

ORGANIZING TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING MODERATION: RESEARCH, DEVELOPMENT, AND INNOVATION INVESTMENT IMPACT ON GDP

Danilo C. Diotay^{*}, Mark Doblás^{**}, Stephen Chellakan^{**}

^{*} Corresponding author, University of Technology Bahrain, Salmabad, Bahrain
Contact details: University of Technology Bahrain, 1213 Block 712, Bldg. 829, Salmabad, Bahrain
^{**} University of Technology Bahrain, Salmabad, Bahrain



Abstract

How to cite this paper: Diotay, D. C., Doblás, M., & Chellakan, S. (2024). Organizing technical and vocational education and training moderation: Research, development, and innovation investment impact on GDP [Special issue]. *Corporate Governance and Organizational Behavior Review*, 8(2), 343–354.
<https://doi.org/10.22495/cgobrv8i2sip9>

Copyright © 2024 The Authors

This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0).
<https://creativecommons.org/licenses/by/4.0/>

ISSN Online: 2521-1889
ISSN Print: 2521-1870

Received: 10.01.2024
Accepted: 17.06.2024

JEL Classification: C01, C51, D04, O11, O33, O57, O38
DOI: 10.22495/cgobrv8i2sip9

This study examines the intricate relationship between investment in research, development, and innovation (RDI) and a nation's gross domestic product (GDP), with a specific focus on understanding how technical and vocational education and training (TVET) performance moderates this association. Utilizing panel data analysis, the research investigates the direct and interactive effects of RDI expenditure and TVET performance on GDP across various national contexts. While the direct impact of RDI on GDP is not statistically significant, the findings illuminate a moderated relationship wherein TVET performance serves as the interaction coefficient. Notably, countries with improved TVET performance demonstrate a significant positive correlation between RDI expenditure and GDP, highlighting the pivotal role of TVET in enhancing the effectiveness of RDI investment for economic progress. This investigation contributes to a deeper understanding of the nuanced interplay among education, innovation, and economic growth, emphasizing the strategic importance of TVET in reinforcing the efficacy of RDI policies for fostering economic advancement. By shedding light on these dynamics, the study provides valuable insights for policymakers, educators, and researchers aiming to design evidence-based strategies for sustainable economic development (Smith & Brown, 2020).

Keywords: Research, Development, and Innovation (RDI), Technical and Vocational Education and Training (TVET), Economic Growth, Moderating Effects, Gross Domestic Product (GDP), Panel Data Analysis, Education Policy, Human Capital Development, Innovation Policies, Economic Development

Authors' individual contribution: Conceptualization — D.C.D., M.D., and S.C.; Methodology — D.C.D., M.D., and S.C.; Software — D.C.D., M.D., and S.C.; Validation — D.C.D., M.D., and S.C.; Formal Analysis — D.C.D., M.D., and S.C.; Investigation — D.C.D., M.D., and S.C.; Resources — D.C.D., M.D., and S.C.; Data Curation — D.C.D., M.D., and S.C.; Writing — D.C.D., M.D., and S.C.; Visualization — D.C.D., M.D., and S.C.; Supervision — D.C.D., M.D., and S.C.; Project Administration — D.C.D., M.D., and S.C.; Funding Acquisition — D.C.D., M.D., and S.C.

Declaration of conflicting interests: The Authors declare that there is no conflict of interest.

Acknowledgements: The Authors gratefully acknowledge the opportunity to present this paper at the University of Technology Bahrain (UTB) Sustainable Innovations in Management in the Digital Transformation Era (SIMDTE): Digital Management Sustainability Conference 2023, held on May 2-3, 2023, at the InterContinental Regency Bahrain. The Authors extend their sincere appreciation to UTB for sponsoring the expenses associated with the publication of this journal.

1. INTRODUCTION

In the era of globalization, intensified competition among companies and economies has underscored the pivotal role of research, development, and innovation (RDI) in driving economic growth (Pece et al., 2015). Contemporary economic theories advocate for policies that foster innovation and human capital investment as crucial drivers of long-term economic development (Rasul et al., 2015; Faggian & McCann, 2009). Indeed, investment in RDI not only fuels economic growth but also generates positive externalities that enhance national economies.

However, the translation of RDI investment into socio-economic value heavily relies on the growth of human capital, particularly in academia and professional institutions (Cohen et al., 2002; Baek & Lee, 2024). Human capital, encompassing the requisite expertise and skills, is fundamental for leveraging technological advancements and driving innovation (Diebolt & Hippe, 2019). Consequently, the infrastructure for human capital development, including higher education institutions (HEIs) and technical and vocational education and training (TVET) programs, plays a pivotal role in mediating the impact of RDI on economic development.

Despite its significance, the moderating role of HEIs and TVET in the relationship between RDI and economic development remains underexplored, particularly in the Middle East and North Africa (MENA) region. This knowledge gap is critical, given the region's challenges in enhancing national participation in technical and professional occupations within the manufacturing sector (Hossain, 2015). Moreover, TVET is a crucial discipline with unique features essential for global economic development (Gyimah, 2020).

Therefore, this study aims to empirically investigate the moderating role of TVET in the relationship between RDI and economic development, focusing specifically on the MENA region. Drawing on insights from seminal works by Pece et al. (2015), Rasul et al. (2015), Cohen et al. (2002), Diebolt and Hippe (2019), and Hossain (2015), as well as recent studies by Faggian and McCann (2009), Tir et al. (2023) and Hassan et al. (2020), the study seeks to provide theoretical insights into the mechanisms underlying the interplay between TVET, RDI, and economic growth. By employing rigorous panel data analysis methods, the research endeavors to offer actionable recommendations for policymakers and stakeholders to optimize the effectiveness of educational infrastructure in driving sustainable economic growth in MENA countries.

The structure of this paper is as follows. Section 2 reviews the relevant literature, providing a comprehensive overview of previous research on TVET, RDI, and economic development. Section 3 outlines the methodology employed in conducting empirical research, detailing the data sources, variables, and analytical techniques utilized. Section 4 presents the empirical findings and discusses their implications. Finally, Section 5 concludes the paper by summarizing the main findings, discussing their significance, and suggesting avenues for future research.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

This section critically examines the existing literature on TVET, RDI, and their interplay with economic development. The review encompasses seminal works spanning recent years (2015-2024) to provide a comprehensive understanding of the theoretical underpinnings and empirical evidence in this domain.

TVET plays a crucial role in equipping individuals with the skills and competencies necessary to meet the demands of evolving industries and drive economic growth (Bennell, 2023). Recent studies emphasize the significance of TVET in enhancing human capital development and facilitating the transition to knowledge-based economies (KBE) (Kapolo, 2023). Moreover, TVET programs contribute to reducing unemployment and addressing skills mismatches, thereby fostering inclusive and sustainable development (Olayele, 2022).

In parallel, RDI is recognized as a key driver of economic progress and competitiveness (Mazzucato, 2018). Governments and policymakers increasingly prioritize RDI investment and innovation ecosystems to spur productivity growth and technological advancement (Tocan et al., 2022). However, the effective translation of RDI into economic value hinges on the availability of skilled human capital (Crescenzi et al., 2019).

Recent empirical studies highlight the complex relationship between TVET, RDI, and economic development. For instance, research by Garcia et al. (2023) underscores the positive impact of TVET on innovation performance in emerging economies, emphasizing the role of vocational skills in fostering entrepreneurial endeavors. Additionally, studies by Hassan et al. (2021) and Fan et al. (2024) highlight the mediating effect of TVET on the relationship between RDI investment, innovation activities, and economic growth, particularly in developing countries.

Moreover, Billett (2009) discusses the policies, practices, and prospects of vocational education and training, shedding light on the importance of effective implementation strategies. Pereira and St. Aubun (2009) provide a comparative analysis of the relationship between education and economic growth in Portugal and other European countries, offering insights into the regional variations and policy implications. Furthermore, Mouzakitis (2010) examine the contribution of vocational education to economic growth, providing empirical evidence supporting its positive impact.

Building on this literature, this study proposes several hypotheses to investigate the moderating role of TVET in the relationship between RDI and economic development in the MENA region.

These hypotheses are derived from theoretical insights and empirical evidence suggesting the pivotal role of TVET in shaping the innovation ecosystem and driving economic development. The subsequent sections present the research methodology employed, the development and the testing of these hypotheses and discuss the empirical findings in light of the existing literature.

2.1. Research, development, and innovation and economic development in the MENA region

About 22 nations in the Middle East and North Africa make up the MENA region. MENA is the geographical area that connects the Middle East and the Maghreb nations (Aydemir & Demirhan, 2017). Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, and Yemen are among the nations that make up the region.

Despite its rich natural resources, Hossain (2013) highlighted that the region considers insufficient skilled labor a significant problem. This dilemma resulted in non-nationals making up the majority of the workforce, around 70% of the population, in 2004. These issues have made it harder for MENA countries to generate knowledge, which has slowed the transition to a KBE (Ahmed & Alfaki, 2013).

Further drivers of economic development related to human capital can be found in the study of Ncube et al. (2014) conducted in the MENA region. According to the study's conclusions, income inequality reduces economic growth and encourages regional poverty. Past growth rate, currency rate, government consumer spending or government burden, initial per capita gross domestic product (GDP), inflation, and primary education are all significant negative determinants for MENA economic growth.

On the other hand, Elish and ElShamy (2016) investigated the relationship between TVET enrollment and economic growth in seven MENA countries from 2003 to 2013. The findings revealed a positive and statistically significant relationship between students' enrollment in secondary and upper secondary vocational education and economic growth as evaluated by the per capita growth rate. Data analysis also revealed structural challenges in this educational system regarding funding, governance, and labor market integration.

The MENA area, noted for its geopolitical significance and natural resources, is increasingly relying on RDI to promote economic growth. Studies emphasize the critical significance of research and development in technological innovation and productivity, with countries such as Israel demonstrating the favorable effects of significant RDI expenditure on economic performance (Filippetti & Archibugi, 2011). Innovation, defined as the application of new ideas and processes, significantly contributes to economic growth, as demonstrated in the United Arab Emirates and Israel, which have robust innovation ecosystems supported by strong government policies and active private sectors (Dutta et al., 2021).

Despite the promise, the MENA area confronts major barriers to reaching its RDI potential. Major impediments include low RDI investment, political instability, regulatory limitations, and limited infrastructure (Arezki et al., 2018). On average, MENA nations invest less than 1% of their GDP in research and development. Addressing these issues necessitates comprehensive innovation policies, as demonstrated by initiatives such as Saudi Arabia's Vision 2030, which aims to transform the economy through significant investments in education, technology, and innovation (Habibi, 2019), and Tunisia's National Strategy for Research and Innovation, which aims to improve public-private partnerships and research quality (Radwan, 2018).

Successful RDI initiatives show how targeted efforts can have an impact on regional economic development. Morocco's advances in renewable energy research demonstrate the advantages of focusing on certain sectors, which contribute to energy security and create new economic prospects (Aimer, 2020). These examples demonstrate how targeted investments and supportive policies may unlock RDI potential, boosting sustainable development and increasing global competitiveness in the MENA area. Continued attempts to improve RDI activities are critical to ensuring long-term economic growth and stability.

Additionally, Otman (2019) discusses corporate governance challenges in the MENA countries, emphasizing the importance of effective governance mechanisms in fostering economic growth and development. Ziberi et al. (2021) investigate skills mismatch in the labor market, offering insights into the future of work and the role of vocational education in addressing skill gaps. Tsaknis et al. (2022) examine the personality effect on students' entrepreneurial intention, highlighting the importance of vocational education in fostering entrepreneurship and innovation. Kalyani and Mondal (2024) explore the relationship between environmental, social, and governance (ESG) disclosure and firm financial performance, underscoring the broader societal implications of vocational education and training initiatives.

Finally, Sinha and Sengupta (2022) found that information and communications technology (ICT) proxies positively and directly affect economic growth. As a result, MENA countries must strengthen their information and communication technology policies and improve their usage of current information and communication technology.

2.2. Research, development, and innovation and economic development

Lomachynska and Podgorna (2018) highlighted the crucial role of innovation development in determining the success of each country's economy. Their findings underscore the importance of fostering innovation as a key driver of economic growth and competitiveness.

Pece et al. (2015) conducted an empirical study demonstrating the necessity of investments in technology and RDI for ensuring competitiveness and sustainable economic prosperity. Their analysis revealed a positive correlation between a country's innovation capacity and long-term economic growth, emphasizing the pivotal role of innovation in driving economic advancement.

Rajput et al. (2012) further emphasized the interrelationship between GDP and the Global Innovation Index (GII), highlighting the significance of managing technological innovations to establish an innovation-driven economy. Their findings suggest that countries with higher innovation capabilities tend to experience greater economic development.

Bhujabal and Sethi (2020) identified ICT as a critical industry fostering economic growth in today's modern globalized era. Their study underscores the importance of leveraging contemporary technologies, including ICT, in driving economic progress and innovation.

Nusairi (2021) highlighted the imperative for nations to transition towards a KBE, emphasizing

the role of highly educated human capital as the primary driver of long-term economic progress and development. Their insights align with the hypothesis proposed by the authors, suggesting a significant relationship between a country's RDI activities and GDP.

With the integration of these studies, it becomes evident that RDI plays a pivotal role in driving economic development, fostering competitiveness, and ensuring sustainable growth. With this, the authors will test the hypothesis below:

H1: There is a significant relationship between a country's research, development, and innovation and economic development activities and GDP.

2.3. TVET, HEIs, and economic development

The significance of knowledge in driving competitiveness for businesses and nations stems from Romer's (1990) endogenous growth theory. Huggins and Johnston (2009) emphasize the role of a nation's knowledge base in fostering economic growth by generating innovative ideas and translating them into tangible products and processes. Universities, as hubs of knowledge creation, play a pivotal role in this process, contributing to the economic knowledge foundation through research and innovation.

Wang and Liu (2016) explore the impact of human capital education on economic growth, categorizing human capital into primary, secondary, and higher education. Their findings highlight the substantial positive effect of higher education on economic growth, underscoring the importance of investing in tertiary education for long-term development.

Kreishan and Al Hawarin (2011) investigated the causal relationship between education and economic growth in Jordan from 1978 to 2007, revealing a sustained positive association between the two variables. Their study underscores the role of a well-educated workforce in driving economic progress, emphasizing the importance of education policies in fostering growth.

In the realm of employment, TVET encompasses formal, non-formal, and informal learning experiences tailored to meet the demands of the labor market (King, 2009). Wolf (2020) positions TVET as a catalyst for change in response to globalization, enabling economies to thrive in knowledge-intensive sectors. This aligns with the findings of Regmi et al. (2015), who identify a positive correlation between state investments in education and training, human capital development, and economic growth.

Moreover, recent research by Mthembu (2022) underscores the significant effect of vocational education on income inequality, shedding light on the socio-economic implications of TVET programs. Their findings suggest that vocational education initiatives can play a crucial role in addressing income disparities, thereby contributing to overall economic development.

Building upon this theoretical framework, the following hypotheses will be examined:

H2: There is a significant relationship between a country's technical and vocational education and training performance and gross domestic product.

H3: There is a significant relationship between a country's higher education institution performance and gross domestic product.

These hypotheses seek to elucidate the role of TVET and HEIs in driving economic development, providing empirical insights into the mechanisms through which investments in education and training contribute to national economic growth.

2.4. The moderating role of TVETs and HEIs

Since Schultz (1960) introduced the concept of human capital, education and training have been recognized as pivotal in advancing human capital (Asadullah & Zafar Ullah, 2018). Education and training enhance individuals' knowledge and skills, facilitating their utilization of technological advancements and fostering innovation across various domains. At the macroeconomic level, TVET and HEIs contribute to economic development by enhancing the productivity, innovation capacity, and adaptability of the labor force (Ali Asadullah, 2019).

A well-trained and motivated workforce is instrumental in maximizing investments in research and development, which constitute significant drivers of economic growth and development (Asadullah & Zafar Ullah, 2018). Thus, the role of TVET and HEIs in mediating the relationship between technological development, innovation spending, and economic growth becomes crucial.

In light of these insights, the following hypotheses are proposed to examine the moderating role of TVET and HEIs:

H4: Technical and vocational education and training performance significantly moderates the relationship between a country's investment in research, development, and innovation and gross domestic product.

H5: Higher education institution performance significantly moderates the relationship between a country's investment in research, development, and innovation and gross domestic product.

These hypotheses aim to elucidate the extent to which TVET and HEIs influence the impact of research development and innovation investment on economic growth, providing empirical evidence on the moderating mechanisms at play in shaping national economic trajectories.

Additionally, the relationship between TVET and HEIs is critical for regulating economic development. TVET programs supplement higher education by offering practical skills for immediate labor market requirements, whereas HEIs contribute advanced knowledge and research. This collaboration is critical for developing a balanced and resilient workforce that can adjust to economic changes (Wheeler, 2017).

Empirical research implies that combining TVET and HEIs can improve economic outcomes. For example, Barton et al. (2012) discovered that economies with strong TVET and HEI systems have reduced youth unemployment and better levels of creativity. Furthermore, collaboration between TVET institutions and universities can result in more comprehensive education and training systems that cover both practical skills and academic knowledge (Maclean & Pavlova, 2011).

3. RESEARCH METHODOLOGY

This study employs a longitudinal panel data approach based on secondary sources to examine the moderating

role of TVET and HEIs in the relationship between RDI and economic development in the MENA region.

3.1. Data source and variables

The panel data utilized in this study were extracted from the Global Knowledge Index (GKI) reports for the years 2020 and 2022. The GKI comprises seven

sub-indices representing different sectors, including pre-university education, TVET, HEIs, RDI, ICT, and economy. The independent and mediator variables, including RDI, TVET, and HEIs, were measured using the GKI. Real GDP data for each country for the years 2020 and 2022 were obtained from the World Bank Open Data Platform to assess economic development.

Table 1. Variables were used to empirically test the moderating role of TVET in the relationship between RDI and economic development

Variable		Explanation
IGDP	Dependent variable	Logarithmic value of real GDP
RDIIndex	Independent variable	GKI Research, Development, and Innovation (RDI) Index score
TVETIndex	Independent variable	GKI Technical and Vocational Education and Training (TVET) Index score
HEIIndex	Independent variable	GKI Higher Education Institutions (HEIs) Index score
$\Delta TVETRank$	Moderating variable	Dummy variable: 1 = improved TVET ranking, 0 = did not improve TVET ranking
$\Delta HEIRank$	Moderating variable	Dummy variable: 1 = improved HEI ranking, 0 = did not improve HEI ranking
$RDIIndex \times \Delta TVETRank$		Product term to represent the interaction between moderating variable $\Delta TVETRank$ and $RDIIndex$
$RDIIndex \times \Delta HEIRank$		Product term to represent the interaction between moderating variable $\Delta HEIRank$ and $RDIIndex$

Finally, multiple linear regression with multiplicative interactions was applied to test the moderating effect of HEI and TVET. This process was done by multiplying the independent variable ($RDIIndex$) with the moderating variables (change in TVET and HEI ranking) to yield a product term that will be included in the model. According to Hao and Zhang (2017), multiplicative interaction at various levels of standard deviation and mod will produce findings that are the same as comparing the means directly (i.e., difference of means = mean of differences).

3.2. Sample selection

Only MENA countries with complete sets of RDI, TVET, and HEI indices for the specified periods were included in the study. This resulted in a sample of 12 countries: Bahrain, Egypt, Israel, Jordan, Kuwait, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, Türkiye, and the United Arab Emirates.

3.3. Data analysis

The panel data from the selected countries for the two periods resulted in a total of 120 entries (12 countries, two years, and six variables). For this study, the country rank and index values for HEIs and TVET were utilized in the analysis, while actual values were used for RDI. Dummy variables were employed to identify countries that improved their TVET and HEI ranking from 2020 to 2022.

3.4. Method of analysis

Multiple linear regression with multiplicative interactions was applied to test the moderating effect of HEI and TVET. This involved multiplying the independent variable ($RDIIndex$) with the moderating variables ($\Delta TVETRank$ and $\Delta HEIRank$) to yield product terms that were included in the model. This approach allows for the examination of how the relationships between RDI and economic development are influenced by changes in TVET and HEI rankings.

3.5. Alternative methods

Alternative methods for conducting this research include:

- Structural equation modeling (SEM). This approach allows for the examination of complex relationships among multiple variables simultaneously, providing insights into the direct and indirect effects of TVET and HEIs on economic development.
- Propensity score matching (PSM). PSM could be used to address potential selection bias by matching treated and control units based on their propensity scores, thereby enhancing the causal inference in observational studies.
- Qualitative comparative analysis (QCA). QCA could complement regression analysis by identifying configurational patterns of conditions that lead to a particular outcome, providing a nuanced understanding of the moderating role of TVET and HEIs.

3.6. Limitations

Limitations of this methodology include potential data availability constraints, sample selection bias, and reliance on secondary data sources, which may introduce measurement errors. Sensitivity analyses and robustness checks will be conducted to address these limitations and ensure the validity and reliability of the findings.

By employing a comprehensive methodology and considering alternative methods, this research aims to contribute to the understanding of the moderating role of TVET and HEIs in driving economic development through RDI in the MENA region.

4. EMPIRICAL RESULTS AND DISCUSSION

Table 2 summarizes descriptive statistics of the continuous variables used in the specification of the regression models used in the study. A separate table is prepared to present the dummy variables ($\Delta TVETRank$ and $\Delta HEIRank$).

Table 2. Descriptive statistics

Variables	Obs.	Mean	SD	Min	Max	Skewness/Kurtosis tests for normality		
						Skewness	Kurtosis	Prob > chi ² *
IGDP	24	10.854	0.556	9.927	11.857	0.7442	0.3022	0.5301
RDIIndex	24	26.595	11.06	17.4	64.5	0.0911	0.1819	0.1102
TVETIndex	24	54.833	8.748	43.5	70.1	0.1944	0.1795	0.1493
HEIIndex	24	43.170	7.784	31.8	61.8	0.0907	0.5705	0.1681

Note: * – joint, SD – standard deviation.

Table 2 provides descriptive statistics for the continuous variables used in the regression models. The log values of *IGDP* exhibit a mean of 10.854 and a standard deviation of 0.556. Comparatively, the *RDIIndex* shows the highest standard deviation (11.06), while the *TVETIndex* exhibits the highest mean (54.833). Skewness and kurtosis tests suggest that the data distribution is within the normal range, indicating that the variables follow a normal distribution.

The results of the regression analysis reveal several significant findings. Firstly, the interaction term between *RDIIndex* and the change in TVET rank ($\Delta TVETRank$) is statistically significant ($p < 0.05$), indicating that TVET performance moderates the relationship between RDI and economic development. Specifically, improvements in TVET ranking amplify the positive impact of RDI on economic growth. This finding underscores the importance of investing in TVET to leverage the benefits of research and innovation for economic development.

Secondly, the interaction term between RDI and the change in HEI rank ($\Delta HEIRank$) is also significant ($p < 0.05$), suggesting that HEI performance moderates the relationship between RDI and GDP. Similarly, enhancements in HEI ranking enhance the positive association between RDI and economic growth. This underscores the pivotal role of HEIs in translating research and innovation into tangible economic outcomes.

Overall, these findings highlight the complementary roles of TVET and HEIs in fostering economic development through research and innovation. Policymakers in the MENA region should prioritize investments in both TVET and HEIs to maximize the socio-economic benefits of RDI. Additionally, efforts to improve the quality and relevance of TVET and HEIs are essential for enhancing their moderating effects on the RDI-economic development relationship.

In summary, the empirical results underscore the significance of TVET and HEIs as key drivers of economic development in the MENA region, particularly in leveraging the benefits of research and innovation. These findings have important

implications for policy formulation and strategic planning aimed at promoting sustainable economic growth and prosperity in the region.

Table 3. Pairwise correlation

Variables	IGDP	RDIIndex	TVETIndex	HEIIndex
IGDP	1.00			
RDIIndex	0.2835	1.00		
TVETIndex	0.1242	0.3164	1.00	
HEIIndex	0.2447	0.3896	0.3655	1.00

Table 3 presents the pairwise correlation between the variables examined in Table 2. Remarkably, no significant correlations are evident among any of the variables. This absence of significant correlations is beneficial as it indicates the absence of multicollinearity issues within the regression models (Shrestha, 2020). Multicollinearity, which occurs when independent variables in a regression model are highly correlated, can distort the estimation of coefficients and undermine the reliability of the results (Shrestha, 2020). Therefore, the absence of significant correlations enhances the validity of the regression analysis results and increases the likelihood of obtaining statistically significant coefficients (Shrestha, 2020).

Moreover, the lack of significant correlations suggests that each independent variable makes a unique and independent contribution to the variation in the dependent variable (*IGDP*). This finding reinforces the distinct roles played by RDI, TVET, and HEI in influencing economic development. It underscores the importance of considering each variable separately when examining their effects on economic growth, rather than conflating them due to high intercorrelations (Shrestha, 2020).

In conclusion, the absence of significant correlations among the variables is a positive indication of the robustness of the regression analysis results. It ensures that the estimated coefficients accurately reflect the relationships between the independent and dependent variables. Policymakers and researchers can thus have confidence in the reliability of the findings presented in this study, which contribute valuable insights into the factors driving economic development in the MENA region.

Table 4. Data pertaining to ranking per index

Index	Improved ranking	Did not improve ranking	Total
TVET	7	5	12
HEI	4	8	12
Total	11	13	24

Table 4 shows the number of countries that improved or did not improve their TVET and HEIs ranking from 2020 to 2022. As can be seen from Table 4, seven out of twelve countries improved their country ranking in TVET, while four did the same in HEIs.

The above table provides insights into the changes in TVET and HEI rankings across the MENA countries from 2020 to 2022. It reveals that a greater proportion of countries improved their TVET ranking compared to their HEI ranking during this period. Specifically, seven out of twelve countries enhanced their TVET ranking, while only four countries saw

improvements in their HEI ranking. This variation in improvement rates underscores the diverse trajectories of educational and vocational training

systems across the region and highlights potential areas for targeted policy interventions to enhance educational outcomes and workforce development.

Table 5. Ordinary least squares regression results with moderating variables

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
<i>RDIIndex</i>	0.0107 (0.0124)	0.0209 (0.0206)	-0.0575 (0.0423)	0.0287 (0.0218)	0.0025 (0.0117)
<i>TVETIndex</i>	0.0003 (0.0180)				
<i>HEIIndex</i>	0.0098 (0.0147)				
$\Delta TVETRank$ (Mod)		-0.1113 (0.2518)	-2.779 (1.184)**		1.363 (0.6917)*
$\Delta HEIRank$ (Mod)		-0.3866 (0.8153)	0.261 (3.105)	2.423 (3.215)	
<i>RDIIndex</i> \times $\Delta TVETRank$			0.1108 (0.0481)**		0.0507 (0.0260)*
<i>RDIIndex</i> \times $\Delta HEIRank$			0.0339 (0.0660)	-0.0523 (0.0590)	
R-squared	0.095	0.196	0.328	0.122	0.232
BIC	49.27	49.22	48.48	48.53	45.33
AIC	44.56	44.51	41.41	43.82	40.62

Model 1 = Loading factors: *RDIIndex*, *TVETIndex*, and *HEIIndex* (no moderators);
 Model 2 = Loading factors: *RDIIndex*, $\Delta TVETRank$, and $\Delta HEIRank$ (no moderators);
 Model 3 = Loading factors: *RDIIndex* with $\Delta TVETRank$ and $\Delta HEIRank$ as moderators;
 Model 4 = Loading factors: *RDIIndex* with $\Delta HEIRank$ as moderator;
 Model 5 = Loading factors: *RDIIndex* with $\Delta TVETRank$ and as moderator.

Note: BIC – Bayesian information criterion, AIC – Akaike information criterion. Standard errors in parenthesis. ** $p < 0.05$, * $p < 0.10$.

The regression analysis presented in Table 5 offers a comprehensive examination of the relationship between various factors, including the *RDIIndex*, *TVETIndex*, *HEIIndex*, and their moderating effects on economic growth in the MENA region.

- In Model 1 and Model 2, the coefficients for the *RDIIndex* are not statistically significant (0.0107 and 0.0209, respectively). This suggests that the direct effects of RDI on economic growth are negligible when not considering moderating variables. Additionally, both models exhibit low R-squared values of 9.5% and 19.6%, respectively. These models also possess the highest BIC and AIC values, indicating poor model fit.

- Model 3 introduces $\Delta TVETRank$ and $\Delta HEIRank$ as moderators to examine their interaction effects with the *RDIIndex*. The significant coefficient for *RDIIndex* \times $\Delta TVETRank$ (0.1108, $p < 0.05$) suggests that improvements in TVET ranking enhance the positive effect of RDI on economic growth. This finding underscores the importance of vocational education and training in complementing RDI investments to drive economic development. However, the coefficient for *RDIIndex* \times $\Delta HEIRank$ is not statistically significant, indicating that changes in HEI rank do not significantly moderate the relationship between RDI and economic growth.

- Conversely, Model 4 includes only $\Delta HEIRank$ as a moderator. The coefficient for the interaction term (*RDIIndex* \times $\Delta HEIRank$) remains statistically insignificant, reinforcing the notion that changes in HEI rank do not contribute significantly to the relationship between RDI and economic growth.

- Model 5 combines the moderators from Models 3 and 4. The significant coefficient for *RDIIndex* \times $\Delta TVETRank$ (0.0507, $p < 0.05$) indicates that improvements in TVET ranking continue to enhance the effect of RDI on economic growth. However, the insignificance of *RDIIndex* \times $\Delta HEIRank$ suggests that changes in HEI rank do not significantly contribute to this relationship.

Considering these regression results alongside findings from Table 4, which provides insights into changes in TVET and HEI rankings across MENA countries, it is observed that improvements in TVET ranking have a more pronounced impact on economic growth compared to HEI ranking improvements (Hao & Zhang, 2017). This highlights the importance of prioritizing investments in vocational education and training systems to maximize the impact of RDI investments on GDP growth. Moreover, the marginal effects analysis from Table 6 could further complement these findings by providing insights into how changes in RDI and TVET rankings translate into actual changes in GDP.

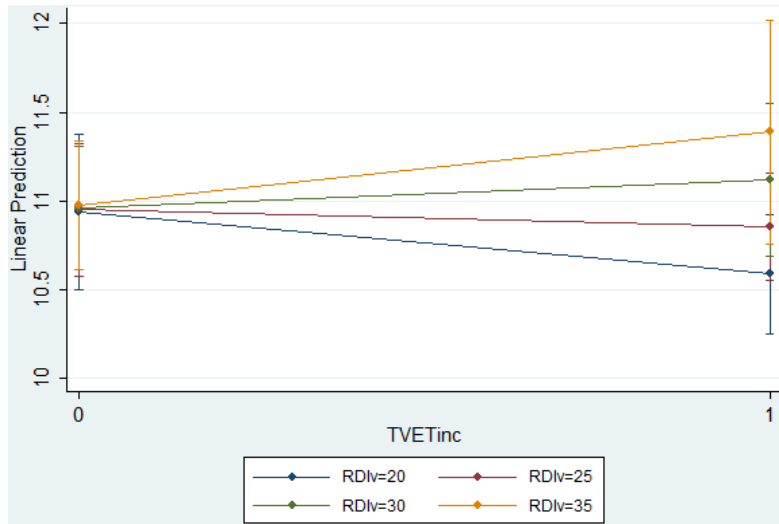
Overall, the findings suggest that fostering synergies between RDI investments and improvements in TVET systems is essential for driving sustainable economic growth in the MENA region (Kreishan & Al Hawarin, 2011). Policymakers should prioritize policies that support both RDI and TVET initiatives, ensuring alignment between educational and innovation strategies. Additionally, further research could explore additional contextual factors that may influence the relationship between RDI, education, and economic growth, providing more nuanced insights for evidence-based policymaking.

Table 6. The marginal effect of *RDIIndex* on *IGDP* with Δ *TVETRank* as a moderator

Expression		Delta-method		t	p > t	[95% conf. interval]	
<i>RDIIndex</i>	Δ <i>TVETRank</i> *	Margin	Std. error				
20	0	10.93663	0.2089457	52.34	0.000	10.50077	11.37248
20	1	10.58818	0.1621199	65.31	0.000	10.25	10.92636
25	0	10.9496	0.1792637	61.08	0.000	10.57566	11.32354
25	1	10.85482	0.1439838	75.39	0.000	10.55447	11.15516
30	0	10.96257	0.1657453	66.14	0.000	10.61683	11.30831
30	1	11.12146	0.2058037	54.04	0.000	10.69216	11.55076
35	0	10.97554	0.1722391	63.72	0.000	10.61625	11.33482
35	1	11.3881	0.3019179	37.72	0.000	10.75831	12.01789

Note: * 1 = with improvement, 0 = no improvement.

Figure 1. Influence of *RDIIndex* on *IGDP* modulated by *TVETRank*



Note: Adjusted predictions with 95% confidence limits.

Table 6 and Figure 1 delve deeper into understanding the dynamics between RDI, TVET ranking, and economic growth. The marginal effect analysis reveals that the influence of RDI on GDP varies based on the level of TVET ranking improvement. Particularly, as RDI increases from 20 to 25, the marginal effect on GDP is more significant (0.266 = 10.854 - 10.588) when TVET rank indicates an improvement (1) compared to when there is no improvement (0) (0.013 = 10.949 - 10.936). This trend persists across all increments of RDI, indicating a synergistic relationship between RDI investment and TVET performance in driving economic growth (Huggins & Johnston, 2009).

The statistically significant marginal effects underscore the importance of aligning investments in research and development with enhancements in vocational education and training systems to maximize their impact on economic development (Gennaioli et al., 2013). These findings empirically support the hypothesis that the effectiveness of RDI investments in stimulating economic growth depends on the quality and performance of a country's TVET system (Tsaknis et al., 2022). Therefore, policymakers and stakeholders should prioritize strategies aimed at improving TVET outcomes to leverage investments in innovation and technology for sustainable economic development (McGuinness et al., 2017).

Furthermore, the visual representation of the marginal effects in Figure 1 enhances the interpretability of the results by illustrating the widening gap in GDP predictions between

countries with improved TVET ranking and those without. This visualization reinforces the idea that advancements in TVET performance amplify the positive effects of RDI investments on GDP, underscoring the importance of targeted interventions to strengthen TVET systems (Kreishan & Al Hawarin, 2011).

Overall, the empirical findings highlight the intricate dynamics shaping the relationship between education, innovation, and economic growth (Acemoglu & Autor, 2012). They provide valuable insights for policymakers, educators, and researchers seeking evidence-based strategies to foster sustainable economic development in the MENA region and beyond. By acknowledging and investing in the synergies between RDI and TVET, countries can position themselves for long-term prosperity and competitiveness in the global knowledge economy (Galor, 2005).

5. CONCLUSION

This study significantly contributes to the understanding of the intricate relationship between investment in education, RDI, and economic development, particularly in the MENA region. By highlighting the moderating role of TVET in enhancing the impact of research and innovation investments on economic growth, the study underscores the strategic importance of investing in human capital development for sustainable development (Stofkova & Sukalova, 2020).

The conclusions of this study have various ramifications for politicians, educators, and academics. First, the study emphasizes the critical need for MENA countries to prioritize TVET reforms and investments in order to increase the region's ability for innovation, productivity, and competitiveness (Bhurtel, 2015; Salehi Fereidooni et al., 2020). Addressing structural obstacles in TVET, such as insufficient funding and governance issues, is critical to realizing its full potential for driving economic development (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2017).

Second, the study emphasizes the importance of conducting a thorough examination of the role of HEIs in supporting innovation and economic growth. While universities are acknowledged as knowledge-generating engines, their role in converting ideas into actual economic benefits has received less attention (Guerrero et al., 2015). Future studies should focus on understanding the mechanisms by which higher education institutions might stimulate innovation and economic development (Etzkowitz & Leydesdorff, 2000).

Furthermore, the findings highlight the necessity of combining education, research, and innovation policy into a cohesive framework aimed at encouraging long-term economic growth. To optimize the impact of education and research investments on economic development, policymakers should consider taking a comprehensive strategy for human capital development that includes both TVET and HEIs (Barrett, 2019; Salmi & Hauptman, 2019).

Despite its contributions, this study has several limitations that warrant consideration in future research. Firstly, the analysis is limited to a specific region (MENA) and a relatively short timeframe, which may restrict the generalizability of the findings (Otman, 2019). Future research could benefit from expanding the analysis to include other regions and a longer timeframe to provide a more comprehensive understanding of the dynamics between education, innovation, and economic growth (Ziberi et al., 2021).

Additionally, the study relies on secondary data sources, which may introduce measurement error and bias into the analysis. Future research could employ primary data collection methods to mitigate these limitations and provide more robust empirical evidence (Tsaknis et al., 2022). Moreover, the study focuses primarily on the direct effects of education and research investments on economic development, neglecting potential mediating and moderating factors that may influence this relationship (Kalyani & Mondal, 2024).

In conclusion, this study underscores the critical role of education and research in driving economic development in the MENA region and beyond. By addressing the identified limitations and building on the findings of this research, future studies can contribute to advancing knowledge and informing evidence-based policies aimed at fostering sustainable economic development globally.

REFERENCES

- Acemoglu, D., & Autor, D. (2012). *What does human capital do? A review of Goldin and Katz's the race between education and technology* (NBER Working Paper No. 17820). National Bureau of Economic Research (NBER). <https://doi.org/10.3386/w17820>
- Ahmed, A., & Alfaki, I. M. A. (2013). Transforming the United Arab Emirates into a knowledge-based economy: The role of science, technology and innovation. *World Journal of Science, Technology and Sustainable Development*, 10(2), 84–102. <https://doi.org/10.1108/20425941311323109>
- Aimer, N. M. (2020). Renewable energy consumption, financial development and economic growth: Evidence from panel data for the Middle East and North African countries. *Economics Bulletin*, 40(3), 2058–2072. <http://www.accessecon.com/Pubs/EB/2020/Volume40/EB-20-V40-I3-P180.pdf>
- Ali Asadullah, M. (2019). Quadratic indirect effect of national TVET expenditure on economic growth through social inclusion indicators. *SAGE Open*, 9(1). <https://doi.org/10.1177/2158244019830557>
- Arezki, R., Mottaghi, L., & Barone, A. (2018). *Middle East and North Africa economic monitor, October 2018: A new economy in Middle East and North Africa*. World Bank. <https://doi.org/10.1596/978-1-4648-1367-2>
- Asadullah, M. A., & Zafar Ullah, A. (2018). Social-economic contribution of vocational education and training: An evidence from OECD countries. *Industrial and Commercial Training*, 50(4), 172–184. <https://doi.org/10.1108/ICT-12-2017-0100>
- Aydemir, O., & Demirhan, B. (2017). The relationship between stock prices and exchange rates: Evidence from MENA countries. In M. Khosrow-Pour (Ed.), *Handbook of research on global enterprise operations and opportunities* (pp. 171–185). IGI Global. <https://doi.org/10.4018/978-1-5225-2245-4.ch011>
- Baek, S., & Lee, D. H. (2024). Can R&D investment be a key driver for sustainable development? Evidence from Korean industry. *Corporate Social Responsibility and Environmental Management*, 31(2), 838–853. <https://doi.org/10.1002/csr.2607>
- Barrett, B. (2019). The dual roles of higher education institutions in the knowledge-economy. *International Journal of Multidisciplinary Perspectives in Higher Education*, 4(1), 76–88. <https://doi.org/10.32674/jimphe.v4i1.1325>
- Barton, D., Farrell, D., & Mourshed, M. (2012). *Education to employment: Designing a system that works*. McKinsey & Company. <https://www.mckinsey.com/industries/education/our-insights/education-to-employment-designing-a-system-that-works#/>
- Bennell, P. (2023). Practising what you preach, preaching what you practice: World Bank support for technical and vocational education and training in sub-Saharan Africa. *Compare: A Journal of Comparative and International Education*, 53(8), 1410–1428. <https://doi.org/10.1080/03057925.2022.2036594>
- Bhujabal, P., & Sethi, N. (2020). Foreign direct investment, information and communication technology, trade, and economic growth in the South Asian Association for Regional Cooperation countries: An empirical insight. *Journal of Public Affairs*, 20(1), Article e2010. <https://doi.org/10.1002/pa.2010>
- Bhurtel, A. (2015). Technical and vocational education and training in workforce development. *Journal of Training and Development*, 1, 77–84. <https://doi.org/10.3126/jtd.v1i0.13094>

- Billett, S. (2009). Overview: The technical and vocational education and training profession. In R. Maclean & D. Wilson (Eds.), *International handbook of education for the changing world of work: Bridging academic and vocational learning* (pp. 1174–1184). Springer. https://doi.org/10.1007/978-1-4020-5281-1_77
- Byrne, B. M. (2016). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (3rd ed.). Routledge. <https://doi.org/10.4324/9781315757421>
- Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2002). Links and impacts: The influence of public research on industrial R&D. *Management Science*, 48(1). <https://doi.org/10.1287/mnsc.48.1.1.14273>
- Crescenzi, R., Iammarino, S., & Ioramashvili, C., Rodriguez-Pose, A., & Storper, M. (2019). *The geography of innovation: Local hotspots and global innovation networks* (Economic Research Working Paper No. 57). World Intellectual Property Organization (WIPO). <https://doi.org/10.34667/tind.40536>
- Dees, P., & Auktor, G. V. (2018). Renewable energy and economic growth in the MENA region: Empirical evidence and policy implications. *Middle East Development Journal*, 10(2), 225–247. <https://doi.org/10.1080/17938120.2018.1520000>
- Diebolt, C., & Hippe, R. (2019). The long-run impact of human capital on innovation and economic development in the regions of Europe. *Applied Economics*, 51(5), 542–563. <https://doi.org/10.1080/00036846.2018.1495820>
- Dixit, P., & Ravichandran, R. (2023). The impact of vocational education on economic growth and development across the G20 countries. *Indian Journal of Vocational Education*, 35, 57–68. <https://www.psscive.ac.in/dvet/IJVE%2035-6Chapter.pdf>
- Dutta, S., Lanvin, B., Rivera León, L., & Wunsch-Vincent, S. (2021). *Global innovation index 2021: Tracking innovation through the COVID-19 crisis* (14th ed.). World Intellectual Property Organization (WIPO). <https://doi.org/10.34667/tind.44315>
- Elish, E., & ElShamy, H. (2016). The impact of students' enrollment in technical vocational education on the economic growth: Evidence from MENA counties. *International Journal of Business and Economics Perspectives*, 11(1). <https://buescholar.bue.edu/eg/econ/38>
- Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From national systems and "Mode 2" to a triple helix of university-industry-government relations. *Research Policy*, 29(2), 109–123. [https://doi.org/10.1016/S0048-7333\(99\)00055-4](https://doi.org/10.1016/S0048-7333(99)00055-4)
- Faggian, A., & McCann, P. (2009). Human capital and regional development reconsidered. In R. Capello & P. Nijkamp (Eds.), *Regional dynamics and growth: Advances in regional economics*. Edward Elgar Publishing. <https://www.researchgate.net/publication/286136775>
- Fan, Y., Zheng, H., Ebonite, R. S., De Asis, W. R., & Juanatas, R. A. (2024). Overview and developmental analysis of China's technical and vocational education and training. *International Journal of Innovative Research and Scientific Studies*, 7(1), 251–260. <https://doi.org/10.53894/ijirss.v7i1.2606>
- Filippetti, A., & Archibugi, D. (2011). Innovation in times of crisis: National systems of innovation, structure, and demand. *Research Policy*, 40(2), 179–192. <https://doi.org/10.1016/j.respol.2010.09.001>
- Galor, O. (2005). From stagnation to growth: Unified growth theory. *Handbook of Economic Growth*, 1(Part A), 171–293. [https://doi.org/10.1016/S1574-0684\(05\)01004-X](https://doi.org/10.1016/S1574-0684(05)01004-X)
- Garcia, R., Araujo, V., Mascarini, S., Gomes Santos, E., Costa, A., & Ferreira, S. (2023). How industrial diversity shapes the effects of foreign direct investment spillovers on regional innovation. *International Regional Science Review*, 46(1), 98–122. <https://doi.org/10.1177/01600176221099182>
- Gennaioli, N., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2013). Human capital and regional development. *The Quarterly Journal of Economics*, 128(1), 105–164. <https://doi.org/10.1093/qje/qjs050>
- Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy*, 44(3), 748–764. <https://doi.org/10.1016/j.respol.2014.10.008>
- Gyimah, N. (2020). *Assessment of technical and vocational education and training (TVET) on the development of the world's economy: Perspective of Africa, Asia and Europe*. <http://doi.org/10.2139/ssrn.3541072>
- Habibi, N. (2019). Implementing Saudi Arabia's Vision 2030: An interim balance sheet. *Middle East Brief*, 127. <https://www.brandeis.edu/crown/publications/middle-east-briefs/pdfs/101-200/meb127.pdf>
- Hair, J. F., Jr., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.
- Hao, N., & Zhang, H. H. (2017). A note on high-dimensional linear regression with interactions. *The American Statistician*, 71(4), 291–297. <https://doi.org/10.1080/00031305.2016.1264311>
- Hassan, N. M., Gutowski, A., Nour, S. S. O. M., Knedlik, T., Tong, C. M. N., Wohlmuth, K., & Alabi, R. A. (2020). *Science, technology and innovation policies for economic transformation in North Africa: Human skills development and country cases*. LIT Verlag.
- Hassan, R. H., Hassan, M. T., Naseer, S., Khan, Z., & Jeon, M. (2021). ICT enabled TVET education: A systematic literature review. *IEEE Access*, 9, 81624–81650. <https://doi.org/10.1109/ACCESS.2021.3085910>
- Hossain, A. (2015). Evolution of mutual knowledge-based economy in regional integration: An experience from the Cooperation Council of Arab States of the Gulf. *Journal of the Knowledge Economy*, 6, 790–817. <https://doi.org/10.1007/s13132-013-0148-5>
- Huggins, R., & Johnston, A. (2009). The economic and innovation contribution of universities: A regional perspective. *Environment and Planning C: Government and Policy*, 27(6), 1088–1106. <https://doi.org/10.1068/c08125b>
- Kalyani, S., & Mondal, R. (2024). Is ESG disclosure creating value propositions for the firms? An SLR and meta-analysis of how ESG affects the financials of a firm. *Corporate Ownership & Control*, 21(1), 96–117. <https://doi.org/10.22495/cocv21i1art9>
- Kapolo, B. N. (2023). *Stakeholder perceptions of technical and vocational education and training (TVET) in Namibia: A social realist perspective* [Doctoral dissertation, Stellenbosch University]. <https://scholar.sun.ac.za/items/0e02916b-1308-4ce0-ab51-a9fb43cfaadb8>
- King, K. (2009). *A technical and vocational education and training strategy for UNESCO. A background paper*. United Nations Educational, Scientific and Cultural Organization (UNESCO). https://unevoc.unesco.org/fileadmin/user_upload/docs/A_Technical_and_Vocational_Education_and_Training_Strategy_for_UNESCO_Background_Paper_by_Kenneth_King.pdf

- Kreishan, F. M., & Al Hawarin, I. M. (2011). Education and economic growth in Jordan: Causality test. *Journal of Economic & Management Perspectives*, 5(1), 45-53. <https://www.proquest.com/openview/c55ced9fe533dde7198381d29511fb85/1?pq-origsite=gscholar&cbl=51667>
- Lee, H. S., Mun Har, W., & Sin Yee, L. (2020). Impacts of lower and upper secondary vocational education on economic growth. *Journal of Technical Education and Training*, 12(1). <https://penerbit.uthm.edu.my/ojs/index.php/JTET/article/view/3992>
- Lomachynska, I., & Podgorna, I. (2018). Innovation potential: Impact on the national economy's competitiveness of the EU developed countries. *Baltic Journal of Economic Studies*, 4(1), 262-270. <https://doi.org/10.30525/2256-0742/2018-4-1-262-270>
- Maclean, R., & Pavlova, M. (2011). Skills development for employability (TVET) in higher education: Issues and challenges. *Journal of Asian Public Policy*, 4(3), 321-330. <https://doi.org/10.1080/17516234.2011.630226>
- Mazzucato, M. (2018). *The value of everything: Making and taking in the global economy*. PublicAffairs.
- McGuinness, S., Poulidakas, K., & Redmond, P. (2017). *How useful is the concept of skills mismatch?* (IZA Discussion Paper No. 10786). IZA Institute of Labor Economics. <http://doi.org/10.2139/ssrn.2979934>
- Mohammed, E. A., Naugler, C., & Far, B. H. (2015). Emerging business intelligence framework for a clinical laboratory through big data analytics. In Q. N. Tran & H. Arabnia (Eds.), *Emerging trends in computational biology, bioinformatics, and systems biology: A volume in emerging trends in computer science and applied computing* (pp. 577-602). Elsevier. <https://doi.org/10.1016/B978-0-12-802508-6.00032-6>
- Mouzakitis, G. S. (2010). The role of vocational education and training curricula in economic development. *Procedia — Social and Behavioral Sciences*, 2(2), 3914-3920. <https://doi.org/10.1016/j.sbspro.2010.03.616>
- Mthembu, M. (2022). *A comparative analysis of technical vocational education and training as an instrument for prosperity attainment in South Africa* [Master's thesis, University of KwaZulu-Natal]. <https://researchspace.ukzn.ac.za/server/api/core/bitstreams/22a73bba-79f6-46f1-a066-3c583d8b713d/content>
- Ncube, M., Anyanwu, J. C., & Hausken, K. (2014). Inequality, economic growth and poverty in the Middle East and North Africa (MENA). *African Development Review*, 26(3), 435-453. <https://doi.org/10.1111/1467-8268.12103>
- Nusairi, A. M. A. (2021). *An empirical study of UAE transformation into a knowledge-based economy: Economy, education, innovation, and information technologies as antecedents* [Doctoral dissertation, University of Dubai]. <https://doi.org/10.6084/m9.figshare.19435058.v1>
- Olayele, T. (2022). Redesigning Africa's TVET to achieve the United Nations Sustainable Development Goals. In F. Olayele & Y. Samy (Eds.), *Sustainable development in post-pandemic Africa: Effective strategies for resource mobilization* (pp. 68-86). Routledge.
- Otman, K. (2019). Corporate governance challenges: In the context of MENA countries. *Journal of Governance & Regulation*, 8(4), 35-45. <https://doi.org/10.22495/jgrv8i4art3>
- 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\(15\)00874-6](https://doi.org/10.1016/S2212-5671(15)00874-6)
- Pereira, J., & St. Aubun, M. (2009). What level of education matters most for growth? Evidence from Portugal. *Economics of Education Review*, 28(1), 67-73. <https://doi.org/10.1016/j.econedurev.2007.12.001>
- Radwan, A. (2018). Science and innovation policies in North African countries: Exploring challenges and opportunities. *Entrepreneurship and Sustainability Issues*, 6(1), 268-282. [https://doi.org/10.9770/jesi.2018.6.1\(17\)](https://doi.org/10.9770/jesi.2018.6.1(17))
- Rajput, N., Khanna, A., & Oberoi, S. (2012). Global innovation index and its impact on GDP of BRICS nations-innovation linkages with economic growth: An empirical study. *Global Journal of Enterprise Information System*, 4(2), 35-44. <https://www.gjeis.com/index.php/GJEIS/article/view/513>
- Rasul, M. S., Ashari, Z. H. M., Azman, N., & Rauf, R. A. A. (2015). Transforming TVET in Malaysia: Harmonizing the governance structure in a multiple stakeholder setting. *The Online Journal for Technical and Vocational Education and Training in Asia*, 4. <https://tvvet-online.asia/4/rasul-et-al/>
- Regmi, P., Deland, T. S., Steibel, J. P., Robison, C. I., Haut, R. C., Orth, M. W., & Karcher, D. M. (2015). Effect of rearing environment on bone growth of pullets. *Poultry Science*, 94(3), 502-511. <https://doi.org/10.3382/ps/peu041>
- Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2), S71-S102. <https://www.jstor.org/stable/2937632>
- Salehi Fereidooni, A., Elmi, Z., & Eisazadeh Roshan, Y. (2020). The effect of brain drain and economic growth in the MENA region. *Macroeconomics Research Letter*, 15(29), 231-259. <https://doi.org/10.22080/iejm.2020.16282.1682>
- Salmi, J., & Hauptman, A. M. (2019). Innovations in tertiary education financing: A comparative evaluation of allocation mechanisms. In A. S. Preker, H. Beciu, & E. L. Keuffel (Eds.), *Financing the education of health workers* (World Scientific Series in Health Investment and Financing, Vol. 3, pp. 421-520). World Scientific. https://doi.org/10.1142/9789813278752_0011
- Schultz, T. W. (1960). Capital formation by education. *Journal of Political Economy*, 68(6), 571-583. <https://www.jstor.org/stable/1829945>
- Shrestha, N. (2020). Detecting multicollinearity in regression analysis. *American Journal of Applied Mathematics and Statistics*, 8(2), 39-42. <https://doi.org/10.12691/ajams-8-2-1>
- Sinha, M., & Sengupta, P. P. (2022). FDI inflow, ICT expansion and economic growth: An empirical study on Asia-pacific developing countries. *Global Business Review*, 23(3), 804-821. <https://doi.org/10.1177/0972150919873839>
- Smith, R. A., & Brown, M. G. (2020). Far beyond postsecondary: Longitudinal analyses of topical and citation networks in the field of higher education studies. *The Review of Higher Education*, 44(2), 237-264. <https://doi.org/10.1353/rhe.2020.0040>
- Stofkova, Z., & Sukalova, V. (2020). Sustainable development of human resources in globalization period. *Sustainability*, 12(18), Article 7681. <https://doi.org/10.3390/su12187681>
- Tir, A., Salah, R. B., Achour, S., & Ferhat, K. (2023). Examining the Global Knowledge Index: A confirmatory factor analysis approach. *Tobacco Regulatory Science*, 9(2), 1416-1421. <https://www.researchgate.net/publication/376799791>

- Tocan, M., Chindriș-Văsioiu, O., Cristea, A., & Gudănescu, N. (2022). Investments in research-development-innovation — A way to overcome the crisis generated by COVID-19. *Hyperion Economic Journal*, 9(1), 3-9. [https://hej.hyperion.ro/articles/HEJ%20nr1\(9\)_2022.pdf#page=4](https://hej.hyperion.ro/articles/HEJ%20nr1(9)_2022.pdf#page=4)
- Tsaknis, P. A., Sahinidis, A. G., Tsakni, G. J., Vassiliou, E. V., Kavagia, C. A., Giovanis, A. N., & Stavroulakis, D. (2022). Personality effect on students' entrepreneurial intention: The mediating effect of the theory of planned behavior. *Corporate & Business Strategy Review*, 3(2), 86-95. <https://doi.org/10.22495/cbsrv3i2art8>
- United Nations Educational, Scientific and Cultural Organization (UNESCO). (2017). *Technical and vocational education and training (TVET) reforms in the MENA region: Challenges and opportunities*. UNESCO Institute for Lifelong Learning.
- Wang, Y., & Liu, S. (2016). Education, human capital and economic growth: Empirical research on 55 countries and regions (1960-2009). *Theoretical Economics Letters*, 6(2), 347-355. <http://doi.org/10.4236/tel.2016.62039>
- Wheeler, L. (2017). TVET and the UNESCO global network of learning cities: Relevance for countries in the Middle East. *International Journal of Training Research*, 15(3), 245-254. <https://doi.org/10.1080/14480220.2017.1376776>
- Wolf, S. (2020). Tools and means to understand different TVET models in developing countries: An approach to the epistemological opening up of international TVET in development cooperation. In M. Pilz & J. Li (Eds.), *Comparative vocational education research: Enduring challenges and new ways forward* (pp. 57-78). Springer. https://doi.org/10.1007/978-3-658-29924-8_4
- Ziberi, B., Rexha, D., & Ukshini, K. (2021). Skills mismatch in the labor market: The future of work from the viewpoint of enterprises in case of Kosovo. *Journal of Governance & Regulation*, 10(3), 104-116. <https://doi.org/10.22495/jgrv10i3art9>