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ABSTRACT

The main purpose of this paper is to test the impacts of foreign direct investments and imports on research and development intensities of European Countries and Turkey. A panel data analysis has been applied to test the relationship between foreign direct investments, imports and research and development intensity for the time period of 1995 – 2007. Following the literature, we assumed that foreign direct investments have positive and import has negative impacts on research and development intensity. Moreover as a result of econometric estimation, we explored that net foreign direct investments inflows, one-year lagged value of net foreign direct investments inflows and one-year lagged value of research and development intensity have positive impacts on the current research and development intensity. On the other hand, current value of imports and its one-year lagged value have statistically no significant effect on the dependent variable.

Key Words: R&D Intensity, FDI, Panel Data Analysis

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1. INTRODUCTION

Economic globalization implies a growing interdependence of locations and economic units across countries and regions. Tecnological change and multinational enterprieses are among the primary driving forces of this process (Narula and Zanfei,2007, 318). Although the internationalization of research and development (R&D) activities is not a new issue, in recent years it has been taking increasing attention both in literature and policy implementations in especially developing countries. Internationalization of research and development activities move through foreign direct investments (FDIs), international trade, patenting activities, international technological and scientific collaborations.

According to the literature, FDI is one of the main factors which provide the flow of R&D activities. As known, multinational companies are leaders in many industries at the international scale. They dominate new patents and often lead innovation in both management and organization.

From this aspect, according to UNCTAD (2005) one of the main reasons of why especially developing countries promote foreign direct investment (FDI) inflows is to access global technology and innovation networks. One of the strongest and most popular arguments in favor of inward investment as a vehicle for local technological upgrading is that foreign firms usually outperform domestic ones (Narula and Zanfei, 2007: 338) . This issue is a very important for Turkey as well. If Turkey would be able to attract more FDI, it could be enhance its R&D activities and as a result it could be more competitive in the international markets.

Hence, the main purpose of this paper is to explore mainly the impact of foreign investments on R&D activities of European Countries and Turkey. Hence the main contribution of this paper will be on the analysis on EU – 15 region and Turkey which have not been analyzed in detail, in the empirical literature yet. The rest of the paper proceeds as follows, Section 2, evaluates some indicators about overall R&D intensity and foreign controlled R&D intensity for European countries and Turkey. Section 3 presents a brief review of literature. Section 4 describes data and method and the empirical results. Section 5, provides brief concluding remarks.

2. THE INTERNATIONALIZATION OF R&D ACTIVITIES OF EUROPEAN COUNTRIES AND TURKEY

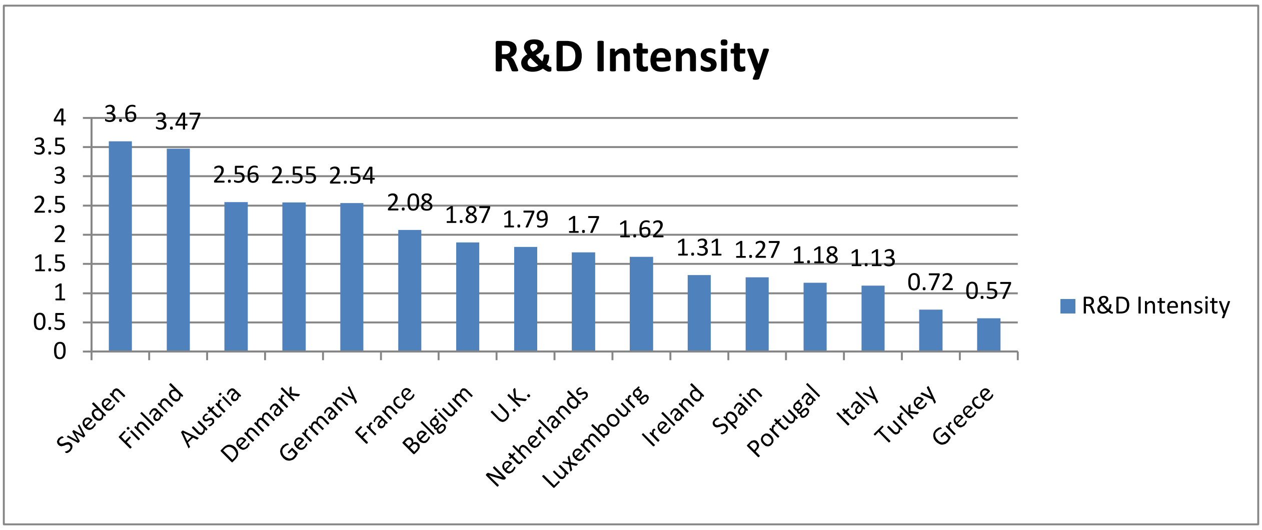
This section presents European countries and Turkey's some important indicators related with R&D activities, FDI and imports which provide some information about the flow of innovative activities.

Thus, the first indicator compares R&D intensities of countries. As a general description, R&D intensity is the ratio of R&D expenditures to some measure of output. For a firm, it is usually the R&D/Sales ratio. For an industry or a country, it is the ratio of business expenditure on R&D (often known as BERD) to total production or value added. For a country it is usually gross expenditure on R&D (GERD) to GDP. The R&D/GDP ratio is used in two primary ways. First, it's used to characterize industries from the view that high BERD/GDP ratios for an industry are held to identify high-technology activities. Second, a high GERD/GDP ratio for a country is often believed to indicate technological progressiveness and commitment to knowledge creation." (Smith, 2005: 155).

Europe's R&D intensity is still at a lower level than most of the other major economies like USA and Japan. After a period of slow growth between the mid-1990s and 2001, the Union's R&D intensity stagnated in 2001-2002 and decreased after that time. In 2005, in EU-27, only 1.84 % of GDP was spent on R&D. On the other hand, in Japan, US and South Korea, the trend over the past decade has been much more positive. As a result, the R&D intensity gap between European Union and its main competitors has not been reduced at all (European Commission, 2007: 15).

Figure 1 shows the R&D intensities of European countries and Turkey for the year of 2007. Figure has been constructed for EU – 15 countries and Turkey by using the data in EUROSTAT (2009).

Figure 1: R&D Intensity (GERD as % of GDP), 2007



Source: EUROSTAT (2009). http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/R_&_D_expenditure.

As seen that Sweden has the highest R&D intensity level and Finland, Austria, Denmark and Germany display high performances. Also Turkey shows lower performance than the most of the EU – 15 countries.

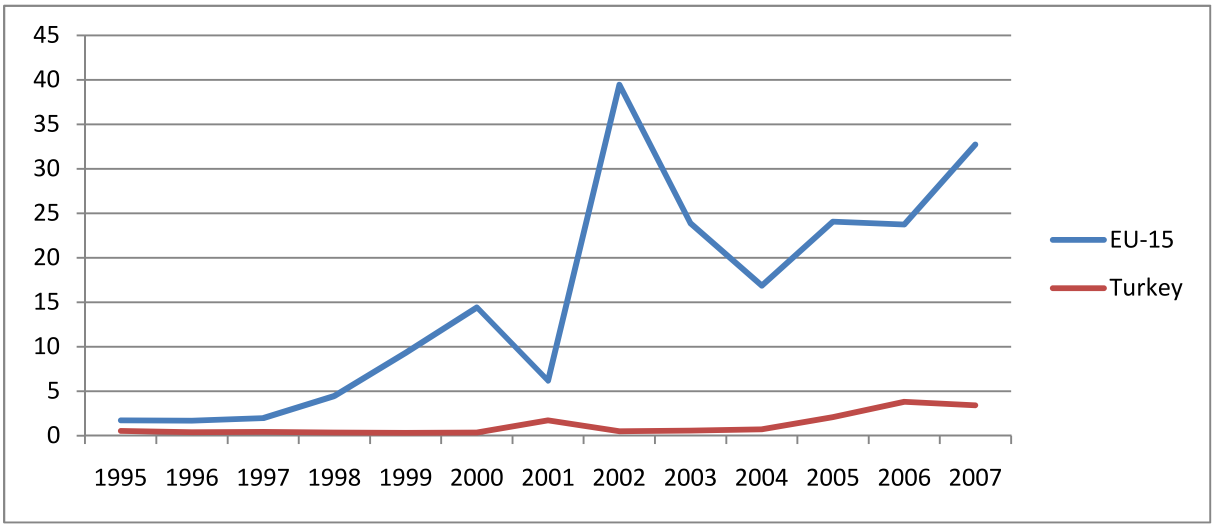
According to UNCTAD (2005), transnational companies (TNC), in other words foreign direct investments, account for a major share of global R&D. With $310 billion spent in 2002, the 700 largest R&D spending firms of the world accounted for %46 of the world's total R&D expenditures and %69 of the world's business R&D (UNCTAD, 2005, p. 119). Consequently, the developments at the worldwide prove the idea behind the hypothesis about the positive impact of FDI on R&D internationalization.

"R&D expenditure by affiliates of foreign companies is contributing increasingly to R&D spending in all EU Member States. In Germany, Ireland, Greece, Spain, France, the Netherlands, Portugal, Finland and the United Kingdom the increase has been less marked but still substantial. Only Turkey experienced a decrease." (European Commission, 2007: 69). The most probable reason of this failure in Turkey is that Turkey is a country which has been experiencing economic crises during 1995 and 2004. Turkey was affected by the global crisis originated from the Asia (1997) and the Russia (1998). In 1999, a huge earthquake occurred in Turkey. In 2000 and 2001, two major economic crises stemmed from mainly banking sector. Many private banks went bankrupt and several private credits called back. Consequently, Turkish business environment may not be very secure for the foreign investors then.

In order to show the positive relationship between FDI inflows and R&D activities in a more clear way for the EU – 15 area and Turkey, it should be better to take a look at the trends in both FDI inflows and R&D intensities for these countries.

The Figure 2 and 3 were constructed by the data retrieved from World Bank's World Development Indicators (WDI) Online Database. The Figure 2 shows FDI inflows in EU – 15 and Turkey for the time period of 1995 – 2007. Turkey shows a steady performance between those years in attracting FDI and its performance is significantly below the EU – 15.

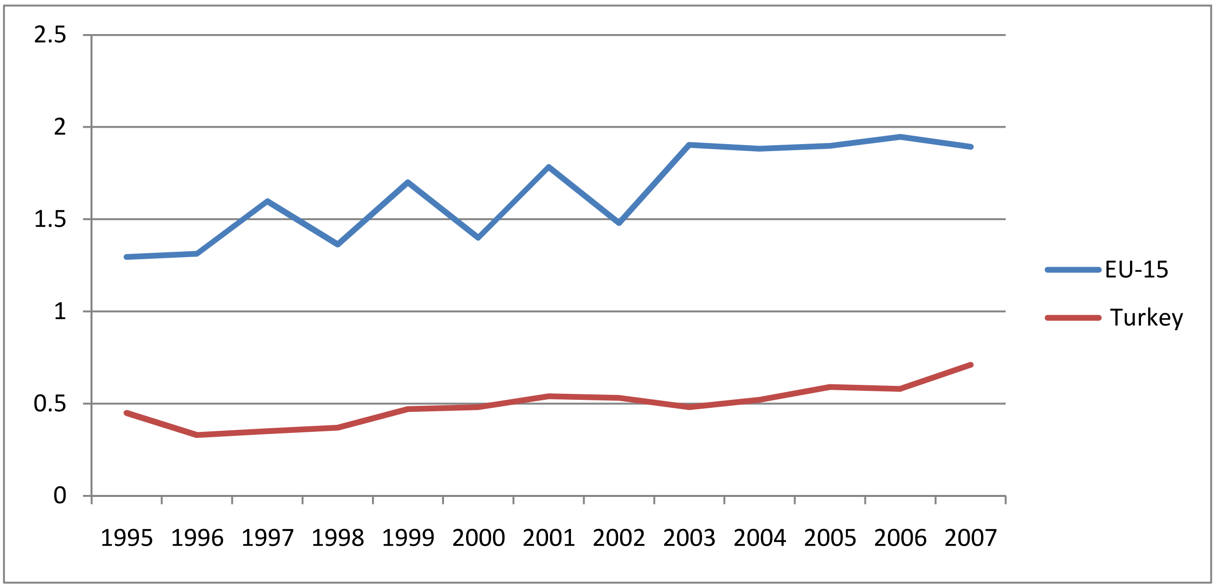
Figure 2: FDI Inflows in EU – 15 and Turkey (1995 – 2007)



Source: Worldbank (2009).

The Figure 3 reveals the R&D intensities as to years of 1995 – 2007 of EU – 15 countries and Turkey. As seen that Turkey expresses a similar performance with FDI inflows. The path is steady and the R&D intensity performance of Turkey is very low. On the other hand, R&D intensity performance of EU – 15 countries is significantly higher than the Turkey like in FDI inflows and also there may seem a slight positive trend.

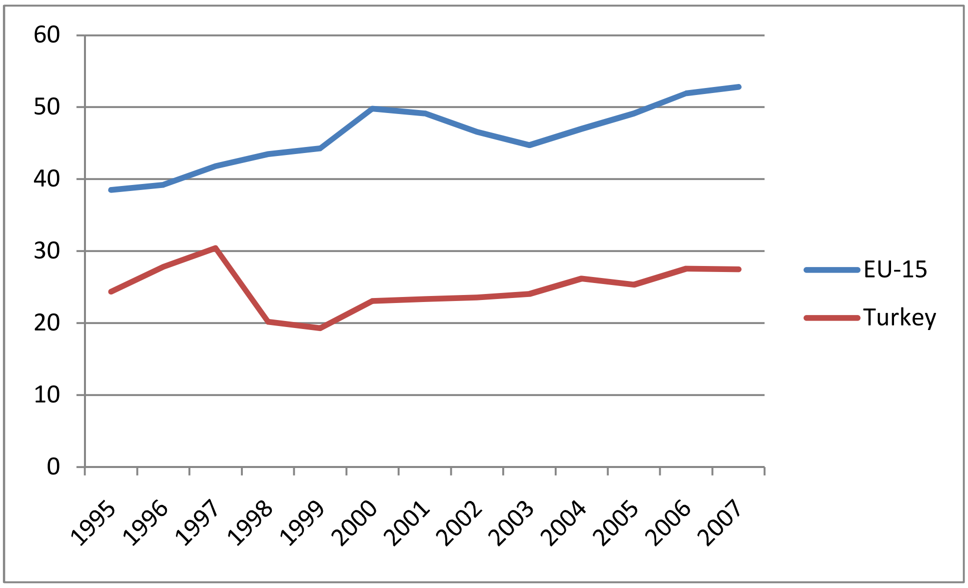
Figure 3: R&D Intensities in EU – 15 and Turkey (1995 – 2007)



Source: Worldbank (2009)

Finally, another important determinant of R&D activities is imports of technology, goods and services as well. Following the related literature, the main idea behind the imports and R&D intensities relationship has been that if a good or a technology is cheaper to import for firms or countries, they would probably choose to import that technology or good rather than invest in R&D. As seen from the figure below, between 1995 and 2007, although imports of EU-15 countries have a smooth increase, imports of Turkey show a fluctuation. Turkey's imports have a similar pattern with EU-15 since 2000.

Figure 4: Imports of Goods and Services (% of GDP) in EU – 15 and Turkey (1995 – 2007)



Source: Worldbank (2009).

3. LITERATURE REVIEW

There is a wide literature about R&D and FDI relationship. Probably the most significant studies about internationalization of R&D and its relation to FDI are: the World Investment Report published in 2005 and OECD report published in 2006. This section expresses the related econometric literature properly. The most important and recent empirical studies in this area are summarized in Table 1.

Table 1 : Summary Table About the Empirical Literature

Author	Data Set	Method	Findings
Bitzer and Kerekes (2008)	10 manufacturing sectors of 17 OECD countries 1973 – 2000	Panel Data Analysis	There are positive and statistically highly significant knowledge spillovers stemming from inward FDI.
Zhu and Jeon (2007)	21 OECD countries and Israel 1981 – 1998	Panel Data Analysis with Dynamic OLS Panel Cointegration	Although bilateral FDI was found to be positively related to international R&D spillovers, their impact on productivity growth was relatively slow.
Kök and Şimşek (2006)	19 OECD countries 1995 – 2001	Panel Data Analysis	FDI has a positive impact on technological spillovers.
Jaumotte and Pain (2005)	20 OECD countries 1982 – 2001	Panel Data Analysis	The main determinants of innovativeness were found to be availability of scientists and engineers, research conducted in the public sector, business-academic links, the degree of product market competition, a high level of financial development and access to foreign inventions.
Lin and Yeh (2005)	Taiwan's 7336 firms 1998	Cross-section analysis An endogenous switching regression model	FDI and R&D are positively related and do reinforce each other.
Taymaz and Lenger (2004)	28 three digit level Turkish manufacturing industris 1983 - 2000	Dynamic panel data analysis	There is a relationship between R&D intensities and multinational firms' manufacturing spillovers but the sign and size of the relation changes according to time and the sizes of domestic firms.
Li and Hu (2004)	Taiwan's SMEs 1989 – 1996	Panel Data Analysis	FDI reinforces the marginal benefit of R&D and also the R&D expenditure of multinational SMEs is higher than domestic SMEs.
Damijan et al. (2003)	Firm level data for 8 transition countries 1994 – 1998	Panel Data Analysis Probit Model	Technology is primarily transferred to local firms through direct foreign linkages. FDI is an important direct channel of technology transfer in Czech Republic, Estonia, Poland, Romania and Slovenia.
Potterie and Lichtenberg (2001)	22 industrialised countries 1971 – 1990	Panel Data Analysis	They indicated that FDI transfers technology but only one direction which meant a country's productivity increases if it invests in R&D-intensive foreign countries but not if foreign R&D-intensive countries invest in it.
Braconier et al. (2001)	Firm level and industry level data for Swedish economy 1978 – 1994	Panel Data Analysis	There is no evidence of FDI-related R&D spillovers neither at the firm-level nor at the industry-level in Swedish manufacturing. The unique variable consistently affecting total factor productivity was found to be own investment in R&D.
Kinoshita (2000)	13 OECD countries 1995 – 1998	Panel Data Analysis	FDI inflows are positively significant determinant of R&D activities.

Table 1 – Continued : Summary Table About the Empirical Literature

Hejazi and Saferian (1999)	22 OECD countries and Israel 1970 – 1990	Panel Data Analysis	Technological spillovers are likely to be larger through FDI and international trade.
Coe et al. (1997)	77 developing countries 1971 – 1990	Panel Data Analysis	A developing country could boost its productivity by importing a larger variety of intermediate products and capital equipment embodying foreign knowledge, and by acquiring useful information that would otherwise be costly to obtain.
Bertschek (1995)	1270 firms 1984 – 1988	Chamberlain's random effects probit approach	Both import share and FDI-share have positive and significant effects on product and process innovations.

Note: Constructed by authors.

As seen that, although different sample countries and years have used in different analyses, the results are mainly similar. According to these studies, R&D activities and FDI are closely related, except the study of Braconier et al. (2001). This paper focuses on this relationship for the EU-15 countries and Turkey in the light of this wide empirical literature.

4. DATA, METHOD AND ECONOMETRIC ESTIMATION

4.1. Data Set and Variables

Data set of this paper consists of 16 countries such as Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, Turkey and United Kingdom for the time period of 1995 – 2007. Our data set is an unbalanced panel data set. The time period has been chosen due to the lack of data on R&D intensities out of this period. Also, EU-15 countries have only been chosen for the analysis of European region due to the same problem. Although it would be better to take into account wider range of countries like EU – 27, there is lack of data especially on R&D intensities.

R&D intensity is the dependent variable of the model estimated in this paper. Net FDI inflows as a percentage of GDP and imports of goods and services as a percentage of GDP are the main independent variables. Moreover the lagged values of the dependent variable and the independent variables have been used for the most proper model, while different models have estimated. These variables were chosen by following the related empirical literature and all the data were retrieved from WDI Online Database "World Bank, (2010)". E-Views 5.1 econometrics program was used in order to estimate the regressions.

R&D intensity is the main indicator showing the R&D performance of a country. It is measured by the ratio of R&D expenditures on the country's GDP. Net FDI inflows as a percentage of GDP shows the attractiveness of a country from the perspective of foreign direct investments. If net FDI inflows are high in a country, it means, this country is an attractive country. Therefore, the expected sign of this variable is positive. Lastly, import performance of a country is thought as an important determinant of R&D activities. If a good or a technology is cheaper to import for firms or the country, they can prefer to import that technology or good rather than invest in R&D in order to produce it by themselves. Hence, the expected sign of this variable is negative.

4.2. Estimation Method and Results

Panel data sets have numerous advantages over cross-section and time-series data sets (Frees, 2004). First of all, they provide multiple observations on each individual in the relevant sample. Also, they usually give a wide data points by increasing the degrees of freedom and reducing the collinearity among independent variables. Hence, econometric estimates become to be more efficient. Moreover, panel data analysis allows researchers to analyze important questions that may not be answered using cross-sectional or time – series data sets (Hsiao, 2002: 1 – 3).

Before beginning estimation procedure, it should be computed unit root tests of the series. If there is unit root problem in a series, the model estimated with those problematic series will produce a spurious regression. According to all panel unit root tests applied in E-Views 5.1 econometrics program (results are given in the Appendix) there are unit root problems in series for the %5 level of significance. In order to get over this unit root problem we got the first differences of the series and used those versions in the estimated models. Table 2 summarizes the estimation results.

Table 2: Estimation Results

	D(IMP)	D(FDI)	D(RD(-1))	D(RD(-2))	D(IMP(-1))	D(IMP(-2))	D(FDI(-1))	D(FDI(-2))
Model 1	-0.0003 (-1.623)	0.0010 (14.950)***	-	-	-	-	-	-
Model 2	0.0005 (0.255)	0.0011 (2.734)***	0.0960 (3.458)***	-	-	-	-	-
Model 3	-0.0026 (-1.207)	0.0016 (2.978)***	0.1020 (1.373)	0.1396 (1.596)	-	-	-	-
Model 4	-0.0029 (-1.582)	0.0017 (3.042)***	-	-	-0.0024 (-1.073)	-	0.0019 (4.362)***	-
Model 5	-0.0018 (-0.847)	0.0021 (2.327)**	-	-	-0.0028 (-0.973)	-0.0002 (-0.089)	0.0025 (3.255)***	0.0015 (1.159)
Model 6	-0.0015 (-0.528)	0.0012 (2.325)**	0.1235 (3.706)***	-	-0.0027 (-0.951)	-	0.0020 (5.497)***	-
Model 7	-0.0061 (-0.910)	0.0032 (1.567)	0.0814 (0.329)	0.3244 (1.356)	-0.0025 (-0.228)	0.0011 (0.086)	0.0019 (0.681)	0.0047 (0.884)

Note: * %10 level of significance
**** %5 level of significance**
***** %1 level of significance.**

In Ad Hoc estimation process, different quantities of lags of variables are used in order to get the most suitable model form. As seen above, Ad Hoc estimation process have been applied in order to get the most proper empirical model for the analysis.

Generalized Methods of Moments Technique was used in order to estimate the models. Arellano and Bond (1991) introduced an efficient generalized method of moment (GMM) estimator and recent developments are summarized by Arellano (2003). Hence, both the theory of dynamic panel data analysis and the related discussion in the literature lead to select GMM estimation method as the most suitable one. When the lagged values of variables are added to the model, GMM estimation technique should be used according to the dynamic panel data analysis theory.

The first values in cells are coefficient values and the parentheses show the t values of those coefficients. The first model includes only current values of the independent variables. The second and the third models are autoregressive models, which contain lagged values of the dependent variable. The fourth and fifth models are distributed lag models, which contain lagged values of the independent variables. Lastly, the sixth and the seventh models contain both the lagged values of dependent and independent variables.

According to the estimation results, model 6 is seen as the most appropriate model. Also J statistic (10.37) of the model shows that there is no identification problem in the selection of instrumental variables (see Appendix). Our instruments covers the two year lagged value of the dependent variable. So, our model is defined in the following way:

$$RD_{it} = ß_1 FDI_{it} + ß_2 IMP_{it} + ß_3 RD(-1)_{it} + ß_4 FDI(-1)_{it} + ß_5 IMP(-1)_{it} + u_{it}$$

The econometric estimation results show that net FDI inflows has positive and statistically significant effect on current R&D intensity for the significance levels of %5 and %10. Although this result is contradicting with Braconier et al. (2001), it is agree with the results of Bitzer and Kerekes (2008), Zhu and Jeon (2007), Kök and Şimşek (2006), Jaumotte and Pain (2005), Lin and Yeh (2005), Li and Hu (2004), Damijan et al. (2003), Potterie and Lichtenberg (2001), Kinoshita (2000), Hejazi and Saferian (1999) and Bertschek (1995).

Also, current import level and its one-year lagged value have statistically no significant effects on the R&D intensity. This finding is contradicting with the results of Hejazi and Saferian (1999), Coe et al. (1997) and Bertschek (1995).

5. CONCLUSIONS

Internationalization of R&D through foreign direct investments and trade has been seen as one of the main outcomes of globalization in the literature. In this paper we tried to test this relation for the EU-15 countries and Turkey for the time period of 1995 – 2007. According to our econometric estimation results, R&D intensity, which shows the R&D investments of a country, is affected by the R&D intensity of previous year, current net FDI inflows and its previous year value. However we couldn't find any significant relationship between imports and R&D intensity for the relevant country group and time period. Our findings are mainly complementary with the related literature. But our study is restricted to European 15 countries as a result of the lack of time series data, especially on R&D intensity. This study can be extended to be added more countries data related to European region. It will be provided better comparisons for Turkey.

According to our estimation results and the results od other studies in the related literature, FDI inflows plays a major role within innovative activities and hence governments need to become actively involved in fostering the FDI inflows. Although Turkey experiences a smooth increase in FDI inflows during last decade, it still lags far behind the EU-15 average. Consequently, Turkey who tries to join EU community, should increase its FDI inflows in order to enhance innovative acitivities inside of the country. Moreover Turkey should also implement other policy options which encourage R&D expenditures in both public and private sectors. Although again there is a slight increase in R&D intensities in Turkey over the last decade, this indicator still lags far behind the EU-15.

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APPENDIX

Table – A1: Panel Unit Root Test on RD

Method	Statistic	Prob.
Levin, Lin & Chu t* (Assumes Common Unit Root Process)	-1.00228	0.1581
Breitung t-stat (Assumes Common Unit Root Process)	-0.59312	0.2766
Im, Pesaran and Shin W-stat (Assumes Individual Unit Root Process)	1.09605	0.8635
ADF - Fisher Chi-square (Assumes Individual Unit Root Process)	23.7791	0.5886
PP - Fisher Chi-square (Assumes Individual Unit Root Process)	56.3199	0.0050
Hadri Z-stat (Assumes Common Unit Root Process)	8.22381	0.0000

Table – A2: Panel Unit Root Test on FDI

Method	Statistic	Prob.
Levin, Lin & Chu t* (Assumes Common Unit Root Process)	-1.07682	0.1408
Breitung t-stat (Assumes Common Unit Root Process)	-3.84499	0.0001
Im, Pesaran and Shin W-stat (Assumes Individual Unit Root Process)	-1.05202	0.1464
ADF - Fisher Chi-square (Assumes Individual Unit Root Process)	35.7491	0.2966
PP - Fisher Chi-square (Assumes Individual Unit Root Process)	64.4407	0.0006
Hadri Z-stat (Assumes Common Unit Root Process)	2.85065	0.0022

Table – A3: Panel Unit Root Test on IMP

Method	Statistic	Prob.
Levin, Lin & Chu t* **(Assumes Common Unit Root Process)**	-2.63433	0.0042
Breitung t-stat **(Assumes Common Unit Root Process)**	-2.78776	0.0027
Im, Pesaran and Shin W-stat **(Assumes Individual Unit Root Process)**	-0.27182	0.3929
ADF - Fisher Chi-square **(Assumes Individual Unit Root Process)**	34.5744	0.3459
PP - Fisher Chi-square **(Assumes Individual Unit Root Process)**	15.2809	0.9945
Hadri Z-stat **(Assumes Common Unit Root Process)**	8.18291	0.0000

Table – A4: Panel Unit Root Test on First Difference of RD

Method	Statistic	Prob.
Levin, Lin & Chu t* **(Assumes Common Unit Root Process)**	-2.51134	0.0060
Breitung t-stat **(Assumes Common Unit Root Process)**	-2.77385	0.0028
Im, Pesaran and Shin W-stat **(Assumes Individual Unit Root Process)**	-2.07145	0.0192
ADF - Fisher Chi-square **(Assumes Individual Unit Root Process)**	41.6097	0.0269
PP - Fisher Chi-square **(Assumes Individual Unit Root Process)**	91.9595	0.0000
Hadri Z-stat **(Assumes Common Unit Root Process)**	3.50285	0.0002

Table – A5: Panel Unit Root Test on First Difference of FDI

Method	Statistic	Prob.
Levin, Lin & Chu t* **(Assumes Common Unit Root Process)**	-4.84049	0.0000
Breitung t-stat **(Assumes Common Unit Root Process)**	-5.46108	0.0000
Im, Pesaran and Shin W-stat **(Assumes Individual Unit Root Process)**	-3.51800	0.0002
ADF - Fisher Chi-square **(Assumes Individual Unit Root Process)**	60.7330	0.0007
PP - Fisher Chi-square **(Assumes Individual Unit Root Process)**	167.134	0.0000
Hadri Z-stat **(Assumes Common Unit Root Process)**	6.33835	0.0000

Table – A6: Panel Unit Root Test on First Difference of IMP

Method	Statistic	Prob.
Levin, Lin & Chu t* (Assumes Common Unit Root Process)	-8.44886	0.0000
Breitung t-stat (Assumes Common Unit Root Process)	-5.94313	0.0000
Im, Pesaran and Shin W-stat (Assumes Individual Unit Root Process)	-4.25906	0.0000
ADF - Fisher Chi-square (Assumes Individual Unit Root Process)	71.6419	0.0001
PP - Fisher Chi-square (Assumes Individual Unit Root Process)	86.4859	0.0000
Hadri Z-stat (Assumes Common Unit Root Process)	-0.16721	0.5664

Table – A7: Original Estimation Outcomes of the Model 6

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RD(-1))	0.123537	0.033328	3.706743	0.0003
D(IMP)	-0.001513	0.002865	-0.528246	0.5983
D(FDI)	0.001288	0.000554	2.325213	0.0217
D(FDI(-1))	0.002003	0.000364	5.497905	0.0000
D(IMP(-1))	-0.002766	0.002908	-0.951348	0.3432
Effects Specification				
Cross-section fixed (first differences)				
R-squared	-0.296804	**Mean dependent var**		0.001298
Adjusted R-squared	-0.337973	**S.D. dependent var**		0.072964
S.E. of regression	0.084398	**Sum squared resid**		0.897491
J-statistic	10.37870	**Instrument rank**		16.00000