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## The Impact of Foreign Direct Investment on High Technology Exports: An Investigation with The Mediating Roles of R&D and Patents<sup>1</sup>

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### Abstract

Foreign direct investment (FDI), research and development (R&D) expenditures and the number of patent applications are closely related and critical factors in enhancing countries' technological development and innovation capacities. While FDI supports R&D activities by providing financial resources, these activities pave the way for the emergence of innovative products and technologies. The number of patent applications is an important measure for the commercialization and protection of these innovations. The main aim of this study is to examine the impact of FDI on exports of high-tech products through the mediating roles of R&D expenditures and the number of patent applications by using the data of 44 developed and developing countries for the period 2010-2023. In this context, a model proposal is presented and path analysis is performed with Structural Equation Modeling (SEM) to examine the direct and indirect effects between variables. The results of the path analysis show that FDI has a positive and significant direct effect on high-tech exports. In addition, indirect effect findings reveal that R&D expenditures and the number of patent applications mediate the relationship between FDI and high-tech exports.

**Keywords:** Foreign Direct Investment, R&D, Patent, High Technology Product Exports, Structural Equation Modelling

**Jel Codes:** B17, C30, F63, O30

## Doğrudan Yabancı Yatırımların Yüksek Teknoloji İhracatı Üzerindeki Etkisi: Ar-Ge ve Patentlerin Aracılık Rollerini ile Bir İnceleme

### Öz

Doğrudan yabancı yatırımlar (DYY), araştırma ve geliştirme (Ar-Ge) harcamaları ve patent başvurularının sayısı, ülkelerin teknolojik gelişme ve inovasyon kapasitelerinin artırılmasında birbirleriyle yakından ilişkili ve kritik faktörlerdir. Doğrudan yabancı yatırımlar finansal kaynak sağlayarak Ar-Ge faaliyetlerini desteklerken, bu faaliyetler yenilikçi ürün ve teknolojilerin ortaya çıkmasının önünü açmaktadır. Patent başvurularının sayısı, bu yeniliklerin ticarileştirilmesi ve korunması için önemli bir ölçüttür. Bu çalışmanın temel amacı, 2010-2023 dönemi için 44 gelişmiş ve gelişmekte olan ülkenin verileri kullanılarak, DYY'nin yüksek teknoloji ürün ihracatı üzerindeki etkisinin, Ar-Ge harcamaları ve patent başvuru sayısının aracılık rolleri yoluyla incelenmesidir. Bu bağlamda, değişkenler arasındaki doğrudan ve dolaylı etkileri incelemek amacıyla bir model önerisi sunulmakta ve Yapısal Eşitlik Modellemesi (YEM) ile yol analizi gerçekleştirilmektedir. Gerçekleştirilen yol analizi sonuçları, DYY'nin yüksek teknoloji ihracatı üzerinde pozitif ve anlamlı bir doğrudan etkisi olduğunu göstermektedir. Ayrıca, dolaylı etki bulguları, Ar-Ge harcamaları ve patent başvuru sayısının, DYY ile yüksek teknoloji ihracatı arasındaki ilişkiye aracılık ettiğini ortaya koymaktadır.

**Anahtar Kelimeler:** Doğrudan Yabancı Yatırım, Ar-Ge, Patent, Yüksek Teknolojili Ürün İhracatı, Yapısal Eşitlik Modellemesi

**Jel Kodu:** B17, C30, F63, O30

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## INTRODUCTION

With globalization, technological developments and liberalization throughout the world have enabled an increase in foreign direct investment (FDI) and exports of high-tech products, which has allowed countries to gain an advantageous position in terms of economic growth and to gain competitive advantage on the international platform (Özmerdivanlı & Akgün, 2024:41). In parallel with this, countries have sought permanent solutions to ensure sustainability in their growth processes and have concluded that high-tech production will contribute to sustainable growth. At this point, expenditures on R&D activities make significant contributions to the development processes and foreign trade volumes of countries (Boz et al., 2019:1113). In the world economy, where countries that produce technology have become the leaders, R&D has become an inevitable growth factor. Countries have had to turn to technology to gain superiority in the international market, and the importance they attach to R&D activities has gradually increased (Yaman et al., 2020:194). Therefore, exporting and producing high-tech goods are essential for nations to obtain and maintain a competitive edge. Foreign investments help spread technological innovations more quickly, even though they also promote international cooperation by providing funding for R&D initiatives. Patents and products created through creative R&D efforts support the export of high-tech goods. Countries can gain a larger position in global markets by becoming more competitive in the technological field through an increase in innovative studies and patent applications.

Differences in income and economic growth between countries are based on technology, A skilled labor force, natural resources, and economic-political stability. In order to close these gaps, countries allocate resources to education, encourage foreign investments including technology transfer, support R&D, and search for new natural resources (Kilic et al., 2014:116). In the context of the global economy, FDI is recognized as an important tool for countries to achieve their growth and development goals. FDI not only provides capital to host countries but also technology, management, production techniques, employment opportunities, and channels of access to world markets. In order to benefit from the economic and technological contributions of FDI, host countries create favorable bureaucratic and economic environments and offer various incentives to attract investments (Belke & Özturgut, 2020:13; Şeker & Şentürk, 2022:414). The qualified labor force available in countries attracting FDI increases technology transfer, which in turn reduces the cost of technology. Reduced costs enable firms to increase their R&D activities and produce their own technologies (Branstetter, 2000:9). In addition to providing financial support to host countries, FDI also transfers knowledge on technology and management expertise (Erdal & Göçer, 2015:750). In countries with high levels of FDI in the long run, the likelihood of realizing high-tech production and R&D-oriented targets increases, and the realization of these targets accelerates technological developments. Thus, countries can use the technology transfer provided by FDI in the production of high-tech products (Çeştepe et al., 2022:3). With this technology transfer, exports of high-tech products increase. The high-tech product production capacity of a country is measured by the ratio of high-tech products exported in international markets. Countries with technologically advanced companies achieve regular growth with sustainability in the export sector (Karahan, 2022:75).

The production of high-tech products is of great importance to ensure global competitive advantage. High-technology production means producing products with high added value and high returns (Erdoğan & Aydınbaş, 2020:498). One way to attract FDI is to focus on R&D investments and technological innovations (Çapık, 2019:83). Today, developed countries

are the leaders in high-tech exports. Sectors that fall within the scope of high technology include sectors such as automotive, energy, textiles, telecommunications, informatics, defense, electronics, health, and recycling (Konak, 2018:58). High technology exports are a critical factor for a country's sustainable economic growth. Technology ownership can be achieved through technology transfer through FDI (Gökmen & Turen, 2013:217). The increase in the development and utilization of technology increases the rate of technology-intensive exports. This increase provides positive developments in value-added production, competitiveness, and welfare levels (Gani, 2009:31; Ustabaş & Ersin, 2016:44). Scientific knowledge and innovation are the basic elements of technological development. R&D is defined as scientific studies conducted to produce new products, increase product quality, apply cost-reducing techniques, and adapt technology to local conditions (Öğüt et al., 2007:416). R&D studies contribute to the production of high-tech products, especially in the production sectors, and increase the export of high-tech products (Archibugi & Coco, 2004:630). Countries that want to gain a competitive advantage allocate more budget to R&D activities (Şeflek, 2015:21). The ability to use the technology developed through R&D is directly proportional to the development levels of countries (Demir et al., 2006:31).

Patents are one of the most important indicators of R&D activities. While patents constitute the source of R&D activities by providing technical information, they contribute to the dissemination of knowledge and the development of an innovative culture (Yaylalı et al., 2010:14; Shukla, 2005:1553). Patent purchases are made to protect the products or services resulting from R&D activities (Öğüt et al., 2007:414). The number of patents is an important indicator reflecting the R&D capacity and innovation potential of a country (Göçer, 2013:220). Revenues from patented technologies that achieve commercial success encourage more R&D investments, which in turn increases future innovations (Karaca, 2021:1180). As a result, patents are a concrete indicator of R&D activities and have strategic importance in terms of the sustainability of technological innovations and supporting economic growth.

The main objective of this study is to examine the effects of FDI, R&D expenditures, and patent applications on high-tech product exports by using the data of 44 developed and developing countries between 2010 and 2023. In the study, The Structural Equation Modeling (SEM) method, which stands out as a superior method in examining the relationships between variables from a holistic perspective, was used, and the analyses were carried out with AMOS 29 software. Unlike other studies, this study analyzes the direct and indirect effects of FDI, R&D expenditures, and patent applications on high technology exports in a holistic model. The analysis of the related relationships using structural equation modeling (SEM) offers both methodological novelty and an in-depth understanding of the contribution of FDI to innovation and technology exports. In these respects, this study is expected to contribute to the literature and provide guidance for a better understanding of technology-based growth strategies.

## **1. LITERATURE REVIEW**

In today's economy, FDI and technological development are of great importance for countries to keep up with rapid changes in the international market, increase their incomes, gain competitiveness, and implement stable economic policies. R&D activities are both one of the most important factors in ensuring FDI inflow to countries and one of the most important indicators of technological innovations. Therefore, the level of development of countries is directly proportional to the intensity of R&D activities (Güzel, 2009:30; Çapık, 2019:74). Patents are an important tool that encourages innovation by

protecting the results of R&D activities and allowing financing for future R&D investments. Countries need to have a strong technological infrastructure in order to have a strong position in the global market. At this point, the importance of R&D and FDI is understood. Having a good technological infrastructure becomes possible through R&D activities on the one hand and FDI on the other (Biçen, 2020:300). R&D expenditures are one of the most critical variables for countries to achieve sustainable growth. R&D expenditures contribute to exports by transforming products in production from low technology to high technology. Due to their high added value, high-tech products positively affect economic growth by increasing export revenues (Kilic et al., 2014:115).

When the literature on the subject is examined, it is seen that there are studies that examine the relationships between FDI, high-tech products, R&D, and patent variables with different analyses. In these studies, it can be stated that the results vary depending on different variables and analysis methods. The literature summary of the related studies is shown in Table 1.

**Table 1:** Literature Summary

Author(s)	Year	Scope of the Study	Key Findings
Liu & Wang	2003	The research was conducted to analyze the effects of foreign direct investments (FDI) on total factor productivity in China's industrial sectors during the period 1993-1999.	The results reveal that FDI is an important factor in the productivity growth of local firms, especially in technology-intensive sectors.
Wu & Zhou	2007	In this study, the long-run effect and causality relationship of R&D expenditures on economic growth in China between 1953-2004 are analyzed.	The findings indicate that R&D expenditures have a bidirectional causality relationship with economic growth and that these expenditures can support sustainable growth.
Braunerhjelm & Thulin	2008	The study analyses the impact of R&D investments on high technology exports and country size in 19 OECD countries in 1981-1999.	The research shows that R&D expenditures support technology-intensive exports and increase the comparative advantages of large countries.
Czarnitzki et al.	2009	This study, which examines the effects of R&D activities on patents and product development in Belgium between 1993 and 2003, analyzed data from 122 firms.	The results reveal that the contribution of R&D to patent production is four times higher through research and development activities.
Falk	2009	This study analyses the impact of high technology exports on economic growth in 22 OECD countries between 1980-2004.	The findings show that high technology exports support economic growth, but R&D intensity is a stronger factor.
Bajo-Rubio et al.	2010	This study, which examines the effects of foreign direct investment (FDI) on regional economic growth	The study reveals that FDI has a positive impact on regional development in various regions of

		in Spain between 1987-2000, uses GMM analysis method.	Spain.
Bojnec & Ferto	2011	This study analyses the effects of R&D activities on manufacturing trade in 18 OECD countries between 1995 and 2003.	The findings suggest that R&D expenditures increase manufacturing exports, but their impact on imports remains limited.
Migratory	2013	The impact of R&D expenditures on exports of high-tech products in 11 Asian developing countries in the period 1996-2012 was evaluated by panel data analysis.	The results show that R&D expenditures have a positive effect on exports of high-tech products and that these exports contribute to economic growth.
Gökmen & Türen	2013	This study analyses the effects of economic freedom, human development and foreign direct investment (FDI) on high technology exports in EU-15 countries between 1995-2010.	The findings reveal that economic freedom, human development and FDI have positive effects on high technology exports.
Liik et al.	2014	The impact of R&D activities on sectors producing high-tech products in 25 OECD countries in the period 1987-2009 has been analyzed.	It is concluded that R&D has a productivity-enhancing effect in high-tech product sectors.
Sandu & Ciocanel	2014	The effects of private sector R&D expenditures on innovation and high technology exports in 26 EU countries in 2006-2010 were analyzed.	Private sector R&D expenditures have been found to significantly increase high technology exports.
Yaylali & Karaca	2014	The impact of R&D expenditures on foreign direct investments (FDI) in Turkey in 1990-2013 was analyzed by using the bounds test approach.	The results show that R&D expenditures have positive effects on FDI in the long run.
Gulmez & Akpolat	2014	The relationships between R&D, innovation and economic growth in Turkey and 15 EU countries in 2000-2010 were investigated by GMM.	R&D expenditures and patents are found to positively affect economic growth.
Erdal & Göçer	2015	The effects of FDI on R&D and innovation in 10 developing Asian countries in the period 1996-2013 have been analyzed.	It is concluded that FDI positively affects R&D expenditures and innovations.
Alagoz et al.	2016	The relationship between R&D expenditures and high technology exports in E7 countries in the period 1996-2014 has been analyzed.	It is observed that R&D expenditures increase high technology exports and these exports contribute to economic growth.
Mehrara et al.	2017	The variables affecting the high technology exports of	Human capital and imports are found to have a

		24 developing countries in the period 1996-2013 are analyzed.	positive effect on high technology exports, while R&D expenditures have a more limited effect.
Yildiz	2017	The effects of FDI on technology diffusion in developing countries in the period 1996-2016 were investigated.	The results suggest that FDI increases local innovation capacity by promoting technology transfer.
Kabaklarlı et al.	2018	The relationship between high technology exports and economic growth in 14 OECD countries in the period 1989-2015 was evaluated by panel data analysis.	It is concluded that high technology exports support economic growth.
Şeker	2018	The effects of FDI and technology transfer on technology accumulation in Turkey between 2010 and 2015 in 11 OECD member countries were analyzed.	Technology transfer through FDI and imports has been found to contribute positively to Turkey's industrial production.
Dereli	2019	The relationship between high technology exports, patents and economic growth in Turkey in the 1990-2015 period is analyzed.	High technology exports and patent applications are found to have positive effects on economic growth both in the short and long run.
Oğuz and Sökmen	2020	In this study, the effect of R&D expenditures on exports of high-tech products is analyzed by panel data analysis method using annual data of 31 OECD countries between 1996-2016.	Empirical findings reveal that there is a positive and significant relationship between R&D expenditures and exports of high-tech products in OECD countries.
Yasar	2020	The effects of R&D expenditures and patent applications on high technology exports in 52 countries in the 2007-2018 period were analyzed.	It is concluded that R&D expenditures and patent applications positively affect high technology exports.
Gurler	2021	The effects of R&D expenditures, patents and FDI on high technology exports in OECD and BRIICS countries are analyzed.	Patents and FDI are found to have favourable effects on high technology exports.
Domazet et al.	2022	The relationship between high technology exports and economic growth in Serbia, Bulgaria, Romania and Hungary in 2008-2018 was analyzed.	In some countries, positive relationships have been found between high technology exports and economic growth.
Zapata et al.	2023	Factors affecting high technology exports in OECD countries in the period 2004-2018 were analyzed.	R&D, human capital and imports are found to positively affect high technology exports.
Shahabadi et al.	2023	The effects of national brand value on high technology exports in 12 countries in the period 2015-2021 were analyzed.	It is concluded that national brand value, FDI and real effective exchange rate have favourable effects on high technology exports.

Han & Feng	2023	The spatial spillover effects of foreign R&D investments in China's high-tech industry in 2007-2016 are analyzed.	Foreign R&D has been shown to create positive spatial spillover effects in terms of technological innovation.
Montines et al.	2023	The effects of FDI, R&D and human capital on high technology exports in ASEAN 5 countries (Indonesia, Philippines, Thailand, Malaysia, Singapore) in the period 2000-2022 were investigated.	It is concluded that human capital positively affects high technology exports, while the effect of FDI and R&D is limited.
Alshubiri & Al Ani	2024	The effects of intellectual property rights on FDI and high technology exports in 32 developed and developing countries in the period 2006-2020 are analyzed.	It is concluded that patent applications have positive effects on FDI and high technology exports in developing countries.

When the studies in Table 1 are evaluated in general, it is seen that FDI, R&D expenditures, and the number of patent applications play an important role in increasing high-tech exports, and these factors contribute positively to economic growth. In particular, findings are consistent with the idea that FDI increases the innovative capacity of domestic firms by providing technology transfer, and R&D expenditures support the export of high-tech products. On the other hand, some studies (Mehrrara et al., 2017; Montines et al., 2023) reported that R&D expenditures do not have a significant effect on high-tech exports or that this effect is limited.

## 2. ECONOMETRIC METHOD AND EMPIRICAL FINDINGS

The variables and data set used in this study were prepared to be analyzed by SEM method. SEM is a powerful statistical analysis technique used in social sciences, psychology, economics, education and many other fields (Martens, 2005; Lee & Song, 2012; Tarka, 2018; Dash & Paul, 2021). SEM goes beyond multiple regression analyses and allows complex relationships between multiple independent and dependent variables to be examined simultaneously through a single model. In addition, it stands out with its ability to analyze the relationships between both observable variables (data that can be measured directly) and unobservable latent variables (constructs that cannot be measured directly but are predicted through observable variables) (Bollen & Hoyle, 2012; Thakkar, 2020; Owolabi et al., 2020). AMOS 29 package programme was used for the analyses conducted within the scope of the study. The data set of the study and the details of the variables considered are presented in Table 2.

**Table 2:** Dataset of The Study

Variable Name	Code	Description	Source
High Technology Product Exports	HTE	Natural logarithm of exports of high-tech products (Current US\$)	World Bank
R&D Expenditure	RD	Share of R&D expenditures in GDP (%)	World Bank/OECD Database
Number of Patents	Patent	Total number of domestic and foreign patent applications	World Bank
Foreign Direct Investments	FDI	Natural logarithm of foreign direct investment inflows (Current US\$)	World Bank/Federal Reserve Bank

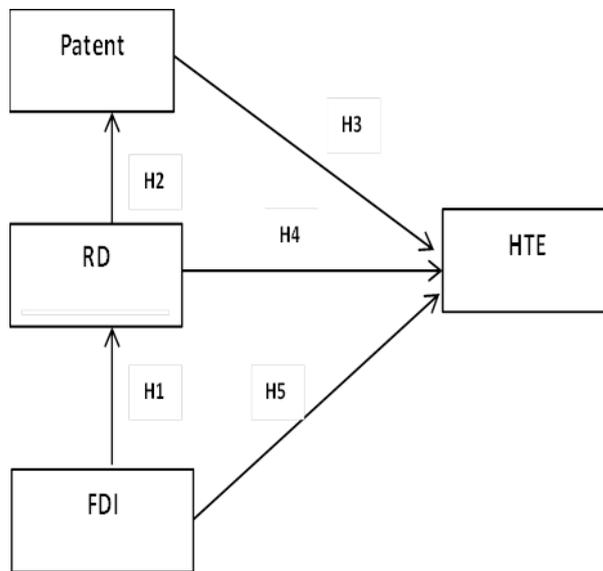
In the study, in order to increase the reliability of the analyses, the maximum number of observations is aimed to be reached in the light of available data in the selection of years and countries. The main reason for selecting 44 countries, both developed and developing, is to examine the effects of foreign direct investment (FDI) on exports of high-tech products from a broad perspective. Developed countries generally have high R&D expenditures and strong patent systems and are leaders in global innovation and technology transfer. In contrast, developing countries have the potential to increase their technological capacity and improve their competitiveness through FDI and R&D investments. Analyzing these countries together allows for a more comprehensive understanding of the relationships between countries with different economic structures and levels of development. In this way, applicable policy recommendations can be developed for both developed and developing countries. The countries analyzed in the study are shown in Table 3.

**Table 3:** Countries Covered in The Study

Country Name	Country Name	Country Name	Country Name
Germany	Estonia	Iceland	Norway
Austria	Finland	Montenegro	Poland
Azerbaijan	France	Kazakhstan	Portugal
Belarus	Georgia	Cyprus	Romania
Belgium	Croatia	Kyrgyz Republic	Russia
United Kingdom	Netherlands	North Macedonia	Slovak Republic
Bosnia and Herzegovina	Ireland	Latvia	Slovenia
Bulgaria	Spain	Lithuania	Tajikistan

Czech Republic	Sweden	Luxembourg	Türkiye
Denmark	Switzerland	Hungary	Ukraine
Armenia	Italy	Moldova	Greece

SEM is an effective technique for determining the indirect and direct effects of one variable on others by considering the relationships between variables in a holistic perspective. This method is used to evaluate how well a theoretical model fits the data. In the model proposed in the research, the relationships between variables and the predicted paths between these relationships are revealed (Hair & Alamer, 2022:5). The hypotheses established within the scope of this study are listed below. The path diagram of the proposed model based on these hypotheses is shown in Figure 1.



**Figure 1:** Proposed Model of the Study

- H1. Foreign direct investments have a positive effect on R&D expenditures.  
H2. R&D expenditures have a positive effect on the number of patents.  
H3. The number of patents has a positive effect on exports of high-tech products.  
H4. R&D expenditures have a positive effect on exports of high-tech products.  
H5. FDI has a positive effect on exports of high-tech products.

Table 4 presents an overview of the data, including the standard deviation, minimum and maximum values, averages, the total number of observations, and correlation analysis results. The degree and direction of the relationship between two variables are measured by the correlation indicator. Strong relationships are indicated by positive values close to 1 and inverse relationships are indicated by negative values close to -1. A value between +1 and -1 is accepted (Ratner, 2009:139). The descriptive statistics for the variables and the correlation matrix are shown in Table 4.

**Table 4:** Descriptive Statistics and Correlation Analysis

<b>Descriptive Statistics</b>	HTE	FDI	RD	Patent
Number of Observations	561	516	518	503
Average	21,49283	22,17325	1,312293	4630,647
Standard Deviation	2,748938	1,947365	0,962934	11794,28
Minimum	13,50748	15,85592	0,07515	3
Maximum	26,1321	26,53119	3,70532	67899
<b>Correlation Analysis</b>				
THE	1			
FDI	0,7063	1		
RD	0,7019	0,5203	1	
Patent	0,4498	0,4236	0,3625	1

When Table 4 is investigated, it is seen that there is a correlation of 0.7063 between HTE and FDI and a correlation of 0.7019 between HTE and RD, indicating a strong relationship between these variables. The correlation between HTE and the number of patents is 0.4498, which indicates a moderate positive relationship. The correlation between FDI and RD is 0.5203 and the correlation between FDI and Patent is 0.4236; both are moderate positive relationships. The correlation of 0.3625 between RD and number of Patents indicates a weaker, but still positive relationship. After the correlation analysis, the hypothesis results of the model proposed within the scope of the study are shown in Table 5.

**Table 5:** Hypothesis Test Results of the Proposed Model

<b>Hypothesis nu</b>	<b>Hypotheses</b>	<b>Standard <math>\beta</math></b>	<b>P</b>	<b>Accept/Reject</b>
H1	FDI > RD	.134	***	Accepted
H2	RD > Patent	.207	.003	Accepted
H3	Patent > HTE	.005	***	Accepted
H4	RD > HTE	.296	***	Accepted
H5	FDI > HTE	.038	***	Accepted

When Table 5 is analyzed, it is seen that all hypotheses tested in the proposed model are accepted. This reveals that the

relationships between the variables in the model are statistically significant and show effects in the proposed directions. In particular, it is observed that the effects of R&D expenditures (RD) on both the number of patents and the high technology industry (HTE) are significant, and other variables also support these relationships. These findings confirm the assumptions of the model and show that the theoretical framework is strongly supported.

The fit indices calculated for SEM are used to evaluate how well the model fits the data. In SEM studies, there is a common consensus that the  $\chi^2/sd$  value should be reported when reporting goodness-of-fit indices. However, there are different approaches on which additional fit indices should be reported. When the literature is examined, it is seen that other goodness-of-fit indices frequently used in SEM studies are CFI, NFI, RFI, IFI and RMSEA (Byrne, 2010; Gürbüz, 2019; Yıldız et al., 2022; Sathyanarayana & Mohanasundaram, 2024). The goodness of fit index values of the model proposed within the scope of the study are presented in Table 6.

**Table 6:** Goodness of Fit Values of The Proposed Model

Indexes of Fit	Goodness of Fit Value Limits	Model Fit Index Values
$\chi^2/sd$ (CMIN/DF)	$\leq 5$	2.38
CFI	$.90 \leq CFI \leq 1.00$	.98
NFI	$.90 \leq NFI \leq 1.00$	.99
RFI	$.90 \leq RFI \leq 1.00$	.96
IFI	$.90 \leq RFI \leq 1.00$	.98
RMSEA	$.00 \leq RMSEA \leq .08$	.06

When Table 6 is examined, it is observed that the fit index values are within acceptable limits, and the model provides a good fit. Therefore, it can be stated that the model established within the scope of the study is compatible with the data and produces valid results.

SEM analyzes the relationships between variables in three different dimensions. While the direct effect refers to the direct effect of one variable on another variable without any intermediary, The indirect effect defines the situation where one variable affects another variable through an intermediary variable. The sum of these two effects shows the total effect between variables. The types and levels of these effects observed in the relationships between variables are presented in Table 7.

**Table 7:** Types and Levels of Effects between Variables

<b>Standardized Total Effects</b>			
Variables	FDI	RD	Patent
RD	0,63	0	0
Patent	0,49	0,46	0
HTE	0,72	0,7	0,58
<b>Standardized Direct Effects</b>			
Variables	FDI	RD	Patent
RD	0,63	0	0
Patent	0	0,46	0
HTE	0,48	0,42	0,58
<b>Standardized Indirect Effects</b>			
Variables	FDI	RD	Patent
RD	0	0	0
Patent	0,49	0	0
HTE	0,24	0,28	0

Upon analysis of Table 7, it becomes evident that the standardized values of the total, direct, and indirect effects between variables are presented in great detail. With regard to the total effects, it is evident that foreign direct investment (FDI) exerts an influence of 0.63 units on R&D expenditures (RD), 0.49 units on the number of patent applications, and 0.72 units on exports of high-tech products (HTE). Furthermore, the total effect of R&D expenditures on patent applications is 0.46 units, while the total effect on high-tech product exports is 0.70 units. The total effect of patent applications on high-tech product exports is determined to be 0.58 units. Upon analysis of the indirect effects, it was observed that FDI exerts an influence of 0.24 units on high-tech product exports through patent applications. Similarly, R&D expenditures exert an indirect effect of 0.28 units on exports of high-tech products through patent applications. These findings underscore the significant contribution of both FDI and R&D expenditures to exports of high-tech products through patents, emphasizing the critical role of mediating variables in this process.

## CONCLUSION

In the current economic environment, the flow of FDI and technological advancements determine a country's ability to prosper in the global marketplace to maintain a competitive advantage, and boost revenue streams through adaptive measures in response to rapid change. As a crucial sign of innovation, R&D activities are regarded as a crucial component for nations looking to draw in foreign direct investment. Therefore, a nation's degree of development is directly correlated with the scope of its R&D efforts. Patents are a crucial component in fostering innovation because they protect the observable outcomes of such endeavors and make it easier to finance upcoming R&D expenditures. On the other hand, a strong technological infrastructure is necessary for nations to be able to establish a strong position in the global economy. One important element in the creation of this infrastructure is the strategic fusion of FDI and R&D. Because R&D expenditures turn low-technology products into high-technology ones, they boost exports and have a positive impact on economic growth.

The purpose of this study is to investigate how FDI affects high-tech exports by looking at the mediating effects of patents and R&D spending. The dataset spans the years 2010–2023 and includes 44 developed and developing nations. The study's conclusions demonstrate that FDI has a statistically significant and favorable effect on exports of high-tech goods. Furthermore, R&D expenses and patent applications mediate this relationship. In accordance with the study's findings, it can be claimed that R&D and foreign direct investments are crucial for a nation's economic development and ability to compete internationally, particularly when it comes to growing its exports of high-tech goods. FDI promotes R&D expenditures that result in patents which are observable outcomes that aid in the process of technology development. These results imply that, in order to improve their technological infrastructure, nations should put policies in place to draw FDI. It is especially evident that FDI promotes R&D endeavors, thereby fostering the manufacturing of technology-intensive goods, which in turn, boosts export earnings and bolsters economic expansion. Therefore, in order to attract FDI, policy makers must simultaneously create investment-friendly environments and increase incentives for R&D activities. The need for more focus on innovation policies is highlighted by the emergence of patents as a factor that reinforces the relationship between R&D and FDI.

The findings of the study are largely consistent with the existing literature (Liu & Wang, 2003; Wu & Zhou, 2007; Braunerhjelm & Thulin, 2008; Czarnitzki, Kraft, & Thorwarth, 2009; Falk, 2009; Bojnec & Ferto, 2011; Göçer, 2013; Gülmez & Akpolat, 2014; Liik et al., 2014; Sandu & Ciocanel, 2014; Yıldız, 2017; Şeker, 2018; Oğuz & Sökmen, 2020; Yaşar, 2020; Gürler, 2021; Zapata et al., 2023; Han & Feng, 2023). While Czarnitzki et al. (2009) and Braunerhjelm and Thulin (2008) emphasize that R&D contributes to patent production and high-tech exports, this study examines in detail the effects of FDI on high-tech exports through R&D and patent applications. Yıldız (2017) and Yaşar (2020) show that FDI encourages technology transfer and increases local innovation capacity through patent applications. While emphasizing the direct and indirect effects of FDI on high-tech exports, this study addresses the mediating role of patents in this process in line with studies such as Liik et al. (2014) and Gürler (2021). Moreover, Bojnec and Ferto (2011) and Sandu and Ciocanel (2014) examine the direct impact of R&D expenditures on high-tech exports, and this study supports the indirect effects of R&D on exports through patent applications. Studies such as Mehrara et al. (2017) draw attention to the contribution of human capital and R&D on high-tech exports, and similar results are obtained in this study. More recent studies such as

Domazet et al. (2022) and Shahabadi et al. (2023) investigated the effects of FDI, national brand equity, and patents on high-tech exports and presented results that align with the findings of this study. This study is also in line with studies that examine spatial spillover effects, such as Han and Feng (2023), and strongly integrates the contribution of FDI to high-tech exports through R&D, and patent applications into the literature. These findings suggest that FDI, R&D and patent applications play a critical role in boosting high-tech exports and that this process is supported by both direct and indirect effects.

In conclusion, this study presents findings consistent with the literature emphasizing the critical role of FDI and R&D in economic growth, technological development, and high-technology exports. Policymakers should encourage R&D investments to increase FDI and pave the way for technological innovation by strengthening the patent system. Establishing innovation centers through public-private partnerships, supporting entrepreneurship, and increasing international knowledge transfer will play a critical role in creating a competitive advantage. Future studies can provide more comprehensive data in determining economic strategies by analyzing the sectoral and country-based differences of these relationships in more detail. Such analyses will help countries make more effective and targeted decisions in their long-term development policies.

## **ETİK BEYAN VE AÇIKLAMALAR**

### ***Etik Kurul Onay Bilgileri Beyanı***

Çalışma, etik kurul izni gerektirmeyen bir çalışmadır.

### ***Yazar Katkı Oranı Beyanı***

Yazarlar tüm çalışmalarını birlikte yürütmüştür.

### ***Çıkar Çatışması Beyanı***

Çalışmada potansiyel bir çıkar çatışması bulunmamaktadır.

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