göre (akademik, bireysel, kamu ve özel şirketler) gruplandırılmış ve her bir grubun yenilik kapasiteleri ortaya konulmuştur.