International Journal of Management Economics and Business, Vol. 21, No. 2, 2025
Uluslararası Yönetim İktisat ve İşletme Dergisi, Cilt 21, Sayı 2, 2025

Research Article / *Araştırma Makalesi*

INVESTIGATION OF THE IMPACT OF FOREIGN DIRECT INVESTMENT ON RESEARCH AND DEVELOPMENT SPENDING IN THE EU COUNTRIES

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ABSTRACT

Foreign direct investment (FDI) is a crucial component, particularly for research and development (R&D) initiatives. In countries receiving FDI, there have been improvements in capital accumulation, a skilled workforce, and R&D activities. Consequently, nations are endeavoring to attract global finance. Currently, scholars are interested in the economic factors associated with which is a topic of interest for them. This study aims to examine the correlation between FDI and R&D in the top ten European Union (EU) member states (Austria, Belgium, Czechia, Denmark, Finland, France, Germany, the Netherlands, Slovenia, and Sweden) that dedicate the greatest proportion of resources to R&D. The study initially assessed the series' stationarity using the CIPS and CADF unit root tests, utilizing data sets from 1996 to 2021. The autoregressive distributed lag (ARDL) approach was employed in accordance with the obtained results. The study's results were analyzed individually for each country, concluding that FDI did not positively contribute to the R&D activities of all countries, and its impact on certain nations was not as anticipated. The nations' technological advancement clearly links to this predicament.

Keywords: *International Economics, Foreign Direct Investment, Research and Development, European Union*

JEL Classification: *F02, F21*

DOĞRUDAN YABANCI YATIRIMIN ARAŞTIRMA GELİŞTİRME HARCAMALARINA ETKİSİ: AVRUPA BİRLİĞİ ÜLKELERİ ÖRNEĞİ

ÖZET

Doğrudan yabancı yatırımlar (FDI) özellikle araştırma ve geliştirme (R&D) faaliyetleri için önemli bir unsur olmaktadır. FDI'ın yöneldiği ülkelerin sermaye birikimlerinde, eğitimli iş gücünde, R&D faaliyetlerinde artışlar gözlenmektedir. Bu sebeple ülkeler dünyada dolaşan sermayeleri kendilerine çekmeye çalışmaktadırlar. Bu noktada FDI'ın etkileşimde bulunduğu ekonomik unsurların neler olduğu araştırmacılar tarafından merak edilen bir konu olmaktadır. Bu çalışma, FDI ile R&D arasındaki ilişkinin Avrupa Birliği'ne (EU) üye ve R&D'ye en çok pay ayıran ilk on ülke (Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Netherlands, Slovenia and Sweden) için araştırmayı amaçlanmaktadır. 1996-2021 yılları veri seti aralığı olarak seçilen çalışmada öncelikle serilerin durağan olup olmadığı CIPS ve CADF birim kök testleri ile test edilmiştir. Elde edilen sonuçlar doğrultusunda yöntem olarak the autoregressive distributed lag (ARDL) kullanılmıştır. Çalışmanın sonucu her bir ülke için ayrı ayrı

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ISSN:2147-9208 E-ISSN:2147-9194
http://dx.doi.org/10.17130/ijmeb.1571133
Received: 21.10.2024, Accepted: 03.03.2025

incelenmiştir ve tüm ülkeler için FDI'ın ülkelerin AR&GE faaliyetlerine olumlu katısı olmadığı birkaç ülkeye etkisinin beklenen gibi olmadığı sonucuna varılmıştır. Bu durum ülkelerin teknolojik gelişmişlik seviyeleriyle ilgili olduğu açıktır.

Anahtar Kelimeler: *Uluslararası İktisat, Doğrudan Yabancı Yatırım, Araştırma ve Geliştirme, Avrupa Birliği*

JEL Sınıflandırması: *F02, F21*

1. Introduction

In the contemporary global landscape, a nation's capacity to commit resources to research and development (R&D) not only fosters economic growth but also confers a competitive edge in securing a position within international markets. One of the most fundamental inquiries in economics is how to satisfy endless wants with finite resources efficiently, compelling nations to commit greater resources to R&D and to invest more in emerging technologies. Even in economically advanced nations, the allocation of resources to R&D from their annual revenue may face constraints.

Technologies emerging from R&D endeavors occasionally transform into universal assets accessible to all cultures, rather than being exclusive to the nations responsible for their development. Not only do the nations that create the technology have this advantage, but investments from several countries can also contribute to it. This scenario arises with foreign direct investments (FDI) originating from many nations. FDI provides resources for R&D activities in the host country, allowing the investing firm or nation to utilize the technology this investment generates. This investment may provide varying impacts in the short and long-term, contingent upon the structural characteristics of the country and sector in which it is executed.

This study investigates the correlation between R&D and FDI across pertinent nation categories. Upon examining the literature about the link between R&D and FDI, it is evident that numerous studies have been conducted for various nations worldwide. Conversely, there is no analogous research to this study that investigates the top ten nations allocating the highest shares to R&D inside the European Union (EU). Thus, the study might have examined the behavior of country groups that attract a significant proportion of foreign investments and potentially influence technical advancements. It is well established that the countries that attract the foreign money and are capable of allocating resources to technology and scientific advancements are located inside the EU. The paper fills the gap in the literature by focusing on this particular characteristic. The study has five components. The introductory section provides an overview of the article's topic matter. Following the introduction, which provides general information on the study, a literature review is undertaken. The fourth section evaluates the acquired data and presents the results, while the third portion elucidates the analytical methodology.

The concluding phase of the research assesses the results derived from the analytical section. Furthermore, the acquired results yield recommendations. In this setting, discussing the short-term impact of FDI on R&D is unfeasible. This circumstance aligns with the anticipation that the impacts of the investments will manifest in the long-term. Nonetheless, the impact of FDI on R&D is predominantly diminishing rather than augmenting. Analyzing the findings for each nation reveals a different situation. The researchers indicate that the data do not support the view that FDI unequivocally enhances the R&D activities of nations. This necessitates the independent examination of the effect for each country, taking into account the specific situations of each nation. The study's findings are used to recommend policies for the researchers.

2. Literature Review

A thorough examination of the literature reveals worldwide studies that investigate the link between FDI and R&D spending, using various variables, models, and analytical approaches. Variations in these factors can provide diverse outcomes in the research. A careful look at the results shows that dynamic panel data estimation methods, cointegration, and causality investigations are used a lot in this field, which uses both time series and panel data. Landesmann and Pfaffermayr (1997) analyzed seven Organisation for Economic Co-Operation and Development (OECD) countries by cointegration and establishing causal relationships between R&D and export data, whereas Grossman and Helpman (1991) highlighted that both domestic and international R&D play a role in the advancement of regional knowledge assets. This section includes different studies on R&D and FDI.

Borensztein et al. (1998) used regression thresholds to analyze the impact of FDI on growth in 69 developing countries. The authors found in their analysis, covering the period from 1979 to 1999, that the influence of FDI on growth is associated with increased productivity levels instead of significant capital accumulation.

Damijan et al. (2003) investigated a connection between FDI and R&D expenditures. The authors examined the Central and Eastern European Countries (CEEC) from 1994 to 1998. The authors concluded from the examination of panel data that FDI connections are how businesses transfer technology.

Basu et al. (2003) examined the relationship between FDI and economic development in a study including 23 developing countries from 1978 to 1996. The authors established an important link between FDI and economic development through their cointegration study.

Cheung & Lin (2004) studied the influence of FDI on R&D activities through external economies in their analysis of China from 1995 to 2000. The authors discovered that FDI increased the quantity of patents in the host country and positively influenced R&D activity.

Todo (2006) investigated the impact of FDI on R&D expenditures at Japanese companies. He assessed data from 50 Japanese enterprises by panel data analysis, focusing on the period from 1995 to 2002. The author concludes that R&D stock positively influences the productivity of domestic enterprises, but capital stock has no effect.

Baskaran & Muchie (2008) analyzed the relationship between a country's domestic innovation system and FDI in their examination of the BRICS nations (Brazil, Russia, India, China, and South Africa), using sectoral and corporate data from 1990 to 2006. The authors highlighted that foreign enterprises mostly invested in sectors aligned with their technological attributes and that foreign investments in R&D activities are contingent upon a nation's domestic innovation framework.

Sasidharan & Kathuria (2008) researched the relationship between FDI and R&D spending. The researchers examined 1,843 Indian companies from 1994 to 2005. The authors found, utilizing the Heckman (1979) two-step method that FDI exerts negligible influence on R&D expenditure in India.

Bajo-Rubio et al. (2010) considered the impact of FDI on economic development in Spain. Using the Generalized Method of Moments (GMM), the authors looked at 17 different areas of Spain from 1987 to 2000. They concluded that FDI has positive and significant effects on technology transfer, technological renewal in the recipient country, knowledge accumulation, and economic growth.

Krammer (2010) performed a study examining the effects of international spillovers through trade and FDI inflows on Total Factor Productivity (TFP), using a dataset of 27 developing and 20 developed countries from 1990 to 2006. The study, utilizing panel unit root and cointegration analyses, demonstrated that FDI exerts a beneficial impact on recipient countries, but R&D capital stock is prevalent in Western Europe and scarce in the East.

Crescenzi et al. (2015) studied the influence of multinational corporations on R&D activities in the nations where they invest. The authors analyzed US corporations from 1998 to 2005 utilizing a firm-level knowledge production function. The research revealed that R&D activity and expenditures rose in sectors where multinational corporations invested.

Cai et al. (2019) examine the impact of institutions and their interaction with businesses' R&D expenditures on FDI inflows in China, utilizing a sample of 680 EU enterprises from 1998 to 2008. Utilizing panel data estimate methods, supplemented by cross-validation techniques, their findings demonstrate that EU FDI in China is affected by the host country's institutions, hence reinforcing institutional theory, and demonstrate that the rule of law, institutional changes, and the interplay between institutional reforms and R&D substantially influence FDI inflows in China.

Minovic et al. (2020) investigate the relationship between FDI and indicators of institutional quality (control of corruption, political stability, and rule of law) in the Western Balkans (Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, and Serbia). The empirical analysis utilizes panel methodologies, including unit root testing and causality, covering the period from 2002 to 2017. The findings demonstrate that the regulation of corruption, political stability, and adherence to the rule of law facilitate an influx of FDI in the Western Balkans.

Bhattacharya, Okafor & Pradeep (2021) explore the moderating influence of R&D intensity on the relationships between international business activities (such as exports, trade in imported inputs and capital products, and FDI and productivity. The writers make an analyzing for OCED countries for 2001-2015 period. The analyzing method for the paper is the Ordinary Least Square (OLS) and fixed-effects (FE) estimators. The findings indicate that, in contrast to low-tech businesses, high-tech enterprises exhibiting elevated R&D intensity in the preceding period experience significant productivity enhancements from FDI and the use of imported inputs and capital goods.

Burlea-Schiopoiu & Popescu (2021) investigated the influence of FDI on emerging economies that are former socialist nations inside the EU. The objective is to assess the influence of various economic and social indices on FDI, net income, and R&D. The study, which utilized panel data analysis, selected data from 2000 to 2017 for each country. A study shows that new regional development strategies need to take into account how different regional innovation policies, like smart specialization, can affect productivity in different areas.

Minovic & Jednak (2021) examine the relationship between economic growth, innovation (R&D spending), and FDI among selected EU member states and candidate countries from 2000 to 2017 with panel data analyzes. By the writers, the findings from the Granger causality test indicate a bidirectional association between economic growth and FDI, economic growth and innovation, as well as between FDI and innovation.

Wu et al. (2023) analyze the impact of inward foreign direct investment (IFDI) concentrations on the R&D strategies of domestic enterprises in emerging countries. The authors use panel data from 161,632 manufacturing enterprises across 525 four-digit coded sectors in China. Their projections indicate that the R&D intensity of local enterprises positively correlates with the existence of IFDI in competitive and symbiotic societies.

3. Research Methodology

This study analyzed the correlation between FDI and R&D utilizing yearly data from ten EU nations that allocate the highest percentage of resources to R&D from 1996 to 2021. The literature review thoroughly analyzed the correlation between R&D and FDI, alongside several other macroeconomic factors.

The model may use a variety of factors, but the GDP and human resources (RD) are two crucial variables for its significance (Bayarçelik & Taşel, 2012; Blanco & Prieger, 2015; Collins & Nguyen, 2021). R&D is preferred as a control variable for this research. The model used is thus in the form of RD = *f* (FDI, BS, GDP). Table 1 presents the indicators, variable codes, their usage patterns, and the sources of data acquired.

Table 1: Descriptions of Variables

Indicators	Codes	Log./Orig.	Source
Research & Development (% of GDP)	RD	Original	World Bank Development Indicators
Foreign Direct Investment (% of GDP)	FDI	Original	World Bank Development Indicators
Human Resources (% Net)	BS	Original	World Bank Development Indicators
Gross Domestic Product (Current US$)	GDP	Logarithmic	World Bank Development Indicators

Panel data analysis has preferred in the study. The model used in the analysis is as in equation 1:

$$RD_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 BS_{it} + \beta_3 \Delta GDP_{it} + \varepsilon_{it} \qquad (1)$$

In the model, Research and Development (RD) serves as the dependent variable, with indices *i* denoting cross sections, indices *t* indicating the temporal dimension, and representing the error term.

3.1. Cross-Sectional Dependence

Assessing cross-sectional dependence is crucial for estimating series prior to doing a unit root test. To ensure accurate testing, these results must be consistent. Unit root tests appropriate for time series are categorized into first-generation and second-generation unit root tests. Cross-sectional dependency informs the selection of unit root tests for conducting the analyses. The cross-sectional dependence of the series requires the use of a second-generation unit root test. Consequently, unit root testing for unitary generation should be favored.

Cross-sectional dependency may be assessed using the Breusch-Pagan (1980) Lagrange Multiplier (LM) test when the temporal dimension of the panel exceeds the cross-sectional dimension, and the Pesaran (2004) Cross-Section dependency (CD) test when both dimensions are substantial. These tests are favored when the cross-sectional dimension is less than the temporal dimension (N<T). The rationale for selecting these two tests is based on a temporal dimension of 26 and a cross-sectional dimension of 10.

The initial form of the LM test statistic is as follows (Breusch & Pagan, 1980):

$$LM = T \sum_{i=1}^{N-1} \sum_{J=i+1}^{N} (\hat{\rho}_{ij}^2) \sim \frac{X_{N(N-1)}^2}{2} \tag{2}$$

The correlation coefficient between the unit coefficients is shown by $\hat{\rho}_{ij}^2$ and j. The null hypothesis posits that no link exists between the horizontal sections; if rejected, it indicates cross-section dependency, necessitating the application of second-generation unit root tests (Breusch & Pagan, 1980: 240). N and T in the equation typically indicate whether the panel has a horizontal component or not. When N and T approach infinity, we presume that no cross-section exists (Pesaran, 2004).

This statistic was later revised and became as follows (Pesaran et al., 2008):

$$LM_{adj} = \left(\frac{2}{N(N-1)}\right)^{\frac{1}{2}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} [\, \hat{\rho}_{ij}^2 (\frac{(T-K-1)\hat{\rho}_{ij} - \hat{\mu}_{Tij}}{v_{Tij}})] \sim N(0,1) \tag{3}$$

$\hat{\mu}_{Tij}$ denotes the mean, while v_{Tij} signifies the variance. The test statistic derived from this analysis exhibits an asymptotic standard normal distribution. Evaluate hypotheses:

H_0: No cross-sectional dependence exists.

H_1: Cross-sectional dependence exists.

Pesaran et al. (2008) state that the null hypothesis (H_0) is rejected at the 5% significance level when the test's p-value is below 0.05.

3.2. Unit Root Tests

Pesaran established the CADF test in 2007. The CADF test statistics are initially computed for all units inside the panel during the test. The panel's (Cross Sectionally Augmented IPS) test statistics determine the arithmetic mean of the computed CADF tests. Thus, CADF is employed for stasis at the unit level, whereas CIPS is utilized in the examination of the panel's stasis. Equations 4 and 5 aid in the calculation of the specified CADF statistics value.

$$\Delta_{yit} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it} \tag{4}$$

$$\Delta_{yi} = \left(\Delta_{yi1}, \Delta_{yi2}, \dots, \Delta_{yiT}\right)', y_i, -1 = (y_{i0}, y_{i1}, \dots, y_i, T-1)' \tag{5}$$

Hypotheses of CADF unit root test are as follows:

H_0: $b_i = 0$, serial is not stationary (For all variables)

H_1: $b_i < 0$, serial is stationary (For at least one variable)

The CADF unit root test is applicable when the temporal dimension (T) of the series is either big or small relative to the cross-sectional dimension (n). The CADF test statistics are computed using the following equation:

$$t_i(N,T) = \frac{\Delta y_i' \bar{M}_w y_{i,-1}}{\sqrt{\hat{\sigma}_i (y_{i,-1}' \bar{M}_w y_{i,-1}}} \tag{6}$$

Then;

$$\Delta_{yi} = \left(\Delta_{yi1}, \Delta_{yi2}, \dots, \Delta_{yit}\right)', y_{i,-1} = (y_{i0}, y_{i1}, \dots, y_{iT-1})' \tag{7}$$

$$\bar{M}_w = I_T - \bar{W}\left(\bar{W}'^{\bar{W}}\right)^{-1} \bar{W}', \bar{W} = (\tau, \Delta\bar{y}, \bar{y}_{-1}) \tag{8}$$

$$\tau = (1,1,\dots,1)', \Delta\bar{y} = (\Delta\bar{y}_1, \Delta\bar{y}_2, \dots, \Delta\bar{y}_T)', \bar{y}_{-1} = (\bar{y}_0, \bar{y}_1, \dots, \bar{y}_{T-1})' \tag{9}$$

$$\hat{\sigma}_i^2 = \frac{\Delta y_i' M_{i,w} \Delta y_i}{T-4} \tag{10}$$

The equation for CIPS test statistics is derived by averaging the T statistics computed for the horizontal portion, as noted by:

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} t_i(N,T) \tag{11}$$

Pesaran juxtaposes the previously discussed CADF and CIPS test statistic data with the crucial values derived from the Monte Carlo simulation to evaluate the stationarity hypothesis. Upon comparing test statistics with tabulated values, if the CADF and CIPS test statistics exceed the crucial table values, the null hypothesis (H0) is rejected. The H1 hypothesis, which posits that the series is stationary, is accepted (Pesaran, 2007: 265-312).

3.3. Panel ARDL

The study's unit root test findings led to the selection of panel ARDL as the analytical method. Based on the unit root results, this method is preferred because it gives both long-term and short-term impact results that are relevant to the study and also makes it easy to analyze the results on a country-by-country level. This section presents theoretical information on the study's methodology.

To evaluate long-term and short-term coefficients in the study, the Poled Mean Group (PMG) method proposed by Pesaran et al. (1999) was utilized. The Panel Autoregressive Distributed Lag (Panel ARDL) Model requires that the long-term coefficients be the same, but it lets the short-term coefficients and error variances vary between groups. PMG provides distinct areas and an alternative method for forecasting conventional fixed-effective projections. It facilitates the assessment of short-term dynamic data for each nation, taking into account the quantity of available time series observations (Pesaran et al., 1999: 621). ARDL methodology, together with a dynamic definition It further offers cointegration testing. The cointegrated time series system may be estimated using the ARDL model, which accommodates variables that are either I(0) or I(1) without necessitating specification of their levels in the cointegration relationship. Nonetheless, the variables must not remain static in the second difference (2) (Neubauer & Odehnal, 2018: 110).

The ADRL model facilitates the estimate of both short-term and long-term associations between the dependent and independent variables. This method also reveals the presence of Granger causality from explanatory factors to the dependent variable. The ARDL approach is very effective with tiny samples, so its usage is strongly advised in such contexts. The ARDL (P, Q) methodology incorporates P lags for the dependent variable and Q lags for the independent variables, as shown below (Sweidan, 2023: 209):

$$Y_t = \delta + \sum_{k=1}^{p} \theta Y_{t-k} + \sum_{j=0}^{q} \gamma W_{t-j} + e_t \qquad (12)$$

In equation 12, the variable Y_t is the dependent variable. W_t explanatory variables: δ, θ, and γ It presents the estimated coefficients of the model and the error term e_t.

Equality 1 may be expressed in line with the ARDL model as shown in equation 13:

$$\Delta RD_{it} = \beta_0 + \beta_1 \sum_{j=1}^{p} FDI_{it-j} + \beta_2 \sum_{j=1}^{q} \Delta BS_{it-j} + \beta_3 \sum_{j=1}^{q} LnGDP_{it} + \pi ECT_{t-1} + \lambda 1 FDI_{it-1} + \lambda 2 \Delta BS_{it-1} + \lambda 3 \mathrm{Ln}GDP_{it-1} + \varepsilon_{it} \qquad (13)$$

In this context, RD is the dependent variable, FDI, BS and LnGDP are the explanatory variables, Δ denotes the difference operator, β and π represent short-term coefficients, and the error correction term is derived from the long-term equilibrium relationship ECT_{t-1}. Additionally, λ1, λ2, and λ3 are the long-term coefficients, while *p* and *q* indicate the maximum lag duration . It indicates the word error term.

4. Empirical Finding

This study assessed the top ten EU member states that contribute the greatest proportion of their resources to R&D. This study aims to identify the short- and long-term effects of FDI on R&D activities of 10 chosen nations. Data spanning one year was utilized for this purpose. The data was sourced from the World Bank (WB), as presented in Table 1. Table 2 presents the descriptive statistics for each dataset.

Table 2: Descriptive Statistics

Statistic	RD	FDI	BS	LnGDP
Mean	2.41730	5.30384	67.70541	26.69341
Max.	3.87380	86.47915	100.86810	29.08463
Min.	1.24643	-36.14035	21.07699	23.73338
Std. Dev.	0.63546	10.73723	15.24821	1.25220
Number of Countries	10	10	10	10
Observations	260	260	260	260

First before analyzing the long-term relationship between variables, it is beneficial to assess the correlation between them. Table 2 presents the correlation coefficients.

Table 3: Correlation Relationship between Variables

	RD	FDI	BS	LnGDP
RD	1			
FDI	-0.2192	1		
BS	0.61	-0.1399	1	
LnGDP	0.275	0.0147	-0.0929	1

According to Table 3, FDI has the highest correlation with GDP. FDI has a negative correlation with RD in contrast. On the other hand, FDI has the highest correlation with human resources for EU countries.

Prior to conducting stationarity tests, it is essential to execute a cross-sectional dependency test for the series in panel data sets to choose the suitable stationarity test (Pesaran, 2006). Table 4 presents the outcomes of the cross-sectional dependence assessment.

Table 4: Cross-Section Independence

Tests	Statistic	p-Values
LM	118.4	0
LM adj*	18.59	0
LM CD	3.356	0.0008

The p-values in Table 4 are assessed at 1% and 5% significance levels. Conclude that cross-section dependence is indeed present. This method's results reject the null hypothesis that no cross-sectional dependency exists. This conclusion indicates that a shock in one country affects other countries as well. This outcome facilitates the execution of the second-generation panel unit root test. The subsequent tables will evaluate the stationarity of the series using a second-generation unit root test.

For the model variables, second-generation stationarity tests were used. These included the CADF test suggested by Pesaran (2006) and the CIPS unit root test suggested by Im et al. (2003). Tables 5 and 6 elucidate the outcomes of these assessments.

Table 5: Cross-Sectionally Augmented IPS (CIPS) Panel Unit Root Test

Variables	Constant	Constant &Trend
	t-Statistic	t-Statistic
RD	-1.494	-1.877
ΔRD	-4.045***	-4.281***
FDI	3.743***	-3.773***
BS	-1.350	-2.116
ΔBS	-3.202***	-3.233***
LnGDP	-2.594***	-2.579***

Note: *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively, while Δ denotes the initial differences. Critical values for constant are -2.21, -2.33 and -2.57 for 1%, 5% and 10% levels, respectively. Critical values for constant and trend are -2.73, -2.86 and -3.10 for 1%, 5% and 10% levels, respectively.

The CIPS test findings indicate that RD and BS are stationary in their initial differences, but FDI and LnGDP are stationary at the level. In the CADF test, RD and BS exhibit stationarity in their initial difference, whereas FDI and LnGDP demonstrate stationarity at the level. The presence of mixed variables like I(0) and I(1), with none exhibiting stationarity in their second difference, suggests that panel ARDL analysis is feasible.

Table 6: Cross-Section Augmented Dickey-Fuller (CADF) Panel Unit Root Test

Variables	Constant	Constant &Trend
	t-Statistic	t-Statistic
RD	-1.764 (0.495)	-1.635(0.989)
ΔRD	-2.631*** (0.002)	-2.790*(0.051)
FDI	-2.190* (0.08)	-2.289* (0.052)
BS	-1.820 (0.422)	-2.126 (0.735)
ΔBS	-2.394**(0.019)	-2.280*(0.054)
LnGDP	-2.372**(0.023)	-2.862** (0.030)

Note: *. ** and *** denote statistical significance at the 10% , 5% and %1 levels, respectively, while Δ denotes the initial differences. Critical values for constant are -2.21, -2.33 and -2.57 for 1%, 5% and %10 levels, respectively. Critical values for constant and trend are -2.73, -2.86 and -3.10 for 1%, 5% and %10 levels, respectively.

To implement the panel ARDL approach, the dependent variable must consist of a combination of I(1) and additional variables that are either I(1) or I(0), and the model should be interpreted as an error correcting mechanism.

The findings of the Panel ARDL (1, 5, 5, 5) PMG estimate is presented in Table 7. Analytical results indicate that the FDI, BS and LnGDP variables are statistically significant over the long-term. The FDI variable exerts a negative influence on R&D expenditures at a significance level of 1%, with a one-unit increase in FDI resulting in a reduction of R&D expenditures by 0.02 units. The control variable BS has a favorable impact on R&D expenditures at a significance level of 1%. A one-unit rise in the control variable LnGDP results in a 0.10 unit increase in R&D spending. These results align with prior research in the literature. Table 7 presents the findings of the short-term analysis. The short-term analysis results show a significant negative error correction coefficient (adjustment speed parameter) of Ec__: -0.4054, indicating a correction of 41% of the imbalance from the previous year at the 5% level.

The short-term analysis yields conclusions that differ from the long-term coefficients. The FDI variable, the BS variable, and LnGDP do not demonstrate a significant level of variation. In other words, it is deemed insignificant. Discussing the short-term impact of the pertinent factors is unfeasible in this context.

Table 7: **ARDL Results (1,5,5,5)**

Variables		Coefficient	Prob.
Long-Term	FDI	-0.02050	0.0000***
	BS	0.0031	0.0046***
	LnGDP	0.1047	0.0069***
Short-Term	Ec__	-0.4054	0.0316**
	D(FDI)	0.0022	0.7775
	D(BS)	-0.0056	0.6537
	D(LnGDP)	-0.2887	0.1322

The Hausman test is utilized in the Panel ARDL methodology to choose the suitable estimator between the Mean Group (MG) and Pooled Mean Group (PMG) estimators. By endorsing the null hypothesis for PMG and MG, we choose PMG over MG because of its enhanced efficiency. The Hausman test results indicate a rejection of the null hypothesis, thereby confirming the consistency of the PMG estimator with the ARDL model. Tables 8 elucidate the outcomes of ARDL/PMG assessments.

Table 8: ARDL Results for Each Country

	FDI		BS		LnGDP		Ec__	
Countries	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
Sweden	0.0121	0.0000***	0.0028	0.0000***	0.113	0.2809	-0.3000	0.0007***
Finland	-0.0077	0.0000***	-0.0225	0.0001***	0.0158	0.7133	-0.3443	0.0000***
Germany	-0.0027	0.0018***	-0.0262	0.0000***	0.7004	0.0001***	-0.0387	0.0015***
Denmark	0.0312	0.0000***	-0.0374	0.0000***	-1.4984	0.0005***	-0.1286	0.0002***
Austria	0.0071	0.0000***	0.0202	0.0000***	0.2683	0.0101**	-0.0693	0.0000***
Belgium	0.0026	0.0000***	0.0384	0.0000***	-0.3404	0.0000***	-0.3255	0.0000***
France	0.0377	0.0000***	0.0416	0.0000***	-0.7318	0.0001***	-1.5777	0.0013***
Netherlands	0.0004	0.0000***	0.0162	0.0000***	-0.4696	0.0001***	-0.0209	0.0005***
Slovenia	-0.0544	0.0000***	-0.0011	0.0000***	0.6197	0.0080***	-0.3964	0.0000***
Czechia	-0.004	0.0002***	-0.088	0.0000***	-0.1786	0.4659	-0.3456	0.0149**

Note: * Prob. < 0.10, ** Prob. < 0.05, *** Prob. < 0.01.

The ARDL results shown in Table 8 necessitate separate examination for each country. In light of the test findings, each country has significant relationship with FDI. The values obtained for all countries are less than the 1% significance value in absolute value. The same situation applies for BS as well. On the other hand, Sweden, Finland and Czechia are not significant for GDP. Gross domestic product does not affect to these countries R&D expenses for selected periods. Their R&D policies may have influenced these results.

5. Conclusion and Recommendations

R&D expenditures typically constitute a minor segment of the yearly budgets of nations, with the exception of those classified as developed countries. Countries may maintain low R&D spending due to the failure to achieve anticipated outcomes or the perception that such investments are not a priority. This study investigates the impact of FDI on the R&D spending of the selected nations individually. The impact is anticipated to be enduring (Pearce, 1989; Cheng & Bolon, 1993; Kuemmerle, 1997). The rationale is that the rewards on R&D investments are realized over the long-term. The association among the variables in the research was initially analyzed. Subsequently, before conducting the study, the presence of cross-sectional dependency was assessed using the LM (Adj. and CD) tests. The appropriateness of the data for the ARDL approach, chosen for the study, was assessed based on the outcome of the cross-sectional dependency using the second-generation unit root tests CIPS and CADF. Consequently, it was determined that the ARDL technique was the most appropriate approach for the investigation.

Examining the method's results reveals that, contrary to predictions, FDI, the control variable in the constructed model, has a negative rather than a positive long-term influence on R&D. The rationale for this is that the nations within the chosen sample group are high-income countries, which may choose to fund R&D using their own resources. As anticipated, FDI has negligible impact in the short run.

Furthermore, an analysis of the selected country set reveals that four nations (Finland, Germany, Slovenia, and Czechia) exhibit distinct variations from the other countries regarding the influence of the control variable on the dependent variable. This may stem from the countries' inclination to utilize their own resources. FDI inflows often deter local R&D activities, implying that FDI serves as a replacement for local R&D initiatives. Furthermore, some researchers (Braconier et al,.2001; Görg & Greenaway, 2001; Hanson, 2001; Damijan et al. 2003) on the adverse impacts of FDI indicate that the heightened competition resulting from FDI may compel local enterprises to shift into less creative sectors or may exclude them from the market altogether. The balance of payments may be adversely impacted by the importation of raw materials, machinery, and equipment necessary for company investment, payments to external entities, profit repatriation, and potential liquidation of the investment. Furthermore, the substantial money produced by the foreign entity may incentivize imports in the nation, contingent upon the marginal propensity to consume. All indicators suggest that foreign direct investment may adversely impact research and development. All these elements elucidate the unfavorable outcome based on the nations analyzed.

Consequently, developed nations with constrained resources for FDI should concentrate their R&D efforts on sectors where they possess a competitive advantage and get other innovations from other nations at reduced rates. In light of the achieved results, it is crucial for the relevant countries to create an economic framework that is immune to external influences, incorporates both domestic and foreign capital, and facilitates investment opportunities within their own borders without obstructing capital flows. The internal dynamics and sociological structures of nations significantly influence their growth and welfare levels. To attract FDI and achieve the needed growth, new structural reforms must be implemented in the areas of economy, education, law, etc. It is also important to keep incentive policies in place, do research, keep an eye on and evaluate the performance of both developed and emerging nations in this area, create an environment that is good for investment, and make the necessary plans and laws.

Conflict of Interest Statement

There is no conflict of interest with any institution or person within the scope of the study.

Contribution Ratio Statement

This study was conducted by a single author and all stages were prepared by the relevant author.

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