THE IMPACT OF FOREIGN DIRECT INVESTMENT SPILLOVERS AND INTERNATIONAL TRADE ON INNOVATION CAPABILITY IN TURKEY AND COMPARATIVE EMERGING MARKETS

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By

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ABSTRACT

Yusuf Çukurçayır, "The Impact of Foreign Direct Investment Spillovers and International Trade on Innovation Capability in Turkey and Comparative Emerging Markets"

Foreign direct investment (FDI) has emerged as a very important source of external resource flows to emerging markets and has become a significant part of capital formation in these countries besides financing current account deficit. There are two competing hypotheses regarding the impact of FDI on innovation capability: it may improve the innovation capability of host countries via spillover channels such as reverse engineering, skilled labor turnovers, demonstration effect, and with vertical linkages from foreign firms to their suppliers, or may lead to crowding-out effect through import of technologies via joint ventures. In this study, the spillover effects of FDI and international trade on innovation capability in Turkey, Hungary, Poland and Czech Republic are analyzed for the period 1995-2005.

Panel data models are employed to test two competing hypotheses. The effect of FDI on innovation in Turkey and comparative emerging markets is analyzed by testing different econometric models such as Ordinary Least Square (OLS), Fixed Effects Model (FEM) and Random Effects Model (REM).

The empirical evidence support that FDI inflows generate spillover effects on domestic innovation capability in Turkey, and comparative emerging countries. This result supports the hypothesis that inward FDI brings knowledge spillovers, new technologies and products into the host country and promote domestic firms' innovation capability. On the other hand, the hypothesis of crowding-out effect of FDI on innovation is rejected for the given sample. With respect to the impact of international trade on innovation capability, import of R&D intensive sectors have positive influence whereas export of R&D sectors have a negative impact. Two periods of empirical results are largely consistent with each other. However, Fixed Effect Model results provide the best fit for the period 2000-2005.

KISA ÖZET

Yusuf Çukurçayır, "Doğrudan yabancı Yatırımının ve Uluslararası Ticaretin Türkiye ve Karşılaştırmalı Gelişmekte Olan Ülkelerde Yenilik(İnnovasyon) Kabiliyetine Etkisi"

Doğrudan yabancı yatırımı gelişmekte olan ülkelerde çok önemli dış kaynak olarak bu ülkelerin sermaye yapılarında önemli bir parça olup cari açıklarını finanse etmelerini sağlamaktadır. Doğrudan yabancı yatırımlarının innovasyon kabiliyetine etkisine dair iki karşıt görüş var. Birincisi, yabancı yatırımlarının innovasyon kapasitesini, tersine mühendislik, yetişmiş eleman yer değiştirmeleri, gösteri etkisi ve yabancı firmaların tedarikçileri ile dikey bağlantı kanallarıyla, artırdığını belirtmektedir. Diğer yandan yabancı sermayenin, otak girişimleri sonucu teknolojinin ithal edilmesiyle, engelleme etkisine crowding-out effect) etkisinin olduğu belirtilmektedir.

Bu çalışmada, 1995–2005 döneminde Türkiye, Polonya, Macaristan ve Çek Cumhuriyetinde, doğrudan yabancı yatırımları ve uluslararası ticaretin innovasyon kabiliyeti üzerindeki yayılma etkisi (spillover effect) incelenmektedir. Yukarıda belirtilen görüşleri test etmek için panel data modelleri kullanıldı. Ampirik bulgular doğrudan yabancı yatırımının yerli innovasyon kabiliyeti üzerinde yayılma etkisine sahip olduğunu desteklemektedir. Bu durum yabancı sermayeye ev sahipliği yapan ülkelerde yabancı sermayenin bilgi yayılması ve yeni teknoloji ve ürünlerin getirilmesi vasıtasıyla yerli firmaların innovasyon kabiliyetlerini arttırdığını desteklemektedir. Uluslararası ticaretin innovasyon kabiliyetine etkisinde ise, araştırma ve geliştirme yoğunluklu sektörlerde yapılan ithalatın artı yönde etkisi olduğu görülmektedir fakat bu sektörlerde yapılan ihracat eksi yönde etki etmektedir.

Çalışmada incelenen iki dönemin sonuçları büyük çoğunlukla uygunluk göstermektedir. Buna rağmen, sabit etki modeli (fixed effect model) sonuçları 2000–2005 döneminde en uygun sonuçları vermektedir.

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CHAPTER I

1. INTRODUCTION

The accumulation of knowledge is one of the key determinants for the economic growth of a country. The stock of knowledge can be increased by deliberate investment in R&D capital or diffusion of existing technology. Foreign direct investment (FDI) has been considered by many development economists as an important channel for transfer of technology to emerging markets, since the inflow of FDI contains knowledge about new technologies and materials, production methods, or organizational management skills. It is suggested that modern, advanced technologies introduced by multinational firms can also diffuse to domestic firms through spillovers. Therefore, one of the primary motivations for developing countries to attract foreign direct investment is to obtain advanced technology from developed countries and then base on this to establish domestic innovation capability.

FDI flows have increased substantially in the last two decades. FDI flows have climbed up after 1995, and the share of developing countries has increased in FDI flows, too. The FDI inflow was $342 billion in 1995 whereas it reached to $1.305 billion in 2006. The FDI flows to emerging countries have climbed up, too. In 1995 the emerging countries were attracting FDI flows around $200 billion; however in 2006 the amount of FDI inflows attracted by emerging markets exceeded $500 billion. This increase has been a result of the reduction of barriers to FDI, considerable improvements in transportation and communication technologies, and the measures implemented by many governments to attract FDI.

After the 1990s, foreign direct investment has emerged as a very important source of external resource flows to emerging markets and has become a significant part of capital formation. However whether FDI can bring positive

spillover effect and stimulate technology progress in emerging markets is controversial. Are there significant spillover effects from inward FDI on R&D activity of host domestic firms besides financing current account deficit in emerging countries? Do emerging countries simply import technologies without developing their innovative ability? What is the impact of international trade on innovation capability? Do export and import of R&D intensive sectors facilitate to create an innovative environment for domestic firms? This paper examines the spillover effects of FDI and international trade on innovation capability in Turkey and as well as comparative emerging markets, Poland, Hungary and Czech Republic for the period 1995-2005. These countries are tested in that study since they have some common points; first, they are regional competitors and they are competing to attract the FDI coming to that region. Second, they have attracted remarkable FDI inflows after 1995 and they use that FDI to transfer improve their technological infrastructure. For example, the automotive industry of Turkey has obtained an in important place in global markets via FDI. Third, they have experienced the European Union Membership process and Turkey is experiencing it know, and finally, they use FDI as a tool for control their current account deficit.

As it is cited in the literature, there are several important channels through which inward FDI can promote innovation activity of domestic firms in the host country (Blomström and Kokko, 1997). First of all, domestic firms can learn about the products and technologies introduced by foreign investors. Reverse engineering is an example for that channel. Secondly, spillovers can occur through labor turnovers where local firms acquire the technological know-how of foreign-investment-related firms by hiring their skilled workers. Third, inward FDI has a demonstration effect on local R&D activity. Foreign products, technologies can encourage and stimulate local

investors to develop new products and processes. Therefore the trial-and-error process of local firms in their research for inventions shortens. Furthermore, since the products and technologies that FDI firms introduced have already tested in foreign markets, the perceived risk of innovating along similar directions is lowered for local firms (Chueng and Lin, 2004). Finally, spillovers may come about vertically from foreign firms to their local suppliers by means of technological know-how transfer, staff training, and so on. These vertical spillovers can develop the innovation capability of local suppliers (Smarznska, 2004).

However, empirical studies show that the net benefits that the host country can benefit from FDI depends on host country characteristic, like industry and policy environment (Blomström and Kokko, 1997), the level of human capital stock (Borensztein, Gregorio and lee, 1998), and absorptive capacity of domestic firms (Kinoshita, 2001).

The main aim of this study is to test the spillover effect of FDI on innovation capability in Turkey and comparative emerging economies. The study is based on country-level data of Turkey, Poland, Hungary and Czech Republic for the period from 1995 to 2005. The number of patent applications is used as a measure of innovation capability. FDI refers to the realized value of FDI in these countries. FDI values lagged one period in order to analyze the spillover effect of FDI. As a measure of input to R&D activity, the number of personnel for research and development personnel and expenditure amount on research and development are included. Besides, export and import of R&D intensive sectors are added as a measure of input to R&D activity. GDP per capita is another explanatory variable.

The effect of FDI on innovation in Turkey and comparative emerging markets is analyzed by testing different econometric models such as Ordinary Least Square,

Fixed Effects Model and Random Effects Model for the period between 1995 and 2005.

Main findings are as follows; empirical results for both periods reveal that FEM outperform OLS and REM for the given sample set. FEM detects country specific changes by assigning a constant term for each country. The coefficient of FDI inflow on domestic innovation capability is always positive in all versions of OLS, FEM and REM estimations. The empirical evidence support that FDI inflows generate spillover effects on domestic innovation capability in Turkey, Hungary, Poland and Czech Republic. This result supports the hypothesis that inward FDI brings knowledge spillovers, new technologies and products into the host country and promote domestic firms' innovation capability. These spillover effects may arise through channels such as reverse engineering, skilled labor turnovers, demonstration effects, and backward linkages. On the other hand, the hypothesis of crowding-out effect of FDI on innovation is rejected for the given sample. The empirical studies of FDI spillover effects on innovation in Turkey are rare. Lenger and Taymaz (2004) study innovation and technology transfer activities of domestic and foreign firms in Turkish manufacturing industries, and the impact of horizontal, vertical and labor spillovers on these activities. Their analyzes indicate that foreign firms are more innovative than their domestic counterparts, transfer technology from abroad, and are likely to establish more co-operative relations for their R&D activities. Another study of Lenger and Taymaz (2006) examines the role of multinational companies as the creator and diffuser of new and superior technologies. Their results suggest that the spillovers from MNCs for the domestic sector of the Turkish manufacturing industry differentiate with respect to size of the recipient domestic firms and by time. They

used firm-level data in their studies and analyzes manufacturing industry however in that study country level data containing all industries is used.

The main contributions of this study to literature are as follows; this study is one of the first studies that use a macroeconomic approach to test the impact of FDI spillover and international trade effects on innovation capability in Turkey. Secondly, the impact of international trade on innovation capability of a country is taken into account through export and import of R&D intensive sectors. Third, innovation measure is defined in parallel to empirical studies in the literature and tested for a group of emerging countries including Turkey. Fourth, a comparative study is conducted for Turkey and its major rivals in terms of attracting FDI for the period 1995-2005.

The rest of paper is organized as follows. Chapter II gives an overview of the concept of FDI is given: what it means and encompasses. Then general trends and characteristics of FDI in the world and in Turkey are highlighted. In chapter III, the literature on the spillovers effects of FDI on innovation and research and development (R&D) have been reviewed. Firstly, the concept of R&D spillovers has been defined. Secondly, papers about the FDI spillovers in the literature have been discussed. Finally, empirical results concerning FDI spillovers on R&D and technology from developed countries, emerging markets, and Turkey have been given. In chapter IV, methodology and data are discussed briefly. Main empirical findings are presented and discussed in chapter V. Chapter VI provides some concluding remarks.

CHAPTER II

2. FOREGIN DIRECT INVESTMENT

In this introductory chapter, firstly, an overview of the concept of foreign direct investment (FDI) is given: what it means and encompasses. Secondly, it provides some information on the long term trend in global FDI and FDI in emerging markets. Finally, in FDI flow to Turkey will be analyzed.

FDI has emerged as one of the most important source of external resource flows to countries after the 1990s and has become a significant part of capital formation. Especially for emerging markets, it plays an important and increasing role in international business. In addition to capital, FDI usually flows as a bundle of resources including production technology, organizational and managerial skills, marketing know-how, and even market access through. For that reason FDI is a vital source for many developing countries to obtain international capital and advanced technology. As a result, one of the primary motivations for emerging countries to attract FDI is to obtain advanced technology from developed countries and then base on this to establish domestic innovation capability.

FDI flows have climbed up after 1995, and the share of developing countries has increased in FDI flows too. The FDI inflow was US$ 342 billions in 1995 whereas it reached to $1.305 billions in 2006. The FDI flows to emerging countries have climbed up too. In 1995 the emerging countries were attracting FDI flows around $200 billions; however in 2006 the amount of FDI inflows attracted by emerging markets exceeded $500 billions. A brief picture of global FDI inflows and the trends in FDI flows in emerging markets and Turkey will be presented in the next part of this chapter.

2.1 The Concept of FDI

In the past decade, FDI has taken part in a key role in the internationalization of business. The size, scope and methods of FDI has been modified reacting to changes in technology, rising liberalization of the national regulatory structure governing investment in establishments, and changes in capital markets. New information technology systems, decline in global communication expenses have made management of foreign investments far easier than in the past. The change in trade and investment policies and the regulatory atmosphere in the past decade, including trade policy and tariff liberalization, easing of restrictions on foreign investment and acquisition in many nations, and the deregulation and privatization of many industries, has been important means for FDI's expanded role (Graham, 2000).

OECD defines FDI as investment by a resident entity in one economy with the objective of obtaining a lasting interest in an enterprise resident in another economy. The lasting interest means the existence of a long-term relationship between the direct investor and the enterprise and a significant degree of influence by the direct investor on the management of the direct investment enterprise. Absolute control by the foreign investor is not required, and ownership of 10% of the voting power is the criterion used (OECD Factbook, 2007).

FDI is an investment made abroad either by establishing a new production facility or by acquiring a minimum share of an already existing company (Bannock, 1998). Unlike foreign bank lending and foreign portfolio investment, FDI is characterized by "the existence of a long-term relationship between the direct investor and the enterprise and a significant degree of influence by the direct investor on the management of the enterprise" (IMF, 1993). Foreign direct investment is considered to be more useful to a country than investments in the equity of its companies because, equity investments are potentially "hot money" which can

disappear at the first sign of trouble, while FDI is durable and usually useful whether things go well or badly (Grahman, 2000).

There are different types of FDI classified by United Nations (UN). One type of FDI is greenfield FDI. The use of the term greenfield FDI has been extended to face any investment made abroad by building new productive assets. It does not subject whether there has been a transfer of capital from country of the investor to the host country. Another type of FDI is cross-border or international merger and acquisitions (M&A). A cross-border M&A is the transfer of the ownership of a local productive activity and assets from a domestic to a foreign entity (United Nations, 1998). In the short-term, a country may have advantage more from a greenfield FDI than from an M&A FDI. One of the reasons is that green-field FDI impacts directly, immediately and positively on employment and capital stock. The installation of a new industry in a foreign country adds to this latter existing capital stock and entails jobs creation.

Profits of existing foreign firms not repatriated by direct investors but reserved in a host country to credit future ventures represent another type of FDI called reinvested earnings. It often happens that a foreign affiliate of a MNC undertakes direct investment abroad. Such a FDI is called indirect FDI because it represents an indirect flow of FDI from the parent firm's country (Kenwood and Lougheed, 1999).

As Reuber (1973) figures out that FDIs-greenfield, M&A and reinvested FDIs- can also be classified into three other categories: export-oriented FDIs, market-development FDIs, and government initiated FDIs. The aim of an export-oriented FDI is either to remove raw materials or to produce component parts or finished goods at a lower cost for export to the investor's home country or elsewhere. This is a vertical extension backwards of the activities of the firm. The investor in making such an investment searches to maintain or increase its market share through sale of cheap goods. When a firm establishes sales subsidiaries abroad,

there is a vertical integration forward of its activities. The purpose of a market-development FDI -sometimes called import-replacement FDI- is to manufacture locally goods and services for sale in the recipient country. The determinants of such an investment are the local market size, the host country trade policy, etc. Such an investment is also called horizontal FDI.

A government-initiated FDI is one pioneered and subsidized by the recipient country. Such an investment is supplied by LDCs in order to reduce unemployment, decrease disparities between regions in the host country and control the deficit of the balance of payments.

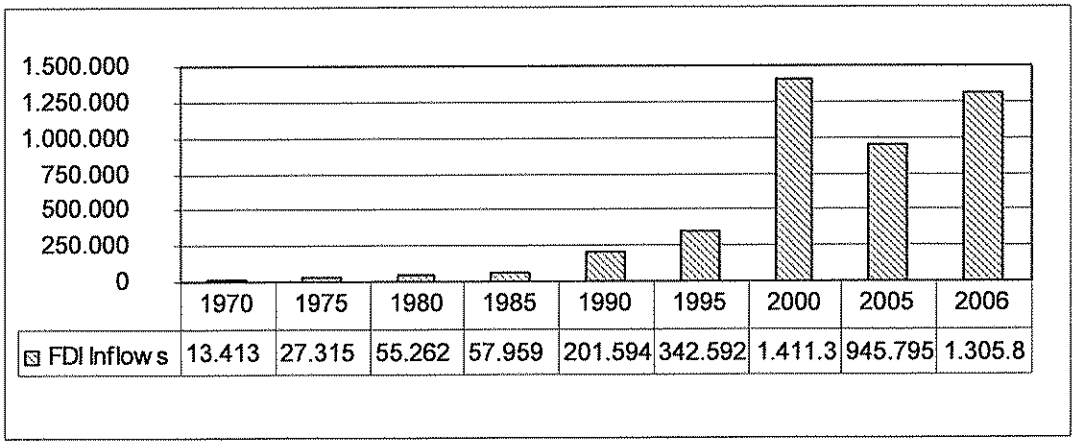
In recent years, given fast growth and change in global investment patterns, the definition has been widened to add the acquisition of a lasting management interest in an enterprise outside the investing firm's home country. Therefore, it may extends to many types, such as a direct acquisition of a foreign firm, construction of a facility, or investment in a joint venture or strategic alliance with a local firm with attendant input of technology, licensing of intellectual property.

2.2 FDI Flows in the Global Economy

World FDI inflows rose slowly from 1970 to 1984. In 1984, world FDI inflows were about 5 times what they were in 1970. There was a fast and sustained growth in world FDI flows from 1985 to 2000. FDI flows climbed up 26 times from 1985 to 2000s. In 2001, world FDI flows dropped. The main reason of this reduction is the general slowdown in the world economy after 2001.

Figure 1 presents the world FDI flows after 1970.

Figure 1: World FDI Inflows (US $ billions)



	1970	1975	1980	1985	1990	1995	2000	2005	2006
FDI Inflows	13.413	27.315	55.262	57.959	201.594	342.592	1.411.3	945.795	1.305.8

Source: UNCTAD database

FDI inflows grew remarkably fast in the second half of the nineties. Higher flows of FDI over the world always mirror a better economic environment in the existence of economic reforms and investment-oriented policies. However, both inflows and outflows of FDI worldwide went down drastically in 2001 following the impressive investment boom of the late 1990s. FDI inflows slowed down for three years, related with the general slowdown of the world economy that followed after 2001, and started growing again in 2004. The global environment for FDI became better in 2005 while corporate profitability was generally strong. Direct investment raised in 2005 when inflows reached $954,8 billions.

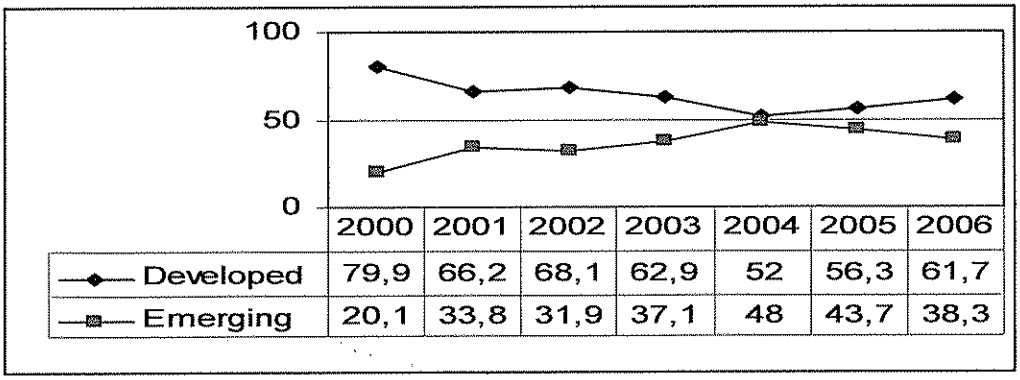
FDI proceed to rise in 2006 this indicated the third consecutive year of growth, and approached the record level of $1,411 billion reached in 2000. It indicated strong economic performance in many parts of the world. It should also be kept in mind that the weakening US dollar has increased the nominal US dollar denominated totals. Inflows increased in all three groups of economies: developed countries, developing countries and the transition economies of South-East Europe. FDI increased in 2006 by 38% than the previous year (World Investment Prospects, 2006).

The rise in global FDI flows was partly driven by increasing corporate profits worldwide and resulting higher stock prices that raised the value of cross-border mergers and

acquisitions (M&As). Such transactions rose significantly in 2006, both in value (by 23%, to reach $880 billion) and in number (by 14% to 6.974), approaching the previous M&A peak in 2000. M&As continued to account for a high share of FDI flows, but greenfield investment also increased, especially in developing and transition economies. As a result of higher corporate profits, reinvested earnings have become an important component of inward FDI. Global FDI flows also rose as a result of a weakening dollar in 2006 (World Investment Prospects, 2006).

From 1970 to 2001, developed countries (DCs) took at least 50 percent of world FDI inflows. The percentage of world FDI received by Central and Eastern Europe countries was almost equal to zero till 1990. After the collapse of the communist bloc in 1990, they have started opening their economies to foreign investors. The shares of the emerging countries between 2000 and 2006 have increased as demonstrated in figure 2.

Figure 2: Distribution of FDI (%)

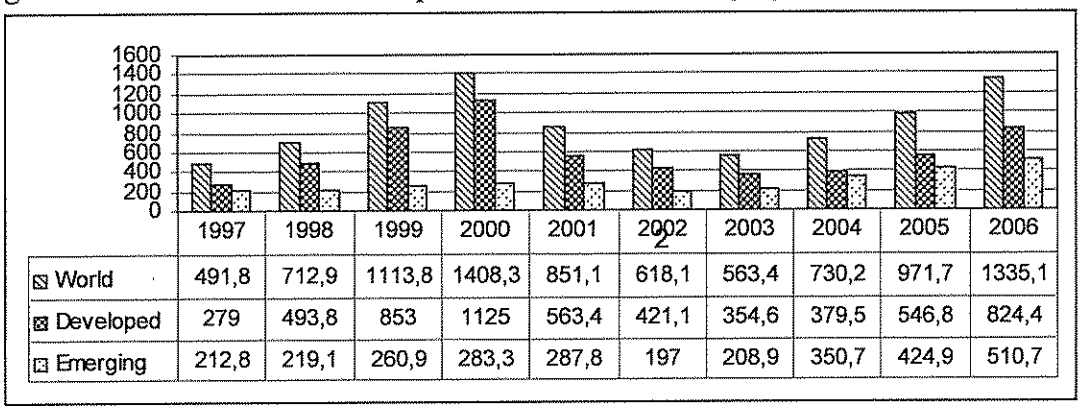


	2000	2001	2002	2003	2004	2005	2006
Developed	79,9	66,2	68,1	62,9	52	56,3	61,7
Emerging	20,1	33,8	31,9	37,1	48	43,7	38,3

Source: UNCTAD

In 2000 the share of emerging countries was about 20%, it increased steadily up to 2005 and reached to 43,7% percent. However in 2006, there is a decrease and the share of emerging countries in FDI flow became 38,3%. The below table present the amounts of FDI flows to developed and emerging countries from 1997 to 2006.

Figure 3: FDI Inflows into Developed Countries and Emerging Countries (US$ billions)



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
World	491,8	712,9	1113,8	1408,3	851,1	618,1	563,4	730,2	971,7	1335,1
Developed	279	493,8	853	1125	563,4	421,1	354,6	379,5	546,8	824,4
Emerging	212,8	219,1	260,9	283,3	287,8	197	208,9	350,7	424,9	510,7

Source: UNCTAD database

The FDI has climbed up after middle of 1990s. The FDI inflow was 342 billions US$ in 1995 whereas it reached to 1305 in 2006. The FDI flows to emerging countries increased remarkably during that period. In 1997 the emerging countries were attracting FDI flows around 200 billions US$, however in 2006 the amount of FDI inflows attracted by emerging markets exceeded 500 billions US$. The table 1 presents the distribution of FDI into major country groups, between 2000 and 2006.

Table 1: Distribution of FDI into Major Country Groups (US $ billions)

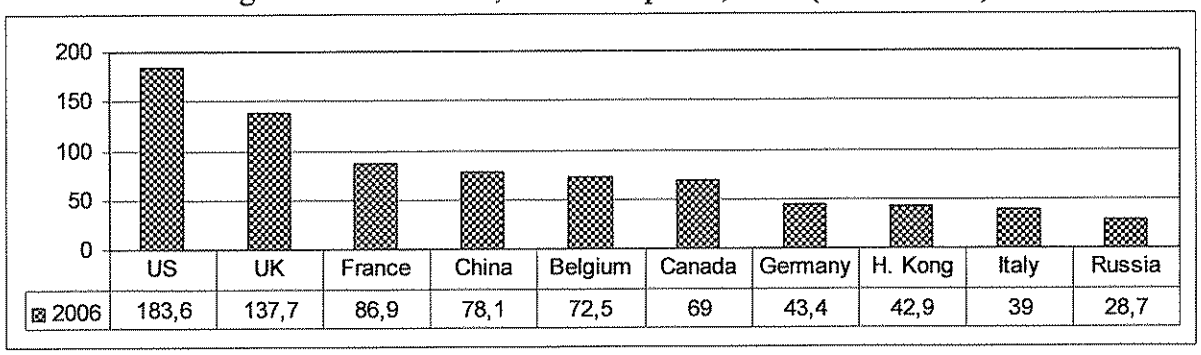
	2000	2001	2002	2003	2004	2005	2006
World total	1413.0	875.1	733.2	655.8	801.7	954.8	1335.1
Developed Countries	1131.1	586.4	539.6	453.9	485.6	555.6	824.4
% of world total	80.0	67.0	73.6	69.2	60.6	58.2	61.7
Emerging markets	281.9	288.7	193.7	201.9	316.1	399.2	510.7
% of world total	20.0	33.0	26.4	30.8	39.4	41.8	38.3
North America	388.1	194.7	102.2	73.2	139.4	143	252.7
Western Europe	717.2	373.5	410.8	362.3	293.7	449.2	554.8
EU15	688.8	357.5	401	337.4	284.6	452.6	496.5
Eastern Europe	29.5	30.0	36.1	35.6	66.1	74.3	105.9
Asia Pacific	165	119.9	111.1	106.4	197.0	146.0	238.6
Developing Asia	141.7	100.7	84.5	88.1	141.8	177.0	212.4
LatinAmerica&Carabbien	97.7	131.1	52.7	48.1	68.9	75.2	102.5
Middle East	6.5	6.8	7.8	11.8	15.9	32.9	46.2
North Africa	3.3	5.6	3.8	5.8	8.8	16.4	22.3
Sub-Saharan Africa	5.7	13.5	8.9	12.7	11.9	18.0	12.2

Source: UNCTAD database

Although FDI flows to each part of world rose, they varied greatly among regions and countries (World Investment Prospects, 2006). FDI flows to developed countries rose in 2006 by 45%, reached to $857 billion well over the growth rates of the previous two years. The

European Union (EU) remained the largest host region, with 41% of total FDI inflows in 2006. FDI inflows to developing countries and economies in transition rose by 21% and 68%, respectively, to new record levels for them. Developing Asia retained its strong attraction for investors, accounting for more than two thirds of the total inflows to all developing countries in 2006. The largest inflows among developing economies went to China, Hong Kong (China) and Singapore, and among the transition economies to the Russian Federation (World Investment Report, 2007). Figure 4 presents the main FDI recipient counties.

Figure 4: FDI Inflows, Main Recipients, 2006 (US$ billions)



	US	UK	France	China	Belgium	Canada	Germany	H. Kong	Italy	Russia
2006	183,6	137,7	86,9	78,1	72,5	69	43,4	42,9	39	28,7

Source: UNCTAD database

In regard to the geographical patterns of FDI flows, around 80 percent of FDI flows originate in developed countries and 60 percent of FDI flows target developed countries. Based on average figures for the 2000-2006 periods, the top five foreign direct investors, in decreasing order, were the USA, UK, France, Netherlands, and Spain, accounting together for approximately 53 percent of world FDI; the top five destinations were the USA, UK, China, Germany, and France, accounting for 43 percent of the world FDI(World Investment Report, 2007) . The United States regained its position as the world's leading FDI recipient, followed by the United Kingdom and France in 2006.

2.2.1 Sectoral distribution of FDI

The most important shift in the sectoral and industrial pattern of FDI over the past quarter century has been the shift towards services, came with by a decline in the share of FDI in natural resources and manufacturing. Recently, nevertheless, FDI in the extractive

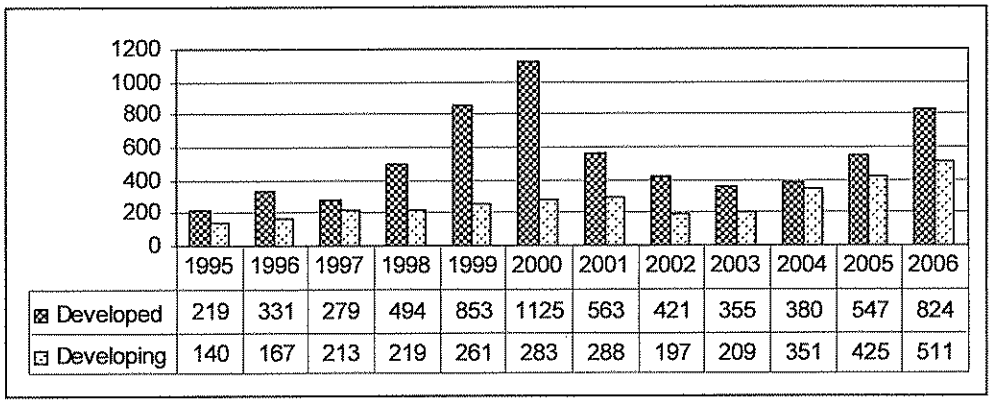
industries of resource-rich countries has gone back, and its importance in infrastructure services is also rising. Over the past 25 years, FDI has increased significantly in absolute terms in all three major sectors: primary, manufacturing and services. However, the shares of the primary and manufacturing sectors in world inward FDI stock have reduced.

Data on cross-border M&As confirm the growing importance of services. This sector's share in worldwide cross-border M&As rose from 37% in 1987-1990 to 58% in 2002-2006, while that of the sector was divided, from 11% to 5% between 1987-1990 and 1996-2000, but it recovered to 11% in 2002-2006. The share of manufacturing fell from 52% of global cross-border M&As in 1987-1990 to 31% in 2002-2006 (World Investment Report 2007).

2.3 FDI in Emerging Markets

In both 2004 and 2005, FDI inflows have increased in emerging markets. After recovering by 57% in US dollar terms in 2004, FDI inflows into emerging markets grew by 26% in 2005 to reach a record high of almost US$400bn (more than 40% of the global total). In 2006, FDI inflows to developing countries and economies in transition rose by 21% and 68%, respectively, to new record levels for them. FDI flows to emerging markets increased by 20% in 2006, to US$511bn. As noted, the increase of FDI to emerging markets in 2005-06 was weaker than that to developed countries, in part because there had already been a strong emerging-market recovery in 2004.

Figure 5: FDI Inflows in Developed Countries and Emerging Markets (US$ billions)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Developed	219	331	279	494	853	1125	563	421	355	380	547	824
Developing	140	167	213	219	261	283	288	197	209	351	425	511

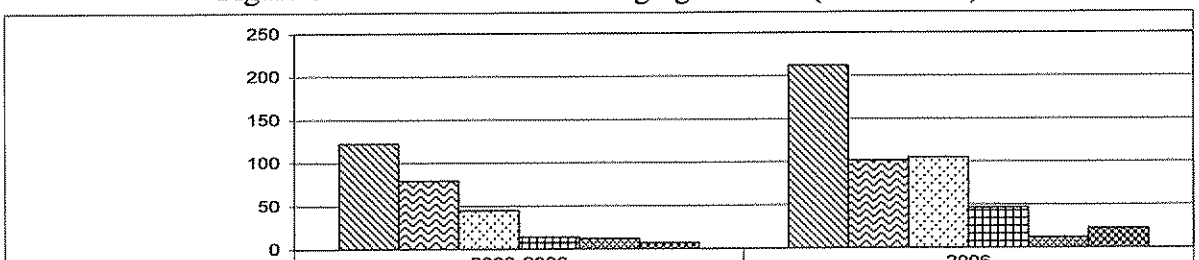
Source: UNCTAD database

FDI flows to emerging markets exceeded US$500bn for the first time. As in the developed world, increased corporate profits and favorable financing conditions fuelled FDI growth. Emerging markets have performed well in recent years, as the global environment has been supportive and they have improved their economic fundamentals—many have been implementing market-friendly reforms and most have consolidated macroeconomic stability (World Investment Prospects, 2007).

FDI inflows rose to all emerging-market regions, and arrived at record levels in every single region excluding Latin America and the Caribbean. Recent trends in FDI have been supported by rising corporate profits and improved balance sheets, as well as optimistic economic growth (World Investment Prospects, 2006).

Figure 6 indicates the distribution of FDI flows into emerging markets during 2004 and 2006 (World Investment Prospects, 2006).

Figure 6: FDI Inflows into Emerging Markets (US$ billion)



	2000-2006	2006
Develping Asia	122,3	212,4
LatinAmerica&Carabbien	79	102,5
Eastern Europa	45,3	105,9
Middle East	13,6	46,2
Sub-Saharan Africa	11,8	12,2
North Africa	7,3	22,3

Source: UNCTAD database

Developing Asia retained its strong attraction for investors; accounting for more than two thirds of the total inflows to all developing countries in 2006. China was far and away the main FDI recipient among emerging markets. With a record inflow of US$79bn, China accounted for one-fifth of all inflows into emerging markets in 2005. A large part of the increase in China was accounted for by financial sector investments worth some US$12bn.

In Africa, FDI inflows exceeded their previous record set in 2005. High prices and global demand for commodities were key factors of that increase. The oil industry pulled investment from TNCs based in both developed and developing countries.

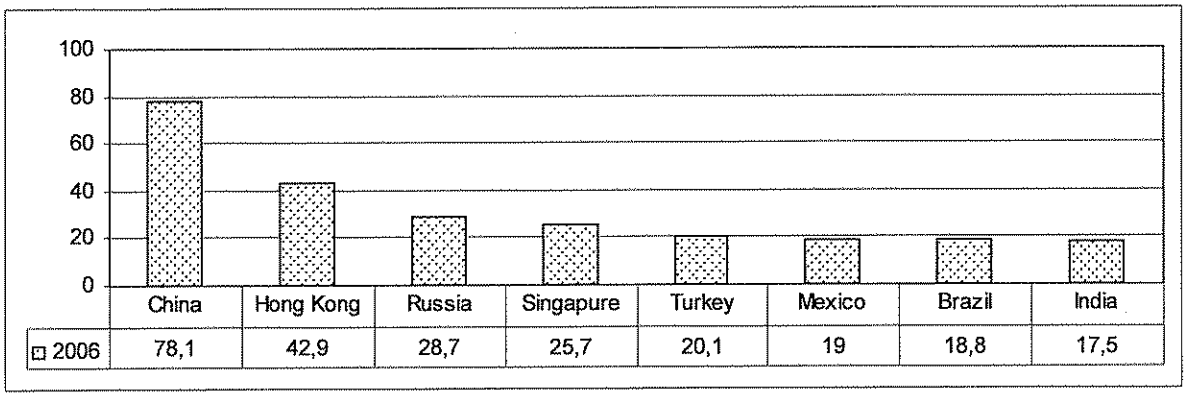
Inflows to Latin America and the Caribbean rose on average by 11% in 2006. Mexico was the largest recipient followed by Brazil. While inflows to Mexico were similar to 2005, those to Brazil increased by 25%.

FDI inflows to South, East and South-East Asia, and Oceania retained their increasing trend, getting a new high in 2006 of $200 billion, an increase of 19% over the previous year. At the subregional level, the shift in favor of South and South-East Asia prolonged. China, Hong Kong and Singapore kept their positions as the three largest recipients of FDI in the region.

In West Asia, FDI flows – both inward and outward – continued their growing trend in 2006.Turkey and the oil-rich Gulf States maintained to attract the most FDI inflows, reaching record levels in 2006 in spite of geopolitical uncertainty in parts of the region. Energy related manufacturing and services were the most targeted activities. FDI inflows to the 19 countries of South-East Europe and the CIS expanded notably in 2006, for the sixth consecutive year.

Figure 7 indicates the too-emerging markets FDI recipients.

Figure 7: Top Emerging-Market FDI Recipients, 2006 (US$ billion)



Source: UNCTAD database

China is again far and away the main FDI recipient among emerging markets, with inflows of US$78bn (China's rank dropped from third to fourth globally, behind the US, the UK and France).Turkey's rank is fifth in emerging markets and twentieth in the world.

2.4 Foreign Direct Investment in Turkey

Potentially, Turkey is an attractive country for global investors. Turkey has a large and dynamic market with a relatively high quality labour force and economic location advantages with easy access to regional markets. Despite these advantages Turkey could only attract $1 billion foreign investment on the average per year since 1990 up to 2002. According to generally accepted international standards, the minimum annual FDI attraction potential of Turkey is $35 billion (UNCTAD, 2002), which means that Turkey faces an investment loss of minimum $34 billion every year up to 2002. In order to catch this potential Turkey has to build confidence to its economy by ensuring stability of rules and regulations, transparency and political stability.

2.4.1 The advantage of Turkey for Attracting FDI

According to TUSIAD' Investment Environment and FDI in Turkey report (2004), Turkey has important advantages besides the improving economic setting with liberalized regulations and radically cut red-tapes. Below discussed advantages offers further attraction for foreign direct investments into Turkey;

Export and domestic market oriented investment: Turkey is one of the few privileged countries that have the potential to attract investment both for export and as well as for domestic market. With a population more than 70 million, Turkey has a big domestic market and among the biggest emerging markets. Moreover, Turkey has a very special location at the crossroads between East and West, overlapping Europe and Asia geographically. The proxy to the new emerging markets in Middle East and Central Asia creates exclusive business opportunities. As a leading investor in Caucasian and Central Asian Turkic Republics and

having strong cultural and historic ties with the region, Turkey offers a special opportunity to develop business with these countries.

The gateway of energy resources: Turkey is located at the entry of Middle East and Caspian petroleum and Central Asian natural gas to the west, which are considered as the future energy reserves of the world. The construction of oil and natural gas pipelines has become a national policy for Turkey, in its quest to harbor different points of connection. In the domestic market, network industries and natural monopolies are being brought in to market competition by the removal of sectoral entry barriers. For that reason, the energy production and distribution business opportunities are attractive. Major legislative changes in the Electricity Market Law, Natural Gas Market Law and Petroleum Market Law create the sector more attractive both for domestic and foreign investors.

Demographic window of opportunity: The size of the adult population will maintain to increase at a stable rate over the next two decades on contrary to the developed countries.

Business skills and high-skilled, competitive labor: Turkish economy is characterized by rather high number of market entries and exits, accounting for about 10% of the number of existing enterprises. This points not only to the high flexibility of Turkish entrepreneurs but also to a liberal regime of market access. The Turkish labor force is well known with its skills and learning capacity, and competitive labor rates offer cutting edge for industries. Entrepreneurial activity is flexible, open to foreign ideas and globalization. Turkey's communication and transportation infrastructures are also highly supportive when compared with its competitors.

2.4.2 An Overview of FDI in Turkey

The first legislation in Turkey regulating foreign investments was introduced in the early 1950s. The Foreign Capital Law was enacted in 1954 and the related Decree of the Council of Ministers had remained in force until the late 1980s. This early legislation

provided a liberal framework designed to create a favorable environment for FDI. However, the cumulative FDI authorized from 1950 to 1980 reached only 229 million USD (Öniş, 1994).

On January 24, 1980, following a serious balance of payments crisis, the Turkish government announced a stabilization program to open up the Turkish economy by replacing the prevalent import substitution strategy by an outwardly oriented liberalization program. The direct aim of this program was to constitute a free market, and an outward-oriented economy, the better to incorporate Turkey with world markets. In 1983, the implementation of the liberalization program in Turkey remained a high priority. In 1989, Turkey fully liberalized its capital account. This operation, which was supposed to increase Turkey's attractiveness to foreign investors, was the last step of the financial liberalization that the country initiated in the early 1980s (Hadjit, Browne, 2006).

Through these reforms, FDI inflows changed magnitude significantly. The authorized investment amounted to $6.4 billion between 1980 and 1990 while the average value per year was $456.3 million in the same period. Despite this increase, Turkey was still attracting relatively low levels of FDI compared to countries of comparable size such as Argentina and Mexico (Hadjit, Browne, 2005).

The complete liberalization of capital accounts in 1989 provided an additional impetus for foreign investment. As a result, the number of firms with foreign participation increased from 78 in 1980 to 1,856 in 1990 and to 5,328 in 2000, whereas total value of inflow of FDI reached 2.6 billion USD in the 1980-89 period and $11.8 billion in the 1990-2000 period. The manufacturing industry alone accounted for 55% of cumulative authorized FDI in the post-1980 period (Öniş, 1994).

The period of the 1990s was critical for Turkey as it entered into a customs union with the EU in January 1996. It implied a removal of tariff and non-tariff barriers on industrial

goods and forced Turkey to adopt the Common External Tariff (CET) against third country imports and all preferential agreements between the EU and third countries by the year 2001. It was intended to stimulate flows of European FDI into Turkey because of the increased stability and competitiveness of the Turkish economy. However, the customs union had a significant impact only on authorized investment between 1995 and 1997. During this period, many investments, especially in the manufacturing sector, were announced but most did not materialize. This could have resulted from the Turkish government's failure to facilitate the large interest shown by inward investors into real investment as weak government coalitions at the time could not convert the investors' positive perceptions into reality because of many factors such as macroeconomic instability and "non-friendly" FDI legislation (Hadjit, Browne, 2005).

When the FDI performance of the Turkey is compared with its competitors, for example Eastern European countries such as Poland, Czech Republic, it can be seen that Turkey was lagged behind in 1990s. The 1990s were the period of speeded growth in global FDI that can be attributed to globalization. Aggregate FDI increased by 238 percent in developed economies and by 98 percent in developing economies over the period 1994–98. However, with an average annual inward FDI to GDP ratio of 0.4 percent for the 1995–2000 periods, Turkey ranked 81st out of 91 developing and transition economies, where the same ratio averaged two percent. Despite the increasing number of foreign companies in the 1990s in Turkey, FDI inflows stayed static. The annual FDI has been about one billion USD in the 1990s.

Many analysts claim that Turkey is under-performing relative to the Central and East European Countries and other countries at the same level of development in attracting FDI. Although they have a different economic background from Turkey, the CEEC represent fierce

competition for Turkey in attracting FDI, the main competitors being Poland, the Czech Republic and Hungary (Ertugal and Loewendahl 2001).

For the 1998–2003 period, net inflows of FDI amounted to less than one percent of GDP in Turkey while they reached six percent for Bulgaria, three percent for Romania and 4.3 percent for the group formed by Hungary, the Czech Republic and Poland. In contrast to the CEEC, who applied for EU membership between 1990 and 1996, Turkey had applied much earlier, on April 14, 1987, but was only recognized as a candidate in 1999 (Ertugal and Loewendahl 2001).

The EU membership brings member countries access to big EU market, increased growth prospects and access to structural funds. But more importantly their EU membership boosts confidence by removing uncertainty in political and economic stability. This can be seen in the FDI performance of CEEC. Since 1995, FDI inflows to the CEEC have almost doubled while Turkey, whose accession to the EU was viewed quite separately from that of the CEEC, still finds it difficult to attract FDI. Bevan and Estrin suggest that countries that take part in the EU accession process benefit from increased FDI while the relative position of the delayed entrants could deteriorate and therefore EU announcements tend to widen divisions in terms of FDI among delayed entrants and candidate countries. The prospect of future accession to the EU may have contributed to widening the gap between the CEEC and Turkish performances in attracting FDI, but is not the only factor. The CEEC were also successful in carrying out reforms in order to comply with the Copenhagen criteria. Although the EU–Turkey customs union paved the way for Turkey's full membership, it did not have a significant impact on FDI, which was needed as Turkish industries were exposed to stiffer international competition on account of the customs union. Recurrent economic crises, combined with weak government coalitions, deterred foreign investors from entering Turkey.

As a result, transition economies of Central and Eastern Europe, although entering the competition in the beginning of the1990s, attracted more FDI in comparison to Turkey in that period.

When the FDI performance of other competitors of Turkey in emerging countries compared with the performance of Turkey, the picture does not change. Turkey could not attract adequate level of FDI. Brazil and Mexico, that are similar countries to Turkey when market potential, population, and industrialization strategies are considered, attracted fifteen, twenty times more FDI flow than Turkey in the last decade.

As a conclusion, in spite of its FDI potential and encouragement laws, Turkey did not receive a satisfactory amount of FDI until 2004. Although it was expected by UNCTAD that Turkey has potential of 30-35 billion dollars of FDI inflow, whereas the country received only 800 million dollars annually during the last decade.

2.4.3 Policy Reforms to Increase FDI Inflows to Turkey

Despite its competitive advantages and diverse market opportunities, FDI inflows have not lived up to the potential Turkish economy. Recognizing the importance of this issue, Turkish Governments placed efforts for improving the investment environment at the top of the political agenda. As it is well recognized in the report of İhracat Geliştirme Etüd Merkezi (IGEME,2006), the Government of Turkey has therefore started a extensive reform program in December 2001, and the other governments has followed reforms, to streamline all investment-related procedures and to pull more private direct domestic and foreign investment. The Government has founded a Co-ordination Board for Improving the Investment Environment (YOIKK). The Board appointed specialized technical committees to work on developing concrete proposals and strategies in order to overcome all main problems.

Laws enacted as a result of the YOIKK Program to date consider the Law on Employment of Foreign Personnel, Foreign Direct Investment Law, amendments to the

Turkish Commercial Code that redesign the company registration process, Mining Law, Labor Law, Turkish Patent Institute Law, the law on the investment allowance system, which alters a shift to an automatic state aids system in line with EU requirements, and other laws regarding insurance, encouragement of tourism, the prevention of smuggling and inflation adjusted accounting. Besides, there are important improvements in some areas by YOIKK Program such as recruitment of expatriates, sectoral licensing, customs and intellectual and industrial property rights. With respect to customs reform, the Undersecretaries of Customs has implemented a reform program to improve its administrative efficiency and effectiveness. The automated customs system has been established at 99% of all customs offices and has been further enhanced to assist customs in controlling the movement of goods. Necessary legislation to strengthen the capacity and infrastructure of the Turkish Patent Institute has been presented, which seeks to ensure effective implementation of the regulation and protection of intellectual and industrial property rights. Reduction in the corporate tax rate from 30% to 20% in 2006 has been implemented and Turkey's competitiveness in terms of corporate tax rates has been strengthened. New regulations on "Opening a Business Place and Work License" have reduced the required number of documents from 52 to 6 for licensing of sanitary business place and from 43 to 7 for licensing of non-sanitary business place. The number of documents required to obtain an Opening License has been reduced from 18 to only 2 (IGEME Report, 2006).

While strengthening the existing capacity on investment promotion, works on the legislation to establish an institutional capacity for investment promotion have been finalized. Law No. 5523 on Establishment of Investment Support and Promotion Agency of Turkey went into effect on July 4, 2006. Under the office of the Prime Minister, the Agency will have administrative and financial autonomy to sustain operational flexibility and provide information and guidance for investors throughout every step of the investment process. The

law on establishment of development agencies regulating the formation of the Investment Support Offices which will assist investors in obtaining necessary permissions and provide coordination in legal procedures, has entered into force in February 2006.

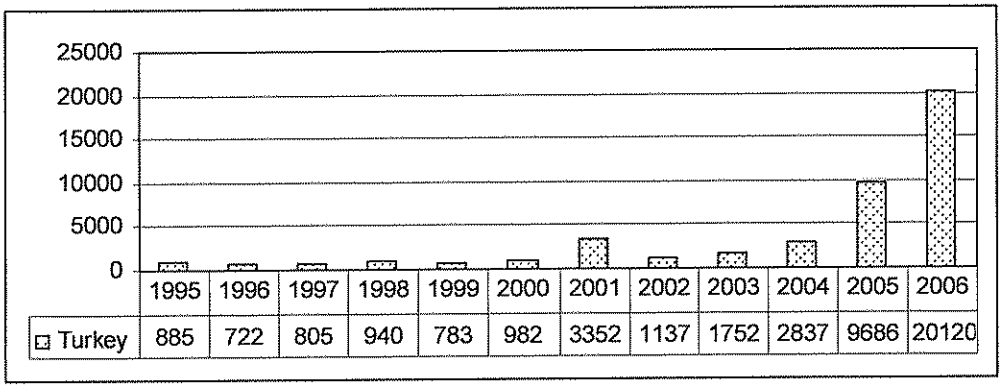
2.4.4 FDI in Turkey in the Post-Crisis Period

All those economic and politic reforms, strong single-party governments and the negotiations with EU have changed the history of FDI inflows to Turkey, and Turkey has started to increase the share of FDI inflows from global investors.

After the national elections of November 2002, weak government coalitions of the 1990s were replaced by a single-party government formed. According to the balance of payment statistics published by the Central Bank of the Republic of Turkey, the capital (inflow) of $1.752 million in 2003 has increased by 55,9 % in 2004 and reached to $2.837 million. Total direct foreign capital (inflow) increased $982 million in 2000 to $3.352 million and US $ 1.137 million in 2001 and 2002, respectively (Turkish Treasury database, 2008).

In line with the recovery of the main economic indicators and efforts to improve investment environment, FDI inflows continued to rise in 2005. Net FDI inflows into Turkey totaled $9.667 million in 2005, implying more than three fold increase compared to 2004. FDI inflows in 2006 has reached its peak level, there became 105, 7 % increase and Turkey has attracted $20,2 billion according to the Central Bank of the Republic of Turkey. Besides, it's expected that Turkey pull about $21.864 billion FDI in 2007 (Foreign Direct Investment Report 2007). Figure 8 shows FDI inflows to Turkey after 1995.

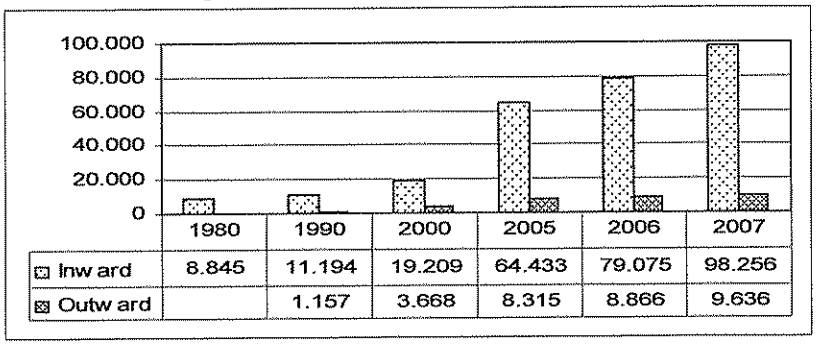
Figure 8: FDI inflows to Turkey (US$ millions)



Source: Turkish Treasury database

Turkey attracted annually average $US853 million between 1995 and 2000. However FDI inflows reached to $9,8 billion in 2005 and $19,896 billion in 2006. Turkey attracted $21.864 billion in 2007. Inward thousands FDI stocks are presented in figure 9.

Figure 9: FDI Stocks (US$ millions)



Source: Turkish Treasury database

The history of FDI of Turkey has changed very drastically after 2000. Total stock of FDI was about $20 billion in 2000, in seven years FDI stock totaled to $100 billion. Table 2 presents the composition of FDI in Turkey between 2003 and 2007.

Table 2: Component of Foreign Direct Investment (US$ million)

	2000	2001	2002	2003	2004	2005	2006	2007
International Direct Investment Total (Net)	982	3352	1137	1752	2885	10029	19918	21864
International Direct Investment Capital	982	3352	754	754	1542	8188	16996	18912
Equity investment	982	3352	617	737	1191	8137	16988	18411
Inflows	1707	3374	622	745	1291	8538	17645	19181
Outflows	-725	-22	-5	-8	-100	-401	-657	-770
OtherCapital	--	--	520	17	351	51	8	501
Real Estate (Net)	--	--	--	998	1343	1841	2922	2952

Source: Turkish Treasury database

The foreign investment consists of direct foreign investment as an amount of $19 billion and sales of real estate from abroad as an amount of $2,9 billion in 2007. There is remarkable increase in real estate sector, in 2000 there is neo considerable FDI to real estate sector, however in 2007 the FDI flow to real estate sector climbed up to $3 billion. Sectoral distribution of FDI in Turkey is presented in table 3.

Table 3: Sectoral distribution of FDI inflows between 2003 and 2007 (US$ millions)

	2003	2004	2005	2006	2007
Agriculture and Fishing	1	6	7	6	5
Mining	14	75	40	122	333
Manufacturing	448	214	788	1.868	4.208
Services	282	996	7.703	15.649	14.635
Total	745	1.291	8.538	17.645	19.181

Source: Turkish Treasury database

Services industries attracted most of FDI inflows; communication and finance sectors are the most FDI attracting industries. In 2006 financial intermediation and transportation, warehousing, and communication industry attracted 76.5% of FDI inflows. Financial intermediation has played an important role in 2007 too. Finance industry attracted $11.409 billon FDI inflows in 2007. Within the manufacturing industries, the leading sectors are (Igeme Report, 2006);

- Automotive and transportation equipment
- Food, beverage and tobacco industries
- Chemical and petroleum products
- Electrical machinery and electronics

Within the services sector, the leading sectors are;

- Banking
- Trade & retail chain stores
- Telecommunications
- Tourism

In the last years, mergers and acquisitions play an important role in global FDI inflows. FDI inflows in Turkey has similar tendency with global economy. In 2005 M&A have 78% shares of total FDI. In turkey this ratio is between 75-80% in 2005 and 2006 emerged. In 2006 finance (44%) and telecommunication (40,5%) industries have important shares in M&A in turkey. The FDI from privatizations is about $1, 8 billion. $15 billion part of this amount is the second payment of sales of Turk Telekom to Oger. Rest of the amount comes from sales of Başak Sigorta and Başak Emeklilik to French Groupama.

2.4.5 Main Source Countries of FDI in Turkey

European Union is the main source country of Turkey for FDI inflows. The 83,5% ($ 14,9 billion) of FDI inflows in 2006 is sourced by EU countries. The FDI inflows from EU countries was 58, 6% ($ 5 billion) in 2005. In FDI inflows in 2006, Holland (29%%, Belgium (19, 4%), and Greece (15, 6%) take the first three. The biggest part of FDI ($4, 6 billion) from Holland is sourced by the sales of Telsim to Vadafone. EU countries continued to be important FDI source for Turkey in 2007. 66,2% of FDI inflows is sourced by UE countries.

Table 4: Source Countries of FDI into Turkey (US$ millions)

Country	2003	2004	2005	2006	2007
EU Countries	555	1.025	5.005	14.489	12.684
Germany	142	73	391	357	995
France	120	34	2.107	439	317
Holland	50	568	383	5.069	5.664
England	141	126	165	628	688
Italy	1	15	692	189	76
Other EU Countries	101	209	1.267	7.807	4.944
Other Europe Countries	70	109	1.650	91	379
African Countries	0	--	3	21	5
USA	52	36	88	848	4.206
Canada	6	61	26	121	11
Latin America & Caribbean	0	--	8	33	490
Asia	60	60	1.756	1.927	1.370
Gulf Countries	0	--	1.675	1.783	296
Middle East	1	54	3	127	298
Other Asia Countries	59	6	78	17	776
Other Countries	2	--	2	115	36
Total	745	1.291	8.538	17.645	19.181

Source: Turkish Treasury database

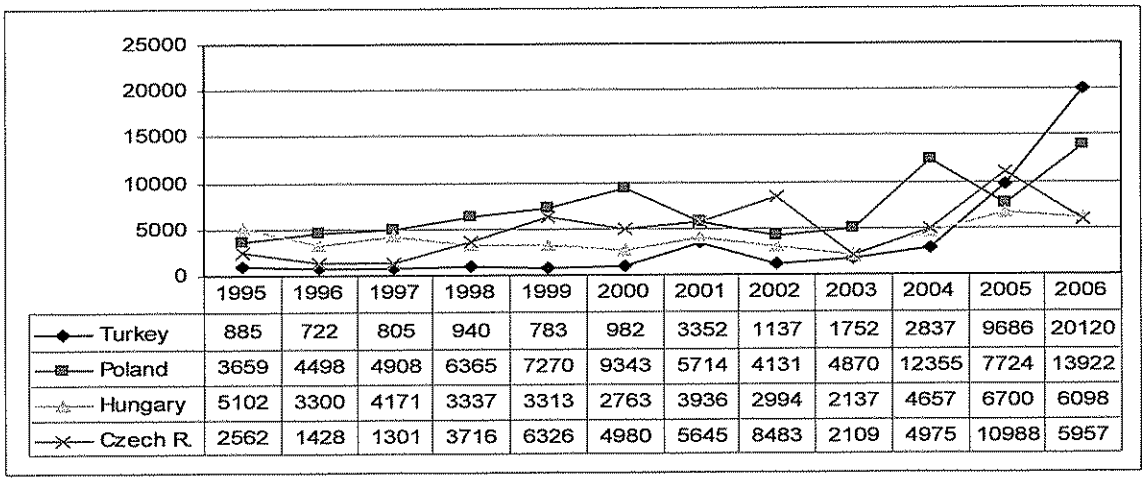
In terms of accumulated foreign capital commitment up to today; the leading investors are Germany, USA, the Netherlands, Greece, Holland United Kingdom, Switzerland, Belgium and Russian Federation. Besides Gulf countries are important investors in Turkey in last years (Foreign Direct Investment Report, 2007).

In regard to regional distribution, Istanbul (94.71%) has attracted the most important part of FDI inflow in 2006. Then Ankara and Izmir follow. Marmara region takes first place in the distribution of foreign firms; there are 9.086 firms in this region. Akdeniz region takes the second place; there are 2.273 firms. And Ege region takes the third place having 2146 firms (Foreign Direct Investment Report 2007).

2.5 FDI Inflows into Turkey and Comparative Emerging Markets

The main competitors of Turkey in attracting FDI inflows in the region are Poland Hungary, and Czech Republic. Those countries are in the same region and they have made many reforms to attract FDI inflow in the same period, after 1990s. Besides, the EU membership period accelerated the rate of FDI inflows to those countries. The figure 12 shows FDI inflows to Turkey and its competitors.

Figure 10: FDI Inflows to Turkey, Poland Hungary, and Czech Republic between 1995-2006(US$ million)

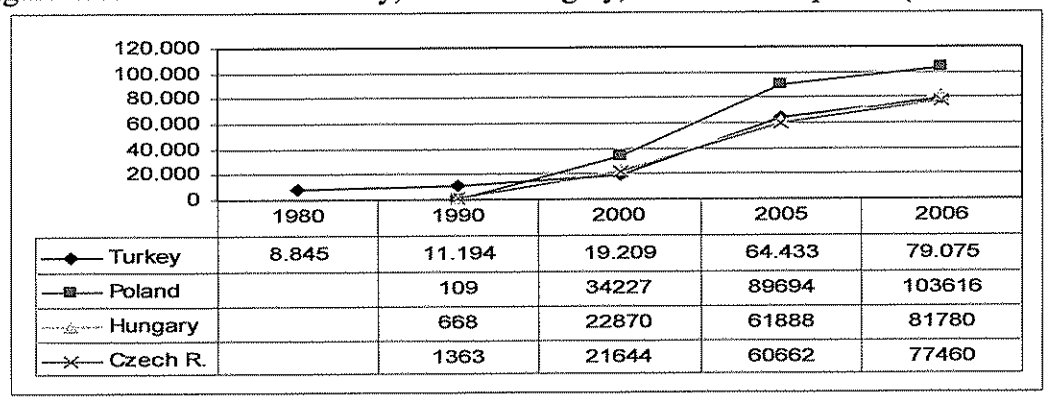


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Turkey	885	722	805	940	783	982	3352	1137	1752	2837	9686	20120
Poland	3659	4498	4908	6365	7270	9343	5714	4131	4870	12355	7724	13922
Hungary	5102	3300	4171	3337	3313	2763	3936	2994	2137	4657	6700	6098
Czech R.	2562	1428	1301	3716	6326	4980	5645	8483	2109	4975	10988	5957

Source: OECD database

Transition economies of Central and Eastern Europe, although entering the competition in the beginning of the1990s, attracted more FDI in comparison to Turkey in that period.

Figure 11: FDI Stocks in Turkey, Poland Hungary, and Czech Republic (US$ million)



	1980	1990	2000	2005	2006
Turkey	8.845	11.194	19.209	64.433	79.075
Poland		109	34227	89694	103616
Hungary		668	22870	61888	81780
Czech R.		1363	21644	60662	77460

Source: OECD database

Even Turkey has started to attract FDI earlier, its competitors performed better in that period. Poland, Hungary and Czech Republic attracted more FDI than Turkey. EU membership is very important factor in that performance. As it is mentioned above, the EU membership brings member countries access to big EU market, increased growth prospects and access to structural funds. But more importantly their EU membership boosts confidence by removing uncertainty in political and economic stability. This can be seen in the FDI performance of CEEC.

Summary and Concluding Remarks

In this chapter, firstly, an overview of the concept of foreign direct investment (FDI) has been presented: what it means and encompasses. Secondly, the pattern in global FDI inflows is presented. Then the distribution of FDI inflows in DCs and emerging markets is discussed. The causes of the upward trend in FDI inflow for Turkey are summarized. Finally, a comparison between Turkey and its competitors is given to provide a background for the empirical analysis.

As it is mentioned before, FDI is a vital source for many emerging countries to obtain international capital and advanced technology. Emerging markets including Turkey attracted an important amount of FDI after 1990s especially after 1995. In order to test the empirical relation between FDI inflows and innovation in emerging countries; the FDI data in Turkey, Poland Hungary, and Czech Republic will be used.

Before presenting the empirical application to those emerging countries, the literature on the spillovers effects of FDI on R&D and innovation will be reviewed in the next chapter.

CHAPTER III

3. LITERATURE RIVIEW

In this chapter, the literature on the spillovers effects of FDI on innovation and research and development (R&D) have been reviewed. Firstly, the concept of R&D spillovers has been defined. As it is given in the literature the impact of FDI inflow on R&D and innovation is discussed. Then, empirical studies of FDI spillovers on R&D and technology from developed countries, emerging markets, and Turkey are presented.

3.1 The Effects of FDI on Technology and R&D

R&D is regarded as a major source of technological change and as one of the main determinants of economic growth. Because firms accumulate technological capability by investing in R&D, it has become broadly acknowledged as a critical input in the strengthening of firms' competitive advantage. Therefore, firms can bring up their level of efficiency and reduce their costs by designing products that are easy to manufacture, or by introducing innovations that can provide additional benefits within the production process. Hence many manufacturing firms, mostly in the advanced countries, are investing considerable amounts of capital into R&D in order to maintain or enhance their level of competitiveness.

Research and development is defined by OECD as follows; "R&D comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. R&D is a term covering three activities: basic research, applied research, and experimental development. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is

systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed".

Technology has been regarded as a major driving force of economic integration and output growth in the global economy. Factor accumulation has been focused on as the source of output expansion by neoclassical economic theory. Technological progress was often handled as exogenous. Recent studies have supplied a new way of dealing with technological change in accounting for economic growth. The nonrival characteristics of technology separate it from other factor inputs in which the marginal costs of technology incurred to additional firms are negligible. Technological investments not only benefit the investors, but they also contribute to the knowledge base that is publicly available to them. These externalities are called "technology spillovers" (Romer, 1990). The endogenous growth model indicates that innovation relies on knowledge resulting from cumulative R&D experience; meanwhile it also contributes to the growth of knowledge stock. R&D activities operate economic growth through the creation of new products (Grossman and Helpman, 1991).

The significance of domestic R&D spillovers has been tested by a large amount of empirical research. With the rapid pace of economic integration in recent years, an increase in productivity in a country not only depends on domestic R&D, but also on foreign R&D through the interaction with foreign economies. Keller (2004) remarks that the main source of productivity growth, which upraised from technological change in OECD countries, are not domestic; instead, they come from abroad. Klenow and Rodríguez-Clare (2004) build growth models which compound international knowledge externalities. Their study concludes that international productivity variations are explained mostly by the differences in R&D investment rates across countries, and countries benefit from international knowledge

spillovers. International R&D spillovers facilitate domestic inventive activities and therefore promote economic growth.

The emerging theories of economic growth in the beginning of 1990's have reemphasized two major points: "(I) technical change is the result of conscious economic investments and explicit decisions by many different economic units, and (II) unless there are significant externalities, spillovers, or other sources of social increasing returns, it is unlikely that economic growth can proceed at a constant, undiminished rate into the future" (Griliches, 1992). For both points, R&D spillovers have great importance; they are considered as a major source of technological opportunities for economic units pursued in innovative activities and as a vehicle allowing the economic system to escape the fate of diminishing returns. Actually, in order to seek some rents, firms invest in R&D. Then public aspects of this R&D spill over to other firms, thereby creating increasing returns relating to scale and long-term growth. R& D spillovers come about because of the inability of firms (or other economic units) to seize all the gains of their innovations. There can be some property problems, unless intellectual property rights or other mechanisms enable economic units to appropriate a sizable proportion of the benefits of their innovations (Harabi, 1997).

International technology spillovers have long been a topic of interest for economists. Grossman and Helpman (1991) identified investment in research and development (R&D) and international R&D spillovers as sources of growth in an open economy setting. In the economic literature R&D plays an important role in at least two different ways. First way, in the theory of industrial organization and also in the theory of international trade, R&D is regarded as a strategic variable by which firms capture, or at the least preserve, market shares, and governments give their domestic firms a competitive edge in international trade, either through cost reductions or through product differentiation. Second way, in growth theory and

in the management literature R&D is thought as an investment in knowledge or in absorptive capacity and hence indirectly as a contributor to economic growth (Mohnen, 1996).

R&D plays a central role in the new theory of economic growth, called endogenous growth theory, which is based on the idea that growth can be explained by R&D efforts leading to new products and new knowledge (Grossman and Helpman, 1991). R&D has two properties that differentiate it from ordinary investment in machines, namely the fact that the knowledge derived from R&D is non-rival and partly non-excludable, which conveys that knowledge can be used simultaneously by two different persons without losing any of its content, and that it cannot always be prevented from being used by others. Therefore the innovator cannot seize all the gains from his new ideas. Part of it goes to others. R&D has two effects in practice. First, it can conduct to new commodities, which provide to innovators to benefit temporary monopoly profits, and it can lead to new knowledge, which can facilitate subsequent innovations. Due to the impossibility of perfect price discrimination, a part of the monopoly rents get transferred to other producers or the consumers. For instance, we all seem to derive a benefit from using computers which is greater than the price that we paid for acquiring them (Mohnen, 1996).

Griliches (1992) determines two main types of R&D spillovers, which are often confused in the literature: rent spillovers and knowledge (pure) spillovers. International rent spillovers picture the fact that the prices of imported intermediate input and capital goods do not represent completely the product innovation or the quality improvement that result from innovation activities. Therefore, the analysis of productivity growth should take into account the indirect benefits that come up from the technological improvement of goods and services produced by trade partners. Rent spillovers take place when qualities of improvements by a supplier are not fully translated into higher prices for the buyers. Productivity gains are

recorded in a different firm or industry than one that generated the productivity gains in the first instance. Rent spillovers emerge in input-output relations.

Pure knowledge spillovers cite to the impact of discovered ideas or compounds on the productivity of the research endeavors of others. Pure knowledge spillovers are benefits of innovative activities of one firm that fall to another following market transaction. R&D enhances the productivity in another sector. Knowledge spillovers can arise in many different ways (Cooper, 2001). Knowledge spillovers arise because of the imperfect appropriability of the knowledge associated with innovations. Some of the reasons of the distribution of R&D are poor patent protection, the inability to keep innovations secret and reverse engineering practices. International knowledge spillovers or the diffusion of knowledge across countries take place when the knowledge generated by a country contributes to the innovation process of other countries. They fall out when ideas (or knowledge) are 'borrowed' by a research team of country j from a research team of country i. As opposed to rent spillovers, knowledge spillovers are not necessarily synonymous to economic transactions or measurement errors. It is generally characterized by the international transfer of technology which may occur by different channels: foreign direct investments, foreign technology payments, international R&D collaboration, publications in technical and scientific papers, and the migration of scientists and skilled labor forces (Cincera, 1997).

3.1.1 R&D and Innovation

The accumulation of knowledge is one of the key determinants for the economic growth of a country. This stock of knowledge or technology can be increased by deliberate investment in R&D capital or by the diffusion of existing technology. Innovations generated by R&D activities and technology spillovers from the stock of knowledge are both important in enhancing firms' productivity as well as being closely related to each other (Kinoshita, 2001).

Kinoshita (2001) propose that R&D not only stimulates innovation but also develops the firm's ability to identify, assimilate, and exploit outside knowledge. This second role of R&D is considered to be very important particularly for assessing the extent of technology spillovers from others. Technology is not an automatic consequence from the presence of others' knowledge stock. It also requires that the recipient possesses the ability to absorb and adopt the technology and that R&D activities will help increase the incidence of technology spillovers by enhancing the firm's absorptive capacity.

Innovation plays a key role in the growth of a modern, knowledge-based economy providing prosperity for all. Although the relationship between R&D and innovation is complex and non-linear, it is clear that substantial advances in technology cannot occur without work undertaken by on a systematic basis. It is important to recognize that innovation can occur at any point in the R&D process. Because companies are ultimately engaged in seeking to develop products for sale, there can be a tendency to look at R&D through the lens of the product development process.

Innovation effort is considered a major engine of technological progress and productivity growth. The R&D process is essentially a knowledge generation process in which one utilizes resources (scientists, engineers, technicians, research equipment, and so on) to create new knowledge. Innovation feeds on knowledge that results from cumulative R&D experience and contributes to this stock of knowledge. The innovative activities of firms not only lead to new products (whose benefits the firm can appropriate), but also contribute to a general stock of knowledge upon which subsequent innovators can be built. So the benefit of innovation accrues not only to the innovators, but spillover to other firms by raising the level of knowledge upon which new innovations can be based. This is referred to as knowledge spillover (JI, 2006).

Some studies have measured the extent to which growth in total factor productivity in a country depends not only on the domestic R&D capital stocks but also on the foreign R&D capital stocks. In a world with international trade in goods and services, foreign direct investment, and an international exchange of information and dissemination of knowledge, a country's productivity depends on its own R&D as well as on the R&D effects of its transaction partners. As important channels for knowledge spillover, trade and inward FDI boost domestic productivity by making products available with the use of foreign knowledge and information that would otherwise be costly to acquire.

3.2 FDI spillovers on R&D and Innovation

There are many ways that host countries and local firms can develop new technology besides its own investment into R&D capital. Foreign Direct Investment (FDI) is potentially the most important international vehicle of technology transfer for firms. This source of productivity growth is important for emerging economies because of the urgent need to restructure rapidly (Blanchard, 1997). FDI may also be the cheapest means of technology transfer, as the recipient firm does not have to finance the acquisition of new technology, and it tends to transfer newer technology more quickly than licensing agreements and international trade (Mansfield and Romeo, 1980).

The term spillover refers to the indirect effects generated by the presence of foreign firms both in the industrial structure of the host country and in the direct and performance of local firms. FDI is also a critical source for many countries to obtain international capital and advanced technology. FDI is an important avenue for technology diffusion through several channels like: demonstration and imitation, competition, linkages, training and market access. Absorptive capacity, policy, and technology gap might be important in determining the effect of diffusion (Mayanja, 2003).

FDI has also important contributions to innovative capability of domestic firms. There are several important channels through which inward FDI can benefit innovation activity of domestic firms in the host country. First, local enterprises can learn about the products and technologies brought in by foreign investors, reverse engineering is an example for this channel. Second, spillovers can fall out trough labor turnovers whereby local firms receive the technological know-how of foreign firms. Third, inward FDI has a demonstration effect on local R&D activity. Foreign products/technologies can encourage and stimulate local innovators to develop new products and processes. This shortens the trial-error process of local firms in their search for inventions. Besides, thanks to the products and technologies that FDI firms introduce have already been tested in foreign markets, the perceived risk of local firms is lowered. Finally, spillovers may take place vertically from foreign firms to their local suppliers by means of technological know-how transfer, staff training (Cheung and Lin 2004).

The simplest example of a spillover is the case that local firms improve their productivity by copying some technology of foreign firms. Another kind of spillover occurs if the entry of s foreign firm leads to more severe competition in the host economy; a third type of spillover effect grants if the competition forces local firms to search new, more efficient technologies (Blomström and Kokko 1997).

Technologies spillovers from FDI incline to occur more frequently if the social capabilities of the host country and the absorptive capacity of the firms in the economy are high. In this case, there may be a tendency for newer vintages of technology to be installed in more advanced countries and thus for FDI to have a larger effect on productivity in such countries. Therefore, R&D can be regarded as having two complementary effects on firm's productivity growth (Cohen and Levinthal 1989). First, R&D directly expands firm's technology level by innovation, which is called innovation effect. Besides, it increases firm's

absorptive capacity-ability to identify assimilate and exploit outside knowledge which is called learning or absorption capacity effect.

Foreign Direct Investments are carried trough by MNCs primarily. MNCs have apparent advantages compared to domestic firms, and own of the most robust parts in the world economy. The gain of technology transfer trough inward FDI for the host country is two-fold. First, the MNCs may bring in new technology in the host country. Second, through the MNCs technology, it may be more accessible to domestically owned firms as diffusion costs related with geographic distance decline (Braconier et al 2001).

The contribution of FDI is evident in theory. Emerging countries attract FDI, and then bring technology spillover effects through demonstration, imitation, reverse engineering, individual contact, diffusion of management skills. However, the spillover effects cannot emerge automatically. FDI may also bring negative spillover effects. Because of the stickiness of information, most technology and knowledge are tacit knowledge (von Hipple, 1994). Besides negative effects are also possible due to competition (Aitiken and Harrison, 1999).The process and the extent to which spillovers happen were determined by both the owner of the advanced technology (MNCs) and the host countries or local enterprises (Narula and Marin, 2003). The introduction of more advanced technology and the requirement of absorptive capability are critical factors of spillovers (Borensztein, 1998).

Whether FDI can bring positive spillover effects and stimulate technology progress is controversial. Some researchers indicated that FDI was important to make economic development and technology progress. However, some researchers indicated that the spillover effects of FDI were anemic, and positive effect of FDI should have some definite conditions. For many countries, there were no significant relationship between FDI and higher productivity growth in domestic firms except for those countries having high-level human capital. (Borensztein, 1998)

However, the effect of FDI spillovers across countries depends on a number of factors; firm-related as well as market-related. The most important firm-related factor is mode of entry into the foreign market. In the form of mergers or acquisition, the potential spillovers may be relatively small as new technology will be introduced in the host country only gradually. On the other hand, if FDI grants through Greenfield investment, new technology will be introduced instantly, therefore, the potential for R&D spillovers is likely to be larger (Blonigen and Slaughter 1999).

3.3 Empirical Evidence on FDI spillovers

There is considerable empirical evidence concerning positive spillovers arising from FDI. In this part, a rather extensive literature is surveyed for FDI spillovers; earliest discussions of spillovers in the literature on FDI date back to the early 1960s. The first author to systematically include spillovers (or external effects) among the possible consequences of FDI was MacDougall (1960), who analyzed the general welfare effects of FDI. Other early contributions were provided by Corden (1967), who looked at the effects of FDI on optimum tariff policy, and Caves (1974), who examined the industrial pattern and welfare effect of FDI (Blomstörn and Kokko 1997). Caves examined the benefit of FDI in the manufacturing sectors of two leading host countries at the time; Canada and Australia. He found insignificant diminishing gains from FDI in Canada and evidence for spillovers in the Australian manufacturing sector.

Globerman (1979) examined the relation between FDI and labor productivity and found labor productivity in Canadian manufacturing plant having positive correlations with foreign ownership. Besides, some others benefits emerge with the migration of workers trained by foreign firms.

Blomström and Kokko (1998) provide an extensive review of the channels of spillovers. They explain FDI related spillovers as "vary systematically between countries and

industries. In particular the positive effects of foreign investment are likely to increase with the level of local capability and competition". In the review of the literature on MNCs and spillovers, they conclude that the evidence on the extent and magnitude of spillovers is inconclusive. The extent of spillovers is probable to rely on local capability and competition. Besides FDI remove the doubts on new technologies untested be local firms therefore accelerate the adoption of new technologies. They also argue that FDI may increase technology transfer and diffusion, by breaking supply bottlenecks, demonstrating new technologies, training new workers, breakdown monopolies and stimulate competition. Their primary conclusion is that spillovers depend mainly on the characteristics of sectors and countries. They find that the positive effects of foreign investment are likely to increase with the level of local capability and competition.

Lui et al (2000) examined intra-industry spillovers in UK in the period 1991-1995. They observe spillovers whose gains depend on the technology gap measured as the ratio of labor productivity in foreign owned firms to local firms. According to their study if the gap is smaller the spillover effect is higher, and absorptive capacity is a key determinant of extent of spillovers. On the other hand, Girma and Greenaway (2001) find no evidence of intra intra-industry spillovers in UK firms for the period 1991-1996. According to their study, firms with low skill and competition benefit less from foreign firms. However, they found that a productivity gap existed between foreign and local firms. In addition to those studies in UK, Mayanja examined the different sources of international technology transfer to UK industries in a panel running from 1979-1991. FDI is found to be more important than trade in the transfer of knowledge to UK industries (Mayanja, 2003).

Barrios (2000) analyzed the spillovers related to foreign FDI using an establishment-level panel of Spanish manufacturing industry that spans the period 1990-1994. They used R&D expenditure data to represent the technological ability of local firms. Their results fail to

identify positive spillovers. Braconier (2001) et al analyzed empirically whether inward and outward FDI works as channels for international R&D spillovers. They used firm-level and industry-level data for Swedish manufacturing. They find no evidence between FDI and R&D spillovers neither at firm-level nor at industry-level in the Swedish manufacturing.

Hejazi and Safarian (1999) measure international spillovers through trade and FDI outflow, as diffusion channels linking total factor productivity, from six of the G-7 countries to all OECD countries and Israel. They find that the R&D spillovers through FDI are greater than those through trade. The importance of trade as a spillover channel is reduced and the overall spillovers increase significantly with the inclusion of FDI. Damijan et al (2001) study the importance of both direct and indirect means of technology transfer for transition countries and its impact on productivity growth of local firms. They used firm-level data for eight transition countries for the period 1994-1998 and employed accounting approach. Their results explore the importance of FDI, intra-industry knowledge spillovers from FDI, firm's own R&D accumulation and of international R&D spillovers trough trade for firm's TFP growth. They found FDI as the most important vehicle of technology transfer to out of eight transition economies.

Keller and Yeaple (2003) find FDI stronger than imports in improving productivity of US manufacturing firms. FDI accounts for 14% of productivity growth. This study is one of rare study using firm level data with significant spillovers. Branstetter (2006) used patent citations data, firm-level panel data set on Japanese firms, to measure the importance of foreign direct investment transferring flows of knowledge spillovers across national borders. The results of the study indicated that there is evidence that FDI is a channel of knowledge spillovers, both from investing firms to indigenous firms and from indigenous firms to investing firms. Besides, it is found that the direction and degree of spillover flow is related to the characteristics of firms.

3.3.1 Empirical Evidence from Developing Countries

For many developing countries, there was no significant relationship between FDI and higher productivity growth in domestic firms, except for those countries having high-level human capital (Borensztein et al., 1998).

As China's Economic growth has been remarkable since the reform started in 1978, the empirical literature on FDI in China is growing rapidly. Most studies conclude FDI has played a positive role in promoting trade, economic growth. Recently some studies investigate whether FDI generates technology spillover from foreign-investment firms to local ones.

There are empirical studies of FDI spillover effects on innovation in China; one of those studies is done by Hu and Jefferson (2001). They used data for large- and medium sized firms to test the spillover effects of FDI in manufacturing industries in China. They concluded that inward FDI has a positive effect on introduction of new product in china. The other study figured out by Cheung and Lin (2003) is complementary to previous one in that they analyze the provincial data and stress on the geographical aspect of FDI spillovers. Cheung and Lin used provincial data from 1995 to 2000, and they find positive effects of FDI on the number of domestic patent applications in China, they also find that science and technical personnel and expenditure are the most major determinants of innovation output. Both studies indicated that inward FDI to China has promoted R&D activity by Chinese firms through different spillover channels.

Chen (2007) examined the relationship between FDI and regional innovation capability (RIC) China. The results of that study indicated that the impact of FDI on RIC is weak; the entry of FDI has no use for enhancing indigenous innovation capability. Beside, inward FDI might have the crowding-out effect on innovation and domestic R&D activity. The research also figures out that increasing domestic R&D inputs, strengthening the

innovation capabilities and absorptive capacity in domestic enterprises are determinant to improve RIC.

Liu and Wang (2002) examined the relation between FDI and TFP for Chinese industrial sectors, and they positive results. Their results indicated that attracting FDI is a significant way of capturing advanced technologies.

JI (2006) tested the spillover effect through import and FDI from the developed countries to China. They found generally significant and positive effect of foreign R&D stocks through trade and FDI by using provincial data for the periods of 1990 to 2002. So that study empirically supports that both FDI and import generates externalities in the form of technology transfer. I addition, FDI has larger effect than trade. Furthermore, macroeconomic data is used in the study due to absence of industrial data.

Haddad and Harrison (1993) tested the spillover hypothesis for Moroccan manufacturing during the period 1985-1989. They conclude that spillovers do not take place in all industrial sectors. They find no significant effects of foreign presence on the rate of productivity growth of local firms. Aitken and Harrison (1999) examined the impact of foreign presence on total factor productivity growth by using plant-level data for Venezuelan manufacturing between 1976 and 1989. They found that domestic firms exhibited higher productivity in sectors with a larger foreign share.

3.3.2 Empirical Evidence from Turkey

There are not many studies about the spillover effect of FD in Turkey. The studies about FDI in Turkey are generally analyzing the determinant of FDI and the effect of FDI on economic development. Therefore studies about FDI spillovers on technology or innovation are rare. Lenger and Taymaz (2004) study innovation and technology transfer activities of domestic and foreign firms in Turkish manufacturing industries, and the impact of horizontal, vertical and labor spillovers on these activities. Their analyzes indicate that foreign firms are

more innovative in than their domestic counterparts, transfer technology from abroad, and are likely to establish more co-operative relations for their R&D activities. According to their research, horizontal spillovers from foreign firms seem to be insignificant, and the effects of foreign firms on technological activities of other firms in vertically related industries are ambiguous. Besides, they find that labor turnover is the main channel of spillovers. Finally, they point out that their findings restate the importance of tacitness of knowledge, and confirm that technology can not easily be transferred through passive mechanism such as demonstration effects or imitation.

Another study of Lenger and Taymaz (2006) examines the role of multinational companies as the creator and diffuser of new and superior technologies. Their study addresses the question of productivity spillovers from the activity of MNCs, whether size of recipient firms and the R&D intensity matter in this respect and do spillovers change by time. They used a longitudinal data for the Turkish manufacturing industry over the 1983-2000 periods. Their results suggest that the spillovers from MNCs for the domestic sector of the Turkish manufacturing industry differentiate with respect to size of the recipient domestic firms and by time. They conclude that the evidence tends to speak in favor negative spillovers in the Turkish manufacturing industry.

3.4 Trade Spillovers

The recent theoretical models in growth theory and international trade argue that devoting more resources to the R&D sector and increased economic integration, such as free flows of goods and services, tends to increase technological knowledge, and this in turn will close the productivity gap. Trade in goods may transmit technology in both direct and indirect ways. Firms may directly learn about new technologies and imitate them; indirectly they may employ new intermediate goods, which are embodied in more advanced technologies in the production of final goods (Unel, 2006).

The study of international R&D spillovers through trade started with a seminal work by Coe and Helpman (1995) examined the R&D spillovers among OECD countries through international trade. They study the effects of the domestic R&D as well as the R&D stocks of a country's trade partners on domestic total factor productivity (TFP), by using cumulative R&D expenditures as a proxy for stock of knowledge. Their results indicate that both domestic and foreign R&D capital stocks have positive and statistically significant effects on a country's TFP, and that the greater the effects of foreign R&D stocks, the more open the economy is. Besides, domestic R&D may be more important in larger countries than in smaller countries.

Their study inspired a number of studies on international R&D spillovers. Coe et al. (1997) extend their sample and estimate the R&D spillovers from industrialized countries to 77 developing countries. Their result indicates that a 1% increase in the foreign R&D stocks of industrialized countries raises output of the developing countries by 0, 06%.

Xu and Wang (1999) decompose total imports into capital goods imports and noncapital goods imports and find that R&D spillovers embodied in trade flows are mainly carried by capital goods. They also suggest that the majority of the R&D spillovers in the OECD countries are transmitted through other unknown channels. Lumenga-Neso et al. (2001) construct an alternative variable to capture the effect of the previous rounds of imports and confirm that the trade contributes to the technology spillover. (Lei and Bang, 2007)

The above studies mainly consider international trade to be the sole channel of R&D spillovers across countries. They are likely to have underestimated the relative magnitude of international spillover effects that pass through other channels. Besides, these works have concentrated on the R&D spillovers using country-level aggregate data. Keller (2000) considers R&D spillovers at the industry level with his main focus on spillovers from the same industries in other countries. The results of that study demonstrate that the most

important contribution comes from own R&D, followed by R&D in other domestic industries and R&D in foreign industries. It implies that the R&D spillovers might occur through channels other than international trade.

Summary and Concluding Remarks

In this chapter, the literature on the spillovers effects of FDI on innovation and R&D have been reviewed. Firstly, the concept of R&D spillovers has been defined. Then, the relation between R&D and innovation is reviewed. Secondly, studies on the FDI spillovers have been analyzed. Finally, empirical results concerning FDI spillovers on R&D and technology from developed countries, emerging markets, and Turkey have been given.

Based on the literature review, the literature of FDI spillovers on technology and innovation can be can be summarized briefly as follows. Most of the studies find that there are positive effects from FDI flow to host country firms in developed economies. But the result of the case of FDI flow to developing economies is mixed. In particular, a number of studies for developing countries document that a foreign investment presents higher in host country sectors while other studies point out to limited or no significant efficiency spillovers. Koko (1992) identifies that there are at least four ways that technology might be transferred from foreign enterprise: (1) demonstration-imitation effect, (2) competition effect, (3) foreign linkage effect, and (4) training effect. However spillovers are not always positive, FDI might generate negative externalities when foreign firms with superior technology force domestic firms to exit. There are some studies founding evidence on externalities such as competition effect, crowding out effect or business stealing effect from foreign firm to domestic firms. On the other hand, empirical evidence display that FDI can contribute to overall domestic productivity growth only when technology gap between domestic firms is not high and there is a need of sufficient absorptive capacity in domestic firms (Damijan et al., 2001).Although it is widely regarded that FDI should play a substantial role in the international technology

diffusion, it has rarely been examined econometrically as a specific channel of technology transfer in a multi country framework.

However, the exact nature of the relation between foreign firms and their host economies seems to vary between industries and countries. It is reasonable to assume that the characteristic of the host country's industry and the policy environment are important determinants of the gains of FDI (Kokko, 1998).

Based on the literature review, it can be sited that; FDI is potentially the most important international vehicle of technology transfer for firms. This source of productivity growth is important for emerging economies because of the urgent need to restructure rapidly. For that reason FDI is a critical source for many countries to obtain international capital and advanced technology. Besides FDI have important contributions to innovative capability of domestic firms. There are several important channels through which inward FDI can benefit innovation activity of domestic firms in the host country. First, local enterprises can learn about the products and technologies brought in by foreign investors, reverse engineering is an example for this channel. Second, spillovers can fall out trough labor turnovers whereby local firms receive the technological know-how of foreign firms. Third, inward FDI has a demonstration effect on local R&D activity.

Besides, as it is figured out in chapter two, there are considerable FDI inflows to emerging markets after 1990s especially after 1995. Therefore in that study, the main aim is to test the relation between FDI and innovation concerning as output of R&D after 1995 in Turkey and comparative emerging economies.

CHAPTER IV

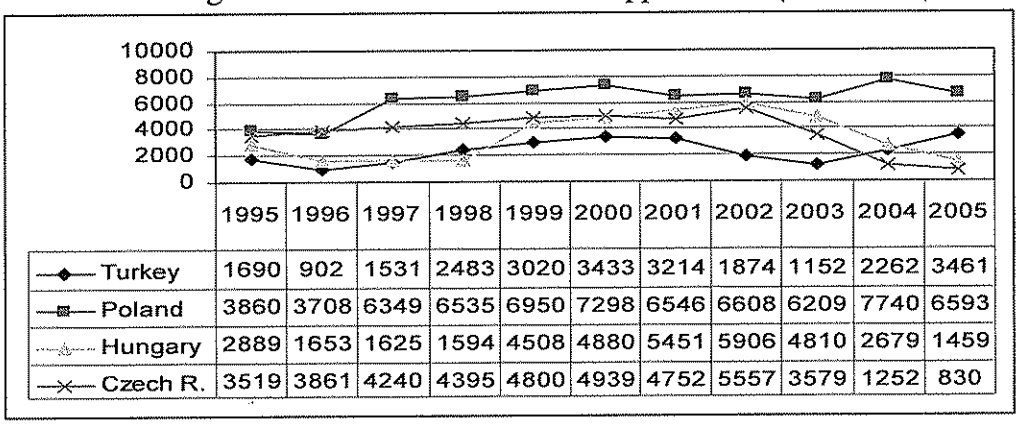
4. METHODOLOGY AND DATA

4.1 The Data

The data used in the model have been retrieved from different sources for each variable. The data on patent applications as the dependent variable are found from national statistics and World Intellectual Property Organization (WIPO) database. The data cover four countries, Turkey, Hungary, Poland and Czech Republic for the period between from 1995 to 2005.

Patent applications data of Turkey is taken from Turkish Patent Institute. The patent application data of Hungary is taken from Hungarian Patent Office. The patent application data of Poland and Czech Republic is taken from WIPO database.

Figure 12: the Number of Patent Applications (1995-2005)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Turkey	1690	902	1531	2483	3020	3433	3214	1874	1152	2262	3461
Poland	3860	3708	6349	6535	6950	7298	6546	6608	6209	7740	6593
Hungary	2889	1653	1625	1594	4508	4880	5451	5906	4810	2679	1459
Czech R.	3519	3861	4240	4395	4800	4939	4752	5557	3579	1252	830

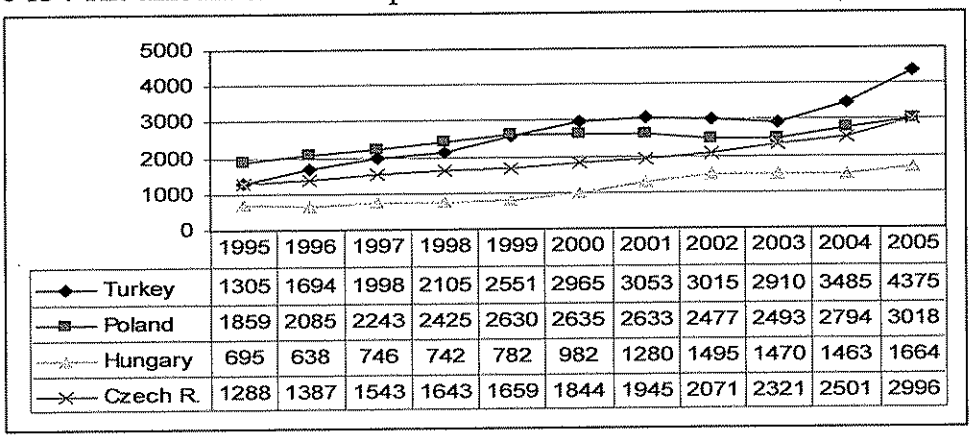
Source: National statistics, WIPO database

There is an increasing trend in the number of total patent applications up to beginning of 2000s. Then the number of patent applications started to decrease. While the number of patent applications started to increase in Turkey and Poland again after 2003, the decrease in patent applications in Hungary and Czech Republic proceed to decrease.

FDI statistics is obtained from OECD database. The data of FDI inflows have been indicated in chapter two. As measures of input to R&D activity, the number of R&D personnel and R&D expenditure data are taken from OECD main science and technology

indicators (MSTI). The data covers the period between 1995 and 2005. The below figures indicate the data of R&D expenditure and R&D personnel respectively.

Figure 13 : The amount of R&D Expenditure between 1995 and 2005 (US$ Millions)

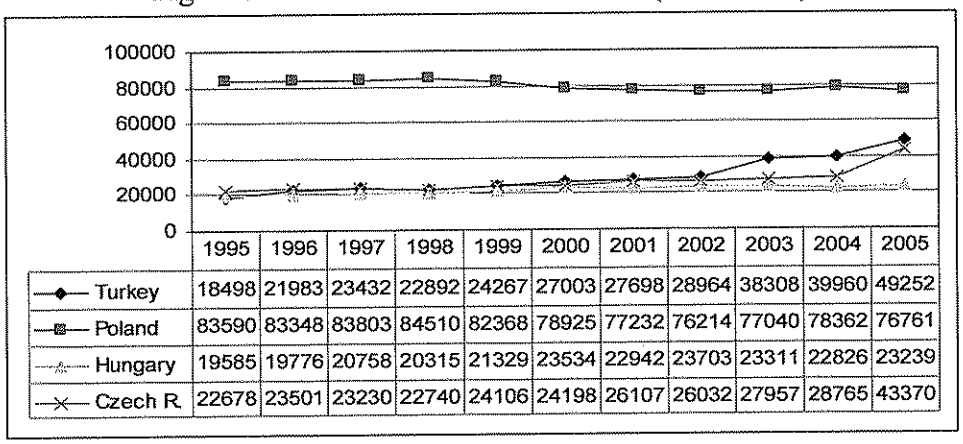


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Turkey	1305	1694	1998	2105	2551	2965	3053	3015	2910	3485	4375
Poland	1859	2085	2243	2425	2630	2635	2633	2477	2493	2794	3018
Hungary	695	638	746	742	782	982	1280	1495	1470	1463	1664
Czech R.	1288	1387	1543	1643	1659	1844	1945	2071	2321	2501	2996

Source: OECD MSTI database

The amount of R&D expenditures has increased after 1995 in Turkey, Poland, Hungary and Czech Republic. However in Turkey there is a remarkable increase after 2003 and Turkey became the leading country in the R&D expenditure in these countries in 2005.

Figure 14: Number of R&D Personnel (1995-2005)



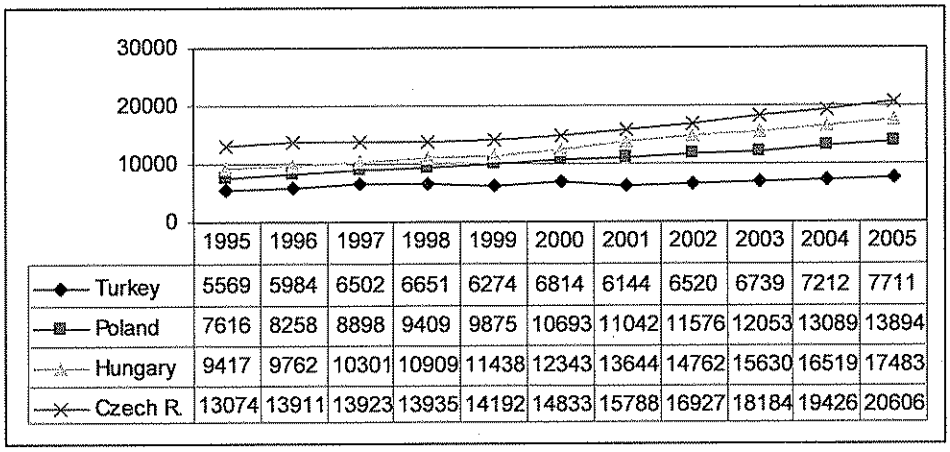
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Turkey	18498	21983	23432	22892	24267	27003	27698	28964	38308	39960	49252
Poland	83590	83348	83803	84510	82368	78925	77232	76214	77040	78362	76761
Hungary	19585	19776	20758	20315	21329	23534	22942	23703	23311	22826	23239
Czech R.	22678	23501	23230	22740	24106	24198	26107	26032	27957	28765	43370

Source: OECD MSTI database

There was not significant change in the number of R&D personnel number in those countries until the beginning of 2000s. However after 2000s the number of R&D personnel has increased in Turkey, Hungary and Czech Republic, while the number of R&D personnel has decreased in Poland after 2000.

The GDP per capita correspond to welfare and development level in a country. Since the developed countries have more fund ad infrastructure to invest in R&D, they direct the R&D activities and have high innovation capability. In order to test the relationship between innovation capability and the level of development in a country, GDP per capita is included as another explanatory variable in the model. The data covers the period between 1995 and 2005, and is taken from OECD database

Figure 15: GNP per Capita between 1995 and 2005 (US$)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Turkey	5569	5984	6502	6651	6274	6814	6144	6520	6739	7212	7711
Poland	7616	8258	8898	9409	9875	10693	11042	11576	12053	13089	13894
Hungary	9417	9762	10301	10909	11438	12343	13644	14762	15630	16519	17483
Czech R.	13074	13911	13923	13935	14192	14833	15788	16927	18184	19426	20606

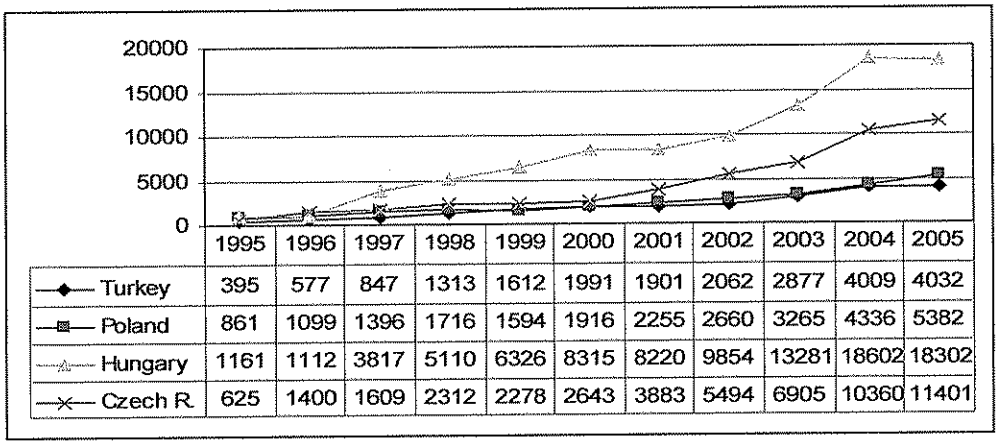
Source: OECD database

The GDP per capita of countries rose increasingly after 1995. after the membership of EU the level of GDP per capita of Poland, Hungary and Czech Republic has increased remarkable. For example the GDP per capita of Czech Republic has increased from $13000 in 1995 to more than $20000 in 2005. The GDP per capita of Turkey has also increased significantly in the last years.

Trade in goods may transfer technology in both direct and indirect ways. Firms may directly learn about new technologies and imitate them or they benefit indirectly by employing new intermediate goods, which are embodied in more advanced technologies in the production of final goods. Therefore, export and import of R&D intensive sectors should contribute in a positive way in the model. The data of export and import of countries in R&D intensive sectors are included into model in order to evaluate the effect of trade on innovation

and R&D activity. R&D intensive sectors are classified as aerospace, electronic, office machinery and computer, pharmaceutical and instruments sectors. The data of export and import in R&D intensive sectors variables are taken from OECD, MSTI (2007) database. The data cover the period between 1995 and 2005. Figure a and figure b presents the amount of export and import amount in Turkey, Poland, Hungary and Czech Republic between 1995 and 2005.

Figure 16: Export Amount of R&D Intensive Sectors between 1995 and 205 (US$ Millions)

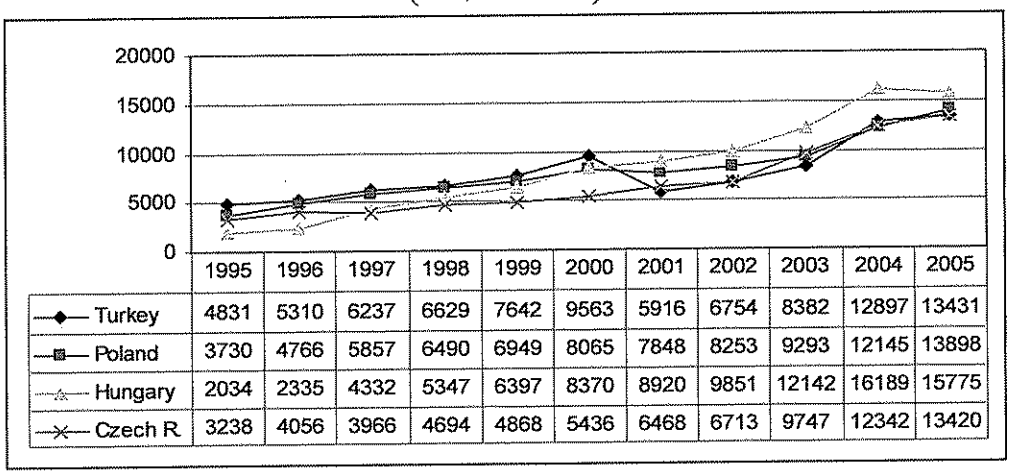


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Turkey	395	577	847	1313	1612	1991	1901	2062	2877	4009	4032
Poland	861	1099	1396	1716	1594	1916	2255	2660	3265	4336	5382
Hungary	1161	1112	3817	5110	6326	8315	8220	9854	13281	18602	18302
Czech R.	625	1400	1609	2312	2278	2643	3883	5494	6905	10360	11401

Source: OECD MSTI database

The amount of exports in R&D intensive sectors has increased in all countries. However there is an significant increase in the amount of export of R&D intensive sectors in Hungary and Czech Republic. The amount of export in R&D sectors of Hungary and Czech Republic rose respectively, from $1 billion in 1995 to more $18 billions in 2005, from $625 millions to more than $11 billions in 2005. it can be said that EU membership has also contributed to increase the level of export in these countries.

Figure 17: Import Amount of R&D Intensive Sectors between 1995 and 2005 (US$ Millions)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Turkey	4831	5310	6237	6629	7642	9563	5916	6754	8382	12897	13431
Poland	3730	4766	5857	6490	6949	8065	7848	8253	9293	12145	13898
Hungary	2034	2335	4332	5347	6397	8370	8920	9851	12142	16189	15775
Czech R	3238	4056	3966	4694	4868	5436	6468	6713	9747	12342	13420

Source: OECD MSTI database

Like the amount of export of R&D intensive sectors, the mount of import in R&D intensive sectors rose. There are similar patterns in the import amount in R&D intensive sectors of those countries. The amounts of import increased more than the amount of export in R&D intensive sectors between 1995 and 2005.

4.2 The Model and the Variables

The R&D process is essentially a knowledge generation process in which one utilizes resources to create new knowledge. In general, the R&D production function can be represented by

$$I = f(L, K, I_0), \tag{1}$$

where L and K represents labor and the capital inputs and I represents the R&D output, which are largely embedded in the new products or new processes generated by the R&D process. The component I_0 stands for the initial level of knowledge available at the beginning of the R&D project concerned (Cheung and Lin, 2003).

One of the important channels that contribute to the initial knowledge level is inward FDI. As it is stated in literature review chapter, by bringing in new technologies and products into the host country, inward FDI can promote domestic firms' innovation in several ways. First, local firms can learn about the designs of the new products and technology, through

reverse engineering for example, and then improve upon them to come up with new innovations. The Japanese experiences in the 1960–1970s are a good example of this form of learning. Second, inward FDI can cause spillovers to local firms through labor market turnover whereby skilled workers who once worked for the FDI firms move to local firms. Third, FDI can generate a demonstration effect. The simple presence of foreign products in domestic markets can encourage local firms' creative thinking and thus help generate blueprints for new products and processes. The demonstration effect is related to the usual R&D spillovers in the literature of innovation, whereby information about a firm's on-going R&D activity leaks to its competitors. Such information can benefit the competitors by improving their efficiency in the searching process for innovation. As Cheung and Lin (2003) state that, the FDI spillover effect, on the other hand, can be seen as originating from the FDI firm's finished R&D projects (their products and technologies) and spillovers to local firms. By observing and analyzing the output of the FDI firm's past R&D projects, local firms become more effective in conducting their own innovation activity (Cheung and Lin, 2003).

To analyze the spillover effect of FDI on innovation capability, equation (1) can be rewritten as,

$$I = f(L, K, FDI) \quad (2)$$

where subscripts i and t denote country and time period, respectively.

Based on the theoretical approach presented above, the empirical model in this study is derived from the study of Cheng and Lin (2003). The model is adjusted to estimate the spillover effects of FDI and international trade on innovation capability in Turkey and as well as comparative emerging markets, Poland, Czech Republic and Hungary.

$$PN = \beta_0 + \beta_1 FDI_{it-1} + \beta_2 R\&Dexp_{it} + \beta_3 R\&Dper_{it} + \beta_4 R\&DX_{it} + \beta_5 R\&DM_{it} + \beta_6 PGDP_{it} + \varepsilon_{it} \quad (3)$$

where subscript i denotes countries and t represents time period.

The dependent and independent variables are defined as follows:

PN : The number of patent applications

FDI-1 : The FDI inflow lagged one year

R&Dexp : The amount of research and development expenditure

R&Dper : The number of research and development personnel

PGDP : Per capita GDP

R&DX : Export amount in R&D intensive sectors

R&DM : Import amount in R&D intensive sectors

The number of patent application, PN, is used as a measure of R&D output which can be defined as innovation capability in a country. FDI is defined as lagged one period to capture the spillover effect of previous year's FDI inflow. The effect of FDI inflows on patent applications is assumed to be positive due to the assumption that inward FDI brings new technologies and products into the host country and promote domestic firms' innovation capability. Spillover effects arise from FDI through channels such as reverse engineering, skilled labor turnovers, demonstration effects, and backward linkages. Whether it can promote technological progress for the host country depends on the sector specific and country specific characteristics, especially technological infrastructure and human capital.

R&D activity in a country depends on the number of personnel employed in R&D intensive sectors and expenditure on R&D. The R&D process is essentially a knowledge generation process where resources like scientists, engineers, technicians, research equipment are employed to create new knowledge. Innovation nourishes knowledge that results from cumulative R&D experience and contributes to this stock of knowledge. Because of this relationship between innovation and R&D activities, the number of personnel employed in R&D activities and the total amount of expenditure on R&D are included as explanatory

variables in the model. The effect of R&D expenditure and R&D personnel number on innovation capability is assumed to be positive.

The GDP per capita (PGDP) represents welfare and development level in a country. Since the developed countries have more fund ad infrastructure to invest in R&D, they lead the R&D activities and have high innovation capability. In order to capture the relationship between innovation capability and the level of development in a country, GDP per capita is included as another explanatory variable in the model.

In addition to variables that are used in Cheng and Lin (2003) study, export and import of R&D intensive sectors are also included as explanatory variables to capture the effect of technological spillovers trough international trade. R&D intensive sectors are classified as aerospace, electronic, office machinery and computer, pharmaceutical and instruments sectors. Trade in goods may transmit technology in both direct and indirect ways. Firms may directly learn about new technologies and imitate them or they benefit indirectly by employing new intermediate goods, which are embodied in more advanced technologies in the production of final goods. For that reason, export and import of R&D intensive sectors should contribute in a positive way in the model.

The effect of FDI on innovation in Turkey and comparative emerging markets is analyzed by testing different econometric models such as Ordinary Least Square (OLS), Fixed Effects Model (FEM) and Random Effects Model (REM). All three models are estimated for two different time periods: (1) the period of 1995-2005, (2) the period 2000-2005. Since the period of 2000-2005 represents a new era in FDI inflows especially for the emerging countries, the sensitivity analysis should also provide an insight for this period empirically.

Ozkan-Gunay (2004) describes panel data procedures as the simultaneous investigation of a system of equations that consider both country specific characteristics and

change over the time. Fixed Effect Model (FEM) assumes that the effects of the numerous omitted individual time varying variables are individually unimportant but are collectively significant where ε_{it} is a classical disturbance with $E(\varepsilon_{it}) = 0$ and $Var(\varepsilon_{it}) = \sigma_E^2$ (Greene , 1998).

$Y_{it} = \alpha_i + \beta / X_{it} + \varepsilon_{it}$

The individual effects can be absorbed into the intercept term of a regression model as a means to explicitly allow for individual or time heterogeneity in the temporal cross-sectional data. Thus α is a separate constant term for each unit that varies both cross-sectionally across countries and over time. The problem of multicollinearity is avoided by imposing the following restriction.

$\sum_i \alpha_i = \sum_i \gamma_t = 0$

In the Random Effect Model (REM), neither the number of time periods observed for each group nor the number of individuals observed in each period need be fixed (Greene, 1998). In REM, the cross section and time series intercepts are considered random variables.

$Y_{it} = \alpha_i + \beta / X_{it} + \varepsilon_{it} + u_i$ where $E[u] = 0$

$Var[u_i] = \sigma_u^2$ and $Cov[\varepsilon_{it}, u_i]$

The random effects model is a generalized regression model where all the disturbances have variance, $Var[\varepsilon_{it}, u_i] = \sigma^2 = \sigma_\varepsilon^2 + \sigma_u^2$.

For a given i, the disturbances in different periods are correlated by virtue of their common component,

$Cor[\varepsilon_{it} + u_i, \varepsilon_{it} + u_i] = \delta = \sigma_u^2 / \sigma^2$

The residual consists of three components indicating that REM considers of time-series errors, cross-section and their interaction.

$V_{it} = \alpha_i + \lambda_t + u_{it}$

Where

α_i is the individual specific component

λ_t is time specific component

u_{it} is the normal error term

LIMDEP has been used in computing the regression analyses.

CHAPTER V

EMPRICAL FINDINGS

Before testing the effect of FDI on innovation in Turkey and comparative emerging markets with different econometric models such as Ordinary Least Square (OLS), Fixed Effects Model (FEM) and Random Effects Model (REM), the descriptive statistics of data of each country has been figured out in order to see the country specific relations between variables. The mean, standard deviation (SD) and intercorrelation between variables has been tested. Table 5 presents descriptive statistics of data of Turkey.

Table 5: Means, Standard Deviations and Intercorrelations of Variable, Turkey

Variables	Mean	SD	FDI-1	R&Dexp	R&Dper	PGDP	R&DX	R&DM	PN
FDI-1	1345,73	922,45	1,00						
R&Dexp	5103,16	8185,81	-0,12	1,00					
R&Dper	29296,09	9337,38	0,63	0,02	1,00				
PGDP	6556,36	585,51	0,55	0,23	0,87	1,00			
R&DX	1965,09	1244,49	0,60	0,11	0,95	0,87	1,00		
R&DM	7962,85	2904,01	0,48	0,27	0,88	0,92	0,92	1,00	
PN	2274,73	918,18	0,16	0,47	0,29	0,43	0,40	0,47	1,00

Number of patent applications has a positive correlation with all independent variables in Turkey. R&D personnel and the amount R&D intensive import have the highest correlation with number of patent applications. There is an interesting point that the correlation between R&D personnel and R&D expenditure is only around 2%, however it is assumed that there is a high correlation between those two variables. Besides, the correlation between FDI and number of patent applications is about 16% in Turkey.

The table 6 presents the mean, standard deviation and the intercorrelations between variables in Poland.

Table 6: Means, Standard Deviations and Intercorrelations of Variable, Poland

Variables	Mean	SD	FDI-1	R&Dexp	R&Dper	PGDP	R&Dx	R&DM	PN
FDI-1	5851,64	2989,34	1,00						
R&Dexp	2481,04	325,55	0,83	1,00					
R&Dper	80195,73	3304,14	-0,58	-0,67	1,00				
PGDP	10582,09	1988,47	0,67	0,89	-0,85	1,00			
R&DX	2407,26	1410,44	0,62	0,82	-0,73	0,96	1,00		
R&DM	7935,85	3005,91	0,69	0,90	-0,74	0,98	0,98	1,00	
PN	6217,82	1280,51	0,52	0,82	-0,48	0,68	0,53	0,66	1,00

Number of patent applications has a positive correlation with all independent variables except the amount of R&D expenditure in Poland. The correlation between the number of patent applications and R&D per is about-0,48. R&D expenditure has the highest correlation with patent application numbers. The correlation between R&D expenditure and R&D personnel is negative around 67% and very high in Poland. Finally, the correlation between FDI and number of patent applications is about 52%.

The table 7 presents the mean, standard deviation and the intercorrelations between variables in Hungary.

Table 7: Means, Standard Deviations and Intercorrelations of Variable, Hungary

Variables	Mean	SD	FDI-1	R&Dexp	R&Dper	PGDP	R&DX	R&DM	PN
FDI-1	3350,00	1123,65	1,00						
R&Dexp	1086,79	389,72	0,02	1,00					
R&Dper	21938,00	1601,41	0,04	0,86	1,00				
PGDP	12928,00	2840,96	0,06	0,98	0,84	1,00			
R&DX	8554,57	6078,49	0,01	0,90	0,78	0,97	1,00		
R&DM	8335,77	4884,51	0,01	0,92	0,82	0,98	1,00	1,00	
PN	3404,91	1729,31	-0,27	0,34	0,61	0,24	0,11	0,17	1,00

The correlation between FDI and number of patent applications is negative around 27% in Hungary. The other independent variables have positive correlation with number of patent applications. R&D expenditure has the highest correlation around 61% with the number of patent applications, and the correlation between R&D expenditure and R&D personnel is positive and high around 86%

The table 8 presents the mean, standard deviation and the intercorrelations between variables in Hungary.

Table 8:Means, Standard Deviations and Intercorrelations of Variable, Czech Republic

Variables	Mean	SD	FDI-1	R&Dexp	R&Dper	PGDP	R&DX	R&DM	PN
FDI-1	3853,91	2435,64	100,00						
R&Dexp	1926,92	515,46	0,51	1,00					
R&Dper	26607,64	5929,24	0,33	0,89	1,00				
PGDP	15890,82	2542,24	0,48	0,98	0,85	1,00			
R&DX	4446,30	3677,47	0,38	0,97	0,85	0,99	1,00		
R&DM	6813,46	3487,32	0,40	0,97	0,85	0,99	0,99	1,00	
PN	3793,09	1492,73	0,14	-0,65	-0,74	-0,69	-0,74	-0,77	1,00

Number of patent applications has a negative correlation with all independent variables except FDI in Czech Republic. The intercorrelation between FDI and the number of patent applications is around 14%. The amount of the import in R&D intensive sectors has the highest negative and around 77% correlation with the number of patent applications in Czech Republic. The correlation between the R&D expenditure and R&D personnel is very high around 89% and they have negative correlation with the number of patent applications.

After testing the mean, standard deviation and the intercorrelations between variables, the relation the impact of FDI and international trade on innovation capability in Turkey and comparative emerging countries has been tested in a panel data approach. The econometric models that are utilized in this study are Ordinary Least Squares (OLS), Fixed Effects Model (FEM) and Random Effects Model (REM). Three sets of these models are run separately for the two periods: (1) the period of 1995-2005, (2) the period 2000-2005. The three sets are classified as: Set I where both R&D expenditure and R&D personnel variables are included as well as all other explanatory variables; Set II where R&D expenditure is included as a measure of R&D activity, and Set III where R&D personnel is the only measure of R&D to avoid correlation between these two variables. Under each set, different versions of the models are run with different explanatory variables to determine the best identification for innovation capability. The results of OLS model with different versions are presented in Table 9 for the period of 1995-2005.

Table 9: Panel Data Estimates of FDI Effects on Patent Applications (1995-2005) : OLS Model

Independent	OLS Set I							OLS Set II					OLS Set III							
variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Constant	644.3	326.93	846.93	701.19	1533.8*	2278.9*	2378.7*	1573.9	2033.7*	2738.2*	2473.1*	2716.7*	676.05	449.82	800.1	1568,6*	2018,3*	1976,9*	1719,5*	1036,8
	(0,6)	(0,35)	(0,93)	(0,76)	(3,12)	(4,65)	(5,41)	(1,35)	(2,28)	(3,13)	(3,56)	(4,1)	(0,63)	(0,5)	(0,92)	(3,42)	(3,15)	(3,16)	(3,17)	(1,19)
FDI-1	0,17	0,16	0,18	0,18	0,25*	0,43*	0,42*	0,38*	0,41*	0,46*	0,44*	0,46*	0,16	0,15	0,18	0,25*	0,26*	0,27*	0,26*	0,17
	(1,38)	(1,3)	(1,5)	(1,46)	(2,42)	(4,2)	(4,28)	(3,06)	(3,71)	(4,12)	(4,11)	(4,37)	(1,33)	(1,3)	(1,46)	(2,45)	(2,44)	(2,6)	(2,47)	(1,46)
R&Dexp	0,03	0,024	0,04	0,02	0,01	0,02		0,01	0,02	0,04	0,01	0,04								
	(0,66)	(0,44)	(0,82)	(0,36)	(0,21)	(0,48)		(0,19)	(0,48)	(0,63)	(0,19)	(0,67)								
R&Dper	0,04*	0,04*	0,04*	0,04*	0,03*								0,04*	0,04*	0,04*	0,03*	0,03*	0,03*	0,03*	0,04*
	(3,37)	(3,41)	(3,79)	(3,49)	(3,35)								(3,33)	(3,46)	(3,54)	(3,43)	(3,08)	(3,429	(2,999	(3,79)
PGDP	0,14	0,15	0,12	0,07				0,09	0,07	-0,01			0,14	0,15	0,07					0,11
	(1,57)	(1,81)	(1,67)	(1,07)				(0,96)	(0,8)	(-0,03)			(1,57)	(1,79)	(1,04)					(1,52)
R&DX	-0,04	-0,1						-0,19	-0,12		-0,1		-0,07	-0,1			0,03		-0,02	
	(-0,36)	(-1,54)						(-1,48)	(-1,63)		(-1,13)		(-0,61)	(-1,54)			(0,4)		(-0,53)	
R&DM	-0,08		-0,11					0,08		-0,07	0,03	-0,07	-0,04				-0,09	-0,06		-0,1
	(-0,63)		(-1,63)					(0,62)		(-0,88)	(0,3)	(-0,98)	(-0,39)				(-0,88)	(-0,96)		(-1,46)
R^2	0.50	0.51	0.51	0.47	0.46	0.30	0.30	0.36	0.35	0.32	0.34	0.32	0.50	0.50	0.47	0.45	0.47	0.47	0.46	0.50
Adjusted R^2	0,44	0.44	0.41	0.42	0.41	0.27	0.28	0.27	0.28	00.25	0,27	0,27	0,44	0,45	0,43	0,43	0,41	0,43	0,42	0,45
F [.,.]	[6,37]	[5,38]	[5,38]	[4,39]	[3,40]	[2,41]	[1,42]	[5,38]	[4,39]	[4,39]	[4,39]	[3,40]	[5,38]	[4,39]	[3,40]	[2,41]	[4,39]	[3,40]	[3,40]	[4,39]
	6.47	7.81	7.92	8.84	11.37	9.14	18.39	4.31	5.38	4.69	5.17	6.41	7.79	9.91	12.00	17.43	8.78	11.91	11.51	9.80

Dependent variable is the number of patent applications

Independent variables:

FDI-1 is the FDI inflow lagged one year

R&Dexp is the amount of research and development expenditure

R&Dper is the number of research and development personnel

PGDP is per capita GDP

R&DX is export amount in R&D intensive sectors

R&DM is import amount in R&D intensive sectors

Figure in parentheses are t statistics

* Significant at the 1% level.

** Significant at the 5% level.

*** Significant at the 10% level.

The first five models include both R&D expenditure and R&D personnel variable as well as all other explanatory variables (OLS Set I). Models through 8 to 12 (OLS Set II) include only R&D expenditures to capture the impact of R&D expenditures on innovation. On the other hand, models from 13 to 20 (OLS Set III) uses R&D personnel as the only measure of R&D.

The explanatory power of the OLS model with all variables (OLS Set I) is around 0.50, indicated by adjusted R-squared. However the adjusted R^2 does not improve for the other versions of OLS models when R&D expenditure and R&D personnel are taken separately. The coefficients measure magnitude of the effect coming from explanatory variables on the number of patent applications which is defined as innovation capability. The effect of FDI spillover on patent applications is statistically significant and positive in all versions of three sets for OLS models. The magnitude of FDI spillover ranges from 16% to 46%. In these models, the magnitude of effect FDI spillover on patent applications is large compared to similar studies in the literature. A 1% increase in FDI inflow results in a 40% increase in the number of patent applications in versions of Set II. The magnitude declines when the variable of R&D expenditure is excluded. Cheng and Lin (2003) find 27% positive impact of FDI on innovation capability. On the other hand, Chen (2007) finds no significant effect of FDI for the number of patent applications. In this study, according to OLS results, it can be said that FDI inflows have positive effect on innovation capability in Turkey and comparative emerging markets for the period 1995 and 2005.

The coefficient of R&D expenditure is positive but it is statistically insignificant even at the 10% level. Based on the OLS model results, it can be concluded that expenditure on R&D has no significant effect on innovation capability. On the other hand, the striking feature of the OLS models is that the coefficient for the R&D personnel is positive and statistically

significant at 1% significance level in both OLS Set I and OLS Set III. It can be interpreted as 1% increase in R&D personnel can lead to a 4% increase in the number of patent applications.

GDP per capita has a positive effect on the number of patent applications in all three version of OLS model, however it is not significant. A 1% increase in GDP per capita leads to approximately 10% increase in the number of patent applications. The impact of GDP per capita ranges from 7% to 15% except version 10 in OLS Set II.

In order to capture the impact of international trade on innovation capability, the export and import of R&D intensive sectors are included in the model. It is assumed that local firms may benefit from technological spillovers through finished R&D projects and products, if it engages in import or export activities in R&D intensive sectors. However, the impact of international trade seems to be negative almost in all models.

The calculated F values in all versions of OLS estimations are higher than the one percent critical value from F Table (around 3.50). Therefore, the hypothesis that the country specific effects are the same is rejected at the one percent level for calculated F values in Table 5. In this context, FEM and REM are also estimated.

FEM assumes that the intercept changes across countries and for each country there is a constant term. This term captures the country specific characteristics, such as differences in economic and political environment, technological infrastructure and regulations for intellectual property rights. Parallel to the OLS estimation approach, three sets of FEM are estimated; FEM Set I (includes both R&D expenditure and personnel), FEM Set II (includes only R&D expenditure), and FEM Set III (includes only R&D personnel). The results of FEM estimations are presented in Table 10.

Table 10: Panel Data Estimates of FDI Effects on Patent Applications (1995-2005) : FE Model

Independent	FEM Set I							FEM Set II					FEM Set III							
variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
FDI-1	0.02	0.05	0.13	0.12	0.12	0.11	0.11	0.01	0.04	0.13	0.05	0.12	0.01	0.04	0.12	0.12	0.01	0.1	0.13	0.13
	(0.17)	(0.4)	(1.13)	(1.7)	(1.18)	(1.08)	(1.1)	(0.13)	(0.35)	(1.1)	(0.42)	(1.07)	(0.13)	(0.34)	(1.03)	(1.19)	(0.14)	(0.92)	(1.23)	(1.13)
R&Dexp	0.02	0.05	0.04	0.05	0.05	0.05		0.03	0.05	0.05	0.03	0.05								
	(0.42)	(0.94)	(0.75)	(1.01)	(1.03)	(0.99)		(0.59)	(0.93)	(0.93)	(0.57)	(1.01)								
R&Dper	-0.06	-0.02	-0.06	-0.03	-0.03								-0.06	-0.02	-0.03	-0.03	-0.06	-0.04	-0.03	-0.06
	(-11.2)	(-0.5)	(-1.3)	(-0.9)	(-1.0)								(-1.3)	(-0.5)	(-0.9)	(-0.9)	(-1.5)	(-1.0)	(-0.7)	(-1.4)
PGDP	0.01	0.35	-0.29	-0.01				0.21	0.38	-0.1			0.01	0.38	0.01					-0.34
	(0.04)	(1.12)	(-0.8)	(-0.1)				(0.61)	(1.24)	(-0.3)			(0.01)	(1.22)	(0.1)					(-1.0)
R&DX	-0,3***	-0.21						-0.36	-0.24		-0.3		-0.37	-0.23			(-0,37**)		-0.02	
	(-1.8)	(-1.2)						(-1.8)	(-1.4)		(-1.7)		(-1.9)	(-1.2)			(-2.2)		(-0.4)	
R&DM	0.38		0.2					0.23		0.04	0.29	-0.01	0.41				0,41**	0.03		0.24
	(1.66)		(0.92)					(1.15)		(0.23)	(1.6)	(-0.2)	(1.89)				(2.31)	(0.49)		(0.25)
R^2	0.62	0.59	0.58	0.57	0.57	.56	0.55	0.60	0.59	0.56	0.60	0.56	0.62	0.58	0.56	0.56	0.62	0.56	0.56	0.58
Adjusted R^2	0.52	0.50	0.49	0.49	0.50	0.5	0.50	0.51	0.51	0.48	0.52	0.49	0.53	0.5	0.49	0.5	0.55	0.49	0.49	0.50
F[.,]	[9,34]	[8,35]	[8,35]	[7,36]	[6,37]	[5,38]	[4,39]	[8,35]	[7,36]	[7,36]	[7,36]	[6,37]	[8,35]	[7,36]	[6,37]	[5,38]	[7,36]	[6,37]	[6,37]	[7,36]
	6.31	6.44	6.25	7.05	8.45	9.94	12.18	6.76	7.46	6.77	7.80	8.08	7.25	7.25	8.05	9.91	8.52	8.14	8.10	7.15

Dependent variable is the number of patent applications

Independent variables:

FDI-1 is the FDI inflow lagged one year

R&Dexp is the amount of research and development expenditure

R&Dper is the number of research and development personnel

PGDP is per capita GDP

R&DX is export amount in R&D intensive sectors

R&DM is import amount in R&D intensive sectors

Figure in parentheses are t statistics

* Significant at the 1% level.

** Significant at the 5% level.

*** Significant at the 10% level.

Adjusted R2 remains almost same with the OLS model, around 0.50. FEM estimations reveal positive effect of FDI on innovation capability, but they are insignificant even at 10% level. In addition, the magnitude of FDI on the number of patent applications seems smaller than the OLS model. It can be interpreted as the spillover effect of the FDI declines when country specific characteristic are take into account. However, since all the coefficients of FDI are positive it can be said that FDI has positive effect on innovation capability in these countries.

However, OLS and FEM estimations are consistent in terms of R&D expenditure coefficients. The impact of R&D expenditure on innovation capability is positive but insignificant. And their effect is quite low. On the other hand, FEM estimations indicate negative effect of the total number of R&D personnel on innovation capability but the magnitude of this negative impact is small and insignificant. The effect of GDP per capita on innovation capability exhibits inconsistent results in terms of sign. In contrary OLS results of trade variables, import of R&D intensive sectors have positive influence on innovation capability while the negative impact still exists with respect to export of R&D sectors.

Instead of assuming a set of given constants in FEM, REM merges differential intercepts with the disturbance term. REM has an error term that captures both country specific (□i) and time variant (λt) effects. Changes in economic and political environment, regulations, quality of infrastructure and intellectual property right are also taken into account with respect to countrywide and time differences in REM. Three sets of estimations for REM are given in Table 11.

Table 11:Panel Data Estimates of FDI Effects on Patent Applications (1995-2005) : RE Model

Independent	REM Set I							REM Set II					REM Set III							
variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Constant	277	3683	1028	1517	1882	3096	3208	1105	1722	3071	2803	3241	308	526	1517	1921	2213.4	2147	2139	1265
	(0.2)	(0.3)	(0.97)	(1.36)	(2.68)	(4.71)	(5.09)	(0.69)	(1.16)	(2.55)	(3.49)	(4.40)	(0.22)	(0.45)	(1.42)	(2.92)	(2.71)	(2.95)	(3.043)	(1.22)
FDI-1	0.11	0.3	0.17	0.17	0,18***	0,19***	0,19***	0.1	0,16***	0.21	0,16***	0.21	0.1	0.13	0.17	0,18***	0.17	0,21***	0,21***	0.16
	(0.95)	(1.12)	(1.48)	(1.49)	(1.8)	(1.91)	(1.93)	(0.82)	(1.41)	(1.85)	(1.46)	(1.98)	(0.88)	(1.13)	(1.47)	(1.82)	(1.68)	(1.98)	(1.97)	(1.45)
R&Dexp	0.03	0.03	0.05	0.03	0.03	0.04		0.02	0.04	0.05	0.02	0.04								
	(0.67)	(0.74)	(0.97)	(0.63)	(0.67)	(0.85)		(0.52)	(0.94)	(0.92)	(0.52)	(0.91)								
R&Dper	0,03***	0,03***	0,04***	0,03***	0,03***								0,03***	0,03***	0,03**	0,03**	0.02	0,03**	0,03**	0,04*
	1.94	2.53	2.93	2.3	2.12								1.85	2.68	2.48	2.307	1.35	2.45	2.14	2.88
PGDP	0.2	0.18	0.12	0.02				0.2	0.18	0.02			0.2	0.17	0.03					0.1
	(1.59)	(1.62)	(1.28)	(0.34)				(1.23)	(1.16)	(0.18)			(1.6)	(1.6)	(0.4)					(1.09)
R&DX	-0.19	-0,14***						-0.1	-0.16		-0.19		-0.22	-0,14***			-0.12		-0.05	
	(-1.3)	(-1.8)						(-1.9)	(-1.5)		(-1.48)		(-1.57)	(-1.76)			(-1.02)		(-0.91)	
R&DM	0.04		-0.11					0.17		-0.04	0.16	-0.03	0.07				0.08	-0.04		-0.09
	(0.28)		(-1.49)					(1.18)		(-0.4)	(1.14)	(-0.4)	(0.59)				(0.62)	(-0.7)		(-1.2)
R^2	0.48	0.49	0.5	0.45	0.44	21	21	26	0.26	0.23	21	0.22	0.47	0.49	0.46	0.44	0.4	0.46	0.45	0.49
HausmanSt.	7.00	5.34	.00	6.99	6.70	5.39	5.04	5.09	5.50	5.50	6.14	5.44	.00	.00	6.35	6.33	13.00	6.09	5.55	8.00

Dependent variable is the number of patent applications

Independent variables:

FDI-1 is the FDI inflow lagged one year

R&Dexp is the amount of research and development expenditure

R&Dper is the number of research and development personnel

PGDP is per capita GDP

R&DX is export amount in R&D intensive sectors

R&DM is import amount in R&D intensive sectors

Figure in parentheses are t statistics

* Significant at the 1% level.

** Significant at the 5% level.

*** Significant at the 10% level.

The adjusted R2 ranges between 0.21 and 0.50 in all sets of REM estimations, indicating the relative strength of variables in explaining the variations in innovation capability. The coefficient of FDI variable is positive and significant at the 10% level in some versions of the model. In these versions, its impact changes from 16% to 21%, indicating that a 1% increase in FDI inflow can lead to 16-21% increase in the number of applications. The coefficients of R&D expenditure, R&D personnel and GDP per capita variables have the expected signs, which is positive. However, R&D expenditure and GDP per capita measures are insignificant while R&D personnel is significant at 10% level in REM Set I and REM Set III. With respect to impact of international trade variables, the coefficient of R&D intensive exports are positive but insignificant, while the coefficient of R&D intensive imports has different signs, causing inconsistency about the impact of this variable.

Lagrange Multiplier (LM) test is used to test the performance of REM against OLS with no individual country effects and the Hausman test is used to test the performance FEM against REM. LM test results favor REM over OLS model for the period 1995-2005. However, the Hausman test favors FEM against REM. The P values under the Hausman test in Set II suggest that the null hypothesis that the REM is the correct specification can not be rejected clearly. However, the R2 values are low and different versions of Set II underperforms compared to other set of estimations. In general, since the FEM captures both the individual country as separate intercepts, it outperforms the REM for this period.

The sensitivity analyses for time period are also considered. In 2000s, the FDI inflow to the emerging countries increased significantly. The FDI stock for the countries in the sample (Turkey, Poland, Hungary, and Czech Republic) was around 5 billions US $ in 1995. However it totaled to 20 billions US $ in 2000. These countries continued to attract high level of FDI inflows and reach to more than 60 billions in 2005. Therefore it is of interest to

analyze the 2000s as a different period. Similar approach is applied for the period 2000-2005 and the results of OLS model are in Table 8.

In the second period, the 2000-2005 period, the explanatory power of the OLS models, which is presented with adjusted R^2 ranges from 0.20 to 0.51. OLS results of the 2000s exhibit a similar pattern with OLS results for the period 1995-2005. The spillover effect of FDI on innovation capability is positive and becomes significant when the explanatory variable of R&D personnel is excluded from the model. The magnitude of the spillover effect of the FDI is almost the same with the OLS results of the first period. It ranges from 15% to 42%, indicating that a 1% increase in FDI inflow may lead to 15-42% increase in the number of patent applications.

The magnitudes of the effect of the R&D expenditures are very low and insignificant at all levels. The number of R&D personnel has a positive impact on innovation capability and is significant for some versions of the OLS models in the period 2000-2005. However the magnitude of the impact is relatively low, ranging from 3% to 6%. Surprisingly, GDP per capita has a negative impact on innovation capability in this sample. International trade impact on innovation states unambiguous evidence with changing signs for R&D intensive exports. The impact of R&D intensive imports has a negative effect on innovation capability in the period of 2000-2005 and it is significant at 10% level in some versions of the model.

The calculated F values are higher than the F table values at different significance levels but they are all higher than the ten percent critical value from F Table. Again, similar to the results of OLS estimation for the period 1995-2005, the hypothesis that the country specific effects are the same is rejected for the period 2000-2005 in Table 12.

Table 12: Panel Data Estimates of FDI Effects on Patent Applications (2000-2005) : OLS Model

Independent	OLS Set I						OLS Set II					OLS Set III							
variable	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Constant	412**	2120	2119	1608***	3161***	3750**	4659**	3669**	4919*	4251**	2424*	4324**	1960	2055	1615**	4013*	3254**	2308**	3940**
	(2.23)	(1.2)	(1.21)	(1.83)	(1.84)	(2.72)	(2.21)	(2.54)	(2.93)	(2.77)	(2.89)	(2.41)	(1.27)	(1.35)	(2.07)	(3.12)	(2.12)	(2.05)	(2.24)
FDI-1	0.19	0.2	0.26	0.23	0.15	0.21	0,4**	0,35**	0,42*	0,36**	0,4*	0.18	0.2	0.26	0.23	0.15	0.15	0.24	
	(1.08)	(1.02)	(1.42)	81.47)	(0.84)	(1.43)	(2.159	(2.08)	(2.89)	(2.52)	(2.82)	(1.03)	(1.08)	(1.47)	(1.56)	(1.1)	(0.86)	(1.65)	
R&Dexp	0.04	-0.01	-0.01	0.01	0.01	-0.01	0.01	-0.023	-0.01	-0.01	0.01								
	(0.62)	(-0.2)	(-0.1)	(0.02)	(0.13)	(-0.05)	(-0.12)	(-0.31)	(-0.1)	(-0.12)	(0.18)								
R&Dper	0,06**	0.03	0.03	0,03**	0,04**	0,04**						0,06**	0.03	0.03	0.03	0,06**	0,04**	0.03	0,07*
	(2.6)	(1.45)	(1.6)	(2.04)	(2.24)	(2.32)						(2.57)	(1.51)	(1.65)	(2.1)	(2.64)	(2.29)	(1.51)	(3.55)
PGDP	-0.03	0.04	-0.03		0.06		-0.04	-0.01	-0.06			-0.03	0.04	-0.03			0.06		
	(-0.2)	(0.3)	(-0.3)		(0.59)		(-0.3)	(-0.06)	(-0.6)			(0.25)	(0.34)	(-0.3)			(0.59)		
R&DX	0.24	-0.9					-0.03	-0.12		-0.07		0.19	-0.09			0.16		-0.06	-0,43**
	(1.27)	(-0.8)					(-0.21)	(-1.03)		(-0.6)		(1.13)	(-0.8)			(1.29)		(-0.85)	(-2.21)
R&DM	-0.5**				-0,2***	-0,2***	-0.12		-0.16	-0.1		-0,4**				-0,4**	-0,2**		0.04
	(-2.1)			(-1.96)	(-1.94)	(-0.65)		(-1.2)	(-0.6)		(-2.1)				(-2.2)	(-2.0)		(0.37)	
R^2	0.55	0.43	0.41	0.40	0.51	0.50	0.38	0.36	0.38	0.37	0.28	0.54	0.43	0.41	0.40	0.54	0.51	0.42	0.52
Adjusted R^2	0.4	0.27	0.28	0.31	0.38	0.40	0.28	0.23	0.24	0.24	0.21	0.42	0.31	0.32	0.35	0.45	0.41	0.34	0.41
F[.,.]	[6,17]	[5,18]	[4,19]	[3,20]	[5,18]	[4,19]	[5,18]	[4,19]	[4,19]	[4,19]	[2,21]	[5,18]	[4,19]	[3,20]	[2,21]	[4,19]	[4,19]	[3,20]	[4,19]
	3.57	2.76	3.32	4.59	3.83	4.86	2,22	2.75	2.91	2.90	4.16	4.36	3.62	4.66	7.23	5.71	5.04	5.01	5.16

Dependent variable is the number of patent applications

Independent variables:

FDI-1 is the FDI inflow lagged one year

R&Dexp is the amount of research and development expenditure

R&Dper is the number of research and development personnel

PGDP is per capita GDP

R&DX is export amount in R&D intensive sectors

R&DM is import amount in R&D intensive sectors

Figure in parentheses are t statistics

* Significant at the 1% level.

** Significant at the 5% level.

*** Significant at the 10% level.

In the second period, the explanatory power improves significantly when FEM is employed, which was not observed for the period 1995-2005. The adjusted R2 ranges from 0.49 to 0.85 which is consistent with the finding of the similar studies in the literature. The spillover effect of FDI on patent applications is positive in all versions of the FEM but the effects of those estimates are not statistically significant, again which is parallel to the findings in the literature. The magnitudes of the spillover effect FDI on patent applications range from 1% to 10%. Other explanatory variables, R&D personnel, GDP per capita, export and import of R&D intensive sectors for the period 2000-2005, exhibit similar pattern with FEM for the period 1995-2005. One of the main distinctions between these two periods is that the effect of R&D expenditure on innovation capability is positive (except two versions of FEM) but insignificant, while the coefficient of R&D personnel has changing signs.

The effect of export in R&D intensive sector is negative and significant at 1% and 5% level in some versions of FEM models in the second period. However, the effect of R&D intensive imports on patent applications is almost positive in all versions of FEM. When the findings of FEM for two periods are compared, the striking difference is that the effect of R&D intensive import on innovation capability is statistically positive in the period 2000-2005. In some versions of FEM, it also has significant effect on domestic innovation capability at 1% and 10% levels.

Since the calculated F values are higher than ten percent critical value (2.20), the hypothesis that country specific effects are the same is rejected, similar to the findings of OLS for the period 1995-2005. The results of the FEM for the period 2000-2005 are presented in Table 13.

Table 13: Data Estimates of FDI Effects on Patent Applications (2000-2005) : FE Model

Independent	FEM Set I							FEM Set II				FEM Set III							
variable	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20
FDI-1	0.01	0.04	0.1	0.08	0.08	0.1	0.11	0.02	0.04	0.09	0.02	0.01	0.03	0.08	0.07	0.01	0.08	0.04	
	(0.04)	(0.4)	(0.8)	(0.5)	(0.59	(0.77)	(0.13)	(0.22)	(0.41)	(0.77)	(0.23)	(0.05)	(0.31)	(0.67)	(0.49)	(0.06)	(0.64)	(0.43)	
R&Dexp	-0.01	0.02	0.05	0.1	0.37	0.05	0.06	0.02	0.02	0.04	0.02				-0.08				
	(-0.03)	(0.04)	(1.03)	(0.2)	(0.6)	(0.97)	(1.1)	(0.52)	(0.68)	(0.98)	(0.53)				(-1.4)				
R&Dper	-0.05	-0.01	0.01	-0.07		0.01	0.03					-0.05	-0.01	-0.01		-0.05	-0.01	-0.01	-0.05
	(-0.9)	(-0.03)	(0.31)	(-1.27)		(0.27)	(0.59)					(-1.1)	(-29)	(-0.06)		(-1.12)	(0.15)	(-0.12)	(-1.13)
PGDP	0.02	0.17	-0,65*			-0.64		-0.02	0.16	-0,66***		0.01	0.23	-0,6*			-0,68***		0.02
	(0.05)	(0.4)	(-3.6)			(-1.7)		(0.05)	(0.47)	(-1.89)		(0.05)	)0.66)	(-3.5)			(-1.87)		(0.06)
R&DX	-0,62*	-0,44*						-0,53**	-0,44**			-0,61*	-0.47			-0,61*		-0,36*	-0,62*
	(-2.8)	(-2.3)						(-2.75)	(-2.44)			(-3.2)	(-2.6)			(-4.12)		(-4.9)	(-3.4)
R&DM	0.3					-0.64	0.3*	0.19		0.02	0.19	0.3				0,31***	0.004		0,3***
	(1.51)					(-1,7)	(-2.9)	(1.2)		(0.13)	(1.34)	(1.69)				(1.89)	(0.23)		(1.78)
R^2	0.87	0.85	0.80	0.64	0.60	0.80	0.76	0.86	0.85	0.80	0.86	0.87	0.85	0.79	0.63	0.87	079	0.84	0.87
Adjusted R^2	0.79	0.78	0.71	0.51	0.49	0.7	0.66	0.80	0.79	0.71	0.81	0.81	0.78	0.71	0.53	0.82	0.70	0.79	0.82
F[.,.]	[9,14]	[8,15]	[7,16]	[6,17]	[5,18]	[8,15]	[7,16]	[8,15]	[7,16]	[7,16]	[7,16]	[8,15]	[7,16]	[6,17]	[5,18]	[7,16]	[7,16]	[6,17]	[7,16]
	11.10	11.24	9.41	5.06	5.55	7.72	7.42	12.51	13.70	9.35	15,25	13.38	13.33	10.75	6.40	16.31	8.71	16.00	16.31

Dependent variable is the number of patent applications

Independent variables:

FDI-1 is the FDI inflow lagged one year

R&Dexp is the amount of research and development expenditure

R&Dper is the number of research and development personnel

PGDP is per capita GDP

R&DX is export amount in R&D intensive sectors

R&DM is import amount in R&D intensive sectors

Figure in parentheses are t statistics

* Significant at the 1% level.

** Significant at the 5% level.

*** Significant at the 10% level.

REM should also be utilized to compare with FEM. The explanatory variables of FDI, R&D expenditures, R&D personnel and GDP per capita demonstrate a similar pattern with REM estimations in the period 1995-2005. They all have expected positive effect on domestic innovation capability. Though, they show difference in terms of significance. FDI spillover effect and the impact of R&D personnel are found to be significant in the period of 1995-2005 whereas they are all insignificant in the period 2000-2005. The impact of GDP per capita is not very clear in REM in the second period. It can be either positive or negative but it is not statistically significant in this sample. The empirical results of REM for the period 2000-2005 are presented in Table 14.

Table 14: Panel Data Estimates of FDI Effects on Patent Applications (2000-2005) : RE Model

Independent	REM Set I						REM Set II					REM Set III							
variable	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Constant	3980	4030	7435	2129	4946	4716	4048	4218	7145	5628	3200	4116	4175	7499	2335	5757.5	5439	5808	4108
	1.87	1.73	3.66	1.74	2.41	3.37	1.8	1.92	3.89	4.88	3.3	1.99	1.86	3.86	2.049	4.6	2.85	4.27	1.99
FDI-1	0.06	0.06	0.18	0.18	0.14	0.15	0.05	0.06	0.17	0.07	0.21	0.05	0.06	0.17	0.17	0.08	0.13	0.08	
	(0.1)	(0.6)	(1.5)	(1.22)	(1.16)	(1.16)	(0.49)	(0.61)	(1.44)	(0.72)	(1.46)	(0.55)	(0.55)	(1.48)	(1.19)	(0.85)	(1.1)	(0.83)	
R&Dexp	0.01	0.02	0.02	0.03	0.05	0.04	0.01	0.02	0.3	0.01	0.02								
	(0.04)	(0.51)	(0.64)	(0.51)	(1.04)	(0.95)	(0.42)	(0.53)	(0.83)	(0.48)	(0.46)								
R&Dper	0.01	0.04	0.01	0.02	0.04	0.04						-0.01	0.01	0.01	0.02	-0.01	0.03	0.01	-0.01
	(0.02)	(0.17)	(0.34)	(1.15)	(1.49)	(1.66)						(-0.17)	(0.08)	(0.28)	(1.13)	(-0.12)	(1.38)	(0.16)	(-0.21)
PGDP	0.18	0.18	-0.34		-0.01		0.17	0.18	-0.12			0.18	0.18	-0,33*			-0.03		0.21
	(0.95)	(0.87)	(-2.9)		(-0.1)		(0.83)	(0.87)	(-0.72)			(1.01)	(0.93)	(-2.8)			(-0.25)		(1.18)
R&DX	-0,4**	-0,41*					-0,48*	-0,42*		-0,4*		-0,47*	-0,42*			-0,38*		-0,3*	-0,5*
	(-2.4)	(-3.3)					(-2.9)	(-3.4)		(-3.1)		(-2.9)	(-3.5)			(-2.94)		(-5.0)	(-3.2)
R&DM	0.04				-0,3**	-0,3*	0.07		-0,21***	0.08		0.07				0.07	-0.28		0.09
	(0.24)				(-2.6)	(-3.4)	(0.52)		(-1.96)	(0.61)		(0.48)				(0.51)	(-2.5)		(0.64)
R^2	0.57	0.87	0.15	0.37	0.43	0.45	-0.11	0.63	0.17	-0.11	0.21	0.23	0.1	-0.91	0.37	-0.48	0.45	0.52	
Hausman	11.50	0.00	11.63	6.17	12.00	3.94	6.25	5.39	7.50	7.44	2.77	11.50	0.00	11.45	5.17	11.25	6.87	6.81	10.19

Dependent variable is the number of patent applications

Independent variables:

FDI-1 is the FDI inflow lagged one year

R&Dexp is the amount of research and development expenditure

R&Dper is the number of research and development personnel

PGDP is per capita GDP

R&DX is export amount in R&D intensive sectors

R&DM is import amount in R&D intensive sectors

Figure in parentheses are t statistics

* Significant at the 1% level.

** Significant at the 5% level.

*** Significant at the 10% level.

The coefficient of R&D intensive exports is always negative which is in line with the findings of REM for the period 1995-2005, as well as FEM for the second period. The main difference is that the coefficient is statistically significant at 1% and 5% levels in REM for the second period. Therefore, it can be concluded that R&D intensive sectors generates a negative impact in the given sample for the period 2000-2005. Another important finding is that the opposite effect coming from R&D intensive imports. Based on the REM estimations for the period 2000-2005, the R&D intensive imports contribute positively to domestic innovation capability at a significance level ranging from 1% to 10% in some versions of REM.

The Hausman test is performed to determine the appropriate model between FEM and REM for the period 2000-2005. Similar to the results for the period of 1995-2005, Hausman test favors FEM over REM, except the second version of estimations in each set.

In summary, panel data approach is used to determine FDI and international trade spillover effect on domestic innovation capability for a group of emerging countries, Turkey, Hungary, Poland and Czech Republic for the period of 1995-2005 and 2000-2005. Main findings are as follows:

- Empirical results for both periods reveal that FEM outperform OLS and REM for the given sample set. FEM detects country specific changes by assigning a constant term for each country. This term captures the country specific characteristics, such as differences in economic and political environment, technological infrastructure and regulations for intellectual property rights.
- The impact of FDI spillover on innovation capability is overestimated when the country specific effects are not taken into account.
- The coefficient of FDI inflow on domestic innovation capability is always positive in all versions of OLS, FEM and REM estimations. The empirical evidence support that FDI inflows generate spillover effects on domestic innovation capability in Turkey, Hungary,

Poland and Czech Republic. This result supports the hypothesis that inward FDI brings knowledge spillovers, new technologies and products into the host country and promote domestic firms' innovation capability. These spillover effects may arise through channels such as reverse engineering, skilled labor turnovers, demonstration effects, and backward linkages. On the other hand, the hypothesis of crowding-out effect of FDI on innovation is rejected for the given sample.

- In the context of FEM, import of R&D intensive sectors has positive influence on innovation capability while the negative impact exists with respect to export of R&D sectors.
- Explanatory variables, R&D personnel, GDP per capita, export and import of R&D intensive sectors for the period 2000-2005, exhibit similar pattern with FEM for the period 1995-2005. One of the main distinctions between these two periods is that the effect of R&D expenditure on innovation capability is positive (except two versions of FEM) but insignificant, while the coefficient of R&D personnel has changing signs.
- Two periods of empirical results are largely consistent with each other. However, FEM results provide the best fit for the period 2000-2005.

CHAPTER VI

CONCLUSION

After the 1990s, foreign direct investment has emerged as a very important source of external resource flows to emerging markets and has become a significant part of capital formation in these countries. The FDI flows attracted by emerging countries were about $200 billions in 1995, however the amount of FDI inflows attracted by emerging markets exceeded 500 billions US$ in 2006.

There are two competing hypotheses about the impact of FDI inflows on R&D activities and innovative capability in host countries in the empirical literature. One perspective provides a positive approach and argues that FDI spillovers may contribute to innovative capability of domestic firms. There may be several channels through which domestic firms in the host country can benefit from inward FDI to raise their innovative activities. First of all, local enterprises can learn about the products and technologies brought in by foreign investors, reverse engineering is an example for this channel. Secondly, spillovers can fall out through labor turnovers whereby local firms receive the technological know-how of foreign firms. Third, inward FDI has a demonstration effect on local R&D activity. Foreign products/technologies can encourage and stimulate local innovators to develop new products and processes. Finally, spillovers may take place vertically from foreign firms to their local suppliers by means of technological know-how transfer, staff training. These vertical spillovers can develop the innovation capability of local suppliers. Therefore, one of the primary motivations for developing countries to attract foreign direct investment is to obtain advanced technology from developed countries and then base on this to establish domestic innovation capability besides financing their current account deficit. On the other hand, crowding-out effect of FDI approach argues that domestic firms may prefer

joint ventures with foreign investors as a form of purchasing technologies from abroad and substitute this activity instead of establishing an innovative environment themselves.

Empirical studies about spillover effect of FDI on innovation capability in emerging markets including Turkey are rare. Whether FDI can bring positive spillover effect and stimulate technology progress in emerging markets is controversial. Therefore, the main aim of this study is to test the spillover effect of FDI on innovation capability in Turkey and comparative emerging economies. In addition, the impact of the international trade through export and import of R&D intensive sectors on innovative capability is also analyzed.

The study is based on country-level data of Turkey, Poland, Hungary and Czech Republic for the period from 1995 to 2005. The number of patent applications is used as a measure of innovation. FDI refers to the realized value of FDI in countries. FDI values lagged one period in order to analyze the spillover effect of FDI. As a measure of input to R&D activity, the number of personnel for research and development personnel and expenditure on research and development are included. Besides, export and import of R&D intensive sectors are added as a measure of input to R&D activity. GDP per capita is another explanatory variable.

The effect of FDI on innovation in Turkey and comparative emerging markets is analyzed by testing different econometric models such as Ordinary Least Square (OLS), Fixed Effects Model (FEM) and Random Effects Model (REM). Three sets of these models are run separately for the two periods: (1) the period of 1995-2005, (2) the period 2000-2005. The three sets are classified as: Set I where both R&D expenditure and R&D personnel variables are included as well as all other explanatory variables; Set II where R&D expenditure is included as a measure of R&D activity, and Set III where R&D personnel is the only measure of R&D to avoid correlation between these two variables. LIMDEP has been used in computing the regression analyses.

Empirical results for both periods reveal that FEM outperform OLS and REM for the given sample set. FEM detects country specific changes by assigning a constant term for each country. This term captures the country specific characteristics, such as differences in economic and political environment, technological infrastructure and regulations for intellectual property rights. The impact of FDI spillover on innovation capability is overestimated when the country specific effects are not taken into account.

The empirical evidence support that FDI inflows generate spillover effects on domestic innovation capability in Turkey, Hungary, Poland and Czech Republic. This result supports the hypothesis that inward FDI brings knowledge spillovers, new technologies and products into the host country and promote domestic firms' innovation capability. These spillover effects may arise through channels such as reverse engineering, skilled labor turnovers, demonstration effects, and backward linkages. On the other hand, the hypothesis of crowding-out effect of FDI on innovation is rejected for the given sample. With respect to the impact of international trade on innovation capability, import of R&D intensive sectors have positive influence whereas export of R&D sectors have a negative impact. Two periods of empirical results are largely consistent with each other. FEM results provide the best fit, especially for the period 2000-2005.

The main contributions of this study to literature are as follows; this study is one of the first studies that use a macroeconomic approach to test the impact of FDI spillover and international trade effects on innovation capability in Turkey. Secondly, the impact of international trade on innovation capability of a country is taken into account through export and import of R&D intensive sectors. Third, innovation measure is defined in parallel to empirical studies in the literature and tested for a group of emerging countries including Turkey. Fourth, a comparative study is conducted for Turkey and its major rivals in terms of attracting FDI for the period 1995-2005.

Using number of patent applications as a measure of R&D output may have some limitations. First of all, it is possible that some innovators may have chosen not to file patent application for their R&D output. Instead, they may have chosen to keep their innovation activity as trade secrets to prevent their competitors from utilizing the information that would be disclosed from filing patent applications. Secondly, filling patent applications standards change according to countries or international patent office. For example, number of patent application of countries is not same in national statistics and European Patent Office database.

In the future studies, more recent data can be used and it may be more meaningful since, the FDI inflows increased remarkable in last years to these emerging countries. Especially, for Turkey it will be better to add 2006 and 2007 FDI data since for these years FDI inflows exceeded $20 billions. The study can be extended by adding other emerging countries for example Brazil, Russia, India and China (BRIC Countries) can be added to data to test the impact of FDI inflows and international trade on innovation capabilities emerging countries. Furthermore, developed countries and emerging markets may be compared by making two different data sets so that it can be seen that which factors are important for these countries or there is any difference in the determinant of FDI in those countries.

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