Effects of Foreign Direct Investment on Intellectual Property, Patents and RD

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Abstract: *As innovative firms have considerable competitive advantage; more foreign direct investment (FDI) research has been related to the innovation. The primary aim of this study is to explore how intra-regional economies interact with host countries' innovative performance, and how they are affected by FDI. Azerbaijan, Georgia and Turkey, located in the South Caucasus region, are selected as examples. Numbers of patent applications, R&D expenditure (% of GDP), and intellectual property payments are chosen as factors indicative of innovation. While this research tries to explore whether these three countries, connected by large trades, can act as a clustered group; Panel cointegration and Panel OLS models are used for analysis. The results show that FDI is an important variable affecting the level of innovation in the panel analysis. Nevertheless, individual relationships with FDI vary, and cointegration analysis shows heterogeneity. That is, foreign direct investment could play a central role in increasing the level of innovation for Azerbaijan and Georgia, but it is not an important determinant of Turkey's economic innovation level. Countries should realize that when their economies are becoming stronger, FDI is not a useful tool for escalating innovation, rather they should be in clusters that can leverage innovation.*

Keywords: Foreign Direct Investment (FDI), Innovation, Panel Data Analysis, Panel OLS, Azerbaijan, Turkey, Georgia

1. Introduction

Foreign investors seeking access to.[1] Scholars have been generally focused on knowledge transfer among multinational corporations (MNCs) and their local suppliers by FDI.[2] Thus, a general comparison between countries' innovation development states, has depended on a firm base,[3], but innovation

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[1] Magnus Blomström and Kokko Ari,' Multinational Corporations and Spillovers [Journal] // Journal of Economic Surveys' [1998] BP 12; Sourafel Girma, Yundan Gong and Holger Görg,' Foreign Direct Investment, Access to Finance, and Innovation Activity in Chinese Enterprises' [2008] TWBER22; Otavio O. Mielnik and J. Goldemberg, 'Foreign direct investment and decoupling between energy and gross domestic product in developing countries' [2002] EP 30.

[2] A. Rahim Jaguli, Inward foreign direct investment (FDI) and local innovative capacity // Loughborough University Institutional Repository' [2011] LUIR; A. Bitzenis 'The Balkans : foreign direct investment and EU accession' (Ashgate Publishing Limited) [2009].

[3]Wilfred Dolfsma and Loet Leydesdorff,' Innovation Systems as Patent Networks: The Netherlands, India and Nanotech' [2011] Innovation 13.

development has not been researched through international multi-R&D-alliance processes.[4] As innovative firms have a more considerable competitive advantage over non-innovative firms in Turkey, Georgia and Azerbaijan,[5] innovation has increasingly become a focus for research.

There are only a few articles that are aimed at a country's innovation system's effect on innovation sectors and an institution(s)' performance.[6] While Innovation-intensive industries increase their contribution to overall exports of these countries,[7] each country has its distinguishable institutional structure and innovation trajectory.[8] In the host countries, domestic and foreign firms show similar R&D behaviour to an increasing degree.[9] Innovative deeds in the host country act in a similar way to a computational fluid, so either foreign investment escalates innovation, or domestic forces de-escalates it. According to Milea (2015), there is a positive correlation between foreign investment and innovation.[10] For R&D-alliances, there are general and alliance-specific independences. The first one depends on technological fields, and the second one on specific areas including finance, and intellectual property. [11]

This research, on the other hand, focuses on Turkey, Azerbaijan and Georgia, by arguing that FDI investment selection is based on cultural (ethnic) identity, rather than geographical boundaries.[12]

However, regional integration agreements and free trade will lead to inflows of FDI from the outside as well as from the rest of the integrating region.[13] According to Buckley et al. (2010), free trade between Canada and the US significantly altered FDI motivation.[14] Consequently, Turkey became the largest trade

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[4] Ulrich Lichtenthaler and Eckhard Lichtenthaler,' Alliance functions: implications of the international multi-R&D-alliance perspective' [2004] T 24

[5] S. Kuriakose, 'Fostering Entrepreneurship in Azerbaijan' (World Bank 2013)

[6] Wilfred Dolfsma and Loet Leydesdorff,' Innovation Systems as Patent Networks: The Netherlands, India and Nanotech' [2011] Innovation 13

[7]Alexander Plekhanov and Florent Silve,' Institutions, innovation and growth: cross-country evidence'[2015]EBRDWP 177

[8]Hee Lee Soo and Taeyoung Too,' Government Policy and Trajectories of Radical Innovation in Dirigiste States: A Comparative Analysis of National Innovation Systems in France and Korea'[2007] TA&SM 19; Miranda Forsyth,' Making the case for a pluralistic approach to intellectual property regulation in developing countries'[2016] QMJIP 6

[9] Heike Belitz, Jakop Edler and Christoph Grenzmann,' Internationalisation of Industrial R&D', in U. Schmoch, C. Rammer, & H. Legler (ed) 'National Systems of Innovation in Comparison Structure and Performance Indicators for Knowledge Societies' (Springer 2006).

[10] C. Milea, 'Connections Between Foreign Direct Investments And Research-Development- Innovation Activity' FS [2015]

[11] Note 4 above.

[12] Richard Fletcher, 'The Impact of Culture on Investment in Emerging Markets',' Foreign Investment in Developing Countries '[2004] PM

[13] Ari Kokko and Magnus Blomström,' Regional Integration And Foreign Direct Investment' [1997] WBWPSEF 172; Mitat Çelikpala and Cavid Veliyev,' Azerbaycan-Gürcistan-Türkiye: Bölgesel İşbirliğinin Başarı Örneği [Azerbaijan-Georgia-Turkey: The Success Case of Regional Cooperation' [2015] CIES

[14] P.J. Buckley, J. Clegg, N. Forsans & K. T. Reilly, 'A Simple and Flexible Dynamic Approach to Foreign Direct Investment Growth: The Canada–United States Relationship in the Context of Free Trade' in P. J. Buckley, Foreign Direct Investment, China and the World Economy (Palgrave Macmillan 2010)

partner of Georgia with the free trade agreement between these two countries,[15] which can shape the FDI flow. However, despite there being no free trade agreement between Azerbaijan and Turkey, huge infrastructure investments in transportation have been escalating regional cooperation between Azerbaijan, Turkey and Georgia in the South Caucasus.[16]

Innovations do not depend solely on monetary capital, but also on human capital. The intensity of physical capital is connected with the market power of the company.[17] Embodied technology flows show that the share of acquired technologies from imports of capital goods and intermediary products is significant in most countries.[18] Human and physical capital, as well as market powers, of these nations are highly correlated. The flow of Azerbaijani capital as foreign investment in Turkey in particular, has deepened economic relations.[19] Still, foreign investment in these countries can have different effects, because stronger intellectual property rights in the host country may reduce inward FDI.[20] For instance, European companies have a greater propensity for American rather than European partnerships.[21] Thus, it can be inferred that the interaction, density, and quality of the network among these elements have an effect on the division of innovative labour in specific areas of innovation activity.[22]

Regional integrative initiatives are increasingly seen as effective tools to promote trade, FDI and technological progress[23]. Therefore, the main purpose of this study is to determine how intra-regional economies interact with host nations' innovative performance, and how this is affected by FDI.

Specifically, this study will investigate whether there is a statistical relationship between FDI and innovation level in Turkey, Azerbaijan and Georgia. Further, if any relationship is found, to determine the direction and strength of this. Neighbouring and trade partner countries are chosen for the impact of FDI on the variables. Thus, the effect of FDI on countries that have similar levels of innovation is analyzed individually; at the same time, due to geographic proximity of countries, overflow effects of FDI are analyzed as well. In this context, panel data analysis emerges as the most appropriate method for this analysis.

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[15] Valeri Modebadze, Mehmet Fatih Sayın and Reha Yılmaz,' Georgian – Turkish Relations since the Breakdown of Soviet Union' [2014] ÇKUJTFEAS.

[16] Ayhan Güney and Selim Özdemir;' Is The Regional Economic Cooperation In South Caucasus Myth or Reality?'[2011]TJFEAS 16

[17] Joel Stiebale and Frank Reize,' The Impact of FDI on Innovation in target Firms Ruhr Economic Papers'[2008]DE

[18] OECD,' National Innovation Systems'[1997] OECD

[19] Şaban Kardaş and Fatih Macit,' Turkey-Azerbaijan Relations: The Economic Dimension'[2015] JCA 1

[20] Anuj Joshua Mathew and Arijit, Mukherjee ' Intellectual property rights, southern innovation and foreign direct investment'[2014]IREF 31; Yang Cao,' Indirect infringement of intellectual property in China' [2016] QMIP

[21] Daniele Archibugi and Alberto Coco,' International partnerships for knowledge in business and academia A comparison between Europe and the USA'[2004]

[22]Michael Fritsch,' Measuring The Quality Of Regional Innovation Systems: A Knowledge Production Function Approach'[2002]IRSR 25

[23] Sadhana Srivastava and Ramkishen S. Rajan, 'What Does the Economic Rise of China Imply for ASEAN and India? Focus on Trade and Investment Flows', in HS Kehal (ed), Foreign Investments in Developing Countries (Palgrave Macmillan 2004)PM

The paper is organized into four sections: Introduction, Literature Review, Methodology, and Conclusion.

2. FDI and Innovation Literature review

Direct investment involves having cross-border investment, which commands or significantly influences the economic view of the host nation. 10 % or more ownership of a firm's voting stock is a key aim for determining the existence of a direct investment relationship. The IMF provides a description of FDI: "A direct investment relationship is established when the direct investor has acquired 10 percent or more of the ordinary shares or voting power of an enterprise abroad".[24] Foreign direct investments are direct equity flows in the reporting economy. FDI is the sum of equity capital, reinvestment of earnings, and other capital.

As many scholars note, FDI brings innovation to a country.[25] Foreign investors who are seeking access to indigenous technology and knowledge to provide a clearer picture of FDI gains, are not just specifically considering the host country and its economic environment alone. Rather, further determinants and heterogeneities must be considered.[26] Multinationals should consider not only the presence and cost of traditional factors, but also dispersed created assets, and the necessity to conclude cross-border augmenting and asset-exploiting alliances,[27] and that a regional approach is very important, with traditional knowledge.[28] As employees move to other firms, various skills may spill over, and employees may set up their own businesses. However, several studies examining the relationship between FDI and individual locally-owned firms[29] that are the intellectual property of individuals. According to Plekhanov and Silve (2015), there is a statistically significant correlation between innovation intensity, human

[24] N. Patterson, M. Montanjees, J. Motala & C. Cardillo, 'Foreign Direct Investment: Trends, Data Availability, Concepts, and Recording Practices' [2004] IMF.

[25] Gheorghe H. Popescu ,' FDI and Economic Growth in Central and Eastern Europe'[2014]S; Laura Alfaro A. Chanda, S. Kalemli-Ozcan & S. Sayek, 'How Does Foreign Direct Investment Promote Economic Growth? Exploring the Effects of Financial Markets on Linkage' [2007] NBER 12522; Jinji Naoto and Xingyuan Zhang,' Innovation in the Host Country and the Structure of Foreign Direct Investment: Evidence from Japanese multinationals'[2013] TI.

[26] Johannes Stephan,' Technology transfer via foreign direct investment in Central and Eastern Europe : theory, method of research and empirical evidence ' (Palgrave Macmillan 2006); Note 23 above.

[27] Frances Ruane and Peter J. Buckley, ' Foreign Direct Investment in Ireland: Policy Implications for Emerging Economies'[2010] PM 2010.

[28] Michael Blakeney,' Protecting traditional knowledge and expressions of culture in the Pacific'[2011] QMJIP 1.

[29] Magnus Blomström and Kokko Ari,' Multinational Corporations and Spillovers [Journal] // Journal of Economic Surveys' [1998] BP 12; Sourafel Girma, Yundan Gong and Holger Görg,' Foreign Direct Investment, Access to Finance, and Innovation Activity in Chinese Enterprises' [2008] TWBER22; Garrick Blalock and Daniel H. Simon, ` Do All Firms Benefit Equally from Downstream FDI? The Moderating Effect of Local Suppliers' Capabilities on Productivity Gains`, JIBS 40(7).

capital endowment, and physical capital endowment.[30] In the same article, statistical significance was found between capital intensity and physical capital; so that it appears that capital intensity affects both human and physical capital.

Abbreviations used in this paper are shown in Table 1.

Table 1: Data and Abbreviations

Data	Abbreviation
Foreign Direct Investment	**FDI**
Patent application number	**PAT**
Research and development expenditure (% of GDP)	**RDEXP**
Charges for the use of intellectual property payments	**IPP**

FDI is a very important key for international technology spillover.[31] However, such spillover is only valuable when local firms are strong enough to absorb them.[32] Nevertheless, FDI inflows do not exert an independent influence on economic growth.[33]

According to Bitzenis (2009; 2008), the types of FDI are: Acquisition, joint venture, greenfield FDI, brownfield FDI, privatization, strategic alliance (Joint Venture), representative office, subsidiary (branch), merger & acquisition, and fade out or planned divestment agreement for the Balkans.[34] Foreign Direct Investment is differentiated from among other foreign involvements, as the intent of the investor is generally profit concentrated.[35] FDI ratings of Azerbaijan, Georgia and Turkey are illustrated in Figure 1, and show that Turkey has considerably more FDI than the other two countries. Effects of FDI vary among industries and countries, due to country characteristics and their political ecosystems.[36] However, the gain from FDI is limited or uncorrelated if and when firms can imitate technologies from abroad.[37] Thus, the effects of FDI are positively associated only if locals engage in their own innovation activities.[38] Other research indicates that FDI-attracting policies can be effective if a country is not too remote from large foreign consumer bases.[39] As discussed previously, this paper aims to determine whether these three countries, connected by significant trade, can act as a clustered group, because

[30] A. Plekhanov & F. Silve, 'Institutions, innovation and growth: cross-country evidence' (European Bank for Reconstruction and Development 2015)

[31] Note 22 above.

[32] Aristidis Bitzenis, `The Balkans: Foreign Direct Investment and EU Accession` (Ashgate Publishing 2009)

[33] Maria Carkovic and Ross Levine,' Does Foreign Direct Investment Accelerate Economic Growth?',' Does Foreign Direct Investment Promote Development? '[2005]IIE

[34] Note 2 above; A. Bitzenis 'Regional concentration of Foreign Direct Investment in the Central and East European region' IJTGM 1(2)

[35] Note 28 above.

[36] Note 28 above.

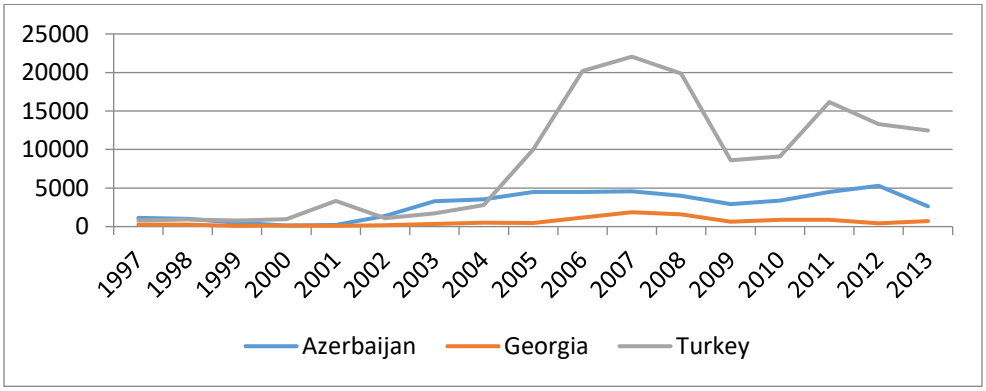
[37] Amy Jocelyn Glass and Kamal Saggi;' Foreign Direct Investment and the Nature of R&D[1999]RCE

[38]Sourafel Girma, Yundan Gong and Holger Görg,' Foreign Direct Investment, Access to Finance, and Innovation Activity in Chinese Enterprises'[2008]TWBER

[39] Badi H. Baltagi, Peter Egger and Michael Pfaffermayr,' Estimating models of complex FDI: Are there third-country effects?'[2007] JE

clusters may act differently in acquiring foreign sources.[40] In terms of this, Garretsen and Peeters (2009) found that if geographically clustered countries share the same type of supply networks, FDI flow to one neighbouring country will trigger such flow to another country.[41] Also, Audretsch and Feldman (1996) indicated that industries with more knowledge spillover, that is R&D, skilled labour and the location of production, have a greater propensity for innovative action to cluster than industries where knowledge externalities are less important.[42] Thus, heterogeneity within clusters has less effect on innovation than when networking and clustering is taken into account and all estimates are adjusted accordingly. In this paper, whether heterogeneity or networking has more weight on innovation, will be determined.

Figure 1: FDI in Azerbaijan, Georgia and Turkey. Millions of US Dollars.



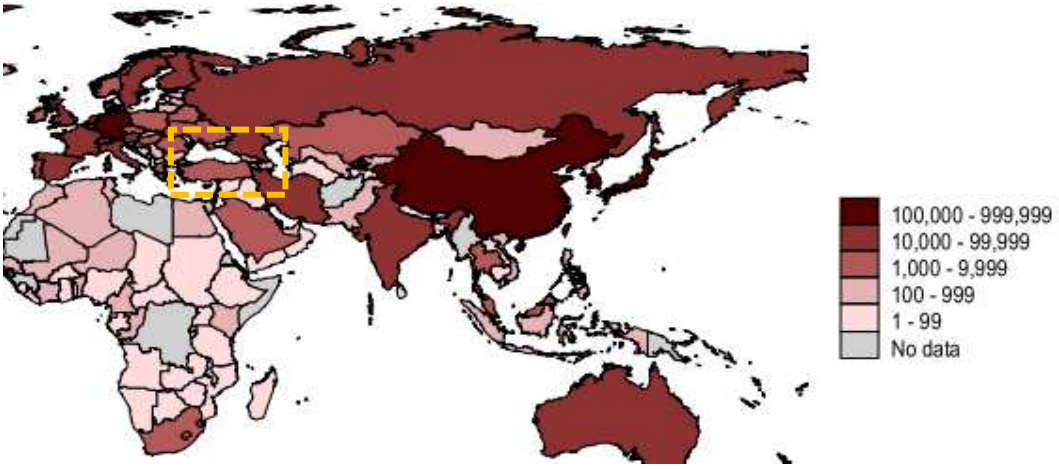
When the FDI of Azerbaijan, Georgia and Turkey are analyzed, it is observed that they were at similar levels during 1997-2004. Since 2005, Turkey's FDI has differed, showing a relatively low rising trend. FDIs look for skilled, educated but preferably low-cost employees or adequate human resource.[43] The production potential of R&D is generally related to the increase of FDI, but at the same time local firms benefit from training their R&D personnel if multinational companies employ locally.[44] Developing countries have a range of labour skills. Effects of FDI on intellectual property in host countries can be in two ways. First, skilled labour embodied internationally can find tenure locally, or local labour may migrate from simple jobs to their own brand, whereas employees of large firms can set their own start-ups.[45]

As seen in Figure 2, the three nations fall into the same colour category for patent applications. That means they have similar innovation drivers, although Turkey's patent applications are a slightly higher.

[40] OECD,' National Innovation Systems'[1997] OECD
[41] H. Garretsen & J. Peeters, 'FDI and the Relevance of Spatial Linkages: Do Third-Country Effects Matter for Dutch FDI?' RWE [2009] 145(2)
[42] D.B. Audretsch & M.P. Feldman, 'R&D spillovers and the geography of innovation and production' AER [1995] 86(3)
[43] Note 28 above.
[44] Note 26 above.
[45] Note 26 above; Ashima Goyal;' Foreign Investment in India: Riding the Wave', Foreign Investment in Developing Countries'[2004]PM

Some studies of this geographic area have found that innovation relates to the benefaction of universities' R&D.[46]

Figure 2: Equivalent patent applications by origin, 2014 (Turkey, Georgia and Azerbaijan are in yellow rectangle) [47]



Also, these countries' R&D expenditures began at the same point (1999), with Georgia and Azerbaijan still maintaining the same trend (Figure 3). Turkey, Azerbaijan and Georgia's spending on R&D as a proportion of GDP, from 1997 to 2014, is shown in Figure 3. Turkey's R&D spending in 2014 (9.4%) was significantly higher than that of Azerbaijan (0.2%) and Georgia (0.1%).

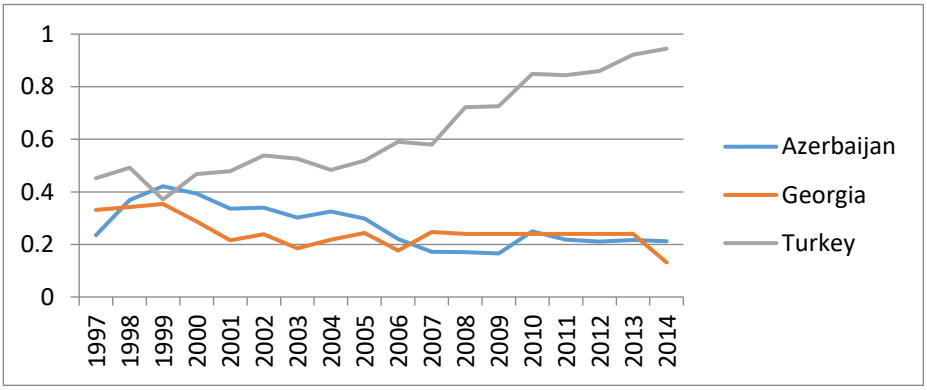


Figure 3: R&D expenditures (%GDP), 1997-2014. Source: Worldbank.

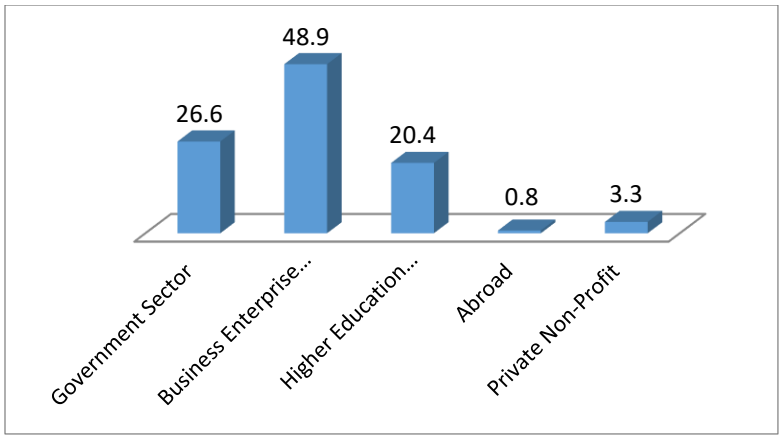
The sectorial distribution of R&D expenditure in Turkey in 2013 is shown in Figure 4. If Turkey's economic R&D expenditure in 2013 is examined, it can be seen that private sector spending (48.9%) led

[46] Robert E. Lipsey and Fredrik Sjöholm,' The Impact of Inward FDI on Host Countries: Why Such Different Answers?',' Does FDI Promote Development? '[2005] IIE

[47] Franchis Gurry, 'World Intellectual Property Indicators' [2015] WIPO

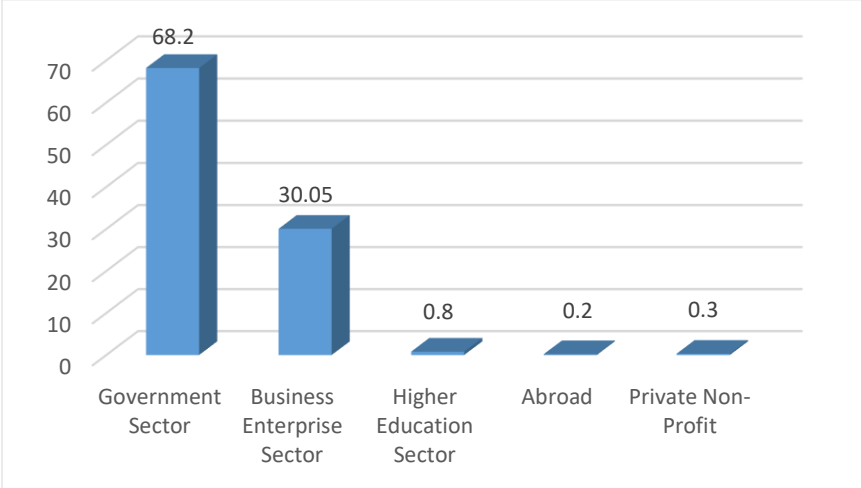
public sector spending (26.6%). While most universities are public in Turkey, the public sector's share becomes 47% when higher education's intuitions are added. R&D spending from abroad has remained very low (0.8%). In this context, it can be expected that R&D expenditure from foreign direct investment will have no significant effect on total R&D expenditure.

Figure 4: Turkish R&D expenditure by source of funds (%), 2013. Source: Eurostat.



Azerbaijan's sectorial distribution of expenditure on R&D in 2013 can be seen in Figure 5. The largest R&D spending in Azerbaijan's economy is used by the public sector (68.2%). R&D spending by the private sector is second with 30.05%. R&D spending share in the economy of Azerbaijan and Georgia's GDP is relatively low compared to sectorial spending distribution of R&D (Fig. 5).

Figure 5: Azerbaijan R&D expenditures by source of funds (%), 2013. Source: Eurostat.



3. Data Sets and Methodology

In this study, the impact of foreign direct investment on innovation indicators was investigated for the economies of Georgia, Azerbaijan and Turkey, using the panel cointegration methods. Data were drawn from World Bank website. Period of analysis time were selected depending on the availability of accurate data.

Foreign direct investment can spill research and development activities to host countries. This enables a positive contribution to the country's innovation. The percentage share of GDP spending on R&D were selected as one of the innovation indicators for this study.

The possible relationship between the relevant variables of countries was investigated through panel data analysis, within the framework of panel cointegration and OLS analyses. The innovation levels of the three countries clearly move in a similar way in time. Therefore, it is interesting to investigate the hypothesis that innovation levels are cointegrated. Panel presence of long-term relations between the series and cointegration analysis is examined. With a Panel OLS estimation, coefficients of series, consequently the correlation and the level of significance of the relationships can be predicted.

Panel data brings various units, e.g. horizontal cross-section of individuals, countries, companies, households, together for a certain period of observation. In other words, panel data consists of both the horizontal cross-sectional dimensions of the units and vertical sectional dimensions, changing their time-dependent size.

Natural logarithms of series of FDI, PAT and IPP are used in this study. RDEXP series are in percentage form so logarithms of this series are not taken. In our study, long-term causality between innovation indicators and foreign direct investment series will be investigated. The most common methods in the literature for causality analysis are Engle-Granger and Johansen cointegration analyses. However, these methods are not appropriate for shorter periods of time. Analysing short periods of time for investigating causality among multiple countries and years is preferred. There are many methods for panel causality analysis. In our study, Pedroni, Kao and Fisher's panel cointegration analysis, the most commonly used in the literature, is utilized.

In the empirical equation, in the first estimation model (Equation 1), a determination of whether FDI directly contributes to R&D activities will be put forward, by investigating the relationship between FDI and R&D expenditures. Expenditures for R&D are aimed at creative work to increase knowledge, including social sciences and the use of knowledge for new applications. R&D covers basic research, applied research and experimental development. The analysis covers the period 1995-2013.

On the other hand, R&D expenditure with patent applications may increase due to FDI foreign investment increases. Therefore, there is an indirect effect on patent applications and foreign investment. In the second estimation model (Equation 2), the study focuses on long-term relationship between foreign direct investment and patents. Patent applications are filed through the formal national Patent Institutions for Exclusive Rights for Invention(s). This provides patent protection for the invention to the owner of the patent for a limited period (generally 20 years). The analysis covers the period 1997-2013.

Since the increase in FDI negatively correlates with intellectual property expenditures abroad, the relationship between long-term payments, intellectual property, and foreign direct investment is investigated in the third analysis. Use of proprietary rights (trademarks, copyrights, industrial processes and designs including trade secrets and franchises) and user agreements through licensing of producing originals or prototypes (such as copyrights on books and Manuscripts, computer software, cinematographic works, and sound recordings) and related rights associated with intellectual property expenditures, are examined. Data are in current U.S. dollars. The analysis covers the 2005-2012 period. Cointegration analysis will be performed separately using three different equations. Computed value of

the estimators that are found by calculating the average coefficients for each country individually, will be determined.[48]

Rejection of a null hypothesis implies cointegrated variables for all panel members. Autoregressive parameters vary in the group statistics over the cross-section. If the null is rejected, at least one individual holds cointegration. For this reason, group tests offer an additional source of heterogeneity among panel members. In Fisher ADF, the null hypothesis of a unit root in the residuals (no cointegration) for all three cross-sections are set against the alternative hypothesis of some cross-sections without a unit root (cointegration). [49]

To use the panel cointegration method, stability of the series is important. For an analysis of the stability of a series LLC (Levin, Lee and Chun), IPS (Im, Peseran and Shin), ADF, and PP panel unit root analyses are used. Levin, Lin and Chu (2002) suggest that individual unit root tests lack power in distinguishing the unit root null from stationary alternatives, and that using panel data unit root tests is one way of increasing the power of unit root tests based on a single time series,[50] deviating from the equilibrium constantly at high rate[51]. This is more serious with small samples, as in this research. Thus, LLC testing offers stronger panel unit root tests than individual unit root tests.[52] Panel unit root tests can be divided into two groups. In this study tests from both groups are used. LLC is in the first group, and allows autocorrelation between the series while it does not offer individual autocorrelation. The second group of panel unit root tests, allows having a series of individual autocorrelation coefficients. IPS, ADF (augmented Dickey-Fuller), and PP (Phillips-Perron) tests are examples of this group. The superiority of the IPS test comes from applying unit root test separately for each series. ADF and PP tests are used for unit root analyses. In the ADF test, classic Augmented Dickey-Fuller test are applied to each series separately. The Phillips-Perron test is applied for each series separately in the PP test.

Empirical Test Results

Before analyzing for long-run (long-term) relationship between series, the stationary nature of the series should be first defined. LLC (Levin, Lin and Chu), IPS (Im, Peseran and Shin) and the ADF and PP tests are used to see whether the series is stationary. The results of unit root tests are shown in Table 2.

[48] António Afonso and João Tovar Jalles, ' Revisiting Fiscal Sustainability Panel Cointegration And Structural Breaks In OECD Countries' [2012] ECB

[49] S.Misra Biswa,' Credit Cooperatives in India: Past, present and future' [2010] T&FG

[50] G. S. Maddala and Shaowen Wu,' A Comparative Study Of Unit Root Tests With Panel Data And A New Simple Test' [1999] ISSUE

[51] Levin, Andrew, Lin, Chien-Fu and James Chu, Chia-Shang, `Unit root tests in panel data: asymptotic and finite-sample properties`, [2002], Journal of Econometrics, 108 (1) 1-24.

[52] B. H. Baltagi,' Econometric Analysis of Panel Data, Fourth edition' [2008]

Table 2: Unit Root Test Results

FDI UNIT ROOT TEST RESULTS						
	Intercept		Trend&Intercept		None	
Method	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Levin. Lin & Chu t	-0.739	0.230	0.066	0.526	0.848	0.802
Im. Pesaran and Shin W-stat	0.069	0.528	-0.324	0.373	-	-
ADF - Fisher Chi-square	4.465	0.614	6.496	0.370	1.477	0.961
PP - Fisher Chi-square	3.363	0.762	2.738	0.841	1.113	0.981
PAT UNIT ROOT TEST RESULTS						
Levin. Lin & Chu t	0.879	0.810	0.142	0.557	-0.073	0.471
Im. Pesaran and Shin W-stat	2.439	0.993	1.443	0.925	-	-
ADF - Fisher Chi-square	0.461	0.998	1.691	0.946	6.496	0.370
PP - Fisher Chi-square	0.748	0.993	2.668	0.849	5.770	0.450
IPP UNIT ROOT TEST RESULTS						
Levin. Lin & Chu t	-3.965	0.000	-5.245	0.000	1.407	0.920
Im. Pesaran and Shin W-stat	-1.083	0.140	-0.259	0.398	-	-
ADF - Fisher Chi-square	11.163	0.084	8.580	0.199	0.683	0.995
PP - Fisher Chi-square	27.953	0.000	19.424	0.004	0.353	0.999
RDEXP UNIT ROOT TEST RESULTS						
Levin. Lin & Chu t	1.203	0.885	-1.623	0.052	1.325	0.908
Im. Pesaran and Shin W-stat	1.822	0.966	-0.572	0.284	-	-
ADF - Fisher Chi-square	1.569	0.955	8.327	0.215	5.064	0.536
PP - Fisher Chi-square	1.533	0.957	8.048	0.235	10.572	0.103

According to test results FDI, PAT and RDEXP series are nonstationary at 5% significance level. The IPP series is nonstationary for IPS and ADF tests, but appears to be stationary for the LLC and PP tests. In this study, IPP series were determined to be non-stationary due to the IPS test result, while the IPS test is a more comprehensive testing method and did not contain the weaknesses of the LLC. Being stationary of the series at I (1) level provides an investigation of the long-term causality relationship with the assistance of cointegration analysis. However, to determine whether the series is still stationary at primary level, the first difference of the series was re-analyzed by unit root analysis. The analysis results are shown in Table 3.

Table 3: Unit Root Test Results (LLC and IPS)

	LLC		**IPS**	
	None		**Intercept**	
	Stat.	Prob.	Stat.	Prob.
DFDI	-5.947	0.000	-3.228	0.000
DPAT	-2.221	0.013	-1.432	0.076
DIPP	-5.229	0.000	-4.523	0.031
DRDEXP	-5.102	0.000	-4.505	0.000

As analysis results in Table 3 show, all series are stationary at level one. After confirming stationary status of the series; long-term relationships amongst series were analyzed. In the analysis of long-term relationships Pedroni Panel Cointegration analysis, Kao Panel Cointegration analysis and Fisher Panel Cointegration analysis were utilized. Equations are shown below (i=1, 2, …, N (countries) and t=1, 2 ,…, T (years).

$$PAT_{it} = \alpha_0 + \beta_1 FDI_{it} + \epsilon_{it} \quad (1)$$

$$IPP_{it} = \alpha_1 + \beta_2 FDI_{it} + \epsilon_{it} \quad (2)$$

$$RDEXP_{it} = \alpha_2 + \beta_3 FDI_{it} + \epsilon_{it} \quad (3)$$

Equation (1), Equation (2) and Equation (3) panels were used in the analysis of cointegration. While the FDI is an independent variable; PAT, IPP and RDEXP (Table 1) variables are dependent. Pedroni Cointegration analysis of long-term relationships amongst the series results are presented in Table 4.

Table 4: Pedroni Cointegration Test Results

	PAT-FDI		**IPP-FDI**		**RDEXP-FDI**	
	Statistic	**Prob.**	**Statistic**	**Prob.**	**Statistic**	**Prob.**
Panel v-Statistic	0.365	0.357	**1.664**	**0.048**	0.494	0.310
Panel rho-Statistic	0.105	0.542	0.512	0.695	-0.462	0.322
Panel PP-Statistic	0.319	0.625	**-2.180**	**0.014**	**-1.889**	**0.029**
Panel ADF-Statistic	0.345	0.635	**-2.606**	**0.004**	**-1.587**	**0.056**
	Statistic	**Prob.**	**Statistic**	**Prob.**	**Statistic**	**Prob.**
Group rho-Statistic	1.378	0.916	1.730	0.958	0.343	0.634
Group PP-Statistic	1.844	0.967	-0.297	0.383	**-1.402**	**0.080**
Group ADF-Statistic	1.974	0.975	-0.601	0.273	**-1.492**	**0.067**

Table 4 shows that there is no causal relationship between patent applications and foreign direct investment is the long-term. On the other hand, IPP and RDEXP variables' panel results are statistically significant (bold numbers in Table 4). In other words, there is a cointegration relationship between IPP and RDEXP series with FDI series in the long term.

Group statistics between FDI and RDEXP indicate a long-term relationship. However, the group test results are meaningless between PAT and IPP, with the FDA relations providing additional information related to heterogeneity. According to this, the series is cointegrated for panel analysis. However, based on individual countries' cointegrations, analysis of series' cointegration relations are differentiated.

Kao Cointegration test results for long-term relations between the series can be seen in Table 5.

Table 5: Kao Cointegration Test Results

	PAT-FDI		**IPP-FDI**		**RDEXP-FDI**	
	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.
ADF	0.480	0.31	1.424	0.07	1.389	0.08

Test results in Table 5 show that FDI has no direct effect on patent applications, but influences intellectual property expenditures and R&D spending at the 10% significance level in the long-term. Fisher Panel Cointegration results can be seen in Table 6.

Table 6: Fisher Panel Cointegration Test Results

	PAT-FDI				IPP-FDI				RDEXP-FDI			
Hypothesized	Fisher Stat.		Fisher Stat.		Fisher Stat.		Fisher Stat.		Fisher Stat.		Fisher Stat.	
No. of CE(s)	Trace Test	Prob.	Max-Eign Test	Prob.	Trace Test	Prob.	Max-Eign Test	Prob.	Trace Test	Prob.	Max-Eign Test	Prob.
None	5.177	0.521	5.528	0.478	**18.72**	**0.004**	**13.44**	**0.036**	**26.96**	**0.000**	**23.61**	**0.000**
At most 1	3.596	0.731	3.596	0.731	**16.99**	**0.009**	**16.99**	**0.009**	**13.19**	**0.040**	**13.19**	**0.040**
	Individual cross section results											
	Trace Test		Max-Eign Test		Trace Test		Max-Eign Test		Trace Test		Max-Eign Test	
Cross Section	Stat.	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.
	Hypothesis of no cointegration											
_AZE	8.672	0.396	8.180	0.360	15.245	0.054	14.378	0.048	26.142	0.000	23.707	0.001
_GEO	2.372	0.988	2.361	0.979	19.601	0.011	12.411	0.096	20.645	0.007	15.082	0.037
_TUR	11.33	0.191	10.547	0.178	12.388	0.139	9.312	0.261	11.053	0.208	10.820	0.163

As results in Table 6 show, there is no long-term relationship between foreign direct investments and patent applications, but there are at least two cointegrated vectors between intellectual property expenditures by foreign direct investment, and at least two cointegrated vectors between FDI and R&D (bold numbers in Table 6). Individual cointegration analysis for each country shows that there is no long-term relationship in Turkey, but at least one cointegrated vector for Azerbaijan and Georgia is observed. These results support Pedroni's test results (Table 4, group statistics). To find out the correlation and strength of the relationship between the series, the panel OLS test is used.

The fixed effect model for countries with similar qualifications, and the random effect model for countries of different natures, may be preferred for Panel OLS[53]. In this study, both fixed random effect models were estimated for comparison. Panel OLS results in Table 7 show the effects of FDI on intellectual property expenditure IPP and R&D expenditure.

[53] Durmuş Çağrı Yıldırım, 'The Effects of European Monetary Union on Macroeconomic Performance' [2012] ATJIR 11 (2)

Table 7: Panel OLS Test Results

Panel OLS Test Results: LIPP and LFDI

	Fixed Effect Model				Random Effect Model			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
C	0.368	0.006	62.936	0.000	0.350	0.242	1.445	0.165
LFDI	**-1.101**	0.318	-3.468	0.005	-0.126	0.365	-0.344	0.734
R-squared	0.623				R-squared	0.007		

Panel OLS Test Results: RDEXP and LFDI

	Fixed Effect Model				Random Effect Model			
Variable	Coefficient	Std. Error	t-Statistic	Prob.				
C	0.003	0.002	1.501	0.143	0.006	0.012	0.523	0.604
LFDI	**0.017**	0.006	2.633	0.013	0.009	0.012	0.733	0.468
R-squared	0.451				R-squared	0.009		

The results obtained of long-term relationships between the series was within our expectations. There is no direct positive relationship between FDI and innovative knowledge stock of the host country invested in, but the knowledge they are using in their own manufacturing operations decreased payments related to host country's intellectual property abroad. On the other hand, there is a relationship, even if it is weak, between FDI and R&D expenditure.

When the test results are examined from Table 7, it is seen that FDI is an important variable affecting intellectual property as well as research and development expenditure. The fixed effect model is more suitable because the three countries examined have similar innovation indicators. According to results every 1-unit increase in FDI decreases IPP by 1.1- unit, but every 1-unit increase in FDI also increases R&D by 0.017-unit (bold numbers in Table 7). Thus, an increase in foreign direct investments reduces intellectual property expenditure, whereas it increases research and development expenditure, as noted in the literature.

As Pedroni (1999; 2001) showed, if there is a long-term cointegration relationship between series, estimators of panel regressors would be inconsistent and biased, and he proposed a FMOLS (Fully-Modified OLS) method in the presence of a cointegration relationship.[54]

FMOLS test results can be seen in Appendix 1. FMOLS model results are similar to the panel OLS results. Direct investments reduce intellectual property expenditure by 1.2 units, but increase R&D spending by 0.03 units.

4. Conclusion

This paper examined the effects of FDI on innovation in a geographically, economically, historically and strategically clustered region. The three countries examined - Turkey, Georgia and Azerbaijan - have the same innovation index. According to our theoretical expectations, we found evidence of the existence of

[54] P. Pedroni, 'Fully Modified OLS for Heterogeneous Cointegrated Panels' Working Paper; P. Pedroni, 'Purchasing Power Parity Tests in Cointegrated Panels' RES [2001] 83(4)

a long-term relationship between FDI, research and development expenditure, and intellectual property expenditure. As a result of the Pedroni, Kao and Fisher panel cointegration tests, the study shows a significant long-term relationship between FDI on R&D and IPP series. On the other hand, results did not gather sufficient evidence for the presence of a long-term relationship between patent applications and FDI.

According to individual Fisher Panel Cointegration Test Results, there was no long-term relationship between FDI, R&D and intellectual property for Turkey, but at least one cointegrated vector for Azerbaijan and Georgia was observed. This result is also supported by the Pedroni cointegration analysis. That is because the impact of FDI inflows on the trade balance is stronger on the recipient economy if the degree of openness is greater and the size of the country is smaller.[55] Also, FDI can be related to Government restrictions such that the effects of FDI can be different in nations that may have concern for national security and economic considerations, which have stricter national sovereignty issues.[56]

Following the analysis of long-term relationships of series; the Panel OLS test and FMOLS were used to analyze the strength and direction of the coentegrations. In accordance with our expectations, the countries analyzed to be subject to a similar classification of innovation indicators suggest that the fixed effect model is appropriate. Fixed effect model results show that FDI is an important variable on both R&D spending and IPP expenditures. Direct foreign investment, acceptable to this paper's theoretical model; contributes to the reduction of intellectual property expenditure, although on the other hand causes an increase in research and development spending.

Panel OLS results show that FDI negatively correlates with intellectual property payments, with countries' expenditures on intellectual property decreasing 1.101 units with every unit of FDI. This implies that Azerbaijan and Georgia's expenditure on intellectual property decreased, but not Turkey's. Also, there is a small but positive correlation between FDI and R&D expenditure (0.11 unit increase for every 1 unit FDI). Considering these results, it should be concluded that even if expenditure, correlated with FDI, may lie in the home or host country, they may be related to a payoff matrix resulting from an oligopoly game,[57] similar to the principle of computational fluid theory. Thus, even if FDI affects countries in the same region differently, the total effect does not change due to relationships. Thus, it can be concluded that total innovation index does not change, but some variance in the index occurs separately. The FMOLS model is used for comparisons, and the results from the Panel OLS and FMOLS models are similar. As a result, it can be stated that FDI is not as effective in Turkey as it is in Azerbaijan and Georgia.

Even though FDI has not changed in the cluster of countries' innovation index, it has a heterogeneous effect. This means that FDI is not an effective factor in Turkey's innovation index, but FDI is an important variable for increasing the innovation index in Azerbaijan and Georgia. In Turkey, innovation predictors can only be affected by internal developments or strengths. However, in Azerbaijan and Georgia, FDI

[55] L.R. De Mello & K. Fukasaku, 'Trade And Foreign Direct Investment In Latin America And Southeast Asia] Temporal Causality Analysis' JID [2000] 12

[56]Richard A Joseph.,' Direct foreign investment in telecommunications A review of attitudes in Australia, New Zealand, France, Germany and the UK'[1995] TP 5-19

[57]H. Jalilian;' A Theory of Foreign Investment: Possibility, Modes and Timing'[1996]MADE 17

affects innovation predictors dramatically, so these countries should do more to attract more FDI. Further research may focus on more countries or longer time periods.

Appendix 1

FMOLS Test Results

FMOLS Test Results: LIPP and LFDI				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFDI	-1.20	0.401	-3.016	0.009
FMOLS Test Results: RDEXP and LFDI				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFDI	0.037	0.021	1.738	0.088