

The role of ICT diffusion and institutional quality in finance-growth nexus: Evidence from North African countries



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ABSTRACT

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The study demonstrates how Information and Communication Technologies (ICT) and institutional quality affect the relationship between finance and growth in four North African countries. This study further expands on the current literature on the relationship between financial development and economic growth by examining how the mediating effect of the two variables (institutional quality and ICT diffusion) will directly and indirectly relate to financial development to grow the economy. Panel data from 2004 to 2022 show that there exists an obvious positive relationship between financial development and economic growth, especially if a country has an acceptable amount of ICT usage and an acceptable level of institutional quality. The evidence underscores that expanding ICT diffusion and strengthening institutional frameworks are major driving forces of the progression of the financial sector and, consequently, economic growth in North African countries, shaping modernization, competitiveness, and sustainable development across diverse national contexts. Therefore, to obtain significant improvements to the financial system, a multi-faceted strategy with a high degree of technological capability and strong institutional capacity is necessary. As such, it is recommended that each government in North Africa implement broad reforms that promote technological innovation and institutional reform. These include implementing anti-corruption laws, promoting the rule of law, and reducing bureaucracy.

Contribution/ Originality: In our study, we demonstrated the positive effects of the combination of technological diffusion and institutional quality on the link between finance and growth in the North African region, an aspect studied with very few details in previous research. The findings indicate that financial development could have stimulated economic growth when governments use new technology and improve the level of institutional quality.

1. INTRODUCTION

In both theoretical and empirical contexts, researchers have thoroughly examined the finance-growth relationship since Levine's seminal contribution in the early 1990s [1, 2]. As shown by many theoretical studies, the interaction between the development of the financial sector and economic growth is not always linear or mechanical; it depends on several country-specific factors that determine the ability of the economy to efficiently use financial resources. The research will seek to add to the existing literature on the issue of financial development and economic growth. It goes beyond the traditional correlation between the two to look at the mediating effect of two important variables: institutional quality and the spread of information and communication technology. This discussion aims to explicate the indirect effect of these two variables on the development of finance and promote economic growth.

Endogenous variables typically affect financial intermediation, including actions of borrowers, government intervention, and corruption; most traditional financial development models, however, fail to explain such variables [3]. In most developing nations, large firms receive credit opportunities at the expense of smaller enterprises, which restricts the total contribution of fiscal growth to overall growth [4]. Results suggest that there is a dire need to design financial policies that are context-sensitive, align with the institutional and economic peculiarities of a particular country, and promote the use of advanced analytical models involving the mentioned conditional variables [5]. Different results arise from varying levels of institutional quality, the structure of a financial system, technological progress, and developmental phases. Khan, et al. [6] argue that institutional quality is a significant threshold at which financial development should start playing an important and long-lasting role in economic growth. Nevertheless, in the low-income group, financial development has proven to enhance economic growth with better access to finance and stimulate entrepreneurship.

The spread of Information and Communications Technology (ICT) to financial institutions is important for their development and modernization as it relates to the delivery of financial products via the Internet (online banking), mobile devices (mobile banking), and other technological innovations specific to the financial industry [7]. ICT diffusion enhances the effectiveness of providing financial services processes and reduces the cost of doing business through developing connectivity and improving data management processes.

Diffusion of ICT has led to the improvement of the efficiency of financial intermediation, which is accomplished by real-time data processing, predictive analytics, and risk management systems, and has led to increased efficiency and coverage of financial institutions [8]. Furthermore, online technologies such as financial technology solutions and digital platforms have proved effective in enhancing financial responsibility and donor engagement when transparency is a key determinant of trust and sustainability [9]. In developing countries, where conventional financial systems lack efficiency, ICT plays a key role in mitigating disparities and democratizing access to financial services [10].

The emergence of ICT, coupled with good institutions, is a valuable ingredient in establishing financial systems and economic growth. The popularity of ICT enhances the effectiveness of financial institutions, may trigger innovation in the financial sphere, and increases the accessibility of financial products as transaction costs are lowered and barriers to financial inclusion can be dismantled [11]. Recent studies have also poorly examined the key transmission channels that shape the nexus between finance and growth, particularly regarding the sharing of ICT and institutional quality. We will explore the positive impacts of financial development on economic growth in two distinct transmission channels in our study.

The diffusion of ICT is one of the most important factors for emerging countries. Initially, these policies fostered economic diversification by diminishing reliance on the traditional sector and encouraging the development of innovative industries such as e-commerce, digital services, and technology-driven start-ups. Secondly, the digitization of government operations, which results from the diffusion of ICT, enhances citizens' access to administrative and social services. ICT is an important tool for spreading education and training because it offers a much higher number of people access to virtual learning systems and connects those who are learning with a global wealth of knowledge. In addition, ICT is also a means of social and economic development by increasing interconnectivity between remote and urban communities as well as creating new job opportunities.

Institutional quality can either increase or decrease the efficiency of the financial system. Although both are increasingly important as intermediaries between financial development and economic growth, little empirical research has been done regarding ICTs and institutional quality as transmission mechanisms for North African countries. These nations offer a distinctive case due to their swift adoption of ICTs, diverse levels of institutional development, and ambitious economic reform programs under initiatives such as innovation and technology in

Agenda 2063.¹ This study seeks to bridge the existing gap by examining how the diffusion of ICTs and the quality of institutions act as transmission channels in the finance-growth nexus in North Africa. These expected findings should provide effective and practical policy recommendations to encourage sustainable economic development in North Africa.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. *Institutional Quality, Financial Development, and Economic Growth*

Financial institutions are key to channeling savings into investments that produce productive output and help allocate resources efficiently. However, the effect of financial institutions on the growth of economies differs significantly between countries; thus, it is likely that there are moderating factors present. Studies suggest that one of the most significant factors is institutional quality [12]. Thus, the quality of institutions is a determinant of the impact of a developed financial sector on economic growth, as well as the relationship between the two. To be effective, a financial system must be able to rely on good-quality institutions to provide regulatory stability and competent law enforcement and, therefore, sustain economic growth over time.

Bayraktar, et al. [13] and Salouka, et al. [14] found that financial development significantly contributes to economic growth only when institutional quality is considered. According to these findings, a financial system needs a sound institutional framework that works in harmony. The credibility of institutions influences the confidence of individuals undertaking economic activity. A poor institutional structure aggravates the financial crisis, but strong institutions augment the stability of the banking system and economic recovery from adversities. Dang, et al. [15] provide empirical evidence that high institutional quality is essential in reducing economic volatility, although it may restrict banks' profitability in the short term. Nguyen [16] demonstrates that effective governance can mitigate the negative impact of undue concentration in the banking industry of emerging economies.

Therefore, it can be inferred that institutions with quality are a necessary condition for creating stable financial systems and sustainable economic growth over the long run. Analysis of different countries also indicates that institutional resilience is especially vital for developing economies. It is believed that strong institutional mechanisms, marked by the absence of corruption and strict adherence to laws, are critical for the promotion of successful financial development [17]. Good institutions lead to the development of clear rules, the protection of property rights, and reductions in transaction costs, which eventually build confidence among economic actors. In turn, institutional reforms are prerequisites for increasing investment, promoting innovation, and facilitating trade to ensure long-term economic growth.

The findings of the research studies confirm that strong institutional structures are essential in allowing financial development to play a positive role in economic development. Anti-corruption measures and better regulatory efficiency are thus the goals many countries aim to achieve to improve the quality of institutions [18]. Excellent institutional quality is regarded as a priority, especially in the developing world. Moreover, establishing the rule of law and reducing corruption will create conditions that promote financial development [19]. These institutional foundations support investment, innovation, and trade by participants; therefore, they promote long-term economic development. As a result, a sound financial system cannot build or sustain itself on weak institutional structures [20].

Küçükçolak, et al. [21] note that anti-corruption initiatives advance finance and FDI in emerging markets. Moreover, Mili [22] claims that complexity in the context of economics does matter but will not drive financial growth without an institutional environment that encourages innovation, supports diversification, and establishes an environment of macroeconomic stability. In this respect, there is a tight connection between the financial system and the institutional environment. Thus, when developing or reforming the financial sector, institutional strengthening must accompany all these endeavors.

¹ Agenda 2063: Technological growth and innovation to drive Africa's growth.

A key condition for a stable and effective financial system is the need to implement institutional reforms that emphasize increased transparency, supervision, and responsibility to ensure long-term sustainability. In the absence of such improvements, financial institutions are unable to direct funds efficiently and adequately; hence, there is a higher chance of failure at the systemic level and a rise in the level of economic inequality. The initial hypothesis of this research is based on this conceptual premise.

Hypothesis 1: The role of financial development in supporting economic growth is influenced by the quality of institutions.

2.2. The ICT Diffusion Role in the Nexus of Finance and Growth

ICT is currently viewed as a growth engine in the financial sector based on the idea that it promotes the evolution of new ideas and the spread of information [23]. The applications of ICT also support financial and economic decision-making by making available the required and timely information to support these decisions. The availability of ICT equips decision-makers with the necessary information to make economic and financial decisions promptly. This enhances the efficiency of the decision-making process by facilitating fast information delivery, lowering transaction costs, and providing equal access to the financial system for all. It is grounded in the transaction cost theory, initially suggested by Coase [24] and followed up by Williamson [25] and [26]. Its technological advances promote financial inclusion and boost the efficiency of economic and organizational operations, which is achieved through promoting interactions between economic players [27].

Awa and Abdou [28] assert that ICT infrastructure development positively impacts financial inclusion and economic growth in WAEMU. Similarly, Endres and Steula [29] state that the widespread use of mobile and fixed-line communication technology is essential for improving financial systems, as evidenced by increased domestic loans to the private sector. Their results indicate that ICT infrastructure is critical in advancing financial inclusion and redefining the banking process [30].

The recent stream of literature confirms the fact that a rise in digital infrastructure brought about by ICTs allows countries to become more financially inclusive and, hence, is essential to the sustainable growth of economies as well as the advancement of social justice [31, 32].

It is through the spread of ICT that growth in the financial system occurs, particularly in high-income nations. The spread of ICT enhances access to financial services and institutional efficiency [33-35]. The situation is more complicated in developing countries because researchers believe that the lack of ICT infrastructure and digital illiteracy can hinder its effectiveness [36-38].

According to the recent study, the positive impact of mobile and Internet penetration on economic growth is substantial and measurable, and the association between finance and technology fields is significantly greater when it advances to some point of penetration [39]. Using digital platforms has been identified as playing a crucial role in promoting organizational innovation and transforming intellectual capital into a competitive advantage [40]. Financial development is possible thanks to the spread of ICT, which reduces informational asymmetry, optimizes credit allocation, and opens an alternative to new financial platforms [41, 42]. Moreover, financial services will be more efficient (with the help of new technology, blockchain, robo-advisors, etc.), transaction costs will decrease, and consumers will be able to trace them better [43].

ICT contributes to the advancement of financial intermediary services by providing enhanced data analysis and risk assessment abilities that lead to an improvement in the overall operation of the financial environment [8]. Implementation of ICT technology in financial institutions represents a significant technological development that has led to increased operational efficiencies for financial intermediaries, as well as a greater ability to link various economic actors and facilitate decision-making based on knowledge. There are three major mechanisms by which the impact of ICT on development can be viewed.

- ICT can stimulate innovation and/or enhancement of productivity [44].

- Creation of knowledge and reduction of informational asymmetries that inhibit lending or reduce the effectiveness of credit distribution mechanisms [45].
- Enhancement of transparency and trust among economic actors regarding data collection/tracking [46].

The UNCTAD report also evaluated the Frontier Technology Readiness Index (FTRI), a country-specific metric used to evaluate countries' preparedness to implement frontier technologies, including AI, through evaluation of digital infrastructure, availability of data, and technological expertise, all of which are direct influences on the North African region's preparedness to achieve these objectives. Therefore, to accomplish the goals, there must be an emphasis placed on filling knowledge gaps and expanding access to capital in developing countries, particularly in the North African region. This conceptual foundation forms the basis for the secondary hypothesis of this study.

Hypothesis 2: The ICT diffusion augmented the effect of financial development on economic growth.

2.3. Conceptual and Theoretical Model in North African Countries.

Since the onset of the 21st century, the member states of North African countries have experienced substantial socio-economic transition, adopting modernization and innovation systems. The political objective of this strategy is to create a diversified economy that relies less on hydrocarbons and to develop an innovative, knowledge-based society.

The capability to embrace ICT depends on the number of government regulations and policies, world trends in ICT, and the prevailing market state, which is influenced by the nature of economic development [47]. Recently, North African countries have gradually implemented digital transformation strategies to modernize their economies and improve public service delivery.

Morocco has already become a leader in this area and has developed from e-government into a full-fledged digital economy through a series of medium-term strategies and institutional reforms [48]. The Digital Morocco program focuses on innovation, cybersecurity, and digitalizing government administrative and financial services. It emphasizes the importance of policies, law, social awareness, and institutional synergy [49].

Algeria is undergoing numerous changes that will help establish its technology sector and enable more people to develop the skills necessary to thrive in the digital world; this is also directly influencing the education system's development. Like Algeria, the Smart Tunisia strategy aims at developing a collaborative environment, and it applies to both the public sector and financial sphere, employing new technologies, including blockchain and artificial intelligence. The government of Tunisia has also created an environment that fosters innovative entrepreneurial actions and investments in digital education and healthcare infrastructure, aiming to promote inclusive economic and social growth.

The Digital Egypt program has triggered large-scale investments in digital infrastructure, e-government, and financial technologies; it has also prompted institutional changes in the financial sector to enhance transparency, add an extra level of accountability, and improve the effectiveness of financial sector operations. Reforms strengthened financial institutions and increased investment appeal; tech and digital banking boost inclusion, access, fintech growth, and risk management, driving growth and competitiveness. Both digital transformation and institutional reform require the same policy tools to ensure the sustainability and strength of the financial system. This research developed its theoretical/conceptual framework through an extensive literature review and hypothesis testing. It examined the impact of digital transformation on the strength of the financial system, as well as the impact of institutional quality on the degree of financial development and the interaction effect of both on economic growth in North Africa.

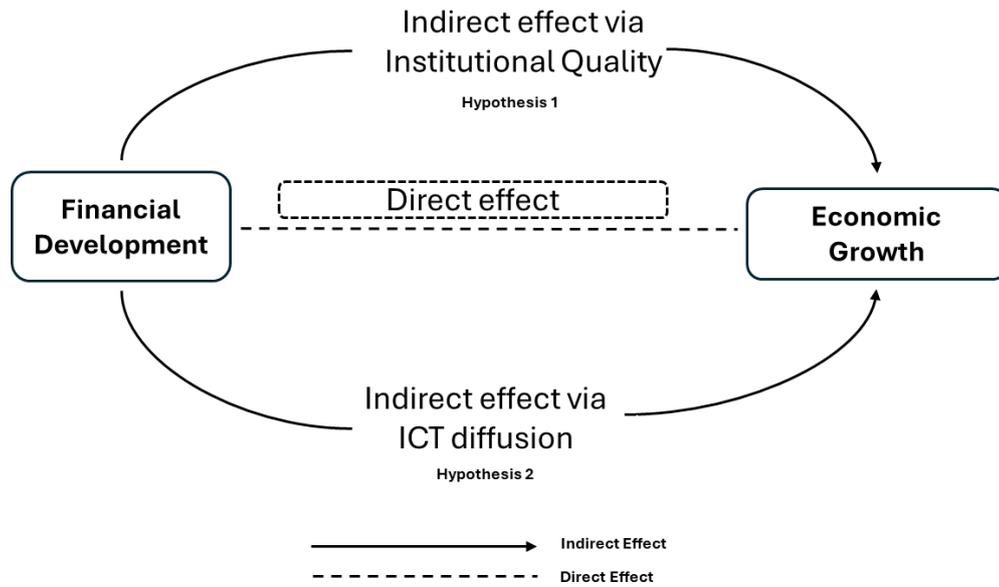


Figure 1. Conceptual and theoretical model.

3. METHODOLOGY

This research utilizes balanced panel data spanning 19 years (2004-2022) from four countries (Algeria, Egypt, Morocco, and Tunisia) to empirically assess the proposed theoretical framework. The selected timeframe signifies the availability of reliable statistical data. The analysis employs the System GMM estimation technique to mitigate endogeneity biases and improve the validity of the empirical findings.

3.1. Empirical Model

The study examines the impact of ICT proliferation and institutional quality on the finance-growth nexus. It is conducted in a cohort of four North African nations from 2004-2022. The World Bank [50] supplies the World Development Indicators (WDI) as the data source. Institutional indicators are derived from the Political Risk Services (PRS) Group database, specifically the annual variables of the International Country Risk Guide (ICRG), a product of the PRS Group. The appropriate model for achieving our research goal is an endogenous economic growth model.

$$y_{i,t} = \beta_0 y_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 X_{i,t} + \mu_t + \varphi_i + \varepsilon_{i,t} \quad (1)$$

Rewriting Equation 1 with growth rate as the dependent variable gives.

$$Growth_{i,t} = y_{i,t} - y_{i,t-1} = (\beta_0 - 1)y_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 X_{i,t} + \mu_t + \varphi_i + \varepsilon_{i,t} \quad (2)$$

In Equation 2, "i" denotes the country, the subscript "t" signifies the different periods, "y" represents the real GDP per capita growth, "FD" indicates financial development, and "X" refers to the matrix of control variables. In this context, μ_t represents a time-specific effect, φ_i is a country-specific unobserved fixed effect, and $\varepsilon_{i,t}$ indicates the error term. Equation 2 serves as the foundation for our estimation. The convergence coefficient is represented as $(\beta_0 - 1)$.

The identification of the transmission mechanisms that clarify the nature and magnitude of the relationship between financial development and economic growth remains ambiguous, both theoretically and empirically. Our study is among the few that directly confront this research gap by particularly addressing the topic at hand. Consequently, ICT spread [51] and institutional quality [52] are the principal methods by which financial development affects economic growth. In Equation 2, we will add a new term that combines ICT diffusion and financial development ($FD \times ICT$) and another term that combines institutional quality and financial development ($FD \times INS$). This will help us explain things better than just using the standard variable in the economic growth model.

$$Growth_{i,t} = (\beta_0 - 1)y_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 (FD_{i,t} \times ICT_{i,t}) + \beta_3 (FD_{i,t} \times INS_{i,t}) + \beta_4 X_{i,t} + \mu_t + \varphi_i + \varepsilon_{i,t} \quad (3)$$

The effect of financial development on economic growth is analyzed by evaluating the coefficients β_2 and β_3 , which quantify the significance of ICT diffusion and institutional quality, respectively. A positive and statistically significant β_2 coefficient may indicate that an increase in ICT diffusion enhances the effect of financial development on economic growth. If β_3 is positive and statistically significant; a robust institutional framework enhances the marginal effect of financial development on economic growth.

3.2. Methodology

In this study, the researchers aim to investigate the roles played by ICT dissemination and institutional quality on financial development and the effects of the two factors in co-determining economic growth. It specifically examines how financial development, along with ICT dispersal and institutional quality, interact with each other to understand the combined effects. In this way, Equation 3 is estimated by using two-stage GMM by Arellano and Bover [53] and Blundell and Bond [54]. We adopt this estimator for two key reasons: first, that it adjusts for country-specific effects, and second, it addresses a simultaneity issue that may arise from the potential endogeneity of some explanatory variables, which can be influenced by other dependent variables. To mitigate endogeneity, the research uses a two-step system GMM estimator in a dynamic panel data estimation.

The null hypothesis may be rejected due to a lack of lag structure or improper instrument choice. All these tests carry significant authentication to the dynamic panel data estimation scheme. The rejection of the null hypothesis, which assumes that the instruments are valid, is significant, and the reliability of the estimation is compromised. A second-order autocorrelation (AR(2)) test called the Arellano-Bond test is used to determine the serial correlation between the different residuals [55]. It is necessary to ensure there is no second-order serial correlation to ensure the consistency of the GMM estimator. The null hypothesis may be rejected due to a lack of lag structure or improper instrument choice. All these tests serve as important validation of the dynamic panel data estimation procedure.

3.3. Data and Sources

Most of the dataset comes from the WDI. Indicators of institutional quality are sourced from the Political Risk Services (PRS) Group database, specifically from the annual variables of the International Country Risk Guide (ICRG), a primary data source of PRS.

3.3.1. The Dependent Variable

The dependent variable is economic growth, assessed by the annual percentage growth rate of GDP per capita at market prices, based on constant local currency. Aggregates are based on U.S. dollars at constant 2015 prices. The World Bank Development Indicators present data gathered from 2004 to 2022. Economic advancement, as measured through GDP growth metrics, enhances a nation's capacity to fulfill its financial obligations and cultivates an enabling environment for the proliferation of ICT [56].

3.3.2. The Independent Variables

The initial GDP per capita serves as a proxy for the conditional convergence rate, measured as the five-year lag of the log of real GDP per capita, in line with Barro [57] and Bernardelli, et al. [58].

ICT diffusion: The literature identifies three primary ICT indicators frequently used in empirical studies: internet usage rate, mobile cellular subscriptions, and fixed broadband subscriptions per 100 individuals [59, 60]. The internet usage rate indicates the percentage of people who have used the internet on different devices in the past three months. Mobile cellular subscriptions play a critical role in developing areas, as mobile networks sometimes replace fixed infrastructure. Fixed broadband subscriptions represent access to high-speed internet services provided by technologies such as DSL, cable, fiber optics, or satellite. Employing Principal Component Analysis (PCA), these indicators from the WDI were synthesized to generate a composite ICT diffusion index [61].

3.3.3. Calculating Synthetic ICT Variable²

The following formula represents a synthetic ICT variable calculated using a standardization approach based on standard deviation.

$$ICT = \sum_{i=1}^t h_i \cdot \frac{X_{it}}{sd(x_i)} \quad (4)$$

Where:

X_{it} = Value of indicator i for country/year t .

$sd(x_i)$ = Standard deviation of the indicator i across all observations.

h_i = Weight assigned to the indicator i (Could be equal or based on importance).

t = Number of indicators.

The statistical values obtained from PCA are given in Table 1.

Table 1. Summary of principal component analysis.

Eigen analysis of the correlation matrix				
Component	Eigenvalue	Difference ($PC_k - PC_{k+1}$)	Proportion covariance	Cumulative
PC1	2.840	2.721	0.946	0.946
PC2	0.119	0.078	0.039	0.986
PC3	0.040	-	0.013	1.000

These values come from the eigen-decomposition of the correlation matrix of the three indicators (individuals using the Internet (% of population), mobile cellular subscriptions (per 100 people), and fixed broadband subscriptions (per 100 people)). The "Difference" column is the drop from PC_k to PC_{k+1} ; "Proportion" is the explained variance ratio per component; "Cumulative" is the running total.

Eigen vectors (Component loadings)				
Variable	PC1	PC2	PC3	
Using Inter	0.585	-0.115	-0.802	
Mob Cellular	0.575	-0.638	0.511	
Fix broadband	0.571	0.761	0.307	

Note: Using Inter: Individuals using the Internet (% of population); Mob Cellular: Mobile Cellular Subscriptions (Per 100 people), and Fix broadband: Fixed broadband subscriptions (per 100 people). PC1, PC2, and PC3: principal components.
PC1 has strong, nearly equal loadings on all three indicators ($\approx |0.97-0.99|$), confirming that it captures the common ICT adoption trend.

Financial development (FD): This variable indicates how much of the GDP banks lend to the private sector [62]. According to North [63] and Robbins [64] financial environment reliability and transparency directly influence public confidence in the financial system.

Institutional variables: The PRS Group database is the main source of institutional indicators used in preparing ICRG measures.

Corruption (COR): Numerous empirical studies demonstrate that corruption hinders financial development and acts as a barrier to long-term economic sustainability, especially in environments marked by fragile institutional frameworks [21].

Law and Order (LO): This concept combines two terms. The first, "legal," indicates the assessment of the autonomy, efficacy, and equity of the judiciary. The second, "order," indicates assessments of overall compliance with laws and the prevalence of criminal behavior. A high score indicates a robust legal framework and a strong degree of compliance with legal norms [65].

² Normalization is essential before performing Principal Component Analysis (PCA) to make indicators comparable. Due to two reasons: 1- Different Units: very different scales between using the Internet (%), mobile cellular subscriptions, and fixed broadband subscriptions (number per 100 inhabitants). 2- Impact on Variance: PCA maximizes explained variance; a variable with a large amplitude dominates the components.

Bureaucratic Quality (BQ): These variables measure the degree of rule compliance and operational efficiency within the organization. Developing a competent bureaucracy and accountability can further enhance the positive effects of financial development on economic growth [66].

3.3.4. Control Variables

Inflation: This variable indicates the annual rate of change in the cost of a typical basket of goods and services utilized by the average consumer. Considering the extensively recorded detrimental impacts of elevated inflation on economic performance [67], a negative coefficient is expected.

Trade openness: This variable indicates the extent of economic engagement with global markets. Neoclassical growth models suggest that the relationship between trade openness and economic growth is unsubstantiated. While openness typically fosters economic progress, it can also have adverse effects [68]. Accordingly, if trade openness contributes positively to economic growth, a positive coefficient is expected. This study adopts the most direct and often accepted definition: the sum of exports and imports as a proportion of GDP.

Tables 2, 3, and 4, respectively, report the descriptive statistics, the correlation coefficients matrix, and the variable measurements and data source descriptive statistics.

Table 2. Descriptive statistics.

Variables	Acronym	Obs	Mean	SD	Min.	Max.
Economic growth	GDPGR	76	1.73	2.71	-9.76	7.06
Initial GDP per capita	LAG-RGDP	76	0.07	0.06	-0.08	0.17
ICT diffusion	ICT	76	42.75	28.28	2.72	99.03
Financial development	FD	76	41.51	18.89	10.18	67.61
Corruption	COR	76	2.20	0.44	1.50	3.00
Law and Order	LO	76	3.91	0.88	2.41	5.00
Bureaucratic Quality	BQ	76	2.06	0.17	2.00	2.52
Trade openness	TRO	76	68.97	22.10	29.85	115.82
Inflation	INF	76	5.43	4.43	0.30	29.50

Table 3. Pairwise correlation coefficients matrix.

	GDPGR	LAG-RGDP	FD	ACP	TRO	INF	COR	LO	BQ
GDPGR	1.000								
LAG-RGDP	0.578*** (0.00)	1.000							
FD	0.003 (0.74)	-0.036 (0.35)	1.000						
ACP	-0.295*** (0.00)	-0.653*** (0.00)	0.221* (0.09)	1.000					
TRO	0.065 (0.574)	-0.018 (0.22)	0.673*** (0.00)	0.0239 (0.51)	1.000				
INF	0.089** (0.018)	-0.066 (0.33)	-0.303*** (0.00)	0.246* (0.09)	-0.335*** (0.00)	1.000			
COR	-0.078 (0.501)	-0.004 (0.41)	0.691** (0.03)	0.226** (0.06)	0.429*** (0.00)	-0.289** (0.011)	1.000		
LO	0.115 (0.317)	0.242** (0.033)	0.809*** (0.00)	-0.153 (0.74)	0.697*** (0.00)	-0.429*** (0.00)	0.686*** (0.00)	1.000	
BQ	-0.055 (0.224)	-0.270* (0.0176)	0.070 (0.543)	0.623*** (0.00)	0.0238 (0.836)	0.202 (0.078)*	0.086 (0.458)	-0.115 (0.317)	1.000

Note: The symbols ***, **, and * indicated statistics of 1%, 5%, and 10%, respectively.

Table 4. Variable measurements and data source.

Variable category	Variable	Acronym	Measurement	Data Sources	Expected signal	Theoretical basis
Dependent variable	Economic growth	GDPGR	GDP per capita growth (annual %)	WDI		Ullah and Khan [69] and Sahoo and Sethi [70].
Independent variables	Initial GDP per capita	LAG-RGDP	GDP per capita, PPP (constant 2021 international \$)	WDI	-	Barro [57] and Bernardelli, et al. [58].
Independent variables	ICT diffusion	ICT	- Individuals using the Internet (% of population) - Mobile Cellular Subscriptions (per 100 people) - Fixed broadband subscriptions (per 100 people)	WDI	+	Chien, et al. [59] and Wen, et al. [60].
Independent variables	Financial development	FD	Domestic credit to the private sector by banks (% of GDP)	WDI & IndexMundi	+	Beck, et al. [71] and Beck and Levine [72].
Independent variables	Corruption	COR	Corruption This measure ranges from 0 to 6.	ICRG Datasets	-	Balguzhina and Irani [73] and Bayar, et al. [74].
Independent variables	Law and Order	LO	Law and Order This measure ranges from 0 to 6.	ICRG Datasets	+	Park and Shin [65] and Efayena and Olele [75].
Independent variables	Bureaucratic Quality	BQ	Bureaucratic Quality This measure ranges from 0 to 4.	ICRG Datasets	+	Khan, et al. [6] and Meniago, et al. [20].
Control variables	Trade openness	TRO	Trade (% of GDP)	WDI	+	Yanikkaya [68] and Tosunoğlu [76].
Control variables	Inflation	INF	Inflation, consumer prices (annual %)	WDI and IndexMundi	-	Akinsola and Odhiambo [67] and Pappas and Boukas [77].

4. RESULTS, DISCUSSIONS, AND IMPLICATIONS

This paper presents an empirical analysis employing panel data methodologies, specifically focusing on the System Generalized Method of Moments (GMM) estimator, utilizing a dataset from four North African countries (Algeria, Egypt, Morocco, and Tunisia) spanning the years 2004 to 2022. Table 5 displays the results of five regression models derived from empirical data. The first model (R1) examines the direct impact of financial development on economic growth. Regressions R2 through R5 examine the indirect effect of financial development on economic growth by incorporating the mediating roles of ICT diffusion and institutional quality.

Table 5. Direct and indirect effects of financial development on economic growth.

Variables	(R1)	(R2)	(R3)	(R4)	(R5)
CONSTANT	0.155 (0.688)	0.038 (0.82)	0.066 (0.86)	0.057 (0.96)	0.07 (1.08)
LAG-RGDP	-0.064 (-2.166)**	-0.043 (-2.86)**	-0.052 (-2.66)**	-0.061 (-2.246)**	-0.073 (-2.284)**
INF	-0.013 (-2.44)**	-0.018 (-2.88)***	-0.022 (-2.84)***	-0.011 (-2.701)***	-0.019 (-2.843)***
TRO	0.023 (2.110)**	0.052 (2.026)**	0.022 (2.268)**	0.013 (2.218)**	0.044 (2.114)**
FD	0.012 (2.022)**				
FD× ICTdiffusion		0.064 (4.322)***			
FD×COR			-0.014 (-1.984)*		
FD ×LO				0.088 (5.654)***	
FD ×BQ					0.022 (4.228)***
Sargan test (p-value)	0.344	0.523	0.558	0.422	0.566
AR(2) test (p-value)	0.598	0.442	0.553	0.484	0.391
Hansen J test (p-value)	0.429	0.546	0.522	0.336	0.468

Note: P-Value *, **, and *** represent significant levels of 10%, 5%, and 1%, respectively. The first line gives the coefficients, while the following line displays the t-statistic values. The Sargan-Hansen test results from the GMM system show that the lagged variables of the distinct endogenous variables work as valid instruments in all regressions.

There is a significant positive relationship between finance and growth (as shown in Table 5) that can be amplified through the inclusion of ICT diffusion and financial development in the regression model. Specifically, we identify five distinct models. The first model (R1) demonstrates the direct influence of financial development on economic growth. The first regression (direct effect) indicates the positive and significant impact of financial development on economic growth. Model two (R2) shows that the ICT environment's beneficial impact on financial development leads to higher growth rates of real GDP per capita. Models three to five (R3–R4–R5) demonstrate how better institutions can increase the impact of financial development on economic growth. The addition of ICT diffusion indicators in the second regression (R2) also made the effect of financial development on economic growth stronger. This improvement is justified by increases in the coefficient values and in the statistical significance of the coefficients from 0.012 to 0.064, which indicate a positive effect.

Research indicates that the integration of ICT and financial development correlates with positive economic growth, particularly in developing economies [78]. For example, in North Africa, there has been an increased investment in digital infrastructure by governments and businesses over the last twenty years through telecommunication networks, Internet services, and digital solutions in both the public and private sectors [74]. Thus, ICT diffusion increases the effect of financial development on economic growth and therefore becomes a critical element in any policy framework designed to promote sustainable development in the area [79]. The inclusion of institutional variables in the two models (R4 and R5) of the empirical analysis, along with the financial development factor, increases the influence of the financial development factor on growth, especially in the size of coefficients and significance.

Adding the "Law and Order" indicator changes these coefficients from 0.012 to 0.088. The value increases to 0.022 upon the inclusion of the "Bureaucratic Quality" indicator. The third regression model indicates that the inclusion of the corruption variable, in conjunction with the financial development variable, reduces the latter's impact on economic growth. The coefficient estimates range from 0.012 to -0.014 for the "Corruption" indicator. Institutional

bad practice, as such, will most likely stop or block the opportunity for the establishment of financial development. North African corruption causes various negative effects; namely, it misallocates funds from their optimal use, increases transaction costs for both consumers and producers, and reduces the availability of loans for businesses and consumers. Therefore, in a corrupt country, financial development is likely to encourage opportunistic behavior and inequality instead of promoting economic growth; as a result, it may either reduce the positive effects of financial institutions or eliminate them. Thus, these results emphasize the necessity of institutional transformation to enhance economic growth and financial development in North African countries.

Several institutional changes, such as structural changes, must be adopted. These changes will enhance investor confidence, entrepreneurship, efficiency, and renew the financial system. One of the most significant issues that led to the country's economic development is the modernization of the Moroccan legal system [50]. Similarly, digital governance technologies in Tunisia have enabled the establishment of new businesses [80]. At the same time, Algeria and Egypt have stepped up their fight against corruption to bring more transparency and integrity to their governing institutions [81, 82]. Meanwhile, there has been an upsurge in anti-corruption movements across Algeria and Egypt in their effort to establish more transparency and integrity within various government structures. These policy measures can be associated with the UN SDGs because they promote inclusive growth [83]. A well-developed financial system and sustainable growth heavily depend on strong institutions and a well-developed ICT infrastructure.

The development of ICT infrastructure facilitates the provision of digital financial services, as it enhances access to banking, reduces transaction costs, and promotes transparency [84]. Similarly, an effective institutional structure encourages financial innovation and confidence among investors [85]. North African countries have empirical studies showing that the increase in ICT facilitates financial development and, therefore, multiplies the positive effects on economic growth [86]. The use of digital technologies in financial services increases the shift to a digital economy and optimizes the financial system [50]. This increases private funding, contributes to entrepreneurship, and stimulates sustainable and diversified development in North Africa [87].

5. CONCLUSION AND POLICY IMPLICATIONS

Since the late 1980s, there has been a developing body of research (empirical studies & theoretical frameworks) that has shown a strong relationship between financial development and economic growth. Until now, the explanation of the causal relations between these variables has been very limited and incomplete. The present paper aims to add to the existing knowledge base about this subject matter, as it relates to the North African region for the period from 2004 to 2022, by using two main independent variables: quality of institutions and ICT diffusion.

Our empirical results confirmed the important role of ICT diffusion, which has been able to improve the efficiency of the financial sector. This improvement is achieved by enhancing access to banking services for both individuals and organizations, as well as by increasing the operational efficiency of these organizations, leading to greater overall economic growth. The increase in coefficient values and the significant value of coefficients, ranging between 0.012 and 0.064, indicate positive effects and support this improvement. A well-developed and established organizational structure also plays a significant role in establishing a secure and efficient system that enables the financial sector to thrive. The practical findings of this article also indicate that there must be a concerted attitude toward economic growth, which is linked to the inter-relationship of IT development and institutional change, to increase the potential positivity of financial development.

North African nations should maintain their momentum in digitizing the banking sector. To enhance economic growth, these countries need stricter regulations, effective anti-corruption laws, and serious law enforcement. These findings should guide policy decisions for North African policymakers. Financial development involves the strategic allocation of resources to a comprehensive ICT infrastructure and the establishment of a robust institutional framework.

This study reveals how a country has a solid institutional system and access to ICT, which is also important to build the banking system and have a stable economy. The right use of technology is crucial in achieving operational efficiency and increasing digital banking operations. In addition, the digitalization of the financial sector contributes to stimulating sustainable economic growth. The study emphasizes the importance of continuing government-provided incentives to facilitate ICT growth and spread, as well as to improve the institutional capacity of organizations. Although research on the conjoint impact of institutional quality and ICT distribution on finance and growth is sparse, the available evidence supports the role these play in economic transformation and improvement in the performance of the financial sector. In our study, we have tried to overcome this limit by showing how such an indirect relationship between the real and financial spheres is explained through the creation of a sound institutional environment and the diffusion of ICT.

This study has some limitations that should be noted. The concepts under investigation, ICT diffusion and institutional quality, are broad and hard to measure with absolute precision. The indicators used in transnational databases do not always correspond to the actual complexity of digital infrastructures on the ground and the concrete functioning of institutions in everyday economic life. Furthermore, some indicators evolve slowly or are based on perceptions, which can reduce the robustness of the relationships observed. These limitations open prospects for future research in several areas. A greater granularity of indicators relating to digital technologies and institutional characteristics would make it possible to identify the most decisive factors in the transmission of the effects of finance on growth. In addition, a comparative analysis between North Africa and other regions would provide relevant insights.

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REFERENCES

- [1] R. Levine, "Stock markets, growth, and tax policy," *The Journal of Finance*, vol. 46, no. 4, pp. 1445-1465, 1991. <https://doi.org/10.1111/j.1540-6261.1991.tb04625.x>
- [2] R. Levine, "Financial development and economic growth: Views and agenda," *Journal of Economic Literature*, vol. 35, no. 2, pp. 688-726, 1997.
- [3] N. Coimbra and H. Rey, "Financial cycles with heterogeneous intermediaries," *The Review of Economic Studies*, vol. 91, no. 2, pp. 817-857, 2024. <https://doi.org/10.1093/restud/rdad039>
- [4] O. Benzizoun, H. Benbachir, N. Nefzi, and I. Bounite, "The challenges of SME financing: Information asymmetry, credit rationing, and innovative alternatives," *African Scientific Journal*, vol. 3, no. 31, pp. 587-614, 2025.
- [5] D. H. Vo, "Does institutional quality matter for financial inclusion? International evidence," *PLoS One*, vol. 19, no. 2, p. e0297431, 2024. <https://doi.org/10.1371/journal.pone.0297431>
- [6] M. A. Khan, D. Kong, J. Xiang, and J. Zhang, "Impact of institutional quality on financial development: Cross-country evidence based on emerging and growth-leading economies," *Emerging Markets Finance and Trade*, vol. 56, no. 15, pp. 3829-3845, 2020. <https://doi.org/10.1080/1540496X.2019.1588725>
- [7] G. R. Sinha, R. C. Mehta, A. Kaikkila, and K. Viitasalo, "Factors and patterns in mobile banking and payment services use in the United States," *Journal of Financial Services Marketing*, vol. 30, no. 1, p. 26, 2025. <https://doi.org/10.1057/s41264-025-00319-6>
- [8] Y. Li, X. Li, and H. Ahmad, "ICT diffusion and financial development: Comparing high, middle, and low-income countries," *PLoS One*, vol. 19, no. 5, p. e0295183, 2024. <https://doi.org/10.1371/journal.pone.0295183>

- [9] D. Agostino, I. Saliterer, and I. Steccolini, "Digitalization, accounting and accountability: A literature review and reflections on future research in public services," *Financial Accountability & Management*, vol. 38, no. 2, pp. 152-176, 2022. <https://doi.org/10.1111/faam.12301>
- [10] L. Klapper and H. Banka, "Developing financial inclusion through digital financial services," *Financial Economics Review*, vol. 156, no. 4, pp. 77-96, 2024. <https://doi.org/10.3917/ecofi.156.0077>
- [11] H. Khan, S. Khan, and F. Zuojun, "Institutional quality and financial development: Evidence from developing and emerging economies," *Global Business Review*, vol. 23, no. 4, pp. 971-983, 2022. <https://doi.org/10.1177/0972150919892366>
- [12] F. Ahmed, S. Kousar, A. Pervaiz, and A. Shabbir, "Do institutional quality and financial development affect sustainable economic growth? Evidence from South Asian countries," *Borsa Istanbul Review*, vol. 22, no. 1, pp. 189-196, 2022. <https://doi.org/10.1016/j.bir.2021.03.005>
- [13] Y. Bayraktar, A. Ozyilmaz, M. Toprak, M. F. Olgun, and E. Isik, "The role of institutional quality in the relationship between financial development and economic growth: Emerging markets and middle-income economies," *Borsa Istanbul Review*, vol. 23, no. 6, pp. 1303-1321, 2023. <https://doi.org/10.1016/j.bir.2023.10.002>
- [14] Y. Salouka, C. S. Kane, and N. T. Tito, "Impact of ICT diffusion on economic growth in WAEMU countries," *European Scientific Journal*, vol. 19, no. 34, p. 103, 2023.
- [15] B. K. Dang, D. T. Vo, and N. T. M. Ha, "The impact of economic uncertainty and institutional quality on bank profitability: Global evidence," *International Economics and Economic Policy*, vol. 22, no. 3, p. 37, 2025. <https://doi.org/10.1007/s10368-025-00664-w>
- [16] H.-T. Nguyen, "Does institutional quality reduce the impact of market concentration on bank stability? Evidence of developing countries," *Cogent Economics & Finance*, vol. 11, no. 2, p. 2244769, 2023. <https://doi.org/10.1080/23322039.2023.2244769>
- [17] E. Z. N. Tadida, "Public auditing: What impact does the quality of the institutional framework have on the level of corruption?," *International Review of Administrative Sciences*, vol. 89, no. 4, pp. 1131-1146, 2023. <https://doi.org/10.1177/00208523231155385>
- [18] S. Hartmann and R. Spruk, "Long-term effects of institutional instability," *Empirical Economics*, vol. 61, no. 4, pp. 2073-2112, 2021. <https://doi.org/10.1007/s00181-020-01934-z>
- [19] F. C. Lisbinski and H. L. Burnquist, "Institutions and financial development: Comparative analysis of developed and developing economies," *Economía*, vol. 25, no. 2, pp. 347-376, 2024. <https://doi.org/10.1108/ECON-11-2023-0201>
- [20] C. Meniago, B. T. Mazorodze, and G. Mah, "Linking financial development and economic growth: Do we have new evidence of the role of institutions in CFA countries?," *Cogent Economics & Finance*, vol. 13, no. 1, p. 2460067, 2025. <https://doi.org/10.1080/23322039.2025.2460067>
- [21] R. A. Küçükçolak, G. Bozkurt, N. İter Küçükçolak, A. V. Ertemel, and S. Küçüköğlü, "Corruption control as a catalyst for financial development: A global comparative study," *Journal of Risk and Financial Management*, vol. 18, no. 2, p. 79, 2025. <https://doi.org/10.3390/jrfm18020079>
- [22] H. Mili, "Financial development and economic complexity: The mediating role of institutional quality," *International Journal of Innovative Research and Scientific Studies*, vol. 8, no. 6, pp. 2481-2490, 2025.
- [23] M. M. Thottoli, M. A. Islam, M. F. B. Yusof, M. S. Hassan, and M. A. Hassan, "Embracing digital transformation in financial services: From past to future," *Sage Open*, vol. 13, no. 4, p. 21582440231214590, 2023. <https://doi.org/10.1177/21582440231214590>
- [24] R. H. Coase, "The nature of the firm," *Economica*, vol. 4, no. 16, pp. 386-405, 1937. <https://doi.org/10.1111/j.1468-0335.1937.tb00002.x>
- [25] O. E. Williamson, *Markets and hierarchies: Analysis and antitrust implications*. New York: Free Press, 1975.
- [26] A. Rindfleisch, "Transaction cost theory: Past, present and future," *AMS Review*, vol. 10, no. 1, pp. 85-97, 2020. <https://doi.org/10.1007/s13162-019-00151-x>

- [27] F. Liu and B. Walheer, "Financial inclusion, financial technology, and economic development: A composite index approach," *Empirical Economics*, vol. 63, no. 3, pp. 1457-1487, 2022. <https://doi.org/10.1007/s00181-021-02178-1>
- [28] T. Awa and K. D. Abdou, "Financial inclusion, ICT development and economic growth in WAEMU countries: Evidence of governance," *African Journal of Economic and Management Studies*, vol. 16, no. 2, pp. 237-254, 2025. <https://doi.org/10.1108/AJEMS-02-2023-0071>
- [29] J. Endres and M. Steula, "The impact of fixed and mobile broadband adoption on economic growth: A panel data analysis," *Journal of Telecommunications and the Digital Economy*, vol. 12, no. 4, pp. 20-44, 2024. <https://doi.org/10.18080/jtde.v12n4.1128>
- [30] S. Nasreen, F. Ishtiaq, and A. K. Tiwari, "The role of ICT diffusion and institutional quality on financial inclusion in Asian region: Empirical analysis using panel quantile regression," *Electronic Commerce Research*, vol. 25, no. 3, pp. 1685-1752, 2025. <https://doi.org/10.1007/s10660-023-09727-z>
- [31] N. O. D. Ellili, "Financial inclusion and sustainability: Evidence from emerging markets," *Sustainability*, vol. 16, no. 2, pp. 789-804, 2024.
- [32] O. Mothobi and K. Kebotsamang, "The impact of network coverage on adoption of fintech and financial inclusion in Sub-Saharan Africa," *Journal of Economic Structures*, vol. 13, no. 1, p. 5, 2024. <https://doi.org/10.1186/s40008-023-00326-7>
- [33] R. Kumari and S. K. Singh, "Impact of ICT infrastructure, financial development, and trade openness on economic growth: New evidence from low-and high-income countries," *Journal of the Knowledge Economy*, vol. 15, no. 2, pp. 7069-7098, 2024. <https://doi.org/10.1007/s13132-023-01332-7>
- [34] C. S. Saba, O. O. David, and T. P. Voto, "Institutional quality effect of ICT penetration: Global and regional perspectives," *South African Journal of Economic and Management Sciences*, vol. 27, no. 1, p. a5180, 2024. <https://doi.org/10.4102/sajems.v27i1.5180>
- [35] D. Ha, P. Le, and D. K. Nguyen, "Financial inclusion and fintech: A state-of-the-art systematic literature review," *Financial Innovation*, vol. 11, no. 1, p. 69, 2025. <https://doi.org/10.1186/s40854-024-00741-0>
- [36] A. Das, M. Chowdhury, and S. Seaborn, "ICT diffusion, financial development and economic growth: New evidence from low and lower middle-income countries," *Journal of the Knowledge Economy*, vol. 9, no. 3, pp. 928-947, 2018. <https://doi.org/10.1007/s13132-016-0383-7>
- [37] M. M. H. Raihan, S. Subroto, N. Chowdhury, K. Koch, E. Ruttan, and T. C. Turin, "Dimensions and barriers for digital (in) equity and digital divide: A systematic integrative review," *Digital Transformation and Society*, vol. 4, no. 2, pp. 111-127, 2025. <https://doi.org/10.1108/DTS-04-2024-0054>
- [38] C. S. Saba, N. Ngepah, and N. M. Odhiambo, "The nexus between ICT diffusion, financial development, industrialization and economic growth: Evidence from Sub-Saharan African countries," *Journal of African Business*, vol. 26, no. 2, pp. 454-478, 2025. <https://doi.org/10.1080/15228916.2025.2451550>
- [39] M. Dev, M. Kumar, and D. Saha, "How do ICTs affect national well-being? The contrasting influence of mobile phones and household computers," *Social Indicators Research*, vol. 179, no. 3, pp. 1431-1461, 2025. <https://doi.org/10.1007/s11205-025-03671-1>
- [40] W. Ben Arfi, L. Hikkerova, and J.-M. Sahut, "Institutional quality and information and communication technology: Effects on financial inclusion," *Technological Forecasting and Social Change*, vol. 161, p. 120315, 2020.
- [41] S. Asongu, S. Le Roux, J. Nwachukwu, and C. Pyke, "Reducing information asymmetry with ICT: A critical review of loan price and quantity effects in Africa," *International Journal of Managerial Finance*, vol. 15, no. 2, pp. 130-163, 2019. <https://doi.org/10.1108/IJMF-01-2018-0027>
- [42] U. F. Saeed and G. E. Klugah, "Driving inclusive growth through financial systems and technology adoption: A global analysis of synergistic pathways using structural equation modeling," *Cogent Economics & Finance*, vol. 13, no. 1, p. 2523955, 2025. <https://doi.org/10.1080/23322039.2025.2523955>

- [43] U. Adam, A. L. Sulemana, M. S. S. Sule, and M. M. Yussif, "Does digitisation determine financial development? Empirical evidence from Africa," *Cogent Economics & Finance*, vol. 12, no. 1, p. 2341214, 2024. <https://doi.org/10.1080/23322039.2024.2341214>
- [44] R. Fulgenzi, S. Gitto, and P. Mancuso, "Information and communication technology and labour productivity growth: A production-frontier approach," *Annals of Operations Research*, vol. 333, no. 1, pp. 123-156, 2024. <https://doi.org/10.1007/s10479-024-05818-8>
- [45] A. Verma, P. S. Dandgawhal, and A. K. Giri, "Impact of ICT diffusion and financial development on economic growth in developing countries," *Journal of Economics, Finance and Administrative Science*, vol. 28, no. 55, pp. 27-43, 2023. <https://doi.org/10.1108/JEFAS-09-2021-0185>
- [46] A. Hussain, "ICT-driven transparency: Empirical evidence from selected Asian countries," *Journal of Telecommunications and the Digital Economy*, vol. 11, no. 3, pp. 19-41, 2023. <https://doi.org/10.18080/jtde.v11n3.658>
- [47] K. Oyetade and T. Zuva, "External organizational drivers of ICT adoption for sustainable growth," *Discover Global Society*, vol. 3, no. 1, p. 116, 2025. <https://doi.org/10.1007/s44282-025-00273-7>
- [48] S. K. Ryu and M. Echkaou, *Morocco's digital transformation journey: E-government, digital government, and digital economy. In A. K. Bwalya, S. K. Ryu, & M. Janssen (Eds.), The art of digital governance*. Germany: Springer, 2025.
- [49] Y. Maleh and Y. Maleh, *Morocco national cybersecurity strategy. In Cybersecurity in Morocco*. Cham: Springer International Publishing, 2022.
- [50] World Bank, *Moroccan economic growth could accelerate with the full implementation of broad-based reforms*. Morocco: Morocco Economic Monitor, 2022.
- [51] L. J. Habeezu and B. N. Epo, "The effect of ICT on inclusive growth in Sub-Saharan Africa," *SN Business & Economics*, vol. 5, no. 11, pp. 164, 2025. <https://doi.org/10.1007/s43546-025-00925-5>
- [52] R. Abaidoo and E. K. Agyapong, "Financial development and institutional quality among emerging economies," *Journal of Economics and Development*, vol. 24, no. 3, pp. 198-216, 2022. <https://doi.org/10.1108/JED-08-2021-0135>
- [53] M. Arellano and O. Bover, "Another look at the instrumental variable estimation of error-components models," *Journal of Econometrics*, vol. 68, no. 1, pp. 29-51, 1995. [https://doi.org/10.1016/0304-4076\(94\)01642-D](https://doi.org/10.1016/0304-4076(94)01642-D)
- [54] R. Blundell and S. Bond, "Initial conditions and moment restrictions in dynamic panel data models," *Journal of Econometrics*, vol. 87, no. 1, pp. 115-143, 1998. [https://doi.org/10.1016/S0304-4076\(98\)00009-8](https://doi.org/10.1016/S0304-4076(98)00009-8)
- [55] M. Arellano and S. Bond, "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations," *The Review of Economic Studies*, vol. 58, no. 2, pp. 277-297, 1991. <https://doi.org/10.2307/2297968>
- [56] T. Aziz, M. G. U. Khan, M. T. Islam, and M. A. H. Pradhan, "An analysis on the relationship between ICT, financial development and economic growth: Evidence from Asian developing countries," *The Journal of International Trade & Economic Development*, vol. 32, no. 5, pp. 705-721, 2023. <https://doi.org/10.1080/09638199.2022.2134912>
- [57] R. J. Barro, "Economic growth and convergence, applied to China," *China & World Economy*, vol. 24, no. 5, pp. 5-19, 2016. <https://doi.org/10.1111/cwe.12172>
- [58] M. Bernardelli, M. Próchniak, and B. Witkowski, *Economic growth and convergence: Global analysis through econometric and hidden Markov models*. UK: Routledge, 2021.
- [59] M.-S. Chien, C.-Y. Cheng, and M. A. Kurniawati, "The non-linear relationship between ICT diffusion and financial development," *Telecommunications Policy*, vol. 44, no. 9, p. 102023, 2020. <https://doi.org/10.1016/j.telpol.2020.102023>
- [60] J. Wen, H. Hussain, R. Jiang, and J. Waheed, "Overcoming the digital divide with ICT diffusion: Multivariate and spatial analysis at China's provincial level," *Sage Open*, vol. 13, no. 1, p. 21582440231159323, 2023. <https://doi.org/10.1177/21582440231159323>
- [61] A. C. Onuogu, N. Ngepah, and N. M. Odhiambo, "Impacts of ICT diffusion, foreign direct investment, trade openness, and globalization on growth in Sub-Saharan Africa," *Global Economy Journal*, vol. 24, no. 1, pp. 1-10, 2024.

- [62] A. Nasim, M. A. Nasir, and G. Downing, "Determinants of bank efficiency in developed (G7) and developing (E7) countries: Role of regulatory and economic environment," *Review of Quantitative Finance and Accounting*, vol. 65, no. 1, pp. 257–294, 2025. <https://doi.org/10.1007/s11156-024-01272-6>
- [63] D. C. North, *Institutions, institutional change and economic performance*. Cambridge, UK: Cambridge University Press, 1990.
- [64] B. G. Robbins, "Institutional quality and generalized trust: A nonrecursive causal model," *Social Indicators Research*, vol. 107, no. 2, pp. 235–258, 2012. <https://doi.org/10.1007/s11205-011-9838-1>
- [65] D. Park and K. Shin, "Economic growth, financial development, and income inequality," *Emerging Markets Finance and Trade*, vol. 53, no. 12, pp. 2794–2825, 2017. <https://doi.org/10.1080/1540496X.2017.1333958>
- [66] S. Naseer, "Public spending, quality of bureaucracy and economic growth: A theoretical analysis," *The Pakistan Development Review*, vol. 58, no. 2, pp. 203–221, 2019. <https://doi.org/10.30541/v58i2pp.203-221>
- [67] F. A. Akinsola and N. M. Odhiambo, "Inflation and economic growth: A review of the international literature," *Comparative Economic Research. Central and Eastern Europe*, vol. 20, no. 3, pp. 41–56, 2017. <https://doi.org/10.1515/cer-2017-0019>
- [68] H. Yanikkaya, "Trade openness and economic growth: A cross-country empirical investigation," *Journal of Development Economics*, vol. 72, no. 1, pp. 57–89, 2003. [https://doi.org/10.1016/S0304-3878\(03\)00068-3](https://doi.org/10.1016/S0304-3878(03)00068-3)
- [69] S. Ullah and M. A. Khan, "The nexus between financial development and economic growth: Panel cointegration and causality analysis for developing countries," *Journal of Risk and Financial Management*, vol. 14, no. 10, p. 489, 2021.
- [70] M. Sahoo and N. Sethi, "Financial development and economic growth in BRICS: A panel data analysis," *Journal of Economics, Finance and Administrative Science*, vol. 24, no. 47, pp. 145–160, 2019.
- [71] T. Beck, A. Demirgüç-Kunt, and R. Levine, "Finance, inequality and poverty: Cross-country evidence," World Bank Policy Research Working Paper No. 3338, World Bank, 2004.
- [72] T. Beck and R. Levine, "Industry growth and capital allocation: Does having a market-or bank-based system matter?," *Journal of Financial Economics*, vol. 64, no. 2, pp. 147–180, 2002. [https://doi.org/10.1016/S0304-405X\(02\)00074-0](https://doi.org/10.1016/S0304-405X(02)00074-0)
- [73] A. Balguzhina and F. Irani, "Exploring the effect of corruption and government quality on bank stability: Evidence from transition countries," *Journal of Financial Risk Management*, vol. 13, no. 3, pp. 525–548, 2024. <https://doi.org/10.4236/jfrm.2024.133025>
- [74] Y. Bayar, Ö. Yorulmaz, O. Yelkesen, and V. Toader, "The interaction between ICT penetration and sustainable development: Empirical evidence from African countries," *Humanities and Social Sciences Communications*, vol. 11, no. 1, pp. 1–17, 2024. <https://doi.org/10.1057/s41599-024-04174-z>
- [75] O. O. Efayena and E. H. Olele, "Moderating the effect of institutional quality on the fiscal policy and economic growth nexus: What evidence exists in Sub-Saharan Africa?," *Journal of the Knowledge Economy*, vol. 15, no. 4, pp. 20436–20458, 2024. <https://doi.org/10.1007/s13132-024-01978-x>
- [76] B. T. Tosunoğlu, "The causal relationship among trade openness, financial development, and economic growth: Recent evidence from newly industrialized countries (NICs)," *Business & Management Studies: An International Journal*, vol. 11, no. 2, pp. 532–540, 2023. <https://doi.org/10.15295/bmij.v11i2.2229>
- [77] A. Pappas and N. Boukas, "Examining impact of inflation and inflation volatility on economic growth: Evidence from European Union economies," *Economics*, vol. 13, no. 2, p. 31, 2025. <https://doi.org/10.3390/economics13020031>
- [78] A. A. Nabi, F. H. Tunio, M. Azhar, M. S. Syed, and Z. Ullah, "Impact of information and communication technology, financial development, and trade on economic growth: Empirical analysis on N11 countries," *Journal of the Knowledge Economy*, vol. 14, no. 3, pp. 3203–3220, 2023. <https://doi.org/10.1007/s13132-022-00890-6>
- [79] F. Alshubiri, S. A. Jamil, and M. Elheddad, "The impact of ICT on financial development: Empirical evidence from the Gulf Cooperation Council countries," *International Journal of Engineering Business Management*, vol. 11, pp. 1–14, 2019. <https://doi.org/10.1177/1847979019870670>
- [80] UNIDO, *Digitalization is driving entrepreneurship in Tunisia*. Austria: UNIDO, 2022.

- [81] OECD, *OECD public governance reviews: Egypt: Strengthening the foundations for more efficient and effective public governance reforms*. France: OECD Publishing, 2024a.
- [82] OECD, *Global forum secretariat helps Algeria prepare for peer review on transparency and exchange of information on request*. France: OECD Publishing, 2024b.
- [83] UNDESA, *The sustainable development goals report 2023*. New York: United Nations, 2023.
- [84] O. Akanfe, P. Bhatt, and D. A. Lawong, "Technology advancements shaping the financial inclusion landscape: Present interventions, emergence of artificial intelligence and future directions," *Information Systems Frontiers*, vol. 27, no. 5, pp. 2189–2212, 2025. <https://doi.org/10.1007/s10796-025-10597-z>
- [85] S. M. Alawi, W. Abbassi, R. Saqib, and M. Sharif, "Impact of financial innovation and institutional quality on financial development in emerging markets," *Journal of Risk and Financial Management*, vol. 15, no. 3, p. 115, 2022. <https://doi.org/10.3390/jrfm15030115>
- [86] V. S. Tchamyou, G. Erreygers, and D. Cassimon, "Inequality, ICT and financial access in Africa," *Technological Forecasting and Social Change*, vol. 139, pp. 169–184, 2019. <https://doi.org/10.1016/j.techfore.2018.11.004>
- [87] World Bank, *Digital financial services*. United States: World Bank Group, 2020.

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