Scientometrics
https://doi.org/10.1007/s11192-025-05438-4

Research output and economic growth: is there any role for institutions?

Chadi Azmeh[1,2,3,4]

Received: 24 November 2024 / Accepted: 6 October 2025

Abstract
This research investigates the connection between research output and economic grwoth, particularly how this connection is shaped by institutional quality within a nation. Utilizing a two-step system generalized method of moments (SYS-GMM) for dynamic panel data alongside GMM quantile regression analysis, the study analyzes data from 15 nations in the Middle East and North Africa (MENA) between 2000 and 2017. The findings indicate a notable positive interaction effect when considering the interplay between research output and institutional quality, particularly highlighting the influential roles of government effectiveness and the rule of law. The GMM quantile regression results reveal that these interaction effects are more pronounced in countries with stronger economic resilience. Specifically, the impact of high-quality research output on economic growth is contingent upon the existing quality of institutions, suggesting that effective institutions significantly enhance the beneficial effects of research on economic development. Hence, the findings emphasize the critical need for policymakers in MENA nations to simultaneously improve both the quality of research endeavors and institutional frameworks, with a focus on strengthening governmental effectiveness and the rule of law to fully harness the benefits of research for sustained economic growth.

Keywords Research output · Institutions · Economic growth · MENA

JEL Classification O11 · O3 · O47

✉ Chadi Azmeh
Chadiazmeh@hotmail.com

[1] Jinan University, JU, Tripoli, Lebanon

[2] International Univeristy for Science and Technology, IUST, Daraa, Syria

[3] University of Kalamoon, UoK, Deir Attia, Syria

[4] Al-Andalus University for Medical Sciences, Qadmus, Tartus, Syria

Published online: 25 October 2025

Introduction

The accumulation of knowledge is essential for driving economic progress. A multitude of researchers have highlighted the creation of new knowledge and enhanced access to information as key elements that affect a nation's productivity and, consequently, its economic development (Becker et al., 1990; Lucas, 1988; Nelson & Phelps, 1966; Romer, 1987, 1990). A considerable volume of research has sought to investigate the link between research productivity and economic growth, predominantly through the use of scientometric metrics for evaluation.

The current body of empirical research can be divided into two primary groups. The first group consists of studies that do not make distinctions between various scientific fields. Results from this group consistently reveal a strong positive relationship between research productivity and economic growth in both advanced and emerging economies. Moreover, some investigations indicated a two-way relationship where economic advancement impacts research output, particularly in countries such as Canada, France, and Italy (Lee et al., 2011; Roula Inglesi-Lotz et al., 2014, 2015; Ntuli et al., 2015; Solarin & Yen, 2016; Azmeh, 2022). The second group concentrates on specific research areas as indicators to assess research effectiveness. For example, Jin (2009, 2010) assessed this impact within the field of economics, while Jaffe et al. (2013) evaluated the role of relative productivity in predicting future economic expansion across different scientific domains. Additionally, Yaşgül and Güriş (2016) studied this interaction within the biotechnological sector, and Pinto and Teixeira (2020) explored the effects of research output across four principal scientific areas. Azmeh (2022) took a more comprehensive approach by examining the relationship across all research disciplines in the MENA region. Azmeh and Al-Raeei (2025) gave evidence of complementary effects of financial development and research output in finance, showcasing the synergetic relationship between the two in promoting economic growth. Azmeh and Darwich (2025) study revealed the importance of quantity and quality of social sciences research in reducing poverty and inequality in the MENA region.

Recently, there has been growing academic and policy interest regarding the role of institutions as a crucial factor in economic development. Empirical studies indicate that a nation's institutional framework significantly impacts its economic outcomes (Acemoglu & Johnson, 2005; Acemoglu et al., 2001; Hall & Jones, 1999; Knack & Keefer, 1995; Nawaz, 2015; Rodrik et al., 2004). For instance, Acemoglu et al. (2001) utilized death rates as an instrumental variable for institutional quality, uncovering a significant effect of institutional standards on per capita income. In a similar vein, Nawaz (2015) emphasized the vital role of institutional growth in facilitating economic development. The institutional framework includes both formal and informal rules that govern interactions within economic, social, and political spheres. Efficient institutions foster a favorable incentive structure, minimizing transaction costs, reducing uncertainty, and enhancing productivity, thereby encouraging investment, technological advancement, and the expansion of the private sector—all of which are crucial for economic progress.

From these two strands of empirical growth literature, it can be concluded that both research productivity and institutional quality have a substantial positive impact on economic progress. Some scholars have examined how institutional development may act as a moderating factor that indirectly influences the connection between financial development and economic growth. This area of research aims to determine whether financial growth and institutional quality function as complements or substitutes in the growth mechanism. While some studies propose that finance and institutions complement each other (Anwar &

Cooray, 2012; Demetriades & Hook Law, 2006), others suggest they could serve as substitutes (Ahlin & Pang, 2008; Compton & Giedeman, 2011).

This investigation intends to address a gap in the existing literature by exploring whether the influence of research productivity on economic growth is moderated by a nation's institutional quality. To this end, a standard growth regression model will be applied, drawing on a dataset of 15 MENA (Middle East and North Africa) countries from 2000 to 2017. The analysis will adopt the two-step system generalized method of moments (2-step SYS-GMM) technique alongside GMM quantile regression analysis for dynamic panel data evaluation. The outcomes of this study could yield valuable insights for policymakers looking to craft strategies to enhance growth within the MENA region. If a complementary relationship between research productivity and institutional quality is established, it would indicate a need for policies aimed at strengthening both areas. Conversely, if a substitutive relationship is identified, policymakers may need to focus on prioritizing one dimension based on its relative importance and effect.

The remaining sections of the paper are organized as follows: Sect. "Literature Review" reviews the prior literature concerning the relationships among research output, institutions, and economic growth. Sect. "Data and methodology" details the data and methods utilized for the analysis, followed by Sect. "Empirical results and discussion", which presents the empirical findings, and Sect. "Conclusion", which concludes the research.

Literature review

Research output and economic growth

Initial investigations by De Moya-Anegón and Herrero-Solana (1999) examined the impact of research activities on economic development, revealing a significant link between research output and GDP in 19 Latin American countries. King (2004) supported these results in OECD nations, identifying both linear and exponential associations between the two factors. Conversely, Vinkler (2008) found no meaningful correlation in European countries, the USA, and Japan.

Subsequent research has broadened the inquiry into how research output affects economic growth in various regions. This body of literature can be segmented into two main categories. The first group encompasses studies that treat all scientific disciplines collectively, relying on total publication numbers or citation indices to measure research output. Lee et al. (2011) employed a Granger causality analysis and revealed a mutual causative relationship between research output and economic growth in several developing Asian countries. However, Inglesi-Lotz et al., (2014, 2015) found no causal connection in Brazil, China, Russia, and South Africa, while affirming a unidirectional causality from research output to economic growth in the United States and a positive correlation for India. In their study of 34 OECD countries, Ntuli et al. (2015) discovered unidirectional causality from research output to economic growth in only four nations: the U.S., Finland, Hungary, and Mexico. Through their analysis involving 169 countries, Solarin and Yen (2016) noted a substantial and affirmative effect of research output on economic growth, independent of the country's level of development. Dkhili and Oweis (2018) echoed this finding, identifying a positive relationship in 43 African nations.

The second category consists of research specifically targeting individual disciplines. Jin (2009, 2010) explored the economic ramifications of research output within economics,

demonstrating a causal link evident in Hong Kong, Korea, and Taiwan. Jaffe et al. (2013) revealed that foundational sciences have a more pronounced impact on economic growth compared to applied sciences. Inglesi-Lotz and Pouris (2013) assessed various scientific fields in South Africa, confirming affirmative influences from disciplines such as biology, biochemistry, chemistry, materials science, physics, and psychology. Jin and Jin (2013) reported comparable outcomes across fundamental sciences, engineering, economics, and business for a sample of 46 countries. In Turkey, Yasgül and Güris (2016) substantiated a beneficial effect of biotechnology research on economic development. Laverde-Rojas and Correa (2019) indicated a positive effect from basic sciences and engineering but only in high-income countries. Pinto and Teixeira (2024) emphasized the significant global influence of research output on economic growth in social sciences, physics, and engineering and technology, showcasing the diverse contributions that research output offers to economic advancement. Furthermore, Azmeh (2020) illustrated the critical importance of the quality of research output in promoting economic growth over merely the quantity of published studies, identifying pivotal areas contributing to this impact, which include Biochemistry, Genetics and Molecular Biology, Engineering, Mathematics, Physics and Astronomy, and Psychology.

In recent years, the complex interaction between the quantity and quality of research contributions has garnered notable scholarly interest. An examination by Pourghaz et al. (2023) across 39 nations revealed a substantial impact of research activities on various macroeconomic measures, including GDP growth, unemployment levels, and inflation. Additionally, Yu and Jin (2024) contended that research output plays a vital role in fostering innovative technologies, thus promoting technological advancement and economic success. Azmeh and Al-Raeei (2024) supplied evidence of a significant relationship between research output in finance and the pursuit of sustainable financial development. Nevertheless, while high-quality research enhances sector activity, it also poses risks to financial stability. Azmeh and Al-Raeei (2025) gave evidence of complementary effects of financial development and research output in finance, showcasing the synergetic relationship between the two in promoting economic growth. Azmeh and Darwich (2025) analyzed data from 15 Middle Eastern countries (2000–2023) using panel regression (PCSE/FGLS), revealing that while both the quantity and quality of social sciences research contribute to reducing poverty and inequality, research quality exerts a stronger impact on poverty alleviation, underscoring the imperative for policymakers to prioritize high-quality research investments to advance sustainable socio-economic development in the MENA region.

Institutions and economic growth

A study by Knack and Keefer (1995) investigated the impact of institutional frameworks on economic development, employing a variety of indicators such as enforceability of contracts and the risk of expropriation. Their results highlighted the crucial role that the quality of institutions plays in fostering economic advancement. In a similar vein, Hall and Jones (1999) contended that differences in productivity can be attributed to variations in institutions and government policies, which they referred to collectively as "social infrastructure." Research by Chong and Calderón (2000) demonstrated a two-way causal relationship between institutional measures and economic growth. Acemoglu et al. (2001) explored institutions in European colonies, utilizing mortality rates as an instrumental variable, and discovered that institutions have a significant effect on per capita incomes, noting that after considering institutional influences, income differences among countries near the

equator diminish. Further support for the advantageous role of institutions was provided by Rodrik et al. (2004). Acemoglu and Johnson (2005) distinguished between two types of institutions, concluding that property rights institutions significantly drive economic growth, investment, and financial development, whereas contracting institutions predominantly affect financial development. The analysis by Akpan and Effiong (2012) examined the effects of governance in 21 Sub-Saharan African countries, confirming that the rule of law, regulatory quality, and political stability positively influence economic performance. Nawaz (2015) studied the institutional impacts on economic growth across 56 nations from 1981 to 2010, finding a strong positive relationship, particularly in developed countries, and emphasized the need for tailored institutional frameworks to address specific long-term growth objectives. Siyakiya (2017) reported a significant link between the quality of institutions and economic outcomes, suggesting that even slight improvements in institutional quality could result in substantial economic growth gains.

Data and methodology

Data

This research represents a pioneering effort to analyze how the efficacy of a nation's institutions might influence the correlation between research productivity and economic progress. To achieve this aim, a conventional growth regression model was implemented, utilizing a dataset comprising 15 countries from the MENA (Middle East and North Africa) region, covering the period from 2000 to 2017. The method of choice for analyzing the dynamic panel data is the two-step system generalized method of moments (2steps SYS-GMM) alongside GMM quantile regression analysis.

The dataset includes a variety of metrics for critical variables, focusing on both the volume and caliber of research outputs as well as indicators of economic growth. Research output is quantified through two specific metrics: the annual number of publications, which reflects quantity, and the total count of citations, which indicates quality. Information on research outputs was gathered from the Scopus database, accessed through the SCImago platform.

To evaluate the quality of institutions, this study uses the World Governance Indicators (WGI), pinpointing one representative metric from each governance aspect relevant to economic development, specifically: the rule of law, government effectiveness, and

Table 1 Summary statistics of key variables for the period (2000–2017)

Variable	Mean	Median	Minimum	Maximum	Std. Dev
GDP%	4.06265	4.34664	−36.6582	53.3818	7.17552
Documents	5576.24	1149.00	42.0000	57,953.0	10,940.0
Citations	82,994.3	18,695.0	651.000	591,009	145,578
Gov_Eff	−0.198101	−0.163734	−1.97728	1.50927	0.721112
R_O_Law	−0.193049	0.0186294	−2.09213	0.958436	0.728710
Voice_Acc	−1.00144	−1.01217	−2.05034	0.0132019	0.469783
Private credit	44.1672	41.7224	1.26603	105.187	24.9229
Inflation	6.81457	3.94559	−10.0675	54.9154	9.11717

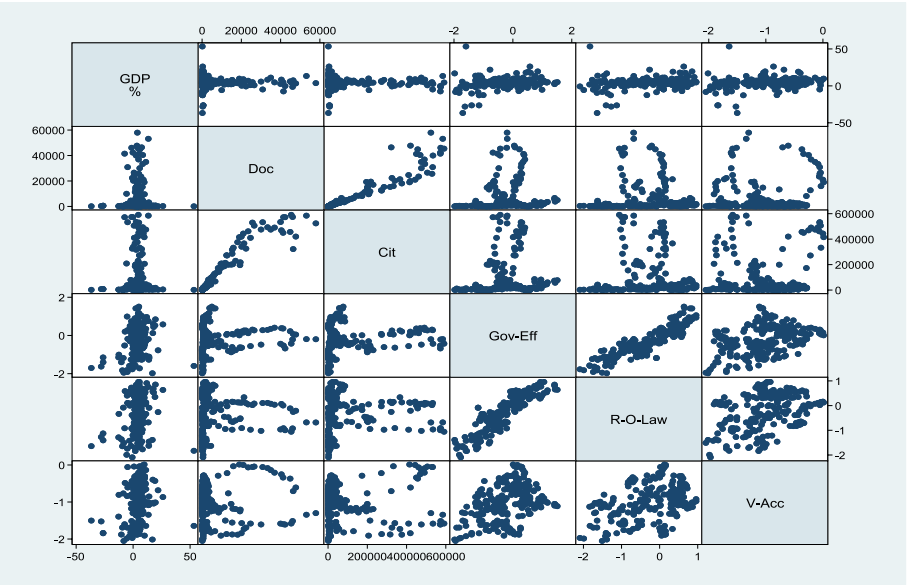

Fig. 1 Graphical matrix of key variables for the period (2000–2017)

the dimensions of voice and accountability. In addition, other growth determinants were sourced from the World Bank database, including variables such as inflation rates, private sector credit. A detailed summary of the statistics and graphical matrix for these essential variables is presented in Table 1 and Fig. 1.

Furthermore, the study seeks to broaden the existing literature by integrating institutional quality into the discourse on research output and economic advancement, providing a more nuanced understanding of the factors that drive development in the MENA region. By analyzing the interplay between these elements, this research aims not only to highlight the importance of strong institutions but also to offer insights that could inform policy-making strategies aimed at fostering both research excellence and sustainable economic growth in the region.

Table 2 Correlation coefficients for the period (2000–2017)

Doc	Cit	Gov_Eff	ROLaw	V_Acc	Priv	Inf	
1.0000	**0.9513**	0.0798	−0.0745	0.0323	0.0833	0.2615	Doc
	1.0000	0.0970	−0.0479	0.0386	0.0400	0.2939	Cit
		1.0000	**0.8953**	0.3854	0.5524	−0.3319	Gov_Eff
			1.0000	0.3863	0.4873	−0.3952	ROLaw
				1.0000	0.3047	−0.1223	V_Acc
					1.0000	−0.2900	Priv
						1.0000	Inf

The significant at 0.05, **

Table 3 Variance inflation factor (VIF) test for the period (2000–2017)

Variable	VIF	VIF	VIF
Documents	11.220	2.520	
Citations	12.696		2.851
Gov_Eff	7.620	7.095	7.618
R_O_Law	4.891	4.873	4.817
Voice_Acc	1.108	1.108	1.108
Private credit	2.065	1.995	1.955
Inflation	1.333	1.300	1.332
Mean VIF	5.08	2.87	2.72

Table 4 Pre-estimation analysis results

Variable	Pearson cross sectional test	Unit root test CIPS	
		Level	First difference
Doc	40.94***	13.76	−3.47***
Cit	28.51***	3.24	−5.48***
Gov_Eff	−0.12	1.6120	−6.7729***
R_O_Law	1.008	0.8355	−6.3932***
Voice_Acc	16.13***	−1.792**	/
Private credit	14.67***	1.9327	−5.2465***
Inflation	10.46***	−2.3991*	/
Westerlund cointegration test			
Dependent variable	Statistic	*p*-value	Cointegration
GDP Growth	−1.4386	0.0751	Yes

***p < 0.01, **p < 0.05, *p < 0.1

In order to identify multicollinearity, a correlation matrix was constructed to determine the degree to which a correlation exists between all variables. Table 2 summarizes the main results.

According to the findings in Table 2, there is two cases of multicollinearity, as the overall association between (Doc and Cit; ROLaw and Cov_Eff) is greater than 70%. To further investigate multicollinearity among independent variables, a VIF test is performed. Results show important VIF values (above value of > 10) for two variables (Doc and Cit), which confirm our concern for the existence of multicollinearity. To solve this issue, we include only one of this two variables that represent quantity and quality of research each time. We rerun the VIF tests two times, one with Doc and the other with Cit. The results for the last two tests, where the mean VIF value is 2.87 for the first and 2.72 for the second, affirm the absence of any multicollinearity when we include only one variable that represent research output. Results are presented in Table 3.

To choose the right estimation model, the study carried out three pre-estimation tests: cross-sectional, unit root, and cointegration tests. The analysis showed that all variables became stationary after the first difference, which means they don't display unit root behavior. Hence, we rejected the null hypothesis of the unit root test.

Additionally, we used the Westerlund method for a cointegration test to see if the variables are cointegrated. The results in Table 4 confirmed the presence of cointegration among the variables, suggesting a long-term relationship. This implies that these variables tend to move together over time, reinforcing the idea of a stable and consistent relationship among them. Based on the outcomes of the three pre-estimation tests, our study identified the dynamic panel Generalized Method of Moments (2 steps SYS-GMM) as the most accurate and reliable for estimation, chosen for its excellent ability to capture the complex relationships within the data.

Model specification

To explore the relationship between research output, institutions and economic growth, we consider the direct effect of research output on economic growth by specifying a standard growth regression model as below:

$$Growth\, i,t = \beta 0 + \gamma\, Income\, i,t-1 + \beta' Xi,t + \psi 1\, \text{Research output}\, i,t + \eta i + \mu t + \varepsilon i,t \tag{1}$$

where *Income* denotes the log of GDP per capita, and *Growth* is the growth rate, Research output represents indicators for the quantity and quality of research output. Xi,t is a matrix of control variables, i stands for a country and t represents a time period. μt is time dummies to account for time-specific effects, ηi is an unobserved country-specific effects and εi,t is an idiosyncratic error term.

We augment Eq. (1) with an institutional variable (Institutions) and interact both measures of research output and institutional quality, then assess for the importance of the interaction coefficient. To guarantee that the interaction term does not serve as a surrogate for research output or institutions, we include these factors independently in the regression as follows:

$$\begin{aligned} Growth\, i,t = {} & \gamma\, Income\, i,t-1 + \beta' X\, i,t + \psi 1\, \text{Research output}\, i,t + \psi 2\, Institutions\, i,t \\ & + \psi 3\, \left[\text{Research output}\, i,t \times Institutions\, i,t\right] + \eta i + \mu t + \varepsilon\, i,t \end{aligned} \tag{2}$$

Our main interest in Eq. (2) is for the sign and statistical significance of the interaction coefficient *ψ3*. Research output and institutions are either complements or substitutes in the growth process, depending on its sign. A negative coefficient indicates that in a country with weak institutions, research output is more successful in increasing economic growth (substitutability). A positive interaction, would suggest higher impact of research output on economic growth in a powerful institutional environment (complementarity).

To incorporate dynamics into our model, Eq. (2) can be written in its simplest form, with *y i,t* as the logarithm of real per capita GDP and *X i,t* as the set of all other regressors that include indicators of research output and institutions, as well as their interaction and all other control variables, as shown below:

$$y\, i,t - y\, i,t-1 = (\gamma - 1)\, y\, i,t-1 + \beta' X\, i,t + \eta i + \mu t + \varepsilon i,t \tag{3}$$

Alternatively, Eq. (3) can be rewritten as follows:

$$y\, i,t = \gamma y\, i,t-1 + \beta' X\, i,t + \eta i + \mu t + \varepsilon i,t \tag{4}$$

To eliminate the country specific and time-invariant component (μ_i), the Eq. (4) can be written in first differences, as:

$$\Delta y\, i,t \;=\; \gamma \Delta y\, i,t-1 \;+\; \beta' \,\Delta X\, i,t \;+\; \Delta \mu t \;+\; \Delta \varepsilon\, i,t \tag{5}$$

The present study uses the dynamic panel Generalized Method of Moments (2 steps SYS-GMM) on the last equation to examine the impact of interaction between research output and institutional quality on economic growth, if they are complements or substitutes. This technique solves problems such as heteroscedasticity, endogeneity, and omitted variable bias that commonly impact growth models. Lagged of control variables are used as instruments. Based on VIF test, the study applies the model two times. First, it considers the quantity of research output (No. of documents) as a measure of research output, while in the second it considers the quality of research output (No. of citations). The study also performs two tests (Sargan and Hansen J-test) for over-identifying restrictions and the Arellano-Bond tests for no autocorrelation in the second-differenced errors. To check if our

Table 5 2 steps SYS-GMM regression with quantity of research output

	(1)	(2)	(3)	(4)	(5)	(6)
L1.GDP	0.251 (0.235)	0.21 (0.13)	−0.05 (0.113)	−0.046 (0.11)	−0.044 (0.11)	−0.04 (0.11)
Log Documents	**−0.49** **(0.514)**	**0.306** **(0.423)**	**−1.79** **(0.87)****	**−1.70** **(0.922)***	**−1.68** **(0.86)***	**−1.412** **(1.042)**
Gov Eff		0.005 (2.02)	1.83 (1.54)	1.08 (3.74)	1.82 (1.67)	1.77 (1.56)
R of Law		1.83 (1.70)	−0.12 (1.11)	−0.14 (1.11)	−0.88 (4.06)	−0.17 (1.08)
Voi Acc		1.48 (0.55)***	1.36 (0.45)***	1.35 (0.49)***	1.36 (0.47)***	0.06 (4.02)
Priv			−0.06 (0.016)***	−0.06 (0.018)***	−0.06 (0.018)***	−0.059 (0.019)***
Inflation			0.11 (0.089)	0.108 (0.087)	0.109 (0.084)	0.108 (0.083)
Doc*Geff				**0.22** **(0.98)**		
Doc*RoL					**0.233** **(3.80)**	
Doc*Vacc						**0.352** **(0.987)**
Constant	4.862 (2.076)**	3.66 (1.18)**	15.106 (3.51)***	14.707 (3.95)***	14.70 (3.80)***	13.53 (4.89)***
No. of Obs	245	232	203	203	203	203
No. of Instrruments	7	10	12	13	13	13
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00
AR(1)	0.166	0.156	0.24	0.232	0.219	0.227
AR(2)	0.476	0.424	0.11	0.120	0.117	0.115
Sargan test Prob > chi2	0.122	0.143	0.814	0.850	0.859	0.854
Hansen test Prob > chi2	0.520	0.630	0.834	0.853	0.857	0.852
Ramsey RESET test Prob > F	0.9892	0.0203	0.7466	0.8571	0.7765	0.6528

Dependent variable is real per capita GDP growth. Robust standard errors in parentheses

***, **, * denotes significance at 0.10, 0.05 and 0.01 levels respectively

Table 6 2 steps SYS-GMM regression with quality of research output

	(1)	(2)	(3)	(4)	(5)	(6)
L1.GDP	0.239 (0.145)	0.225 (0.222)	−0.046 (0.11)	−0.055 (0.093)	−0.05 (0.091)	−0.054 (0.092)
Log Citations	**−0.175 (0.44)**	**0.271 (0.404)**	**−1.13 (0.437)****	**−0.714 (0.413)***	**−0.655 (0.477)**	**0.624 (1.138)**
Gov Eff		−1.809 (1.089)*	0.244 (1.479)	−9.33 (3.505)***	−0.718 (1.208)	0.085 (1.389)
R of Law		2.115 (1.53)	−0.415 (0.901)	−0.111 (0.769)	−12.39 (3.56)***	−0.296 (0.822)
Voi Acc		1.11 (0.658)*	0.907 (0.568)	0.583 (0.419)	0.44 (0.404)	−8.217 (7.198)
Priv			−0.044 (0.042)	−0.036 (0.041)	0.001 (0.049)	−0.039 (0.042)
Inflation			0.078 (0.045)*	0.068 (0.032)**	0.083 (0.052)***	0.067 (0.036)*
Cit*Geff				**2.11 (0.558)*****		
Cit*RoL					**2.77 (0.762)*****	
Cit*Vacc						**1.811 (1.34)**
Constant	3.919 (2.266)*	3.339 (1.806)*	12.58 (4.012)***	9.949 (3.184)***	7.869 (3.142)**	3.56 (7.56)
No. of Obs	204	192	167	167	167	167
No. of Instrruments	6	9	14	14	14	14
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00
AR(1)	0.183	0.194	0.214	0.155	0.128	0.174
AR(2)	0.488	0.472	0.138	0.136	0.135	0.131
Sargan test Prob > chi2	0.509	0.778	0.880	0.903	0.862	0.911
Hansen test Prob > chi2	0.507	0.382	0.941	0.951	0.904	0.955
Ramsey RESET test Prob > F	0.9373	0.0160	0.6753	0.7389	0.5399	0.4978

Dependent variable is real per capita GDP growth. Robust standard errors in parentheses

***, **, * denotes significance at 0.10, 0.05 and 0.01 levels respectively

System GMM model's functional form assumptions hold up, we ran Ramsey's RESET test. Looking at the results across different specifications (see Tables 5, 6), most of the models showed high p-values (ranging from 0.7466 to 0.9892 in Table 5 and 0.4978 to 0.9373 in Table 6), which means we couldn't reject the null hypothesis of no misspecification. This indicates that our linear specification works well for the majority of the regressions. However, there were two models (Table 5, column 2: Prob > F = 0.0203; Table 6, column 2: Prob > F = 0.0160) that hinted at possible misspecification, likely because of the non-linear dynamics of the interaction terms. We decided to keep these models for robustness since their Hansen/Sargan tests confirmed that the instruments were valid ($p > 0.1$), and the key coefficients remained stable. We begin with a baseline model that contains only our research output variable for a standard growth model. Next, we introduce proxies for institutional quality and macroeconomic environment to assess their impacts on economic

growth. Lastly, we augment the model with the interaction between research output and institutions. Results are reported in Tables 5 and 6).

Model identifiability

To ensure the identifiability of our dynamic panel model, we rigorously addressed potential multicollinearity and endogeneity while adhering to established econometric principles. First, we mitigated multicollinearity by estimating separate models for research quantity (Documents) and quality (Citations), which reduced mean VIF values to below 3 and preserved a full-rank design matrix—a prerequisite for parameter identification. Second, we employed the two-step system GMM estimator to resolve endogeneity, utilizing lagged levels and differences of endogenous variables as instruments. These instruments satisfied exclusion restrictions, as confirmed by Sargan/Hansen tests ($p > 0.6$), ensuring orthogonality between instruments and errors. We explicitly modeled interaction terms (e.g., Research × Institutions) alongside constituent variables to avoid omitted variable bias, aligning with best practices for interpretable interaction effects. The absence of autocorrelation in second-differenced errors (AR(2): $p > 0.1$) further validated the model's dynamic structure. These steps were consistent with Tabrizi et al. (2020), who emphasized isolating collinear predictors and testing instrument validity in mixed-data frameworks. Collectively, these measures—coupled with stable, statistically significant coefficients across specifications—demonstrated that the model uniquely identified the interplay between research output, institutions, and economic growth, robustly addressing theoretical and empirical identifiability concerns (Table 7).

Robustness check

To make sure our findings are solid, we used a Generalized Method of Moments (GMM) quantile regression as a way to double-check our results (Afshan et al., 2024; Machado & Santos Silva, 2019). This method is really useful because it lets us explore how research output, institutional quality, and economic growth relate to each other at different levels of the dependent variable. This gives us a deeper understanding of how these factors influence economic performance in various ways. GMM is particularly good at handling issues like endogeneity, unobserved differences, and measurement errors, which are common challenges in econometric modeling. By using GMM quantile regression, we can get consistent and efficient estimates that strengthen our conclusions about how research output and institutional quality interact. When we compare the interaction effects from the GMM quantile regression with our main results. Results are reported in Tables (7 and 8).

Empirical results and discussion

Interaction between quantity of research output and institutional quality

In the initial model, the research evaluates the volume of academic articles published in Scopus across various countries as an indicator of research productivity. The dependent variable analyzed is the growth of GDP, while the independent variables consist of research productivity, the quality of institutions, inflation rates, and the level of financial

Table 7 GMM Quantile regression with quantity of research output

Variables	Quantiles								
	25	50	75	25	50	75	25	50	75
LogDoc	−0.180	−0.761	−1.576**	0.771	0.116	−0.782	−0.455	−0.885	−1.501*
	(0.557)	(0.572)	(0.765)	(1.189)	(1.225)	(1.610)	(0.533)	(0.565)	(0.779)
GovEff	1.956	1.620	1.148	1.785	1.459	1.013	5.481*	3.348	0.283
	(1.259)	(1.302)	(1.702)	(1.294)	(1.334)	(1.741)	(3.297)	(3.509)	(4.823)
ROLaw	0.164	0.249	0.367	−0.0440	0.131	0.370	−0.353	−0.0678	0.342
	(3.099)	(3.207)	(4.186)	(1.242)	(1.281)	(1.669)	(1.230)	(1.327)	(1.806)
VAcc	0.578	0.756	1.006	−2.828	−2.588	−2.259	0.691	0.812	0.984
	(0.777)	(0.803)	(1.050)	(4.625)	(4.772)	(6.216)	(0.766)	(0.828)	(1.125)
Priv	−0.051***	−0.0541***	−0.0584**	−0.0451**	−0.0484**	−0.0528**	−0.0545***	−0.0557***	−0.0574**
	(0.0178)	(0.0185)	(0.0241)	(0.0191)	(0.0197)	(0.0256)	(0.0165)	(0.0178)	(0.0242)
Inf	0.00924	0.0584	0.127	0.0110	0.0608	0.129	0.0111	0.0593	0.129
	(0.0806)	(0.0831)	(0.110)	(0.0801)	(0.0824)	(0.109)	(0.0786)	(0.0838)	(0.115)
DocROLaw	−0.114	−0.0796	−0.0317						
	(0.879)	(0.910)	(1.188)						
DocVAcc				0.936	0.910	0.875			
				(1.154)	(1.190)	(1.550)			
DocGovEff							−1.105	−0.545	0.259
							(0.865)	(0.920)	(1.266)
Constant	6.378***	9.938***	14.93***	2.651	6.491	11.75*	7.682***	10.53***	14.63***
	(2.144)	(2.196)	(2.996)	(5.071)	(5.222)	(6.892)	(1.926)	(1.994)	(2.800)
Observations	221	221	221	221	221	221	221	221	221

Dependent variable is real per capita GDP growth. Robust standard errors in parentheses

***, **, * denotes significance at 0.10, 0.05 and 0.01 levels respectively

Table 8 GMM Quantile regression with quality of research output

Variables	Quantiles								
	25	50	75	25	50	75	25	50	75
LogCit	−0.160	−0.675	−1.375*	0.785	0.265	−0.440	−0.421	−0.832	−1.417*
	(0.551)	(0.587)	(0.805)	(1.214)	(1.263)	(1.665)	(0.535)	(0.567)	(0.785)
GovEff	1.933	1.526	0.972	1.802	1.408	0.873	7.176	3.235	−2.361
	(1.243)	(1.337)	(1.803)	(1.248)	(1.298)	(1.707)	(4.729)	(4.968)	(6.916)
ROLaw	0.151	−0.893	−2.315	−0.0619	0.204	0.563	−0.381	0.00656	0.557
	(4.243)	(4.561)	(6.157)	(1.185)	(1.232)	(1.618)	(1.239)	(1.343)	(1.835)
VAcc	0.589	0.722	0.903	−4.046	−4.440	−4.974	0.737	0.797	0.882
	(0.769)	(0.828)	(1.116)	(6.192)	(6.439)	(8.445)	(0.769)	(0.837)	(1.141)
Priv	−0.051***	−0.053***	−0.0561**	−0.0457**	−0.0485**	−0.0523**	−0.056***	−0.056***	−0.0568**
	(0.0182)	(0.0195)	(0.0263)	(0.0189)	(0.0196)	(0.0258)	(0.0169)	(0.0184)	(0.0250)
Inf	0.0105	0.0602	0.128	0.00908	0.0586	0.126	0.0107	0.0598	0.129
	(0.0815)	(0.0873)	(0.119)	(0.0781)	(0.0811)	(0.108)	(0.0809)	(0.0862)	(0.119)
CitROLaw	−0.0721	0.236	0.656						
	(0.911)	(0.978)	(1.322)						
CitVAcc				0.948	1.052	1.193			
				(1.183)	(1.230)	(1.614)			
CitGovEff							−1.185	−0.377	0.770
							(0.965)	(1.013)	(1.410)
Constant	6.599**	10.48***	15.76***	1.641	5.579	10.91	8.228***	11.43***	15.97***
	(2.603)	(2.756)	(3.831)	(6.591)	(6.854)	(9.061)	(2.388)	(2.458)	(3.462)
Observations	221	221	221	221	221	221	221	221	221

Dependent variable is real per capita GDP growth. Robust standard errors in parentheses

***, **, * denotes significance at 0.10, 0.05 and 0.01 levels respectively

development. This analysis incorporates annual data from 15 countries in the Middle East and North Africa (MENA) region for the years spanning from 2000 to 2017.

The results indicate a predominantly negative effect of research productivity on economic growth across nearly all the regression analyses presented in Table (5). The sole exception occurs in regression number (2), where only the variables of research productivity and institutional quality are included; in this case, the relationship is positive, though it lacks statistical significance. Regarding the institutional quality metrics, the variable "Voice and Accountability" emerges as the only factor with a demonstrably positive and statistically significant effect on economic growth at the 1% level.

Additionally, the analysis reveals that the variable representing financial development has a negative and statistically significant influence on GDP growth. On the other hand, inflation demonstrates a negative effect on economic growth, but this impact does not reach statistical significance.

One of the key insights from regressions (4, 5, and 6) is that there appears to be a positive interaction effect between the quantity of research output and the quality of institutions on economic growth, even if this finding lacks statistical significance. It is important to note that the interpretation of the interaction term is reliant on the sign of its coefficient. A positive coefficient suggests that research productivity and institutional quality act as complementary forces for economic growth, while a negative coefficient signifies that these two variables function as substitutes. Our findings provide supporting evidence for the idea that these two factors complement each other in promoting growth, albeit the result does not achieve statistical significance.

Interaction between quality of research output and institutional quality

In our subsequent model, the research employs the quantity of citations sourced from Scopus for each nation as an indicator of the caliber of research output. The results indicate a notable negative relationship (at a 5% significance threshold) between the quality of research output and economic growth once all independent variables are included in the analysis (refer to regression (3) in Table (6)). Examining our control variables, the findings reveal a statistically significant positive effect of inflation on economic growth. The effects of other control variables, however, were not statistically significant, except for scenarios where we incorporated interaction terms in regressions (4, 5, and 6). In those cases, the influence was negative and significant regarding the institutional variables included in the interaction. Notably, the outcomes from regressions (4, 5, and 6) demonstrate that the interplay between the quality of research output and institutional frameworks positively influences economic growth, achieving statistical significance specifically in the context of government effectiveness and the rule of law. These findings are particularly crucial as they underscore a complementary relationship between the quality of research output and institutional performance. In essence, our analyses suggest that the effect of research output quality on economic growth is significantly influenced by the quality of a country's institutions, particularly in relation to government effectiveness and the enforcement of legal frameworks.

Comparison of interaction effects: GMM quantile regression vs. main results

Tables 5 and 6 provide a clear overview of the findings from two-step SYS-GMM regression, where we looked at both the quantity (number of documents) and quality (number of

citations) of research output. These results offer valuable insights into how these factors interact with institutional quality.

When it comes to the quantity of research output, the interaction between the number of documents and the various aspects of institutional quality mostly showed non-significant but generally positive coefficients in our earlier analysis. However, the GMM quantile regression, detailed in the robustness tables, highlights certain quantiles where these interaction terms become significant at different p-levels. Notably, at the higher quantiles (specifically the 75th), where economic growth is more pronounced, the interaction term reveals a positive coefficient. This suggests that in countries with stronger economic resilience, there's a more substantial complementary effect between the quantity of research output and institutional quality. This finding indicates that in nations experiencing robust economic growth, improvements in institutional effectiveness can further enhance the positive relationship with research output, reinforcing the case for better institutional frameworks.

When we look at the quality of research output, we see some interesting shifts compared to the earlier SYS-GMM results. Our robustness check reveals a stronger and more significant positive link between the quality of research output—measured by citations—and institutional quality across different quantiles. For instance, at the 75th quantile, the relationship between the number of citations and government effectiveness stands out with solid significance. This suggests that as research quality improves, its positive impact on economic growth is especially noticeable in countries with robust institutional frameworks, particularly in areas like government effectiveness and the rule of law. These findings reinforce our main conclusions, highlighting that effective institutions are better positioned to harness high-quality research for economic benefits, which adds further weight to the insights we've gathered from our primary models.

Policy implications

The findings highlight a pressing need for policymakers in the MENA region to embrace a comprehensive strategy that combines strengthening institutions with targeted investments in high-quality research to foster sustainable economic growth. Strong institutional frameworks—bolstered by governance reforms, transparency, and accountability—should be the foundation of this strategy, as they enhance the effectiveness of research by creating a supportive environment for innovation and the application of knowledge. At the same time, it's essential to make strategic investments in research quality, which includes competitive funding opportunities, partnerships between public and private sectors in R&D, and incentives for collaboration between academia and industry. These efforts are crucial for translating impactful research findings into commercial applications and evidence-based policymaking. Coordination across sectors is also key: aligning education, research, and economic development initiatives will help build a knowledge-based economy, while robust monitoring systems will allow for adaptive policy adjustments to maximize the benefits of research investments. Importantly, fostering a culture of innovation through research-focused education, scholarships, and national recognition programs will support long-term capacity building. By focusing on these interconnected pillars—strong institutions, quality research, sectoral collaboration, and innovation ecosystems—MENA countries can unlock significant socio-economic advancements, boost economic growth, ultimately promoting equitable development and better living standards.

Conclusion

This study aimed to explore the extent to which the relationship between research output and economic growth is shaped by the quality of a country's institutions. To achieve this objective, we applied a standard growth regression model using a comprehensive dataset that encompasses 15 nations in the MENA (Middle East and North Africa) region, with data spanning from 2000 to 2017. Our analysis employed the two-step system generalized method of moments (2-step SYS-GMM) alongside GMM quantile regression analysis for dynamic panel data, allowing for a robust examination of the relationships involved. The research output data were sourced from the Scopus database, as published on the SCImago website, while additional data on economic growth and relevant control variables were drawn from the World Development Indicators (WDI).

The results of our analysis revealed a predominantly negative relationship between both the quantity and quality of research output and economic growth across most of our regression models, with 9 out of 12 analyses reflecting this trend. However, a significant shift occurred in this relationship when considering the interaction between research output and institutional quality, resulting in a positive correlation. Specifically, our findings provided strong evidence of a complementary dynamic between research output and the effectiveness of institutions, particularly highlighting the influential roles of government effectiveness and the rule of law.

In addition, the robustness checks using GMM quantile regression revealed stronger and more significant interaction effects between quality of research output and institutional quality across different quantiles, confirming the nuanced relationship between these variables. Notably, the quantile regression outcomes indicated that in nations experiencing robust economic growth, improvements in institutional effectiveness can significantly enhance the positive relationship with research output. This suggests that as research quality improves, particularly in countries with effective institutions, the positive impact on economic growth becomes increasingly pronounced, underscoring the importance of context in understanding this interplay.

From a policy standpoint, these findings accentuate the critical need for simultaneous enhancements in both the quality of research and the effectiveness of institutional frameworks within the MENA region. Policymakers should prioritize targeted strategies that aim to improve institutional quality, especially in areas pertaining to government effectiveness and adherence to the rule of law. By investing in these domains, countries can better harness the potential of research endeavors to stimulate economic growth. Furthermore, fostering a conducive research environment, supported by strong institutions, is essential for yielding robust and sustainable economic development in the region. Enhanced collaboration between researchers, government agencies, and other stakeholders will be crucial in this process, paving the way for a more innovative and growth-oriented MENA region. Overall, our study highlights the intricate interplay between research output, institutional quality, and economic growth, suggesting that efforts to bolster one without addressing the other may lead to suboptimal outcomes.

Funding The author declare that no funds, grants, or other support were received during the preparation of this manuscript.

Declarations

Conflict of Interest The author has no relevant financial or non-financial interests to disclose.

References

Acemoglu, D., & Johnson, S. (2005). Unbundling institutions. *Journal of Political Economy, 113*(5), 949–995. https://doi.org/10.1086/432166

Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review, 91*(5), 1369–1401. https://doi.org/10.1257/aer.91.5.1369

Afshan, S., Yaqoob, T., Ho, W. K., & Leong, K. Y. (2024). Achieving sustainable growth in emerging economies: Insights from advance method moment of quantile regression. *Gondwana Research, 127*, 182–198.

Ahlin, C., & Pang, J. (2008). Are financial development and corruption control substitutes in promoting growth? *Journal of Development Economics, 86*(2), 414–433. https://doi.org/10.1016/j.jdeveco.2007.07.002

Akpan, G. E., & Effiong, E. L. (2012). Governance and development performance: A cross-country analysis of Sub-Saharan Africa. *Governance, 3*(14), 54–67.

Anwar, S., & Cooray, A. (2012). Financial development, political rights, civil liberties and economic growth: Evidence from South Asia. *Economic Modelling, 29*(3), 974–981. https://doi.org/10.1016/j.econmod.2012.02.009

Azmeh, C. (2022). Quantity and quality of research output and economic growth: Empirical investigation for all research areas in the MENA countries. *Scientometrics*. https://doi.org/10.1007/s11192-022-04512-5

Azmeh, C., & Al-Raeei, M. (2024). Impact of Research Output in Finance on Financial Development: Empirical Investigation from Middle Eastern Economies. *Finance: Theory and Practice*. https://doi.org/10.26794/2587-5671-2026-30-1-1584-01

Azmeh, C., & Al-Raeei, M. (2025). Financial development, research in finance, and economic growth. *Cogent Economics & Finance, 13*(1), Article 2448220. https://doi.org/10.1080/23322039.2024.2448220

Azmeh, C., & Darwich, H. (2025). Leveraging social science research to combat poverty and inequality in the Middle East - a pathway to achieving SDGs 1 and 10. *Cogent Social Sciences, 11*(1), Article 2473650. https://doi.org/10.1080/23311886.2025.2473650

Becker, G. S., Murphy, K. M., & Tamura, R. (1990). Human capital, fertility, and economic growth. *Journal of Political Economy, 98*(5, Part 2), S12–S37. https://doi.org/10.1086/261723

Chong, A., & Calderón, C. (2000). Causality and feedback between institutional measures and economic growth. *Economics & Politics, 12*(1), 69–81. https://doi.org/10.1111/1468-0343.00069

Compton, R. A., & Giedeman, D. C. (2011). Panel evidence on finance, institutions and economic growth. *Applied Economics, 43*(25), 3523–3547. https://doi.org/10.1080/00036841003670713

De Moya-Anegón, F., & Herrero-Solana, V. (1999). Science in America Latina: A comparison of bibliometric and scientific-technical indicators. *Scientometrics, 46*(2), 299–320. https://doi.org/10.1007/BF02464780

Demetriades, P., & Hook Law, S. (2006). Finance, institutions and economic development. *International Journal of Finance & Economics, 11*(3), 245–260. https://doi.org/10.1002/ijfe.296

Dkhili, H., & Oweis, K. A. (2018). Does research output matter for economic growth in sub saharan African countries? Quantity and quality analysis. *International and Multidisciplinary Journal of Social Sciences, 7*(3), 221. https://doi.org/10.17583/rimcis.2018.3108

Hall, R. E., & Jones, C. I. (1999). Why do some countries produce so much more output per worker than others? *The Quarterly Journal of Economics, 114*(1), 83–116. https://doi.org/10.1162/003355399555954

Inglesi-Lotz, R., & Pouris, A. (2013). The influence of scientific research output of academics on economic growth in South Africa: An autoregressive distributed lag (ARDL) application. *Scientometrics, 95*(1), 129–139. https://doi.org/10.1007/s11192-012-0817-3

Inglesi-Lotz, R., Balcilar, M., & Gupta, R. (2014). Time-varying causality between research output and economic growth in US. *Scientometrics, 100*(1), 203–216. https://doi.org/10.1007/s11192-014-1257-z

Inglesi-Lotz, R., Chang, T., & Gupta, R. (2015). Causality between research output and economic growth in BRICS. *Quality and QuantiTy, 49*(1), 167–176. https://doi.org/10.1007/s11135-013-9980-8

Jaffe, K., Caicedo, M., Manzanares, M., Gil, M., Rios, A., Florez, A., et al. (2013). Productivity in physical and chemical science predicts the future economic growth of developing countries better than other popular indices. *PLoS ONE, 8*(6), Article e66239. https://doi.org/10.1371/journal.pone.0066239

Jin, J. C. (2009). Economic research and economic growth: Evidence from East Asian economies. *Journal of Asian Economics, 20*(2), 150–155. https://doi.org/10.1016/j.asieco.2008.12.002

Jin, J. C. (2010). Research publications, economic growth and causality: Japan's experience. *Pacific Economic Review, 15*(5), 666–673. https://doi.org/10.1111/j.1468-0106.2010.00522.x

Jin, J. C., & Jin, L. (2013). Research publications and economic growth: Evidence from cross-country regressions. *Applied Economics, 45*(8), 983–990. https://doi.org/10.1080/00036846.2011.613785
King, D. A. (2004). The scientific impact of nations. *Nature, 430*(6997), 311–316. https://doi.org/10.1038/430311a
Knack, S., & Keefer, P. (1995). Institutions and economic performance: Cross-country tests using alternative institutional measures. *Economics & Politics, 7*(3), 207–227. https://doi.org/10.1111/j.1468-0343.1995.tb00111.x
Laverde-Rojas, H., & Correa, J. C. (2019). Can scientific productivity impact the economic complexity of countries? *Scientometrics, 120*(1), 267–282. https://doi.org/10.1007/s11192-019-03118-8
Lee, L.-C., Lin, P.-H., Chuang, Y.-W., & Lee, Y.-Y. (2011). Research output and economic productivity: A granger causality test. *Scientometrics, 89*(2), 465. https://doi.org/10.1007/s11192-011-0476-9
Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7
Machado, J. A. F., & Santos Silva, J. M. C. (2019). Quantiles via moments. *Annals. in Honor of Roger Koenker, 213*(1), 145–173. https://doi.org/10.1016/j.jeconom.2019.04.009
Nawaz, S. (2015). Growth effects of institutions: A disaggregated analysis. *Economic Modelling, 45*, 118–126. https://doi.org/10.1016/j.econmod.2014.11.017
Nelson, R. R., & Phelps, E. S. (1966). Investment in Humans, Technological Diffusion, and Economic Growth. *The American Economic Review, 56*(1/2), 69–75.
Ntuli, H., Inglesi-Lotz, R., Chang, T., & Pouris, A. (2015). Does research output cause economic growth or vice versa? Evidence from 34 OECD countries. *Journal of the Association for Information Science and Technology, 66*(8), 1709–1716. https://doi.org/10.1002/asi.23285
Pinto, T., & Teixeira, A. A. (2024). Research output and economic growth in technological laggard contexts: A longitudinal analysis (1980–2019) by type of research. *Scientometrics, 129*(3), 1197–1230.
Pinto, T., & Teixeira, A. A. C. (2020). The impact of research output on economic growth by fields of science: A dynamic panel data analysis, 1980–2016. *Scientometrics, 123*(2), 945–978. https://doi.org/10.1007/s11192-020-03419-3
Pourghaz, A., Samani, E. B., & Shokri, B. (2023). Analysis of the impact of research output on economic growth with using a multivariate random effects model. *Scientometrics, 128*(4), 2259–2282.
Rodrik, D., Subramanian, A., & Trebbi, F. (2004). Institutions rule: The primacy of institutions over geography and integration in economic development. *Journal of Economic Growth, 9*(2), 131–165. https://doi.org/10.1023/B:JOEG.0000031425.72248.85
Romer, P. M. (1987). Growth Based on Increasing Returns Due to Specialization. *The American Economic Review, 77*(2), 56–62.
Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5), S71–S102. https://doi.org/10.1086/261725
Siyakiya, P. (2017). The impact of institutional quality on economic performance: An empirical study of European Union 28 and prospective member countries. *World Journal of Applied Economics, 3*(2), 3–24.
Solarin, S. A., & Yen, Y. Y. (2016). A global analysis of the impact of research output on economic growth. *Scientometrics, 108*(2), 855–874. https://doi.org/10.1007/s11192-016-2002-6
Vinkler, P. (2008). Correlation between the structure of scientific research, scientometric indicators and GDP in EU and non-EU countries. *Scientometrics, 74*(2), 237–254. https://doi.org/10.1007/s11192-008-0215-z
Yaşgül, Y. S., & Güriş, B. (2016). Causality between research output in the field of biotechnology and economic growth in Turkey. *Quality & Quantity, 50*(4), 1715–1726. https://doi.org/10.1007/s11135-015-0230-0
Yu, E., & Jin, J. (2024). Scientific research, technology, and economic growth in a cross section of countries. *Applied Economics*. https://doi.org/10.1080/00036846.2024.2323021