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A panel data analysis of export-led growth, FDI spillovers and innovation effects

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ABSTRACT

Innovation, as a driving force of economic growth, plays a vital role in improving productivity, enhancing competitiveness, and strengthening production capacities. This research aiming at investigating the impact of innovation on economic growth in Iranian provinces, uses panel data from 31 provinces of Iran over the period 2011 to 2021 and employs the Fully Modified Ordinary Least Squares (FMOLS) method. The research findings indicate a positive and significant relationship between the innovation component and economic growth, such that an increase in innovation in Iranian provinces leads to increased economic growth. In this study, the number of researchers, research centers, and universities are considered as key indicators of innovation, and all these indicators are shown to have a positive and significant effect on the economic growth of the provinces. More precisely, increasing specialized human capital and developing research and university infrastructures have led to improvements in gross domestic product. Furthermore, provinces with greater investment in research and scientific development, having stronger research infrastructures and more capital invested in innovation, have experienced sustained economic growth.

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1. Introduction

Economic growth refers to the increase in the productive capacity of a country or region over time, leading to an increase in the production of goods and services over a specific time period, typically one year. Economic growth is usually measured as the percentage change in Gross Domestic Product (GDP)

Economic growth in Iran is influenced by various internal and external factors and has experienced significant fluctuations in different time periods. This growth depends on many factors, such as oil prices, government economic policies, international sanctions, investments, and also internal conditions like productivity and domestic production.

Innovation plays a vital role in Iran's economic growth. By improving technology and processes, production efficiency increases and product quality improves. In fact, innovation can help attract foreign investment and increase exports. Innovation involves creating, developing, or introducing new ideas as well as improving ideas, products, services, or processes that create added value for individuals, organizations, societies, and the country. It can also take the form of a completely new invention or an improvement on an existing idea and technology. The goal of innovation is usually to solve problems, increase productivity, improve the quality of life, and create a competitive advantage in the market.

Innovation in Iran encompasses a range of endeavors, achievements, and activities in various scientific, technological, cultural, and economic fields aimed at producing new products and services or improving existing processes and methods. With its rich history of science and research, Iran has made significant strides in innovation in recent years.

The necessity of this research stems from the numerous challenges in today's world, making recent innovations more significant than in previous years. Solving problems and challenges using outdated methods leads to wasted time, human resources, and financial resources, resulting in societal and national backwardness and hindering progress. Therefore, it is necessary to utilize new and modern methods in line with the current era and employ technology to solve problems. Companies use innovation to gain a competitive advantage and improve productivity, fostering trade growth through the development of new systems to compete with rivals (Hoisl, 2011; Lazarotti et al., 2017). Despite challenges such as economic sanctions, a lack of foreign investment, and weaknesses in resource management, focusing on innovation and the development of new technologies can place Iran on a path of long-term economic growth, increasing employment and improving public welfare.

The objective of this research is to examine the impact of innovation on gross domestic product in Iranian provinces, identifying components that can effectively contribute to economic growth. The research questions are 1) Can innovation be considered as a source of growth in Iranian provinces? and 2) Can it be recommended that provinces adopt specific policies to promote innovation in order to achieve high and sustainable economic growth?

Data from Iranian provinces from the years 2011 to 2021 were collected from the World Bank website, the Statistical Center of Iran, and provincial statistical yearbooks. Panel data econometrics (Fully Modified Ordinary Least Squares – FMOLS), using Eviews 12 software, was used for data analysis. This research consists of five sections: the first section is the introduction, the second section covers the theoretical foundations and literature review, the third section details the research methodology,

the fourth section presents the research findings, and finally, the conclusion and recommendations of the research are presented in the last section.

2. Literature review

Economic Growth. Economic growth refers to the increase in the production of goods and services in a country over time and is typically measured using Gross Domestic Product (GDP). Economic growth is a complex phenomenon influenced by numerous factors. Understanding these factors and their impacts on society and the macroeconomy can help policymakers make better decisions to improve the economic situation. However, economic growth should be managed in a way that does not exacerbate social and economic inequalities and leads to sustainable development. Entrepreneurship can have effects on the per capita income level of countries. In countries with high per capita income, entrepreneurship usually has a positive effect on economic growth, while in low-income and poor countries, this effect may be negative (Sabahi et al, 1392). In The Wealth of Nations, Adam Smith, the first classical economist, states that the process of economic growth is based on increasing returns to scale. He considers skills as effective factors that increase production by improving the division of labor and ultimately lead to growth, suggesting that the growth process is spontaneous. Regarding the relationship between innovation and economic growth, he states that increasing the efficiency of individuals in the field of production leads to the growth of society and consequently economic growth; otherwise, society will not achieve sustainable growth (Nasiri Aghdam et al, 1390).

Schumpeter (1947), about the problems of theoretical Growth, along with other economists, highlight the prominent role of entrepreneurship and innovation in the process of economic growth, stating that multiple factors contribute to economic growth, such as the physical environment, social organization, institutions, and technology. However, innovation and entrepreneurship form the foundation of economic growth. Economic growth is not independent but depends on numerous external factors. Investment in human resources leads to the promotion, strengthening, and development of human abilities and skills, which results in economic growth (Mousavi et al, 1393). Technological advancement leads to qualitative changes in production. A financial system is efficient when it improves productivity, enables the effective mobilization of economic resources, reduces costs, and strengthens profitability, ultimately leading to improved development and economic growth (Ghamrouzman & Jiangou, 2017). Human capital is a key factor in economic growth. Societies with stronger human resources have better potential for development, compared to societies with a shortage of human resources. However, some theorists point out that despite the emphasis on the importance of higher education in economic development, there is no linear and positive relationship between education and economic growth in practice (Thomas & Wang, 2002).

Creativity and Innovation. The acceptance and recognition of innovation's role through human capital as a fundamental element in economic literature dates back to the early 1960s. At that time, economists attempted to provide convincing explanations for a significant portion of economic growth that remained unexplained. However, in the late 1980s, human capital, based on strong theories, entered the economic growth model as a production factor, particularly in line with Lucas's studies, which gave this issue special importance. These developments represent a paradigm shift in our understanding of the factors affecting economic growth and the importance of human capital as a key source for innovation and economic progress.

Innovation theory is based on the principle that innovation can lead to increased production and, consequently, economic growth. In this regard, promoting human capital with an emphasis on innovation and creativity is considered a key factor. To achieve this goal, investment in human

resources is of particular importance. Research has shown that strengthening individuals' skills and abilities can lead to improved economic performance. This not only helps increase productivity but also lays the groundwork for technological development and improved production processes. Therefore, creating a suitable environment for innovation and creativity among the workforce is essential. Investment in employee training and skill development can act as a catalyst for economic growth. These investments should be designed to promote key skills such as creative thinking and problem-solving. Ultimately, these processes facilitate innovation, increase individuals' productive capacity, and bring about sustainable economic growth (Rabiei, 2009).

Innovation means creating or introducing new ideas, products, or methods that can help improve processes, increase efficiency, or solve existing problems. This concept is important in many fields, including technology, business, art, and social sciences. Innovation can contribute to economic growth, increased competitiveness, and improved quality of life. In today's world, organizations and countries that value innovation are usually more successful and advanced. Innovation is recognized as a driving force for economic growth in today's world, and successful countries are usually those that value innovation and provide the necessary infrastructure to support it. Innovation is the foundation of competitive power, leading to progress and advancement, and consequently, sustainable economic growth (Pisi et al, 2015). One of the factors influencing economic growth is innovation, which is the basis for advancing production and creating a comparative advantage and depends on specialized and entrepreneurial managers (Rabiei, 2009). Porter and Stern (2000) state that the use of macroeconomic data is important in examining the impact of innovation on economic growth. Innovation has a positive relationship with human capital, especially in the research and development sector, as there is also a positive relation between innovation and production growth. Innovation means creating new products or significantly improving existing products, as well as discovering new methods in marketing or business organization. The main point about innovation is that it must reach the implementation stage since a new product or process is considered innovative when it is actually introduced in the market and used in the company's operations (Gault, 2018).

Lucas believed that physical capital and human capital have a direct and significant relationship. He realized how human capital could be created. Lucas argued that training a skilled and specialized workforce could lead to human capital, which relates to individuals pursuing education and knowledge. In fact, education is the engine of human capital growth. The function attributed by Lucas to production makes it a function of labor, general knowledge, and the existing stock of knowledge capital. The national innovation system has the ability to create innovations and inventions and identify their novelty. The effectiveness of the national innovation capacity indicates progress in economic growth (Romer, 1990). Innovation has significant direct and indirect effects (i.e., spillovers) on the economic growth of a country or region. Achieving sustainable economic growth depends on innovation (Keshavarz & Hosseinzadeh, 1402). The words creativity and innovation are often used synonymously, but most researchers believe that these two words should be used separately (1969). Through creativity and innovation, countries promote and develop productivity, ultimately leading to economic growth (Mohammadzadeh et al., 2021). Innovation creates a competitive environment between companies and countries to offer new products in the market, which leads to sustainable economic growth (Prager, 2016). With the advancement and dissemination of innovation, there is an impact on economic factors, especially the labor force. As a result of innovation, the level of employment decreases, and unemployment increases, leading to a more efficient economic system with the progress of innovation (Sterly, 2001; Mortensen & Pissarides, 1998; and Vivarelli & Pianta, 2001). Barra et al. (2016) state that financial innovation can have a negative impact on a country's gross domestic product (GDP) by excessively increasing liquidity outside the banking system, leading

to increased imports, decreased productivity, and inflationary pressures. Innovation, as the engine of economic growth and national prosperity, takes shape within the framework of an innovation system that includes interactions between businesses, universities, researchers, and governmental and non-governmental institutions. Designing a national innovation system to create suitable conditions for innovative activities and technology creation is of great importance (Weng, Song & Sheng, 2012).

Developed countries strive to improve the social environment so that people can increase and strengthen their skills and abilities, acquire new jobs, and prevent unemployment in society (Galindo & Mendez, 2014). In organizational processes, innovation stems from various sources and new ideas, which demonstrates the efficiency and success of that organization (Dodgson, Gann & Phillips, 2014).

Human capital has four basic pillars: 1) education 2) health and well-being 3) employment and labor force 4) enabling environments. Each of these pillars includes components for which there are indicators to evaluate and measure, which affect economic growth (Heidari, 2016: 862).

Entrepreneurship. Entrepreneurship forms the foundation of economic growth. In competitive environments, achieving economic growth and prosperity without entrepreneurship is not feasible. A skilled entrepreneur is always seeking new and multiple ways to stimulate prosperity and increase production (Schumpeter, 1911). Entrepreneurship impacts economic growth through various mechanisms such as knowledge spillover, increased competition, and product diversification. These mechanisms include job creation, the introduction of new innovations, and increased productivity. Entrepreneurs, through innovation, help improve knowledge and identify consumer preferences by offering new products and services (Van Praag & Versloot, 2007). The term entrepreneurship was first used by Cantillon, who recognized economic factors such as landowners, entrepreneurs, and employees. In his view, an entrepreneur is a person who is engaged in business without certainty; he believed that the essence of entrepreneurship lies in the lack of proper forecasting (Wennekers & Thurik, 1999). Entrepreneurship, by employing modern technology and new services, improves the standards of living and leads to economic growth and prosperity (Alvani et al., 2011). In competitive conditions, when new high-quality products are offered in the market, innovation is improved, and entrepreneurs are able to develop new projects and products, increasing the level of efficiency and, consequently, leading to economic growth (Galindo, 2014). The important thing is not which individuals undertake entrepreneurial work and activities, but the key point is that there should be no structural restrictions or prohibitions preventing individuals from freely using their entrepreneurial abilities and talents in the best possible way to create reliable and new information, develop productivity and efficiency, and ultimately help achieve economic growth

Government Expenditure. whether in the form of consumption or capital expenditures, have a positive and significant impact on economic growth. However, capital expenditures, due to their infrastructural nature and role in increasing productivity, can have an impact on economic growth for up to two years. Consumption expenditures are mainly focused on the same fiscal year, and their effects are short-term and fleeting (Gaskari & Eghbali, 2007).

Foreign Direct Investment. Foreign Direct Investment (FDI) plays a crucial role as a key economic indicator in fostering economic growth and sustainable development of countries. FDI is typically accompanied by the transfer of managerial and technological knowledge, which helps to enhance the competitiveness of domestic industries and provides a basis for increased productivity and innovation (Mahdavi et al, 2008).

Research Background. Keshavarz and Hosseinzadeh (2023), in a study titled "Investigating the Effect of Innovation Spillover on Economic Growth," found that capital and innovation have the

highest direct impact coefficient on the economic growth of countries and regions. Furthermore, innovation has indirect effects (spillovers) that have a positive and significant impact on the economic growth of countries.

Hassanzadeh et al (2022), in a study titled "The Effect of Innovation on Economic Growth in Developed and Developing Countries," noticed that innovation, considering control variables, has a positive and significant effect on economic growth in both developed and developing countries. In developing countries, the level of innovation is lower, but its effect on economic growth is greater than in developed countries. Therefore, supporting innovation and supporting intellectual property rights and institutions related to the national innovation system should be considered in national planning to increase economic growth.

Mohammadzadeh et al (2020), in a study titled "The Impact of Innovation and Entrepreneurship on Economic Growth," found that innovation and entrepreneurship have a positive and significant impact on economic growth. A one percent increase in the rate of entrepreneurship and innovation will cause a 13% and 0.04% change in the growth rate, respectively, implying that innovation and entrepreneurship play an effective role in growth.

Fashari and Vali Beigi (2017), in a study investigating the impact of the innovation system on the economic growth of developing countries during the period 1980-2014, found that innovation had a positive and significant impact on economic growth. The results also indicated that human capital, foreign direct investment, and the degree of trade openness also contributed to the economic growth of these countries.

Ramzanian Bajgiran et al. (2017) conducted a study titled "Using the Correct Vector Error Model, the Causal Relationship and Correlation between Innovation and Economic Growth in Iran within the Period "1995-2011," and stated that there was no relationship between the innovation index and the export of goods with better technology on economic growth, suggesting that there was a one-way relationship between innovation and economic growth. In fact, the FDI variables, consisting of the GDP growth rate and gross capital formation, had a positive and significant relationship on economic growth.

Salimifar et al. (2017) in a study titled "Investigating the Causality Relationship and Impact of Innovation on Economic Growth in Selected MENA Countries," reached the following conclusions:

Innovation and Economic Growth: Innovation has a positive impact on economic growth in the short and long term.

Innovation and Exports: There is no relationship between innovation and the export of high-tech goods and economic growth.

Variables affecting economic growth: Foreign direct investment, gross capital formation, and the GDP growth rate in previous years are positively and significantly related to economic growth, while government spending does not have a significant relationship with economic growth.

Pen et al. (2024) examined the effects of innovative entrepreneurship on regional development and stated that the distribution of innovative entrepreneurship in sparsely populated areas can benefit urban areas. This entrepreneurship creates positive and stimulating effects in cities. In other words, innovative activities in sparsely populated areas can help improve and develop cities.

Zhou et al. (2022) measured green innovation efficiency based on the stochastic frontier analysis model. They found that R&D expenditures are key factors affecting innovation.

Amini and Farahmand (2021) investigated the effect of innovation and R&D spillovers on growth in

Iranian provinces. The results show that the natural logarithm of GDP, R&D expenditures, years of schooling, and population structure directly affect regional growth. However, the spatial lag of these variables, especially GDP and population structure, has a reverse effect on regional growth.

Wang et al (2021) used Moran's I index and a spatial econometric model to analyze the trend of change and spillover effects of innovation output in a Chinese region. They argued that regional innovation is dependent on spatial correlation, and its outputs have positive spillover effects. Furthermore, environmental regulations can contribute to promoting innovation in this area.

Zhang and Jiao (2021) analyzed the spatial mechanism of regional innovation in Chinese provinces using patent data. The results showed that regional innovation capability is a dynamic economic phenomenon characterized by instability and spatial heterogeneity between different regions of the province.

Qi et al (2020) investigated the spatial spillover effect of knowledge and innovation among regions, revealing that regional innovation convergence indicates that developing regions can benefit from greater innovation spillovers compared to developed regions. This implies that these regions can leverage new innovations and technologies created in more advanced areas to their advantage, consequently accelerating growth and development.

Andre (2019) examined regional spatial spillovers in the European Union from 2008 to 2012, finding that the influx of innovation into a region was influenced by spatial correlation, and innovation output was also affected by spatial spillover effects. In other words, innovation in one region could impact neighboring regions, and these impacts manifested themselves as positive or negative effects on innovation outcomes in those regions.

Pradhan et al (2018) used the VECM method to investigate the impact of innovation and financial development on economic growth in 49 European countries over the period 1961-2014, finding a correlation between innovation, financial development, and economic growth. The results of the Vector Error Correction Model (VECM) show that financial development helps improve resource allocation and reduce risks, leading to economic growth. In addition, innovation contributes to economic growth by increasing productivity and output.

Pekka et al. (2015), in their research titled "The Effect of Innovation on Economic Growth," examined the impact of innovation on economic growth in Eurozone countries during the period 2000-2013 and found that innovation, including R&D expenditures and the number of registered patents, had a positive and significant impact on economic growth.

Galindo and Méndez (2014) investigated entrepreneurship, economic growth, and innovation using a Schumpeterian endogenous growth model in 13 developed countries and employing panel data with fixed effects for the period 2002-2007. The results indicated that both variables, entrepreneurship and innovation, had a significant impact on economic growth.

Hassan and Touchi (2011) conducted a study on the impact of innovation on economic growth in 58 selected countries during the period 1980-2003. They found that countries with high levels of patent registration experienced high economic growth. They added that countries should strive to increase their patent registrations, and in return, they will experience significant economic growth.

Innovation can play a vital role in Iran's economic growth, but it requires more attention and investment to infrastructure, culture, and relevant regulations. By creating the right conditions, Iran can capitalize on the benefits of innovation and achieve sustainable growth. This study focuses on the impact of innovation on economic growth in Iranian provinces. Data from the years 2011-2021 in Iranian provinces were collected from the World Bank website and the Statistical Center of Iran. For

data analysis, the panel data econometrics method (Fully Modified Ordinary Least Squares - FMOLS) was used with Eviews 12 software, which is an innovation of this research.

3. Research Methodology

The current research is applied in terms of purpose and descriptive and analytical in terms of nature. In terms of method, it is panel data research, which attempts to investigate and identify the impact of innovation components on the economic growth of the provinces of the Islamic Republic of Iran. An econometric model is used for data analysis, and panel data FMOLS (Fully Modified Ordinary Least Squares) is estimated using Eviews 12 software.

Initially, the information and data required for the research were collected annually from the information available on the World Bank website, the Statistical Center of Iran, and provincial yearbooks during the years 2011-2021 using library methods. The statistical population under study is the 31 provinces of Iran.

Research Variables. Dependent Variable: The dependent variable in this research is the Gross Domestic Product (GDP) in the provinces.

Independent Variable: In this study, research innovation is considered the independent variable. This variable is composite and includes three components: (number of researchers, number of research centers, and number of universities). To collect the relevant data, reliable statistical sources were used. Preliminary data was collected from the Statistical Yearbook of Iranian Provinces and was processed and analyzed using the Morris method. Finally, the adjusted data of these three components were combined to obtain a comprehensive and reliable index for measuring research innovation. This process, while increasing the accuracy and validity of the analyses, allows for the presentation of valid and documented scientific results. The Morris method is expressed below:

$$Y_{it}=((X_{ij}-X_{imin})/(X_{imax}-X_{imin}))100$$

Control variables. In the present study, labor productivity, exports, government spending, and foreign direct investment are used as control variables. Data for these variables were collected from the Statistical Yearbook of Iranian Provinces and statistical centers.

Research model. The research model examined in the present study for evaluating the effect of innovation on economic growth based on theoretical discussions and empirical findings is as follows:

In our model, the dependent variable is economic growth (GDP), and the independent variables include labor force, foreign direct investment, exports, government expenditure, and innovation. Innovation is a composite variable consisting of three components (number of researchers, number of research centers, and number of universities);

$$LGDP\ it=B_0+B_1LLAB_{it}+B_2LFDL_{it}+B_3LEXP_{it}+ B_4LGOV_{it}+B_5LINO_{it}$$

where LGDP it is the logarithm of gross domestic product, LLAB it is the logarithm of labor productivity, LFDI it is the logarithm of foreign direct investment, LEXP it is the logarithm of total exports, LGOV it is the logarithm of government expenditure, and LINO it is the logarithm of innovation. it is the error term, where I represent the provinces of Iran, and t represents time.

4. Research Findings

In this research, we examine the impact of innovation components on economic growth. Before estimating the model, we first conduct stationary tests, followed by the Kao test (co-integration), the

Chow test or F-Limer test, and the Housman test.

Stationary and non-stationary. Since the non-stationary of variables can lead to various spurious results, including the formation of spurious regression, we first perform a stationary test on the data before estimating the model. If the variable is not within the range of 0.0000 to 0.05, then the variable is not stationary.

Table 1. Levin, lin & chu stationary test, variables of the research after differentiating

Stationary	Level		Variable
	Prob	statistic	
Stationary (2)	0.0000	9.93463	GDP[1]
Stationary	0.0474	-1.67044	INO[2]
Stationary (2)	0.0000	-18.5820	FDI[3]
Stationary (2)	0.0140	-2.19629	GOV[4]
Stationary	0.0001	-3.77244	EX[5]
Stationary	0.0000	9.49123	LAB[6]
Source: Research Findings			

As can be seen in the table above, the Prob value for all variables is less than 0.05, indicating that all variables are stationary.

Kao Counteraction Test. To prevent spurious and unrealistic regressions before the model is estimated, co-integration tests must be applied to ensure whether a long-term relationship exists among the variables. Based on the obtained results, the regression is estimated. If the p-value is between 0.0000 and 0.0555, it indicates a long-term and significant relationship between the independent and dependent variables.

Table 2. Results of kao co-integration test

prob	t-statistic	Statistic
0.0000	-11.38824	ADF[7]
Source: Research Findings		

According to this table, as can be observed, the p-value is estimated to be less than 5%, which indicates that the existence of co-integration in the model is accepted, and the null hypothesis (H0) of no cointegration is rejected. It can be argued that there is a long-term relationship between the independent and dependent variables.

1. Abbreviation for Gross Domestic Product Index
2. Abbreviation for Innovation Index
3. Abbreviation for Foreign Direct Investment Index
4. Abbreviation for Government Expenditure Index
5. Abbreviation for Export Index
6. Abbreviation for Labor Productivity Index
7. Automatic Direction Finder

Chow Test or F-test. The Chow test or F-test is used to select regression methods for examining whether the data is panel or pooled. The results of the Chow test or F-test are presented in Table 3.

Table 3. Results of chow test or f-test

Effects Test	Statistic	d.f.	prob
Cross-section F	483.905433	30.303	0.0000
Cross-section Chi-square	1318.713760	30	0.0000
Source: Research Findings			

According to this table, the test statistic's p-value is less than 5%. This indicates that the null hypothesis (H0) is rejected, and the data for the variable is panel data.

Housman Test. After it is determined using the Chow test (F-test) that the data is panel data, the Housman test is used on the panel data to determine the type of model (fixed effects or random effects). If the null hypothesis is rejected, the model has fixed effects.

Table 4. Results of housman test

Test summary	Chi-sq.statistic	Chi-sq.d.f.	prob
Cross-section random	182.285251	5	**0.0000**
Source: Research Findings			

According to this table, we conclude that the obtained statistic is smaller than the table statistic. Therefore, the null hypothesis (H0) is rejected, and the model will be estimated based on the fixed effects regression method.

Model Estimation and Analysis

To estimate the relationship between economic growth as the dependent variable and the composite innovation indicators as independent variables, the following model is presented. The estimation results of this model for 31 provinces of Iran during the years 2011 to 2021 were obtained using EViews 12 software and the Fully Modified Least Squares (FMOLS) method.

Table 5. The impact of innovation on economic growth in Iranian provinces
(Fully Modified Least Squares Method)

Variable	coefficient	Std. Error	t-statistic	prob
Innovation	0.187808	0.026896	6.982804	0.0000
Government Expenditure	0.977063	0.022885	42.69539	0.0000
Exports	0.108734	0.017485	6.218759	0.0000
Foreign Direct Investment	0.016157	0.005126	3.152109	0.0018
Labor Productivity	0.522670	0.038595	13.54246	0.0000
			R2	0.7557

Variable	coefficient	Std. Error	t-statistic	prob
Source: Research findings using Eviews 12				

Observing the research results in the table 6-5, it can be stated that if there is a one-percent change (increase) in the innovation component, there will be a 0.187 percent increase in economic growth in the long run, as the relationship between them is positive and significant. Moreover, if there is a one-percent increase in government expenditure, then we will see a 0.977 percent increase in economic growth, and the relationship between them is positive and significant. If exports increase by one percent, then economic growth will increase by 0.108 percent in the long run, and the relationship between them is positive and significant. If foreign direct investment increases by one percent, then economic growth will increase by 0.016 percent, and there is a positive and significant relationship between them. Also, for every one percent increase in labor productivity, we will see a 0.522 percent increase in economic growth, and the relationship between them is long-term, significant, and positive.

We conclude that all independent and dependent variables had the long-term, positive, and significant relationships. All variables have a prob value of 0.0000, meaning they are significant at the 99% level. The coefficient of determination (R-squared) obtained in this model is 0.7557, indicating that 75.57 percent of the changes in the dependent variable (economic growth) in the provinces of Iran are explained by the independent variables in the model, meaning that the model has good explanatory power.

5. Conclusion and Recommendations

This research aimed to explain the combined indicators of innovation on economic growth, using statistical data of the three components of innovation, which were combined using the Morris method. The data of the explanatory variables used in the specification of this research during the years 2011 to 2021 were analyzed using panel data approach and the FMOLS (Fully Modified Least Squares) method.

The results obtained from the model specification using the Fully Modified Least Squares method indicate that the three components and indicators of innovation had a positive and significant impact on economic growth. According to the research findings, a one-percent increase in innovation components will lead to a 0.187 percent change in economic growth in the long term.

Furthermore, by including auxiliary variables such as labor productivity, foreign direct investment, exports, and government expenditures, a positive and significant long-term relationship with economic growth was established, consistent with theoretical foundations.

Innovation plays a crucial role in Iran's economic growth. By improving technologies and processes, production efficiency increases, product quality improves, and new opportunities for investment and exports are created. Innovation can take the form of a new invention or an improvement to an existing technology, and by providing creative solutions, it solves problems, increases productivity, and creates a competitive advantage. Ultimately, innovation not only contributes to economic development but also improves the quality of life and paves the way for the country's progress.

Also, according to the research model output, the following suggestions can be presented to improve innovation, considering the research topic:

- Expanding scientific collaborations between universities and industries to commercialize research results.
- Developing supportive policies to increase the number of researchers and attract top talents in innovative fields.

- Increasing government and private sector investment in establishing and equipping research centers.
- Implementing educational and training programs with the aim of increasing innovative skills in the workforce.
- Creating special technology and innovation zones in provinces with high potential for knowledge-based economic growth.
- Strengthening scientific and economic cooperation between different provinces to distribute innovation capacities more fairly.
- Facilitating foreign investment in the research and development sector.
- Supporting innovative industries to attract researchers and invest in research and development.

References

1. Alvani, M., Boudlaei, H., & Gharib Gerkani, M. (2011). Challenges and proposals (solutions) in developing the concept of entrepreneurship. *Specialized Quarterly Journal of Science and Technology Parks and Growth Centers*, 8(29), 35-46.
2. Amini, M., & Farahmad, S. (2021). Spatial analysis of the spillover effects of innovation and R&D on regional growth in Iran. *Journal of Economic Research (Tahghighat-E-Eghtesadi)*, 55(4), 761-780. (in Persian).
3. Bajgiran, N. R., Najimeidani, A. A., & Salimi-Far, M. (2017). Investigating the causal relationship and the impact of innovation on economic growth in selected MENA countries. *Journal of Monetary Economics and Finance (Formerly Knowledge & Development)*, New Series, 24(13), Spring & Summer 2017.
4. Bara, A., & Mudzingiri, C. (2016). Financial innovation and economic growth: Evidence from Zimbabwe. *Investment Management and Financial Innovations*, 13, 65-75.
5. Dodgson, M., Gann, D., & Philips, N. (2014). *The Oxford handbook of innovation management*. Oxford University Press.
6. Galindo, M. A., & Mendez, M. T. (2014). Entrepreneurship, economic growth, and innovation: Are feedback effects at work? *Journal of Business Research*, 67, 825-829. https://doi.org/10.1016/j.jbusres.2013.05.002
7. Gao, X., & Zhai, K. (2021). Spatial mechanisms of regional innovation mobility in China. *Social Indicators Research*, 156(1), 247–270. https://doi.org/10.1007/s11205-021-02734-1
8. Gaskari, R., & Eghbali, A. R. (2007). Government expenditures and economic growth in Iran. *Economic Research Journal*, 81, Winter 2007, 209-226.
9. Gault, F. (2018). Defining and measuring innovation in all sectors of the economy. *Research Policy*, 47(3), 617–622. https://doi.org/10.1016/j.respol.2018.01.022
10. Hassan, I., & Tucci, C. H. (2011). The innovation-economic growth nexus: Global evidence. *Research Policy*, 39(10), 1264–1276. https://doi.org/10.1016/j.respol.2011.08.005
11. Hassanzadeh, M., Hazeri Niri, H., & Davazdah Emami, Z. (2022). The effect of innovation on economic growth in developed and developing countries. *Innovation and Value Creation Quarterly*, 11(22), Autumn & Winter 2022, 1-10.
12. Heidari, A. (2016). Government and human capital policy-making in Iran (2005-2013). *Quarterly Journal of Political Studies*, 46(4), 862-880.

13. Huerta de Soto, J. (2015). *Austrian school of economics: Market order and entrepreneurial creativity* (M. Motavaseli & M. Saeedi Kia, Trans.). Tehran, Iran: Nashr-e Cheshmeh.

14. Keshavarz, H., & Hosseinzadeh, R. (2023). Investigating the effect of innovation spillover on economic growth. *Economy and Regional Development*, 30, Serial 26, Autumn and Winter 2023.

15. Mohr, L. B. (1969). Determinants of innovation in organizations. *American Political Science Review*, 63, 111-126. https://doi.org/10.2307/1953485

16. Mahdavi, R., & Mahdavi, R. A. (2008). The impact of foreign direct investment and financial market development on economic growth in Iran. *Journal of New Economy and Commerce*, 14, Autumn 2008, 129-147.

17. Mohammadzadeh, P., Goldizadeh, S. K., & Kamangar, S. (2020). The impact of innovation and entrepreneurship on economic growth: A cross-country study. *Iranian Journal of Economic Research*, 25(82), Spring 2020, 121-148.

18. Mohammadzadeh, P., Khan Goldizadeh, S., & Kamangar, S. (2020). The impact of innovation and entrepreneurship on economic growth. *Iranian Journal of Economic Research*, 25(82), Spring 2020, 121-148.

19. Mortensen, D. T., & Pissarides, C. A. (1998). Technological progress, job creation, and job destruction. *Review of Economic Dynamics*, 1(4), 733-735. https://doi.org/10.1006/redy.1998.0043

20. Mousavi, S. S. A., Haghighat, J., & Salmani Bishak, M. R. (2014). The impact of human capital on economic growth in Iran (Nonlinear approach). *Iranian Economic Review*, 20(63), 121-144

21. Nasiri Aghdam, A., Dehghan Tarzjani, A., Rezaei, A., & Beyk Mohammadloo, H. (2011). The impact of innovation on growth, 160-182.

22. Pan, Y., Zhang, S., & Zhang, M. (2024). The impact of entrepreneurship of farmers on agriculture and rural economic growth: Innovation-driven perspective. *Innovation and Green Development*, 3(1), 100093.

23. Pece, A. M., Simona, O. E. O., & Salisteanu, F. (2015). Innovation and economic growth: An empirical analysis for CEE countries. *Procedia Economics and Finance*, 26, 461-467. https://doi.org/10.1016/S2212-5671(15)01070-1

24. Porter, M. E., & Stern, S. (2000). Measuring the 'ideas' production function: Evidence from international patent output. *NBER Working Paper No. 7891*. Cambridge, Massachusetts: National Bureau of Economic Research.

25. Pradhan, R. P., Arvin, M. B., & Bahmani, S. (2018). Are innovation and financial development causative factors in economic growth? Evidence from a panel Granger causality test. *Journal of Technological Forecasting and Social Change*, 132, 130–142. https://doi.org/10.1016/j.techfore.2018.02.017

26. Prieger, J. E., Bampoky, C., Blanco, L. R., & Liu, A. (2016). Economic growth and the optimal level of entrepreneurship. *World Development*, 82, 95-109. https://doi.org/10.1016/j.worlddev.2015.07.015

27. Qamruzzaman, M. D., & Jianguo, W. (2017). Financial innovation and economic growth in Bangladesh. *Financial Innovation*, 3, 19. https://doi.org/10.1186/s40854-017-0071-9

28. Qiu, J., Liu, W., & Ning, N. (2020). Evolution of regional innovation with spatial knowledge spillovers: Convergence or divergence? *Networks and Spatial Economics*, 20(1), 179–208. https://doi.org/10.1007/s11067-019-09537-6

29. Rabiei, M. (2009). The effect of innovation and human capital on economic growth in Iran. *Journal of Science and Development (Scientific-Research)*, 16(26), Spring 2009.

30. Ramezanian Bajgiran, N., Salimifar, M., Najimeidani, A. A., & Salimifar, M. (2017). A study under the title of investigating the causal relationship and the impact of innovation on economic growth in selected MENA countries. *Monetary Economics and Finance*, 24(13), 22-40.

31. Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71–S102. https://doi.org/10.1086/261725

32. Sabahi, A., Najimeidani, A. A., & Soleimani, E. (2013). Investigating the effect of entrepreneurship on economic growth in selected countries. *Scientific Journal of Research on Economic Growth and Development*, 3(11), Summer 2013.

33. Schumpeter, J. A. (1947). Theoretical problems of economic growth. *The Journal of Economic History*, 7(SI), 1-9. https://doi.org/10.1017/S0022050700000193

34. Thomas, V., & Wang, Y. (2002). Education, trade reform, and investment returns: Policy research working paper. *World Bank, Washington, D.C.*

35. Todaro, M. P. (2008). *Economic development in the Third World* (G. Farjadi, Trans.) (8th ed.). Tehran, Iran: Institute for Management and Planning Studies.

36. Van Praag, C. M., & Versloot, P. H. (2007). What is the value of entrepreneurship? A review of recent research. *Small Business Economics*, 29(4), 351–382. https://doi.org/10.1007/s11187-007-9080-3

37. Weng, L., Song, W., & Sheng, S. (2012). Empirical research on scientific and technical innovation and economic growth in Shanghai. *American Journal of Operations Research*, 2, 82–90. https://doi.org/10.4236/ajor.2012.22010

38. Wennekers, S., & Thurik, R. (1999). Linking entrepreneurship and economic growth. *Small Business Economics*, 13(1), 27–56. https://doi.org/10.1023/A:1008013205532

39. Wang, Y., Zhang, F., Zheng, M., & Chang, C. P. (2021). Innovations spillover effect in China: Incorporating the role of environmental regulation. *Environmental Modeling & Assessment*, 26(5), 695–708. https://doi.org/10.1007/s10666-021-09734-y

40. Xu, Y., Zhang, Y., Lu, Y., & Chen, J. (2022). The evolution rule of green innovation efficiency and its convergence of industrial enterprises in China. *Environmental Science and Pollution Research*, 29(2), 2894–2910. https://doi.org/10.1007/s11356-021-13409-3