International Journal on Economics, Finance and Sustainable Development (IJEFSD)

e-ISSN: 2620 – 6269
p-ISSN: 2615 - 4021

Volume: 6 Issue: 12 | December 2024

https://journals.researchparks.org/index.php/IJEFSD

Article

Measuring and Analyzing the Effect of Innovation on Economic Growth: A Study of Selected Countries for the Period (2020-2022)

Nazhan Mohammed Sahho[1*], Muneam Ahmed Khudhair[2], Gailan Ismael Abdullah[3]

[13] College of Administration and Economics, University of Samarra, Iraq
[2] Al-Qalam University College, Iraq
* Correspondence: alsaho.n@uosamrra.edu.iq

Abstract: This research aims to study and analyze the impact of the Global Innovation Index (GII) 2020 on Gross Domestic Product (GDP) [as an indicator to express Economic Growth] for the year 2022 across a selected sample of countries worldwide using Eviews-13 software. The returns indicate that global innovation has a positive and significant effect on the GDP of the sample comprising 78 countries, categorized into three groups based on income: high-income countries, upper-middle-income countries, and lower-middle-income countries. This aligns with the research hypothesis. The impact varied according to the coefficient of determination (R^2), explaining 61% of the changes in GDP due to variations in the GII for high-income countries, 44% for upper-middle-income countries, and 32% for lower-middle-income countries. The research also identified a long-term equilibrium relationship between the GII and GDP based on cointegration results. Additionally, there were no issues of autocorrelation or heteroscedasticity at a significance level of 5% for the model variables across all three groups in the sample. The research recommends several suggestions, the most important being the necessity for middle-income and low-income countries (developing nations) to enhance their innovation index in line with improving the components of this index to boost their GDP. Furthermore, developing countries need to rely on a knowledge-based economy grounded in creativity and innovation in the context of global competition, making human development vital for accommodating and advancing all technological innovations.

Keywords: Innovation Economics, Global Innovation Index, Economic Growth, Economic Competitiveness, Knowledge Economy

Citation: Sahho, N, M. Measuring and Analyzing the Effect of Innovation on Economic Growth: A Study of Selected Countries for the Period (2020-2022). International Journal on Economics, Finance and Sustainable Development (IJEFSD) 2024, 6(12), 344-362.

Received: 10th Aug 2024
Revised: 11th Oct 2024
Accepted: 24th Nov 2024
Published: 27th Dec 2024

1. Introduction

Innovation is a crucial element for the superiority and dominance of countries on both economic and social levels. It is the primary component that nations rely on to achieve greater success and prosperity in the future. Innovation is one of the twelve pillars that enhance global competitiveness, as well as one of the four pillars of the knowledge economy. The knowledge economy represents a new pattern of economic and social development adopted by most successful economies to achieve significant developmental leaps, moving away from dependence on traditional natural resources through the cultivation and development of human capital. In an era characterized by continuous economic, technological, and political changes, innovation serves as the fundamental driver of economic growth and technological development. Given this importance, this research aims to examine the impact of innovation on GDP growth in a sample of countries with varying income levels, to assess innovation performance across global economies.

2. Materials and Methods

Research problem:

Economic progress is no longer linked to the possession of natural resources or material capabilities, as much as it is linked to cognitive and technological content, quality and innovation. Japan is a country without resources, but with attention to human resources and economic innovation, Japan has been able to be one of the most important economies in the world and achieve the highest rates in its gross domestic product. Therefore, the research problem lies in the fact that countries that suffer from weak cognitive and technological content cannot advance their economy and economic growth, unlike developed countries that possess advanced technology and have a long history in the fields of innovation, as they can achieve significant economic growth

Research Hypothesis

The research is based on the hypothesis that "the Global Innovation Index 2020 positively influences economic growth for the year 2022 for the sample of research countries."

Research Objective:

The research aims to define the Global Innovation Index and determine the nature of the relationship between the Global Innovation Index and GDP growth.

Research Scope:

The research deals with studying the effect of the Global Innovation Index on economic growth for a selected sample of countries for the period (2020-2022).

Research Method:

The research employs a descriptive-analytical approach supported by the use of quantitative analysis to enhance the validity of the results.

Research Structure:

To achieve the research objective and validate its hypothesis, the research was divided into three sections:

1. The theoretical framework of innovation: This section explores the foundational concepts and theories related to innovation
2. Analysis of the reality of the Global Innovation Index 2020 for the sample countries: This section provides an in-depth examination of the Global Innovation Index for the selected countries

Measuring the effect of the Global Innovation Index 2020 on Economic Growth in 2022: This section measures the influence of the Global Innovation Index on economic growth for the year 2022 in the sample countries

Literature Review

1. The study by Li and Atuahene-Gima (2001) titled "Product Innovation Strategy and Performance of New Technology Projects in China" examined the relationship between product innovation and performance in several new technology projects in China, serving as a research model for joint ventures. The study highlighted the presence of an intermediary factor between innovation and performance, which includes various environmental factors such as the nature of the environment—whether it is turbulent or stable—and institutional support for these projects, in addition to the relationship with the core strategy adopted by such joint ventures.
2. The study by Thorburn (2005) titled "Knowledge Management and Innovation in Service Companies" aimed to investigate the role of knowledge-intensive service activities in the field of innovation by collecting qualitative data on innovation in the tourism, software, and mining technology industries, with a focus on decision-making processes that lead to the utilization of external sources for certain components of innovation for knowledge. The study was conducted on (18) companies within the tourism, software, and mining sectors, varying in size and age, and employed both external and internal services to support innovation incrementally. The study reached several conclusions, the most significant of which

is that companies utilize external information and services in managing innovation through professionals such as lawyers and auditors. Additionally, it found that there are routine aspects of innovation achieved by purchasing innovative services through market reports, marketing research, or legal services.

3. The study by Apilo (2010) titled "A Model for Corporate Renewal Requirements for Innovation Management" aimed to enhance the understanding of continuous corporate renewal to achieve a competitive advantage through innovation. The study addressed innovation management, strategic renewal, organizational learning, organizational change, and adaptation, providing an integrated perspective on these four interrelated approaches relevant to innovative companies. A comparative analysis was conducted between the innovation management system of the company and the systems of four other multi-objective firms. A new model for continuous corporate renewal was developed, highlighting the importance of independence and the exploration of an approach that forms the forefront of the innovation process while increasing the effectiveness of the organization's knowledge and resources and its innovation network.
4. The study by Abdulwahab (2012) titled "The Role of Innovation in Supporting the Competitive Advantage of Economic Institutions: A Case Study of Algeria Telecom Mobile" aimed to highlight the role of innovation as an effective strategic option for economic institutions and to assess the state of innovation within them in light of the changes occurring in the national market. The study reached several conclusions, the most significant of which is that innovation often does not require new technology as much as it necessitates new or unconventional ideas. Moreover, innovation is key to the survival of institutions in changing circumstances and serves as the most important means for organizations to maintain their presence in a constantly evolving environment

3. Result and Discussions

The first section: The theoretical framework of innovation

1. The concept of innovation

Innovation is defined as "the process of arriving at something new through organized development and the practical application of a new idea" (Kreitner, 1989, 118). It is also described as "a company's ability to produce something new that adds greater value and does so faster than competitors in the market" (Najm, 2003, 22). Furthermore, it is defined as "a specific process in which an individual, by utilizing their thinking and mental capabilities, along with various stimuli and different individuals surrounding them, aims to create something new relative to their environment, provided that this production is beneficial to the society in which they live" (Jalda & Aboudi, 2006, 20). According to the economic perspective of American economist Joseph Schumpeter, innovation encompasses "radical technological advancements that lead to profound changes in productivity, stimulate economic growth, create businesses in industrial and service sectors, and enhance social welfare" (Mckelvey, 2000, 1). Innovation is also defined as "the practical application of invention or the process of creating a new product or developing an existing one to make it more economically viable" (Afandi, 1994, 214). In light of this, innovation can be defined as the emergence of new ideas or concepts that are translated into a new or existing product that has value and utility for individuals or companies. This may involve a new product, a new technology, or a new service

2. The importance of Innovation

Today, innovation is considered one of the most significant indicators that greatly assist in assessing the progress of institutions. The perception of innovation has evolved significantly at both the institutional and national levels. It has become a criterion by which the advancement and prosperity of countries and nations are measured. Moreover, it is viewed as a source of wealth creation and a crucial factor in driving economic and social

development, playing a major role in both areas. Additionally, innovation creates new job opportunities and establishes markets through the products developed. In other words, it enhances productivity and contributes to the growth of national wealth. Innovation is essential for survival in a competitive world, especially for private enterprises. It signifies the practical application of knowledge in the form of new and improved technologies, acting as a driving force for development and growth. It also supports the establishment of an economy based on research and development networks and information systems (ESCWA, 2005, 6). Furthermore, innovation plays a crucial role in reducing unemployment, particularly among graduates. As industries evolve and new technologies emerge, such as financial technology (FinTech), the demand for skilled workers increases, creating new job opportunities. This not only helps integrate graduates into the workforce but also encourages entrepreneurship, enabling them to become job creators. By fostering an innovative environment, including advancements in FinTech, we can effectively mitigate unemployment and equip the workforce with essential future skills (Khudhair et al., 2023, 147) (Abdullah, 2022, 258).

Consequently, innovation has a significant impact on technological improvement and contributes to enhancing the means of achieving well-being. Intellectual activities, including research and development, technological innovation, product design, software development, communication, medical equipment, and education in large industrial companies in the United States, add value to their Gross Domestic Product (GDP) by more than 76% (Al-Shammari, 2008, 36).

It is noteworthy that the global economy is currently being reshaped by new information technologies and radical technological changes driven by science-based research and development activities. Therefore, understanding innovation is crucial for improving the relationship between technological change and economic performance.

The importance of innovation can be summarized as follows:

1. Enhances Decision Quality: It improves the quality of decisions made to address issues in various fields, including technical, financial, and marketing domains.
2. Improves Product Quality: Innovation leads to better quality produc
3. Reduces Time Lag: It helps to decrease the time between the introduction of new products, allowing the organization to stand out in terms of time-based competition
4. Enhances Competitiveness: It fosters and strengthens the organization’s competitive capability.
5. Increases Sales Opportunities: Innovation creates avenues to activate and increase sales volume
6. Builds a Positive Image: It helps to establish and enhance a favorable image of the organization among its customers

3. Connotations of Innovation

Innovation in companies can take on the following connotations (Najm, 2003, 103–106).

1) Differentiation: Innovation represents differentiation, where it signifies the distinctiveness of a product or service compared to competitors, whether they are direct or indirect.
2) Novelty: Innovation embodies novelty, indicating something entirely or partially new in contrast to existing conditions (current processes or products) that represent the old or what preceded the innovation. This type of innovation serves as a source of renewal to maintain and enhance the company’s market share, reflecting the idea that "innovation = sustainable competitive advantage."
3) New Combination: Innovation can also be viewed as a new combination, where it involves placing familiar or old elements into a new configuration within the same field or transferring them to a previously unused domain.
4) Innovation is to be the first to move: Innovation can signify being the first mover, distinguishing the innovator as the pioneer in developing an idea, product, or

market ahead of others, who are often mere imitators or followers. In this context, the innovator is the fastest of his competitors in arriving at and introducing what is new or improved.

The Second section: Analyzing the Reality of the Global Innovation Index 2020 for Selected Countrie

1. Constructing the Global Innovation Index 2020:

Many international organizations have focused on publishing reports about the Global Innovation Index (GII) and its measurement methodology. This index comprises key and sub-indicators that determine a country's ranking based on its performance.

The Global Innovation Index 2020 ranks the economies and performances of 143 countries worldwide, based on 81 indicators. It is jointly published by Cornell University, INSEAD, & World Intellectual Property Organization (2020), a specialized agency of the United Nations. The GII 2020 report highlights various aspects of the human capital necessary for driving innovation, including qualified employment, higher education, the relationship between human capital, financial capital, and technical capital, as well as talent retention and mobilizing individuals with high educational levels. Understanding the human factors underlying innovation is crucial for designing national and local policies that support economic development. The leading countries in this economic index are ranked as follows: Switzerland, the United Kingdom, Sweden, the Netherlands, the United States, Singapore, Denmark, Luxembourg, and Hong Kong (China).

The Global Innovation Index 2020 is calculated as the average of two sub-indices. The sub-index for innovation inputs measures innovative activities grouped into five areas

1. Institutions
2. Human capital
3. Markets sophistication
4. Infractructure
5. Business sophisticatio

Meanwhile, the sub-index for innovation outputs assesses tangible indicators of innovation results, which are further divided into two domains:

1. Knowledge and technology output
2. Innovative outputs

2. Sample of the Research

Before beginning the analysis, it is essential to provide an overview of the research sample and its organization to understand the analytical approach. The research sample comprises 78 countries selected from the Global Innovation Index, out of a total of 141 countries. The selection process ensured representation from all global regions, including North America, South and Central America, Europe, Commonwealth countries, Africa, the Middle East, and Asia.

The countries included in the Global Innovation Index 2020 report were divided into three groups based on the aforementioned index guidelines. As shown in Table 2, which presents the countries ranked in descending order according to the innovation index, the first group consists of high-income countries with scores ranging from 26.50 to 66.08, totaling 35 countries. The second group includes upper-middle-income countries (as detailed in Table 3), with scores between 19.48 and 53.28, comprising 23 countries. The third group consists of lower-middle-income countries (Table 4), with scores ranging from 17.74 to 35.59, encompassing 20 countries.

The three groups are represented by their average scores from the Global Innovation Index and their average Gross Domestic Product (GDP), as illustrated in Table 1.

Table 1. Average Global Innovation Index 2020 and Gross Domestic Product (GDP) 2022 for Sample Country Groups

Indicator	Total	Average	Number of Countries	Innovation Index Score
Innovation Index	1654.65	47.276	35	High-Income Countries 66.08-26.50
GDP	59956	1713		
Innovation Index	719.54	31.284	23	Upper-Middle-Income Countries 53.28-19.48
GDP	28042	1219.217		
Innovation Index	512.66	25.633	20	Lower-Middle-Income Countries 35.59-17.74
GDP	8068.2	402.41		

Source: The table is the work of the researchers based on Tables (2, 3, 4).

3. Analyzing the Impact of the Global Innovation Index 2020 on GDP 2022 for a Sample of Countries

From observing Table 4, it is evident that the countries in the first group rank at the top due to their significant achievements in the Global Innovation Index, which has positively influenced their GDP levels. The average GDP for these countries is the highest among the three groups. This group includes several developing nations, such as the United Arab Emirates, Saudi Arabia, Qatar, Bahrain, Kuwait, and Oman, which have made substantial progress in implementing measures to enhance their Global Innovation Index, reflecting positively on their local output.

In contrast, the group of upper-middle-income countries, according to their scores in this index, exhibited lower GDP results compared to the first group. This trend also applies to the third group, which received modest scores in the Global Innovation Index for 2020.

As shown in Table 1, the average score of the Global Innovation Index for the high-income group was 47.296, with an average GDP of 1,001.531 million dollars. The upper-middle-income countries achieved an average score of 31.284 on this index, with an average GDP of 681.21 million dollars. Meanwhile, the lower-middle-income countries had an average score of 30.49 and a GDP of 282.08 million dollars.

This analysis indicates a clear correlation between a country's performance in the Global Innovation Index and its GDP, emphasizing the importance of innovation in driving economic growth.

The Third Section: Measuring and Analyzing the Impact of the Global Innovation Index on Economic Growth for a Selected Sample of Countries (2020–2022)

1. Description of the Research Variables:

The impact of the Global Innovation Index on economic growth is measured using the statistical program Eviews-13. Below is a description of the model variables:

1) Dependent Variable: This is represented by a single variable, the Gross Domestic
2) Independent Variable: This is represented by a single variable, the Global Innovation Index (GII) for the year 2020

Table 2. Global Innovation Index and GDP for (High-Income Countries) for the Period (2020–2022)

No.	Country	Global Innovation Index (2020)	GDP (2022) (Billion USD)
1	Switzerland	66.08	807.7
2	Sweden	62.47	2757.6
3	United States	60.56	560.4
4	United Kingdom	59.78	3070.6
5	Denmark	57.53	395.4
6	Finland	57.02	280.8
7	Singapore	56.61	466.7
8	Germany	56.55	4072.2
9	Republic of Korea	56.11	1665.2
10	Hong Kong (China)	54.24	359.8
11	France	53.66	2782.9
12	Israel	53.55	522
13	Ireland	53.05	529.2
14	Japan	52.70	4231.1
15	Canada	52.26	2139.8
16	Luxembourg	50.84	82.3
17	Australia	50.13	2806.0
18	Iceland	49.23	27.8
19	Estonia	48.28	38.1
20	New Zealand	47.01	247.2
21	Italy	45.74	2010.4
22	Spain	45.60	1397.5
23	Portugal	43.51	251.9
24	United Arab Emirates	41.79	507.5
25	Hungary	41.53	178.7
26	Latvia	41.11	41.2
27	Poland	39.95	688.2
28	Slovakia	39.70	75.1
29	Lithuania	39.18	70.3
30	Chile	33.86	301
31	Saudi Arabia	30.94	1108.1
32	Qatar	30.81	237.3
33	Kuwait	28.40	184.6
34	Bahrain	28.37	44.4
35	Oman	26.50	114.7

Source: World Bank Data [http://data.albankaldawli.org/]
Global Innovation Index 2020, Table 1

Table 3. Global Innovation Index and GDP for (Upper-Middle-Income Countries) for the Period (2020–2022)

No.	Country	Global Innovation Index (2020)	GDP (2022) (Billion USD)
1	China	53.28	17963.2
2	Malaysia	42.42	406.3
3	Bulgaria	39.98	89
4	Romania	35.95	301.3
5	Russia	35.63	2240.4

6	Costa Rica	33.51	68.4
7	North Africa	32.67	56.8
8	Armenia	32.64	19.5
9	Brazil	31.94	1920
10	Georgia	31.78	24.6
11	Iran	30.89	388.5
12	Colombia	30.84	343.9
13	Jamaica	29.10	17
14	Peru	28.79	2256.9
15	Kazakhstan	28.56	220.6
16	Argentina	28.33	632.8
17	Jordan	27.79	47.4
18	Albania	27.12	447.5
19	Lebanon	26.02	23.1
20	Botswana	25.43	193.7
21	Ecuador	24.11	115
22	Sri Lanka	23.78	74.4
23	Algeria	19.48	191.9

Source: World Bank Data [http://data.albankaldawli.org/]
Global Innovation Index 2020, Table 1

Table 4. Global Innovation Index and GDP for (Lower-Middle-Income Countries) for the Period (2020–2022)

No.	Country	Global Innovation Index (2020)	GDP (2022) (Billion USD)
1	India	35.59	3385
2	Philippines	33.86	404.3
3	Mongolia	33.41	16.8
4	Republic of Moldova	32.98	11.5
5	Tunisia	31.21	15.2
6	Morocco	28.97	134.2
7	Indonesia	26.49	1319.1
8	Kenya	26.13	113.4
9	El Salvador	24.85	1037.9
10	Uzbekistan	24.54	26.4
11	Senegal	23.75	27.6
12	Honduras	22.95	31.7
13	Egypt	24.23	476.7
14	Pakistan	22.31	376.5
15	Ghana	22.28	19.5
16	Cambodia	21.46	29.9
17	Bangladesh	20.39	76.1
18	Nigeria	20.13	477.3
19	Zambia	19.39	29.7
20	Myanmar	17.74	59.4

Source: World Bank Data [http://data.albankaldawli.org/]
Global Innovation Index 2020, Table 1

2. The Impact of the Global Innovation Index on Economic Growth in High-Income Countries for the Period 2020-2022:

Testing the Stability of Variables

Time series can be categorized based on their stability characteristics into two types: (Narayan & Smyth, 2008, 230):

1) Stable Series: These are series that exhibit levels changing over time without altering their mean over a relatively long period. In other words, they do not display a general trend of either increase or decrease (do not contain a unit root).
2) Unstable Series: These are series whose mean continuously changes, either increasing or decreasing (containing a unit root).

Before estimating and selecting the relationship between economic variables, it is essential to analyze the time series to confirm the stability of these variables and to ensure they are free from unit roots. The statistical properties of the series must also be understood. A time series is considered completely stable if the following conditions are met:

1) The mean is constant over time: $E(X_t) = \mu$
2) The variance is constant over time: $Var(X_t) = \sigma_x^2$
3) Joint Variance Stability: The joint variance between any two values of the same variable should depend on the time gap between those two values, rather than on the actual value at which the variance is calculate
4) This means that the two series (X_t, X_{t+k}) should have a joint correlation that depends on the lag (k); thus, the joint variance is defined as :

$$Y_k = Cov(X_t , X_{t+k}) = E(X_{t-u})(X_{t+k-u})$$

In the case of an unstable time series, a problem known as Spurious Regression may arise. Spurious regression refers to the existence of a general trend in the time series of variables that can lead to a significant relationship between these variables, even if the general trend is the only thing they have in common. More generally, spurious regression occurs when both (X) and (Y) contain a unit root; thus, the ordinary least squares (OLS) estimation of this regression will yield completely incorrect or misleading results (Kop, 2009, 324).

Augmented Dickey-Fuller Test to Detect Time Series Stability

Table 5. Results of the Augmented Dickey-Fuller Test for Time Series Stability

At Level			
GDP	GII		
-5.6052	0.4317	t-Statistic	With Constant
0.0001	*0.9808*	*Prob.*	
***	no		
-6.0873	-1.2775	t-Statistic	
0.0002	*0.8728*	*Prob.*	With Constant & Trend
***	no		
-4.5238	-5.3384	t-Statistic	
0.0001	*0.0000*	*Prob.*	Without Constant & Trend
***	***		
At First Difference			
d(GDP)	d(GII)		
-5.3493	-5.3352	t-Statistic	With Constant
0.0003	*0.0002*	*Prob.*	
***	***		
-8.5488	-5.5325	t-Statistic	With Constant & Trend

0.0000	*0.0006*	*Prob.*	
***	***		
-5.1072	-1.1486	t-Statistic	
0.0000	*0.2214*	*Prob.*	Without Constant & Trend
***	no		

a: (*) Significant at the 10% ; (**) Significant at the 5% ; (***) Significant at the 1% ; and (no) Not Significant.
b: Lag Length based on SIC.

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 5: The results of the Time Series Stability Test indicate that the variable GDP, representing Gross Domestic Product, is stationary at a level, whether with a constant, a constant, and a trend or without a constant and a trend at a significance level of (1%). On the other hand, the variable GII, representing the Global Innovation Index, also stabilized at a level without a constant and trend at the significance level of (1%).

Testing the ARDL Model for Long-Term Equilibrium Relationship (Co-integration)

The ARDL model is one of the dynamic modeling approaches for cointegration. This model provides a method for including lagged variables as independent variables in the model. It was developed by Pesaran (1997), Shin and Sun (1998), and Pesaran et al. (2001). A key feature of this model is that it does not require the time series to be integrated in the same order. Pesaran argues that the ARDL model can be applied regardless of the properties of the time series, whether they are stationary at the level (I(0)), at the first difference (I(1)), or a combination of both. The only condition for applying this test is that the time series must not be integrated of order two (I(2)) (Alimi, 2014, 106). Additionally, Pesaran's ARDL methodology has superior properties when dealing with short time series compared to traditional cointegration testing methods, such as the two-step Engle-Granger (1987) method and Johansen's cointegration test within a VAR framework (Pesaran et al., 2001, 291).

The ARDL model allows for an adequate number of lag periods to be included to achieve optimal results in the general framework model. It does not require the lag period to be the same for all variables. Moreover, the ARDL model provides the best estimates for parameters in both the short and long run, making it suitable for small sample sizes. The ARDL model can distinguish the short-run effects from the long-run effects, allowing us to identify the co-integrating relationship between the dependent and independent variables in both time frames within the same equation, in addition to assessing the impact of each independent variable on the dependent variable (Pesaran and Shin, 2000, 295).

To test for the presence of a cointegration relationship among the variables within the ARDL framework, Pesaran et al. (2001) proposed a modern approach for testing long-term equilibrium relationships among variables under an unrestricted error correction model. This method is known as the Bounds Test. The presence of cointegration in this test is confirmed by comparing the calculated F-statistic with the critical values provided by Narayan (2005) at significance levels of (1%, 2.5%, 5%, and 10%). If the calculated F value is greater than the upper critical value (I1 Bound), the null hypothesis (H_0: b=0) is rejected in favor of the alternative hypothesis

(H_1: b≠0), indicating the existence of a long-term cointegration relationship among the variables. Conversely, if the calculated value falls between the upper and lower critical values, the result is inconclusive. If the calculated F value is less than the lower critical value (I0 Bound), this indicates the absence of a long-term relationship (Al-Birmani and Dawood, 2017, 290).

Table 6. Results of the Bounds Test for Long-Term Equilibrium Relationship

Test Statistic	Value	K [Number of Independent Variables]
F-statistic	18.66300	1
Significance Level	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

Table 6 shows the results of the Bounds Test for the Relationship Among Research Variables. It is observed that the calculated F-statistic value was 18.66300, which is greater than the upper critical value of 7.84 at the significance level of (1%), as well as at the (5%, 2.5%, and 10%) levels. Therefore, we reject the null hypothesis and accept the alternative hypothesis, which states that there is a long-term equilibrium relationship, indicating the existence of long-term cointegration among these variables.

Estimation of the Error Correction Model and Short- and Long-Term Relationships According to the ARDL Model

After confirming the existence of a long-term equilibrium relationship (co-integration) among the research variables, the next step is to determine the short- and long-term relationships between these variables. This will be done by estimating the error correction model, which represents an important step in ARDL testing. This test relies on the error correction term (CointEq(-1)) to indicate the correction of the relationship between the short and long run. If the error correction term (CointEq(-1)) is negative and statistically significant, it implicitly indicates the existence of cointegration between the two variables. This means that short-term deviations are corrected towards the long-term equilibrium value within the same year (Pradhan et al., 2013, 914).

Table 7. Results of the Error Correction and Short- and Long-Term Relationships Among Research Variables According to the ARDL Model

Co-integration Form (Short-Term Model)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GII)	127.098393	69.288370	1.834339	0.0785
CointEq(-1)	-1.191450	0.194321	-6.131336	0.0000
R^2	0.61			
F-stat	354.98			
Prop-F	0.0000			
Cointeq = GDP – (106.6754*GII – 3647.6066) Error Correction Equation				
Long Run Coefficients (Long-Term Model)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GII	106.675366	56.108025	1.901250	0.0689
C	-3647.606592	2846.693073	-1.281349	0.2118

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

Table 7 shows an analysis of the Short-Term and Long-Term Relationships. It is observed that the short-term coefficient for the independent variable D(GII) was positive and amounted to 127.09. This indicates that an increase in the Global Innovation Index (GII) by one unit in 2020 led to an increase in Gross Domestic Product (GDP) by 127.09 in 2022.

Furthermore, the error correction term CointEq(−1) was found to be (−1.19), which is statistically significant at the 1% level. This suggests the existence of a long−term equilibrium relationship, leading us to reject the null hypothesis and accept the alternative hypothesis that a long−term equilibrium relationship exists. The coefficient of determination (R^2) was 0.61, indicating that the independent variable (Global Innovation Index) explains approximately 61% of the variation in the dependent variable (Gross Domestic Product). The remaining 39% can be attributed to random variables not included in the estimated model. The overall significance of the model, as indicated by the F-statistic, was 354.98 with a significance level of 0.0000.

In terms of the long-term relationship, it is also noted that there is a positive relationship between the Global Innovation Index and Gross Domestic Product. Specifically, an increase in the Global Innovation Index by one unit in 2020 resulted in an increase in Gross Domestic Product by 106.67 in 2022

Autocorrelation and Heteroscedasticity Testing in the ARDL Model:

The estimated models are tested to ensure they are free from the issue of autocorrelation (serial correlation among the values) using the (Breusch-Godfrey Serial Correlation LM Test). Additionally, the (Heteroskedasticity Test: ARCH) is employed to verify that the estimated models are free from heteroscedasticity at the (5%) significance level concerning the relationship among the research variables.

Table 8. Results of Autocorrelation and Heteroscedasticity Tests for the Relationship Among Research Variables

Breusch-Godfrey Serial Correlation LM Test			
F- statistic	0.996632	Prop . F	0.3281
Obs*R-squared	1.116378	Prob. Chi-Square	0.2907
Heteroskedasticity Test: ARCH			
F-statistic	0.005661	Prob. F	0.9406
Obs*R-squared	0.006113	Prob. Chi-Square	0.9377

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

It is observed from Table 8 that the estimated ARDL model is free from the issue of autocorrelation according to the Breusch-Godfrey Serial Correlation LM Test. Thus, the null hypothesis stating the absence of autocorrelation is accepted, as both the Prop. F and Prob. Chi-Square values are not significant at the 5% significance level, leading to the rejection of the alternative hypothesis. Additionally, the ARDL model is also free from the problem of heteroscedasticity, as both Prob. Chi-Square and Prop. F values were not significant at the 5% level, as indicated by the Heteroskedasticity Test: ARCH.

3. The Impact of the Global Innovation Index on Economic Growth in Upper-Middle-Income Countries (2020-2022):

Augmented Dickey-Fuller Test to Detect Time Series Stabilit

Table 9. Results of the Augmented Dickey-Fuller Test for Time Series Stability

		1. <u>At Level</u>	
GDP	GII		With Constant
-4.3974	2.0687	t-Statistic	
0.0045	*0.9996*	*Prob.*	
***	no		
-6.5222	2.8356	t-Statistic	With Constant & Trend

0.0006	*1.0000*	*Prob.*	
***	no		
-3.6244	-1.8204	t-Statistic	Without Constant & Trend
0.0014	*0.0666*	*Prob.*	
***	*		
At First Difference			
d(GDP)	d(GII)		With Constant
-11.5431	3.1548	t-Statistic	
0.0000	*1.0000*	*Prob.*	
***	no		
-11.8729	2.7245	t-Statistic	With Constant & Trend
0.0000	*1.0000*	*Prob.*	
***	no		
-12.2058	2.5733	t-Statistic	Without Constant & Trend
0.0001	*0.9947*	*Prob.*	
***	no		

a: (*) Significant at the 10% ; (**) Significant at the 5% ; (***) Significant at the 1% ; and (no) Not Significant.
b: Lag Length based on SIC.

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 9, which presents the results of the stationarity test, it is evident that the variable GDP, representing Gross Domestic Product, is stationary at a level regardless of whether it includes a constant or a constant with a trend, or neither, at the 1% significance level. Similarly, the variable GII, representing the Global Innovation Index, is also stationary at a level without a constant and trend at the 10% significance level.

Testing the ARDL Model for Long-Term Equilibrium Relationship (Co-integration):

Table 10. Results of the Bounds Test for Long-Term Equilibrium Relationship

Test Statistic	Value	K [Number of Independent Variables]
F-statistic	9.479205	1
Significance Level	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 10, which illustrates the results of the bounds test for the relationship among the research variables, it is observed that the calculated F-statistic is 9.479205, which exceeds the critical upper bound value of 7.84 at the 1% significance level, as well as at the (2.5%, 5%, and 10%) levels. Consequently, the null hypothesis is rejected in favor of the alternative hypothesis, which posits the existence of a long-term equilibrium relationship, indicating that there is a long-term cointegration relationship among these variables.

Estimation of the Error Correction Model and Short- and Long-Term Relationships According to the ARDL Model

Table 11. Results of the Error Correction and Short- and Long-Term Relationships Among Research Variables According to the ARDL Model

Co-integration Form (Short-Term Model)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GII)	21.110795	31.216752	0.676265	0.5117
CointEq(-1)	-1.198245	0.278592	-4.301072	0.0010
R^2	0.44			
F-stat	257.83			
Prop-F	0.0000			
Cointeq = GDP – (17.6181*GII – 229.6337) Error Correction Equation				
Long Run Coefficients (Long-Term Model)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GII	17.618097	26.052598	0.676251	0.5117
C	-229.633677	795.851536	-0.288538	0.7779

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 11, it is observed that the short-term coefficient for the independent variable (D(GII)) is positive, with a value of 21.11. This indicates that an increase in the Global Innovation Index by one unit in 2020 resulted in an increase in the GDP by 21.11 in 2022. Additionally, the error correction term, or the speed of adjustment CointEq(-1), is -1.19 and is statistically significant at the (1%) level, suggesting the presence of a long-term equilibrium relationship. Consequently, the null hypothesis is rejected in favor of the alternative hypothesis, confirming the existence of a long-term equilibrium relationship.
The (R^2) value is 0.44, indicating that the independent variable included in the model explains approximately (44%) of the variation in the dependent variable, while the remaining (56%) is attributed to random variables not included in the estimated model. The overall significance of the model, as indicated by the F-statistic, is 257.83, with a significance level of 0.0000.
In terms of the long-term relationship, it is also noted that there is a positive relationship between the Global Innovation Index and Gross Domestic Product, indicating that an increase in the Global Innovation Index by one unit in 2020 resulted in an increase in Gross Domestic Product by 17.61 in 2022.

Autocorrelation and Heteroscedasticity Testing in the ARDL Model

The estimated models are tested to ensure they are free from the issue of autocorrelation (serial correlation among the values) using the (Breusch-Godfrey Serial Correlation LM Test). Additionally, the (Heteroskedasticity Test: ARCH) is employed to verify that the estimated models are free from heteroscedasticity at the (5%) significance level concerning the relationship among the research variables.

Table 12. Results of Autocorrelation and Heteroscedasticity Tests for the Relationship Among Research Variables

Breusch-Godfrey Serial Correlation LM Test			
F- statistic	1.317632	Prop . F	0.2754
Obs*R-squared	1.604568	Prob. Chi-Square	0.2053
Heteroskedasticity Test: ARCH			
F-statistic	0.073460	Prob. F	0.7910

Obs*R-squared	0.085181	Prob. Chi-Square	0.7704

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 12, it is observed that the estimated ARDL model is free from the issue of autocorrelation according to the Breusch-Godfrey Serial Correlation LM Test. Thus, the null hypothesis, which posits the absence of autocorrelation, is accepted, as both the Prop. F and Prob. Chi-Square values are not significant at the 5% significance level, leading to the rejection of the alternative hypothesis.

Furthermore, the estimated ARDL model is also free from the problem of heteroscedasticity, as both Prob. Chi-Square and Prop. F values were not significant at the 5% level, as indicated by the Heteroskedasticity Test: ARCH.

4. The Impact of the Global Innovation Index on Economic Growth in Lower-Middle Income Countries (2020-2022):

Augmented Dickey-Fuller Test to Detect Time Series Stability

Table 13. Results of the Augmented Dickey-Fuller Test for Time Series Stability

At Level			
GDP	GII		
-18.4124	-0.2012	t-Statistic	With Constant
0.0000	*0.9254*	*Prob.*	
***	no		
-17.3233	-1.3459	t-Statistic	
0.0000	*0.8495*	*Prob.*	With Constant & Trend
***	no		
-16.4457	-2.2343	t-Statistic	
0.0001	*0.0276*	*Prob.*	Without Constant & Trend
***	**		
At First Difference			
d(GDP)	d(GII)		
-7.1387	-2.9138	t-Statistic	With Constant
0.0000	*0.0598*	*Prob.*	
***	*		
-6.8372	-2.8314	t-Statistic	
0.0001	*0.2017*	*Prob.*	With Constant & Trend
***	no		
-7.3540	-1.7602	t-Statistic	
0.0000	*0.0746*	*Prob.*	Without Constant & Trend
***	*		

a: (*) Significant at the 10% ; (**) Significant at the 5% ; (***) Significant at the 1% ; and (no) Not Significant.

b: Lag Length based on SIC.

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 13, which presents the results of the stationarity test for the time series, it is observed that the variable representing Gross Domestic Product (GDP) is stationary at the level, regardless of whether an intercept or a trend is included, at a significance level of 1%. Similarly, the Global Innovation Index (GII) also exhibits stationarity at the level, specifically without an intercept or trend, at a significance level of 5%.

Testing the ARDL Model for Long-Term Equilibrium Relationship (Co-integration)

Table 14. Results of the Bounds Test for Long-Term Equilibrium Relationship

Test Statistic	Value	K [Number of Independent Variables]
F-statistic	16.33156	1
Significance Level	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 14, which illustrates the results of the bounds test for the relationship between the research variables, it is observed that the computed F-statistics value is 16.33156. This value exceeds the upper critical value of 7.84 at the 1% significance level, as well as at the (2.5%, 5%, and 10%) levels. Based on these results, the decision is to reject the null hypothesis, which posits the absence of a long-term equilibrium relationship. Instead, we accept the alternative hypothesis, indicating the presence of a long-term equilibrium relationship, or cointegration, among the research variables.

Estimation of the Error Correction Model and Short- and Long-Term Relationships According to the ARDL Model:

Table 15. Results of the Error Correction and Short- and Long-Term Relationships Among Research Variables According to the ARDL Model

Co-integration Form (Short-Term Model)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GII)	13.249714	23.847367	0.555605	0.5846
CointEq(-1)	-1.022023	0.062462	-16.362325	0.0000
R^2	0.32			
F-stat	120.44			
Prop-F	0.000			
Cointeq = GDP – (12.9642*GII – 149.2754) Error Correction Equation				
Long Run Coefficients (Long-Term Model)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GII	12.964207	22.982497	0.564090	0.5790
C	-149.275425	804.451957	-0.185562	0.8547

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 15, it is noted that the coefficient for the short-run variable D(GII) is positive, with a value of (13.24). This indicates that an increase in the Global Innovation Index by one unit in 2020 resulted in an increase in Gross Domestic Product (GDP) by 13.24 in 2022. Furthermore, the error correction term CointEq(-1) is reported at -1.02 and is statistically significant at the (1%) level. This significance confirms the presence of a long-term equilibrium relationship, leading to the rejection of the null hypothesis in favor of the alternative hypothesis, which posits that a long-term equilibrium relationship exists.

The coefficient of determination R2 is 0.32, suggesting that the independent variable included in the model explains approximately (32%) of the variance in the dependent variable, while the remaining (68%) is attributed to random variables not included in the estimated model. Additionally, the overall significance of the model, indicated by the F-

statistic, is 120.44 with a significance level of 0.0000, reinforcing the robustness of the model.

In terms of the long-term relationship, a similar positive correlation is observed, where an increase in the Global Innovation Index by one unit in 2020 leads to an increase in GDP by 12.96 in 2022.

Autocorrelation and Heteroscedasticity Testing in the ARDL Model:

The estimated models are tested to ensure they are free from the issue of autocorrelation (serial correlation among the values) using the (Breusch-Godfrey Serial Correlation LM Test). Additionally, the (Heteroskedasticity Test: ARCH) is employed to verify that the estimated models are free from heteroscedasticity at the (5%) significance level concerning the relationship among the research variables.

Table 16. Results of Autocorrelation and Heteroscedasticity Tests for the Relationship Among Research Variables

Breusch-Godfrey Serial Correlation LM Test			
F- statistic	0.716787	Prop . F	0.4077
Obs*R-squared	0.836146	Prob. Chi-Square	0.3605
Heteroskedasticity Test: ARCH			
F-statistic	0.050791	Prob. F	0.8240
Obs*R-squared	0.055728	Prob. Chi-Square	0.8134

Source: The table was prepared by the researchers based on the outputs f Eviews 13 software.

From Table 16, it is observed that the estimated ARDL model is free from the issue of autocorrelation, as indicated by the results of the Breusch-Godfrey Serial Correlation LM Test. This allows for the acceptance of the null hypothesis, which states that there is no autocorrelation problem, since both the Prop.F and Prob.Chi-Square values are not statistically significant at the 5% level, leading to the rejection of the alternative hypothesis. Additionally, the estimated ARDL model shows no signs of heteroskedasticity. The values for both Prob.Chi-Square and Prop.F are not significant at the 5% level according to the Heteroskedasticity Test: ARCH.

These results confirm the reliability of the ARDL model, indicating that the estimates are not biased due to autocorrelation or heteroskedasticity. This enhances the validity of the model's findings regarding the relationship between the variables under research.

4. Conclusion

1) Innovation, as represented by the Global Innovation Index, is one of the modern and significant indicators for governments and economic decision-makers. This index plays a crucial role in influencing the national economy and economic growth, as it is based on numerous sub-indicators that encompass various aspects of economic and social life. The importance of this index is further underscored by the interest of many international organizations and most countries around the world.
2) The group of high-income countries ranked first in terms of (GDP), while the group of upper-middle-income countries occupied the second position, and lower-middle-income countries ranked third, as illustrated in Table 1.

3) This supports the research hypothesis that there is a positive relationship between the innovation index and economic growth.
4) The results of the time series stability test, according to the Augmented Dickey-Fuller test, indicate that both GDP and the Global Innovation Index (GII) are stable at the level for all three groups in the research sample.
5) The results of the cointegration test, based on the bounds test, suggest a long-term equilibrium relationship between GDP and the Global Innovation Index.
6) The results of the regression analysis demonstrate that the Global Innovation Index for 2020 has a significant and positive impact on GDP (economic growth) for 2022 across the three groups in the research sample, aligning with the research hypothesis.
7) The explanatory power reflected by the (R^2) indicates that 61% of the variations in GDP (economic growth) for high-income countries can be attributed to changes in the Global Innovation Index. For upper-middle-income countries, the (R^2) value explains 44% of GDP variations due to changes in GII, while for lower-middle-income countries, the (R^2) stands at 32%. This highlights the extent of the innovation index's impact on GDP in these countries.
8) The diagnostic results of the relationship between the Global Innovation Index and GDP indicate no issues of autocorrelation according to the LM test, nor any problems of heteroscedasticity as per the ARCH test at a significance level of 5% across all three groups in the research sample.

5. Recommendations

1) Countries, particularly developing ones with upper-middle and lower-middle incomes, are required to enhance their Global Innovation Index by focusing on achieving the necessary sub-indicators of this index. This alignment is crucial for improving their scores and, consequently, boosting their GDP.
2) There is a pressing need for greater efforts to combat financial and administrative corruption, which is more pervasive in developing countries compared to advanced economies, as it poses a significant barrier to enhancing the Innovation Index.
3) It is essential to focus on reallocating local economic resources more efficiently and to encourage foreign direct investment, which serves as a key to transferring modern technology and improving the quality of local products. This, in turn, facilitates access to global markets and enhances the competitiveness of these countries.
4) Developing countries must rely on a knowledge economy, which is founded on creativity and innovation. In the context of global competition, human development becomes crucial for absorbing and advancing all technological innovations.
5) Resource-limited countries need to prioritize support for creativity and innovation through strategies and initiatives adopted by governments and relevant institutions. This is essential to ensure the optimal use of limited resources and to bridge the gap with advanced economies.
6) Developing countries should establish partnerships in trade, investment, education, science, and technology. These nations need to build their capacity to engage in and benefit from the modern economy based on innovation and technology.
7) Developing countries must seek to leverage their relative advantages by identifying industries and opportunities available for achieving growth based on innovation and technology.

REFERENCES

1. Abdelwahab, B., (2012). The role of innovation in supporting the competitive advantage of economic institutions: A case study of Algeria's mobile telecommunications, University of Mettouri, Algeria.
2. Abdullah, G. I. (2022). FinTech in Iraq and the risks of using it in money laundering operations. *World Economics and Finance Bulletin*, 17, 256-268.
3. Afandi, A. H. (1994). *New trends in management: Theory and practice*. Center for Political Research and Studies, Cairo University. (1st ed.).
4. Al-Bayramani, S. M., & Dawood, M. N. (2017). The impact of government consumption expenditure on the trade balance in Iraq for the period (1990-2014) using the ARDL model. *Journal of Economic and Administrative Sciences*, Baghdad, (98), 23.
5. Alimi, R., & Santos, R. (2014). ARDL bounds testing approach to cointegration: A re-examination of the augmented Fisher hypothesis in an open economy. *Asian Journal of Economic Modeling, 2*(2).
6. Al-Shammari, M. J. (2008). The role of technology in human capital activities to preserve knowledge: A case study of a group of global companies. In *Proceedings of the Third Scientific Conference* (April 21-22, 2008). Karbala: University of Karbala.
7. Apilo, T. (2010). *A model for corporate renewal: Requirements for innovation management* (Doctoral thesis, Lappeenranta University of Technology). Lappeenranta, Finland.
8. Cornell University, INSEAD, & World Intellectual Property Organization. (2020). *The Global Innovation Index 2020: Who will finance innovation?* (Eds. Soumitra Dutta, Bruno Lanvin, & Sacha Wunsch-Vincent). Ithaca, Fontainebleau, & Geneva. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf
9. ESCWA. (2005). *Establishing research and development networks in Arab countries*. New York: United Nations, Economic and Social Commission for Western Asia.
10. Jalda, B., & Aboudi, Z. (2006). *Creativity and innovation management*. Dar Kunoz Al-Ma'arifa, Amman, Jordan.
11. Khudhair, M. A., Jweer, M. A., & Abdullah, G. I. (2023). Graduate unemployment in Iraq: Reality and solutions. *American Journal of Economics and Business Management*, 6(6): 147-162.
12. Kop, G. (2009). *Analysis of economic data* (F. B. K. Al-Abadi & A. S. Al-Humaid, Trans.). King Fahd National Library, Saudi Arabia.
13. Kreitner, R. (1989). *Management*. Boston: Houghton Mifflin Company
14. Li, H., & Atuahene-Gima, K. (2001). Product innovation strategy and the performance of new technology ventures in China. *Academy of Management Journal*, 44(6), 1123-1134. http://dx.doi.org/10.2307/3069392
15. Mckelvey, M. (2000). *Evolutionary innovation*. Oxford: Oxford University Press.
16. Najm, A. (2003). *Innovation management: Concepts, characteristics, and recent experiences*. Dar Wael for Publishing and Distribution, Amman.
17. Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics, 37*(17), 1979–1990. https://doi.org/10.1080/00036840500278103
18. Narayan, P., & Smyth, R. (2008). Energy consumption and real GDP in G7 countries: New evidence from panel cointegration with structural breaks. *Economic No. 30*.
19. Pesaran, M. H., Shin, Y., & Smith, R. J. (2000). Structural analysis of vector error correction models with exogenous variables. *Journal of Econometrics, 97*(1).
20. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*.
21. Pradhan, R., Badir, N., & Samadhan, B. (2013). Transport infrastructure, foreign direct investment, and economic growth interactions in India: The ARDL bounds testing approach. *Social and Behavioral Sciences, 104*.
22. Thorburn, L. (2005). *Knowledge management and innovation in service companies: Case studies from tourism, software, and mining technologies*. Study for the Department of Industry, Tourism & Resources. OECD Report. ISBN 0-9751826-2-5.