The Effect of Foreign Trade on Innovation: The Case of BRICS-T Countries

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Abstract

The power that makes countries superior to each other in global competition is their ability to be innovative. With Industry 4.0, today's industrial policies are being established on an innovation basis. The degree of countries' trade openness in the economy is very important for developing countries in terms of learning and developing information and technology and ultimately contributing to the improvement of their innovation capacities. This study aims to determine the effects of the main foreign trade indicators on innovation with respect to the developing countries group BRICS-T through panel cointegration analysis for the period 2007-2019. In terms of foreign trade, "export", "import", and "foreign direct investment" have been taken into account, and the "global innovation index" has been taken into consideration as the indicator of innovation. As a result of the cointegration analysis, it has been determined that the variables are related in the long run, exports have a positive effect on innovation, whereas imports and foreign direct investments adversely affect innovation. As a result of causality analysis, a two-way causality relationship has been found between export and innovation while a one-way causality has been detected with direct foreign investment and import.

Keywords: Innovation, Foreign Trade, Panel Cointegration Analysis
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1. Introduction

In economic literature, Joseph Schumpeter was the first economist to realize the significance of innovation in terms of microeconomics and macroeconomics. Schumpeter (1978) made a distinction between invention and innovation, argued that the entrepreneur and innovation created by the entrepreneur were the main driving force of the capitalist system. He referred to this process as "Creative Destruction".

According to Drucker (1998), innovation means creating prosperity either by finding new resources or by enhancing the capacity of existing resources. Innovation must not be confused with novelty. The difference between innovation and novelty is that innovation creates value.

According to Freeman (1982), innovation refers to all design, manufacturing, management, and commercial activities performed in the marketing of a new product or for the first commercial use of a new process or equipment.

According to Elçi & Karataylı (2008);

- Innovation is not about putting into practice the big and bright ideas found incidentally. Innovation is realized through deliberate and systematic steps.
- Innovation is not just a pursuit of novelty.
- At the same time, improving, developing, and differentiating an existing product or a process is also innovation.
- Innovation and invention are not the same. An invention is the transformation of an idea with a dimension of innovation into a product or process. Unless the invention is commercialized successfully, it cannot create social and economic benefits, and therefore cannot be called innovation. Innovation certainly benefits from the results of inventions, except that innovation can be realized without invention.
- Innovation does not mean R&D. Like invention, R&D can generate input for innovation, but innovation can be achieved without R&D. R&D is the transformation of money into knowledge; innovation is the transformation of knowledge into money.
- Innovation should not be seen as an action independent of other activities of the company. On the contrary, all activities and processes should be carried out as intertwined with innovation. Every work done should be open to development and improvement, and to differentiation in a way that creates value. The companies that

made innovation their corporate culture and integrated it with their processes are those with a high level of innovation performance.

- Innovation should have continuity. Nowadays, the competitors who can easily access information and technology mimic innovation quickly and easily.

Innovation is today a concept with increasing importance in the sense of microeconomy and macroeconomy. In terms of both businesses and the national economy, innovation is required for the following reasons (Işık & Keskin, 2013):

- Today, countries cannot achieve the desired success with their “grand” industrial policies.
- Innovation is the key to competitive power. Therefore, countries need new capabilities and skills.
- Due to the pressures originating from globalization, “sheltered” areas for countries and businesses are decreasing gravely.
- Market forces fall short of bringing businesses and economies from disadvantageous positions to advantageous positions. However, innovation has an important place for both companies and countries in order to show the power of national and international competition.

This study discusses the BRICS countries (Brazil, Russia, India, China, and South Africa) consisting of developing countries and Turkey that is evaluated in a similar category by being occasionally included in this group of countries. The effect of export, import, and FDI (foreign direct investment) variables on innovation was investigated in these countries (BRICS-T countries). The “global innovation index” was chosen as an indicator of innovation. The study covers the period 2007-2019. The method of the research is panel cointegration analysis. Numerous variables were examined like R&D, the number of patents, and the number of scientific publications that represented innovation when the studies in the literature about innovation were reviewed. However, the importance of this study and its differentness from other studies in the literature is choosing the "global innovation index", which has started to be issued in recent years, to represent innovation. Thus, innovation would be approached using a different measurement indicator, and it would be tested whether it matched the results obtained in the literature.

In this study, first, the theoretical background of the relationship of innovation to export, import, and FDI, and the main studies on this subject in the literature were presented. Later, the econometric analysis of this relationship was carried out. Finally, the econometric and economic assessment of the analysis results was performed.

2. Theoretical Background and Literature Review

2.1. Export & Innovation Relationship

There are different theories in the literature about the direction of the relationship between innovation and export. According to Posner's (1961) "technology gap theory", Vernon's (1966) "product life cycle theory", and Krugman's (1979) "north-south trade model", innovation increases export by raising competitiveness in the market. According to Posner, comparative cost differences originating from particular technical changes in a country provide an export advantage to the innovating country until the technical innovation in question is learned and imitated by other countries. Vernon emphasizes the effects of the innovation timing, scale economies, ignorance, and uncertainty on foreign trade, rather than comparative cost differences. According to the "Product life cycle theory", the first stage in industrialized countries with high proportions of skilled labor and R&D expenses is the introduction of new products. The product itself is not standardized yet. It requires a large time gap to arrange the inputs, the manufacturing process, and its final specifications. For this reason, the levels of production and export are low. In the second stage, which is called the maturing product, production and export increase. In the standardized product stage, production is shifted to less-developed countries due to low input costs, and exports are substantially performed by those underdeveloped countries. In Krugman's model, the innovative Northern country where innovation is accomplished exports new products to the Southern country in the beginning. Afterward, as the said production technology also becomes available in the Southern country, due to low-wage competition, the Northern country now imports those old products from the Southern country. Ayar & Erdil (2018) investigated the effect of R&D and innovation activities of the exporting companies in Turkey on the perception of export performance. The survey was conducted with 313 companies, as of 2017. As a result of the factor analysis, it was found that innovation and R&D activities had a positive effect on the perception of export performance. According to Dam & Yıldız (2016), innovation positively affects economic growth through exports, pursuant to the results of the panel data analysis involving the BRICS countries as well as Turkey and Mexico, concerning the period 2000-2012. Perçin, Karakaya & Ağazade, (2015) investigated the causality relationship between innovation and export in the Turkish manufacturing industry using the data of the period 2008-2013. According to the analysis results, the direction of causality is unilateral and it is from innovation towards export.

The view that exports cause innovation or R&D expenditures, depends on endogenous growth models internalizing innovation and R&D based on the idea of learning by exporting which was adapted from Arrow's (1962) “learning theory” (Romer, 1990). According to this approach, if companies operate internationally or engage in foreign trade, they will face stronger competition. Surviving despite the intense competition in the international arena and providing competitive edge lead to "the effect of learning by exporting". In this way, companies start to attach importance to innovation and R&D (Perçin, Karakaya, & Ağazade 2015). In the study conducted by Neves, Teixeira & Silva (2016) on the relationship between export, R&D, innovation, economic performance, and sales increase in Portugal; it was observed that engaging in export activities increases companies' probability of engaging in R&D activities as an indicator of innovation, also, the companies engaging in R&D activities achieve a more successful export performance than the ones not engaged in those activities.

Studies in the literature show that the relationship between innovation and export can also be mutual. According to Aw, Roberts & Xu (2011), as an indicator of innovation, R&D investments increase the future profitability of the company expected from exports. At the same time, exports also contribute positively to the return on R&D investments, affecting innovation positively. In Palangkaraya’s (2012) study covering 3000 SMEs for 2007, a statistically and economically significant positive correlation was detected between export and innovation in the period in question. Besides, the study proved that the direction of causality was bidirectional for process innovation, especially for the services sector. Golovko & Valentini (2011) identified a positive complementarity relationship between innovation and export, in their study for Spain over the period 1990-1999.

2.2. Import & Innovation Relationship

Innovation occurs in two ways. The first is to generate new knowledge by making R&D investments, and the second is to acquire knowledge via getting inspired by innovations made by others or via transferring technology. The first way is adopted mostly by developed countries. Developing countries, on the other hand, cannot generate innovation based on their own internal efforts due to inadequate and unqualified physical and human capital accumulation and financing problems. Therefore, developing countries often transfer technology and knowledge from developed countries through import or FDI and attempt to generate innovation. Import from developed countries means the transfer of the knowledge embodied in the product into the country. In particular, imports from developed countries, which are considered as innovationists and as the center of innovative knowledge, are an important source of knowledge for developing countries. Based on that, in their study involving 26 developed and 18 developing countries for the period 1998-2007, Tüylüoğlu & Saraç (2012) concluded that developing countries acquired technological knowledge through imports, which eventually contributed to innovation production. Schneider (2005) analyzed the impacts of foreign trade, FDI, and the protection of intellectual property rights on innovation. She used the panel data method in her study concerning 47 developed and developing countries for the 1970-1990 period. According to the results of the research; (1) high-technology imports are relevant in explaining domestic innovation both in developed and developing countries; (2) foreign technology has a stronger effect on per capita GDP growth than domestic technology; (3) Intellectual property rights affect the innovation rate, but this effect is more significant for developed countries; the results regarding FDI are inconclusive. Busse & Groizard (2006) concluded that the import of R&D intensive goods increased the country's knowledge stock, accelerated innovation production through total-factor productivity in the long run, and created a reducing effect on income gaps among countries.

Competition is more intense in the sectors where companies with similar technological levels operate. Fierce competitive market structure in those sectors forces companies to innovate in order to get out of the competitive environment. Through R&D and innovation, companies strive to take a step ahead of their competitors and thus increase their market shares. Accordingly, since the innovating company will be secured by laws that protect intellectual property rights for a certain period, it will get some gains in terms of elements such as profitability and protecting and increasing its market share (Kurtoğlu, 2014). In economic theory, it is called the "escape-competition effect" which explains the relationship between competition and innovation. According to Aghion et al. (2009), import competition generally discourages innovation by decreasing sector-wide profits but encourages companies that are close to the technological frontier to escape competition by increasing investments in R&D. Only the most productive companies have an adequately high probability of surviving the increase in foreign competition. Similar results were obtained in the study of Bombardini, Li, & Wang (2018) regarding China covering the period 2000-2007. As a result of the membership accession of China to the World Trade Organization and a drop in import tariffs, in the face of import competition in China, productive firms generally escaped from innovative activities. Similar results were obtained not only on a company basis but also for the sector in general.

2.3. FDI & Innovation Relationship

In literature, the relationship between innovation and FDI is usually associated with technology transfer. FDI is one of the methods of transferring technological knowledge generated in other countries to the host country. FDI might affect technological innovation in host countries through various mechanisms: backward linkages, forward linkages, competitive effect, demonstration effect, effects on human capital formation and dissemination of knowledge through the brain (Hirschman, 1958 quoted by Berger & Diez, 2008; Loukil, 2016):

- *Backward linkages:* Multinational Companies (MNCs) will provide inputs and services from local sources. These links are regarded as good opportunities for MNCs' spillovers. In this case, the subsidiaries of MNCs provide information on international quality standards and can even support local providers through financial assistance, technology transfer, training, and sharing of information and knowledge.

- *Forward linkages:* Subsidiaries of the MNCs sell products to local customers inducing, hence, the knowledge transfer (especially in case of capital equipment sales) by offering training for learning the operation and maintenance of the equipment.

- *The competitive effect:* MNCs usually penetrate into domestic markets and compete with local companies. That might motivate local companies to increase their efforts to improve technologies, enabling them to improve competitiveness. For domestic companies, however, this competitive effect might create the threat of being driven from the market (crowding-out effect).

- *The demonstration effect:* MNCs' subsidiaries are distinguished by the high quality of their technology and management practices. Local companies can benefit if they continue to observe, copy, and adapt these technologies and practices.

- *The effects on human capital formation:* Subsidiaries are in connection with national research and education institutions to secure a sufficient human resources supply. In this case, MNCs offer students financial support and access to new technologies. Moreover, employment opportunities in MNCs' subsidiaries might encourage students to prefer fields of science and technology. As long as MNCs do not employ all the graduates, the availability of highly skilled labor can increase.

The relationship between innovation and FDI appears in the literature in different ways. According to Shatz & Venables (2000), who investigated the reasons for an international corporation's decision to engage in FDI, FDI is made in two ways: "Vertical FDI" aims to strengthen the company's competitive position by expanding the base. However, a major part of FDI activities worldwide is "horizontal FDI". The aim here is to minimize production costs. The cost-cutting effect of infrastructure systems is bigger; therefore, they affect the horizontal type of FDI. Innovation, on the other hand, has a bigger impact on the vertical type of FDI, usually because of creating technological competitiveness (Mike & Oransay, 2015). Mike & Oransay (2015) investigated the impact of infrastructure and innovation changes on FDI for Turkey, using the annual data of the period 1975-2013 through Johansen cointegration analysis. According to the results of the analysis, it was concluded that placing more emphasis on infrastructure expenditures and promoting innovation contributed to increasing FDI levels. Baskaran & Muchie's (2008) study about BRICS countries examined the direction by which the weakness or strength of national innovation systems influences FDI flow to the host country. It was concluded that the national innovation system had a stronger and wider impact on FDI in China, where the system was stronger, compared to other BRICS countries, and had a weaker effect in South Africa.

Odagiri & Goto (1993) divided the science, technology, and innovation periods of Japan into five. During the Meiji period between 1868 and 1911, advanced technology imports were made through getting foreign books, sending students to foreign countries, bringing experts, and purchasing machinery and equipment. Through FDI, progress was made in several areas such as catching up with Western countries economically and militarily, modernization, improvement of infrastructure, transportation, communication, education, the opening of factories by the state, development of manufacturing industry, military production, developments in heavy industry, and endogenous technological development. In the period between the two world wars, the economy took off, heavy industry developed, and the scientific and engineering foundation was strengthened. With the influence of the wars as well, the domination of high technology was ensured in military areas. Significant quantitative and qualitative developments were accomplished in public and private sector R&D laboratories. Endogenous technology production matured and technology deficit decreased. After the Second World War, technology and qualified labor force developed for pre-war military purposes were transferred to the civilian area; new technologies were imported, assessed, adapted, and improved (Turanlı & Sarıdoğan, 2010). Odagiri & Goto refer to Japan's post-1960s era as the period in which Japan strengthened its own innovation. During this period, the technology import of Japan, which had become one of the leading countries in international competitiveness, decreased and it started to produce its own technology. The example of Japan shows that there is a positive relationship from FDI toward innovation. In Ekiz & Aytun's (2016) study involving the G7 countries during the period 1981-2014, it was concluded that there was a positive and one-way causality relationship from FDI toward R&D expenditures that represented innovation. In the study of Sivalogathasan & Wu (2014), a panel data approach was employed to identify the international technology spillover effect on domestic innovation capacity for a group of emerging South Asian markets between 2000 and 2010. The empirical data reveals that FDI inflows create spillover effects on domestic innovation capacity in South Asian countries. This outcome confirms the hypothesis that incoming FDI carries knowledge spillovers and new technologies and products into the host country and increases domestic companies' innovation capability. Those spillover effects may originate from channels like reverse engineering, skilled labor turnovers, demonstration effects, and backward linkages.

Sasidharan & Kathuria (2008) examined 1,843 Indian manufacturing companies operating between 1994 and 2005 through panel data analysis. According to the results of the analysis, FDI has no impact on the innovation strategies for India. When the analysis is conducted based on different subsamples, FDI inflow encourages foreign-owned corporations in high-technology industries and companies in minority ownership to make investments in R&D. In the study of Tüylüoğlu & Saraç (2012), FDI coefficient was revealed to have a positive effect in developed countries, but a negative effect in developing countries. A 1% variation in FDI generates a forward variation of 0.03% in developed countries while generating a backward variation of 0.56% in developing countries. A panel threshold model prepared by Loukil (2016) with a sample of 54 developing countries for the period 1980-2009 revealed the existence of non-linear effects in the relationship between FDI and innovation. In the study, it was concluded that there was a threshold value of technological advancement below which FDI negatively affected innovation and above which FDI had a significant positive effect on innovation. The results suggest that the intensity of FDI's impact on innovation capabilities depends on the domestic industry's absorptive ability and complementary assets. Therefore, it is not adequate that economic policies attract FDI; it is still required to promote local companies in developing an absorptive capacity that will enable them to profit from the advantages of multinational corporations (Loukil, 2016).

3. Econometric Analysis

3.1. Method

Cross-sectional dependence and homogeneity tests were administered for the analyses; Im, Pesaran & Shin (2003), Maddala & Wu (1999), and Choi (2001) first-generation unit root tests were implemented; the stationarity was tested by CIPS test from the second-generation unit root tests; Westerlund & Edgerton (2007) LM Bootstrap Panel Cointegration test was employed to determine the long-run relationship between the variables. After long-run coefficient estimations were completed through FMOLS, Dumitrescu & Hurlin (2012) causality test was analyzed.

3.2. Data

In the study, BRICS_T countries were examined for the years 2007-2019, and panel cointegration analysis was applied to determine the relationship between foreign trade indicators import, export, and foreign direct investments and the dependent variable global innovation index. The data were created from the database of www.worldbank.org. The analyses were achieved using the Gauss codes and EViews 10.0. The variables used in the model are given in Table 1.

Table 1: Variables

Variables	Abbreviation	Description
Export	EXP	Independent variable
Import	IMP	Independent variable
Foreign Direct Investment	FDI	Independent variable
Global Innovation Index	GII	Dependent variable

3.2. Cross-sectional Dependence and Homogeneity Tests

The cross-sectional dependence between the series was discovered through the LM CD test developed by Pesaran (2004) and the LM adj. test, whose deviation had been corrected by Pesaran, Ullah & Yamagata (2008), and the test results are exhibited in Table 2. Additionally, homogeneity of cointegration coefficients was tested utilizing the delta tilde and adjusted delta tilde tests of Pesaran & Yamagata (2008), and the test results are given in Table 2.

Since $p<0.05$ for cross-sectional dependence, the null hypothesis (no cross-sectional dependence) was rejected, and the cross-sectional dependence was identified between the series. Since $p<0.05$ for homogeneity testing, the null hypothesis (Slope coefficients are homogeneous) was rejected, and the cointegration coefficients were ascertained to be heterogeneous.

Table 2: Cross-sectional dependence and homogeneity test results

Cross-sectional dependence test (H_0 :No cross-sectional dependence)		
Test	**Test statistics**	**p-value**
LM (Breusch & Pagan, 1980)	43.908	0.000
LM $_{adj}$ (Pesaran et al., 2008)	39.362	0.000
LM CD (Pesaran, 2004)	38.321	0.000
Homogeneity test (H_0 : Slope coefficients are homogeneous)		
Test	**Test statistics**	**p-value**
Delta_tilde	10.672	0.002
Delta_tilde_adj	11.557	0.000

3.3. First Generation Unit Root Test Results

First-generation unit root tests are divided into two as homogeneous and heterogeneous models. Since the coefficients were heterogeneous, Im, Pesaran, & Shin (2003), Maddala & Wu (1999), and Choi (2001) first-generation unit root tests based on heterogeneous model assumptions were used.

Table 3: Panel unit root test results

Variables	**Maddala & Wu Test**		**Im, Pesaran & Shin Test**		**Choi Test**	
	Level	**First difference**	**Level**	**First difference**	**Level**	**First difference**
	Trend + Constant	**Constant**	**Trend + Constant**	**Constant**	**Trend + Constant**	**Constant**
GII	0.135	0.005*	0.182	0.003*	0.194	0.005*
IMP	0.249	0.014*	0.215	0.001*	0.233	0.012*
EXP	0.211	0.007*	0.228	0.013*	0.241	0.000*
FDI	0.193	0.000*	0.209	0.000*	0.227	0.000*

* Stationary variable for 0.05, Probability (p) values are given in the table. The null hypothesis of the tests is as there is a unit root. The optimal lag length was determined using the Schwarz information criterion.

As can be seen in Table 3, every variable owns a unit root, in their level values. On the other hand, the first-order difference series do not contain unit roots. Hence, it is understood that all variables are I(1), that is to say, they are stationary for the first-order difference. First-generation unit root tests are based on the premise that the cross-sectional units that compose the panel are independent and that every cross-sectional unit is equally affected by a shock occurring to any of the units in the panel. It is more realistic to consider that a shock to a cross-sectional unit in the panel will differently affect other units. To fix the deficiency, second-generation unit root tests were developed for stationarity analysis, considering the dependence between cross-sectional units. If the existence of cross-sectional dependence in the panel data set is rejected, the 1st generation unit root tests can be applied. However, if the panel data has a cross-sectional dependence, the use of 2nd generation unit root tests assure a more consistent, efficient, and strong estimation.

In the study, since cross-sectional dependence was ascertained, second-generation unit root tests were utilized. CADF that is one of the second-generation unit root tests was employed. The results of the CADF test developed by Pesaran (2007) are presented in Table 4.

Table 4: Second generation panel CADF unit root test results

Variables	Level		First Difference	
	Constant	Constant + Trend	Constant	Constant + Trend
GII	-1.261	-1.134	-8.632*	-9.369*
IMP	-1.066	-1.112	-8.281*	-9.070*
EXP	-0.903	-1.035	-7.903*	-8.364*
FDI	-1.105	-1.164	-8.372*	-9.045*

* For 1% and 5%, H_0 is rejected, stationary variable

In the CADF tests, the maximum lag length was applied as 2, and the optimal lag length was set according to the Schwarz information criterion. It is observed that the null hypothesis is rejected at the significance level of 0.05. Unit root test results reveal that the series are not stationary at the level, that is to say, they contain unit roots, and the variables are stationary at the level I(1).

3.4. Panel Cointegration Test

In the present study, the LM bootstrap panel cointegration test developed by Westerlund & Edgerton (2007) to determine the long-run relationship between variables was exercised. The H_0 hypothesis cannot be rejected in this test, indicating that there exists a cointegration relationship for all cross-sections.

Table 5: Westerlund & Edgerton (2007) LM boostrap cointegration test results

LM_N^+	Constant			Constant + Trend		
	Statistic	Asymptotic p-value	Bootstrap p-value	Statistic	Asymptotic p-value	Bootstrap p-value
	9.891	0.326	0.405	10.825	0.384	0.429

Bootstrap probability values were taken from a distribution of 10,000 iterations. Asymptotic probability values were obtained from the standard normal distribution. Lag and premise levels were taken as 1. It is observed that there is a cointegration relationship between the series for the country group (p> 0.05). In that case, the series move together in the long run. Once it is verified that the series are cointegrated, the coefficients in the model can be estimated via the cointegration estimators. Long-run coefficients of the model were estimated through FMOLS.

3.5. Long-Run Cointegration Coefficients Estimation via FMOLS (Fully Modified OLS)

In the study, long-run cointegration coefficients were analyzed through FMOLS (Fully Modified OLS) method. The FMOLS method eliminates second-order bias effects, as it takes into consideration the simultaneous relationships between error terms of equations of the variables. The FMOLS estimator resolves diagnostic problems that happen with standard estimators. This method was developed by improving OLS, considering the autocorrelation problem.

Table 6: FMOLS long-run cointegration coefficients

Countries	**Coefficients**		
	IMP	EXP	FDI
Brazil	-0.073*	0.052*	-0.044*
Russia	-0.832*	0.074*	-0.062*
India	-0.068*	0.056*	-0.055*
China	-0.093*	0.135*	-0.106*
South Africa	-0.070*	0.104*	-0.054*
Turkey	-0.053*	0.060*	-0.108*
Panel	-0.084*	0.091*	-0.079*

* Significant variable for 0.05

The independent variables examined were found to be statistically significant for innovation. According to long-run coefficients panel-wide: as import increases, the innovation index will decrease by 8%; as export increases, the innovation index will increase by 9%; and as FDI increases, the innovation index will decrease by 7%. As can be seen, FDI and IMP variables negatively affect innovation. Export, on the other hand, positively affects innovation.

3.6. Dumitrescu & Hurlin (2012) Causality Analysis

The causality test to be applied varies according to whether a cointegration relation exists between the panel series. All panel causality tests produce estimates under the assumption of horizontal cross-sectional independence. Only through Dumitrescu & Hurlin (2012) test, an estimation can be made in the case of both horizontal cross-sectional dependence and horizontal cross-sectional independence, and effective results can be achieved. The Dumitrescu & Hurlin (2012) test is similar to the Granger causality test for heterogeneous panels. It signifies the average of individual Wald tests calculated for horizontal cross-section units within the Granger causality test. It takes into account both heterogeneity and cross-sectional dependence. Another feature of the Dumitrescu & Hurlin test is that it works both in the presence and absence of a cointegrated relationship. Three different statistical values were calculated in the panel causality test.

Table 7: Dumitrescu & Hurlin (2012) test results

Null Hypothesis	Test	Statistics Value	p
"The variable IMP is not the Granger cause of the GII"	*Whnc*	9.430	0.008
	Zhnc	8.995	0.000
	Ztild	7.156	0.000
"The variable GII is not the Granger cause of IMP"	*Whnc*	1.588	0.315
	Zhnc	1.304	0.453
	Ztild	1.246	0.372
"The variable EXP is not the Granger cause of the GII"	*Whnc*	8.642	0.000
	Zhnc	8.071	0.000
	Ztild	7.162	0.000
"The variable GII is not the Granger cause of EXP"	*Whnc*	8.902	0.005
	Zhnc	7.385	0.022
	Ztild	7.677	0.007
"The variable FDI is not the Granger cause of the GII"	*Whnc*	7.532	0.003
	Zhnc	6.808	0.000
	Ztild	8.263	0.002
"The variable GII is not the Granger cause of FDI"	*Whnc*	8.483	0.184
	Zhnc	7.621	0.109
	Ztild	7.099	0.245

According to Dumitrescu & Hurlin (2012) test results;

- Import is the Granger cause of innovation, but innovation is not the Granger cause of import. There is a one-way causality.

- Export is the Granger cause of innovation, and innovation is the Granger cause of export. There is a two-way causality.
- FDI is the Granger cause of innovation, but innovation is not the Granger cause of FDI. There is a one-way causality.

4. Conclusion

The advancement of information and communication technologies gradually increases competition in the global economy. Creative thinking concerning goods and services is becoming increasingly important. In today's world economy, concepts such as R&D, invention, novelty, and innovation are increasingly gaining ground. To invest in R&D investments, to invent, and to innovate are not enough alone to raise countries' welfare levels. It is expected that every invention or innovation presented will economically and socially create value, in other words, it will turn into an innovation. Therefore, innovation is especially more important for developing countries.

This study covers the BRICS countries consisted of developing countries and Turkey that appears to be included in this group of countries in various studies. For the mentioned countries, a panel cointegration analysis was conducted based on the 2007-2019 period. Through this analysis, the study tried to determine the effects of export, import, and FDI on innovation in BRICS-T countries. What makes this study different from other studies in the literature is the consideration of the "global innovation index", which has started to be issued in recent years and shows countries' innovativeness. Other studies in the literature are based on the variables that do not fully represent the innovation concept such as R&D, number of patents, intellectual property rights or number of scientific publications, as indicators of innovation.

In the present study, the independent variables are EXP (export), IMP (import), and FDI (foreign direct investments). The effect of the independent variables examined on innovation was found to be statistically significant. The dependent variable is the GII (global innovation index). As a result of the cointegration analysis, it was determined that the variables were related in the long run and that EXP positively affected innovation, whereas IMP and FDI had a negative effect on innovation.

According to long-run coefficients panel-wide: the GII will decrease by 8 percent for every 1 percent increase in IMP, the GII will increase by 9 percent for every 1 percent increase in EXP, and the GII will decrease by 7 percent for every 1 percent increase in FDI. As can be seen, FDI and IMP variables negatively affect innovation. EXP, on the other hand, positively affects innovation.

As a result of the causality analysis, a two-way causality relationship was obtained between EXP and the GII, and a one-way causality relationship between FDI and IMP.

In the analysis, no different results were obtained among BRICS-T countries. Therefore, when evaluating the results of the analysis in terms of economy, the overall panel was taken as the basis, not individual countries. The fact that the results of the analysis show the same tendency in all countries despite the presence of countries within the BRICS-T country group that are different from each other, such as China and South Africa, might be broadly discussed in another study. In this respect, a study that might lead to new academic studies has been presented.

When looking at the overall panel, the fact that there is a bidirectional causality relationship between export and innovation and that export has a positive impact on innovation coincides with the studies in economic theory and literature, as explained in the literature review section of this study. The results were obtained particularly within the framework of the theories developed by Arrow (1962) and Romer (1990). It is inevitable that companies and countries entering into the international competitive environment by exporting try to behave innovatively to be able to hold on and compete in a highly competitive market.

When the studies examining the relationship between import and innovation are reviewed in the literature, there exist several articles showing that imports affect innovation negatively or positively. The fundamental ground of the studies showing that imports have a positive effect on innovation is the knowledge to be obtained through imported goods and to increase innovation in the country by using and improving that knowledge. It is assumed that imports will improve innovation, especially if imported goods are high-tech products. In this study, for the overall panel, a one-way and negative relationship was detected between import and innovation, which is from import toward innovation. When reviewing the literature, it is possible to see some studies in which similar results were obtained. Herein, the starting point is the competition. Companies that have difficulty in competing with imported goods and whose profits have decreased are alienated from making innovative initiatives. A kind of discouragement can be mentioned here. Among countries with similar levels of development, e.g., developed countries; considering high-tech products that they import from each other, they do not focus on developing new technologies and innovation through innovative moves, they do not compete amongst themselves anymore, because there is not much technology gap between those countries. At this point, imports will have a positive impact on innovation. In the economic literature, this situation is referred to as the "escape-competition effect". However, in terms of the technological level, there is a severe difference between developed countries and developing countries like the BRICS-T countries discussed in this study. With the high-technology products that they import from developed countries, the developing countries might move further away from innovation due to reduced profitability, rather than aiming at enhancing innovation within the country. Considering that it does not conflict with economic theory, it may be an appropriate approach to seek the driving force of innovation in developing countries like BRICS-T, out of imports.

There exist different studies in the literature that explain the relationship between FDI and innovation as bidirectional. The effect of FDIs on innovation was found to be positive in some studies and negative in some studies. In this study, looking at the overall panel, there is a one-way and negative relationship between FDI and innovation from FDI to innovation. Tüylüoğlu & Saraç (2012) links this negative relationship to the fact that developing countries do not have the infrastructure to adapt and develop technological knowledge they acquire through FDI in accordance with their conditions. Thus, MNCs become monopolistic corporations that have technology and innovation in those developing countries. That decrease in the absorptive capacity of the local companies also hampers their capability to compete with the MNCs that come to the country and restrains their ability to generate innovation by increasing the monopoly power of MNCs. This situation undermines the innovationist initiatives of companies in developing countries. In other words, this situation shows that FDI's contribution to technological development and R&D activities and its ability to create an innovative effect depend on whether the host country has reached a certain technological level. Besides, technology spillovers from foreign companies toward domestic companies might be less than anticipated. In fact, MNCs are sometimes reluctant to convey the state of the art technology because they are afraid of losing intellectual property rights and potential competition to the businesses grasping new technologies (Loukil, 2016).

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