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Analyzing R&D Activities of Foreign Enterprises in Emerging Economies. Lessons from Turkey

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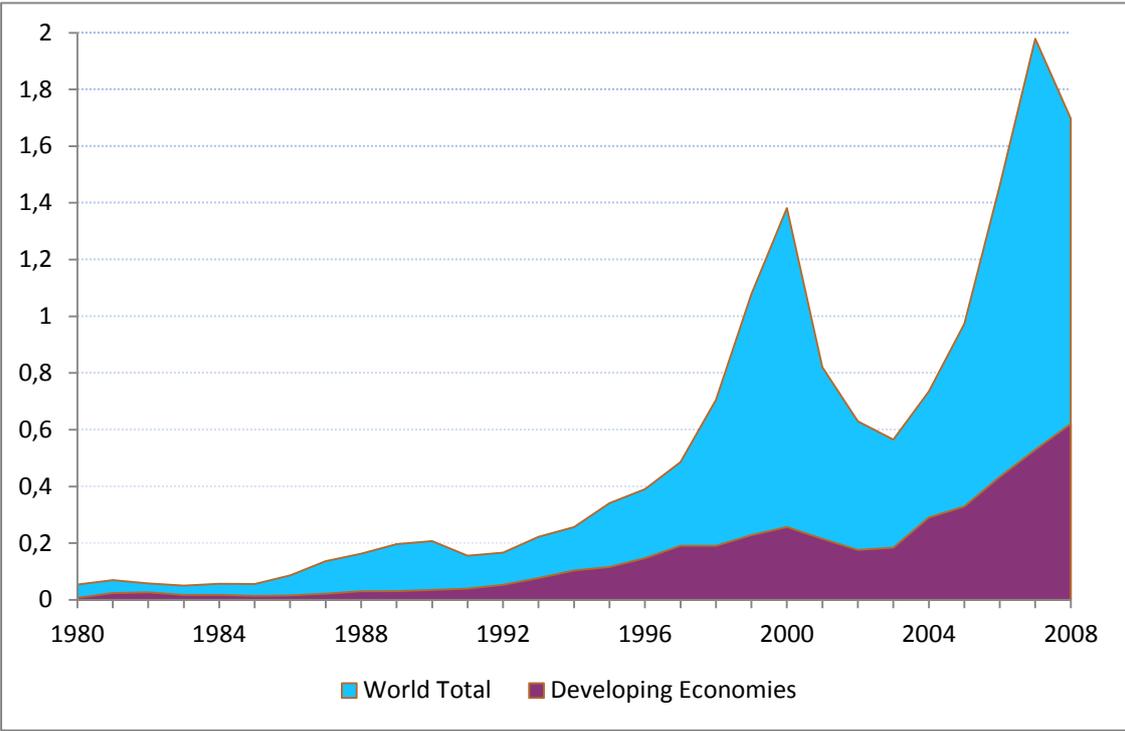
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1. Introduction

Globalization of economic activity has been ongoing at least since the early sixties. The spread of production activities around the globe has been mainly attributed to the activities of the multinational enterprises (MNEs) in the developed nations as a result of worldwide liberalization of economic activities and rapid technological change since the eighties. Increased flows of foreign direct investment (FDI) all around the world has been the evidence of accelerated globalization movement as presented in Figure 1 below. An interesting feature of these international flows over the period 1980-2008 is the accompanying rise in the share of developing regions receiving these flows. By the end of 2008, developing economies has received one third of the world total FDI flows. The FDI figures below are the outcome of greenfield investments, merger and acquisitions as well as of expansions implemented by existing foreign firms.

Figure 1: Evolution of FDI flows: 1980-2008 (trillion dollars)



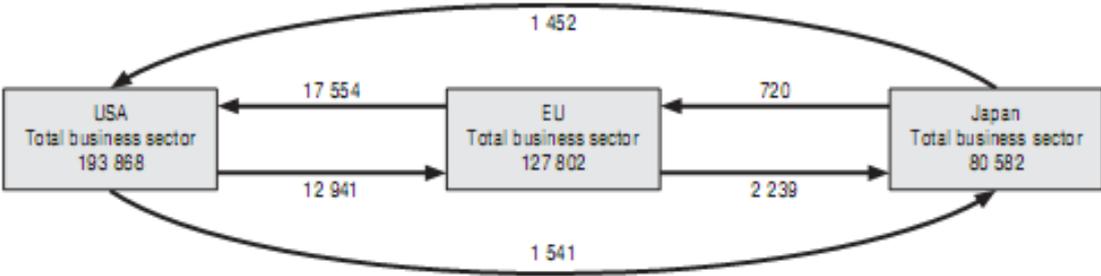
Source: World Investment Report 2010.

Beginning in the nineties, the globalization of manufacturing function of MNEs – accompanied by that of marketing & sales –was followed by the offshoring of their R&D activities, pointing to the spread of innovation activities of MNEs all around the world. Although data supporting globalization of R&D is scarce, available evidence points to the increasing importance of this phenomenon. For instance, Data provided in UNCTAD (2005) shows that over the period 1995-2004 the share of the total R&D budget of Western European MNEs allocated to their affiliates located outside Europe

increased from 25.7% to 43.7%, almost a 20 percentage point increase. For North American MNEs, a similar evolution is observed with the aforementioned share rising from 23.2% in 1995 to 35.1% in 2004. Data for Japan indicates a similar scenario although its degree of R&D globalization is much smaller than the other two regions.

Figure 2 below relates to R&D flows between the European Union (EU), USA and Japan. When R&D expenditures made by the enterprise sector only is taken into consideration, it can be observed that the main flows in 2002 took place between EU and USA whereas R&D flows both to and from Japan were less important. When *both* incoming and outgoing R&D flows are taken into account, the degree of internationalization of R&D amounts to 23.4% for the EU and 15.5% for the US in the year 2002.

Figure 2: R&D flows between EU, US and Japan in 2002 (millions of USD)



Source: OECD (2006).

Finally, data provided in OECD (2008) informs us about the evolution of the geographical distribution of R&D expenditures carried out by foreign affiliates of US MNEs over the period 1995-2005. The total amount of R&D expenditures of US affiliates abroad increased by 133% from 12.8 billion USD in 1995 to 28.3 billion USD in 2005. The proportion of these R&D expenditures carried out in the EU went down from 70.4% to 61.0% while that in the Asia-Pacific region increased from 14.8% to 18.2%, which is largely due to the increasing share directed to China –rising from 0.1% in 1995 to 2.5% in 2005. On the other hand, Japan’s share decreased significantly over the same period from 10.2% to 6.2%.

Data presented above confirms the increasing trend towards globalization of R&D activities emphasized by previous research³. Therefore, R&D activities of MNEs can no more be presented as a case of non-globalized activity of MNEs⁴. Furthermore, available data indicates that an increasing

³ UNCTAD (2001 and 2005).
⁴ Patel and Pavit (1991).

share of off-shored R&D flows into emerging countries, pointing to the necessity of analyzing issues related not only to attract these international R&D activities but also how to use them to enhance the quality of the national systems of innovation in these countries.

In this study, Turkey, a mid-sized emerging economy, was chosen as a case study to analyze various issues involved in the internationalization of R&D activities. Indeed, after having pursued an import-substitution based development strategy from the early 1950s until 1980, Turkey switched to a more outward-oriented one from 1980 onward. Liberalization policies introduced included measures aimed at export promotion and import liberalization, and at a later stage, at deregulation of the financial sector and promotion of foreign direct investment (FDI). FDI flows recorded an upward trend especially from 2000 onwards and data on the MNC affiliates in Turkey indicates that their shares not only in the production, value added, employment and investment but also in the R&D activities at the sector level have increased significantly.

In order to identify and analyze opportunities but also problems associated with the increased foreign presence in the field of innovation activities in the Turkish economy, we prepared an open-ended questionnaire and conducted semi-structured in-depth interviews with the CEOs and R&D, product and production directors of 26 MNE affiliates operating in the manufacturing and ICT sectors in 2010. These firms operate in the pharmaceutical sector, automotive sector, electrical/electronics sector, and in the ICT sector. They are all wholly or partly owned affiliates of well-known MNEs present all over the world. Case studies were our preferred research methodology mainly because we believe that information embedded in individuals and organizations on the issues we are interested in can only be identified and retrieved by administering an open-ended questionnaire to relevant actors in MNEs.

By using information provided by the in-depth interviews, we intend to analyze issues such as why⁵, how and by whom (parent company or its affiliate in Turkey⁶) the decision to carry out R&D activities in Turkey was taken. Besides, the nature of R&D activities -adaptive or more innovative- conducted by these firms will be analyzed as well as the role of domestic *versus* international/regional markets therein. Information concerning the extent of internationalization of R&D activities of the parent company, and its current and future locations will be examined as well. Another major section in the open-ended questionnaire concerns the impact of institutional and legal environment in Turkey on international R&D activities and the implications of recent R&D support policies implemented in Turkey on R&D expenditures of MNE affiliates. The final objective is to identify major problems that impede the increase in the volume and quality of existing R&D activities in Turkey or the attraction of new greenfield R&D-based FDI. Policy proposals to address these issues will be formulated

The remainder of this paper is organized as follows. Section 2 proceeds with a discussion of the internationalization of R&D while section 3 examines the evolution of FDI flows and international R&D activities in the Turkish economy. Findings of our interview with the CEOs and R&D, product and

⁵ This question takes into account the impact of business environment at the broad sense (cost, skilled workforce, collaboration with universities, regulatory framework, relations with suppliers, R&D support schemes, etc.).

⁶ The initiator of the R&D in the host country is an important research question and has implications for interrelations of the parent company with its affiliates: see von Zedwitz and Gassmann (2002), and Miesing et al. (2011).

production directors of MNE affiliates are presented and analyzed in section 4. Section 5 concludes by presenting the main findings of our study and formulating a number of policy proposals.

2. Internationalization of R&D: determinants and policies

Several reasons can be mentioned as to why R&D or more generally innovative activities of firms should be carried out within the firm, rather than contracted to external actors – other firms or research laboratories⁷.

Firstly, a successful or efficient innovation process often requires intense interaction between different departments—R&D, design, manufacturing, marketing and sales – within the firm⁸. The need for interaction is motivated by the largely tacit nature of the knowledge created during the innovation process and by the need to circulate it within the firm. Furthermore strategic factors such as secrecy of the R&D process and its outcome may force a firm to keep its R&D activities in-house. The prospect of leakages occurring in the R&D activity may lead firms to use relatively less external actors for this activity.

Secondly, at a more aggregated level of economic activity, i.e. at the national- or sector-level innovation activities of firms occur within the framework of networks involving different types of agents. The identification of appropriate agents and the formation of useful linkages with them are costly in monetary terms as well as in time devoted to the generation and management of these networks. At the macro level, all the links established and interactions occurring between the actors involved in the innovation process constitute the national innovation system (NIS)⁹. Firms are *embedded* in these networks, meaning that it is extremely difficult and costly for them to reproduce the same set of relationships with similar actors outside their national borders. This situation leads very often to a situation of *path dependency* with respect to the NIS of a country, i.e. its structure, links between its actors and its outcome evolves rather gradually with time. Of course, a situation of *lock in* can appear if at least some parts of the NIS has to change for a country to remain competitive at the international level but cannot due to *inertia* of different nature – institutional, political or technological.¹⁰

Therefore, in order to examine the issue raised earlier, i.e. the analysis of factors responsible in the globalization of R&D activities of MNEs, we must first identify the changes occurring at the economic environment which mitigated the relative importance of aforementioned factors in R&D location decisions¹¹.

First of all, the new economic era is characterized by a rapid pace of technological change and increased competition on all markets (national and international) due to the liberalization and deregulations of markets all over the world. One major way for firms to confront the intensified

⁷ Narula and Zanfei (2005), OECD (2006) and Carlsson (2006).

⁸ Kline and Rosenberg (1986).

⁹ Lundvall (1992) and Edquist (2005).

¹⁰ Narula (2003).

¹¹ Criscuola (2005).

competition on their markets is through innovating, i.e. by offering new or better products on the market or the same products at a lower price or both. The critical point here is that consumers are not willing to pay significantly higher prices for the new products that come as a result of the innovation process. Therefore, in a highly competitive environment firms are struggling to maintain the cost of the innovation through different means.

The situation described above coincides with problems related to the availability and the high cost of skilled workforce in industrialized nations, due to an aging population and a loss of interest of new generations in scientific disciplines. Therefore, since it becomes rather difficult and costly to recruit people for R&D activities in their country of origin (NIS), MNEs turn their attention to those developing or emerging economies where the labor force with appropriate skills and knowledge exist in sufficient numbers and good quality. By the help of the new ICTs, this process has resulted in the delocalization of some parts of R&D activities of MNEs towards a limited number of developing countries, with China and India being at the top of the list¹².

Table 2.1 below summarizes the mains factors influencing the internationalization of R&D activity of MNEs.

Table 2.1: Supply- and demand-related factors in the internationalization of R&D

FACTORS	Characteristics of S&T supply	Characteristics of demand
Centralization in the home country	<ul style="list-style-type: none"> • Strong S&T capabilities at the home country • Economies of scale in R&D 	<ul style="list-style-type: none"> • Home country is a lead market
International dispersion	<ul style="list-style-type: none"> • Attractive centers of excellence abroad • Low cost talent pool: increasing supply of scientist and engineers in emerging countries 	<ul style="list-style-type: none"> • Adaptation to foreign markets and local production conditions • New lead markets abroad

Source: adapted from Sachwald (2008)

¹² See UNCTAD (2005) for a discussion of the determinants of attractiveness of R&D activities for MNEs and a list of countries ranked by the CEOs of largest MNEs in the world. See also Schmiele (2011).

In fact, empirical findings and theoretical research indicate that offshoring of R&D activities by MNEs obey to two different forces. If we define MNEs as owners of intangible proprietary assets, the act of carrying out R&D activities abroad can enable them either to use those assets to obtain a competitive advantage or to benefit from the research infrastructure and skilled labor of those host countries at competitive prices. This is particularly important if their NIS is unable to provide them at home¹³.

The first type of R&D activity (abroad) –part of what is called *asset-exploiting FDI* is observed in emerging or developing economies and is usually aimed at adapting products or production processes -conceived, designed in and manufactured for the markets of developed nations- to the new environments in emerging economies. They thus tend to be of an incremental kind and are carried out with the requirements of the domestic market in mind (preferences and tastes of consumers, lower per capita income levels, peculiarities of the climate and physical infrastructure). Recently, R&D activities of MNEs have been changing in nature. Rather than being merely adaptive and domestic market oriented, more innovative R&D practices are taking place with a target of a region or the world market. However their link with the production activities still remains. Furthermore a final stage in the R&D activities of MNEs in emerging countries emerges. MNEs that have not had any previous manufacturing presence in a developing country do not hesitate to invest in those countries with the sole purpose of R&D and with the world market as the main target¹⁴.

The second type of R&D activity –linked to the *asset-augmenting FDI*– is observed in developed nations and is usually carried out by foreign firms in order to access the scientific and research capability of the host country. A well known example of this type of R&D activity is the R&D investment made by the European pharmaceutical firms in the USA during the last ten years in order to take advantage of the strengths of USA in this field and to make up for the gap observed in Europe in this field. The outcome of such investments in R&D is in general products or services offered to the world market. In fact, R&D activities abroad aimed at mitigating the deficiencies of the NIS of MNEs' home countries constitute the first wave of globalization of R&D and has been going on for quite a while since the sixties.

Following the classification of the different types of R&D activity conducted by MNEs abroad, recent research on the internationalization of R&D point to three different kinds of R&D units implemented by MNEs' affiliates: Local development center, global development center and global research laboratory. The local development center pursues adaptive, incremental R&D mainly aiming for domestic and possibly the regional market, global development center carries out innovative research targeting the world market and global research laboratory performs world class research and generates genuine innovative products for the world market. Table 2.2 below presents the supply- and demand-side factors impacting of the innovation activities of these entities.

¹³ On the determinants of different types of FDI, see European Commission (2007), OECD (2006) and UNCTAD (2005).

¹⁴ Recent R&D activities of MNC affiliates in the ICT sector in China – resulting from greenfield investment with no prior production experience –are of this kind. See UNCTAD (2005).

Table 2.2: Determinants of the location of R&D units

		Attractive local characteristics	
		Scientific and technological supply	Demand
Type of R&D unit	Local development center	Quality of training (engineers, technicians ...) and local technological infrastructure	<i>Large local market (size, purchasing power)</i>
	Global research center	<i>Excellence centers, good relations between research and industry</i>	Lead market
	Global development center	<i>Good cost/efficiency ratio for some R&D activities</i>	---

Source: Sachwald (2008)

What are the effects exerted by R&D activities of foreign firms on the host economy? Through which channels do these effects – positive or negative – materialize? To which extent and through which policies and related instruments can governments maximize the amount of positive effects?

Although FDI flows¹⁵ can influence positively the level of investment in machinery and equipment, foreign exchange earnings and employment in the host country – a developing or emerging economy in our case – the most important and durable effect of FDI on the host economy in the long term is its positive impact on the pace of productivity growth. Different channels such as technological and organizational innovations, imitation, reverse engineering, informal and formal transfers of knowledge, must be examined to elucidate how FDI affects the host economy positively.

In general, two effects of the activity of foreign firms on the performance of the host economy are identified¹⁶.

The first one is the *direct* effect exerted solely by the presence of foreign firms on the host economy. Due to the proprietary intangible assets they possess, we expect foreign firms to perform better than domestic firms – a fact confirmed by the empirical studies. Therefore, the mere establishment of foreign firms in a developing country will exert a positive effect on its productivity level. However,

¹⁵ By 'foreign firm', we refer here mainly to foreign affiliates of MNEs.

¹⁶ Blomstrom and Kokko (1998), Gorg and Greenaway (2003), Saggi (2005) and Smeets (2008).

what counts when the positive effects of FDI on the host economy is analyzed, is the multiplier effect they can exert through their positive effects on the performance of domestic firms. These *indirect* effects are called *FDI-related knowledge* or *technology spillovers*, and their existence and magnitude condition to a large extent the benefits host countries can obtain from FDI.

There are three main channels through which FDI can affect the productivity of domestic firms¹⁷. The first one is called the *demonstration effect* and occurs when foreign firms with advanced technologies enter a local market and introduce newer technologies to the industry. Through direct contact with foreign affiliates of multinationals, local firms can watch and imitate the way foreigners operate and can become more productive – by reverse engineering, for instance. The second channel of FDI spillovers is through *labor mobility*: skills or human capital acquired by employees in foreign firms can be transmitted to new or existing local firms through mobility of the workforce; *Third*, the entry of foreign firms may lead to more intense competition in the local industry and domestic firms are forced to use more efficiently existing technologies and resources by reducing their inefficiencies. Domestic firms may also be forced to acquire and introduce new technologies in order to maintain their market shares. Increased competition may be able to eliminate monopolistic profits and enhance the welfare of a country. However, there is also a possibility that the competition effect is harmful to domestic firms.

Note that the FDI spillovers examined above are called horizontal or intra-industry spillovers in contrast to vertical or inter-industry spillovers which occur between firms located in different industries. Vertical spillovers are as important as horizontal spillovers.¹⁸

The literature on FDI spillovers examined above includes hardly any reference to R&D activities of foreign firms and thus does not analyze spillovers that might arise from their R&D activities. Such an approach is not erroneous in itself since many developing nations stand far behind the technology frontier in many sectors. However, a number of factors lead to the fact that R&D departments of foreign firms may now become the new source of FDI-related spillovers¹⁹. Following the widespread codification of knowledge through the use of ICT, the relative share of formal innovation activities has been increasing in the two last decades with respect to informal ones. This development underlined the importance of the R&D departments of firms. Secondly, the role of innovation activities of firms in their competitive strategies is much more prevalent today than two decades earlier.

The available evidence as well as the conceptual framework used for the analysis of R&D-related FDI spillovers is less developed than the one on the classical FDI spillovers examined previously. However, the distinction between direct and indirect effects remains: indeed, it is necessary to distinguish between the direct contribution made by the R&D activities of foreign firms to nation-level performance from the indirect contribution it exerts through its impact on *domestic* firms performance, especially by means of a positive effect on R&D expenditures of *domestic* firms.

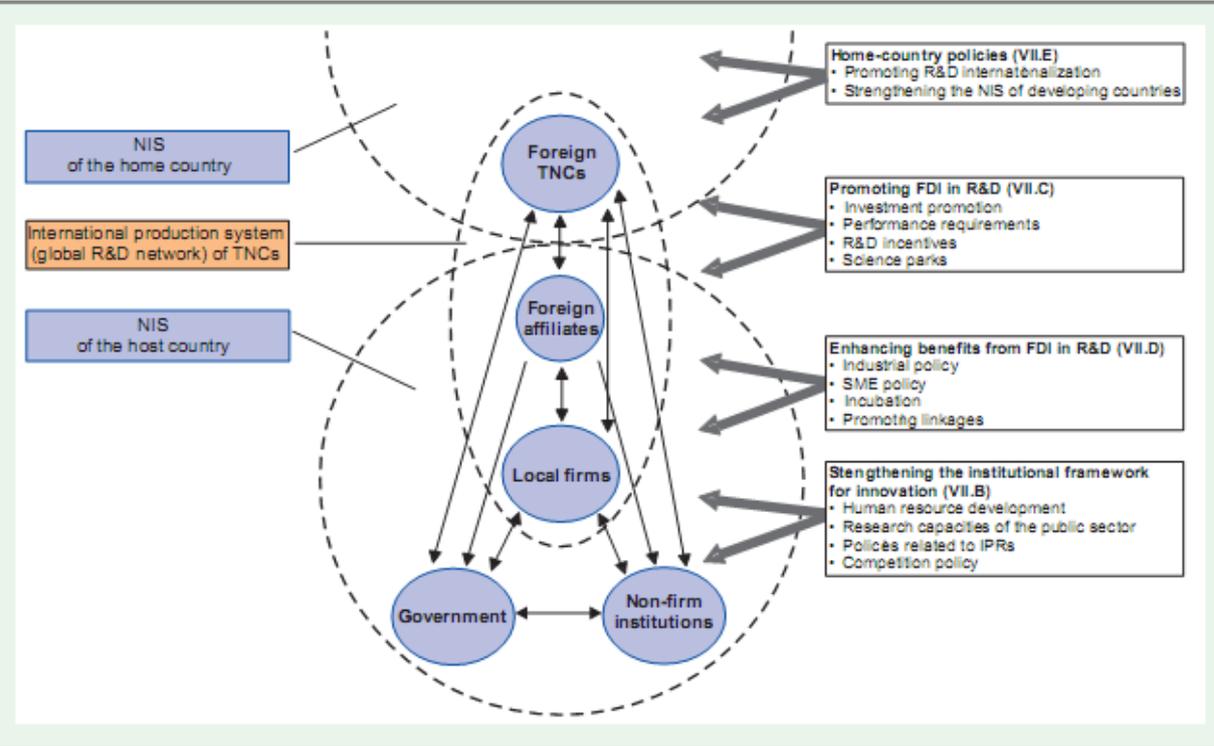
¹⁷ Pamukçu et al. (2006).

¹⁸ Javorcik (2004).

¹⁹ See Kalayci and Pamukçu (2011) and references cited therein.

Attracting FDI-based R&D and materializing its benefits through R&D spillovers from foreign to domestic firms is a sophisticated process involving many actors with different motives and making use of a number of policies not all related to FDI promotion, a challenge which Figure 2.1 below presents.

Figure 2.1: National Innovation Systems and FDI in R&D



Source: UNCTAD (2005).

This figure illustrates the importance of the following factors for enhancing benefits from FDI in R&D: (i) existence of a strong scientific and technological infrastructure (ii) promotion of linkages and formation of networks between domestic and foreign firms (iii) constitution of clusters around foreign firms in domains where domestic firms enjoy comparative advantage and (iv) strengthening the institutional framework for innovation through designing and implementing appropriate policies in the field of competition, human resources and IPR regulation. Notwithstanding the validity of these generic policies for the developed world, the FDI related R&D policies of the developing countries will certainly be different.²⁰

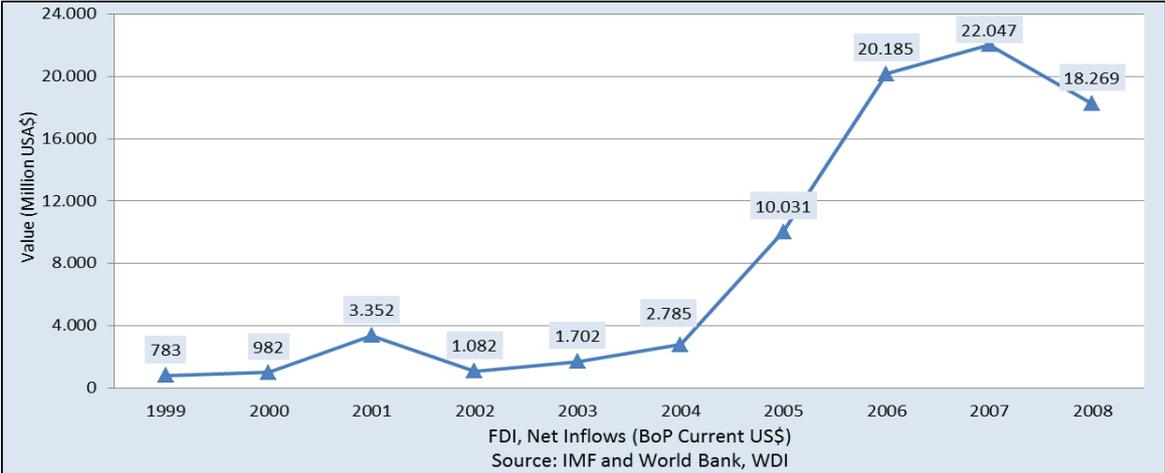
²⁰ Narula and Guimon (2010).

3. Evolution of FDI and R&D expenditures in the Turkish economy

After the shift from the import-substitution based development strategy to a more-outward-oriented one in the year 1980, a number of changes in the regulatory framework, privatizations, liberalization of the financial system, elimination of restrictions on foreign exchange, foundation of a capital market and heavy investment in telecommunications technology contributed to the development of a favorable environment for FDI throughout the 1980s. As a result, by 1990 the annual FDI flow reached \$ 684 million. However, FDI flows remained rather stable in the 1990s. When we look at the 2000's, we see a much more favorable environment for foreign investors with a strongly regulated financial system, a reduced inflation rate and the establishment of a Coordination Council for Improving the Investment Climate. Following the enactment of the new foreign capital law, Law 4875, in June 2003, minimum capital requirements and permits were eliminated, ownership of property without any restrictions, the right to international arbitration and employment of expatriates were granted.

Figure 3.1 below presents the evolution of the FDI flows over the period 1999-2008. From 2006, a significant increase is observed in FDI flows, with a ten-fold increase in 2007 with respect to 2004. Data nonreported here on the ratio of FDI flows to GDP show that except for 2001, this ratio was less than 1% until 2005 and increased onwards to attain 5% in 2006.

Figure 3.1: Evolution of the FDI/GDP ratio in Turkey: 1998-2008 (million dollars)

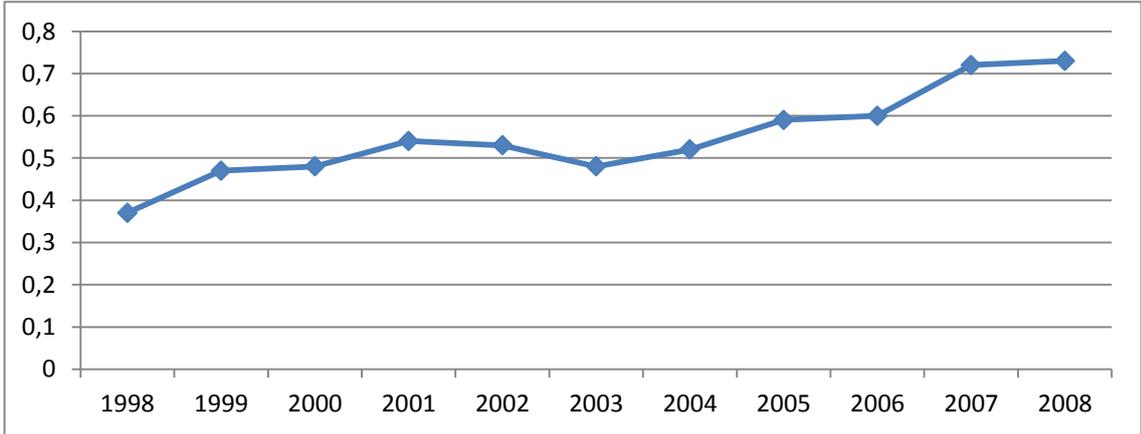


Source: Undersecretariat of Treasury.

This increasing trend in FDI flows was accompanied by significant changes in the sectoral distribution of these flows: leading to a gradual reorientation from manufacturing to services sector is observed over the period 2002-2009.

On the other hand, a similar evolution is observed for the R&D /GDP ratio in Turkey, with the value of this ratio rising from 0.38% in 1998 to 0.72% in 1998 (Figure 3.2). The proportion of this increase in R&D expenditures performed in and funded by the enterprise sector increases as well during this period: the proportion of R&D expenditures performed by the higher education sector decreased from 61.1% to 44.2% from 1998 to 2008 whereas the corresponding share of the business sector increased from 31.6% to 43.8% over this period. A similar evolution is observed for the funding of R&D expenditures in Turkey.

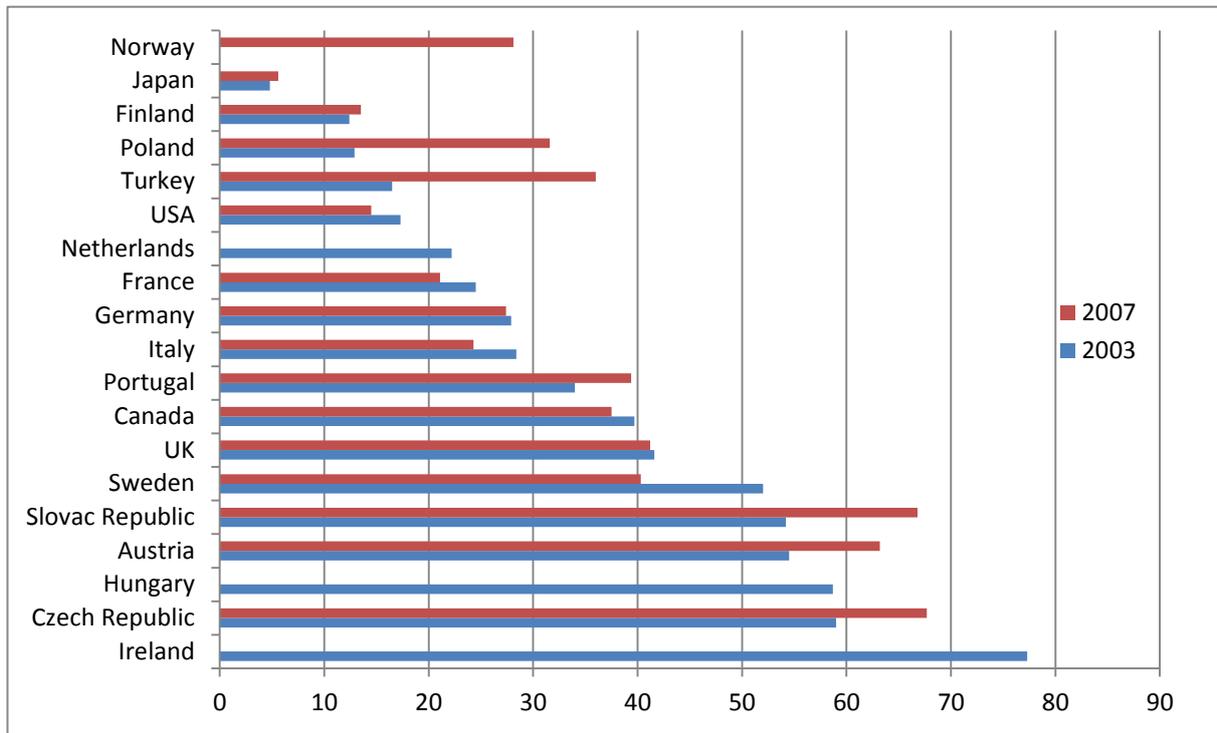
Figure 3.2: Evolution of the R&D / GDP ratio in Turkey: 1998-2008 (%)



Source. Turkish Institute of Statistics (TurkStat), R&D surveys.

Data about the degree of internationalization of R&D activities in Turkey for 2003 and 2007 are presented in Figure 3.3 along with data for other OECD countries.

Figure 3.3: Share of foreign firms in the R&D expenditures of the manufacturing sector in OECD countries: 2003 and 2007 (%)



Source: OECD, AFA (activities of foreign affiliates) database and Turkstat, R&D surveys.

The proportion of R&D expenditures performed by foreign firms in the Turkish manufacturing sector increased from 16 % in 2003 to 36% in 2007, a twenty percentage point increase over five years. Along with Poland, Turkey is one of the two countries where the role played by foreign firms in R&D increased most over the examined period. It seems to us that this evolution by itself requires the analysis of the implications of such R&D activities on the Turkish national innovation system.

4. Analysis of factors influencing R&D behavior of foreign enterprises in Turkey²¹

In this section, findings of face-to-face semi-structured interviews conducted with R&D directors of foreign firms in four different sectors are analyzed in order to understand those factors that impact on their R&D behavior in the Turkish economy. The analysis will be conducted separately for each sector and for each subsection of the open-ended questionnaire used for the interviews (see section 3). First, we will make use of international and national datasets to examine the characteristics of the

²¹ The terms “foreign/international firms” and “foreign affiliates/branches of MNEs” are used interchangeably in this paper. In a similar vein, “headquarters” and “parent company” of foreign firms both refer to the same entity.

parent companies of the interviewed firms and assess the role played by their affiliates in the Turkish economy. Secondly, after presenting information on firm profile -especially data on R&D activities of foreign firms which is missing from the national dataset- we will attempt to answer the following questions:

1. General information about firms, current situation of their R&D activities and prospects for the next three years.
2. Impact of business environment on R&D; how the initial R&D decision was taken; information about the R&D activities of parent company; global location of R&D sites; nature of firms' R&D activities in Turkey; role of domestic *versus* export markets; R&D funding schemes.
3. Impact of institutional and legal environment in Turkey on R&D activities; implications of R&D support policies; human infrastructure; and collaboration activities of firms.

Detailed information obtained through interviews will enable us to assess the motivations of MNEs when deciding to conduct R&D outside their traditional home base in general and in Turkey, in particular. Discussion of identified factors will lead us later to formulate policy recommendations at the sector level for a better integration of R&D activities of foreign firms into the Turkish national system of innovation.

4.1 General R&D trends and performance indicators

In Table 4.1 we present performance indicators for the headquarters of foreign firms interviewed for our study. In this table, companies are ranked according to the level of their R&D expenditures both at the EU and global levels, but also within their sector of activity. Other performance indicators include (i) R&D expenditures in 2009 and its change over the three previous years (ii) net sales in 2009 and its change over the three previous years (iii) number of employees in 2009 and its change with respect to the previous year and (iv) R&D intensity, defined as the ratio of R&D expenditures to net sales, in 2008 and 2009.

Twenty-six foreign firms interviewed for this study operate in:

- **Pharmaceutical industry:** Johnson & Johnson (J&J), MSD, Sanofi Aventis, Novartis and Pfizer
- **Automotive industry:** Oyak Renault, Tofas²², Mercedes-Benz, Ford and Toyota
- **Electrical/Electronics industry:** BSH, General Electric, Bosch TT, Indesit and Arçelik
- **ICT sector:** Alcatel Lucent, Ericsson, Cisco, Nortel Netas, Turkcell, Yapi Kredi Bilisim and Avea
- **Various:** Unilever, Procter & Gamble and Schott Orim²³

²² A joint venture of the Koç Holding with Italian automotive company Fiat.

²³ Three firms present in our sample operate in sectors other than automotive, ICT, electrical-electronics and pharmaceuticals. They will not be examined in this paper.

Table 4.1: Rankings and performance indicators of the parent companies of interviewed foreign firms (2009)

COMPANY	Country	EU ranking	Non-EU ranking	EU sector ranking	Non-EU sector ranking	R&D exp. (million euro)	Change in R&D exp. (%) (2008-2009)	Change in R&D exp. (%) (2007-2008)	Change in R&D exp. (%) (2006-2007)	Net sales (million Euro)	Change in net sales (%) (2008-2009)	Change in net sales (%) (2007-2008)	Change in net sales (%) (2006-2007)	# Employees	Change in # employees (%) (2008-2009)	R&D/net sales (2009)	R&D/net sales (2008)
ALCATELLUCENT	France	11	-	2	-	2.714	-14,3	-6	69,4	15.157	-10,8	-5,7	25,2	78.373	0,8	17,9	18,6
CISCO	USA	-	14	-	1	3.630	1,1	14,5	10,6	25.172	-8,7	13,2	22,6	65.550	-0,9	14,4	13,0
NORTEL NETAS	Canada	-	105	-	7	528	-51,9	-8,7	-11,1	3.800	-47,7	-4,8	-4,1	-	-	13,9	15,1
TURKCELL	Turkey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
YAPI KREDI BILISIM	Turkey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ERICSSON	Sweden	13	-	3	-	2.402	-12,1	10,4	0,4	20.155	-1,2	11,3	5,6	86.360	9,3	11,9	13,4
AVEA	Turkey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMS	USA	-	23	-	8	2.542	1,7	9,2	7,0	15.078	1,3	7,0	11,5	28.000	-20,0	16,9	16,8
J & J	USA	-	6	-	4	4.869	-7,8	-1,3	7,8	43.139	-2,9	4,3	14,6	115.500	-2,7	11,3	11,9
MSD	USA	-	10	-	5	4.074	21,6	64,2	33,7	19.116	15,0	87,9	19,8	100.000	-	21,3	20,1
S. AVENTIS	France	3	-	1	-	4.569	0,2	0,9	2,7	29.785	8,0	-1,7	-1,1	104.867	6,8	15,3	16,5
NOVARTIS	Switzerl.	-	5	-	3	5.156	2,5	12,6	21,1	30.852	6,8	4,2	7,5	99.834	3,2	16,7	17,4
PFIZER	USA	-	4	-	2	5.404	-2,4	-1,8	6,4	34.854	3,5	-0,3	-7,6	116.500	42,4	15,5	16,5
ARCELIK	Turkey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BSH	Germany	75	-	2	-	271	3,2	-0,4	11,9	8.405	-4,0	-0,7	6,1	39.683	-2,5	3,2	3
GE	USA	-	25	-	2	2.317	10,1	0,4	1,3	107.979	-13,8	19,8	-10,9	304.000	-5,9	2,1	1,7
BOSCH TT	Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INDESIT	Italy	459	-	11	-	22	16,8	-26,0	1,6	2.613	-17,2	-8,2	5,8	16.294	-6,0	0,8	0,6
OYAK RENAULT	France	19	-	7	-	1.643	-26,5	-9,2	2,6	32.759	-10,2	-7,7	-2,4	124.307	-5,1	5,0	6,1
TOYOTA	Japan	-	1	-	1	6.768	-5,7	7,6	9,6	153.697	-21,9	9,8	13,8	320.808	1,5	4,4	3,6
TOFAS	Turkey	-	370	-	35	111	-19,0	-	100,0	2.372	6,3	34,5	16,9	7.014	-19,3	4,7	6,1
MERCEDES BENZ	Germany	5	-	2	-	4.164	-6,2	-9,2	-6,6	78.924	-17,7	-25,9	-15,3	258.628	-5,7	5,3	4,6
FORD	USA	-	16	-	4	3.415	-32,9	-2,7	4,2	82.454	-19,1	-15,2	7,7	198.000	-7,0	4,1	5,0

Source: compiled from IPTS (2010).

In IPTS ranking, Bosch TT is not listed but it is a subsidiary of Bosch.

23 out of the 26 interviewed firms are present in the ranking done by the IPTS.²⁴ A major observation is that interviewed firms are subsidiaries of sector leaders -at least one of their parent companies is always among the first three firms for the sector ranking- and most of them perform well also at the global and EU level rankings. It turns out that among the sectors examined pharmaceuticals is the most active R&D performer, both in terms of its level of R&D expenditures and its R&D intensity. In terms of R&D intensity pharmaceuticals

(16.2 %) is followed by the ICT sector (14.5%) while the remaining two sectors, automotive (4.7%) and electronics (4.5%), are far below the first two ones for this indicator. These indicators and ratings are informative about the R&D potential of parent companies of interviewed firms and are influenced by several factors including sector-level technological opportunities and company strategy. Data on changes in R&D expenditures and net sales in 2008 point to the negative effects the economic crisis will exert later on their performance.

A simple calculation shows that global R&D investments of the 22 firms listed in Table 4.1 are 20 times larger than the total R&D investments conducted in Turkey in 2009. In the hypothetical case 10% of global R&D investments of the parent companies were attracted to Turkey, this amount would at last triple!

Another dataset is collected by the Istanbul Chamber of Industry (ISO) through its annual survey on the 500 largest industrial firms operating in Turkey. Industrial firms are ranked here in terms of their sales revenues. Selected variables and the rankings are reproduced in Table 4.2 for the firms interviewed in our study. 12 interviewed firms are not in this table because either some of them are not classified as manufacturing firms or because their performance measured in terms of sales is not sufficient for them to appear amongst the top 500 firms. As expected, the most important sales figures are attained by automotive firms. Further, ISO data indicates that the presence of interviewed companies is particularly strong in the automotive sector where they account for 58% of total sales, 74% of exports, and 56% of total number of employees. Besides the fact that some of the interviewed firms are not present in this Top 500 list, no data is collected on R&D expenditures of these companies. Data collected during the interviews we conducted with foreign firms established in Turkey will enable us to present and analyze their R&D expenditures in the next section.

²⁴ Arçelik, a subsidiary of Koç Holding, is not listed but Koç Holding is ranked as 355th in the global ranking and 14th in sectoral ranking.

Table 4.2: Descriptive statistics for interviewed foreign affiliates of MNEs in Turkey, 2009

Company	Rank	Sales (US\$ 1000)	Exports (US\$ 1000)	Exports/sales (%)	Number of employees	Share of capital (domestic)	Share of capital (foreign)
ALCATEL LUCENT	297	214.087	49.437	23,1	568	35,0	65,0
CISCO	-	-	-	-	-	-	-
NORTEL TELETAŞ	258	114.669	49.894	43,5	1.081	46,9	53,1
TURKCELL	-	-	-	-	-	-	-
YAPI KREDİ BİLİŞİM	-	-	-	-	-	-	-
ERICSSON	-	-	-	-	-	-	-
AVEA	-	-	-	-	-	-	-
BMS	-	-	-	-	-	-	-
JOHNSON & JOHNSON	-	-	-	-	-	-	-
MSD	-	-	-	-	-	-	-
SANOFI-AVENTIS	-	-	-	-	-	-	-
NOVARTIS	143	513.231	-	-	-	0	100
PFIZER	152	210.817	20.733	9,8	1.426	0	100
ARÇELİK	3	3.684.045	1.612.476	43,8	12.553	100	0
BSH	15	1.522.153	625.147	41,1	3.586	0,72	99,28
GE	-	-	-	-	-	-	-
BOSCH TT	168	739267,8	567.329	76,7	550	0	100
INDESIT	-	-	-	-	-	-	-
OYAK RENAULT	2	3.730.813	2.799.005	75,0	5.947	49,0	51,0
TOYOTA	12	1.464.627	1.442.292	98,5	741	0	100
TOFAS	4	3.287.714	2.004.257	61,0	6.939	62,14	37,86
MERCEDES BENZ	19	1.592.107	486.734	30,6	3.975	7,05	84,99
FORD	5	3.628.603	1.894.266	52,2	7.729	58,96	41,04

Source: Top 500 Industrial Firms database of ISO.

4.1 General Firm Profile

In this first section, responses of the interviewed foreign firms to the first part of the semi-structured questionnaire are presented and analyzed. Table 4.3 below summarizes the main R&D-related data obtained from the survey.

First, the time span during which foreign firms in our sample were established in Turkey covers a long period and ranges from the 1950s to the new millennium. Second, parent companies of these firms are located in a wide range of countries and continents including USA, EU countries, Switzerland, Canada and Japan. Third, except one firm operating in the automotive industry all the firms in our sample do conduct R&D activities although its volume and innovative content differ from one sector to another. Further, ten firms declared they have -at least- one R&D center functioning in accordance with the R&D law no 5746. Fourth, information provided by foreign firms about their R&D activities do not facilitate comparison of R&D intensities between as well as within sectors: besides the fact that not all firms provided this information - hence the missing values in Table 4.3 - available information on sales did not allow us to calculate R&D intensity for all the firms with the information on R&D expenditures. However, data on the share of R&D personnel in total employment is available for all but one firm and indicate the extent of R&D activities conducted in these firms.

Other questions contained in the first part of the questionnaire is about the estimation of growth rate of R&D expenditures and staff for the last three years as well as forecast of firms for the three years to come about these two variables.

Data relating to the general characteristics of firms and of the sector they operate in are analyzed next separately for each sector.

Table 4.3: R&D-related statistics for interviewed foreign affiliates of MNEs in Turkey, 2009

Company	Year	Home country	R&D activities in Turkey	R&D center (Law No 5746)	R&D/sales <u>or</u> R&D exp. (US\$ 1000)	R&D personnel	Number of employees	R&D personnel /employees (%)
ICT sector								
ALCATEL LUCENT	1985	France	Yes	Yes	-	62	610	10,1
CISCO	-	USA	Yes	-	-	-	-	-
NORTEL TELETAŞ	1973	Canada	Yes	Yes	-	922	1.084	85,0
TURKCELL	2007	Turkey	Yes	No	4.543	330	360	91,6
YAPI KREDİ BİLİŞİM	2006	Turkey	Yes	No	8.788	314	550	57,1
ERICSSON	1986	Switzerland	Yes	No	-	84	450	18,7
AVEA	2004	Turkey	Yes	Yes	9.435	174	800	21,8
Pharmaceuticals								
BMS	1995	USA	Yes	No	1.000	6	200	3-4
JOHNSON & JOHNSON	2006	USA	Yes	No	609	0	250	0
MSD	1995	USA	Yes	No	2.500	15	1.000	1,5
SANOFI-AVENTIS	2003	France	Yes	Yes	11.000	80	1.020	7,8
NOVARTIS	1998	Switzerland	Yes	No	9.564	28	2.400	1,2
PFIZER	1957	USA	Yes	No	14.000	30	1.500	2,0
Electrical & electronics								
ARCELİK	1955	Turkey	Yes	Yes	1,33	850	18.000	6,8
BSH	1992	Germany	Yes	Yes	-	120	2.000	3,3
GE	2000	USA	Yes	No	1.000	80	86	93,0
BOSCH TT	1992	Germany	Yes	No	0,42	37	550	6,7
INDESIT	1994	Italy	Yes	No	-	23	1.320	1,7
Automotive sector								
OYAK RENAULT	1969	France	Yes	Yes	0,27	179	5.918	3,0
TOYOTA	1994	Japan	No	No	0	0	-	0
TOFAS	1968	Turkey	Yes	Yes	4,70	450	5.900	6,5
MERCEDES BENZ	1967	Germany	Yes	Yes	0,79	188	3.989	4,7
FORD	1959	USA & Turkey	Yes	Yes	1,28	603	7.600	7,8

(-) not available.

Source: calculations by authors based on semi-structured interviews conducted with foreign affiliates of MNEs in Turkey.

4.1.1. Pharmaceuticals

Six affiliates of MNEs operating in the pharmaceutical sector participated to semi-structured interviews²⁵. Pharmaceutical sector exhibits significant differences on various grounds with respect to other sectors analyzed in this paper. Its R&D-intensive structure makes it a critical sector for any country aiming to attract R&D-based FDI²⁶, while the peculiarities in the organization of R&D in this sector create difficulties both on practical and policy grounds²⁷. Almost all firms agree that health industry in Turkey is currently undergoing a transition period, obliging firms to restructure their activities and organization. Other firms pointed to the large and growing size of drug market in Turkey and also to scale economies-related advantages it offers.

The high cost of R&D activities in the pharmaceutical sector led MNEs to locate their clinical trial activities in a number of emerging economies. In this context, intense competition occurs among different foreign branches of the same MNE in order to attract clinical research projects. On the other hand, molecular or basic research is generally carried out either at the home base of the parent company or in R&D centers located in OECD countries. The speed with which clinical trials are conducted and results obtained determines the ultimate costs and returns to R&D activities in pharmaceuticals –about a period of 10 years elapses after the granting of patent protection before the new drug is commercialized. Those countries where foreign subsidiaries of MNEs organize clinical research rapidly without major obstacles tend to receive the highest part from the R&D budget of the parent company. As will be discussed later, Turkey does not perform well on these grounds due to an unfriendly institutional environment and frequent regulatory changes. However, it seems that for Turkey other factors such as a large and growing drug market, disease diversity, high treatment and young population as well as a large pool of qualified researchers are sufficient enough to outweigh problems related to the institutional environment and IPR protection. All participant firms indicated that their R&D expenditures would increase if significant attempts are made to deal with the institutional problems mentioned (see section 4.3.1).

Most interviewed firms were established in Turkey in the mid-1990s. Data in Table 4.3 confirms the worldwide dominance of US-based firms in this sector. There are substantial differences among firms as to their size since the number of employees in our sample changes between 200 and 2400. Their development activities in Turkey take mainly the form of clinical trials in university hospitals. The number of regularly employed R&D staff by these firms is generally low, though the number of people not recruited but indirectly employed through clinical research -health personnel in hospitals- is significant²⁸. All the interviewed firms declared conducting R&D activities but only one of them had a R&D center established according to the recent R&D support law no 5746. The restrictions on the location of research facilities imposed by this law create serious problems for pharmaceuticals firms that wish to benefit from R&D incentives. By its nature, clinical trials are performed in hospitals not in company laboratories and this situation impedes building R&D centers in the premises of

²⁵ Firms from the pharmaceutical sector are BMS, Johnson&Jonhson, MSD, Sanofi Aventis, Novartis, and Pfizer.

²⁶ See Tables 4.1 and 4.3.

²⁷ First, molecular research is done in by the parent company in its home country and/or in other developed countries. Once a molecule is discovered, clinical research in hospitals – not in R&D laboratories of pharmaceutical firms – is required for the effective use of the molecule and takes several years. In general clinical trials are conducted in developing countries.

²⁸ No data was provided on the extent of this indirect employment.

pharmaceutical firms as required by the law. However, one firm has used R&D incentives provided by the Technology Development Zone (TDZ)²⁹ law and developed strong relations with a university in which a TDZ is located.

Their R&D expenditures -mostly clinical trials- range from 609 000 to 14 million dollars. The amount of R&D expenditures is not influenced by public incentives since clinical research is not conducted within the premises of pharmaceutical firms by their personnel but rather in university hospitals by health personnel. The number of full-time R&D personnel changes between 6 and 80 with an average of 32 employees. These figures represent 3% of total employment, though it does not include part-time project-based clinical research teams. Therefore, the ratio of R&D personnel is much higher than 3% but it is not possible to calculate the full-time equivalent researchers because of problems due to data availability.

R&D expenditures of pharmaceutical firms increased between 10% and 50% over the last three years. In some firms, increases up to 400% are observed in the number of R&D personnel. In the next three years, firms do not expect such important changes but rather 30% increase both in R&D expenditures and personnel. However, it was pointed out that these increases in R&D expenditures and staff might even more important if regulation in this sector becomes more industry-friendly.

4.1.2. Automotive sector

Five foreign firms were interviewed in the automotive sector³⁰. One firm is a subsidiary wholly owned by a MNE while the remaining ones are joint ventures established by foreign and Turkish partners³¹. As data in Table 4.2 indicates, Turkish partners own the majority of firm equity in two joint ventures while the share of the Turkish partner amounts to 49% for the third one. The ownership structure in this sector is thus very different from the one observed in the pharmaceutical sector with significant implications for the nature and extent of R&D activities conducted therein, as will be pointed to later on.

The automotive industry is one of the engines of growth of the Turkish economy in terms of its contribution to employment creation -direct and indirect-, exports, R&D expenditures and it has intense relationships with a dynamic part and component suppliers sector³². Although established as a major actor of the import substitution regime in the 1950s and 1960s through joint ventures formed with foreign firms and aiming exclusively at the domestic market, it switched its production from domestic to the world market since the mid-1990s, especially after a Customs Union agreement was signed between Turkey and the EU in 1995. The shift of the target market from domestic to world accelerated in the early 2000s and was accompanied by significant FDI flows. As a result, it is acknowledged today that Turkish automotive industry, manufacturers as well as suppliers, has

²⁹ TDZs are locations where innovative firms operate and benefit from a number of fiscal incentives for their activities.

³⁰ These firms are Tofas (a joint venture with the Italian firm Fiat), Ford Otosan, Mercedes Benz, Oyak Renault and Toyota.

³¹ Note that the home country of the foreign partner is different in each case.

³² See Wasti et al.(2006), and Pamukçu and Sönmez (2011) on this issue.

developed significant manufacturing and design capabilities. In 2009, this sector ranked as the 16th largest automotive producer in the world and 7th in the EU.

Four of the interviewed firms -joint ventures- were established during the period 1959 to 1969 while the last one has operated in Turkey since 1990. The home country of the foreign partner is different for each of these five firms. Information provided by four interviewed firms point to an average firm size of 6850 employees, ranging from 400 to 7500 persons. Four amongst the five interviewed firms do conduct R&D activities in Turkey while the fifth one stopped its R&D activities after the departure of the Turkish partner. Further, all of these four firms have established R&D centers in accordance with the R&D support law of 2008. The ratio of R&D expenditures to sales ranges from 0.27% to 4.7% (mean value: 1.76%) while the share of R&D personnel in total employment of foreign affiliates is comprised between 3% and 7.8% (mean value: 5.5%)³³, which is larger than the 3.3% in pharmaceuticals.. This finding is all the more striking since pharmaceutical industry is recognized as being the most R&D intensive manufacturing sector³⁴: This probably points to the problems pharmaceuticals encounter in Turkey when it comes to increase their R&D expenditures (see section 4.1.2).

The average R&D intensity in this sector is 5.5% which is higher than the percentage for pharmaceuticals which is 3.2%³⁵. Since firms did or could not provide accurate data on their past or future expected R&D expenditures, we will focus here on the R&D personnel. Of the three firms that answered this question, two declared that their R&D staff increased at an average rate comprised between 10% and 30% over the past three years while the third one pointed simply to an increase. As to the forecasts over the next three years, firms indicated growth rates ranging between 7% and 20 % in R&D personnel.

4.1.3 Electrical/electronics sector

This sector has acquired over the years an important manufacturing expertise with significant implications for the R&D activities conducted by firms. As result of this expertise, firms are conducting intensive R&D activities and implementing on a frequent basis product and process improvements in reaction to market signals. Specialization of firms over the years exerted a positive effect on their R&D dynamism and convinced them about critical importance of this factor for the sustainability of their success. Furthermore, the increasing role of exports in demand, together with the competitive pressure that accompanied this trend, made all the more strategic R&D activities for firms operating in this sector. This resulted in attempts aimed to attract more R&D projects of the parent company towards Turkey, in which these firms have been successful due to the significant R&D capabilities they owned (see section 4.2.3).

³³ Data on these ratios as well as on the number of R&D personnel is provided in Table 4.3

³⁴ OECD (2008).

³⁵ This finding is all the more striking since pharmaceutical industry is recognized as being the most R&D intensive manufacturing sector: see OECD (2008). This points to the problems pharmaceuticals encounter in Turkey when it comes to increase their R&D expenditures.

Except a firm that is fully owned by local agents, other firms were established in the 1990s. Two affiliates are US-based while the remaining three are EU-based. Except one firm that is specialized in industrial electronics, all others are developing and producing consumer electronic products.

Advanced production capabilities are reflected in the high number of employees. Leaving aside the purely domestic firm with 18 000 employees, this number ranges from 86 to 200 in the remaining firms (mean value 865 employees). High-level production capacities which are revealed by the large-scale production capacity of these firms impact positively on their R&D activities. Indeed, all the firms interviewed declared they have been conducting R&D activities and two of them have already established R&D centers in order to benefit from the R&D incentive law that entered in force recently in 2008. Two other firms declared that they intended to apply very soon in order to benefit from this law. Moreover, our impressions from the interviews is that recent R&D support policies have definitely had a positive impact on the R&D activities of electrical/electronic firms and further incentives in this direction would accelerate this positive effect.

On average, the proportion of R&D employees in the in total employment attains 25 % since 93 % of all employees of one interviewed firm are researchers. Once this firm is not taken into account, this proportion falls to 4.5%. One foreign firm declared the ratio of its R&D expenditures to sales is 0.42 while R&D expenditures of another one attain one million dollars.

Three firms reported an average increase in their R& expenditures ranging from 5% to 35% over the least three years while a fourth firm reported it aimed to maintain its R&D intensity equal to 1.5% over the same period. A similar trend is expected for the three years to come.

4.1.4. ICT sector

Seven firms operate in the ICT sector³⁶. One recent development concerns the inflow of skilled labor from abroad: Skilled Turkish workforce employed by the parent companies abroad has started to return back to Turkey, facilitating the transfer of the human capital embedded in these people to the domestic sector. The links between local affiliates and their headquarters also contribute positively to the transfer of international business practices and R&D culture to their Turkish affiliates.

Interviewees declared that high growth rates have been recorded in the telecommunications sector since the 1980s and in the information sector since the second half of the 1990s. These high growth rates and a dynamic environment offered new opportunities and prospects for ICT firms. On the other hand, intense competition on the mobile phone market impacted positively on innovation and accelerated product and process development activities. However, some firms point that quality R&D projects has deteriorated over time.

The average firm size in the ICT sector is more than 900 employees, largely above the average firm size in Turkey. As expected, this large firm size exerts a positive effect on their R&D activities since all the interviewed firms do conduct such activities. Organization of R&D activities differs amongst firms,

³⁶ These firms are Alcatel Lucent, Cisco, Nortel Netas, Turkcell, Yapi Kredi Bilisim, Ericsson and Avea. See Table 4.3

however. As will be discussed later part of these differences in the organization of R&D activities are due to genuine characteristics existing among organizations and part of it to different research structures generated by the nature of different R&D support schemes used by firms. Indeed, six out of seven firms have a separate R&D department and another one is operating in a TDZ, considering therefore itself as a pure research firm. Four firms have established R&D centers in accordance with the recent R&D support law numbered 5746, which aims to enhance R&D expenditures of firms through fiscal incentives.³⁷ It turns out that interviewed firms have all established R&D departments by taking advantage of various R&D support programs implemented since the early 2000s, although some firms had also performed R&D activities long before these support schemes.

The average R&D budget of the interviewed ICT firms represents 1-1.5% of their annual sales and approximately one third of their employees work in the R&D department, which is an extremely high figure for a typical firm in Turkey. Significant increases have been observed both in R&D expenditures and R&D personnel in the last three years, with an average increase in R&D expenditures of about 10-15% while the average increase in R&D personnel ranges from 10% to 50%. Forecasts for the next three years show that these changes will persist but slow down due to the rapid increase in R&D activities that took place in the last five years thanks to the significant increase in the volume and scope of public R&D support in Turkey³⁸.

4.2 Business environment and R&D activities of foreign firms

This section deals with the following issues as far as affiliates of MNEs in Turkey we interviewed are concerned:

- (i) influence of different aspects of business environment³⁹ in Turkey on the R&D activities of foreign firms
- (ii) the way the decision to launch R&D activities in Turkey was taken
- (iii) purpose of R&D conducted in Turkey
- (iv) main R&D areas aimed at by foreign affiliates in Turkey
- (v) global location of R&D centers of the parent company,
- (vi) nature (adaptive *versus* innovative) of R&D activities conducted by foreign firms in Turkey

³⁷ The law numbered 5746 is a law on enforcement and regulation aimed at supporting R&D activities and came into force in July 2008. The English translation of this law can be accessed at http://teknokent.sdu.edu.tr/en/files/application-first/5746_regulation.pdf.

³⁸ See World Bank (2009).

³⁹ These different components of business environment relate to: (i) costs (ii) skilled labour force (iii) manufacturing expertise (iv) domestic and regional markets (v) markets served (vi) pace of commercialization of R&D activities (vii) labor division of R&D within the parent company (viii) taxes (ix) subsidies (x) higher education system (xi) IPRs (xii) collaboration with universities and other firms (xiii) R&D expertise in the sector (xiv) relations with suppliers and (xv) regulatory framework and institutional environment.

- (vii) domestic or global market focus of R&D
- (viii) performance indicators used to assess R&D activities
- (ix) external funding used for R&D

4.2.1. Pharmaceuticals

The most important environmental factors in pharmaceuticals influencing foreign R&D are related to the supply of *skilled labor* and the *quality of the demand*. Part-time personnel working in clinical research teams in university hospitals are considered to be highly skilled and medical infrastructures and other equipment used in clinical research are noted as being of good quality. As regard to the quality of the demand, the geographical proximity of Turkey to the markets of Central Asia and Middle East, racial variety and relatively high population density all make Turkey more attractive for pharmaceutical companies.

However, interviewees point to several problems in areas such as *manufacturing expertise*, *intellectual property rights (IPR) protection*, *collaborations with universities*, and *the institutional context*. Deficiency in manufacturing expertise in the ICT sector is considered as a moderate obstacle since firms generally address this issue through on-the-job training activities. The high cost of molecular and clinical research makes IPR-related issues vital for the sector. Participant firms emphasize problems stemming from imitation of granted patents -patent infringement-, enforcement of IPR legislation and leakages of data pertaining to the results of clinical research to their competitors in Turkey⁴⁰. One firm complained about the relatively short time period granted for patent protection⁴¹. Hence, the existence of a strong sector manufacturing generic drugs -dominated by domestic firms-⁴² and problems encountered in the enforcement of IPR legislation are seen as important barriers for expanding existing foreign R&D in Turkey as well as for attracting MNEs to conduct new R&D activities in Turkey. Furthermore, three factors mentioned below result in making the university-industry cooperation rather limited at present: (i) existence of administrative barriers: for instance, the major part of payments -more than 65%- made to health personnel and academicians participating to clinical research in university hospitals are absorbed by revolving fund of universities (ii) the fact that no real advantage is associated for collaboration with the health personnel within the premises of TDZs and (iii) red tape. Finally, firms strongly express the need for a new clinical research regulation in order to increase their R&D activities – mainly clinical research but also some basic research.

As for the decisions regarding *international location of R&D activities*, interaction between local branches and their parent company is considered to be of critical importance. The final decision is always taken by the parent but and it is influenced by the various characteristics of the host country. Interviewed firms mention the duration period of clinical trials, the extent of administrative barriers

⁴⁰ Findings from different rounds of clinical research involving patients and healthy subjects (volunteers) are communicated to the Ministry of Health on a continuous basis. Leakages mentioned relate to this information.

⁴¹ This period is 20 years long but the complete R&D cycle in this sector ranges from 12 to 15 years and leaves a very short period to pharmaceutical companies rentabilize their R&D investments.

⁴² Contrarily to the ICT sector, domestic firms have been operating in the pharmaceutical sector since the 1970s

faced by firms and the stability of the institutional environment for R&D activities -mainly regulations relating to clinical trials- as being the critical factors for this decision. Foreign subsidiary may influence the final decision of the parent company by providing information on the following issues: (i) number of patients that will take part in clinical tests (ii) quality of the technical infrastructure in hospitals (iii) human capital of people working in health institutions (iii) the extent of variety in diseases in the research area which may be critical for the decision-making process. Consequently, the capacity of the local subsidiary to transfer to its parent company quality data on a timely basis about the results of the clinical tests is a significant factor for attracting R&D. It turns out that some firms are using extensively ICT tools for accurate and rapid data transfer. The current situation can be described as one of severe competition among the foreign branches of the same MNE for attracting new clinical research. The performance of local branches in systematic auditing by the global center is another criteria used for the sustainability of the clinical research abroad. Furthermore, some interviewed firms declared that Turkish experts were recruited by the parent company at mid- or high-level administrative positions, which resulted in an increasing R&D commitment of the parent company with respect to Turkey. Some firms noted that Turkey is classified as a core or high-volume country by the global centers due to its market size advantages.

A *global trend* is that the development centers in the sector are shifting away from USA and Europe to developing countries, although molecular research activities are still predominantly carried out in developed countries. The high and increasing cost of R&D activities will most likely lead firms to shift both molecular and clinical research out from the developed countries to developing ones in the next five years –China is seen as the most attractive country. In Turkey, firms are engaged only in the clinical research stage of R&D in pharmaceuticals. All participant firms pointed to the global nature of R&D activities conducted in this sector. Indeed, the same molecules are experimented in different countries by different research teams and the resulting data is sent to and processed by the global center, which later exploits these findings for the commercialization of discovered molecules -new drugs- around the world. The outcome is a process akin to an international knowledge production. As emphasized by all firms, not only the process leading to the development of a new drug but also its commercialization stage, i.e. the market aimed at, is global: All firms confirmed that their goal is not to sell solely on the domestic market but also on the world market.

4.2.2. Automotive sector

The most important environmental factors impacting on foreign R&D in the automotive sector are examined below.

One firm declared that the *average cost of engineers* in Turkey is lower than in some EU countries but not when it is compared to, for instance, a new member like Poland. Turkey's major advantage with respect to the EU for attracting FDI seems to be the availability of a large pool of skilled workforce with advanced engineering and production capabilities. Another firm pointed out that the low cost of labor will no more provide a competitive edge to Turkey in the near future. As an example, it indicated that it had been losing 30% of the labor cost differential it enjoyed with respect to its foreign partner. Another firm pointed out that (i) Turkey had been a low cost production site until recently but now is in the process of being overtaken by countries like China and India on the

cost front (ii) no major difference exists between Turkey and the home country of its parent company located in the EU with respect to the cost of skilled workforce, including engineers and technicians⁴³ and (iii) longer working hours in Turkey are not necessarily translated into a cost advantage, due to higher levels of productivity attained by automotive firms in the EU- a situation likely to exert a negative impact when it comes to attract foreign R&D into Turkey. All these remarks point to the need for the automotive industry to upgrade, to move up in the capability ladder, especially by investing more in R&D.

Firms agree about the fact that although engineers in Turkey are well educated, they are more often than not well-trained. The characteristics of the Turkish *higher education system* are to blame since priority therein is given to theoretical studies and not to enough work in enterprises through -for instance internships. As a result, on-the-job training following recruitment by automotive firms is almost always necessary and provided by most firms to increase the productivity of the skilled worked-force. Another firm pointed out that the large number of skilled workforce in Turkey is an important element for conducting R&D. In addition, several firms pointed to the positive attitude, flexibility and dynamism of a young workforce in Turkey⁴⁴.

Interviewed firms replied to the question about *manufacturing expertise* by pointing to the fact that their production capabilities were highly advanced, that know-how and experience in manufacturing were the main competitive weapons of the automotive sector in Turkey. One firm declared that the strong production capability possessed by manufacturers as well as by their suppliers could influence positively decisions of MNEs for starting or expanding R&D activities in Turkey.

In general, firms estimate that growth on *domestic and international markets* close to Turkey are satisfactory but find the size of the market in Turkey not being conducive to R&D expenditures or its expansion -in contrast for instance to another emerging economy like Brazil. This is mainly the outcome of excessive indirect taxes that are levied on passenger cars by the government. A firm declared that this is also in contrast with respect to the EU countries where internal market expanded at a rate higher rate than in Turkey since no excessive indirect taxes are paid on car sales⁴⁵.

Concerning the impact of *characteristics of the markets* aimed at by foreign firms on their R&D activities, one firm declared that they produce and export mainly for the EU market and that solely the domestic market size in Turkey is not large enough to warrant significant R&D expenditures. However, this firm later indicated that they successfully implemented a R&D project involving the design and manufacturing of two new light commercial vehicles in Turkey. These two models were commercialized in 2007 and 2008 and sold on export markets, contributing significantly to sales revenues of the firm in 2009⁴⁶. Another firm declared that they conducted R&D activities of a mainly adaptive nature stemming from differences between the world and domestic market related to

⁴³ It indicated that a salary of 1300 to 1400 euros was sufficient to recruit engineers in the home country of its EU-based parent company while wages paid to engineers in Turkey changed between 2000 and 3000 euros.

⁴⁴ One firm provided the following example: employees in its affiliate in Brazil speak mainly Portuguese and in its affiliate in Japan mainly Japanese while in Turkey, English and German are spoken fluently on the workplace.

⁴⁵ It indicated that the indirect tax rate on passenger cars is 67% in Turkey while this rate is only 27% in the EU.

⁴⁶ Although production activity is carried out under a license owned by its foreign partner, this firm is owned in majority by the Turkish partner. The decisive role played by the Turkish partner in launching the R&D project and its later championing shows that the structure of capital ownership *does* matter for international R&D activities. More information on this unusual R&D project is provided in Celikel et al. (2011).

regulations and users' demands. For instance, modifications were brought to original truck designs in order to manufacture a new model adapted to the -lower- education level of Turkish truck drivers and to the requirements of the market –in this last case, capable of transporting maximum load at a reasonable cost – and this truck is manufactured solely for the Turkish market. For buses, it was indicated that (i) the Turkish affiliate participated to joint projects together with other affiliates of the parent company located abroad and (ii) adaptive R&D was undertaken to comply with regulatory requirements (for instance, school buses). One major need for the Turkish market has always been to increase the luggage volume passenger buses and consequently adaptive R&D efforts have taken place to design and manufacture such a bus – which is now sold mainly on the Turkish market. Further, this firm estimated that the Turkish market was a “late follower” as far as the adoption of regulations enacted in the EU is concerned. Indeed, safety and environmental regulations introduced to the EU legislation (for instance those pertaining to airbag use and emissions) were translated into Turkish law some years later. The main reason for his delay is the cost-increasing effect of complying with these regulations – this late-follower or adopter behavior concerns only vehicles sold on the domestic market, not for those exported to the EU.

One firm indicated that *R&D incentives* have been successful in increasing the attractiveness of Turkey as a international R&D location. Direct R&D support provided by the Scientific and Technological Research Council of Turkey (TUBITAK) as matching grants with the funding rate of projects changing between 40% and 60%, were said to be instrumental for attracting international, i.e. intra-MNE, projects to Turkey and for enhancing R&D capabilities of these firms. A shortcoming mentioned concerns the sustainability of these direct R&D supports since this company was told after a while to fund its R&D expenditures by using its own financial resources. Another interviewed firm emphasized shortcomings of the recent R&D incentive law no 5746 encountered during its implementation. For instance, event a temporary absence of a researcher at the R&D center for any reason – on leave or for professional reasons – has the immediate effect of drastically reducing the amount of support received. It was said that although people from the Ministry of Industry and Trade, in charge of the inspection of the R&D centers, acknowledge the problem, the Ministry of Finance, as the final instance that has to approve the transfer of funds, does not – which obviously creates a coordination problem with deleterious effects on foreign R&D. Another deficiency pointed to by the same firm is that one of the requirements of the R&D incentive law, the recruitment of 50 FTE persons, makes it totally inappropriate for the automotive part suppliers that are in their majority SMEs – so, it exerts no significant positive effect on their R&D capabilities. Further, the only firm in our sample that does not conduct any R&D in Turkey was very critical about the way R&D supports are granted. Firstly, it said it was convinced that R&D supports were provided mostly to activities aimed at product and process development or improvements rather than at activities involving research *per se*. Second, it pointed to the absence of any study conducted in order to evaluate the impact of R&D subsidies on the R&D expenditures, value added and exports of recipient firms, questioning the effectiveness of existing R&D programs⁴⁷.

In general, firms confirmed the existence, in limited numbers however, of a group of *parts and components suppliers* in the automotive industry that possess strong capabilities in manufacturing and design. Further, it seems that a strong R&D capability is a necessary condition in order to

⁴⁷ To this date there are only two studies that use econometric techniques to carry out an impact analysis of R&D subsidies granted in Turkey: see Özcelik and Taymaz (2008) and Pamukcu and Tandogan (2011).

become the supplier of a manufacturer firm and work on joint research projects⁴⁸. Firms emphasized the fact that there are a few number of competent suppliers capable of taking part to joint research projects with foreign firms. The few number of suppliers capable of complying with high quality standards of foreign manufacturers has mainly the following implications: (i) knowledge and technology transferred from foreign firms to domestic suppliers remains limited (ii) foreign suppliers –some of them are suppliers of the parent company in the home country -invest in Turkey to seize the opportunities related to the large size of the market – domestic and regional and (iii) significant imported content of vehicles manufactured in Turkey⁴⁹.

As to the question concerning *how the decision to conduct R&D in Turkey was taken*, one interviewed firm reported that its Turkish partner negotiated directly with the parent company in order to launch R&D activities in Turkey and justified its decision by the strong R&D capability it already possessed. Another firm emphasized the evolutionary nature of the development of its R&D capability. Indeed, its “R&D” activities initially addressed problems arising from organization of production, product quality and high costs but also aimed at responding to market needs more rapidly. Later, in a second stage, R&D activities have increased in scope and included advanced capabilities such as product and process development, and design⁵⁰. This firm pointed to three factors that have impacted positively on its R&D decision: a large pool of skilled workforce, high education level in general and existence of R&D incentives in Turkey. It also added that it encountered difficulties in accessing a sufficiently large labor pool at reasonable wages in the home country of the parent company and that continual increase in the number of R&D projects within the parent company made it almost inevitable to outsource some of these projects to its affiliates abroad. The advantages provided by the generous R&D support scheme in Turkey and a large labor supply played an important role in attracting part of these R&D projects to Turkey.

As to the question of *who decides in which fields to conduct R&D in Turkey*, one firm indicated that the final approval of a R&D project was done by the parent company although ideas or proposals could originate from its subsidiaries located all over the world. This firm also mentioned that it was once asked by the parent company to conduct a R&D project but it could not do it since the research infrastructure in Turkey was not developed enough. This firm plans to collaborate with universities and conduct part of its research -required for an ongoing project- within university premises. Another firm mentioned that it took an initiative to launch R&D projects in Turkey but in relation

⁴⁸ It was mentioned that besides working on joint projects, acting as a supplier to a manufacturer firm provides a number of advantages to supplier firms, mainly through knowledge and technology transfers -less frequently in terms of financial assistance. Another spillover is the positive contribution of this status to the commercial reputation of the supplier firm. More evidence on the existence of knowledge and technology transfer in the automotive sector is provided in Pamukçu and Sönmez (2011).

⁴⁹ A firm pointed out that partly as a result of this situation (few competent suppliers), 80% of inputs used in its bus manufacturing facilities were imported from abroad.

⁵⁰ The launching of genuine R&D activities in the second stage was possible thanks to the determination of the Turkish partner and was anything but inevitable - involvement of the Turkish partner has been decisive. This is one area where the presence of a local partner owning more than 50% of the firm's equity *and* its resolution to use R&D as a competitive weapon really made the difference. See Celikel et al. (2011) for more details on the importance of local initiatives for R&D activities of foreign firms.

with the parent firm's research priorities⁵¹. This R&D project was conducted entirely in Turkey and funded on its own budget, and resulted in collaborations with universities.

To the question concerning *internationalization of R&D activities of the parent company* and location of its global R&D sites, all interviewed firms replied that the trend is definitely one of internationalization of R&D activities of the parent firm and added that the choice of the location for new R&D sites depended on a number of factors related to the type of vehicle (light or heavy commercial vehicle vs. passenger car) and on the models to be designed and developed. To be more specific, one firm declared that in addition to a R&D site in Brazil, its parent firm planned to establish two new sites in India and China⁵². Another firm reported that although it did not consider conducting R&D at foreign locations for its buses, research – or some part of it – might be transferred to Turkey and its production to India.

As for the *new locations* where MNEs prefer conducting R&D, many countries from different continents were mentioned by the interviewed firms⁵³, confirming that emerging economies would be the main receivers of R&D activities, existing or new to come.

Concerning the *goals of R&D activities conducted in Turkey*, a technologically active firm declared that they conducted both adaptive and innovative R&D aimed at developing electrical cars. R&D activities of this company included localization/indigenization, development and design but also product and process development aimed at both domestic and export markets. Another firm pointed out that R&D activities of different degree of sophistication exist⁵⁴ and that in Turkey their R&D activities aimed mainly at developing new products. Further, this firm indicated that since 80% of its production is oriented towards export markets, its R&D activities are aimed directly at developing new products for these export markets⁵⁵. The last interviewed firm declared that it conducted R&D to develop vehicles, engines and transmission system and parts for both domestic and export markets.

As for the *external sources mobilized for financing R&D expenditures*, all interviewed firms declared that they made use from the direct R&D supports provided by TUBITAK and/or from the recent R&D law no 5746 aimed at creating R&D centers through fiscal incentives. One firm indicated that they were also active in an EU Seventh Framework project but that the main reason for their presence therein was learning and being present on EU platforms. Another firm indicated that it took part to EU projects directed by its parent company and that some funding came also through these sources.

⁵¹ In this case, a R&D project aimed at developing an electrical car.

⁵² This firm mentioned that in Brazil, there was a huge market which is relatively closed and functions with its own rules.

⁵³ These countries are Argentina, Brazil, China, Czech Republic, France, India, Japan, South Korea, Turkey, Roumania, Russia and USA.

⁵⁴ It suggested that advanced R&D takes about 10 years while R&D oriented at developing new products takes about two years.

⁵⁵ We asked this firm whether it would consider in the future implementing R&D activities to substitute imported inputs used in the production process with local inputs– mainly a process innovation. The answer was that it would be extremely difficult to implement this kind of import substitution oriented R&D – so the answer was negative.

4.2.3 Electrical and electronics sector

Main factors related to *business environment* and their effects on foreign R&D activities in the electrical/electronics sector are examined below.

Most firms agree that *costs*, especially labor costs are not low in Turkey. These firms pointed out that costs of various factors of production are higher than the ones observed in China and Poland, two major competitors of foreign firms established in Turkey. Firms have mixed opinions as to whether costs are lower or higher in Turkey than those in EU countries. Those firms that think costs are higher in Turkey than in the EU point to the positive effect of R&D supports which compensate at least partly these cost differentials.

As to the availability of *skilled workforce* in Turkey, most firms point to an abundant supply but also to an insufficient training level. Two firms emphasized the importance of updating higher education curricula in a more business-friendly way and indicated. They have contacted universities –especially engineering departments– with this idea in mind and proposed some changes. A third firm indicated that there are excellent universities in Turkey which supply the market with high-quality competent engineers that can be recruited at a reasonable wage, which is an important competitive advantage for Turkey. This firm also emphasized the high motivation and commitment of these engineers or researchers towards projects they worked on and also their flexibility. These last characteristics, it seems, are very different from what happens in countries of Central Europe.

Most firms agree about the high-level *manufacturing expertise* of this sector in Turkey. One firm indicated that one of the major production facilities among about fifty all over the world was located in Turkey and that advanced production capacities was instrumental in their decision to add R&D activities to their operations. Another firm mentioned that thanks to their advanced manufacturing expertise, they were able to upgrade as well their suppliers' capabilities in this field and aimed now at increasing the proportion of domestic suppliers in the supply chain, currently only 34 %. This firm pointed to learning-by-doing, transfer of human capital (managers) from competitors and recruitment of educated labor as the main sources of its manufacturing expertise.

One firm pointed out that its global character made relatively less important Turkish domestic *market* compared to international markets, which increased the importance of R&D activities to sustain their competitiveness. Two firms emphasized, however, the importance of the size and growth of domestic market for their activities. Another firm indicated that rising quality requirements and expectations of Turkish customers had a positive but not the most important effect on its R&D activities.

Only one firm answered the question about the existence of *labor division in R&D activities* in the MNE. It indicated that R&D activities are in general conducted at the home base of the MNE but also in countries where foreign affiliates operate manufacturing facilities. So, no rigid or inflexible labor division seems to characterize R&D activities of the MNE, and those foreign affiliates who act rapidly and innovatively are offered R&D projects by the parent company.

As far as the *taxes* levied by the government are concerned, one firm complained about the high level of indirect taxes levied on their products and pointed to a possible negative effect on their R&D

activities since it reduces their potential market. Another firm mentioned high social security contributions paid by labor and the non-transparent character of the tax legislation in Turkey in opposition to the situation prevailing in the EU.

As for the *governmental support provided to business R&D*, one firm stated that it played an important role for the growth of its R&D. It also mentioned, however, that tackling issues such as complicated and long submission procedures and important red tape, rather than simply increasing the amount of the support granted, had to be put on the agenda. Another firm pointed to the importance of both fiscal R&D incentives and direct subsidies for attracting foreign R&D and of conditioning these support schemes to the establishment of technological collaborations between agents. It added, however, that the amount of support granted was by no means sufficient to face the global competition in force in their sector.

One firm declared they endeavored to promote *university-industry relations* in many ways. For instance as members of advisory board of a number of engineering departments, firm representatives contributed to update of their curricula. Further, funding of theses of graduate students relevant to the interests of the firm proved to be an important way of technology transfer in both directions. As a result, while protocols signed with academics enabled the firm to protect its IPRs related to these theses, well-trained graduates were subsequently recruited by the firm⁵⁶. Another firm reported that they collaborated with the universities and private companies including Middle East Technical University and Turkish Aero Industry (TAI), and had also subcontractors abroad.

As for the *relations of foreign firms with their suppliers*, the opinions expressed by the respondents were mixed. One firm declared that relationships between manufacturers and suppliers were not developed or strong in the electrical/electronics sector in Turkey since suppliers could hardly conduct R&D activities on their own. It added that while it was possible to find some suppliers who could take in charge all the stages of a project including its R&D activities, these suppliers were very limited in number. Another firm gave the example of Spain where electrical/electronics manufacturers have been able to collaborate and offer new products on the market now for a while. According to the same firm, such a situation did not characterize Turkey mainly because R&D capabilities of the manufacturers were not yet developed enough. As part of their strategy to alleviate this problem, this firm has set up supplier development programs for a while now, the objective being to train supplier which could solve their problems over the long term. Another firm estimated that there was a successful supplier industry in the electrical/electronics sector in Turkey and that this success was mainly related to the excellent imitation capability of suppliers⁵⁷. This firm declared being in close collaboration with its suppliers and indicated that they trained them, assisted them in launching their production activities mainly because they needed competent suppliers.

Responses of interviewees point to the importance of convincing the parent company about the necessity and the advantages of carrying R&D activities in Turkey. One firm reported it used three arguments to start conducting R&D activities: (i) being a manufacturing platform in Turkey it had to

⁵⁶ It was said that more than 160 MSc or PhD theses were funded in this way.

⁵⁷ It was reported that while suppliers were very successful in acquiring production capabilities related to some products (machinery), they were much less successful when imitation and learning-by-doing were not enough to acquire such capabilities (new materials).

start conducting R&D in order to face the increasing global competition (ii) to benefit from the opportunities (fiscal incentives) provided by the recent R&D law no 5746 and (iii) the possibility to collaborate with universities for R&D projects. Another firm reported that they had to convince their EU-based parent firm of the opportunity to conduct R&D projects in Turkey and their capabilities to do so. At the end, flexibility, rapidity, existence of R&D supports and capable suppliers enables them to finish with success R&D projects, which paved the way for new ones.

Responses of interviewed firms to the question about the degree of *internationalization of R&D* activities of the parent company and its *international locations* confirm the ongoing trend to off shore R&D for all firms and in many continents and countries.

As to the *goals of R&D activities* conducted in Turkey, one firm declared that it carries out adaptive R&D activities to satisfy peculiar demands of the market as well as more innovative R&D. Another firm pointed out that its R&D activities consist mainly in the adaptation of existing products, product improvements and cost reductions. Besides, it also develops and manufactures more innovative products mainly for the US market. Two other firms reported that their R&D activities were motivated mainly by the need to accommodate local peculiar circumstances, and also occurred in reaction to signals received from the market. One of these firms indicated that the relative of innovative R&D activities compared to adaptive ones tended to augment in recent years while the other firm reported that its R&D activities were by no means radical innovations.

4.2.4. ICT sector

The most important *environmental factors* in the ICT sector impacting positively on R&D decisions are the *supply of skilled labor* and the existence of *manufacturing expertise* in Turkey *plus* the volume and growth rates of the domestic and regional (Central Asia and Middle East) markets. Firms' opinions differ as to whether Turkey is a low-cost country and whether such an advantage exerts a positive effect on R&D decisions of foreign firms. Firms reported not experiencing major deficiencies in accessing a large pool of skilled labor although it seems that the supply of skilled labor is not increasing at the same rate as the demand of skilled labor. Thus, although the availability of skilled labor is not a problem currently the supply might fall short of demand in the future. This did not preclude some firms from complaining about the high cost of skilled labor.

A demanding *domestic market* and rapid pace of diffusion of technological change among firms in the ICT sector are seen as important advantages for Turkey. Firms believe that these characteristics of domestic demand increase Turkey's attractiveness and ease exports of innovative products towards neighboring regional markets. Moreover, existence of high quality products in Turkey and demand for these products on the world market may influence positively the flow of foreign R&D into Turkey. Significant forward linkages established by this sector as an input supplier to many other sectors also exert a positive impact on its growth. However, in the case of Turkey, being a latecomer in this sector seems to be at the origin of a number of disadvantages especially in when it comes to capture a reasonable share in world markets.

The role played by local branches of MNEs in launching R&D activities in Turkey⁵⁸ is real although it is not synonymous with full autonomy. Efforts pursued by local branches to make a case for conducting R&D investments in Turkey influence indeed the ultimate decision of their parent company about the location of the R&D unit. The existence of R&D incentives is seen as a decisive factor when local branches negotiate with their centers in matters related to R&D.

As to the *goals of their R&D activities*, it seems that R&D activities are implemented in general in reaction to market signals and these signals lead firms to carry out activities aimed at product development and improvement.

As for the *internationalization of R&D activities* in this sector, the dominant trend is one of off shoring of R&D centers towards East Asia and especially to India. The main country that seems to attract R&D is India. It was also reported that reallocations of responsibilities among the global or regional R&D centers was observed, depending on the comparative advantage of each country.

It turns out that R&D activities conducted by foreign firms in the ICT sector are *aimed mostly* at product development and adaptation of products to local circumstances. Firms in the telecommunications sector conduct R&D activities to meet the needs of telecom operators. In the information technology sector, firms conduct R&D of an adaptive nature aimed at the domestic market but also R&D resulting in innovative products for both the domestic and world markets. Therefore, domestic market in Turkey has as dual role as far as R&D activities are concerned: domestic demand may accelerate R&D activities of foreign firms and contribute to the diffusion and of these products on the domestic market, which may constitute a precondition for their acceptance on international markets.

One major criteria used to assess the *performance* of R&D activities is whether an ongoing project is implemented in accordance with the initial timeline and budget adopted. Additional criteria such as customer satisfaction and the market share of innovative products are utilized as well.

Another finding is that *R&D incentives* are used by the majority of interviewed foreign firms to fund their R&D activities in addition to their own financial resources. These firms believe, however, that more awareness raising activities are required for these support schemes to reach a larger part of the population of foreign ICT firms in Turkey. Two major risks associated with R&D activities seem to be the occurrence of shortage of funds during global and domestic economic crises and failure to commercialize new products in global markets.

4.3 Legal, institutional and policy framework and R&D collaborations of foreign firms

In this section, we discuss our findings about the implications of the regulatory framework and institutional environment and that of the policy framework in Turkey for attracting FDI, foreign R&D investments and skilled labor from abroad. They were also asked whether they believed Turkey had a

⁵⁸ Decisions for launching R&D activities for the first time or extending the volume of existing R&D.

strategy in order to benefit from the on-going internationalization process of R&D and if so to point to the main problems involved. We also examine factors influencing R&D collaborations of original firms with other actors of the national innovation system in Turkey. Finally, questions were also asked about any possible negative/positive discrimination practices with respect to foreign firms and their opinions about recent policy changes aimed to attract FDI and especially international R&D to Turkey.

4.3.1. Pharmaceuticals

In evaluating the impact of the recent *R&D law no 5746* on four phases of clinical research⁵⁹, one firm mentioned that incentives are provided only for first and second phases of clinical trials and added that the requirement for conducting two consecutive phases of clinical research -a necessary condition to benefit from the law- should be relaxed since it is not based on rational grounds. Firms should be allowed to start conducting development activities at any phase without restriction. Another firm criticized this law on grounds that the compulsory employment of 50 full-time equivalent researchers in R&D departments is not realistic when clinical research conducted mainly in university hospitals is concerned. Besides, it seems that incentives granted in the form of full or partial exemptions granted on social security contributions and income taxes are not effective in attracting R&D investments from abroad, so that there is an urgent need for a brand new regulation and policies for clinical research⁶⁰.

Another criticism concerns the *lack of a strategy paper* prepared in order to attract foreign R&D investments into Turkey. It seems that existing documents and plans made about the pharmaceutical sector aim to protect domestic producers whereas R&D well as production activities in this sector are by now of a global nature. The rapidity with which clinical trials are conducted is crucial for their success⁶¹. Pharmaceutical firms claim that no real incentive system exists in Turkey to increase R&D investments for foreign or domestic firms in this sector. There is thus an urgent need for awareness-raising actions on this issue yet to this date, there is no strategy or an action plan prepared for this sector. The general opinion is that more clinical research can be attracted to Turkey only if a new legislation taking into account peculiarities of the R&D activities in this sector is enacted. Moreover, firms point out that the incentive system should be designed in such a way to provide Turkey with real advantages distinguishing it from other candidate locations for R&D sites. An additional problem area is related to IPR protection. Indeed, both the existence of an IPR regulation and its effective implementation are influential for attracting foreign R&D to an emerging economy. Therefore, one way to attract international R&D to Turkey would be to extend the period of patent protection from 20 to 25 years and improve its enforcement. Firms also declared that although the government

⁵⁹ For the detailed description of clinical research, see http://www.clinicalresearch.pitt.edu/docs/comparison_of_clinical_trial_phases.pdf

⁶⁰ The latest regulations are from the years 1993 and 2008 yet the last one was cancelled by a court decision.

⁶¹ One firm gives the example of Hungary. In Hungary, clinical research approval is given in 60-70 days on average yet it takes 150 days to obtain the required approval in Turkey. Under these circumstances, foreign subsidiaries of pharmaceutical MNEs in Turkey may face with the risk of exclusion from global projects of the parent company.

objective of attracting foreign R&D to Turkey is real, rarely these intentions are not transferred into real action.

One firm mentioned that no *discrimination*, positive or negative, is exerted with respect to foreign firms in the Turkish innovation system since these firms mostly finance R&D investments by their internal resources. Another firm contested this view, pointing to the negative reactions of the public opinion when R&D support is provided to foreign firm -the argument being that due to their large size foreign firms should be able to finance their R&D expenditures easily without external support. Besides, two other issues were raised about (i) the new drug pricing system recently introduced by the government caused pharmaceutical products to be priced at a level which is 23% lower than the prices on the world market, led to significant losses in revenues and (ii) IPR protection provided to foreign firms by the patent system in Turkey is not effective and negative discrimination seems to exist against them in issues related to IPR protection⁶².

In terms of the *global collaborations of pharmaceutical firms*, interviewees point to the existence of a dense network of relations worldwide. In general small biotechnology firms offer the output of their basic research to the large pharmaceutical MNEs, which take care of the clinical research and commercialization phases. Although not very frequent, firms also mention cases of global R&D collaborations with their competitors in the industry for a number of diseases. Moreover, cooperation with other subsidiaries of the parent company located abroad seems to be very common.

Finally, firms have similar opinions about the nature of *policy developments* occurring in Turkey in order to attract FDI, especially international R&D. They believe that positive developments are to come and that a more stable and nondiscriminatory approach is needed to attract FDI and stimulate foreign R&D investments. On the other hand, interventionist policies tend to decrease trust on the stability of the institutional environment and increase uncertainty which impacts negatively high risk-bearing R&D activities conducted in the sector. If the government succeeds in providing a stable institutional environment (regulation, legislation, IPR) for a period long enough, R&D activities would then be conducted more efficiently. The main problem seems to be the lack of dialogue between stakeholders in the sector, especially between foreign firms and the policymakers- mainly the Ministry of Health. Firms also estimate that the policies aimed to attract foreign R&D in this sector are largely insufficient. For instance, awareness about incentives granted for collaborations with pharmaceutical in the TDZs firms is quasi inexistent. Another example pertains to the relations of industry with the pharmacy faculties which are weak although these faculties are actively engaged in R&D. In general, there is a general objective to increase FDI and R&D investments, yet its translation into real action remains problematical.

4.3.2. Automotive sector

⁶²It is claimed that foreign firms refrain from launching court suits in case of patent infringement since they are convinced that the outcome of the juridical process will be against them.

Interviewed firms replied as follows when they were asked about the consequences of the *recently enacted R&D support law* providing fiscal incentives to business R&D (Law no 5746). One firm pointed to problems arising in practice from the application of this law. For instance, in case a researcher working at the R&D center is on leave, its status changes from full- to part-time employee, reducing the amount of support to which the firm is entitled. In a similar vein, in case a researcher leaves the R&D center to attend a seminar or present a communication to a conference, this immediately results in revenue losses for the firm. Another firm pointed to other problem areas: (i) the unrealistic compulsory threshold of 50 FTE researchers to be recruited in order to benefit from the R&D support law (ii) compulsory presence on the workplace of a researcher if the firm wishes to continue to benefit from the R&D support and (iii) the fact that the R&D center should be itself located in a separate facility from the administrative center or production facilities of the firm. This firm also pointed out to another basic but crucial problem: although an English translation of the original R&D support law is available, the working language in this company was neither Turkish nor English so that employees of the firm had had to translate themselves the law into the working language of the firm - a process which was not easy since the law was written in a quite technical terminology. Another difficulty is that criteria that should be fulfilled in order to be entitled to fiscal incentives are not clear at all. It was added that under present conditions and level of technological capabilities it is almost impossible to shift ongoing R&D activities from home base to or launch new types of R&D activities in Turkey. The final comments of this firm about the R&D incentive are: (i) adaptive types of R&D activities besides innovative ones, as well as design activities in the broad sense should be included in the law (ii) transfer of know-how and knowledge toward automotive suppliers should be a major component of this law – which apparently is not the case.

In general firms responded negatively to the question concerning the *existence of a strategy aimed at attracting foreign R&D to Turkey*. Some declared that a loose strategy and a number of ambiguous objectives were conceived, even roadmaps were worked on but that all these became ineffective because of the insufficiency and complexity of the steps involved in the implementation stage. They indicated that priority areas should be determined at the sector and technology levels and incentives to foreign R&D should be provided within the framework of such a strategy document. They acknowledged that a number of strategy papers existed for particular sectors including the automotive sector⁶³ and that direct R&D support provided through TUBITAK have probably impacted positively on business R&D but none of these –nor other– initiatives were part of a coherent and coordinated strategy to promote, *inter alia*, international R&D investments in Turkey. Finally, one firm admitted that Turkey owed the success it has acquired over the years to its advanced manufacturing capabilities, capable and –once- inexpensive skilled workforce. The same firm also indicated, however, that Turkey had to transform herself from a manufacturing to a design-related activities platform in order to sustain its success in the automotive industry since these last advantages would disappear sooner or later due to the competition of low-cost stemming from countries such as China and India. As a result, this firm valued highly all types of R&D supports since they would accelerate the move to such design-based activities.

⁶³ Some examples are (i) the *strategy paper for the automotive industry* prepared by the Ministry of Industry and Commerce (ii) *technology platforms* which aim to regroup large companies operating in a sector in order to make them cooperate on R&D-related issues – supervised by TUBITAK and (iii) pre-competitive collaborations aimed at technology development, which require cooperation with universities.

Among the firms with R&D activities, three indicated that being foreign firms in Turkey did not entail any positive or negative *discrimination for R&D activities*. One firm pointed out that interpersonal relations were still important in Turkey for investments-related issues, that state bureaucracy did often impede transparency and all this might constitute a disadvantage for foreign firms. The only foreign company that does not conduct R&D activities in Turkey declared that it decided to end its R&D activities after the departure of its Turkish partner from the joint venture. This firm then realized that working with a Turkish partner enabled it to solve many problems and go through obstacles associated with the R&D incentive process. After the departure of its partner, its R&D activities were no more productive and hence decided to end them. This firm firmly believes a negative discrimination exists against foreign firms in Turkey in the allocation of not only R&D but also investment (machinery and equipments) incentives – so it stated clearly it had lost its trust into the innovation system in Turkey.

Finally, *international collaborations* of these firms include cooperation with the R&D center of the parent company at its home base – intra-firm or EU project involving other partners – or to a less extent with other foreign affiliates of the parent company in other countries.

4.3.3 Electrical and electronics sector

Opinions of firms about the *R&D law no 5746* were mixed. One firm believed that this law had an awareness-rising function but did not address many genuinely R&D-related problems. Another firm criticized the law on grounds that the compulsory employment at least 50 FTE researchers might push some firms to reallocate or transfer their existing workforce to the R&D centers, which might be harmful for the credibility of the R&D law. Another firm stated that the parent company invested in Turkey initially only for production-related activities but realized as time went by that skilled workforce and engineers were available in Turkey which could be mobilized for R&D activities. The recent R&D law reinforced their determination to conduct R&D in Turkey.

Respondents differed amongst them as to the *existence of a strategy to attract international R&D activities*. While one firm pointed to the existence of such a strategy it also stressed its ambiguous character. Another firm declared that it did not believe such a strategy existed in Turkey and emphasized that there is even no official website informing interested parties on different R&D support schemes in force. It mentioned that such a website and other awareness-rising methods should be used aggressively by Turkish authorities because of the intense competition existing between emerging countries to host MNE-based R&D activities and but also because a proactive policy aimed to reach potential foreign investors rather than waiting for them to invest is a much more realistic and effective way to attract foreign R&D. Another firm welcomes incentives provided by the recent R&D law and declared that it impacted positively on the intentions of some MNEs towards conducting R&D in Turkey. The same firm, however, added that the design, implementation and monitoring phases of the R&D support programmes should be assessed carefully and on a continual basis on the level of programs as well as individual projects.

Most firms acknowledged *negative discrimination against foreign firms* for granting R&D supports as a reality albeit for different reasons. One reason advanced is that R&D funding agencies are skeptical

as to the outcome or value added for the country if R&D projects of foreign firms established in Turkey are funded. This may occur mostly not because of an entrenched discrimination but rather due to the view that launching or sustaining further R&D expenditures is an easy matter for foreign firms compared to many domestic firms with much lesser financial and human resources. Another firm made a similar remark and pointed out that it had to allocate huge efforts and time to convince funding agencies that their granting R&D subsidies to their wholly-owned subsidiary status would not reduce in anyway the socioeconomic impacts of the project accepted. It was also admitted that without the R&D subsidies received, this firm would have been unable to convince its parent company in the EU to invest more in production- as well as R&D-related activities in Turkey.

As for their *international R&D collaborations*, one firm declared that it cooperated with companies and research institutes in the EU and USA and also with firms in the East Asia for electronics-related products. Another firm pointed out that it had a dense and strong collaboration network, especially with R&D center of the parent company and that being part of such networks *per se* has numerous advantages. The last firm declared that it had a number of joint product development projects with other domestic as well as foreign firms, among which figures also competitors.

Finally, firms were asked whether they noticed any significant *changes in policies aimed at attracting FDI or foreign R&D* into Turkey. Three firms consider the recent R&D law no 5746 as a positive development since it has raised awareness in Turkey about the importance of R&D and might attract more international R&D. However, they also added that more thoroughly thought and conceived as well as better coordinated R&D policies are needed and that policymakers should adopt a proactive rather than a reactive stance in face of an accelerating pace of R&D internationalization.

As for the *external sources mobilized for financing R&D expenditures*, it is remarkable that all the interviewed firms were aware and used extensively several external funding mechanisms such as project-based R&D subsidies granted by TUBITAK or in collaboration with national (university) or international partners (private firms in the Seventh Framework Program). One firm operated in free industry zone which includes a number of fiscal exonerations, two other has established a R&D center in accordance with the Law no 5746 with the associated benefits.

4.3.4. ICT sector

All participant firms agree about the positive impact of the *R&D support law no 5746* -enacted in 2008- not only on the volume of their R&D investments but also on the sustainability of these efforts. However, a number of shortcomings related to this law should be tackled for attracting foreign R&D to Turkey. Among those deficiencies interviewed firms mention the absence of priority sectors determined by the government, lack of a systematic and strategic approach aimed at attracting foreign R&D and the unrealistic requirement of employing 50 FTE research personnel, especially for firms operating in the information technologies sector. Another area of consensus is that Turkey has no strategy aimed at attracting foreign R&D investments. Even though Turkey implemented a new strategy in order to increase R&D investments of firms during the last decade, no specific effort is made to attract FDI-based R&D investments. In fact, it seems that the links between legislations related to FDI and R&D is weak, pointing to the necessity of efforts aimed at coordination. In order to

attract new foreign R&D investments, there is an urgent need for formulating a new strategy that should not be only the financial support provided by the government but should also include identification of a number of sector-level priorities combined with regional and local supports for skilled labor supply and on-the-job training.

Participant firms declared that in general they do not face any *discrimination*, negative or positive, due to their foreign status. However, one participant mentioned existence of positive discrimination with respect to domestic firms and claimed that an expectation exists for MNEs to launch their R&D activities without financial support from the government, given the huge financial resources they possess. Another firm would like to see a positive discrimination applied to MNEs and is in favor of a new R&D support legislation aimed to attract FDI-based R&D investment, in addition to the recent R&D support law.

Most of the interviewed firms *collaborated* with other subsidiaries of the parent company at the project level, i.e. intra-company R&D collaborations do occur among affiliates of MNEs. In many instances, findings of a project successfully conducted by the R&D center of a subsidiary are subsequently transferred and used in its R&D centers worldwide. One firm reports collaboration with universities in Turkey and participation into R&D projects with other subsidiaries of parent company in EU projects. One firm established a university-industry relations department to transfer knowledge from universities to the industry and coordinated various procedures. This department acts as a facilitator between the different units of the firm and universities, and undertakes the paper work.

None of the firms experienced significant problems for transferring *skilled labor* from abroad through either brain gain or by recruiting foreigners. However, bureaucratic problems are mentioned by firms for obtaining residence and work permits. What is striking is their high degree of awareness about the incentives offered to transfer skilled labor from abroad. The most popular among those incentives is the EU Marie Curie supports for mobility. Some firms also recruit third generation Turkish immigrants especially from the EU whereas one firm does not see any advantage in transferring skilled labor from abroad because of the high quality of the workforce in Turkey. Another firm employs Turkish citizens living abroad on part-time basis in some projects.

Finally, when firms were asked about the *policy changes* they believed are necessary to attract R&D-based FDI to Turkey the answers were similar to those provided above. They believe explicit links should be established between R&D support and FDI legislations given that such links are not created automatically, thus forcing the government to regulate this issue with a new legislation. The legislation should identify sectors to be treated in priority and provide accordingly sector-specific incentives for R&D expenditures. In this context, it is expected that Turkish Investment Agency⁶⁴ be proactive rather than reactive and develop FDI promotion and R&D support programs in coordination with other public agencies.

In sum, the ICT firms that participated to semi-structured interviews identified major problem areas calling for urgent solution such as the lack of systemic policies towards attracting foreign R&D investments, building links among FDI and R&D strategies, identification of priority sectors, and the removal of some barriers for ICT sector in the recent R&D support law.

⁶⁴ For a detailed information on Turkish Investment Agency see <http://www.invest.gov.tr/en-US/Pages/Home.aspx>.

5. Concluding Remarks

The objective of this paper was to identify and analyze opportunities and problems due to the increased foreign presence of MNEs in innovation activities in the Turkish economy. To this end an open-ended questionnaire was prepared and used to conduct semi-structured in-depth interviews with the CEOs and R&D, product and production directors of 26 MNE affiliates operating in the manufacturing and ICT sectors in 2010. These firms operate in the pharmaceutical sector, automotive sector, electrical/electronics sector, and in the ICT sector. They are all wholly or partly owned affiliates of well-known MNEs present all over the world. Case studies were our preferred research methodology mainly because we believe that information embedded in individuals and organizations on the issues we are interested in can only be identified and retrieved by administering an open-ended questionnaire to relevant actors in MNEs.

Our findings point to problems specific to each sector as well as to common issues in attracting new and/or increasing existing international R&D activities in the Turkish economy. We have dealt with sector-specific issues in detail in section 4 and therefore the focus will be on problems expressed by all or a majority of firm representatives that attended the interviews.

One major problem concerns the indirect taxes levied on products sold on the domestic markets that are higher than taxes levied in other emerging countries or even in the European Union. The obvious detrimental effect of this situation is to limit the size of the market -rather its growth rate- and acts as an impediment for further R&D expenditures by foreign firms. Especially firms in the automotive and electrical/electronic sectors complained about this negative effect of this issue on their R&D expenditures – present and to come.

The relatively low level of technological capabilities of suppliers was mentioned as another problem area by many firms. This has the undesirable outcome of limiting the extent of cooperation between manufacturers and suppliers, which impacts negatively on the competitiveness of foreign manufacturers in the sectors analyzed. Another negative effect is to increase the import dependency of these firms, hence of the overall economy in Turkey. Again firms in the automotive and electrical/electronic sectors complained most about this problem and added that the recently enacted R&D incentive law no 5746 would be unable to increase R&D capabilities of suppliers since it excludes from its scope SMEs.

Several firms in all the sectors pointed to the contrast between the high-education level of especially engineers and their low level of work experience, which, in other countries, is acquired through internships while studying. Firms mentioned that they had to train themselves for several months their workforce in order to bring them productivity to acceptable levels. Absence of high quality collaborations with the universities is bailed for this situation.

Many firms complained about negative discriminatory practices they suffered from, especially for the allocation of R&D subsidies. Gaining the trust of funding agencies by convincing them that their foreign status would not reduce the socio-economic impacts of funds received was one major way to mitigate this problem. However, larger MNE affiliates pointed to the sustainability of R&D funds since

funding agencies believed that their large size would enable them to pursue on their own R&D activities initially subsidized.

Insufficient level of collaboration between MNE affiliates and universities was mentioned as another issue to deal with. This problem was partly blamed on the incapacity of engineering faculties to address concrete problems of affiliates and had the disastrous consequence of not limiting the amount of R&D expenditures of foreign firms but also their integration into the Turkish national innovation system.

Many firms reported administrative obstacles and problems for benefiting from direct subsidies and fiscal incentives provided to R&D. These included red tape, low transparency of the subsidy ranking process, ambiguous performance criteria for fiscal incentives, insufficient awareness-raising activities and risk of exclusion of foreign firms from the subsidy process. Firms declare that besides increasing the amount of R&D support, these problems should be dealt with if the objective is to maximize international R&D activities in Turkey.

Weak links between FDI-promotion policies and those related to R&D support were reported by firms. Further integration of policies aimed at increasing individually each item –FDI or R&D in general– was recommended as an absolute necessity to attract more international R&D to Turkey.

Finally, several firms complained about the absence of priority sectors and technology fields to be promoted by policymakers. According to them, establishing such a priority list would send a clear message to headquarters of MNEs leading them to take into consideration Turkey in their future R&D decisions.

Therefore, attracting international R&D to Turkey is related to a host of factors including the design of policies relating to higher education, tax and FDI-promotion policies, and to the strengthening of relationships between manufacturers and their suppliers. Policy proposals and tools aimed at tackling these issues must be formulated and implemented through negotiations involving all relevant actors in the national system of innovation. In a nutshell, bringing international R&D to Turkey requires the preparation of a policy mix and its implementation through coordination with relevant actors.

REFERENCES

- Blomstrom, M. ve A. Kokko (1998), "Multinational corporations and spillovers", *Journal of Economic Surveys*, 12, 1-31.
- Carlsson, B. (2006), "Internationalization of innovation systems: A survey of literature", *Research Policy*, 35, 56-67.
- Celikel, A.T., Karabag, S. F. and C. Berggren (2011), "The limits of R&D internationalization and the importance of local initiatives: Turkey as a critical case", *World Development* (forthcoming).
- Criscuola, P. (2005), *Internationalization of corporate R&D: A survey of literature*, SPRU - University of Sussex & MERIT- University of Maastricht, mimeo.
- Edquist, C. (2005), "Systems of Innovation: Perspectives and Challenges", in: J. Fagerberg, D. Mowery, and R. R. Nelson (eds.), *The Oxford handbook of innovation*. Oxford: Oxford University Press.
- European Commission (2007), *Europe in the Global Research Landscape*, EC, Brussels.
- Gerybadze, A. ve G. Reger (1999), "Globalization of R&D: Recent trends in the management of innovation in transnational corporations", *Research Policy*, 28, 251-271.
- Gorg, H. and Greenaway, D. (2004), *Much Ado About Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?*, IZA Discussion Paper Series, No. 944.
- Guimon, J. (2009), "Government strategies to attract R&D intensive FDI", *Journal of Technology Transfer*, 34, 364-379.
- Javorcik, B. S., (2004), "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages", *American Economic Review*, 94, 605-627.
- Kalayci, E. and T. Pamukcu (2011), *Analysis of foreign ownership, R&D and spillovers in developing countries: Evidence from Turkey*, Economic Research Forum for the Arab Countries, Iran and Turkey (ERF) Working Paper Series, No 642, October, 41 pages.
- Kuemmerle, W. (1997), "Building effective R&D capabilities abroad", *Harvard Business Review*, 75, 61-70.
- Kuemmerle, W. (1999), "Foreign direct investment in industrial research in the pharmaceutical and electronics industries--results from a survey of multinational firms", *Research Policy*, 28, 179-93.

Le Bas, C. ve Siera. C. (2002), "Location versus home country advantages in R&D activities: some further results on multinationals' location strategies", *Research Policy*, 31, 589-609.

Lundvall, B.A. (1992), *National Systems of Innovation: Towards A Theory of Innovation and Interactive Learning*, Pinter, London.

Miesing, P, Kriger, P.K. and Slough, N. (2007), "Towards a model of effective knowledge transfer within multinationals. The case of Chinese foreign invested enterprises", *Journal of Technology Transfer*, 32, 109-122.

Narula, R. and A. Zanfei (2005), "Globalization of Innovation: The Role of Multinational Enterprises", Fagerberg, J., Mowery D.C. and R.R. Nelson (eds.), *The Oxford Handbook of Innovation*, Oxford University Press, 318-337.

OECD (2006), "The internationalization of R&D", chapter 4 in: *OECD Science, Technology and Industry Outlook*, OECD, Paris, 121-147.

OECD (2008), *The Internationalisation of Business R&D: Evidence, Impacts and Implications*, OECD, Paris.

Özçelik, E., and Taymaz, E. (2008), R&D support programs in developing countries: The Turkish experience. *Research Policy*, 258-275.

Pamukcu, T., Bertinelli L. and Strobl E. (2006), "Technology Spillovers due to Foreign Ownership and Productivity of Domestic Firms: Analyzing the Evidence" (2007) in *Selected Papers from the 13th International Conference of ERF*, Economic Research Forum (ERF), Egypt, 187-230.

Pamukcu, M. and Sönmez A. (2011), *Analysis of Knowledge and Technology Transfer by Multinational Companies to Local Suppliers in the Turkish Automotive Industry* (in Turkish), research project funded by the The Scientific and Technological Research Council of Turkey (TUBITAK), project no 109K587, Middle East Technical University, Ankara, 140 pages.

Pamukcu, T. and Tandogan, S. (2011), *Evaluating effectiveness of public support to business R&D in Turkey through concepts of input and output additionality*, Economic Research Forum for the Arab Countries, Iran and Turkey (ERF) Working Paper Series, No 593, June, 36 pages.

Patel, P. and Pavitt K. (1991), "Large firms in the production of the world's technology: an important case of non-globalization", *Journal of International Business Studies*, 22, 1-21.

Sachwald, F. (2008), "Location choices within global innovation networks: the case of Europe", *Journal of Technology Transfer*, 33, 364–378

Saggi, K. (2005), "Foreign Direct Investment, Linkages, and Technology Spillovers", in: Hoekman, B. and Javorcik, B. S. (eds.), *Global Integration and Technology Transfer*, Washington DC, 51-66.

Schmiele, A. (2011), "Drivers for international innovation activities in developed and emerging countries", *Journal of technology Transfer* (forthcoming).

Smeets, R. (2008), "Collecting the Pieces of the FDI Knowledge Spillovers Puzzle", *The World Bank Research Observer*, 23, 107-138.

UNCTAD (2001), *World Investment Report 2001: Promoting Linkages*, United Nations, New York and Geneva.

UNCTAD (2005). *World Investment Report 2005: Transnational Corporations and the Internationalization of R&D*. United Nations, New York and Geneva.

von Zedtwitz, M. and Gassmann O. (2002), "Market versus Technology Drive in R&D Internationalization: Four Different Patterns of Managing Research and Development", *Research Policy*, 31, 569–88

Wasti, N. S., Kozan, M. K. and Kuman, A. (2006), "Buyer-supplier relationships in the Turkish automotive industry", *International Journal of Operations & Production Management*, 26, 947-970.

World Bank. (2009), *Turkey National Innovation and Technology System, Recent Progress and Ongoing Challenges*. Europe and Central Asia Region: World Bank, 48755-TR, Washington, DC.