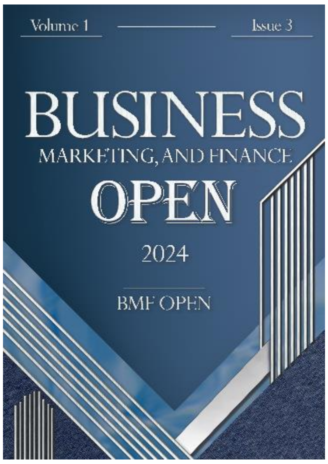
The Impact of Knowledge-Based Economy Indicators on Economic Growth (Case Study: Selected Persian Gulf Countries)



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Abstract: The knowledge-based economy can bring numerous benefits to societies and nations. Through knowledge-driven production, the possibility of enhancing economic growth and improving economic conditions in societies arises, with economic growth subsequently leading to wealth creation and increased economic welfare. Additionally, countries are witnessing the emergence of knowledge-based, technology-driven businesses, which exhibit the highest growth rates and aim to capture the largest share of global markets, thereby contributing to the development and consolidation of a knowledge-based economy. Therefore, given the significant effects of the knowledge-based economy on broader economic outcomes and growth, the purpose of this study is to analyze the impact of knowledge-based economy indicators on the economic growth of selected Perisan Gulf countries during the period 2010 to 2022. To this end, the Generalized Method of Moments (GMM) approach was employed. The results indicated that institutional quality—as a component of economic incentives and institutional systems within a knowledge-based economy—has a positive and significant effect on economic growth. Similarly, innovation—as a core of the innovation and technology system—human capital and active labor force—as pillars of education and workforce skills—and the level of personal internet use and the security of internet servers—as elements of information infrastructure and communication technologies—also positively and significantly influence the economic growth of the selected Persian Gulf countries.

Keywords: knowledge-based economy, economic growth, Persian Gulf countries.

1. Introduction

The knowledge-based economy emphasizes the significance of skills in a service-oriented economy, which represents the third stage of economic development, often referred to as the post-industrial economy. These terms are associated with the information economy, which stresses the value of information as a non-physical asset and the role of the digital economy, highlighting how information technology facilitates commerce. According to several scholars, indicators of a knowledge-based economy grounded in technological development include: (1) access to high-speed internet lines, (2) the presence of secure servers (per 100,000 people), (3) the number of websites per 1,000 individuals, (4) mobile phone subscriptions per 100 people,

(5) internet users per 100 people, and (6) citizens' investment in information and communication technologies (ICT) [1].

A knowledge-based economy refers to a production system that utilizes knowledge to generate tangible or intangible added value. A nation's economic capital is not limited to underground resources like oil; rather, human capital constitutes the primary asset. In fact, the fundamental principles of a knowledge-based economy rest on a creative and specialized human workforce [2-5]. This form of economy has played a pivotal role in countries worldwide. Its notable outcomes include accelerated economic growth, technological advancement, the expansion of high-tech industries, increased employment among university graduates, and the growth of both goods and engineering services exports. A significant share of GDP originates from knowledge-intensive sectors such as high- and medium-technology industries and knowledge-based financial and commercial services. In such economies, knowledge surpasses traditional factors like labor and capital in driving production, and the value of many software and biotech companies stems not from physical assets, but from their intellectual property, licenses, and scientific advantages [2, 3].

According to definitions provided by the World Bank and the European Bank for Reconstruction and Development (2019), a knowledge-based economy rests on four foundational pillars: (1) economic incentives and institutional systems, (2) innovation and technology systems, (3) education and human resource skills, and (4) information and communication infrastructure. The first pillar—economic incentives and the institutional regime—implies that governments must establish stable legal frameworks, foster entrepreneurship, and invest in ICT through appropriate regulations and procedures. The second pillar—innovation systems—is the core of a knowledge-based economy, necessitating a network of research centers, universities, think tanks, private enterprises, and social groups to expand knowledge resources, adapt knowledge to local needs, and generate new knowledge. The third pillar—education and human resources—highlights the need for a skilled workforce capable of creating, disseminating, and utilizing necessary knowledge, which can be achieved through sustainable educational infrastructure and academic development. The fourth pillar—information and communication infrastructure—focuses on developing ICT networks to construct a modern industrial economy [2].

The Knowledge Economy Index (KEI) serves as a global metric for evaluating the extent to which countries rely on science and technology for economic development. Sweden ranks first with a score of 9.43, followed by Finland, Denmark, and the Netherlands. Norway, New Zealand, and Canada are the next leading countries in this domain, followed by Germany, Australia, Switzerland, Ireland, and the United States. Taiwan, with a score of 8.77, ranks 13th and is the leading Asian country in terms of knowledge economy performance [6].

Many Persian Gulf countries have increased their focus on developing knowledge-based and digital economies. For example, Saudi Arabia aims to raise the share of non-oil exports in its GDP from 16% in 2016 to 50% by 2030. The United Arab Emirates intends to double the size of its knowledge-based and digital economy over the next decade by establishing smart infrastructure and enhancing government digital readiness. In 2008, Qatar introduced the Qatar National Vision 2030 with the strategic goal of developing a knowledge-based economy. Iran has also experienced relatively significant growth in the number of knowledge-based companies and their employment generation in the past three years. This trend became particularly prominent in 2022, the year named "Production: Knowledge-Based and Job-Creating." Accordingly, the number of knowledge-based companies increased from 6,632 in 2021 to 8,260 in 2022, and to 9,733 in 2023. As of now, a total of 9,970 knowledge-based companies have been approved by the Vice-Presidency for Science, Technology, and Knowledge-Based Economy. Of these, 861 are classified as technology companies, 2,337 as innovative companies, and 6,771 as startups. Therefore, the number of knowledge-based firms in July 2024 has grown by approximately 50% compared to 2021 [1].

The literature reveals a consistent emphasis on the positive relationship between knowledge-based economy indicators and economic growth across diverse national contexts. Karimi and Yadgari (2024) highlighted the transformative impact of organized information in forming knowledge economies, aligning with the OECD's characterization and emphasizing its role in addressing regional disparities in growth through knowledge and innovation [1]. Mahmoudi et al. (2021) confirmed a long-term, statistically significant relationship between knowledge-based economy indices and economic growth in Islamic countries using Johansen co-integration and variance decomposition methods [2]. Similarly, Hassan Zadeh et al. (2021) found innovation to significantly enhance growth in both developed and developing nations, with a notably stronger effect in the latter. Salim (2018) emphasized the role of human capital and social capital, using panel data from 139 countries to show their significant positive effects on growth [3]. Hanushek and Woessmann (2020) stressed the importance of cognitive skills over mere educational attainment for long-term growth [4]. Barkhordari et al. (2019), using GMM estimation on MENA countries, reinforced the vital roles of human capital, infrastructure, and R&D in stimulating economic expansion [7]. Kaur and Singh (2016) noted a generally positive correlation between the knowledge economy index and economic level, though its marginal effect on growth was modest [8]. Dias and Tebaldi (2011) emphasized the structural institutional role in long-term growth, highlighting human and physical capital accumulation as central to sustained development [9]. Finally, Karagiannis (2007), studying 15 EU countries, demonstrated that investment in R&D, IT infrastructure, and human capital had a significant and positive impact on growth, affirming the strategic value of knowledge-economy-driven policies [10].

Overall, the knowledge-based economy is fundamentally built on four pillars: economic incentives and institutional systems, innovation and technology systems, education and human capital skills, and ICT infrastructure. Given the current global economic climate—with increasing international focus on the high-value asset of knowledge, the acceleration of globalization, and the growing number of countries joining the World Trade Organization (WTO), which has resulted in the removal of trade barriers and decreased governmental protection for domestic industries—the question arises: has the economic growth of selected Persian Gulf countries been influenced by knowledge-based economy indicators? Therefore, the aim of this study is to investigate and address this question in selected Persian Gulf countries (Iran, Iraq, Saudi Arabia, the UAE, Kuwait, Qatar, and Oman) during the period from 2010 to 2022 using econometric approaches.

2. Methodology

The knowledge-based economy framework, consistent with the existing literature, assumes that total factor productivity is influenced by the level of workforce education and the degree of innovation in the economy. Here, a broader approach is considered, incorporating the economic and institutional regime and the level of information and communication technologies (ICT) as key determinants of total factor productivity. Therefore, the aggregate production function is presented as Equation (1):

$$\mathbf{Y = A(g, e, r, i) * F(L, K)} \qquad (1)$$

where **g** represents the economic and institutional regime, **e** denotes education and training, **r** indicates the level of domestic innovation (including both technology creation and adaptation), and **i** stands for information and communication infrastructure (Chen & Dahlman, 2004).

As discussed in the theoretical framework, based on the definition by the World Bank and the European Bank for Reconstruction and Development (2019), the knowledge-based economy rests on four foundational pillars: (1) economic incentives and institutional systems, (2) innovation and technology systems, (3) education and human capital skills, and (4) information and communication infrastructure. The first pillar—economic incentives and institutional regimes—requires governments to establish stable regulatory frameworks, support entrepreneurship, and invest in ICT through appropriate laws and procedures. The second pillar—innovation systems—is the most fundamental and entails a network of research centers, universities, think tanks, private firms, and social groups necessary for knowledge accumulation, adaptation to local needs, and the creation of new knowledge. The third pillar—education and human capital—emphasizes the need for a skilled population to generate, disseminate, and utilize knowledge, achieved through sustained investment in education and training systems. The fourth pillar—ICT infrastructure—focuses on expanding ICT networks to build a modern industrial economy.

Accordingly, this study, drawing upon the indicators and pillars of the knowledge-based economy as defined by the World Bank, the European Bank for Reconstruction and Development (2019), and the research by Bousrih et al. (2020), specifies the final model as follows:

$$\mathbf{EG\_it = \beta_0 + \beta_1 EG\_it_{-1} + \beta_2 RQI\_it + \beta_3 L\_INN\_it + \beta_4 L\_HC\_it + \beta_5 L\_L\_it + \beta_6 L\_ICT\_it + \beta_7 L\_SIS\_it + \varepsilon\_it} \qquad (2)$$

In this model, all variables except economic growth (EG) and regulatory quality (RQI) are expressed in logarithmic form. Specifically:

- **EG (Economic Growth)**: The dependent variable; data sourced from the World Bank.
- **RQI (Regulatory Quality Index)**: Represents the first pillar (economic incentives and institutional systems). Based on Mahmoudi et al. (2021), RQI data from the World Bank are used, defined as an efficient, responsive, and corruption-free government with a legal system that protects commercial laws and property rights.
- **INN (Innovation)**: Represents the second pillar. Following Cameron (1998), who emphasizes R&D expenditure as a theoretical and data-supported proxy for innovation, data on R&D spending from the World Bank are used. Innovation refers to selecting the right ideas and effectively converting them into products, services, and processes for profit and growth. High creativity is required for investors aiming to increase their innovation capacity.
- **HC (Human Capital) and L (Labor Force)**: Represent the third pillar. Due to missing HC data for some countries, this study uses secondary and tertiary school enrollment rates from the World Bank (as in Bousrih et al., 2020). Labor force data are also taken from the World Bank. Human capital includes competencies, knowledge, and social-personal traits (e.g., creativity, imagination) required for economic value creation. The labor force comprises individuals of legal working age.
- **ICT (Information and Communication Technology Infrastructure)**: Due to the unavailability of comprehensive ICT data, personal internet usage (IUI) is used as a proxy, and secure internet servers (SIS) from the World Bank are used to reflect ICT infrastructure (following Bousrih et al., 2020). ICT infrastructure comprises hardware, software, networking, and communication systems facilitating efficient access to information.
- **ε_it**: The error term, with **i** and **t** indicating cross-section and time dimensions, respectively.

It is noteworthy that economic growth is included with a lag as an explanatory variable, meaning lagged physical investment is implicitly incorporated into the model.

The statistical population of this study comprises selected Persian Gulf countries (Iran, Iraq, Saudi Arabia, the UAE, Kuwait, Qatar, and Oman) during the period from 2010 to 2022.

To analyze the effects of knowledge-based economy indicators on economic growth in the selected Persian Gulf countries, the Generalized Method of Moments (GMM) is used. This method allows for the examination of dynamic changes. GMM offers several advantages, including the ability to account for individual heterogeneity, use more information, eliminate biases found in cross-sectional regressions, and provide more efficient and accurate estimations with reduced multicollinearity. This facilitates a better understanding of economic dynamics.

GMM has become one of the most widely used econometric techniques for both cross-sectional and panel data estimation due to its flexibility and minimal assumptions. It is particularly useful when the model is over-identified. In this model, the lag of the dependent variable appears on the right-hand side of the equation, enabling dynamic panel estimation and the derivation of short-run elasticities.

GMM is an extension of the moment method, generalized to various models beyond linear regression. This estimation technique posits that unknown parameters should be estimated by aligning population moments (functions of unknown parameters) with appropriate sample moments.

The rationale for using GMM in this study is based on its advantages over other econometric methods. It is suitable for at least three key reasons:

1. GMM allows for the use of endogenous variables. One way to control for endogeneity is through instrumental variables. A valid instrument must be strongly correlated with the endogenous variable but uncorrelated with the error term. However, finding such instruments is often challenging.
2. A major advantage of GMM is the ability to use lagged variables as valid instruments to control for endogeneity.
3. GMM also accommodates the dynamics within the examined variables, enabling the model to reflect time-based behavioral changes effectively.

3. Findings and Results

The first step in the statistical analysis involves examining the descriptive statistics of the variables. Table 1 presents the descriptive statistics, including the mean, median, maximum, minimum, standard deviation, sum, and number of observations for the variables under study.

Table 1. Descriptive Statistics of Variables

Index	EG	RQ	INN	HC	L	ICT	SIS
Mean	3.10	-0.06	0.44	34.67	65.24	934.57	70.87
Median	2.92	0.15	0.39	1.78	69.29	1093.00	78.00
Maximum	19.59	1.09	1.49	120.53	88.86	203430	100.00
Minimum	-12.03	-1.70	0.03	0.87	41.52	1.00	2.50
Std. Deviation	4.76	0.84	0.36	47.19	16.25	32223.42	28.25
Sum	282.55	-6.31	40.90	3155.16	5739.19	850629	6446.19
Observations	92	91	91	91	91	91	91

The statistical data of the present study and the descriptive table of variables indicate that the mean economic growth for this group of countries is 3.10%. The mean of institutional quality, representing the pillar of economic incentives and institutional systems, is negative at -0.06%. The mean value of the innovation and technology system in the selected Persian Gulf countries is 0.44%. The mean values for human capital and the labor force, representing the pillar of education and workforce skills, are 34.67% and 65.24%, respectively. The mean values for ICT and its infrastructure, representing the information and communication technology pillar, are 934.50 and 70.87%, respectively.

Since the present study is panel-based, it is essential to conduct a cross-sectional dependence test before estimating the model. In this study, the Pesaran cross-sectional dependence test is used to determine the presence or absence of cross-sectional dependence. The null hypothesis of this test suggests no cross-sectional dependence. The results for the model are presented in the table below.

Table 2. Pesaran Cross-Sectional Dependence Test

Dependent Variable	Test Statistic	Probability
EG	5.43	0.00

As shown in Table 2, the null hypothesis indicating the absence of cross-sectional dependence is rejected since the probability value is less than 0.05. Therefore, the model exhibits cross-sectional dependence, and conducting unit root tests without accounting for this dependence would lead to incorrect results.

One of the critical steps before estimating models is to examine the stationarity of the variables. Given the presence of cross-sectional dependence in this study, the augmented Dickey-Fuller (ADF) unit root test is used to assess the stationarity of panel data. The null hypothesis of this test states the presence of a unit root, i.e., non-stationarity of variables. The results for the introduced variables are presented in the table below.

Table 3. Augmented Dickey-Fuller Unit Root Test

Variables	ADF Test Statistic (p-value)
EG	-2.69 (0.00)
RQ	-3.74 (0.00)
LINN	-4.23 (0.00)
LHC	-2.79 (0.00)
LL	-4.26 (0.00)
LICT	-4.41 (0.00)
LSIS	-4.63 (0.00)

According to the results of the ADF unit root test, all variables are stationary at level. Since the probability values for all variables are less than 0.05, the null hypothesis of a unit root (non-stationarity) is rejected.

The results of the estimation for Model (1) are presented in Table 4 for the selected Persian Gulf countries. Due to the presence of country-specific unobservable effects and the inclusion of a lagged dependent variable among the explanatory variables—which pose a fundamental challenge in estimating dynamic panel models—the Generalized Method of Moments (GMM) is used in this study. To estimate the model using this method, it is necessary first to identify the instrumental variables employed. For the selected Persian Gulf countries, the chosen instrument is the one-period lag of the target variable, economic growth.

To ensure the reliability of results in dynamic models, it is essential that the number of observations be sufficiently large. In the GMM method, a small number of observations may result in biased estimates and complicate interpretation. The time frame of this study spans 13 years from 2010 to 2022, which sufficiently supports the number of required observations. The panel comprises 7 countries, resulting in a total of 91 observations.

Table 4. Estimation Results of the Model

Variables	Coefficients	t-statistic	Probability
EG(-1)	8.37	2.88	0.00

RQ	8.02	3.07	0.00
LINN	7.78	3.49	0.00
LHC	6.32	3.71	0.00
LL	8.90	3.70	0.00
LICT	7.38	3.34	0.01
LSIS	5.29	3.95	0.00

Table 5 presents the results of the Sargan test and other model fit statistics.

Table 5. Sargan Test

Test Statistic (J)	Probability
27.43	0.15

Given the J-statistic value at the 5% significance level, the null hypothesis of no correlation between the instrumental variables and the error term is not rejected. Therefore, the instrumental variables are appropriately chosen. The Sargan test results confirm the validity of the instruments.

As previously mentioned, the consistency of the GMM estimator depends on the validity of the assumption of no serial correlation in the error terms and the instruments. To verify the outcome of the Sargan test, the Arellano-Bond serial correlation test is also conducted. The results of this test are provided in Table 6.

Table 6. Arellano-Bond Serial Correlation Test

Order of Serial Correlation	Test Statistic	Probability
AR(1)	7.45	0.54
AR(2)	6.23	0.40

Based on the Arellano-Bond test results, the validity of the Sargan test is confirmed. Since the p-values for both AR(1) and AR(2) exceed 0.05, the null hypothesis of no serial correlation is not rejected. Thus, no serial correlation exists in the residuals.

Table 7 shows the results of the Wald test.

Table 7. Wald Test

Test	Test Statistic	Probability
F-statistic	3.97	0.00
Chi-square	23.82	0.00

Based on the results of the Wald test in the regression model—which follows the F-distribution and Chi-square distribution with degrees of freedom equal to the number of explanatory variables minus one constant term—the null hypothesis stating that all coefficients are jointly zero is rejected at the 5% significance level. Since the p-values are less than 0.05, the estimated coefficients are considered statistically valid.

To examine the normality of residuals, the Jarque-Bera test is used. The results are shown in Chart 2.

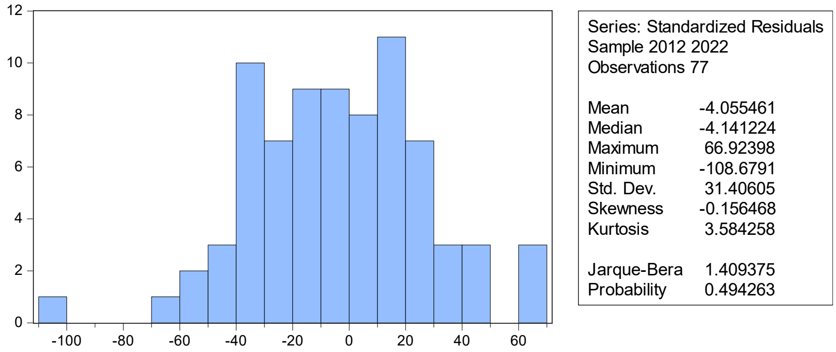

Figure 1. Jarque-Bera Normality Test for Residuals

According to the test results, since the p-value exceeds 0.05, the null hypothesis of normally distributed residuals is not rejected. Therefore, the residuals follow a normal distribution.

4. Discussion and Conclusion

The present study sought to investigate the impact of knowledge-based economy indicators on the economic growth of selected The Persian Gulf Countries during the period from 2010 to 2022 using the Generalized Method of Moments (GMM) estimation technique. The results revealed that all four primary pillars of the knowledge-based economy—including economic incentives and institutional quality, innovation, human capital, and information and communication technology (ICT) infrastructure—have a statistically significant and positive influence on economic growth in these countries. Furthermore, the lagged value of economic growth was also significant, underscoring the dynamic nature of growth processes in the selected economies.

The finding that institutional quality (RQI) significantly and positively affects economic growth is aligned with the theoretical premise that efficient institutions form the foundation of productive economic systems. These institutions ensure regulatory quality, protection of property rights, and government accountability—all of which stimulate investor confidence and economic activity. This result is consistent with the empirical work of Mahmoudi et al. (2021), who found that institutional regimes play a crucial role in promoting long-term economic growth among Islamic countries [2]. Similarly, Dias and Tebaldi (2011) confirmed the influence of structural institutions over long-term economic performance using cross-country panel data. The presence of robust and transparent institutional systems in the Selected Persian Gulf Countries —particularly in countries like the UAE and Qatar—may have enhanced the mobilization of knowledge assets and facilitated better governance structures for economic expansion [9].

The results also showed that innovation (measured through R&D expenditures) significantly impacts economic growth, which supports the notion that technological development and innovation are essential drivers of productivity. This outcome resonates with the findings of Hassan Zadeh et al. (2021), who emphasized the direct relationship between innovation and economic performance in both developed and developing contexts, noting that its impact is even more pronounced in countries with lower levels of existing innovation [3]. Karagiannis (2007), in the context of EU countries, also affirmed the positive impact of R&D spending on growth, further supporting the role of innovation systems in high-income and transitioning economies alike [10]. Additionally, the broader interpretation of innovation—as encompassing not only research and technological breakthroughs but also the commercialization and practical deployment of new knowledge—provides a meaningful pathway for sustainable development in the Persian Gulf region, where diversification away from oil dependency is a strategic objective.

The effect of human capital and labor force indicators on economic growth was also positive and statistically significant. This supports the assertion that human resources are central to the functioning of a knowledge-based economy. By investing in education and developing skills, nations can enhance labor productivity, increase employability, and support high-value industries. These findings are in agreement with those of Salim (2018), who demonstrated that human capital is one of the most robust predictors of economic development in a large sample of countries. Moreover, Hanushek and Woessmann (2020) emphasized that it is not merely the years of schooling, but the cognitive and technical skills of the workforce that critically shape long-term growth patterns. In the Selected Persian Gulf Countries, ongoing national visions—such as Saudi Arabia's Vision 2030 and Qatar's National Vision 2030—have explicitly prioritized human capital development as a catalyst for economic diversification and innovation [4].

The ICT infrastructure and its components—including internet usage and secure internet servers—were also found to be significantly associated with economic growth. This reinforces the growing consensus that digital infrastructure is no longer a complementary element but a core enabler of economic performance. The digital economy, enabled by widespread connectivity, efficient information systems, and cyber security, can substantially reduce transaction costs, enhance market access, and promote e-government and e-commerce. Similarly, Barkhordari et al. (2019) identified ICT, along with human capital and research, as key contributors to economic performance in MENA countries. The Persian Gulf states, by expanding broadband access and investing in smart city initiatives and 5G networks, have created fertile ground for ICT-driven innovation, contributing to higher GDP growth [7].

The dynamic nature of economic growth was also evident from the positive and significant coefficient of the lagged dependent variable. This suggests that past growth exerts a momentum effect on current performance, likely reflecting accumulative capital formation, policy continuity, and the persistence of growth drivers. This observation supports the use of dynamic panel models such as GMM, which accommodate such effects and help avoid bias due to omitted variables and endogeneity.

From a comparative perspective, the findings affirm that knowledge-based economy indicators operate similarly in the Persian Gulf region as they do in other parts of the world, though with regional variations in intensity and implementation. While studies such as Kaur and Singh (2016) observed relatively weaker marginal effects of the knowledge economy on growth in some developing nations [8], the current study suggests that even countries traditionally reliant on natural resources can benefit significantly from investing in knowledge pillars. This shift is particularly important for the Selected Persian Gulf Countries, where economic diversification is not just a developmental ambition but a strategic necessity in the face of fluctuating oil revenues and a rapidly evolving global economy.

In summary, the current study confirms that the key components of a knowledge-based economy—including institutional quality, innovation, human capital, and ICT infrastructure—are critical drivers of economic growth in Selected Persian Gulf Countries. These findings are strongly supported by global and regional empirical research and suggest that sustained investment in knowledge assets is essential for achieving long-term, inclusive, and innovation-led development.

Despite the robustness of the results, this study is not without limitations. First, the reliance on secondary data from international databases such as the World Bank may entail issues of data consistency and completeness, particularly for some indicators such as human capital in countries with limited reporting practices. Second, the scope of the study is restricted to selected Persian Gulf countries, which, although economically and culturally similar, might not fully represent the broader dynamics of the developing world. Third, the GMM method, while effective in addressing endogeneity and serial correlation, may still produce biased results in the presence of weak instruments or small sample sizes. Furthermore, the study does not disaggregate the effects across sectors, which could provide deeper insights into the sector-specific benefits of knowledge-based economy policies.

Future studies should consider expanding the geographical scope beyond the Selected Persian Gulf Countries to include other developing and transition economies in Asia and Africa to allow for broader generalizability and comparative analysis. In addition, incorporating micro-level data—such as firm-level productivity and innovation practices—would enable a more granular understanding of how knowledge assets translate into economic performance. Researchers could also apply nonlinear or threshold models to detect potential asymmetries or saturation effects, especially in mature digital economies. Lastly, longitudinal studies examining policy interventions in real-time could shed light on the causal mechanisms and time lags associated with knowledge economy reforms.

Policymakers in the Persian Gulf region should prioritize the development of robust institutional frameworks that enhance regulatory quality, transparency, and property rights enforcement to foster investor confidence. Investment in innovation ecosystems—including R&D subsidies, technology transfer mechanisms, and public-private research collaborations—should be scaled up to drive technological advancement. Expanding access to quality education, technical training, and digital literacy programs is essential to build a competitive, future-ready workforce. Finally, continued expansion and security of digital infrastructure will be vital for enabling entrepreneurship, digital government services, and participation in the global knowledge economy.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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