

Title: Digital Renaissance: Boosting Economic Growth in North African Nations

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Abstract

The digital economy has become a major force behind economic growth in the modern world, transforming established industries and opening up new opportunities for productivity and innovation. Digital technologies are revolutionizing company operations, increasing efficiency, and promoting global interconnection as they become ingrained in numerous sectors. This research explores the intricate relationship between the digital economy and economic growth, highlighting how advancements in digital infrastructure and information technology contribute to sustained economic development and prosperity. Using annual data from 2000 to 2022 and the PMG estimator, this paper gives a comparative analysis of the short- and long-term effects of digital economy on economic growth in North African nations. The findings indicated that, the error correction coefficient had a negative and statistically significant value (-

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1.160). This suggests that there is a long-run integration between variables. The PMG estimates showed the negative impact of access to information and communication technology services indicators (INT) by 0.001 and the absence of impact of digital economy infrastructure (MCS) and Technology Revenue (RICT) on economic growth in North African nations. This is due to a shortage in the workforce, insufficient legal frame of technology, and a restricted digital infrastructure are major obstacles. These obstacles may impede the uptake and assimilation of digital technology, hence hindering the process of economic diversification and expansion.

Keywords: Digital Economy, Economic Growth, North African nations, Panel Data.

Introduction

Since the digital transformation is seen as the primary driver of growth and development in the twenty-first century and beyond, several theories have been developed to explain the various digital activities. The three most significant of these theories are the Varian theory, the Roll Katz and Potalez Kotorubis theory, and the Joseph Schumpeter innovation theory.

Schumpeter shared his opinions on the investigation of economic development theory in 1911. He focused on innovation and regeneration, which boost national wealth and rely on modern technology. He said that the country's GDP is rapidly increasing due to new technology that enter the market and draw in new investments. One theory that explains how economic development and growth are related is Schumpeter's. It emphasizes demolition that is, tearing down the old economy and building a new one through sophisticated industrial innovation that examines macroeconomic statistics and experimental data in a new format, such as digitization. (Madani .D, 2021)

In the process of structural transformation towards a digital economy, it is critical to build strong physical and ICT infrastructure. Infrastructure lowers the cost of development, allowing both domestic and international businesses to engage in market operations. For instance, ICT infrastructure generates positive externalities as a result of digitalization Internet, cell phone, and satellite technology are examples of networks. (Koutroumpis, 2009)

In North African countries, the digital economy presents both opportunities and challenges. While the potential for economic growth through digitalization is immense, these countries face significant obstacles in fully realizing this potential. Issues such as inadequate infrastructure, limited digital literacy, regulatory hurdles, and socio-economic disparities hinder the widespread adoption of digital technologies. Addressing these challenges is crucial for North African nations to harness the benefits of the digital economy and achieve sustainable development.

Thus, in order to better understand how digital economy affects economic dynamics, this paper delves into the intricate relationship between digital economy and economic growth. Using annual data from 2000 to 2022 and the PMG estimator, this paper compares the short- and long-term effects of digital economy on economic growth in North African nations (Algeria, Morocco, Tunisia).

1- Literature Review

The digital economy is now growing and contributing significantly to the economic development of many countries. It is mostly based on data and information technology. In order to better understand the connection between the digital economy and economic growth, numerous descriptive and empirical studies have been carried out. (Olofin, 2023) The impact of the digital economy and high-quality institutions on the economic development of Bangladesh, Ethiopia, Kenya, and Nigeria is investigated in this study. The feasible generalized least square method is used in the study, which uses annual panel data from 1985 to 2017. The findings indicate that while corruption, socioeconomic conditions, and bureaucratic quality impede economic progress, the digital economy, human capital and knowledge workers, and democratic accountability foster it. Additionally, the relationship between corruption and the internet economy fosters growth. However, the relationship between the digital economy and institutional

quality impedes economic progress. This may be because these nations have low levels of economic digitalization and declining institutional quality. The study comes to the conclusion that efforts to transform into emerging markets may benefit from the digital economy and high-quality institutions. (Wei Zhang & Yuan Yao, 2021) This paper measures the digital economic development index of 30 Chinese cities from the three dimensions of digital infrastructure, digital industry, and digital integration. It then uses panel data of 30 Chinese cities from 2015 to 2019. The findings indicate that the digital infrastructure in China is clearly growing, the country's digital economy is developing at a faster rate each year, and the country's digital industry is developing more slowly. The influence coefficients for digital infrastructure, digital industry, and digital integration, respectively, are 0.2452, 0.0773, and 0.3458, and they all significantly increase regional total factor productivity. The study concludes that technological progress has a mediating effect of 0.1527 on the transmission mechanism from the digital economy to high-quality economic development. In the eastern, northeastern, central, and western regions, this effect is 1.70 percent, 9.25 percent, 28.89 percent, and 21.22%, respectively. (Abendin & Pingfang, 2021) This study uses a sample of 53 nations from 2000 to 2018 to investigate how the digital economy affects international trade and how it affects economic growth in Africa. The sample was subsequently separated into five sub-regions, and the GMM models, POLS, and random and fixed effects were used to estimate the results. Trade significantly increases economic prosperity both with and without the interactive term in the RE, FE, and sys-GMM estimations. The output elasticities of labor and capital have positive and negative effects on economic growth, respectively. The regressions for the sub-sample produced statistically significant differences in the output elasticities for the indicators. The results indicated that trade only positively affects economic growth when it interacts with the digital economy in the POLS estimations. (Raef & Alaa A, 2019) Using a panel -GMM model over the years 2007–2016, the study attempts to assess the effect of information and communication technology (ICT) on the economic growth of a subset of developing countries in the Sub-Saharan Africa (SSA) and Middle East and North Africa (MENA) regions. The econometric model's results indicate that, aside from fixed telephones, other ICTs like mobile phones, Internet usage, and broadband adoption have been the primary forces behind economic growth in developing nations in SSA and the Middle East and North Africa (MENA) between 2007 and 2016. Furthermore, the findings attest to the fact that MENA nations outperform SSA nations in terms of broadband adoption and Internet usage. from the standpoint of policy. (teniou & dehan, 2019) This study uses the International Telecommunication Union's (ITU) created ICT Index to quantify the digital gap in the Arab world. This index measures the digital divide along three dimensions: ICT skills, ICT use, and ICT access. This study demonstrated that: the digital divide between developed and Arab nations is one of the biggest issues facing the Arab world; digital competency is a prerequisite for the digital economy and its absence exacerbates the digital divide. (Chabossou, 2018) Through the use of the VECM model, the study seeks to understand how information and communications technology contributed to Benin's economic growth between 1985 and 2015. The findings demonstrated a long-term positive correlation between capital and economic growth in the digital economy. The Granger causality test established a unidirectional causal relationship by demonstrating that economic growth is boosted by investments in information and communication technology, not the other way around. Therefore, Benin has a chance to experience sustainable economic growth through ICT development.

2- Data and Methodology

The digital economy has become a major factor behind economic progress and transformation in the modern period. The digital economy, which includes e-commerce, digital banking, online services, and information and communication technologies (ICT), is defined by the widespread usage of digital technology. Policymakers, economists, and stakeholders are finding it increasingly important to conduct research on how the digital economy affects economic growth as countries and corporations incorporate digital advances into their operations. to investigate the relationship between economic growth and the digital economy, this section uses the Panel-ARDL (Autoregressive Distributed Lag) model as the main analytical framework to explore the complex relationship between the digital economy and economic growth in North Africa nations. The Panel-ARDL model offers a robust methodological approach to examine both short-term and long-term dynamics within panel data settings, making it particularly suited

for studying economic phenomena across multiple countries or regions over time. The estimated PAN-EL-ARDL model presented by Pesaran and Smith in 1995.

The original formulation of the ARDL model (p, q, q,, q) was as follows: (Pesaran & et al, 1997).

$$y_{it} = \sum_{j=1}^p \lambda_{ij} y_{i,t-j} + \sum_{j=0}^q \delta_{ij} x_{i,t-j} + \mu_i + \varepsilon_{it} \dots \dots \dots (1)$$

Where X_i (k X 1) and d_i (s X 1) are vectors of explanatory variables, the X_i varies over both time periods and groups, the d_i only over time periods. The value of T should be sufficiently large to allow for estimating the model for each group. However, it is not necessary for T to be the same for each group. For the sake of simplicity in notation, we will assume a common value for T. It is also straightforward to allow for different lag orders on the different variables in X_i . The coefficients of the lagged dependent variables, λ_{ij} , are scalars, and δ_{ij} and y_i are K X 1 and S X 1 vectors of unknown parameters.

It is convenient to work with the following re-parameterization (1) : (Blackburne & W. Frank, 2007)

$$\Delta y_{it} = \theta_i (y_{i,t-1} - \bar{\theta}_i X_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-1} + \sum_{j=1}^{q-1} \delta_{ij}^* \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \dots \dots \dots (2)$$

The parameter $\theta_i = -1 - \sum_{j=1}^p \lambda_{ij}$ is the error-correcting speed of adjustment term. It should be less than zero ($\theta < 0$); and if $\theta = 0$, then there would be no evidence for a long run relationship. This parameter is expected to be significantly negative under the prior assumption that the variables show a return to long run equilibrium. The vector $\bar{\theta}_i$ ' contains the long run relationship of the variables. (Shuaibu & Popoola Timothy, 2016)

3.1- Data

The following model is defined for the study in order to account for the impact of the digital economy on economic growth in the North African nations:

$$GDP_t = \beta_0 + \beta_1 INT_t + \beta_2 MCS_t + \beta_3 RTIC_t + \varepsilon_t \dots \dots (1)$$

Where β_0 is the intercept. β_1 , β_2 , β_3 respectively are the estimation coefficients to be estimated. It is the error term. Subscripts i and t denote country and year ($i = 1, 2, 3$; $t = 1, 2, \dots, 23$). The definitions of variables are presented in Table1.

Table .1: Definitions and data sources

Variable	symbol	Measurement	expected	Source
Economic growth	GDP	gross domestic product %	Dependent variable	UNCTAD
Digital Economy Infrastructure Indicators	MCS	Individuals using Mobile cellular subscriptions (% of population)	+	BW
Access to Information and Communication Technology Services Indicators	INTE	Individuals using the Internet (% of population)	+	BW
Technology Revenue	RICT	Revenue, communication services %	+	SESRI

Source: Authors'

3.2 Model Specification

The impact and relationship between the digital economy and economic growth were investigated using panel data for three North African countries over the 2000–2022 period: Algeria DZA, Morocco MOR, and Tunisia TUN. The data were gathered from the World Bank (2024), UNCTAD (2024), and SESRIC (2024), the Statistical, Economic and Social Research and Training Centre for Islamic Countries.

This article examines the effects of determinants of the digital economy on economic growth using a variety of pertinent approaches, including the IPS test for stationarity, the PMG and MG estimators for long-run estimates and short-run parameters, and the Hausman Test for comparing the various estimators.

4- Empirical Results and Discussion

4.1 Preliminary Analysis

4.1.1 Results of Unit Root Test

The IPS test was employed to examine the stationary and determine the degree of integration of the selected variables.

H0: Panel data has unit root

H1: Panel data has not unit root

Table. 2 Unit root test

At Level					
	VAR	GDP	RICT	MCS	INT
Trend	<i>prob.</i>	(0.000)	(0.004)	(0.000)	(0.076)
Demean	<i>prob.</i>	(0.000)	(0.000)	(0.000)	(0.145)
At first difference					
Trend	<i>prob.</i>	/	/	/	(0.004)
Demean	<i>prob.</i>	/	/	/	(0.000)
Order of integration		I(0)	I(0)	I(0)	I(1)

Source: Authors' calculations

All variables are stationary at level, with the exception of INT at first difference, according to the testing results displayed in Table 3.

4.1.2 Homogeneity test

The group mean estimator (MG) from 1995 and the combined group mean estimator (PMG) from 1999 which does not require individual homogeneity of the PANEL ARDL dynamic model determined in order to explain the nature of the relationship between the determinants of the digital economy and economic growth in North African nations. Alternatively, homogeneity may be required by the dynamic fixed effects model (DFE) and the combined group mean (PMG) estimation.

Table. 3 Homogeneity test

Homogeneity test
Test of parameter constancy
chi2(54) = 84.68
Prob> chi2 = 0.000

Source:
Authors'

calculations

We infer that the estimates of MG and PMG will be calculated since the probability value is 0.000, which is less than the 5% level of significance.

4.2 Estimation Results

4.2.1 PMG and MG estimators

In order to examine the relationship between the digital economy and economic growth in North African nations, we estimated the Mean Group (MG), introduced in 1995, and the Pooled Mean Group (PMG), approved in 1999. (Masih & Majid, 2013).

Table. 4 PMG and MG Estimators

PMG				MG			
Variables	Coef.	Std. Err.	Prob	Variables	Coef.	Std. Err.	Prob
Long run				Long run			
MCS	-.0642533	.0364049	0.078*	MCS	.0333176	.0245581	0.175
INT	-.0009779	.0003403	0.004***	INT	-.0014098	.0004813	0.003***
RICT	.3250278	.164203	0.048**	RICT	-.0023059	.0089549	0.797
Short run				Short run			
MCS	.0490363	.0018411	0.000***	MCS	-.008641	.0294051	0.769
INT	-.0069468	.0064663	0.283	INT	-.0046449	.0060373	0.442
RICT	-.0908584	.050273	0.071*	RICT	.114805	.0708731	0.105
_cons	.1315663	.0318833	0.000***	_cons	.1103578	.0310551	0.000***
EC	-1.160276	.0741545	0.000***	EC	-.9145349	.1340684	0.000***

*, **, *** The t-statistic's statistical value indicates whether the parameter is significant at the 10%, 5%, or 1%, respectively, levels.

Source: Authors' calculations

the error correction coefficients MG (-0.914) and PMG (-1.160) are both negative and statistically significant at 1%. The model presents a relationship of co-integration between the independent and dependent variables.

3.2.2 Hausman test

To perform the comparison, the 1978 Hausman test (Chu & Sek, 2014) will be employed. For this test, the alternative hypothesis and the null hypothesis have the following format:

H0: PMG is the appropriate model.

H1: The MG model is the appropriate model.

Table. 5: Hausman test

VAR	(b)	(B)	(b-B)	$\sqrt{\text{diag}(V_b - V_B)}$
	mg	pmg	Difference	S.E.
MCS	-.0642533	.0333176	-.0975709	.0391034
INT	-.0009779	-.0014098	.0004319	.
RICT	.3250278	-.0023059	.3273337	.2080801
$\chi^2(3) = (b-B)'[(V_b - V_B)^{-1}](b-B) =$			3.99	
Prob>chi2 =			0.2622	

Source: Authors' calculations

The probability (0.2622) is higher than 5% and 10% significance level. This means the PMG estimator is the appropriate model.

4.2.3 PMG estimator for each country (short run regression)

The PMG estimator default results are the long-run parameter estimates and the averaged short-run parameter estimates. Moreover, The PMG estimates are given by a two-equation model that consists of the short-run dynamic coefficients and the normalized cointegrating vector. (Edward & W, 2007)

Table. 6 PMG estimator for each country (short run regression)

ALGERIA	VAR	Coef.	Prob	Morocco	VAR	Coef.	Prob	Tunisia	VAR	Coef.	Prob
	EC	-1.047098	0.00***		EC	-1.050103	0.00***		EC	-.646403	0.00***
	MCS	-.0639866	0.03**		MCS	.0362546	0.67		MCS	.001809	0.91
	INT	-.0165228	0.02**		INT	-.0005859	0.82		INT	.0031739	0.29
	RICT	.1152774	0.26		RICT	-.0081862	0.17		RICT	.237324	0.005***
	_cons	.1491417	0.00***		_cons	.1329792	0.00***		_cons	.0489525	0.05

*, **, *** The t-statistic's statistical value indicates whether the parameter is significant at the 10%, 5%, or 1%, respectively, levels.

Source: Authors' calculations

4.3 Discussion

The study used panel data from 2000 to 2022 to examine the relationship between the digital economy and economic growth in the North African nations of Algeria, Morocco, and Tunisia. The following is a summary of the empirical findings of the study:

GDP is significantly impacted negatively by Access to Information and Communication Technology Services Indicators (INT) with 0.001 in North Africa nations. This is consistent with the short term for Algeria by 0.16. The exacerbation of the digital divide can be attributed to a number of factors, including the inverse relationship between Internet services and economic growth. An unfair distribution of Internet services among the population can widen the economic and social divide, which has a negative impact on economic growth. Furthermore, if the economy is largely dependent on Internet services,

then any unfavorable changes in this industry could have a detrimental impact on economic expansion. Businesses may cease working effectively if there is a disruption or decline in the efficiency of technology services, which would impede economic growth.

When estimating the equation in the long and short terms for all three North African nations (Algeria, Tunisia, and Morocco) between 2000 and 2022, the MCS variable, which expresses the digital economy infrastructure index, did not show its impact; however, in the short term, it had a negative impact on growth for Algeria. At a significance level of five percent, the economic value is 0.06. We haven't seen any evidence of its influence on Morocco or Tunisia. There are a number of reasons why the economic progress of North African nations has not been clearly impacted by digital infrastructure as gauged by mobile phones. These issues include economic and political factors: other economic or political obstacles, such as a lack of investment in the technology sector or limitations on Internet freedom, may make it difficult to fully utilize the digital infrastructure; social disparity: some people may find it more difficult to fully benefit from digital technologies due to the social and economic divide between social classes; quality of use: due to a lack of appropriate training or the societal shift toward digitalization, it could be difficult to turn the widespread usage of mobile phones into meaningful economic prospects; and the effect of the business environment: establishing a suitable business climate to encourage innovation and investment in the technology industry may prove difficult for certain nations.

When estimating the equation in the long and short terms for all North African nations (Algeria, Tunisia, and Morocco) between 2000 and 2022, the variable RICT, which expresses revenues from telecommunications services, did not show its impact; however, in the short term, for Tunisia, its positive impact on economic growth by 0.04 at a significance level of 5% was noted. We have not seen its effect with reference to Algeria and Morocco. Long-term effects of telecom service revenues on economic growth in North African nations are unclear for a number of reasons, including economic structure: although communication services improve company efficiency and facilitate communication, they may not play a major role in promoting economic growth in a nation whose economy is heavily based on other sectors, such as industry or agriculture. For instance, Morocco depends largely on the tourism industry, while Algeria is primarily dependent on the fuel industry. Additionally, outdated communications technology: if the infrastructure for communications is inadequate, citizens and businesses may not have adequate access to contemporary services, which could limit potential economic gains.

3- Conclusion

This study investigated at the relationship between economic growth and the digital economy in North African nations, such as Algeria, Morocco, and Tunisia, between 2000 and 2022. In this case, North African nations' economic development faces both tremendous potential and problems from the digital economy. A skills deficit in the workforce, insufficient legal frameworks, and a restricted digital infrastructure are major obstacles. These obstacles may impede the uptake and assimilation of digital technology, hence hindering the process of economic diversification and expansion.

Nevertheless, there may be significant advantages if these issues are resolved. Innovation and entrepreneurship can be stimulated by improved digital infrastructure, which can improve connectivity and access to international markets. Upskilling the workforce can guarantee that the populace can fully engage in the digital economy, while adequate rules can offer a stable environment for digital transactions and investments.

All things considered, even though North Africa's shift to a digital economy is not without challenges, conquering them can lead to notable economic development, heightened competitiveness, and improved integration into the global economy.

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