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ORIGINAL RESEARCH PAPER

The impact of human capital, institutional quality, and innovation on the regional gross domestic product: panel data approach

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ABSTRACT

BACKGROUND AND OBJECTIVES: Differences in the fundamental factors of production and technology are cited as the reason for the disparity in growth rates by primary research. Improving the quality of human capital through education, the quality of institutions such as the public policies and innovation play an important role in economic growth. Also, technological innovation creates circumstances for any region to extract more value from limited resources to support sustainable economic growth. In this study, the effect of human capital, institutional quality, and innovation are investigated on regional gross domestic product per capita in oil-exporting countries. Moreover, the effect of institutional quality has been investigated on the regional gross domestic product through government consumption expenditures.

METHODS: The panel data method is used to investigate the effect of human capital, institutional quality, and innovation on regional gross domestic product per capita from 2011 to 2021. The Levin-Lin-Chu test was employed to determine the reliability of the variables. The panel cointegration are used to ensure the existence of long-term relationship between the dependent variable and the independent variables. In order to select the pooling and panel method, Flemer's test was used, and Hausman's test was used to select fixed and random effects methods. Also, statistical and econometric analysis is done with Stata17.0 software.

FINDINGS: The results of the random effects method in the first and the second models indicated that the human capital index has had a positive and significant effect on gross domestic product per capita at the level of 1% and its coefficient are 0.878 and 0.905, respectively. So, human capital improvement facilitating the absorption of technology, and boosting the productivity of production factors and increases economic growth. Also, the institutional quality has had a positive and significant effect on gross domestic product per capita at the 1% level in the first model and its coefficient is 0.182. Moreover, the coefficient of interaction effects of institutional quality and government consumption expenditure in second model is 0.073 and is statistically significant at the 1% level. According to this, Institutional quality shape the economic environment of countries and improves the economic performance. The Innovation index has had a positive and significant effect on gross domestic product per capita at the level of 1% and its coefficient in the first and the second models are 0.324 and 0.331, respectively. Therefore, strengthening the innovation system expanding the supply of new products and services.

CONCLUSION: The results indicate that, growth rate of gross domestic product per capita averaged at 2.12% over the sample period with standard deviation of 3.66 among the selected oil-exporting countries. Based on the results, improving the human capital through education and the acquisition of diverse skills have led to an increase in gross domestic product per capita at the level of 1%. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. According to this, institutional quality has increased regional gross domestic product through government consumption expenditures at the level of 1%. In addition, improving the system of innovation by maximizing the use of existing resources and boosting productivity has increased production.

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INTRODUCTION

The vast disparity between national growth rates has prompted economists to do extensive research on growth models. Differences in the fundamental variables of production and technology are cited as the basis for the disparity in national growth rates by primary research. In recent theoretical and experimental investigations of growth, it has been demonstrated that the internal components and mechanisms of an economy, including human capital, the external effects of physical capital, technological innovation, and institutional quality, can influence economic growth (Slesman *et al.*, 2015; Teixeira and Queiros, 2016; Ogbeifun and Shobande, 2022). The accumulation of production factors and increasing productivity will improve economic growth (Limam and Miller, 2007). Improving the quality of human capital index through education, training, and the acquisition of diverse skills plays a crucial role in sustainability of economic growth within the framework of endogenous growth models (Shobande, 2021; Shidong *et al*., 2022; Ogbeifun and Shobande, 2022; Kozlovskyi et al., 2020 ; Mansour, 2023). Furthermore, human capital will moderate the relationship between the Internet and economic growth (Ficawoyi, 2019; Pourehtesham, 2022). In addition, increased access to health and treatment services enhances the physical and mental health of individuals, hence enhancing the quality of human resources and boosting economic growth. As a result, increasing the health of the workforce will be one of the strategies to create human capital (Kurt, 2015). Another group will achieve economic growth through the external effects of physical capital (Romer, 1986; Khan *et al*. 2022). In the third set of endogenous growth models, emphasis has been placed on the ongoing growth of new production ideas or growth generated by technical innovation. By evaluating the patent right for innovative production concepts in order to continue them, it expands the production knowledge available to the public and provides the foundation for continuing growth. In these approaches, innovative ideas are suggested as the growth engine. The use of an idea by one person does not restrict others from adopting it simultaneously. These types of concepts create a strong connection between idea-based growth models and rising scale-based efficiency (Grossman and Helpman, 1991). Also, technological innovation creates circumstances for any region to extract more value from limited resources to support sustainable economic growth (Acemoglu, 2008). Economic development has entered a high-quality phase due to the increase in the supply of innovation and enhance the innovation environment. This has created the attractiveness of an innovative economic system and creates a modern globalization space (Babenko *et al*., 2020). Theoretical literature of endogenous growth models is based on the external of physical capital, the accumulation of human capital, and technological innovation. In various studies, the effects of infrastructure for research and development, invention, and innovation on economic growth have been examined (Aghion and Howitt, 1990; Grossman and Helpman, 1991; Huallachain, 2007; Pece *et al.*, 2015; Dalali *et al.*, 2016; Ogbeifun and Shobande, 2022). In the late 1990s, the theory of new institutional economics was introduced, prompting academic circles to focus more on the role of institutions in the economic progress of countries. Institutional quality, such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between countries (Kaufmann *et al.*, 1999; Kurtz and Schrank, 2007; Slesman *et al.*, 2015). In addition, various variables, including physical capital, human capital, institutional quality, public consumption expenditure, trade, natural resource, and technology absorption capacity, influence economic growth and regional integration (Islam, 2003; Alatas and Çakir, 2016; Teixeira and Queiros, 2016; Widarni and Bawono, 2021; Ogbeifun and Shobande, 2022). Improving the quality and effectiveness of economic institutions, regulating social relations in the field of environmental protection and ensuring the environmental security of society, and drafting environmental laws can also be the main way to achieve a green economy (Timoshenkov *et al.*, 2020; Samimi and Shahriari Moghadam, 2020). In addition, enhancing the quality of human resources through education, training, and the acquisition of diverse skills, the role of innovation and technology absorption capacity, the role of institutional factors such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion are significant contributors to variances in the economic performance of countries, and institutions shape the economic environment of countries. According to this, the purpose of this study is to investigate the effect of

human capital, institutional quality and innovation on regional gross domestic product (GDP) per capita using panel data method in oil-exporting countries from 2011 to 2021. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. So, the effect of institutional quality has investigated on regional gross domestic product through government consumption expenditures. In this regard, the present study aims is to answer the question that "Does human capital, institutional quality, and innovation have an effect on the regional gross domestic product?". Also, "Does institutional quality have an effect on the regional gross domestic through government consumption expenditures".

Background of research

Shidong *et al*. (2022) examined the moderating role of human capital and renewable energy in promoting economic development by using comparatively new panel estimation techniques "continuously updated fully modified" (Cup-FM) and "continuously updated bias-corrected" (Cup-BC) of G-10 countries. The overall results demonstrate that human Capital and renewable energy stimulate higher economic development. Manifestly, the interaction of both variables reports a more substantial impact on economic development, implying that human capital development is a stimulus to boost the positive effects of renewable energy sources on economic growth. Based on the findings, the stakeholders are recommended to invest in human Capital and renewable energy adoption. Ogbeifun and Shobande (2022) examined the relationship between human capital accumulation and economic growth in OECD countries from 1986 to 2018 using the Two-Stage Least Squares (2SLS) method. According to the findings human capital, savings rate, and trade openness have a positive impact on economic growth. Shobande (2021) examined the relationship between human capital accumulation and economic growth in Organization for Economic Cooperation and Development (OECD) countries from 1986 to 2018 using the Two-Stage Least Squares (2SLS) method. Human capital, savings rate, and trade openness have a positive impact on economic growth, according to the findings. Using the Autoregressive Distributed Lag (ARDL) approach, Widarni and Bawono (2021) evaluated the impact of human capital and technology on Indonesia's growth from 1984 to 2019 using data from Indonesia. Increasing human capital and advancing technology have a positive effect on economic growth, according to the research. Mozafari (2021) investigated the impact of human capital on Iran's economic growth from 2013 to 2018 using the Generalized Method of Moments (GMM) technique. According to the findings increasing the number of human capitals has enhanced economic growth. Also, physical capital, government spending, and industrialization have had a positive effect on economic growth, whereas commercial freedom has had a negative effect. Timoshenkov *et al.* (2020) have analyzed the obstacles to Ukraine's transition to a green economy and have determined the development and improvement of Ukraine's environmental legislation as a mandatory condition for this transition. In this research, the main goals of amending the environmental law are to improve the quality and effectiveness of economic institutions, to regulate social relations in the field of environmental protection and to ensure the environmental security of society, and to formulate environmental laws as the main way to achieve these goals. Babenko *et al.* (2020) have examined the current state of China's innovation development using a comparative analysis of macroeconomic indicators in period 2013 to 2019. The results show that the expansion of market mechanisms and the stimulation of micro-level innovation is an important role in China's leadership using macroeconomic regulation leverage. Barkhordari *et al.* (2019) investigated the effects of the knowledge-based economy on the economic growth of Middle East and North Africa (MENA) countries using the Generalized Method of Moments (GMM), from 2010 to 2015. The results indicate that knowledge-based economy enhance growth performance. Ficawoyi (2019) investigated the effect of telecommunication infrastructure on economic growth in countries with better access to education compared to countries with less access using a panel method consisting of 45 sub-Saharan African countries from 1993 to 2015. It shows that in countries with better access to education, the Internet contributes to economic growth; while cell phones don't seem to do that. These results show that while education is considered central to the Internet, it appears to be irrelevant to mobile phone use. Aleemran and Aleemran (2017) investigated the impact of information and communication

Table 1: A summary of empirical studies

Source	Period	Method	Result
Ogbeifun and Shobande (2022)	1986-2018	2SLS	Human capital, savings rate and trade openness have a positive effect on economic growth in OECD countries.
Widarni and Bawono (2021)	1984-2019	ARDL	Human capital and technology have had a positive effect on economic growth in Indonesia.
Mozafari (2021)	2013-2018	GMM	Human capital, government spending and industrialization have had a positive effect on economic growth in Iran.
Barkhordari *et al*. (2019)	2010-2015	GMM	Components of knowledge-based economy have positive effects on economic growth in MENA countries.
Teixeira and Queiros (2016)	1960-2011	Panel data	Human capital and its interaction with structural change in knowledge-based industries have had significant effects on economic growth in OECD countries.
Alatas and Çakir (2016)	1967-2011	Panel data	Human capital has had a positive effect on the economic growth in developing countries.
Slesman *et al.* (2015)	1983-2009	GMM	Better-quality political and economic institutions can have positive effects on economic growth in 39-member countries of the Organization of Islamic Cooperation (OIC).
Pece *et al*. (2015)	2000-2013	Multiple regression models	Innovation, foreign direct investment, human capital and exports have had significant effects on economic growth in Central and Eastern Europe countries.
Galindo and Mendez (2014)	2014	Panel data	Entrepreneurship and innovation have a positive impact on economic growth in developing countries.

technology on economic growth in the D8 group of countries using causal-analytical. According to the research findings, information and communication technology has a positive and significant effect on the economic growth of these countries. Alatas and Çakir (2016) evaluated the empirical relationship between human capital and economic growth using the panel data method, in 65 countries during the period 1967-2011. In this study, the human capital index of every individual is evaluated based on schooling, education efficiency, and infant mortality (per 100 births). The results indicate that human capital has had a positive significant effect on economic growth. Teixeira and Queiros (2016) studied the relationship between human capital and structural change on economic growth in OECD countries from 1960 to 2011 using a dynamic panel data approach. According to this study human capital and its interaction with structural change in knowledge-based industries have had significant effects on economic growth. Furthermore, these interacting effects have been more pronounced in highly developed countries. Pece *et al.* (2015) studied the role of innovation on the long-term economic development of the countries of Central and Eastern Europe (Poland, Czech Republic, and Hungary) using the multiple regression model from 2000 to 2013. The results demonstrate a positive correlation between innovation and economic growth. Galindo and Mendez (2014) analyzed the impact of entrepreneurship and innovation on the economic growth using the panel data approach in selected developing countries from 2002 to 2007. The results show that entrepreneurship and innovation contribute positively to economic growth. Experimental research using econometric approaches, have explored the effects of variables such as physical capital, human capital, invention and innovation, institutional quality, public consumption expenditure, natural resource and the openness of the economy on economic growth and regional integration. The novelty of this study is to investigate the impact of human capital, institutional quality, and innovation as components of the knowledge-based economy on gross domestic product per capita in the oil-exporting countries over the period of 2011 to 2021, using panel data approach. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. Based on this, the effect of institutional quality on the region's gross domestic product has been investigated through government consumption expenditures. The current study has been carried out in oil-exporting countries for the period of 2011 to 2021.

MATERIALS AND METHODS

Model specification

In this study, the effect of human capital, institutional quality and innovation has been investigated on the regional GDP per capita in oil-exporting countries using the panel data method from 2011 to 2021. Panel data has more information, more variability, higher degrees of freedom and higher efficiency than time series and cross-sectional data. Flimer's test is used to distinguish between pooling and panel data (Baltagi, 2005). In addition, the effect of institutional quality on the region's GDP has been investigated through government consumption expenditures. The components of the knowledge-based economy affecting the gross domestic product are: *1)* human capital that in a knowledge-based economy differs from traditional education and has a lifelong quality (Dadgar *et al.*, 2019). Developing education and increasing the number of educated and specialized individuals by contributing to the growth of technology, facilitating the absorption of technology, and boosting the productivity of labor and capital increases economic growth and shifts the total supply curve downwards (Heidari *et al.*, 2011). Many countries' disregard for the issue of development and the dissemination of new skill-based education leads to economic instability and negative growth (Hofmarcher, 2021); *2)* Institutional quality, which includes the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between countries (Kaufmann *et al.,* 1999; Kurtz and Schrank, 2007; Slesman *et al.*, 2015; Izadkhasti, 2019). In addition, institutional factors such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion are significant contributors to variances in the economic performance of countries, and institutions shape the economic environment of countries; *3)* Innovation that can be defined as the application of any new idea to the organization, whether the new idea is applied to products, processes, or services, or whether it is included into the organization's management and marketing systems (Bundy, 1994). Strengthening the innovation system by expanding the supply of new products and services and employing innovative production and distribution techniques will enhance the overall supply and reduce economic inflation. In addition, enhancing the system of innovation by maximizing the use of existing resources and boosting productivity will cut production costs and curb economic inflation (Najafi and Azarbaijani, 2016). The World Business School and the World Intellectual Property Organization (WIPO) created the Global Innovation Index (GII) to determine how to identify the approaches and components that constitute innovation. Innovation index consists of two categories of internal innovation components, namely institutions, human capital, and research, infrastructure, market complexity, and business complexity, and two categories of external innovation components, namely technological output and creative output. *4)* Information and Communication Technology, causes to shift in the traditional modes of consumption, production, and company governance. Also, will facilitate the development of a quantitative knowledge-based economy by reducing costs, removing geographical barriers, enhancing the flow of information, and decreasing transactional uncertainty (Gressgard *et al.,* 2014). The growth of information technology reduces unemployment through reducing production costs, enhancing competitiveness, expanding the market, increasing the amount of production, and creating jobs. Increasing the usage of technology will also decrease production costs and shift the whole supply curve downward (Memarnejad and Dizaji, 2019). This study will therefore explore the effect of the information and communication technology index on economic growth. Based on theoretical literature and following Grossman and Helpman (1991); Dargahi and Qadiri (2012); Ogbeifun and Shobande (2022), the first model is specified in Eq. 1. The hypotheses related to Eq. 1 are as follows:

1) Human capital has a positive effect on the regional gross domestic product; 2) Institutional quality has a positive effect on the regional gross domestic product; 3) Institutional quality has a positive effect on the regional gross domestic product.

$$LnGDPP_{i,t} = \alpha + \beta_1 LnCaf_{i,t} + \beta_2 LnGov_{it} + \beta_3 LnOil_{i,t} + \beta_4 LnHdi_{i,t} + \beta_5 LnInv_{i,t} + \beta_6 LnIct_{i,t} + \beta_7 LnInq_{i,t} + \eta_i + \varepsilon_{i,t} \quad (1)$$

Where, LnGDPi,t is logarithm of gross domestic

product per capita (at constant 2015 prices); LnCafi,t is logarithm of physical capital formation as a percent of GDP representing private and public sector investment); LnGovi,t is logarithm of government consumption expenditure as a percent GDP as an indicator of the government's role in the formulation of macro policies, LnOili,t is logarithm of oil revenues as a percent of GDP, LnHdii,t is logarithm of human capital index, LnInvi,t is logarithm of innovation index, LnInqi,t is logarithm of institutional quality index, LnIcti,t is logarithm of information and communication technology in the country i in the period of t, η_i is the fixed effects of the countries and ε_{it} is the stochastic error term. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. So, the interaction effect of institutional quality and government consumption expenditures on gross domestic product per capita will be investigated in Eq. 2. Also, the hypothesis related to Eq. 2 is as follows:

2) Institutional quality increases regional gross domestic product through government consumption expenditures.

$$LnGDPP_{i,t} = \alpha' + \beta_1' LnCaf_{i,t} + \beta_2' LnGov_{i,t} * LnInq_{i,t} + \beta_3' LnOil_{it} + \beta_4' LnHdi_{i,t} + \beta_5' LnInv_{i,t} + \beta_6' LnIct_{i,t} + \eta_i' + \varepsilon_{i,t}' \quad (2)$$

Where, LnGovi,t*Inqi,t is the interaction effect of institutional quality index and government consumption expenditures as a percent of GDP. The conceptual model of study is depicted in Fig. 1.

Data collection

To estimate the models, time series data are taken from World Bank data series (World Bank, 2023) and World Intellectual Property Organization (WIPO) reports (Global Innovation Index, 2021) for the period of 2011 to 2021 in selected oil-exporting countries. The data related to gross domestic product per capita, physical capital formation as a percent of GDP, government consumption expenditures as a percent of GDP, oil rents as a percent of GDP, are collected from World Bank data series for the period of 2011-2021. The data related to human capital index, institutional quality, innovation index, and information and communication technology are collected from World

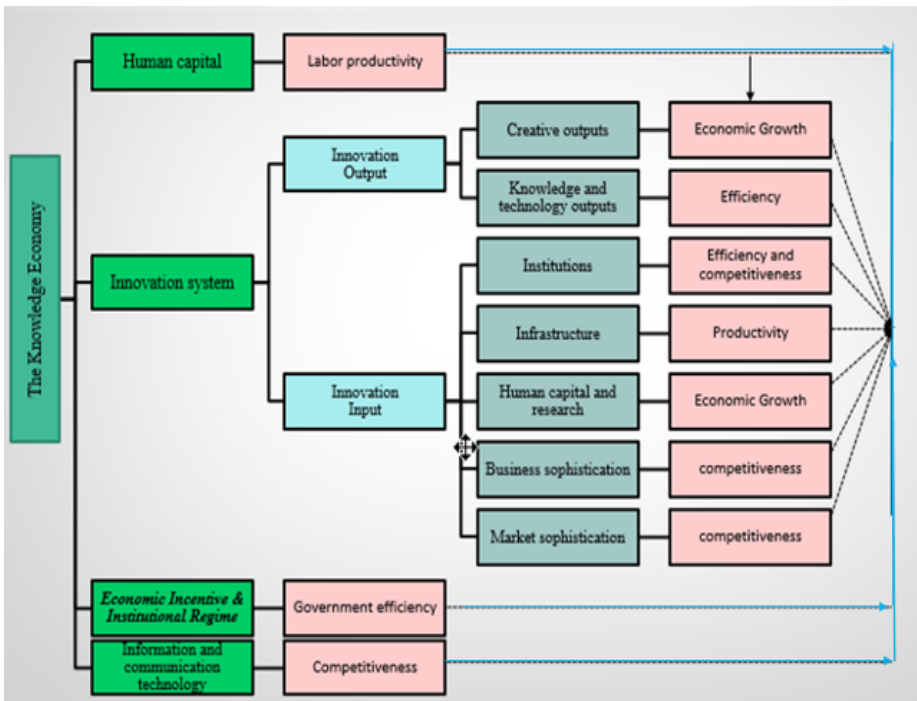

Fig. 1: The conceptual model of research

Table 2: Pedroni's cointegration tests

Tests Statistics	Model 1		Model 2	
	Panel	Group	Panel	Group
Variance ratio	-2.404*	-	-2.531*	-
Rho statistic	5.403*	6.980*	5.437*	6.998*
PP statistic	-0.721	-1.775*	-0.987	-2.226*
ADF statistic	8.993*	9.103*	8.956*	7.635*

Notes: ADF and PP are Augmented Dickey-Fuller and Phillips-Peron statistic, respectively. * The null hypothesis that there is no cointegration is rejected at the 5% level. In the Pedroni test, the critical value at the 5% level is -1.64.

Intellectual Property Organization (WIPO) reports for the period of 2011-2021. The oil exporting countries include Organization of the Petroleum Exporting Countries (OPEC) and OPEC+ countries. OPEC member countries include Algeria, Iran, Iraq, Kuwait, Libya, Solomon Islands, Qatar, Saudi Arabia, United Arab Emirates, Ecuador, Nigeria, Angola, Venezuela and Congo. OPEC+ member countries also include Russia, Mexico, Azerbaijan, Bahrain, Sudan, South Sudan, Malaysia, Kazakhstan, Brunei and Oman. Due to the incomplete data of some countries, such as Iraq, Libya, Venezuela, Sudan, etc., finally, the countries of Algeria, Iran, Kuwait, Qatar, Saudi Arabia, the United Arab Emirates, Ecuador, Russia, Mexico, the Republic of Azerbaijan, Bahrain, Malaysia, Kazakhstan and Oman have been selected in this research.

Analytical framework

The panel data method is used to estimate the models, because this method has more information, more variability, higher degrees of freedom and higher efficiency than time series and cross-sectional data. Flimer's test is used to distinguish between pooling and panel data (Baltagi, 2005). If the calculated Flimer's test is greater than the critical value, the null hypothesis is rejected and the panel data method is used in the estimation. Also, it is necessary to use the Hausman test in order to determine the method of estimating fixed or random effects (Baltagi, 2005). If the null hypothesis is rejected, the model is estimated using the fixed effects method. To ensure the existence of long-term relationship between the dependent variable and the independent variables, the panel cointegration tests provided by Pedroni (2004) are used before estimating the model to avoid false regression. Pedroni's cointegration test includes four panel cointegration statistics and three group panel cointegration statistics, which include: Variance ratio, Rho panel statistics, Phillips-Peron panel statistic (PP statistic), Augmented Dickey-Fuller panel statistic (ADF statistic). In the Pedroni test, the critical value at the 5% level is -1.64. According to the results in Table 2, there is a cointegration relationship in both models at the 5% level. Therefore, a long-term relationship could be noticed between the dependent variable and the independent variables. Statistical analysis and econometrics are performed using Stata 17.0 software.

RESULTS AND DISCUSSION

Descriptive statistics

In this study, the descriptive statistics reported in Table 3, are based on the data are extracted from the World Bank data series and World Intellectual Property Organization (WIPO) reports for the period of 2011-2021. The logarithm of gross domestic product per capita (at constant 2015 prices) is dependent variable and its average, minimum and maximum values are 9.465, 8.251 and 11.084 respectively. Other variables are independent variables that based on theoretical foundations affect regional gross domestic product. Logarithm of physical capital formation as a percent of GDP representing private and public sector investment and its average, minimum and maximum values are 3.300, 2.552 and 3.927 respectively. Logarithm of government consumption expenditure as a percent of GDP is an indicator of the government's role in the formulation of macro policies and its average, minimum and maximum values are 2.749, 2.118 and 3.401 respectively. Logarithm of oil revenues as a percent of GDP and its average, minimum and maximum values are 2.533, 0.172 and 4.063 respectively. In order to achieve the research objectives, the effect of four variables, including human capital, institutional quality, innovation and information and

communication technology as components of the knowledge-based economy (that are measured on a 0-100 score by WIPO) have been used on the regional gross domestic product. The average, minimum and maximum of the logarithm of the human capital index are equal to 4.379, 4.131 and 4.504, respectively. The average, minimum and maximum of the logarithm of institutional quality index are equal to 3.678, 2.484 and 4.270, respectively. The logarithm of Innovation index is averaged at 3.513 with a minimum of 2.965 and a maximum of 3.864. The average, minimum and maximum of the Logarithm of innovation index. Finally, the average, minimum and maximum of the logarithm of information and communication technology are equal to 2.684, 1.363 and 3.175, respectively.

Unit root test

To examine the durability of the model variables, the unit root test was performed before estimating the Models. Models followed by the Levin-Lin-Chu (LLC) test to determine the reliability of the variables, and the results are reported in Table 4. The results show the existence of a unit root in the gross domestic product per capita and the Innovation index. Other variables are stable at the level. In order to avoid spurious relationships and to ensure the existence of long-term relationship between the dependent variable and the independent variables, the panel cointegration tests provided by Pedroni (2004) are used before estimating the model.

Panel cointegration tests

Gross domestic product per capita is dependent variable and physical capital formation as a proportion of GDP, government consumption expenditures as a proportion of GDP, oil revenues as a proportion of GDP, human capital index, institutional quality index, innovation index, and information and communication technology index are independent

Table 3: Summary of descriptive statistics

Variables	Obs.	Mean	Std. dev.	Min	Max
Ln (Gross domestic product per capita)	154	9.465	0.796	8.251	11.084
Ln (Physical capital formation (%GDP))	154	3.300	0.247	2.552	3.927
Ln (Oil revenues (%GDP))	154	2.533	0.892	0.172	4.063
Ln (Government consumption expenditure (%GDP))	154	2.749	0.283	2.118	3.401
Ln (Human capital index)	154	4.379	0.546	4.131	4.504
Ln (Institutional quality)	154	3.678	0.426	2.484	4.270
Ln (Innovation index)	154	3.513	0.186	2.965	3.864
Ln (Information and communication technology)	154	2.684	0.322	1.363	3.175

Table 4: Results of the durability of the model variables

Variables	Levin-Lin-Chu test		Results	Levin-Lin-Chu test		Results
	At the level	Probability		At the first order difference	Probability	
Ln (Gross domestic product per capita)	-3.64	0.24	I(1)	-4.82	0.085	I(0)
Ln (Physical capital formation (%GDP))	-6.91	0.000	I(0)	-	-	-
Ln (Oil revenues (%GDP))	-8.78	0.000	I(0)	-	-	-
Ln (Government consumption expenditure (%GDP))	-7.68	0.000	I(0)	-	-	-
Ln (Human capital index)	-5.13	0.000	I(0)	-	-	-
Ln (Institutional quality)	-6.83	0.000	I(0)	-	-	-
Ln (Innovation index)	-4.04	0.32	I(1)	-8.44	0.000	I(0)
Ln (Information and communication technology)	-10.55	0.000	I(0)	-	-	-

variables. In order to avoid spurious relationships and to ensure the existence of long-term relationship between the dependent variable and the independent variables, the panel cointegration tests provided by Pedroni (2004) are used before estimating the model. According to the results in Table 2, there is a cointegration relationship in both models at the 5% level.

Flimer and Hausman test

Based on the F-test in Table 5, the value of F-test in the first and the second models are 674.2 and 738.6, respectively. So, the null hypothesis is rejected at the %1 level in the first and the second models and the panel data method is confirmed. The value of Hausman test in the first and second model is 5.90 and 6.33, respectively. The null hypothesis is not rejected in the first and the second models at the %5 level, so random effects method is confirmed. In this study, the dependent variable is the GDP per capita (constant 2015 US$). Independent variables are physical capital formation as a percent of GDP, government consumption expenditure as a percent of GDP, oil rents as a percent of GDP, innovation index, human capital index, and information and communication technology. All variables are in logarithmic form. The results of the fixed and random effects estimation in the first and second models are reported in Table 5. According to Hausman test in Table 5, random effects method is confirmed in the first and the second models.

Random effects panel estimation results

Random effects method is confirmed in the first and the second models. According to the results with random effects method in Table 5, human capital index has had a positive and significant effect on gross domestic product per capita at the 1% level and its coefficient in the first and the second models are 0.878 and 0.905, respectively. In other words, a

Table 5: Results of equations estimation using panel data method

Variables	Model 1		Model 2	
	Fixed-effects	Random effects	Fixed-effects	Random effects
Ln (Physical capital formation (%GDP))	0.042* (0.024)	0.042 (0.029)	0.041* (0.024)	0.041 (0.028)
Ln (Government consumption expenditure (%GDP))	-0.197*** (0.038)	-0.190*** (0.045)	-0.410*** (0.082)	-0.476*** (0.093)
Ln (Oil rents (%GDP))	-0.038*** (0.011)	-0.034** (0.013)	-0.037*** (0.012)	-0.035*** (0.013)
Ln (Human capital index)	0.785*** (0.152)	0.878*** (0.178)	0.816*** (0.151)	0.905*** (0.172)
Ln (Innovation index)	0.297*** (0.049)	0.324*** (0.057)	0.306*** (0.048)	0.331*** (0.055)
Ln (Information and communication technology)	0.007 (0.011)	0.007 (0.013)	0.008 (0.012)	0.008 (0.013)
Ln (Institutional) quality index	0.133*** (0.043)	0.182*** (0.050)	-	-
Ln (Institutional quality index) ∗ Ln (Government consumption expenditure (%GDP))	-	-	0.055*** (0.017)	0.073*** (0.019)
Cons	5.158*** (0.773)	4.45*** (0.910)	5.506*** (0.763)	5.01*** (0.879)
R-sq.	Within = 0.47 Between = 0.66 Overall = 0.62	Within = 0.46 Between = 0.74 Overall = 0.70	Within = 0.47 Between = 0.67 Overall = 0.64	Within = 0.47 Between = 0.74 Overall = 0.71
F-test*	674.2***		738.6***	
(prob)	(0.000)		(0.000)	
Hausman test	5.90		6.33	
(prob)	(0.551)		(0.502)	
Observations	154			
Number of countries	14			

Notes: The figures enclosed in parentheses beneath the regression coefficients represent standard errors. *, **, and *** are significant at the 10 %, 5 %, and 1 % levels respectively.

one percent increase in the human capital index in the first model causes an increase in gross domestic product per capita by 0.878 percent. Also, a one percent increase in the human capital index in the second model causes an increase in gross domestic product per capita by 0.905 percent. So, the first hypothesis related to Eq. 1 is confirmed and human capital has a positive and significant effect on the regional gross domestic product at the level of 1%. These results are consistent with the finding of Kurt (2015); Teixeira and Queiros (2016); Shobande (2021); Ogbeifun and Shobande (2022); Shidong *et al*. (2022). This finding indicates that improving the quality of human capital index through education, training, and the acquisition of diverse skills plays a crucial role in sustaining economic growth within the framework of endogenous growth models. The institutional quality has had a positive and significant effect on gross domestic product per capita at the 1% level in the first model and its coefficient is 0.182. According to this, a one percent increase in the institutional quality index in the first model causes an increase in gross domestic product per capita by 0.182 percent. Therefore, the second hypothesis related to Eq. 1. is confirmed and institutional quality has a positive and significant effect on the regional gross domestic product at the level of 1%. These results are consistent with the finding of Kaufmann *et al.,* (1999); Kurtz and Schrank, (2007) and Slesman *et al.*, (2015). The improvement of the institutional quality such as the political system, the behavior of rulers and public policies, is accomplished by increasing political stability and the absence of violence in the society, securing property rights, enhancing the government's effectiveness, enhancing the quality of laws and regulations, reducing corruption, increasing long-term investments, and expanding employment opportunities (Dutta *et al.*, 2013; Slesman *et al.*, 2015). In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. Also, the coefficient of interaction effects of institutional quality and government consumption expenditure in the second model is 0.073 and is statistically significant at the 1% level. Therefore, the hypothesis related to Eq. 2. is confirmed and interaction effects of institutional quality and government consumption expenditure has a positive and significant effect on the regional gross domestic product at the level of 1%. According to this, institutional quality index has increased regional gross domestic product through government consumption expenditures. Innovation index has had a positive and significant effect on gross domestic product per capita and its coefficient in the first and second model are 0.324 and 0.331, respectively. So, an increase of one percent in Innovation index in the first and the second models causes an increase in gross domestic product per capita by 0.324 and 0.331 percent. So, the third hypothesis related to Eq. 1. is confirmed and Innovation index has a positive and significant effect on the regional gross domestic product at the level of 1%. These results are consistent with the finding of Grossman and Helpman (1991); Acemoglu (2008); Galindo and Mendez (2014); Pece *et al.,* (2015); Barkhordari *et al.* (2019). The use of an idea by one person does not restrict others from adopting it simultaneously. These types of concepts create a strong connection between idea-based growth models and rising scale-based efficiency (Grossman and Helpman, 1994). In addition, improving the system of innovation by maximizing the use of existing resources and boosting productivity will decrease production costs and curb economic inflation (Najafi and Azarbaijani, 2016). Information and communication technology infrastructures will facilitate the development of a quantitative knowledge-based economy by reducing costs, removing geographical barriers, enhancing the flow of information, and decreasing transactional uncertainty (Gressgaard *et al.,* 2014). The coefficient of Information and communication technology infrastructures in the first and the second models is equal to 0.007 and 0.008, respectively, which is insignificant at the 10% level. Moreover, Physical capital formation as a percent of GDP has had a positive and insignificant effect on gross domestic product per capita and its coefficient in the first and the second models are 0.042 and 0.041, respectively. In both models, Oil revenues has had a negative effect on gross domestic product per capita and its coefficient are -0.034 and -0.035, respectively. Oil revenues are one of those factors that can be seen as a blessing or a curse in determining economic growth (Khan *et al*. 2022 and Dramani *et al.* 2022). Accordingly, oil rent as a percent of GDP has had a negative effect on economic performance. This result is consistent with the results of Mavrotas *et al.* (2011) and Dramani *et al.* (2022). Government

consumption expenditure as a percent of GDP in the first and the second models has had a negative effect on gross domestic product per capita and its coefficient are -0.190 and -0.476, respectively. This result is consistent with the results of Pourehtesham (2022). Therefore, an increase in public spending on profitable projects can promotes economic growth, but an increase in government current expenses can negatively affect economic performance. According to this, the relationship between public sector spending and economic growth over the past few decades is still relevant today and is still a matter of debate among policymakers and researchers (Poku *et al.*, 2022). In some studies, such as Ogbeifun and Shobande (2022) used the two-stage least squares (2SLS) method and Widarni and Bawono (2021) used the Autoregressive Distributed Lag (ARDL) method to investigate the effects of human capital and technology on economic growth.

CONCLUSION

Differences in the fundamental variables of production and technology are cited as the basis for the disparity in national growth rates by primary research. Theoretical literature of endogenous growth models is based on the external of physical capital, the accumulation of human capital, and technological innovation. Moreover, since the late 1990s, institutional quality, such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between countries. In this study the effect of human capital, institutional quality and innovation are investigated on regional gross domestic product per capita in 14 oil exporting countries from 2011 to 2021 using panel data method. In addition, the institutional quality limit government spending and direct financial resources towards healthy investments. According to this, the effect of institutional quality index has investigated on regional gross domestic product per capita through government consumption expenditures. Also, statistical and econometric analysis is done with Stata17.0 software. Based on Pedroni cointegration test there is a long-term relationship between the dependent variable and the independent variables. The results of random effects method in the first and the second models indicated that human capital has a positive and significant effect on the regional gross domestic product per capita at the level of 1%. So, improving the quality of human capital index through education, training, and the acquisition of diverse skills plays a crucial role in sustainability of economic growth within the framework of endogenous growth models. The institutional quality has had a positive and significant effect on gross domestic product per capita at the 1% level in the first model. According to this, Institutional quality, such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion, have been cited as significant determinants of economic performance disparities between oil exporting countries. Moreover, Institutional quality index has increased regional gross domestic product through government consumption expenditures. So, the institutional quality limit government spending and direct financial resources towards healthy investments. The results also show that Innovation index has had a positive and significant effect on gross domestic product per capita in the first and the second models. According to this, technological innovation creates circumstances for any region to extract more value from limited resources to support sustainable economic growth. In this way, strengthening the innovation system by expanding the supply of new products and services and employing innovative production and distribution techniques will enhance the overall supply. The study therefor concludes that, physical capital formation as a percent of GDP has a positive and insignificant impact on gross domestic product per capita. Of course, oil rents as a percent of GDP has had a negative and significant effect on gross domestic product per capita in both models. Thus, oil revenues are one of those factors that can be seen as a blessing or a curse in determining economic growth. In addition, the role of natural resources in economic growth largely depends on the amount of rent it generates. Finally, Government consumption expenditure as a percent of GDP has had a negative and significant effect on gross domestic product per capita. Therefore, an increase in public spending on profitable projects can promotes economic growth, but an increase in government current expenses can negatively affect economic performance.

Policy implications

Considering that the descriptive statistics growth rate of GDP per capita averaged at 2.12% over the period from 2011 to 2021 in 14 oil exporting countries. Thus, it seemed necessary to recommend these countries to improve the economic performance: 1) apply policies to increase the level and quality of human capital through education, training, and the acquisition of diverse skills; 2) improving institutional quality such as the political system, the behavior of rulers, public policies, corruption control, and culture and religion; 3) Strengthening the innovation system by expanding the supply of new products and services and employing innovative production and distribution techniques. In addition, oil revenues are one of those factors that can be seen as a blessing or a curse in determining economic. So, the role of oil revenues in economic growth largely depends on the amount of rent it generates. In the end, it is suggested that, by disciplining the government's current expenditures, the share of infrastructure expenditures should increase.

AUTHOR CONTRIBUTIONS

H. Izadkhasti, conducted the research materials, methods, introduction, and literature review, analyzed and evaluated the data, and wrote the manuscript text, citations, and final version.

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CONFLICT OF INTEREST

The author declares no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

ABBREVIATIONS

ADF	Augmented Dickey-Fuller
ARDL	The Autoregressive Distributed Lag
Cup-FM	Continuously updated fully modified
Cup-BC	Continuously updated bias-corrected
GDP	Growth Domestic Product
GMM	Generalized method of moments
LLC	Levin-Lin Chu test
MENA	Middle East and North Africa
OECD	Organization for economic cooperation and development
OPEC	Organization of the Petroleum Exporting
WDI	World Development Indicators
WIPO	World Intellectual Property Organization
2SLS	The two-stage least squares

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