Vol.7 Issue.4 December 2022

RSEP Review of Socio - Economic Perspectives
ISSN: 2149 - 9276
E-ISSN: 2547-9385

Effects of R&D, innovation and investments on development in Türkiye: An empirical investigation for the 1990-2019 period[1]

Ibrahim Aytekin[1,•]
[1] *PhD in economics, Independent Researcher, Türkiye*

Article History

Received: 30 July 2022 Revised: 24 November 2022 Accepted: 29 November 2022 Available Online: 5 December 2022

Keywords: R&D, innovation, development, Türkiye, investment
JEL classification: C32; E22; O10; O31; O32

Citation: Aytekin, I. (2022). Effects of R&D, innovation and investments on development in Türkiye: An empirical investigation for the 1990-2019 period, *Review of Socio-Economic Perspectives*, 7(4), 31-41.

Abstract

This study aims to examine the effects of research and developmnet expenditures, innovation, and investments on development between 1990-2019 in Turkey. In the examination, the Auto-Regressive Distributed Lag (ARDL) model was used as a method. The reason for the use of this method in the analysis is that the variables are static at different levels. As a result of the analysis performed in this direction, it was found that there was a cointegration relationship between the variables. Then the error correction model was established and the long-term coefficients of the series were estimated. In the forecasts, a positive and statistically significant relationship was found between research and developmnet expenditures and development in the long term. Between innovation and development, there was a positive but statistically meaningless relationship. In the analysis, it was concluded that there was a negative and statistically meaningless relationship between development and investments.

1. Introduction

Development is an important indicator of whether a country has developed economic, social, cultural, political, educational, health, and many similar issues. Therefore, they aim to develop by improving indicators that improve the quality of life of their citizens such as increasing prosperity in each state country, developing health and education system, making innovations, and providing security and peace (Aytekin, 2021).

Investment is one of the basic dynamics necessary to achieve economic growth which is accepted as the locomotive of development. Therefore, while a country can grow economically by increasing its investments, the continuity of investments brings stability to economic growth in that country. This stability is an important driving force for development. Other important ways of capturing stability in economic growth, technology, human capital, specialization in certain areas, and many similar innovative policies, especially research & developmnet (R&D) and innovation, are to apply. Such policies to be implemented are the driving force for development as in investments (Aytekin, 2021).

Some of the studies dealing with innovation, R&D, investment, and development in the literature Crosby (2000), Lederman & Maloney (2003), Bilbao-Osorio & Rodríguez-Pose (2004), Sharma & Gani (2004), Ünlükaplan (2009), Samini & Alerasoul (2009), Wu (2011), Akbey (2014), Bujari & Martinez (2016), Firat et al. (2016), Gökmenoğlu et al. (2018), Jimenez & Zheng (2018), Nurpeisova et al. (2020), Özer & Ünlü (2020) and Aytekin (2021).

[1] **Acknowledgement:** This study is an extended and developed version of the oral summary declaration presented at the I. International Artuklu Economic and Political Sciences Congress 20-21 Now 2021 in Mardin-Türkye.
* **E-mail:** ibrahimaytekin63@gmail.com & **ORCID**: https://orcid.org/0000-0002-3574-1007
• **E-mail:** ibrahimaytekin63@gmail.com & **ORCID:** https://orcid.org/0000-0002-3574-1007
DOI: https://doi.org/10.19275/RSEP139
Article Type: Original Paper

In this direction, the main purpose of this study is to examine the effects of R&D expenditures, innovation, and investments on development between 1990 and 2019 in Turkey. The econometric time series method used in the examination of these effects is the ARDL bound test approach by the results of Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root tests.

The study consists of introduction, investment and development, innovation and development, research-development (R&D) and development, literature review, data set and model, methodology, empirical findings, and result sections.

2. Investment and Development

Investment is the activity of reproduction of capital (Eğilmez, 2016). In other words, investment means connecting the capital to use capital or to make profits. Investment is the process of current that starts with expenditure and continues with the range of payments. In particular, the investment is the case of money to obtain future payments that will eliminate the uncertainty of inflation and future payments that are expected during the period in which the funds are attached to the investor for a certain time. This definition covers the investments made by companies in land, buildings, machines, and devices, as well as investments made by individual investors in investment instruments such as bonds, stocks, foreign exchange, gold, commodity, or real estate. Investments in the assets such as land, building, and machinery in the literature "Physical (Material) Investments"; investments in assets such as bonds, stocks, gold, and foreign currency are expressed as "financial asset investments". In other words, investments; it is divided into two physical (material) and financial investments (Tarhan-Mengi & Yılmaz-Türkmen, 2013).

One of the most important indicators affecting the development of a country is economic growth. Therefore, one of the main objectives for the development of countries is to grow economically. In economic growth, which is accepted as the locomotive of development, the way to achieve these goals is through investments (Aytekin, 2021). Therefore, investments are of great importance in terms of supporting the development of both countries and regions. Investments from the past to the present day are considered to be the motor of growth and development in almost the world. For this reason, countries take special measures to promote investments in specific regions and specific sectors. Countries compete with each other to attract international investments (Şahin & Uysal, 2011).

3. Innovation and Development

The concept of innovation was first defined by J. Schumpeter (1934) as a driving force of economic development. Innovation according to Schumpeter; is the introduction of a new feature of a new product or an existing product, putting new production techniques into practice, entering new markets, finding new sources of supply, and having a new organization of industry. According to Schumpeter, who settled entrepreneurs at the center of economic activities, he stated that the main task of an entrepreneur is not only to reorganize goods and resources but also to launch new ones of entrepreneurs' goods and resources. This task undertaken by entrepreneurs organizes the flow of economic activities on the one hand, while the extreme profit that emerges through innovations also encourages entrepreneurs' desire to carry out innovative activities. However, due to its nature, the imitation of invocations by other entrepreneurs over time produces positive externalities. These positive externalities make significant contributions to the economic growth and development process (Özer & Ünlü, 2020).

Today, the concept of innovation has become one of the important arguments in development debates. Innovation is no longer not only for developed countries but also in developing economies; the ability to introduce new technologies and organizations is seen as a very important element in the process of industrialization and modernization. In this process, many developing and rising economies from Eastern Europe to China, China to India, from India to Latin America; continues to make great efforts and research to introduce new products and processes, imitate pioneering innovators rapidly, to adopt new capital equipment and production technologies widely and to expand the use of new goods and services. The advantage of this ongoing innovation research is the multidimensional nature of technological change in complex and firms, inputs, outputs, resources, targets, and blocking factors (Bogliacino et al. 2012). Therefore, innovation systems innovative companies; Universities, research centers, regulators, competitors, customers, and suppliers (Bujari & Martinez, 2016). As a result of these relations, the innovations created are the driving force for growth, employment, development, and many similar economic and social development, especially production.

4. R&D and Development

R&D is defined as the use of scientific and technical knowledge in new applications. Today, the R&D subject is the subject of all economic study areas as well as the production and production method. R&D; is a tool that

provides more beneficial and good access to the economy by increasing efficiency and efficiency in terms of its purpose, scope, and quality. Expenditures on R&D provide an increased return on the scale during the production of new information. The reason why R&D provides an increasing return on the scale is that information has the basic input feature not only in a final element but also in terms of producing new information and is re-used at every stage of production due to its iridescence (Fırat et al. 2016).

Since 1980, technological advances have played a key role in promoting economic growth, and science and technology innovation. This encourages R&D investments to increase the economic growth and national competitiveness of many countries. For this reason, R&D investments in science, technology, and other issues are considered one of the key criteria for evaluating the economic development and competitiveness of a nation. R&D investments affect economic growth through multiple channels such as innovation, capital accumulation, and human resources development, and all of them gradually contribute to the general development and development of the economy (Bor et al. 2010). As a result, new products, new processes, and R&D investments that result in new information are important sources of technical change, efficiency, efficiency, and increase in production (Dominique & Potterie, 2001). The positive effects of such a source contribute to the economic growth of countries and their development with this growth (Bor et al. 2010).

5. Literature Review

As a result of the literature screening, among the studies examining the relationship between innovation, R&D, investment, and development; Crosby (2000), Lederman & Maloney (2003), Bilbao-Osorio & Rodríguez-Pose (2004), Sharma & Gani (2004), Ünlükaplan (2009), Samimi & Alerasoul (2009), Wu (2011), Akbey (2014), Bujari & Martinez (2016), Fırat et al. (2016), Gökmenoğlu et al. (2018), Jimenez & Zheng (2018), Nurpeisova et al. (2020), Özer & Ünlü (2020) and Aytekin (2021). In these studies, the studies reaching similar results are as well as studies reaching different results. Detailed analysis, classification, and examinations of these studies in the literature are given in chronological order of the following studies.

Crosby (2000) has explored the importance of innovation in the economic growth of Australia. In the study, it was found that the increases in innovation activities positively affect both labor efficiency and economic growth.

Lederman & Maloney (2003) concluded that there was a correct relationship between development and R&D activities in the study, which deals with the selected countries within the framework of the 1975-2000 period.

Bilbao-Osorio & Rodríguez-Pose (2004), the European Union (EU) linear regression analysis method, especially in the EU's surrounding areas of the EU's higher education R&D investments have positively affected innovations. In addition, it has been concluded that the capacity that transforms R&D investment into innovation and ultimately innovation into economic growth depends on the region-specific socioeconomic characteristics.

Sharma & Gani (2004) examined medium and low-income countries for the 1975-1999 periods by the fixed impact model method. In the examination, it was concluded that foreign direct investments have a positive effect on development for both groups of countries.

Ünlükaplan (2009) observed that there is a high relationship between economic development, competitiveness, and innovation among 27 members of the European Union.

Samimi & Alerasoul (2009) examined the R&D and economic growth variables of 30 developing countries for the 2000-2006 period by panel data method. In the examination, it was observed that R&D expenditures had no positive effect on economic growth.

Wu (2011) has examined the impact of R&D and innovation on regional economic growth in China. In the examination, R&D and innovation have a positive effect on regional economic growth.

Akbey (2014) stated that the economic dimension of the relations between R&D and innovation is of great importance. In this respect, the support of the private sector in the support of R&D and innovation processes stated that it is very important for sustainable development to support the process by governments.

Bujari & Martinez (2016), 12 Latin American countries, the effect of technological innovation on economic growth with a dynamic panel data model. As a result of the examination, technological innovation processes have shown a positive effect on economic growth in the region. In this direction; the investment in the export of R&D, patents, and high-tech products increases total factor efficiency in most Latin American countries and GDP per capita.

Fırat et al. (2016), Türkiye's R&D, innovation, and development variables within the framework of the 2004-2014 period by comparative analysis method examined. In the examination, it is seen that Türkiye's research and development studies, innovation, and development are different in every region. It is seen that human resources, technology, and information cannot be developed at the desired level among regions, and resources are not

effectively distributed. It has been concluded that there are differences in development between the regions causing innovation, development, and research and development studies to slow down.

Gökmenoğlu et al. (2018), Nigeria's 1972-2013 period of development and foreign direct investments Johansen examined by the cointegration method. In the examination, it has concluded that there is a long-term relationship between foreign direct investments and development.

Jimenez & Zheng (2018) should be considered as part of development. It is argued that innovation contributes to development in terms of both process and result and this should only be evaluated economically. For this reason, technology centers should be perceived as useful corporate mechanisms for human development and should be encouraged and supported by fund providers, international organizations, and local governments.

Nurpeisova et al. (2020) in the study, that deals with Kazakhstan within the framework of the 2000–2018 period; a positive relationship was found between innovations and development between GDP and R&D expenditures.

Özer & Ünlü (2020) have analyzed the development and innovation variables of upper and medium-income countries by panel data method within the framework of the 2000-2017 period limits. In the analysis, it is stated that there is a positive relationship between economic development and innovation.

Aytekin (2021) examined the relationship between the variables of development, innovation, R&D, education, and health expenditures of the period between 1990 and 2019 with the Vector Auto-Regressive model (VAR). In the examination in Türkiye; it has been observed that there are significant causality relations between development, innovation, R&D, education, and health expenditures. But effect-response functions; shows that educational expenditures in Türkiye cannot increase innovation to the desired level. In addition, the significant decrease in R&D expenditures on innovation (innovations) after the 10th semester shows that R&D expenditures cannot be used effectively in Türkiye.

6. Data and Model

In the econometric analysis of this study, 30 years of data between 1990-2019 were used. The reason why the analysis period was selected between these years is the data restriction due to the purpose of forming common data. Detailed information about the analysis variables is given in Table 1 shown below.

Table 1. Analysis variables and source

Variable Name	Short Name of the Variable	Source
Human Development Index	Development	United Nations Development Program (UNDP)
R&D expenditures	R&D	Turkish Statistical Institute and (Sungur, Aydın & Eren, 2016)
Number of Patents	Innovation	Turkish Statistical Institute and (Sungur, Aydın & Eren, 2016)
Investment	Investment	The International Monetary Fund (IMF)

The functional relationship between the variables that make up the model of the study is expressed as follows:

$$\text{Development} = f(\text{R\&D}, \text{Innovation}, \text{Investment})$$

Econometric analyzes are estimated by the regression model shown in Equation 1:

$$\text{Development}_t = \beta_0 + \beta_1 \text{R\&D}_t + \beta_2 \text{Innovation}_t + \beta_3 \text{Investment}_t + e_t \quad (1)$$

Here it refers to the β parameter coefficients, t time dimension, and e error term.

7. Methodology

In this study, which examines the effect of investment, R&D, and innovation on development in Türkiye, the time series analysis method was used. In the first stage of the econometric analysis of the study, the statistical summary and correlation matrix of the variables used in the analysis was created. Then, whether the variables are

stationary, the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests were examined. In the third stage, it was decided to apply the ARDL bound test to variables based on the results of the unit root tests. The cointegration relationship between the ARDL bound test and variables was examined. In the final stage of the analysis, the long and short-term coefficients of variables were estimated through the ARDL bound test. In this section, the theoretical foundations of these models used in the analysis are briefly mentioned.

7.1. The Augmented Dickey-Fuller (ADF) Unit Root Test

In time series analysis, unit root tests are the tests where the variables are controlled whether the variables contain unit root (Aytekin, 2022). To prevent the emergence of counterfeit regression in time series analysis, the variables used in the analysis should not contain a unit root, ie a static stationary (Gujarati, 2011). For this reason, unit root tests are of great importance in time series analysis (Aytekin, 2022).

In this study, one of the models used to test the stationary structures of the variables is the ADF unit root test. The ADF unit root test was developed by adding delayed values to the dependent variables of the regression equations of the Dickey-Fuller (DF) unit root test in 1981. The regression equations of the ADF unit root test are estimated as three models given below (Dickey & Fuller, 1981);

$$\Delta Y_t = \rho Y_{t-1} + \sum_{i=1}^{n} \Theta_i \Delta Y_{t-i} + e_t \quad \text{(Without Constant \& Trend)} \quad (2)$$

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \sum_{i=1}^{n} \Theta_i \Delta Y_{t-i} + e_t \quad \text{(With Constant)} \quad (3)$$

$$\Delta Y_t = \alpha + \beta T + \rho Y_{t-1} + \sum_{i=1}^{n} \Theta_i \Delta Y_{t-i} + e_t \quad \text{(With Constant \& Trend)} \quad (4)$$

7.2. Philips-Perron (PP) Unit Root Test

In this study, another unit root test used to test the stationary structures of the variables is PP (1988) unit root test. The PP unit root test was developed by making several corrections to the error terms of the ADF unit root test. This unit root test explains how to deal with autocorrelation and changing variance problems that are not explained in the errors in the equations of the ADF unit root test. The regression equations of the PP unit root test are estimated as three models given below (Phillips & Perron, 1988);

$$Y_t = \alpha Y_{t-1} + e_t \quad (t = 1,2,\ldots..) \text{ ve } \alpha = 1 \quad (5)$$

$$Y_t = \mu + \alpha Y_{t-1} + e_t \quad \text{(With Constant)} \quad (6)$$

$$Y_t = \mu + \alpha Y_{t-1} + \beta\left(t - \frac{T}{2}\right) + e_t \quad \text{(With Constant \& Trend)} \quad (7)$$

The critical values of the test statistics used in the tests of the ADF unit root test and PP unit root test consist of critical values converted into a table by Mackinnon (1996). Therefore, the same hypothesis tests are used for the regression equations of these two units of root tests, these tests are formed as shown below (Mackinnon, 1996);

H_0: $\alpha=0$ There is unit root (serial is not stationary).

H_1: $\alpha<0$ There is not unit root (serial is stationary).

7.3. The Auto-Regressive Distributed Lag (ARDL) Bound Test

ARDL bound test is a boundary test where the variables are tested whether they are coordinated. This test Pesaran & Shin, (1995) and Pesaran et al. (2001) developed by. The most important advantage of this test is that all of the variables are at the same level stationary (all of them I (0) or all I (1)) as well as when the variables are stationary (some of the variables I (0) and some of them I (1)) is also applicable. In this model, two bound test values were created, one I (0) and one I (1) to determine the cointegration relationship between the variables. According to these limit tests; the lower limit value I (0), in which all variables are considered stationary at the level; where all variables are considered stationary in the first difference I(1), have been calculated as two critical limit values (Pesaran & Shin, 1995; Pesaran, et al., 2001). In this direction, the estimated ARDL bound test in this study is modeled as the equation given below.

$$\Delta Development_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta Development_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta R\&D_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta Innovation_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta Investment_{t-i} + \beta_5 Development_{t-1} + \beta_6 R\&D_{t-1} + \beta_7 Innovation_{t-1} + \beta_8 Investment_{t-1} + e_t \quad (8)$$

Here it refers to β_0 constant coefficient, β_1, β_2, and β_3 short-term coefficients, β_4, β_5, and β_6 long-term coefficients, Δ difference processor, t time, and e the error term.

8. Empirical Findings

In this study, the first stage of econometric analysis is descriptive statistics. The descriptive statistical summary calculated in this direction is given in Table 2 shown below.

Table 2. Descriptive statistics

Variable Name	Number of Observations	Minimum Value	Maximum Value	Mean	Standard Deviation	Skewness	Kurtosis
R&D	30	0.330	1.063	0.645	0.208	0.408	1.969
Innovation	30	902	8.343	2.628	2.078	1.558	4.195
Investment	30	18.025	31.003	25.499	3.329	-0.117	2.109
Development	30	0.671	0.806	0.751	0.034	-0.483	2.812

When the descriptive statistics given in Table 2 are examined, the average of R&D was calculated as 0.645 and the standard deviation was calculated as 0.208. The average of the innovation variable was calculated as 2.628, while the standard deviation was calculated as 2.078. The average of the investment variable was calculated as 25.499 and the standard deviation was calculated as 3.329. The average of the development variable was calculated as 0.751 and the standard deviation was calculated as 0.034. On the other hand, according to Table 2, the distribution of R&D and Innovation variables receive positive values and the distribution is distorted to the left. The distribution of investment and development variables is distorted to the right because the distortion coefficients receive negative values. Finally, it is understood that the distribution of all of the variables in Table 2 received positive values of the substitution values are pointed compared to normal distribution. These results confirmed that the variables are suitable for the analysis. In the next stage of the analysis, the correlation matrix was created for the variables, and this matrix is given in Table 3 shown below.

Table 3. Correlation matrix

Variable Name	R&D	Innovation	Investment	Development
R&D	1.000			
Innovation	0.136	1.000		
Investment	0.618	0.093	1.000	
Development	0.516	0.205	0.323	1.000

When the correlation matrix given in Table 2 is examined, it is understood that there is a positive correlation relationship between R&D, innovation, investment, and development variables. After the correlation matrix, unit root tests of the variables were performed and the findings obtained are given in Table 4 shown below.

Table 4. ADF and PP unit root test findings

Level	Variable Name	ADF		PP	
		With Constant	With Constant & Trend	With Constant	With Constant & Trend
		t-Statistic (Probability)	t-Statistic (Probability)	t-Statistic (Probabilit)	t-Statistic (Probability)
	R&D	-0.936	-1.467	-0.070	-2.400
		(0.994)	(0.811)	(0.944)	(0.372)
	Innovation	-2.109	-2.019	-2.109	-2.019
		(0.243)	(0.567)	(0.243)	(0.567)

At Level	Investment	-2.410	-3.360	-2. 317	-3. 360
		(0.148)	(0.077)	(0.174)	(0.077)
	Development	-3.224**	-4.789*	-3.220**	-4.804*
		(0.029)	(0.003)	(0.029)	(0.003)
At First Difference	Δ(R&D)	-3.583**	-3.796**	-7.390*	-8.088*
		(0.014)	(0.035)	(0.000)	(0.000)
	Δ(Innovation)	-5.227*	-5.168*	-5.228*	-9.530*
		(0.000)	(0.001)	(0.000)	(0.000)
	Δ(Investment)	-7.179*	-7.024*	-8.427*	-8.122*
		(0.000)	(0.000)	(0.000)	(0.000)

* indicates statistical significance at the 1% significance level, ** indicates statistical significance at the 5% significance level, while the Δ symbol represents the difference operator.

According to the results of the constant and constant & trend models of the ADF and PP unit root tests given in Table 4, it is understood that only the development variable is stationary at the level. In other words, according to the results of the ADF and PP unit root test, the development change is I(0). The R&D, innovation, and investment variables in Table 4 were found to be stationary in the first difference according to the results of constant and constant & trend models of ADF and PP unit root tests. In other words, according to the results of the ADF and PP unit root test, R&D, innovation, and investment variables are I(1). As a result, according to the results of the ADF and PP unit root tests, it was observed that the variables were stationary at different levels (I(0) and I(1)).

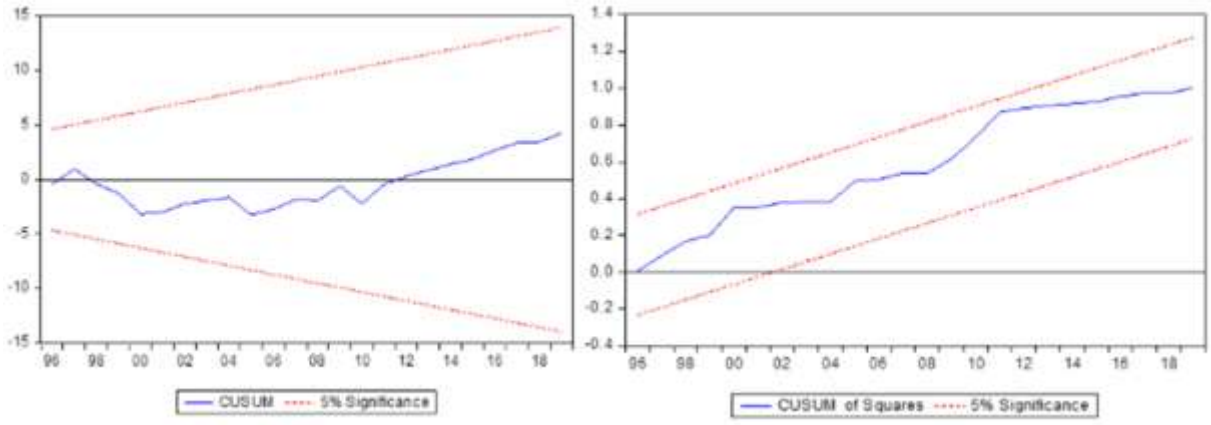
Determining that the variables are stationary at different levels shows that the most suitable model for the cointegration test is the ARDL bound test approach (Pesaran & Shin, 1995; Pesaran, et al., 2001). For this reason, the ARDL (1, 0, 0, 0) bound test was estimated in which development is considered a dependent variable, and R&D, innovation, and investments are considered independent variables. In this direction, the tests of this model, which are estimated, and the ARDL bound test results are given in Table 5.

Table 5. ARDL bound (cointegration) test findings

F-statistics Value: 19.581	**Critical Values**	
	I(0) Bound	**I(1) Bound**
%1	4.29	5.61
%5	3.23	4.35
%10	2.72	3.77
Model Information		
Model	ARDL(1, 0, 0,0)	
Information Criterion	Schwarz Information Criterion (SIC)	
Lag Length	1	
Diagnostic Tests		
	F-statistics	**Probability (P)**

Serial Correlation LM Test (Breusch-Godfrey)	0.676	0.518
Heteroskedasticity Test (Breusch-Pagan-Godfrey)	1.001	0.426
Ramsey Reset Test (Ramsey Reset)	1.942	0.176
	Jarqua-Bera	**Probability (P)**
Normality Test	0.398	0.819

CUSUM and CUSUM Square Tests



According to the estimates of the ARDL bound test performed as shown in Table 5, F statistical value was calculated as 4.47. This calculated F statistics value is a large value from the upper limit value of the 5 % level (F = 4.47> 4.35). The calculation of 5% of the statistical value as a value greater than I (1), which is the upper limit value of 5%, means that a long-term relationship (cointegration relationship) is between variables. In addition, the results of the CUSUM tests with the diagnostic tests given in Table 1 show that the estimated ARDL model is established healthily and the stability requirement is achieved in the model. Following the encountering relationship between the variables, the error correction coefficient and short-term coefficients were estimated and the results obtained are given in Table 6 shown below.

Table 6. Error correction model (ECM) and short-term test results

Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**Probability (P)**
D(R&D)	0.085	0.047	1.799	0.084
D(Innovation)	0.000	0.000	0.801	0.430
D(Investment)	-0.000	0.002	-0.045	0.964
CointEq(-1)	-0.956	0.242	-3.951	0.000

In Table 6, when the error correction coefficient of the model is first considered, it is seen that this coefficient is calculated as -0.956. The fact that the t statistics of this coefficient and the probability value is significant and that this coefficient is between 0 and 1 and a negative value confirms that the error correction mechanism works smoothly in the model. This result shows that the deviations from the average in the short-term balance will reach approximately [1/(|-0.956 |) = 1,05] 1,1-year (1 year 1 month).

In Table 6, when the short-term coefficients of the variables are taken into consideration, it is understood that there is a statistically significant relationship between R&D and development in the short term. Accordingly, it is understood that a 1% increase seen in R&D expenditures in Türkiye in the short term made a positive contribution to development by 0.08%. According to the other short-term results given in Table 6, there was no

significant relationship between investment and development in Türkiye, and no significant relationship was found between innovation and development. In the next and final stage of the analysis, the long-term coefficients of the model are calculated and the results are given in Table 7 shown below.

Table 7. Long term test results

Variable	Coefficient	Standard Error	t-Statistic	Probability (P)
R&D	0.088	0.039	2.266	0.032
Innovation	0.000	0.000	0.834	0.412
Investment	-0.000	0.002	-0.045	0.964
C	0.689	0.049	13.990	0.000

When the long-term coefficients given in Table 7 are examined, it is seen that the long-term results in Türkiye are similar to the short-term results. Therefore, when the results in Table 7 are evaluated, it is understood that there is a statistically significant relationship between long-term R&D expenditures and development in Türkiye. Accordingly, it is understood that a 1% increase in R&D expenditures in Türkiye has made a positive contribution to development by 0.08% on development. In addition, according to the other long-term results given in Table 7, there was no significant relationship between long-term investment and development in Türkiye, and no significant relationship was found between innovation and development.

9. Conclusion

In this study, which examines the 30-year process of Türkiye between 1990 and 2019; it has been concluded that there is a cooperative relationship between R&D, innovation, investment, and development. In this period, it was concluded that the relationship between R&D expenditures and development in Türkiye was statistically significant in the short and long term. However, during this period, there was no statistically significant relationship between short and long-term investment and development in Türkiye, and there was no statistically significant relationship between innovation and development.

The result of the relationship between R&D expenditures and development in the 1990-2019 period in Türkiye shows that R&D expenditures in Türkiye affect development positively. Therefore, it is possible to say that R&D expenditures are an important driving force for development in Türkiye. This result is that R&D expenditures are not a sufficient factor for the development of Türkiye alone, and it is possible to increase the share of R&D expenditures in this process as well as to make development sustainable by activating other factors.

To conclude that the relationship between investment and development in the 1990-2019 period in Türkiye is statistically meaningless; it shows that some investments in Türkiye cannot be directed to the right regions or areas, and therefore the desired success and results in national and regional development policies cannot be achieved. In addition, it can be included in the main reasons between the failures in which the incentives and support processes for investments cannot be well managed and enough inspections cannot be performed. Such negative developments may interfere with cumulative development in Türkiye.

Finally, as in investments, it was concluded that the relationship between innovation and development in Turkey in the 1990-2019 period was statistically meaningless. During this period, most of the innovations in Turkey are removed from the shelves without being put into practice as in the projects. The main reasons for this situation are possible to list the human power difference between the regions, technological development, education and transportation opportunities, difference between regions at the level of development, imbalance in resource and income distribution, and similar reasons. For these reasons, it is an important indication that innovation cannot make a serious contribution to development.

The results achieved in this study are included in the literature and Lederman & Maloney (2003), Bilbao-Osorio & Rodríguez-Pose (2004), Samimi & Alerasoul (2009), Wu (2011), Akbey (2014), Fırat et al. (2016), Gökmenoğlu et al. (2018), Nurpeisova et al. (2020), and Aytekin (2021), while supporting the results of the studies conducted by; Crosby (2000), Sharma & Gani (2004), Ünlükaplan (2009), and Özer & Ünlü (2020) do not support the results of the studies carried out by.

Based on these results, it is useful to review the policies and practices for these issues to create positive effects on innovation and investments in Türkiye. In addition, the revenue enlargement and employment creative of investments, as well as innovation or patents that can create significant added value in production, and the functioning of patents from the shelves can have a serious impact on Türkiye's development. In addition, it is

possible to increase the development of R&D expenditures in Türkiye as well as to make development by being activated in other factors. In addition to the variables used in this study, the study can be developed by including human capital, export, import, employment, unemployment, technology, and similar variables.

References

Andrea J., & Yingqin, Z. (2018). Tech Hubs, İnnovation and Development, *Information Technology for Development, 24(1),* 95-118. Doi: 10.1080/02681102.2017.1335282.

Akbey, F. (2014). Ar-Ge, İnovasyon ve Kalkınma İlişkisine Yönelik Bir Literatür Taraması: Kuramsal Özet. *Maliye Dergisi, (166),* 1-16.

Aytekin, I. (2022). Türkiye'de Karayolu ve Demiryolu Ulaştırma Hizmetleri ile Kalkınma Arasındaki Nedensellik İlişkisinin Analizi. *Anadolu İktisat ve İşletme Dergisi, 6(1),* 17-35.

Aytekin, I. (2021). Kalkınma İnovasyon Ar-Ge Eğitim ve Sağlık Harcamaları Arasındaki İlişkinin Analizi: Türkiye Örneği. *3. Uluslararası Sosyal Bilimler ve İnovasyon Kongresi*, pp. 38-53, 21-22 Ekim 2021. Ankara/Türkiye.

Bilbao-Osorio, B., & Rodríguez-Pose, A. (2004). From R&D to Innovation and Economic Growth in the EU. *Growth and Change, 35(4),* 434-455.

Bujari, A. A., & Martinez, F. V. (2016). Technological Innovation and Economic Growth in Latin America: Dynamic Panel Data Model Estimated with System GMM. *Revista Mexicana de Economia Finanzas, 11(2),* 77-89.

Bor, Y., Chuang , Y., Lai , W., & Yang , C. (2010). A Dynamic General Equilibrium Model for Public R&D Investment in Taiwan. Economic Modelling, 27(1), 171- 183.

Crosby, M. (2000). Patents, Innovation and Growth. The Economic Record, 76(234), 255 - 262.

Dickey, D. A., & W. A. Fuller (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of American Statistical Association*, 74(366), 427-431.

Dickey, D. A., & W. A. Fuller. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica, 49(4),* 1057-1072.

Dominique, G., & Potterie, B. P. (2001). R&D and Productivity Growth: Panel Data Analysi of 16 OECD Countries. *OECD Economic Studies 2(33),* 104-125.

Fırat, E., Karaçor, Z., & Altınok, S. (2016). Kalkınmada Ar&Ge ve İnovasyonun Önemi Türkiye Örneği. *Avrasya Ekonomileri Uluslararası Konferansı,* ss. 830-838. Kaposvar-Hungary, 29-31 Ağustos 2016.

Bogliacino, F., Perani, G., Pianta, M., & Supino, S. (2012). Innovation and Development: The Evidence From Innovation Surveys, *Latin American Business Review, 13(3),* 219-261, Doi:10.1080/10978526.2012.730023.

Gujarati, D. (2011). *Econometrics by Example* (1. Edition). Palgrave Macmillan: England.

Gökmenoğlu, K., Apinran, M. O., & Taşpınar, N. (2018). Impact of Foreign Direct Investment on Human Development Index in Nigeria. *Business and Economics Research Journal, 9(1),* 1-13. Doi:10.20409/berj.2018.90.

Lederman, D., & Maloney, W., F. (2003). R&D and Development, The World Bank Policy Research Working Paper, Series No: 3024, 1-37.

MacKinnon, J. G. (1996). Numerical Distribution Functions for Unit Root and Cointegration Tests. *Journal of Applied* Econometrics, (11), 601-618.

Nurpeisova, A., Mauina, G., Niyazbekova, Sh., Jumagaliyeva, A., Zholmukhanova, A., Tyurina, Yu., Murtuzalieva, S., & Maisigova L. (2020). Impact of R&D expenditures on the country's innovative potential: a case study. *Entrepreneurship and Sustainability Issues, 8(2),* 682-697.

Özer, B., & Ünlü, F. (2020). İnovasyon ve Ekonomik Kalkınma İlişkisi: Üst-Orta Gelirli Ülkeler Üzerine Panel Veri Analizi. *Yönetim ve Ekonomi Araştırmaları Dergisi, 18(4),* 91-111. http://dx.doi.org/10.11611/yead.778898.

Pesaran, H. M., & Y. Shin (1995). An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. *The Symposium at the Centennial of Ragnar Frisch the Norwegian Academy of Science and Letters*, March 3-5, 1995, Oslo.

Pesaran, H. M., Y. Shin & R., J. Smith (2001). Bounds Testing Approaches to the Analysıs of Level Relationships. *Journal of Applied Econometrics*, (*16),* 289–326.

Phillips, P. C. B., & P. Perron. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika, 75(2),* 335-346.

Samimi, A. J., & Alerasoul, S. M. (2009). R&D and Economic Growth: New Evidence from Some Developing Countries. *Australian Journal of Basic and Applied Sciences, 3(4),* 3464- 3469.

Sharma, B., & Gani, A. (2004). The Effects of Foreign Direct Investment on Human Development. *Global Economy Journal, 4(2),* 1-18.

Schumpeter, J. A. (1934). *The Theory of Economic Development*. New Jersey: Transaction Publishers.

Sungur, O., Aydın, H. İ., & Eren, M. V. (2016). Türkiye'de Ar-Ge, İnovasyon, İhracat ve Ekonomik Büyüme Arasındaki İlişki: Asimetrik Nedensellik Analizi. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 21(1),* 173-192.

Şahin & Uysal, (2011). Bölgesel Kalkınma Çerçevesinde Yatırım Teşviklerinin Shift-Share Analizi. *Maliye Dergisi, (160),* 111-138.

Tarhan-Mengi, B., & Yılmaz-Türkmen, S. (2013). Yatırım Hileleri. *Öneri, 10(39),* 31-39.

The International Monetary Fund (IMF). (2022). World Economic Outlook Database. https://www.imf.org/en/Publications/WEO/weo-database/2022/April. (Date of Access 25.06.2022).

Turkish Statistical Institute. (2022). www.tuik.gov.tr. (Date of Access 08.06.2022).

United Nations Development Program (UNDP). (2021). Human Development Index. www.undp.org. (Date of Access 25.05.2022).

Ünlükaplan, İ. (2009). Avrupa Birliği Üyesi Ülkelerde İktisadi Kalkınma, Rekabetçilik ve İnovasyon İlişkilerinin Kanonik Korelasyon Analizi ile Belirlenmesi. *Maliye Dergisi, (157),* 235-250.

Wu, Y. (2011). Innovation and Economic Growth in China: Evidence at the Provincial Level. *Journal of the Asia Pacific Economy, 16(2),* 129-142. Doi: 10.1080/13547860.2011.564752.