Girişimcilik ve İnovasyon Yönetimi Dergisi

Journal of Entrepreneurship and Innovation Management

Turkish-German Economic Relations via Foreign Direct Investment and Patents

Doğrudan Yabancı Yatırımlar ve Patentler Aracılığıyla Türk-Alman Ekonomik İlişkileri

Yeşim KUŞTEPELİ*, Canan BALKIR**, Sedef AKGÜNGÖR***, Yaprak GÜLCAN****, Mehmet Aldonat BEYZATLAR*****, Şule GÜNDÜZ KALAYCIOĞLU******

Abstract

This working paper aims to identify Turkish-German economic relationship of foreign direct investment and patents in line with the Turkish-German collaboration project (TGIN). Econometric methods such as correlation, regression and Granger causality to analyze the effect of German FDI inflow to Turkey on total foreign-based patent applications for the period from 1999 to 2011 have been used. The results justify the relationship between patents and FDI. The reciprocity between patent applications and FDI is more remarkable for Turkish-German interaction via flow of FDI and patents. German-based FDI fosters patent applications faster with respect to foreign-based FDI to patent transformation.

Keywords: Turkey and Germany, Foreign Direct Investment, Patents

Özet

Bu çalışma raporu Türk-Alman ekonomik ilişkilerinde doğrudan yabancı yatırım ve patentleri Türk-Alman işbirliği projesi (TGIN) kapsamında tespit etmeyi amaçlamaktadır. Bu çalışmada, 1999-2011 döneminde Türkiye'ye gelen Alman doğrudan yatırımlarının Türkiye'nin yabancı patent başvurularına etkisini analiz etmek için korelasyon, regresyon ve Granger nedensellik analizi gibi ekonometrik metotlar kullanılmıştır. Sonuçlar, patentlerle doğrudan yabancı yatırımlar arasındaki ilişkiyi teyit eder niteliktedir. Patent başvuruları ile yabancı doğrudan yatırımların karşılıklılığı Türk Alman yabancı doğrudan yatırımları ve patentler etkileşiminde daha dikkat çekicidir. Almanya bazlı doğrudan yabancı sermaye patent başvurularını yurtdışı bazlı yabancı sermaye girişlerinin patente dönüşümü anlamında daha fazla desteklemektedir.

Anahtar Kelimeler: Türkiye ve Almanya, Doğrudan Yabancı Yatırım, Patentler

* Prof. Dr., Dokuz Eylül Üniversitesi, İşletme Fakültesi, İngilizce İktisat Bölümü, E-mail: yesim.kustepeli@deu.edu.tr

** Prof. Dr., Dokuz Eylül Üniversitesi, Sosyal Bilimler Enstitüsü, Avrupa Birliği Anabilim Dalı Kaynaklar Yerleşkesi, 35160 Buca İzmir, E-mail: canan.balkir@deu.edu.tr

*** Prof. Dr., Dokuz Eylül Üniversitesi, İşletme Fakültesi, İngilizce İktisat Bölümü Kaynaklar Yerleşkesi, 35160 Buca İzmir, E-mail: sedef.akgungor@deu.edu.tr

**** Prof. Dr., Dokuz Eylül Üniversitesi, İşletme Fakültesi, İngilizce İktisat Bölümü, Kaynaklar Yerleşkesi, 35160 Buca İzmir, E-mail: yaprak.gulcan@deu.edu.tr

***** Araştırma Görevlisi, Dokuz Eylül Üniversitesi, İşletme Fakültesi, İngilizce İktisat Bölümü Kaynaklar Yerleşkesi, 35160 Buca İzmir, E-mail: mehmet.beyzatlar@deu.edu.tr

****** Proje Asistanı, Dokuz Eylül Üniversitesi, İşletme Fakültesi, İngilizce İktisat Bölümü, Kaynaklar Yerleşkesi, 35160 Buca İzmir, E-mail: sulekalaycioglu@yahoo.com

1. Introduction

Innovation is crucial for a firm in enhancing its product quality, production efficiency and competitiveness. The innovative performance of a firm is linked closely to its research and development (R&D) activities; external sources and boundary-spanning networks for the development of new products and processes. Innovation networks are primary environments within which actors exchange knowledge and experience in an easier and less costly way (Pyka, 2001; Pyka and Buchmann, 2011). Besides their impact on learning and diffusion, innovation networks also play an important role in the development and integration of economies. Saxenian (2006) discusses the old core/periphery model of economic development with a new approach in terms of the role of individuals which convey competences from the core to the periphery regions which she labelled "commuting entrepreneurs". Knowledge transfer takes place within innovation networks which are spawned between the core and the periphery by these individuals and their economic engagement in both regions.

The case of Turkey and Germany offers a riveting case to explore the role of innovation networks in connecting the two economies and fostering catching-up processes as well as cross-border mutual learning. The joint project by Turkish and German academics[1] (Knowledge Transfer in Turkish-German Innovation Networks in the Context of European Integration) intends to contribute to the economic and social integration and technology transfer between Turkey and Germany. It entails an alternative model to launch the dynamics of change and innovation between these two countries, with different levels of economic development. The project proposes to provide practical and theoretical insights on (i) how the networks between both sides are formed; (ii) which bottlenecks are to be dissolved and (iii) which strengths and foremost practices can be fostered. Once the structural and dynamic features of the networks are apprehended, negative features can be avoided, rigidities can be overcome and knowledge flows can be enhanced.

Foreign Direct Investment (FDI) is a significant criterion for international economic integration of the countries. Economic integration facilitates the flow of technology and knowledge between countries via FDI. In this way,

1 For detail, see www.tginnet.org

FDI is effectuated innovation, which becomes international oriented. Therefore, integration generates innovation. As one of the most visible, this type of integration emerged during the EU enlargement processes.

The aim of this working paper is to explore the relationship between Turkey and Germany via flow of Foreign Direct Investment (FDI) and patents, based on the fact that FDI is a channel for the diffusion of knowledge for both the hosting and investing country. Investment fosters R&D, then patents come into existence as outputs of R&D and finally, new products or production processes and others are marketed as innovation. This linkage is investigated by using patent statistics, which shows the joint cooperation between German and Turkish synergy. Patent and FDI data have been gathered from Turkish Patent Institute and Turkish Ministry of Economy respectively.

This paper consists of 5 sections including the introduction as Section I. The next section is the literature review, which compiles studies regarding the interaction between FDI, patents and other economic factors. Section III expresses economic relations between Turkey and Germany via FDI and patents. Section IV develops a time series data approach to reveal correlation, regression and Granger causality between FDI and patents. Section V presents our main conclusions.

2. Literature Review

There is a vast literature on the extent to which FDI affects knowledge spillovers, which are measured through patents, and contribute to economic growth providing the linkage between FDI and growth. The world economy has been evolving smaller with globalization effect, but the linkage volume of activities has been increasing dramatically. Therefore, being innovative fosters the survival of economies. Knowledge creation and the flow of information make economic policies and activities more information-oriented. After 1980s, much attention has been given to scrutinizing Intellectual Property Rights (IPR) as paramount policy direction and the effects of IPR on economic activities caught on. Braga and Fink (1999) examine the impact of stronger intellectual property rights on FDI flows. Although many studies suggest that firms prefer to invest in countries where IPRs are strongly

protected, this study does not acquire any conclusive empirical evidence to brace this idea.

FDI can be examined as "knowledge spillover" dragger. Damijan et al (2003) consider FDI and trade as the two basic channels for technology transfers. Branstetter (2005) investigates the presence of this relationship for Japanese multinationals investing in USA by employing patent data to find the impact of FDI on knowledge spillovers across national borders. The ramifications reveal that FDI is a channel for diffusion of knowledge both for the FDI receiving firm and the investor firm.

Although many economists agree on the fact that FDI is a crucial channel for knowledge spillovers and it fosters the technological development of countries, it is vital that governments support the FDI policies. Çeştepe and Tüylüoğlu (2006) analyse the Irish economy to figure out the impact of FDI on technological progress and knowledge spillovers. Ireland is given as an exemplar to demonstrate how countries can enjoy the positive externalities created by FDI inflows. They conclude that for a country to be able to benefit from technological know-how brought by FDI, political as well as economic infrastructure has to be solid. Aslanoğlu (2000) also argues that unless supported by appropriate long term and strictly implemented strategies of government it is not likely for domestic industries to enjoy the competitive environment created by the foreign firms in terms of productivity increases. Navaratti and Tarr (2000) are among the scholars who support the idea that FDI has positive impact on international knowledge flows, however they claim that knowledge absorption and learning capacity of countries has to be supported by government policies as well.

Seyoum (2006) ascertains the effect of patent protection on FDI inflows by analysing patent data and FDI inflows of 63 countries. The results of the study are in line with the generally accepted idea that FDI inflows towards countries that protect the property rights and the innovations through a reliable patent system. The level of patent protection has positive and significant influence on FDI inflows. The article concludes that a good understanding of the relationship between the two variables can facilitate governments and firms to set up a solid policy which will in turn encourage the growth through FDI inflows.

Ford and Rork (2010) analyses the relationship between FDI flows and patent rates at the state level in United States. The conclusion of their study is that inward FDI inflows from neighbour states contribute to the level of knowledge and hence the number of patents rises. They also conclude that not only FDI is important for this positive impact but human capital is as much important since it is the requisite tool for the creation of new knowledge.

The firm-specific examination of FDI engagement is studied by Garcia et al (2012). Their paper analyses the relationship between industry-level and firm-level inward FDI and the innovative performance of host countries. They investigate 1799 Spanish firms for the period 1990-2002, by using patent application counts and product innovation counts as dependent variables. The findings of the study indicate that industry and firm level FDI inflows have negative impact on the innovativeness of local firms. This suggests that the investors in Spain keep on carrying the innovative processes in their home countries. The study also points out the fact that for some developing countries inward FDI flows may adversely affect local innovation. All in all, this study implies that FDI may not the best way for knowledge transfer and spillovers to local industries for some developing countries. The findings of Borenzstein et al. (1998) also imply that FDI inflow has a positive impact on the economic growth of the FDI receiving country if and only if the host country has a human capital endowment which is sufficient to absorb the technology received.

The link between patents and FDI flows has attracted both theoretical and empirical research in the economic literature. The motivation for examining such a versatile and multinational type of connection in terms of innovative economy fosters reciprocal policy production of hosting and investor countries. FDI has a vital importance for many human capital and/or natural resources intensive but cash and/or technology scarce countries vice versa. In line with the literature, this working paper examines aspects of the effects of Foreign Direct Investment (FDI) for a developing country (Turkey). Existing literature, which generally shows a positive relationship between FDI and patents, considers only the relationship between variables. The contribution of this paper is to rely on developed-developing country linkage, with a social and historical background.

3. Turkish-German Economic Relations

Turkey and Germany are two countries with long-lasting political, military, economic, social, cultural, and historical ties. As soon as the German unification succeeded in the 19th century, the two European powers -Ottoman Empire and Prussia- linked with each other in fields such as military, diplomacy, and education, as well as the coalitions in wars and German contribution to Turkish modernization and development.[2]

The relationship between Turkey and Germany has gained momentum within the framework of "Contract Labour Migration" that was signed by the two countries in 1961. Such intensive multi-faceted relations continue today with strong international trade investment ties as well as immigrants from Turkey comprising the largest group of immigrants currently living in Germany, and German retired migrants being the second populous group in Turkey after the British. Although, the phenomenon of innovation networks has to be considered to be in its childbed in Turkish-German relations, already a few cases exist which indicate the rich possibilities for economic integration and development of Turkish-German innovation networks.

Germany invests heavily in Turkey and indeed is its major foreign investor: Since 1980, Germany has invested over $7 billion in Turkey and there are nearly 4000 German-owned or German-shareholder companies. The sectors in which they are active range from manufacturing to service sector, such as business management.

Also, tourism is a crucial channel between the two countries, with Germans making up the largest group of visitors to Turkey with 15%.[3] Nearly 4.5 million German tourists visited Turkey in 2008 and 4.8 million in 2011 that shows the trend is on the rise.[4] The existence of both Turkish immigrants in Germany and retired German migrants in Turkey serves to transform these relations into issues of domestic policy for both countries. There has been a German Association of Chambers of Industry and Commerce in Turkey

2 C. Balkır (2013),German-Turkish Relations: From Immigration to Innovation Networks? TGIN Working paper No.4 p.1,

3 http://www.kultur.gov.tr/EN,36568/number-of-arriving-departing-foreigners-and-citizens.html

4 http://www.kultur.gov.tr/EN,36568/number-of-arriving-departing-foreigners-and-citizens.html

since 1985. There are regular bilateral consultations on economic cooperation as well as consultations under the auspices of the German-Turkish Cooperation Council, with its four working groups on industry and investment, trade, tourism and science and research, and the German-Turkish Steering Committee for Intensifying Cooperation in the Agricultural and Food Industries.

In 2009, Germany and Turkey jointly celebrated 50 years of bilateral development cooperation. In those fifty years, more than ğ4.3 billion has been made available in the form of loans and grants under Financial Cooperation. Economic cooperation is also being expanded by various bilateral research and technology projects. The Federal Ministry of Education and Research has implemented a number of initiatives with Turkey, including cooperation with the Scientific and Technological Research Council of Turkey (TUBITAK).

3.1. Foreign Direct Investments (FDI)

Table 1 shows the change in FDI inflow of some EU member states and Turkey. Inward FDI flow of EU member countries such as Estonia, Czech Republic, Hungary, Poland and Slovak Republic increased dramatically after the accession to the EU. However the increase of FDI flow to new member countries after 2004 contains mostly EU-based FDI. In the case of Turkey, the total FDI inflow is twice the EU-based FDI, which shows that the diversity of FDI inflection for Turkey is higher than member countries.

Table 1: FDI Flow to New Members EU and Turkey (million US dollars)[5]

Receiving Country	EU25			Total World		
	2003	**2004**	**2005**	**2003**	**2004**	**2005**
Czech Republic	919	4005	11117	2109	4976	11655
Estonia	798	735	2810	928	958	2863
Hungary	2914	2564	6343	2138	4509	6948
Poland	3664	11969	8355	4870	12756	10249
Slovak Republic	1968	3144	2049	2161	3033	2427
Slovenia	NA	NA	NA	302	832	540
Turkey	599	1375	4518	1752	2885	10031

Table 2 reveals that after 2003 not only the rank but also the percentage share of Turkish FDI inflows increased[6] in the world. This is due to two reasons; the first being the granting of the candidacy status to Turkey in 1999 Helsinki Summit which paved the way to the alignment process with the acquis communitaire. The second reason is the 2002 stand-by agreement with the IMF which began the process of macroeconomic reforms.[7] Thus the alignment with the acquis communitaire and the IMF conditionality became the two anchors of the Turkish economy, improving its competitiveness and getting its macroeconomic indicators more in line with the Maastricht criteria. In due course it had a definite positive impact on the FDI inflow. The increasing trend of FDI inflow of Turkey continued until the 2008 global economic crisis. As expected, during the crisis, the FDI flow to Turkey decreased more than half, due to the decrease of the FDI inflow from Europe.

5 OECD.Stat Extracts, FDI flows by partner country: http://stats.oecd.org/

6 This increase is partly due to institutional arrangements for FDI that particularly cause into effect after 2003. FDI law that passed in June 5th, 2003 (Law no: 4875) aims to the establishment of the guidelines to encourage foreign direct investment, to protect of the rights of foreign investors, to define investment and investor compliance with international standards and to increase foreign direct investment through established policies.

7 For detail, see http://www.tcmb.gov.tr/research/yillik/02ing/sectionV4.pdf

Table 2: FDI Inflow to Turkey (Billion US $)

Year	FDI	Rank	Global FDI	% in Global FDI
2000	1	53	1396,5	0,0007161
2001	3,3	37	825,9	0,0039956
2002	1,1	51	716,1	0,0015361
2003	1,8	50	632,6	0,0028454
2004	2,7	35	648,1	0,004166
2005	10	25	958,7	0,0104308
2006	20	17	1411	0,0141743
2007	22	23	1833,3	0,0120002
2008	19,5	17	1744,1	0,0111806
2009	8,4	30	1185	0,0070886
2010	9,1	27	1243,7	0,0073169

Source: Ministry of Economy Annual Reports 2004-2011[8]

Besides being the primary partner in trade, Germany is also one of the top FDI providers for Turkey. Among 28,500 international firms in Turkey, 4688 are German[9] (See Table 3). German FDI in Turkey followed a continuous increase both in absolute terms and as the share of total FDI, despite the economic crisis in the Eurozone and the reduction of German international investments, German-owned companies continued to invest and/or settle in Turkey.

8 http://www.ekonomi.gov.tr/index.cfm?sayfa=EF97CB6E-D8D3-8566-45203BDBD548B25D

9 http://www.turkishweekly.net/news/126102/germany-makes-highest-investment-in-turkey.html accessed on 18.03.2012

Table 3: German FDI in Turkey 2005-2011 (million dollars)

Year	Rank	German FDI	Total FDI	% of FDI in Turkey
2005	6	391	8480	4,6
2006	9	366	17817	2,1
2007	4	1004	19190	5,2
2008	5	1217	14911	8,2
2009	4	498	6252	8
2010	3	598	6536	9,1
2011	10	605	15887	3,8

Source: Ministry of Economics Annual Reports 2004-2011[10]

Table 4: The Distribution of Foreign-owned Companies in Turkey 2007-2011

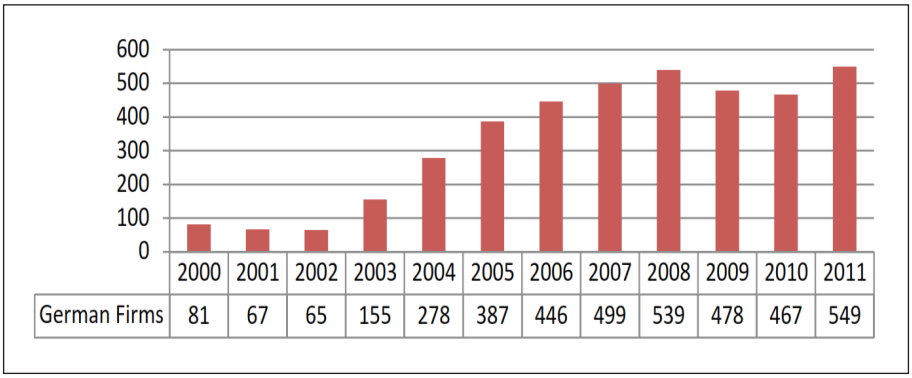
Countries	2007	2008	2009	2010	2011	1954-2011
EU Countries	1901	1686	1419	1422	1598	15308
Germany	499	539	478	467	549	4790
Netherlands	228	255	142	175	163	1979
England	404	223	189	160	170	2338
Italy	76	97	90	94	97	911
Other EU countries	694	572	520	526	619	5290
Other European Countries	368	430	331	408	430	3340
African Countries	44	44	67	99	115	594
USA	118	107	111	103	152	1213
Canada	30	18	31	31	26	207
China	36	42	40	41	41	432
South Korea	22	13	20	18	14	181
Total	3231	3069	2841	3304	3979	29399

Source: Ministry of Economy Annual Reports 2004-2011[11]

[10] http://www.ekonomi.gov.tr/index.cfm?sayfa=EF97CB6E-D8D3-8566-45203BDBD548B25D
[11] http://www.ekonomi.gov.tr/index.cfm?sayfa=EF97CB6E-D8D3-8566-45203BDBD548B25D

Among the foreign firms established in Turkey, German firms are the first in the ranking with a number of 4790 for the period 1954-2011. Data gathered from the Ministry of Economy, indicate that there are 4885 German-owned firms in Turkey processing in a diverse range of 54 sectors as of June 2012. The number of firms in each sector is displayed in the Appendix. The "Wholesale Trade and Trade Brokerage, Construction, Hotels and Restaurants, and Retail Trade and Repair of Goods" are the top sectors with over at least 300 firms operating in each sector.

The number of German-owned firms that started to operate in Turkey has increased rapidly after 2003. This can be observed from Figure 1 and Figure 2.

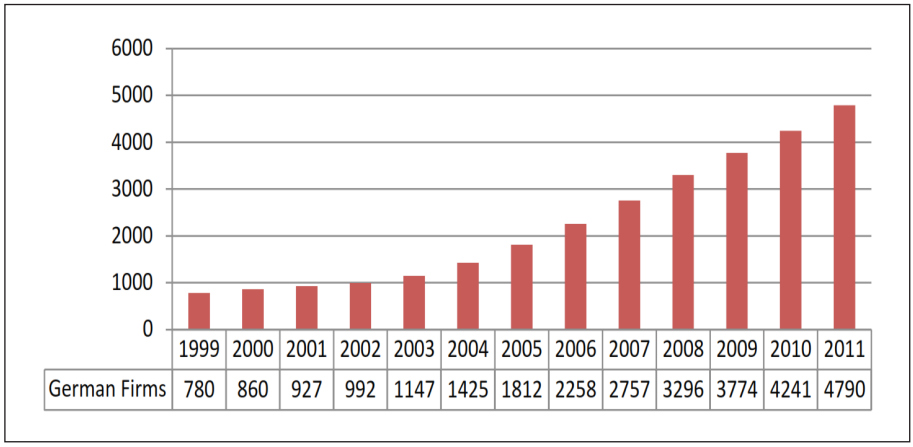


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
German Firms	81	67	65	155	278	387	446	499	539	478	467	549

Figure 1: The Annual Number of German Firms Established 2000-2011

Source: Data is gathered from Ministry of Economics Annual FDI Reports.

Although German FDI to the whole world decreased from 110.5 billion dollars in 2010 to 54.4 billion dollars in 2011 according to OECD database, the German FDI to Turkey increased from 597 million dollars to 605 million dollars in the same period.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
German Firms	780	860	927	992	1147	1425	1812	2258	2757	3296	3774	4241	4790

Figure 2: Total Number of German Firms in Turkey 2000-2011

Source: Data is gathered from Ministry of Economy Annual FDI Reports.

3.2. Innovative Activities: Patent Applications

The study proceeds with the investigations of the patent applications of the two countries. On the one hand, the Turkish patent applications with German inventors and also German applications with Turkish inventors are investigated. The data is gathered from the TPI (Turkish Patent Institute) for the period 2003-2012. International Patent Classification (8th edition, 2006) is made use of for the sectoral classification of patents. The International Patent Classification (IPC) system developed out of the Strasbourg Agreement of 1971 as an internationally acknowledged method of classifying patents for inventions, including published patent applications, utility models and utility certificates. The IPC is structured into sections, classes, subclasses, main groups and subgroups. The IPC divides patentable technology into eight key areas:

- A: Human Necessities
- B: Performing Operations, Transporting
- C: Chemistry, Metallurgy
- D: Textiles, Paper

- E: Fixed Constructions
- F: Mechanical Engineering, Lighting, Heating, Weapons
- G: Physics
- H: Electricity

In this study, the IPC is acknowledged according to the first digit (e.g. patent data with IPC number E04H 12/22 and E04B 2/74 both considered as E: fixed construction).

3.2.1. Descriptive analysis of Patent Data for Turkish Patent Applications with German Inventors (2003-2011)

This analysis is comprised of Turkish Patent Applications with German Inventors and German Patent Applications with Turkish Inventors. SPSS 18.0 software package is employed for statistical analysis of the data gathered from the Turkish Patent Institution. For the period between 2003 and 2011, the total number of patent applications to Turkish Patent Institute is 48465. Among these 48465 applications, 16422 of them are domestic and 32043 of them are foreign applications. In between 2003-2011 only 57 of the domestic patent applications possessed a German inventor. Since Turkey and Germany are economically closely tied to each other, 57 is fewer than expected. Figure 3 indicates that the highest Turkish patent application with German Investors is in 2005 and the number of applications is 20. These twenty applications were made by Huppe. In 1995, Huppe Germany bought Intermart, which was established by Turkish entrepreneurs under the name Intermart in Adana in 1986, and the name of the company altered to 'Huppe Turkey'.

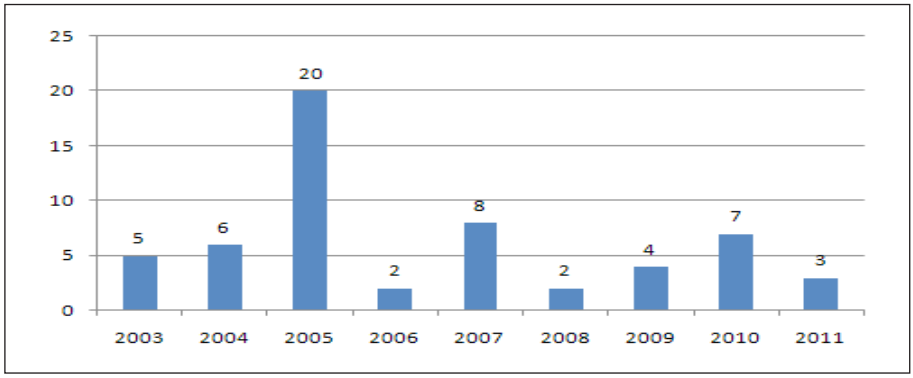


Figure 3: Turkish Patent Applications with German Inventors (2003-2011)

Source: Statistics are gathered from Turkish Patent Institute.

Figure 4 exhibits the sectoral classification of patents by means of the International Patent Classification (8th edition, 2006) in between 2003-2011. There are 19 applications in Human Necessities, 15 in Performing Operations and Transporting, 13 applications in mechanical engineering lighting, heating and weapons, 8 applications in fixed construction 2 applications in textiles and paper, no applications in physics and electricity sectors and in chemistry and metallurgy.

Table 5 represents the classification of Turkish Applications with German Inventors from 2003 to 2011.Tekirdağ is first in the ranking with 28 applications. 20 of these 28 applications were made by the same company, Huppe Insaat Malzemeleri San. ve Tic. A.Ş. Istanbul has the second placement with 28 applications. Ankara is the third in the ranking and has 12 applications. This result implies that the most of the patent applications are made from Marmara Region, which acts like a gateway between Europa and Asia.

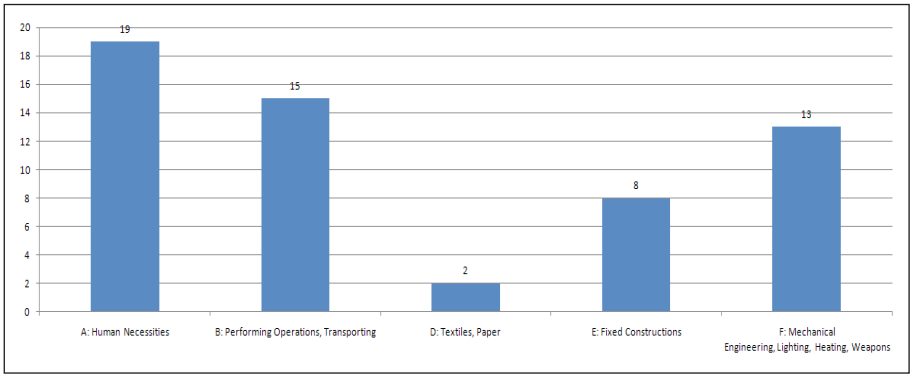


Figure 4: IPC of Turkish Applications with German Inventors (2003-2011)

Source: Statistics are gathered from Turkish Patent Institute.

Table 5: Regional distribution of Turkish Applications with German Inventors (2003-2011)

	Frequency	Percentage
Tekirdağ	28	49
İstanbul	16	28
Ankara	7	12
İzmir	2	4
Kocaeli	2	4
Bursa	1	2
Kayseri	1	2

Source: Statistics are gathered from Turkish Patent Institute.

3.2.2. Descriptive analysis of Patent Data for German Patent Applications with Turkish Inventors (2004-2011)

SPSS 18.0 is used for statistical analysis of the data gathered from the Turkish Patent Institution. The total number of German Patent Applications with Turkish Inventors is 97.

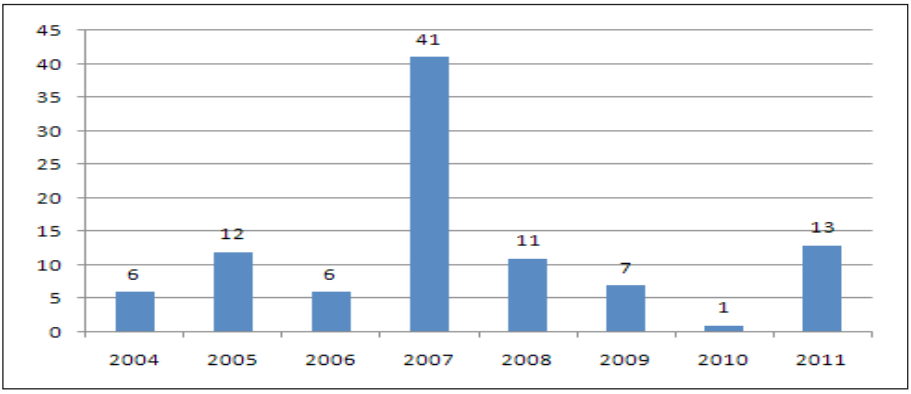


Figure 5: German Patent Applications with Turkish Inventors (2004-2011)

Source: Statistics are gathered from Turkish Patent Institute.

The highest German patent application with Turkish Investors is in 2007 and the number of applications is 41. 30 applications belong to the same company, Robert Bosch GmbH, which is located in Stuttgart (Figure 5). Figure 6 shows the sectoral classification of patents according to the International Patent Classification (8th edition, 2006) in between 2004-2011. There are 62 applications in mechanical engineering, lighting, heating and weapons, 22 in Performing Operations and Transporting, 6 applications in electricity sectors 3 applications in Human Necessities, 2 applications in fixed construction, 2 applications in physics, no applications in chemistry and metallurgy and no applications in textiles and paper.

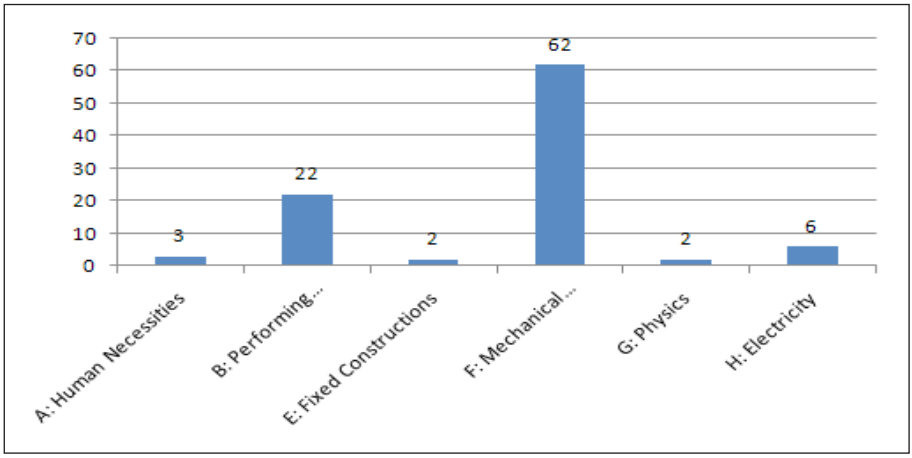


Figure 6: Sectoral Classification of German Applications with Turkish Inventors (2004-2011)

Source: Statistics are gathered from Turkish Patent Institute.

Table 6: Regional distribution of German Applications with Turkish Inventors (2004-2011)

City	Frequency	Percentage
Stuttgart	71	73
München	11	12
Wiehl	4	4
Rehau	3	3
Wiedenzhausen	3	3
Bacharacher	2	2
Frankfurt am Main	1	1
Mannheim	1	1
Rüsselsheim	1	1

Source: Statistics are gathered from Turkish Patent Institute.

Table 6 represents the regional distribution of German Applications with Turkish Inventors from 2004 to 2011. Stuttgart is the lead in the rank-

ing with an application number of 73. Stuttgart is also the city with one of the highest number of Turkish-German citizens in Germany, as well as being dominated by patent oriented industries. The locomotive industry is basically the automotive. Munich has the second placement with 12 applications.

4. Econometric Analysis of FDI and Patents

This part is designed to fulfil the data analysis of the connection between FDI flows and the number of patent applications in Turkey. This analysis is divided into two parts in order to investigate the impact of total FDI inflow to Turkey on patent applications and the effect of German-based FDI inflow to Turkey on German-based patent applications. The data of both sets are annual and cover the period from 1999 to 2012. Patent data and FDI data are obtained from Turkish Patent Institute and Central Bank of Turkey databases respectively.

4.1. Correlation and Regression Analyses

According to the correlation and OLS regression results (Table 7 and Table 8), there is a significant relationship between FDI inflow to Turkey and patent applications to Turkish Patent Institute. The correlation between German FDI and German based patent applications (0.768) is higher than the correlation between total FDI inflow and foreign-based patent applications (0.704). This shows that, the relationship between Germany and Turkey is more generative with respect to average effect of all countries investing and patenting in Turkey.

Table 7: Correlation Results

	German FDI	German Patents
German FDI	1.000000	0.767943
German Patents	0.767943	1.000000

	Total FDI	Foreign Patents
Total FDI	1.000000	0.704044
Foreign Patents	0.704044	1.000000

Regression results at Table 8 also indicate that, German based FDI-patent interaction is higher in line with statistically significant positive coefficients. In the model investigating the relationship between German FDI and German-based patents from 1999 to 2012, the coefficient of German FDI is 0,516 while the interaction of total FDI inflow is 0,329 with a smaller estimation coefficient value.

Table 8: OLS Regression Results

Independent Variable	Dependent Variable	
	Foreign-based Patent Applications	German-based Patent Applications
Constant	5,178*** (1,108)	3,661*** (0,847)
Total FDI inflow to Turkey	0,329** (0,118)	
German-based FDI inflow to Turkey		0,516*** (0,133)
R-squared	0,427	0,546

Notes: Dependent and independent variables are logarithms in both models. Standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

4.2. Granger Causality Analysis

In addition to correlation and regression analyses, Granger causality test is applied to FDI-Patent relationship. Granger (1969) methodology is used in this section by transforming his causality equations with our variables. German FDI and German patents relations are hypothesized by estimating equations 1 and 2.

$$\Delta GermanPatents_{i,t} = \sum_{k=1}^{p} \beta_k \Delta GermanPatents_{i,t-k} + \sum_{k=0}^{p} \theta_k \Delta GermanFDI_{i,t-k} + v_{i,t} \quad (1)$$

$$\Delta GermanFDI_{i,t} = \sum_{k=1}^{p} \beta_k \Delta gGermanFDI_{i,t-k} + \sum_{k=0}^{p} \theta_k \Delta GermanPatents_{i,t-k} + u_{i,t} \quad (2)$$

On the other hand, the causality relation between total FDI and foreign patents are hypothesized via estimating equations 3 and 4.

$$\Delta ForeignPatents_{i,t} = \sum_{k=1}^{p} \beta_k \Delta ForeignPatents_{i,t-k} + \sum_{k=0}^{p} \theta_k \Delta TotalFDI_{i,t-k} + v_{i,t} \quad (3)$$

$$\Delta TotalFDI_{i,t} = \sum_{k=1}^{p} \beta_k \Delta gTotalFDI_{i,t-k} + \sum_{k=0}^{p} \theta_k \Delta ForeignPatents_{i,t-k} + u_{i,t} \quad (4)$$

According to our results showed at Table 9, one-way causality evidence is observed from German FDI to German-based patents with 2 lags at 10% significance level. That corresponds, FDI inflow from Germany fosters patents applied by German applicants and hypothesis (equation 1) is verified. Besides, there is also a one way causality relationship from total FDI inflow of Turkey to foreign-based patents with 3 lags at 5% significance level, which can be monitored at Table 10. This shows that, knowledge and technology flow transformed to patents by German based FDI before average. German based FDI might be more effective and integrated because of organic bonds between Turkey and Germany.

Table 9: Granger Causality Test Results I

Equation	Hypothesis	F-Stat	Lag
(1)	German FDI Granger Cause German-based Patents	1,588	1
		4,047*	2
		3,197	3
(2)	German-based Patents Granger Cause German FDI	3,306	1
		2,395	2
		1,387	3

Notes: * p < 0.10, ** p < 0.05, ***p < 0.01.

Table 10: Granger Causality Test Results II

Equation	Hypothesis	F-Stat	Lag
(3)	Total FDI Granger Cause Foreign-based Patents	1,961	1
		1,136	2
		22,870**	3
(4)	Foreign-based Patents Granger Cause Total FDI	0,227	1
		2,472	2
		2,905	3

Notes: * p < 0.10, ** p < 0.05, ***p < 0.01.

5. Conclusion and Implications for Further Research

This working paper aims to identify Turkish-German economic relationship within the limits of foreign direct investment and patents in line with the Turkish-German collaboration project TGIN. In order to expand this involvement to sectoral diversification, FDI and patent information sources are examined in-depth. FDI data has been gathered from annual reports of the Ministry of Economy, Turkish National Bank online database and OECD online database. Patent data has also been investigated from many online databases such as OECD, EuroStat and European Patent Institute, but data has been gathered from Turkish Patent Institute because TPI offers further periods for patent data. Moreover, the relationship between patents and FDI is also tested with econometric methods such as correlation, regression and Granger causality.

Foreign Direct Investment (FDI) appeal of countries varies according to domestic as well as international economic and political junctures and furthermore, depends on the domestic institutional infrastructure of the country. The Turkish perspective towards foreign capital has been transformed after 2003 legal regulations, which paved the way to better collaboration between local firms and FDI. Turkish provisions concerning patents have also been upgraded in laws No 4128 and No 5194 after 1995. Many changes on these issues have taken place due to the Customs Union between EU and Turkey, under which Turkey had to harmonize its legislation in line with the Community legislation in relevant trade-related fields such as technical barriers to trade and competition policy, and patents and intellectual property rights (Balkır, 2010: 1-16).

Turkey is party to the Paris Convention, the Patent Cooperation Treaty (PCT), the Strasbourg agreement and the Budapest Treaty on the Deposit of Microorganisms, as well as the European Patent Convention. Turkey has also signed the Patent Law Treaty.[12] Turkey renewed its Foreign Direct Investment Law (Law No. 4875) in 2003. The indicated law intends to set guidelines for encouraging foreign direct investments, protect the rights of

[12] For detail, see European Union Screening Report Turkey Chapter 7 – Intellectual property law, http://ec.europa.eu/enlargement/pdf/turkey/screening_reports/screening_report_07_tr_internet_en.pdf

foreign investors, and provide investor compliance with international standards. In the aftermath of the establishment of that law, the FDI rank of Turkey has steadily increased and started to converge to top ten countries in the ranking. Besides ranking, the share of FDI in the total global share has also increased. The FDI accrual to Turkey increased agilely after 2003 until the 2008 world economic crisis. During the last economic crisis, the FDI flow to Turkey diminished more than a half.

Germany's FDI inflow to Turkey followed a continuous increase from 2005 to 2008 and from 2009 to 2011 despite the crisis effect. Also the share of Germany in total FDI increased from 2006 to 2010 continuously. The number of German firms established in Turkey stands clearly in the first rank with respect to all other countries from 1954 to 2012 period with a total of 4885 firms.

According to the data gathered from the Turkish Patent Office, the number of Turkish patent applicants with German inventors is 57 between the years 2003-2011. On the other hand, the percentage of Turkish origin German inventors among all the inventors is 12. As far as sectoral classification is concerned, 19 is the highest number of Turkish Applications with German Inventors and it is in Human Necessities. Tekirdağ is the city with the highest percentage of patent applications with 49%. In between 2004-2011, the total number of German applications with Turkish Inventors is 97. The highest number of German Applications with Turkish Inventors is in Mechanical Engineering, Lighting and Heating. Stuttgart has an application number of 73 and is placed first in the ranking.

The ordinary least squares (OLS) regression model is used in this study to analyse the effect of total FDI inflow to Turkey on total foreign-based patent applications to Turkish Patent Institute and the effect of German FDI flow to Turkey on German-originated patent applications to Turkish Patent Institute from 1999 to 2011. In each of the two models, the dependent variables are log of annual FDI inflows and independent variables are log of annual patent applications. The results of regression tests justify the relationship between patents and FDI. The reciprocity between patent applications and FDI is more remarkable for Turkish-German interaction via flow of FDI and patents. In other words, German FDI transformed into patents with less scrap.

Correlation coefficients between FDI inflows and patent applications showed the same rather than Granger causality results. The foreign-originated correlation is around 0.70 but German-originated stands nearly 0.76. Granger causality testing is also applied to examine cause-effect relationship between FDI and patents. German-based FDI fosters patent applications faster with respect to foreign-based FDI to patent transformation.

The social aspects of this bridge between Turkey and Germany could be supported by data and econometric analyses in terms of economic, knowledge and investment linkage as well as case study analysis. Forthcoming studies could also cover social aspects of Turkey-Germany relations arise from migration since 1960s, which creates data and case studies. There are interesting case studies of the interaction between Turkey and Germany, which offer widespread sector-base, firm-base and/or entrepreneur-base facts, waiting to be observed from an economic, social and scientific perspectives. Academia and renewable energy sector based examinations would also be densely investigated to dig out intriguing success stories from both countries. Also sectoral surveys would be expanded to get more ideas about Turkish-German connection. The network analysis and statistical tools would necessarily exist as ingredients for future studies.

References

Aslanoğlu, Erhan (2000), "Spillover Effects of Foreign Direct Investments in Turkish Manufacturing Industry", *Journal of International Development*, 12, 1111-1130.

Balkır, Canan (2010), "Turkey's Road to EU Membership: Economic Outlook", Köz-Gazdaság Special Issue No. 3, Budapest: University of Corvinus, 1-16.

Balkır, Canan (2013) German-Turkish Relations: From Immigration to Innovation Networks? TGIN Working paper No.4 p.1,

Braga, Carlos A. Primo and Carsten Fink (1999), "The Relationship between Intellectual Property Rights and Foreign Direct Investment", *Duke Journal of Comparative & International Law*, 9, 163-181.

Branstetter, Lee (2006), "Is foreign direct investment a channel of knowledge spillovers? Evidence from Japan's FDI in the United States" *Journal of International Economics*, 68, 325-344.

European Commission, Inno-Policy TrendChart-Innovation Policy Progress Report Turkey, 2009.

Çeştepe, Hamza and Şevket Tüylüoğlu (2006), "Yabancı Doğrudan Yatırımlar Yoluyla Teknoloji Transferi: İrlanda Örneğinden Tükiye İçin Dersler", *Ankara Üniversitesi SBF Dergisi*, 61(2), 45-62.

Damijan, Joze P., Mark Knell, Boris Majcen, and Matija Rojec (2003), "The Role of FDI, R&D Accumulation and Trade in Transferring Technology to Transition Countries: Evidence from Firm Panel Data for Eight Transition Countries", *Economic Systems*, 27, 189-204.

FDI Annual Reports, Ministry of Economy, Republic of Turkey: http://www.ekonomi.gov.tr/index.cfm?sayfa=EFA4F979-D8D3-8566-45204113F4424A25 (Erişim: 16.01.2013)

FDI Statistics, Ministry of Economy, Republic of Turkey: http://www.ekonomi.gov.tr/index.cfm?sayfa=F91901DD-D8D3-8566-4520D35C6C07575F (Erişim: 16.01.2013)

Ford, Timothy C. and Jonathan C. Rork (2010), "Why buy what you can get for free? The effect of foreign direct investment on state patent rates", *Journal of Urban Economics*, 68(1), 72–81.

Garcia, Francisco, Byungchae Jin and Robert Salomon (2012), "Does inward foreign direct investment improve the innovative performance of local firms?", *Research Policy*, 42, 231-244.

Germany meets Turkey Forum: http://www.culturaldiplomacy.org/germanymeetsturkey/index.php?en_forum_the-state-of-relations (Erişim: 27.12.2012)

Gloor, Peter, Maria Paasivaara, Detlef Schoder and Paul Willems (2006), "Correlating Performance with Social Network Structure Through Teaching Social Network Analysis", 7th IFIP Conference on Working Enterprises.

Gülcan, Yaprak, Sedef Akgüngör and Yeşim Kuştepeli (2009), "Regional Innovation Systems and Knowledge Generation in Turkish Textile Industry: A Comparison of İstanbul and Denizli Regions", 4th International Seminar on Innovation, October 15-16, Napier University, Edinburgh.

Granger, C.W.J. (1969), "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", *Econometrica*, 37(3), 424-438.

Industry General Directorate, (2010), Türk Makina Sanayi, . (Erişim: 25.01.2013)

Lesser, William (2002), "The Effects of Intellectual Property Rights on Foreign Direct Investment and Imports into Developing Countries in the Post-TRIPS Era", *IP Strategy Today*, 5, 1-16.

Ministry of Customs and Trade and Turkish Statistical Institute: http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=10782 (Erişim: 01.02.2013)

Navaretti, Giorgio Barba and David Tarr (2000) "International Knowledge Flows and Economic Performance: A Review of the Evidence", *The World Bank Economic Review*, 14(1), 1-15.

Press Release about FDI Statistics, Ministry of Customs and Trade & Turkish Statistical Institute, Republic of Turkey: http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=10782 (Erişim: 01.02.2013)

Pyka, Andreas (2001), "Innovation Networks in Economics – From the incentive-based to the knowledge-based Approaches", *European Journal of Innovation Management*, 5(3), 152-163.

Pyka, Andreas and Tobias Buchmann (2011), "Innovation Networks", Ed. Jackie Krafft and Michael Dietrich, *Handbook on the Theory of the Firm*, Cheltenham, UK: Edward Elgar Publisher.

Saxenian, Anna Lee (2006), *The New Argonauts: Regional Advantage in a Global Economy*, Cambridge, MA: Harvard University Press.

Seyoum, Belay (2006), "Patent Protection and Foreign Direct Investment", *Thunderbird International Business Review*, 48(3), 389-404.

TPI (Turkish Patent Institute) Patent Search Engine: http://online.tpe.gov.tr/EPATENT/servlet/EPreSearchRequestManager (Erişim: 16.01.2013)

TPI (Turkish Patent Institute) Patent Statistics Manual: http://online.tpe.gov.tr/EPATENT/servlet/EPreSearchRequestManager (Erişim: 16.01.2013)

TPI (Turkish Patent Institute) Patent Statistics Manual: TÜİK, Turkish Statistical Institute, www.tuik.gov.tr (Erişim: 16.01.2013)

Appendix

Table A1. Sectoral Distribution of German-owned Firms in 2012

Sector	Firms
Wholesale Trade and Trade Brokerage	988
Construction	404
Other Business Activities	397
Hotels and Restaurants	300
Retail Trade and Repair of Goods	261
Electricity, Gas, Steam and Hot-water production and distribution	188
Transport Activities	182
Real Estate	178
Computer and Related Business	177
Retail Fuel Sales	117
Machinery and Equipment Manufacturing	113
Chemical Products Manufacturing	102
Food and Beverages	93
Other Service Activities	85
Textile Products Manufacturing	79
Entertainment, Culture and Sport Activities	76
Health Care and Social Services	76
Metal Products Manufacturing	75
Motor Vehicles' Manufacturing	73
Postal and Telecommunications	73
Furniture Manufacturing	62
Agriculture and Hunting Related Service Activities	61
Electrical Machinery and Equipment Manufacturing	57
Land Carriage and Transport via Pipeline	49
Printing and Publishing	41
Plastic and Rubber Products Manufacturing	38

Table A1. Continued

Sector	Firms
Radio, TV and Communication Apparatus	35
Non-metallic Products Manufacturing	34
Education Services	34
Other Transport Vehicle Manufacturing	31
Wearing Apparel Manufacturing	28
Main Metal Industry	27
Waterway Transport	23
Public Administration	20
Leather Processing	19
Activities auxiliary to financial intermediation	19
Wood and Mushroom Products Manufacturing	17
Financial Institutions" Activities	17
Paper and Paper Products Manufacturing	16
Recycling	15
Water Collection, Purification and Distribution	14
Crude Oil and Natural Gas Extraction and Related Service Activities, Except Research and Exploration	14
Air Transport	12
Insurance and Pension Fund Related Activities	11
Forestry Activities	10
Sewage and Waste Collecting	9
Machinery and Goods Rental	9
Mining of Metal Ores	5
Fishery	4
Office, Accounting and Computing Machinery	4
Research & Development	4
Home services	1

Source: Statistics are gathered from Ministry of Economy.[13]

[13] http://www.ekonomi.gov.tr (Erişim 01.02.2013)