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Research Article

Effect of Knowledge Spillover on the Logistics Performance

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ABSTRACT

This study aims to investigate whether Foreign Direct Investment (FDI) inflows and innovative activities act as a knowledge spillover channel that increases the logistics performance of countries. In the analysis, the effects of these activities on the logistics performance were questioned according to the development levels of countries and six different logistics performance indicators by the Ordinary Least Squares (OLS) Estimator method. The estimation results show that FDI, R&D investments and patent applications, which are considered as the knowledge spillover channels, have a statistically significant and positive effect on the logistics performance of countries. In addition, it is concluded that this effect is higher in developing countries compared to developed ones.

Keywords: Knowledge Spillover, Logistics Performance, Innovation, FDI

Bilgi Yayılımının Lojistik Performansa Etkisi

ÖZ

Bu çalışmanın amacı, doğrudan yabancı sermaye girişlerinin ve yenilikçi faaliyetlerin ülkelerin lojistik performanslarını artıran bir bilgi yayılım kanalı olarak hareket edip etmediğini araştırmaktır. Analizde, bu faaliyetlerin lojistik performansı üzerindeki etkisi Sıradan En Küçük Kareler (SEKK) Tahmin Edicisi yöntemi ile ülkelerin gelişmişlik seviyelerine göre ve altı farklı lojistik performans göstergelerine göre sorgulanmıştır. Tahmin sonuçları, bilgi yayılım kanalı olarak ele alınan doğrudan yabancı yatırımlarının, AR-GE yatırımlarının ve Patent başvurularının ülkelerin lojistik performansları üzerinde istatistiksel olarak anlamlı ve pozitif etkisi olduğunu göstermektedir. Ayrıca gelişmiş ülkelere kıyasla gelişmekte olan ülkelerde bu etkinin daha yüksek olduğu sonucuna ulaşılmıştır.

Anahtar Kelimeler: Bilgi Yayılması, Lojistik Performans, İnovasyon. Doğrudan Yabancı Yatırım

1. Introduction

Nowadays, we live in an age in which, economic borders have been left behind in the face of globalization it is possible to say that the factor that determines the power of the countries is the knowledge capital. Countries with higher knowledge accumulation have the ability to produce more specialized and qualified products using advanced technologies.

The concept of the knowledge spillovers is a prevalent term in the literature which is used for knowledge diffusion, knowledge dissemination, knowledge externalities, knowledge transfers and knowledge migration etc. According to Helpman and Grossman (1991) knowledge is non-rival because one idea can be used at the same time in different places and non-excludable because of difficulty extracting compensation of different usage of others. Jaffe (1998) in his most cited study in this area defines knowledge spillover "Knowledge created by one agent can be used by another without compensation, or with compensation less than the value of the knowledge.

Several mechanisms of how knowledge accumulation and diffusion occur has been defined in Figure 1.

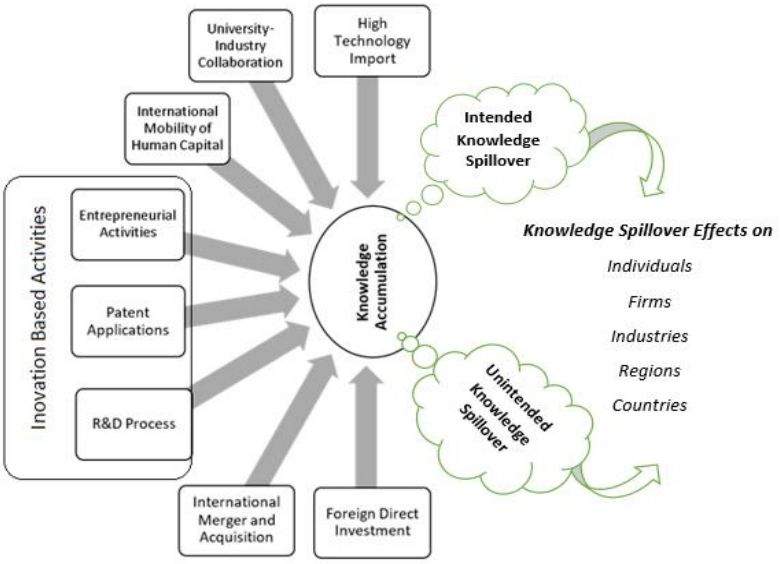

Figure 1. The Mechanism of Knowledge Spillovers

For the purpose of this study, two of the knowledge spillover channels, FDI and innovation, are emphasized.

The main premise underlying FDI spillovers is that the investment firms are technologically ascendant to the domestic firms and that the knowledge they possess is transferred to the domestic firm by means of interactions, which in turn leads to an increase in productivity (Newman et. al., 2015). OECD (2001) discusses how FDI forms knowledge spillover from four perspectives:

i) by technology transfer of MNEs to local companies (vertical linkages)

ii) through imitation or develop their own technologies of the local firms due to increased competition from MNEs (horizontal linkages);

iii) by educated or formerly employed labor by MNE

iv) Internationalization of R&D of multinational companies.

Another key important mechanism behind knowledge spillovers is innovation-based activities which involve investment in R&D, patent applications or citations and entrepreneurial activities. It is emphasized in the knowledge spillover literature that the spillover effect of knowledge arises the result of research activities (Grilliches, 1992; Cohen and Levinthal, 1989). Studies explaining the knowledge spillover effect in the context of R&D activities is generally discussed through Total Factor Productivity (see for example Fazlioglu et. al., 2018). R&D Spillover effects is first introduced by Coe and Helpman (1995). They find that both domestic R&D intensity and trading partner's R&D expenditures' impacts positively on domestic TFP for OECD countries. Moreover, it is shown that the impact of R&D spillover is greater for more open economies, namely R&D spillover is associated with trade openness. Patent applications, are also extremely important for creation of knowledge spillovers because it reflects the knowledge density of the community and leads to overflow of knowledge. Two alternative measures of patents are used in knowledge spillover studies. While one of them is "patent citations", the other is the patent applications made by the foreigners in the host countries. Like patent citations, patent applications made by foreign affiliated units can be seen also as a source of knowledge spillovers. The patents cover the traces of the person who finds the invention on them, and include the technical knowledge of the patented thing. For this reason, foreigners' patent applications in different countries indicate that knowledge flows to the applicant country. Another channel we address under innovation-based activities that play a role in the creation of knowledge spillover is entrepreneurship activities. Entrepreneurial activities are included in the knowledge spillover with "knowledge spillover theory of entrepreneurship that claims investment in the creation of new knowledge will generate opportunities for entrepreneurship as a mechanism for knowledge spillovers" (Audretsch and Lehmann, 2005).

This study aims to investigate whether FDI inflows and innovative activities act as a knowledge spillover channel that increases the logistics performance of countries that is an indicator of the international competitiveness. The efficiency of logistics processes and the superiority of logistics performance advance the countries in the world of competition.

The World Bank has developed an index that allows countries to measure and compare how good they are in logistics processes, which is called Logistics Performance Index (LPI). LPI analyzes countries through six indicators (World Bank, 2018):

1. The efficiency of customs and border management clearance (Customs Clearance).
2. The quality of trade and transport related infrastructure (Infrastructure).
3. The ease of arranging competitively priced international shipments (International Shipment).
4. The competence and quality of logistics services (Logistics Service Quality).

5. The ability to track and trace consignments (Traceability).
6. The frequency with which shipments reach consignees within the scheduled or expected delivery time (Timeliness).

The logistic performance index helps governments as a measure for assessing their performance in logistics and shows how close they are to their goals. It is also a guide for improvement by revealing the advantages or weaknesses in six components of LPI.

In this study, the impact of FDI and innovative activities on logistics performance has been questioned according to the level of development of countries and six different logistics performance indicators in terms of Customs Clearance, Infrastructure, International Shipment, Logistics Service Quality, Traceability and Timeliness. When the structure of the data set and the suitability of the research question were considered, the Ordinary Least Squares (OLS) Estimator was used as the estimation method.

The original value of the study is considered in terms of conceptual and practical contributions. Conceptually; there is a limited literature on the impact of FDI and innovation activities on logistics performance of countries. This is the first study to integrate FDI and innovations as knowledge spillover channels in analyzing the relationship between knowledge spillover and LPI. Practically; the relationship of the knowledge spillover and LPI revealed in the study are expected to guide the country's policies in fields of logistics, FDI and R&D Investments.

2. Literature Review

The literature review conducted at the stage of determining the research problem shows that the effects of foreign direct investments and innovations, which are the knowledge spillover channels, on the logistics performance of the countries are not studied adequately.

For example, in their case study, Flint et al. (2005) stated that logistics research has largely ignored the concept of innovation; In fact, after a long time of this study, Grawe (2009) 's study on top logistics journals showed that there are very limited number of theory based researches on logistics innovation and claimed that few empirical tests were conducted. The importance of the studies to be carried out in this area is evident in the following determination: In the case of optimization of innovation management, transporters generally increase their EBIT rates by 4.4%, while the most innovative ones among logistics service providers can increase this ratio by 8.5% on average (Little, 2007). However, when analyzing this data, it should be considered that logistics service providers bears more cost of innovation than other service providers (Busse, 2010).

Klink and Visser (2004) determined the types of Innovation in Logistics as follows:

Type of innovation	Management level	Objective	Example
Process Innovation	Operational	Cost Saving	ICT-based order intake (EDI, b2b e-commerce)
Product Innovation	Tactical	Cost Saving and Value Added	New packaging materials, postponed manufacturing
System Innovation	Strategic	Value Added	Supply chain management, 3rd and 4th party logistics
Market Innovation	Strategic	Value Added and Cost Saving	Specialization in logistic service supply for specific industries, exit and entry

Table 1. Types of Innovation in Logistics

A small number of researchers studying on innovation in logistics management discipline seem to focus on two channels: Logistics innovation and innovation management of logistics service providers (Busse and Wallenburg, 2014). Some of the few researches on innovation and logistics are as follows:

Burmaoğlu (2012) examined the effects of national innovation indicators on national logistics performances in EU countries by using canonical correlation and multiple regression analysis methods. The results of the study show a positive relationship between innovation indicators and logistics performance. In this study; innovation indicators in The European Union Innovation Scoreboard published in 2010, such as Human Resources, Research Systems, Finance and Support, Firm Investments, Entrepreneurship, Intellectual Assets, Innovators and Economic Impacts, have been used.

Similarly, Sipos and Bizoi (2015) concluded by conducting the least squares method that the impact of innovation performance in EU countries on the logistics performance of the EU countries was positive for the year 2012.

In another study examining the impact of innovations on the Logistics Performance Index (LPI), Wong et. al. (2016) used the productivity increases of the 3rd Party Logistics Companies between 2007 and 2012 in Malaysia as a dependent variable. The results of the study show that technological deficiencies and innovation shortages are the cause of productivity reductions in logistics industry.

In another study analyzing the determinants of the Logistics Performance Index using the panel data set covering 2007-2014 and 93 countries, Wong and Tang (2018) found out that the variables of corruption, political stability, infrastructure, technology, labor and education had a significant effect on LPI. Although this study is similar to our study in terms of using the panel data set and the Ordinary Least Squares Method, the focus of the research is different from this study.

Another factor related to the logistics performance of the countries in the literature is global competitiveness. Çemberci et. al. (2015) determined that it is very important to make improvements in logistics services categories such as International Transport, Cargo Tracing and Tracking and Timeliness if a country targets the highest level in The Global Competitiveness Index.

As mentioned above, there is very limited study on FDI and logistic performance in the literature.

Political decisions and policies directly and indirectly influence the attractiveness of a region or country in terms of business decisions and / or FDI. In this context, the productivity of the transport system and the industry are closely related. Reducing inventories with high turnover, responding to volatile demand, short lead times and reaching the lowest shipping costs are the key elements of a company's competitiveness. (Ojala and Celebi, 2015: 7).

In their study of India (Pradhan et. Al., 2013), their findings Show that it is necessary to urgently promote the development of the transport infrastructure if this country needs to attract additional FDI and economic growth. Çelebi et. al. (2015) also found out that the effect of FDI on the relationship between LPI and GDP was statistically significant.

The relationship between the logistics infrastructure and FDI is mutual. Developing countries with better logistics capabilities tend to attract FDI, and have low transaction costs, a diversified export structure and higher growth (Memedovic et al. 2008). This is also confirmed by the expectations from The Belt and Road Initiative, which China has started in recent years to reach world markets and thus revive the Silk Road by reducing total shipping time and costs. So it is expected that this initiative could pave the way for the increase in investments and gross domestic product in the countries in which the transport network passes. (Chen and Lin, 2018).

3. The Aim, Method and Limitations of the Study

As stated earlier, the aim of this study is to find out whether FDI and Innovation activities act as a knowledge spillover channel affecting the logistics performance of countries. For this purpose, three basic research questions are determined.

Research question 1: Are FDI and Innovation activities effective on the Logistics Performance Index?

The following Model 1 was established to test the first research question.

$$\boldsymbol{LPI_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}}$$

$$\boldsymbol{Model\ 1}$$

Research question 2: Are the sub-indicators of the Logistics Performance Index such as Efficiency of Customs Clearance Process, Trade Infrastructure Quality, Competitive Pricing of Shipments, Logistic Service Quality, Traceability, Timely Delivery, affected by the FDI and Innovation activities?

Models 2, 3, 4, 5, 6 and 7 were established to test the second research question.

$$\boldsymbol{Customs_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}}$$

$$\boldsymbol{Model\ 2}$$

$$\boldsymbol{Infrastructure_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}}$$

$$\boldsymbol{Model\ 3}$$

$$\boldsymbol{Logistic\_quality_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}}$$

$$\boldsymbol{Model\ 4}$$

$$\boldsymbol{Shipment_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}}$$

$$\boldsymbol{Model\ 5}$$

$$\boldsymbol{Tracking_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}}$$

$$\boldsymbol{Model\ 6}$$

$$\boldsymbol{Timeliness_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}}$$

$$\boldsymbol{Model\ 7}$$

Research question 3: Does the development level of countries have a decisive role in the impact of FDI and Innovation activities on the logistic performance index and its sub-indicators?

Within the scope of the third research question, all models (from Model 1 to Model 7) were tested separately for the sub-sample groups in developed countries and developing countries with the benchmarking regression.

In this study, knowledge spillover channels are limited to FDI and R&D Investments and Patent Applications as Innovation Indicators.

Logistics Performance Index (LPI), created by the World Bank to measure the performance of countries in the field of logistics, is used as a dependent variable while Logarithm of the FDI net inflows (Current US $), the share of R & D expenditures in GDP (%) and Logarithm of Number of Patent Application are used as independent variables. Since the R&D and Patent data for the year 2016 is missing, to provide period consistency in the data, data from 2010, 2012 and 2014 is used for the panel data set of 104 countries including both developed and developing ones obtained from World Bank-World Development Indicators.

In the analysis, considering the structure of the data set and the suitability of the research question, the Ordinary Least Squares (OLS) Estimator was used as the estimation method. The alternative methods for panel data analysis such as The Fixed Effects Estimator, which shows unit effects over the country and years, and the Generalized Moments Method, which control endogenity, have not been used due to the limits in time series in the data set.

The reliability of the OLS estimator results used in this study depends on the validity of the following six assumptions.

1. It is assumed that there is a linear relationship in the first model. Based in this assumption, Model (1) is estimated.

$$LPI_{i,t} = \beta_0 + \beta_1 DYY_{i,t} + \beta_2 Innovation_{i,t} + \partial Controls_{i,t} + \varepsilon_{i,t}$$

Model 1

2. Average value of error term is “0”. The constant term we add to the model (β_0) ensures the validity of this assumption.

3. The independent variables must not be correlated with the error term. Because of this assumption, the variables are considered to be completely external.

4. There must be no correlation between observed values of error terms. In other words, there must be no autocorrelation or serial correlation problems in the time series. Since the data set we use covers 2010, 2012, 2014, there is no contradiction to this assumption. Also, Durbin-Watson and Breusch Godfrey autocorrelation tests run, but couldn't result.

5. Under the assumption that error terms have constant variance, heteroscedasticity is checked by the Breush-Pagan and White Tests. According to test results; heteroscedasticity is not observed. The assumption that error terms have constant variance is valid.

	White Test	Breusch-Pagan / Cook-Weisberg Test
Prob	0,6967	0,2191

Table 2. Breush-Pagan ve White Test Statistics

6. The validity of the assumption that there must not be multicollinearity between explanatory variables was controlled by variance inflation factor (vif). According to the VIF values (vif <10), no multiple linearity problem was observed in the model.

Since the necessary assumptions are provided, the reliability of OLS estimation results is high in established models.

4. Estimation Results

In this part of the paper, we present estimation results. First of all, we investigate the link between LPI and knowledge spillover channels in terms of FDI and innovation based activities such as Patent and R&D. Also, we would like to show that the role of country development level on this relation. For this purpose, we run Model 1 for all, developed and developing countries separately. We must note that Patents and R&D as innovation indicators were included in the model separately because they caused multiple linearity problems. The result from OLS regression are reported in Table 3. Columns (1), (2) and (3) indicate the results when patent is used as only innovation variable, while columns (4) (5) (6) show the estimation results for only using of R&D. Also, Columns (1) and (2); (3) and (4); (5) and (6) represent the results for all, developed and developing countries respectively.

In Table 3, FDI, Patent and R&D are found to have a statistically positive significant effect on LPI and generally this result do not alter even after controlling for countries development level. Infact, both FDI and innovations are more effective on developing countries' logistic performance. It is seen that from table one percent increase in the FDI inflows increases the LPI by about 0.04 percent for all countries while increase is 0.10 percent for developing countries. The results imply that FDI inflows and innovation activities in a country contributes to logistics performance for all countries.

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory Variables	All	Developed	Developing	All	Developed	Developing
lngdpper	0.289***	0.398***	0.0971*	0.235***	0.338***	0.0894**
	(0.0259)	(0.0508)	(0.0537)	(0.0230)	(0.0629)	(0.0408)
FDI	0.0409***	0.0218	0.0976***	0.0273*	0.0261**	0.103***
	(0.0156)	(0.0133)	(0.0310)	(0.0142)	(0.0117)	(0.0306)
lnpop	0.0543***	0.0560***	0.000281	0.0435**	0.0671***	-0.0396
	(0.0165)	(0.0195)	(0.0313)	(0.0188)	(0.0175)	(0.0369)
PATENT	0.0273*	0.0240	0.0687***			
	(0.0163)	(0.0252)	(0.0219)			
R&D				0.147***	0.126*	0.125***
				(0.0279)	(0.0729)	(0.0389)
Constant	-1.422***	-2.055***	-0.298	-0.274	-1.654**	0.730
	(0.279)	(0.496)	(0.490)	(0.356)	(0.636)	(0.578)
Observations	226	87	109	188	82	82
R-squared	0.737	0.773	0.629	0.753	0.780	0.643
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						

Table 3. The dependent variable: Logistics Performance Index (LPI)

Next, we question the relationship between knowledge spillover channel and the sub-indicator of LPI such as such as Efficiency of Customs Clearance Process, Trade Infrastructure Quality, Competitive Pricing of Shipments, Logistic Service Quality, Traceability, Timely Delivery. In the line with our second research question, we run models from Model 2 to Model 7. Outputs from these estimations where innovation variable is R&D expenditure. are presented in Table 4. (see Table 6 in Appendix for Patents as innovation variable).

The results from Table 4 demonstrate that the coefficients of R&D statistically positive significant for all logistics performance indicators. Similarly, FDI has positive and statistical significant level almost for all model. However, the any statistically significant impact of FDI isn't found on Timelines and Shipment.

According to results, we can obviously note that from knowledge spillover channels, FDI and R&D positively effect to countries' logistic performance. Especially, customs clearance, logistics infrastructure, logistics quality and traceability is influenced from both of these channels.

	Dependent Variables						
Explanatory Variables	**LPI**	**Customs Clearance**	**Infrastructure**	**Logistics Quality**	**Tracking**	**Timeliness**	**Shipment**
lngdpper	0.235***	0.276***	0.326***	0.263***	0.220***	0.236***	0.116***
	-0.023	-0.0332	-0.0294	-0.0263	-0.0325	-0.0263	-0.0292
FDI	0.0273*	0.0404**	0.0351**	0.0264*	0.0309*	0.01	0.0222
	-0.0142	-0.0172	-0.0171	-0.0152	-0.016	-0.0133	-0.0168
lnpop	0.0435**	-0.00245	0.0680***	0.0646***	0.0546***	0.0662***	0.0182
	-0.0188	-0.0235	-0.0232	-0.0197	-0.0205	-0.0185	-0.0209
R&D	0.147***	0.138***	0.149***	0.159***	0.169***	0.103***	0.162***
	-0.0279	-0.0364	-0.0352	-0.0306	-0.0328	-0.0311	-0.032
Constant	-0.274	-0.434	-1.793***	-0.909**	-0.34	0.129	1.278***
	-0.356	-0.488	-0.443	-0.368	-0.477	-0.411	-0.413
Observations	188	188	188	188	188	188	188
R-squared	0.753	0.68	0.75	0.762	0.704	0.643	0.558
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1							

Table 4. The results of OLS Estimation where R&D Expenditure is used as an innovation variable.

Finally, we investigate whether there are any systematic differences of the impact of knowledge spillovers on sub-indicator of LPI between developed and developing

countries. Hence, we run the benchmark regressions separately for sub-indicators of LPI. Regressions that are reported from Table 5 is explored in order to reveal the role of countries' development level.

In Table 5, the results show that the FDI have significantly positive effect on Customs Clearance, Logistics Quality and Tracking in both developed and undeveloped countries. However, the impact of FDI on logistics infrastructure and shipment varies from the developed countries to developing countries. Namely, there is no significant effect of FDI on logistics infrastructure and shipment in developed countries. Moreover, R&D has statistically positive significant level on logistic infrastructure, logistics quality and traceability for both developed and developing countries. On the other hand, there is no any significant effect of R&D in developed countries' logistics performance in terms of customs clearance, timeliness and shipment. According to these finding, as an answer our third research question, we can say that there is a systematic difference between developed and developing countries in the relation of knowledge spillover and LPI indicators. Similar to R&D, the impact of Patents' on sub-indicators of LPI varies from developed to developing countries. Also, Patents are more effective in developing countries' logistics performance (see Table 7 in Appendix for estimation results where Patents is used as an innovation variable).

	Customs Clearance		Infrastructure		Logistics Quality		Tracking		Timeliness		Shipment	
Explanatory Variables	Developed	Developing	Developed	Developing	Developed	Developing	Developed	Developing	Developed	Developing	Developed	Developing
lngdpper	0.409***	0.0717	0.556***	0.125**	0.370***	0.118**	0.317***	0.0744	0.302***	0.166***	0.143**	-0.00388
	-0.0928	-0.0482	-0.0744	-0.0488	-0.0736	-0.0459	-0.0804	-0.0622	-0.0845	-0.0488	-0.07	-0.0508
FDI	0.0396***	0.141***	0.0173	0.154***	0.0312**	0.0983***	0.0331**	0.101**	0.0221	0.0377	0.014	0.0952***
	-0.0135	-0.0355	-0.012	-0.0349	-0.013	-0.0342	-0.0143	-0.0394	-0.0154	-0.0317	-0.016	-0.0354
lnpop	0.0314	-0.119**	0.100***	-0.0549	0.0701***	-0.00485	0.0859***	-0.0371	0.0825***	0.0262	0.0410*	-0.0499
	-0.0231	-0.0454	-0.0207	-0.0425	-0.0197	-0.04	-0.0205	-0.0411	-0.0212	-0.0383	-0.021	-0.0405
R&D	0.159	0.0984**	0.184**	0.111**	0.195**	0.118***	0.153*	0.150***	-0.0508	0.105**	0.116	0.164***
	-0.105	-0.0462	-0.081	-0.0486	-0.0794	-0.0395	-0.0866	-0.0451	-0.0908	-0.0416	-0.081	-0.0502
Constant	-2.306**	1.1	-4.268***	-0.563	-2.191***	-0.071	-1.862**	0.914	-0.98	0.829	0.86	1.889***
	-0.913	-0.787	-0.804	-0.684	-0.7	-0.572	-0.707	-0.857	-0.769	-0.709	-0.695	-0.664
Observations	82	82	82	82	82	82	82	82	82	82	82	82
R-squared	0.746	0.529	0.833	0.674	0.791	0.651	0.749	0.549	0.535	0.54	0.43	0.465
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1												

Table 5. The results of OLS Estimation when RD (R&D Expenditure) is used as an innovation variable and country development level is controlled.

5. Conclusions and Recommendations

For global trading companies, logistical performance is one of the key factors that provide competitive advantage. With the developments in communication and transportation technologies, the disappearance of borders increased the importance of logistics. At the same time, together with these technological developments, knowledge accumulation has increased and international knowledge spillover has accelerated. Nations are benefiting from knowledge spillover by obtaining advanced

technical knowledge and use it different fields. In this study, the contribution of FDI and innovation, one of the information propagation channels, to the logistics performance of the countries is examined.

The estimation results show that the FDI, R&D investments and patent applications we have dealt with as knowledge spillover channels have a statistically significant and positive effect on the logistics performance of countries. When the development levels of countries were checked, it was concluded that this effect was higher in developing countries than in developed countries. The following results are obtained from the perspective of the sub-indicators of logistics performance;

- Customs clearance procedures, infrastructure, traceability and logistics service quality are the most affected ones by FDI and innovations.

- Timeliness and the ease with which shipments can be charged are the least affected.

This shows that the logistics performance of developing countries is more sensitive to our independent variables. In addition, it is determined that the foreign investment and R&D expenditures in developing countries will provide a higher performance acceleration for the sector. According to the results of the analysis for all countries, the logistics performance categories that R&D investments make the most contribution are the infrastructure, logistic service quality and traceability; and patents for infrastructure and international transportation, the knowledge obtained by FDIs is more effective in customs clearance, logistics quality and Timeliness.

This study can be extended with more comprehensive data set. If a more comprehensive data set is available, further analysis methods such as FE or GMM can be used. Furthermore, the impact of other knowledge spillovers' variables can be explored on LPI.

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Appendix

	Dependent Variables						
Explanatory Variables	**LPI**	**Customs Clearance**	**Infrastructure**	**Logistics Quality**	**Tracking**	**Timeliness**	**Shipment**
lngdpper	0.289***	0.308***	0.374***	0.320***	0.287***	0.299***	0.171***
	-0.0259	-0.0349	-0.0335	-0.0293	-0.0287	-0.024	-0.0297
FDI	0.0409***	0.0531**	0.0471**	0.0439**	0.0485***	0.0280**	0.0262
	-0.0156	-0.0207	-0.0193	-0.0171	-0.0169	-0.0137	-0.0171
lnpop	0.0543***	0.0151	0.0760***	0.0742***	0.0605***	0.0651***	0.0402**
	-0.0165	-0.0215	-0.0207	-0.0178	-0.0182	-0.0163	-0.0182
PATENT	0.0273*	0.0305	0.0397*	0.0239	0.0359**	-0.0112	0.0460**
	-0.0163	-0.0225	-0.0221	-0.0156	-0.0174	-0.0158	-0.0202
Constant	-1.422***	-1.470***	-2.872***	-2.151***	-1.680***	-0.812**	0.0585
	-0.279	-0.4	-0.362	-0.299	-0.314	-0.319	-0.343
Observations	226	226	226	226	226	226	226
R-squared	0.737	0.652	0.743	0.724	0.715	0.651	0.531
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1							

Table 6. The results of OLS Estimation where Patent is used as an innovation variable

	Customs Clearance		Infrastructure		Logistics Quality		Tracking		Timeliness		Shipment	
Explanatory Variables	Developed	Developing	Developed	Developing	Developed	Developing	Developed	Developing	Developed	Developing	Developed	Developing
lngdpper	0.433***	0.0382	0.646***	0.143**	0.497***	0.113*	0.400***	0.131**	0.268***	0.183***	0.212***	-0.004
	-0.0594	-0.078	-0.0664	-0.0682	-0.0619	-0.0672	-0.059	-0.0621	-0.0706	-0.0508	-0.0595	-0.047
FDI	0.0325**	0.140***	0.0117	0.138***	0.0251*	0.0932***	0.0321*	0.0868**	0.0198	0.0703**	0.0089	0.0643*
	-0.0155	-0.0424	-0.0144	-0.0375	-0.0147	-0.0353	-0.0162	-0.0343	-0.0158	-0.0301	-0.0177	-0.034
lnpop	-0.00784	-0.0714*	0.0879***	-0.00577	0.0688***	0.0277	0.0781***	0.014	0.0802***	0.0158	0.0364	0.018
	-0.025	-0.0423	-0.0237	-0.0381	-0.0233	-0.0369	-0.0238	-0.0348	-0.025	-0.0309	-0.0238	-0.0329
PATENT	0.0848**	0.0687**	0.0289	0.0704**	0.00731	0.0751***	0.0184	0.0749***	-0.00534	0.0139	0.0124	0.106***

	-0.0337	-0.028	-0.0268	-0.0291	-0.0302	-0.0203	-0.0274	-0.0241	-0.0333	-0.0211	-0.0327	-0.0281
Constant	-2.101***	0.232	-4.940***	-1.657**	-3.295***	-0.887	-2.591***	-0.584	-0.528	-0.0189	0.335	0.833
	-0.586	-0.716	-0.678	-0.638	-0.574	-0.577	-0.563	-0.559	-0.701	-0.521	-0.585	-0.518
Observations	87	109	87	109	87	109	87	109	87	109	87	109
R-squared	0.747	0.498	0.826	0.651	0.762	0.594	0.728	0.617	0.523	0.512	0.401	0.469
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1												

Table 7. The results of OLS Estimation where PATENT (the number of patent applications) is used as an innovation variable and country development level is controlled.