THE INTERACTION BETWEEN ECONOMIC DIGITALIZATION AND ECONOMIC GROWTH IN MENA REGION

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SUMMARY

This study analyses the influence of economic digitalization on economic growth in MENA region. We applied a system GMM estimator on a sample composed of 15 MENA countries from the period of 2012 to 2016. We used the Networked Readiness Index (NRI) to capture the economic digitalization. The results show that the digitalization is positively associated with economic growth. All the NRI sub-indexes variables seem to be positively significant; however, skills and education variables are not significant. This study recommends the MENA governments to invest more in ICT, especially in ICT human capital to enhance economic growth in the region, and use efficiently labor force when adopting the frontier technology.

KEY WORDS

Digital Economy, ICT, MENA region, Economic growth, Networked Readiness Index (NRI).

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التفاعل بين الاقتصاد الرقمي والنمو الاقتصادي في منطقة الشرق الأوسط وشمال أفريقيا

ملخص

تحلل هذه الدراسة تأثير الرقمنة الاقتصادية على النمو الاقتصادي في منطقة الشرق الأوسط وشمال إفريقيا. طبقنا أداة تقدير GMM للنظام على عينة مكونة من 15 دولة في منطقة الشرق الأوسط وشمال إفريقيا من الفترة 2012 إلى 2016. استخدمنا مؤشر الجاهزية الشبكية (NRI) لالتقاط الرقمنة الاقتصادية. تظهر النتائج أن الرقمنة مرتبطة بشكل إيجابي بالنمو الاقتصادي. يبدو أن جميع متغيرات الفهارس الفرعية لمؤشرات NRI ذات أهمية إيجابية: ومع ذلك، فإن متغيرات المهارات والتعليم ليست مهمة. توصي هذه الدراسة حكومات منطقة الشرق الأوسط وشمال إفريقيا بالاستثمار بشكل أكبر في تكنولوجيا المعلومات والاتصالات وخاصة في رأس المال البشري لتكنولوجيا المعلومات والاتصالات لتعزيز النمو الاقتصادي في المنطقة ، واستخدام القوى العاملة بكفاءة عند اعتماد التكنولوجيا الرائدة.

كلمات المفتاحية

الاقتصاد الرقمي ، تكنولوجيا المعلومات والاتصالات ، منطقة الشرق الأوسط وشمال إفريقيا ، النمو الاقتصادي ، مؤشر الجاهزية الشبكية (NRI).

L'INTERACTION ENTRE L'ECONOMIE DIGITALE ET LA CROISSANCE ECONOMIQUE DANS LA REGION MENA

RÉSUMÉ

Cette étude analyse l'influence de la digitalisation économique sur la croissance économique dans la région MENA. Nous avons appliqué un estimateur GMM système sur un échantillon composé de 15 pays de la région MENA sur la période allant de 2012 à 2016. Nous avons utilisé l'indice de préparation au réseau (NRI) pour capturer la numérisation économique. Les résultats montrent que la digitalisation est positivement associée à la croissance économique. Toutes les variables des sous-indices NRI semblent être positivement significatives: cependant, les variables relatives aux compétences et à l'éducation ne sont pas significatives. Cette étude recommande aux gouvernements de la région MENA d'investir davantage dans les TIC, en particulier dans le capital humain spécialisé dans les technologies, afin d'améliorer la croissance économique, et d'utiliser efficacement la main-d'œuvre lors de l'adoption de la technologie de pointe.

MOTS CLÉS

Economie digital, TIC, Région MENA, l'indice de préparation au réseau (NRI)

INTRODUCTION

Technology has become an essential part of our daily lives. Economies around the world are becoming aware of the importance of integrating technology into development processes. Governments tend

to implement digital economy strategies for a greater diffusion of ICT in the different economic sectors (retail, transportation, education, health, energy, banking...) to be thus be in phase with the fourth industrial revolution. The COVID 19 pandemic that has disrupted the global economy since 2020 has consolidated the idea of the urgency of adopting an effective digital economy strategy in order to be able to circumvent the new disruptions imposed by the new context. The size of the digital economy is estimated to be between 4.5% and 15.5% of global GDP (UNCTAD, 2019). As for the added value in the ICT sector, the United States and China alone account for 40% of the total world. It is also important to notice that the number of jobs in ICT sector increased from 34 million in 2010 to 39 million in 2015. In addition, the share of ICT sector in total employment also increased over the same period, from 1.8% to 2%, (UNCTAD, 2019). Therefore, digitalization of the economy is becoming a big issue for MENA countries. With the reduction in international demand, raw material exports (oil, gas, minerals, etc.) have also declined negatively affecting the region's economic growth. According to the World Bank (2021), the region experienced a 4.2% contraction in economic activity in 2020. Looking for other channels of value creation is therefore becoming inevitable. The share of digitalization in the Middle East's GDP is 4.1%, a very encouraging but low performance compared to the United States whose contribution is 8%, or that of the European Union, which is 6.2%, McKinsey (2016).The literature review reveals that, in comparison to developed and Asian countries, ICT research in the MENA regions is still in its early stages, requiring further investigation and discussion to produce a clear picture of the impact of ICT diffusion on economic growth in the region.

The objective of our study is to investigate the influence of economic digitalization factors on economic growth, in order to come out with an appropriate economic digitalization strategy corresponding to the specificities of the MENA region countries. Caselli F and Coleman II (2006) argue in their work that developed countries are more efficient in adopting technological change than developing

ones because of the difference in skilled labor. In industrialized nations, there is a surplus of skilled labor; the technological transition is then quicker and more effective. On the other hand, the labor force in developing countries remains less skilled, and its use in the adoption of frontier technology is inefficient.

This article will verify to what extent this theory is valid for the MENA region. We will first conduct an empirical study by applying a system GMM analysis on a sample composed of 15 MENA countries over the period from 2012 to 2016. To capture the effects of digitalization on economic growth, we use the Networked Readiness Index indicators published by the World Economic Forum. Then, we assess empirically the relationships between NRI Index sub-factors and economic growth in MENA countries. The empirical study is based on estimation with system GMM estimators. The structure of this paper is as follows: The first section discusses the theoretical background of our study. The data and the methodology used in this paper are given in section 2. Section 3 highlights our empirical results and their discussion.

1- LITERATURE REVIEW

Several studies attempted to analyze the interaction that could exist between economic growth and economic digitalization. Most studies show a positive influence between ICT and economic growth. Before exposing the literature review, it is important to define economic digitalization to avoid any ambiguity. According to Rouse M. (2016), "The digital economy is the worldwide network of economic activities enabled by information and communication technologies (ICT). It can also be defined more simply as an economy based on digital technologies". Digital economy is an economy which functions primarily by means of digital technology, and ICT, especially electronic transactions made using the internet, (OUP, 2017). The literature emphasizes that ICT has a critical role in supporting economic success in developed and developing countries. Simon Abedine S and al (2021)

examined the effect of international trade on economic growth in Africa, taking into consideration the role of the digital economy. Their study used annual panel data from 53 African countries from 2000–2018, the results show that international trade has significant adverse effects on Africa's economic growth but they also show that there is a significant positive effect on economic growth only when there is interaction with the digital economy. Gedz D and al (2019), used in their study descriptive and panel data analyses to answer the question: does digitalization increase economic growth? The study covered eight ASEAN middle-income countries from 1999 to 2014. The results demonstrate that the physical, the human capital and the ICT indicators highly impact economic growth in the region. Solomon E.M and al (2020) investigated the impact of the use of digital technology on economic growth for 39 African countries from 2012 to 2016. Using the Networked Readiness Index as a proxy of digitalization, their analysis relies on the system GMM estimator to determine the extent to which the use of digital technology influences growth. They show that only individual usage has a positive impact. Furthermore, a disaggregated analysis of the types of usage reveals the importance of ICTs for government vision and the significance of social media for growth . Habibi F and Zabardast A.M (2020) conducted a comparative study on the impact of digitalization on economic growth in 10 MENA countries, and 24 OCED countries. They applied a panel dataset from 2000 to 2017; the results confirm that in both categories of countries the impact is positive. The impact of internet users is small in the Middle East when compared to OECD countries, but the impact of mobile subscribers is bigger in the Middle East than in the OECD countries. Sassi S and Goaied M (2013) studied the effect of financial development, Information, and Communication Technology (ICT) on economic growth. They assess empirically these relationships in some MENA countries and confirm the positive interaction between the variables. They apply a dynamic panel model with system GMM estimators. The analysis consists on a yearly data of 17 MENA countries, from 1960 to 2009. The results show that ICT proxies have a favorable and large

direct effect on economic growth. In the growth regression, the association between ICT penetration and financial development seems to be positive and significant. This means that economies in the MENA region may only profit from financial development, if they have reached a certain level of ICT development. Using a panel, Generalized Method of Moment (GMM) growth model, Bahrini R and Qaffas A (2019) assess the impact of information and communication technology (ICT) on the economic growth of selected developing countries in the Middle East and North Africa (MENA) and Sub-Saharan Africa (SSA) regions from 2007 to 2016. According to their study, mobile phones, Internet usage, and broadband adoption are the key drivers of economic growth in MENA and SSA emerging nations. Acikgoz S and Ben Ali M.S (2019) focus on identifying factors that contribute to economic growth in 15 MENA nations from 1970 to 2014. The analysis of the co-integration panel reveals that capital accumulation contributes more to economic growth than productivity growth in six MENA nations. The results of the estimations also suggest that technological improvement is the primary and dominant source of growth for eight MENA countries.

2- DATA AND METHODOLOGY

2-1- Data and sources

We used the System Generalized Methods of Moment (SYSGMM) estimator to undertake an empirical investigation on a panel of 15 MENA countries from the period 2012 to 2016, the selected countries are : Algeria, Bahrain, Egypt, Iran, Israel, Jordan, Kuwait, Morocco, Qatar, Lebanon, Oman, Saudi Arabia, Turkey, Tunisia and UAE. In this study, the Networked Readiness Index (NRI) is a broad measure that captures the degree of digitalization in one country. The NRI assesses how well economies throughout the world use ICT to boost their competitiveness. It assists policymakers in tracking their economies strengths and weaknesses as well as their progress over time (Dutta.S

et al., 2012). The NRI provides an overview of top-ranked countries with the highest ICT expansion, (Kirkman.S and al, 2002). The NRI framework consists of four sub-indexes, it measures; the environment of ICTs, the Readiness of a society to use ICTs, the actual usage of ICTs and the Impacts of ICTs generate in the economy and society. We used in our study the three first indicators of NRI index as it is highlighted in table 1. First, the environment sub-index consists on indicators, which measure the degree to which the legal, political, and business environments enable ICT to thrive. The readiness sub-index measures the extent to countries which are 'ready' to use ICT technology by measuring the availability of physical and ICT infrastructure, quality of education, and affordability of ICT. Second, the usage sub-index measures the adoption of ICT by individuals, businesses, the government and includes the proportion of households with internet access, use of social networks, the capacity for innovation and the government online service index. Finally, the impact sub-index captures the economic and social effects of ICT, (Solomon E.M and al, 2020). Our proxies for economic digitalization are the three NRI sub indexes, which are our main variables of interest.

Table 1. Networked Readiness Index (NRI) indicators used in the research

Networked Readiness Index (NRI)			
Sub index	The Environment of ICT	The Readiness of a society to use ICT	The actual Usage of ICT
Pillars	Political & Regulatory Environment	Infrastructure	Individual Usage
	Business & Innovation Environment	Affordability	Business Usage
		Skills	Government Usage

Source: Author's compilation.

2-2- Model specification

This study aims to evaluate the impact of economic digitalization on economic growth of 14 MENA countries from 2012 to 2016.The limitation of the analysis to the year 2016 was determined by the fact that after 2016 the NRI index was not calculated by the WEF. We added three control variables: FDI, Education and Inflation. We estimate that these variables influence economic growth in the region. The dynamic panel data model is as follows:

$$\Delta\ In\ Growth_{it} = \beta_0 + \beta_1\ In\ Growth_{i\ t-1} + \beta_2\ In\ FDI_t + \beta_3\ In\ Education_t + \beta_4\ In\ Digitalization_t + \beta_5\ In\ Inflation_t + \delta_i + \varepsilon_{it} \qquad (1)$$

Where: i represents each country in the panel and t indicates the period. Δ In $Growth_{it,}$ refer to growth of Gross Domestic Product (GDP) per capita of country i over the period t. Following Barro (1998), we include lagged GDP per capita ($Growth_{i\ t-1}$) in order to capture the convergence effect. β_0 is a constant. β_2, β_3, β_5 are the coefficients of our control variables, $\beta 4$ is a coefficient which serves to evaluate the impact of digitalization variables on economic growth in MENA. Finally, δi terms represent unobserved specific terms for each country in the sample, and the error terms are denoted by ε_{it}. By adopting the GMM approach, we can eliminate all the issues associated with country-specific effects, serial correlation, and endogeneity. According to (Arellano and Bond 1991), GMM estimator can be applied in either a one-step or two-step process. In this research, we use a two-step GMM estimator rather than a one-step GMM estimator, this approach is commonly used in the previous literature. A system GMM allows the introduction of more instruments and can dramatically improve efficiency. (Roodman

D, 2009). The inclusion of the lagged dependent variable in the specification makes equation 1 a dynamic panel data model. In such models, the pooled ordinary least squares (POLS) and fixed effects (FE) estimators are biased and inconsistent arising from a correlation between the lagged dependent variable and the error term. The GMM estimator of Arellano and Bond (1991), otherwise known as the first differenced estimator, was proposed as one way of correcting the bias. Its implementation involves the first differencing of all variables and instrumenting the first differenced series using appropriate lags of each variable. However, in short dynamic panels that are persistent, the lags can be weak instruments for the first differenced series, thus, leading to bias (see Bond et al., 2001). To mitigate the weak instrument problem of the Arellano and Bond (1991) estimator, Arellano and Bover (1995) and Blundell and Bond (1998) developed the SYSGMM estimator. This estimator consists of the first differenced series augmented with the lagged levels of each variable plus the original (level) series instrumented with the lagged first differences of each variable.

To find out which of the NRI sub-indexes influences economic growth in MENA region, we introduce the NRI sub-factors in our first equation.

The model to estimate is then:

$$\Delta\, In\ Growth_{it} = \beta_0 + \beta_1\, In\ Growth_{i\,t-1} + \beta_2\, In\ FDI_t + \beta_3\, In\ Education_t + \beta_4\, In\ Inflation_t + \beta_5\, In\ Environment + \beta_6\, In\ Readiness + \beta_7\, In\ ICT\ usage + \delta_i + \varepsilon_{it} \qquad (2)$$

We have pushed the analysis further, trying to estimate the influence of the pillars of the sub-indicators on economic growth by using the System GMM. The three equations to estimate are:

ICT usage pillars:

$$\Delta \, In\ Growth_{it} = \beta_0 + \beta_1\ In\ Growth_{i\ t-1} + \beta_2\ In\ FDI_t + \beta_3\ In\ Education + \beta_4\ In\ Inflation_t + \beta_5\ In\ Individual\ usage + \beta_6\ In\ Business\ usage + \beta_7\ In\ Government\ usage + \delta_i + \varepsilon_{it} \quad (3)$$

Environment pillars:

$$\Delta \, In\ Growth_{it} = \beta_0 + \beta_1\ In\ Growth_{i\ t-1} + \beta_2\ In\ FDI_t + \beta_3\ In\ Education_t + \beta_4\ In\ Inflation_t + \beta_5\ In\ Political\ and\ regulation\ envi + \beta_6\ In\ Business\ and\ innovation\ envi + \delta_i + \varepsilon_{it} \quad (4)$$

Readiness pillars

$$\Delta \, In\ Growth_{it} = \beta_0 + \beta_1\ In\ Growth_{i\ t-1} + \beta_2\ In\ FDI_t + \beta_3\ In\ Education + \beta_4\ In\ Inflation_t + \beta_5\ In\ infrastructure + \beta_6\ In\ affordability + \beta_7\ In\ skills + \delta_i + \varepsilon_{it} \quad (5)$$

2-3- Preliminary analysis (Descriptive analysis)

In this study, we took our data from the World Development Indicators published by the World Bank. We extract the data relating to digitalization from the World Economic Forum database. The table 2 summarizes the variables used in our research.

Table 2. Variables Definition and Summary of Source of Data

Variables	Definition of variable	Source
Growth	Growth in GDP per capita	WBD

FDI	FDI inward flows in % of GDP	WBD
Education	School enrollment, tertiary (% gross)	WBD
Inflation	Consumer price Index %	WBD
Digital economy (NRI index)	Networking Readiness Index	WEF (2012-2016)
Environment	Sub-factor of NRI index	WEF (2012-2016)
Political and regulation envi	1th pillar of the NRI index	WEF(2012-2016)
Business and innovation envi	2nd pillar of the NRI index	WEF (2012-2016)
Readiness	Sub-factor of NRI index	WEF (2012-2016)
Affordability	3th pillar of the NRI index	WEF (2012-2016)
Infrastructure	4th pillar of the NRI index	WEF (2012-2016)
Skills	5th pillar of the NRI index	WEF (2012-2016)
Digital Technology usage	Sub-factor of NRI index	WEF (2012-2016)
Individual usage	6th pillar of the NRI index	WEF (2012-2016)
Business usage	7th pillar of the NRI index	WEF (2012-2016)
Government usage	8th pillar of the NRI index	WEF (2012-2016)

Table 3. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Log Growth	75	0.4700233	0.3057144	-0.674459	1.126983
Log FDI	75	0.225063	0.3851698	-0.679868	1.059032
Log Education	75	1.588372	0.2032217	1.038342	1.897517
Log Inflation	75	0.4681024	0.4429303	-1.185152	1.563517
Log NRI Index	75	0.6210845	0.0728243	0.4444781	0.7354638
Log Environnement	75	0.6080407	0.1150674	-0.164813	0.7255023
Log Business innov	75	0.5890241	0.0836081	0.3915625	0.7233936
Log Readiness	75	0.6808823	0.0459544	0.5666029	0.7626796
Log Infrastructure	75	0.6199932	0.1050737	0.3855937	0.7738966
Log Affordability	75	0.70547	0.0938791	0.4888068	0.8369324
Log Skills	75	0.693622	0.0652465	0.5208141	0.8028159
Log Poli regulation	75	0.6471824	0.0702066	0.4370484	0.7301712

Log Usage	75	0.6062011	0.0924473	0.3838899	0.7509135
Log Indiv usage	75	0.6171858	0.1175257	0.3430564	0.8006608
Log Buss usage	75	0.5623286	0.0839129	0.3324217	0.7636358
Log Gouv usage	75	0.6294949	0.1045918	0.3920495	0.7916442

Table 3 highlights the descriptive statistics. Log transformation has been made to stabilize the data. The descriptive analysis highlights the existence of heterogeneity in terms of economic performance. Some countries are managing to achieve appreciable economic growth, while others are still struggling to generate growth. Inward FDI flows are very marginal in some countries, such as Algeria and Tunisia, while flows seem to be moving towards the Gulf States, where countries are more attractive. For the NRI index, some countries such as UAE and Saudi Arabia are investing massively in technological development and, consequently, score well in terms of digitalization, while other countries such as those in North Africa are still lagging behind.

3- RESULTS AND DISCUSSION

3-1- Variables stationarity

To check the stationarity of our variables we used the Levin-Lin-Chu unit-root test (LLC-test). The results of the panel unit root tests reported in table 4 show that our main variables are conclusively and consistently stationary at level. Only the infrastructure variable is stationary at first difference.

Table 4. Variables stationarity

Variables	LLC	
	At level	At first difference
Economic Growth	-7.1907 (0.0000)***	-4.7042 (0.0000)***

FDI	-9.6675 (0.0000)***	-9.5874 (0.0000)***
Education	-1.0807 (0.0010)***	11.4566 (1.0000)
Inflation	-7.0060 (0.0000)***	-96.4906 (0.0000)***
NRI Index	-15.6082 (0.0000)***	4.8139 (1.000)
Environment	-15.8113 (0.0000)***	-4.0663 (0.0000)***
Business innovation	-21.1231 (0.0000)***	0.9471 (0.8282)
Political regulation	-10.5150 (0.0000)***	1.0051 (0.8426)
Readiness	-7.7775 (0.0000)***	3.2309 (0.9994)
Infrastructure	0.1061 (0.5423)	-43.4743 (0.0000)***
Affordability	-6.6712 (0.0000)***	10.0248 (1.000)
Skills	-14.2032 (0.0000)***	-11.1698 (0.0000)***
Usage	-7.9261 (0.0000)***	6.9597 (1.000)
Individual usage	-2.2836 (0.0112)***	14.6051 (1.000)
Business usage	-3.5681 (0.0002)***	22.0596 (1.000)
Government usage	-30.9601 (0.0002)***	1.3066 (0.9043)

Note: t statistics. () represents the P- value, ** and *** indicate rejection of the respective null hypothesis at the 5% and 1% significance levels, respectively.

3-2- Estimation results and discussion

The table 5 indicates the impact of digitalization on economic growth in MENA region. The results of the system GMM

estimator (SYSGMM), with the pooled OLS (POLS), fixed effects (FE) and Random effects (RE) models are presented for comparison.

As we can notice, focusing in traditional panel data analysis, Hausman test indicates that fixed effect is the model to valid. Three variables seem to be significant: FDI, Education and Digitalization. The later seems to be significant in all our models; the GMM model results show that lagged GDP per capita coefficient is positive and significant which indicates the existence of convergence relationship. At the same time, the previous GDP influence the current GDP. Education and digitalization are significant at 1% threshold. One percent increase of digitalization is predicted to increase GDP growth by about 0.13%. Education coefficient is negative and significant. That means there is a negative correlation between the two variables. This could be explained by the fact that, despite the increase in the level of education especially in the tertiary sector, the quality of education remains very poor; the majority of universities in the MENA region struggle to ensure quality education that meets the requirements of the ICT sector. This reality penalizes the development of sectors that require modernization and digital transformation through technology. The non-availability of qualified human capital due to the failure of universities has a severe impact on economic growth.

Table 5. Growth FDI Education Inflation and Digital economy, Dependent variable: Economic growth

	Model 1	Model 2	Model 3	Model 4
Variables	OLS	Fixed-effects	Random-effects	GMM
Δ InGrowth $_{t-1}$				1.1915** (0.4103)

In FDI	0.2108** (0.1017)	0.3947*** (0.1194)	0.1589 (0.1049)	0.1725 (0.0756)
In Education	-0.2530 (0.2523)	-1.7265*** (0.2523)	-0.2125 (0.2032)	-3.9895*** (0.9956)
In Digitalizat	0.7379** (0.7379)	5.2242*** (1.7098)	1.5365** (0.6017)	0.1379*** (1.1632)
In Inflation	-0.2305** (0.1161)	-0.1158 (0.1338)	-0.2511** (0.1881)	0.1138 (0.0923)
Constant	-0.2439 (0.6169)	-0.1878 (1.1772)	-0.2737 (0.1061)	-2.2383 (2.0777)
R-squared	0.39	0.41		
Hausman test p-value		0.032		
AR(1) p-value				0.0413**
AR(2) p-value				0.4464
Sargan test p-value				0.909

** and *** indicate the rejection of the respective null hypothesis at the 5% and 1% significance levels, respectively.

This result could also be explained by the *skill bias technological changes*. Any major technical development leads to changes in the production patterns of the economy by saving labor: this is what has been called "biased technical progress" to describe the fact that the demand for skilled labor increases sharply at the expense of unskilled people. Thus, new technologies have an important effect on the distribution of jobs in any given economy. In addition, technical progress increases the demand for skills workers through education and reduces the demand for workers who rely on physical effort. The demand for low-skilled workers decreases compared to the demand for more skilled workers. The skilled workforce is adapting more quickly with more complex technologies. Therefore, economic digitalization tends to make skilled work more valuable. Caselli F and

Coleman II (2006) explain in their study that, in the case of developing countries, unskilled labor is abundant, so we may expect firms to stick to the old technology, and avoid the loss in the efficient use of the abundant factor. Countries with a low factor endowment of skilled labor tend to lose efficiency when they adopt new technologies, because these countries will tend to use inefficient labor compared to developed countries, which have the advantage of having an abundant skilled labor force. In addition to this, if there are fewer workers with the right skills than less skilled workers, (which is the case for developing countries), resources may be diverted to current production at the expense of the introduction and implementation of new technologies with negative effects on productivity growth in the long run. This situation is explained by the fact that the skills offered in public institutions and the needs of the technology do not match. For MENA countries, this theory seems to be verified.

Table 6 indicates the interaction between the sub-indicators of NRI index and economic growth. The results highlight the significance of all our variables of our GMM model, at 1% level, except the inflation variable, which is not significant. The coefficients of the environment variable, Readiness variable, and ICT usage variable are highly significant and positively correlated with economic growth.

Table 6. NRI sub-indicators and economic growth GMM model

Variables	Coefficient	Std error	Prob
Constant	-1.973018	1.39062	0.156
Δ In Growth $_{t-1}$	1.266215	0.4131895	0.002***
In FDI	0.276359	0.064454	0.000***
In Education	-3.669492	1.277264	0.004***
In Inflation	-0.066254	0.1642781	0.687
In environment	0.3857149	0.1433833	0.007***

In Readiness	3.904232	1.354683	0.004***
In Usage of ICT	7.394381	2.020261	0.000***
AR (1)			0.020**
AR (2)			0.3982
Sargan test p value			0.7309

** and *** indicate the rejection of the respective null hypothesis at the 5% and 1% significance levels, respectively.

These findings converge with the previous literature confirming that the digital transformation must be done by ensuring an adequate environment for technological development, in other terms this implies a serious commitment on the part of the government to implement the necessary reforms for the flourishing of ICT. The use of ICT is also important for generating economic growth. The penetration and the usage of ICT is essential for economic growth, ensuring a country's competitiveness by connecting it to the global economy. Our results converge, therefore, with the findings of Hassan M.K. (2005).

Tables 7, 8 and 9 indicate the impact of the NRI pillars on economic growth in MENA region. Table 7 shows the influence of digital technology usage sub-indexes on economic growth. The GMM model results indicate that FDI is significant and positively correlated with economic growth. Of the three pillars, only business usage variable and government variable are significant at 1% threshold. The more ICT are used by SME, banks and all business sectors, the more economic growth rate will be increased. In addition to that, the usage of e-commerce in business operations has the potential to boost the economic development of both small and large businesses.

Table 7. Digital technology usage sub-indexes and economic growth

Variables	Coefficient	Std error	Prob
Constant	2.819482	1.434906	0.049**
Δ In Growth $_{t-1}$	0.1816722	0.3344837	0.587
In FDI	0.2768582	0.0951731	0.004***
In Education	-1.587336	1.004224	0.114
In Inflation	-0.0771747	0.1439244	0.592
In Individual usage	-0.2311885	1.116685	0.836
In Business usage	0.1010916	0.0097835	0.000***
In Government usage	0.0859645	0.0224055	0.000***
AR (1)			0.0762
AR (2)			0.3281
Sargan test p value			0.4484

** and *** indicate the rejection of the respective null hypothesis at the 5% and 1% significance levels, respectively.

The relationship between digitalization and the implementation of ICT by the government seems to be complex. This result converges with Albiman M.M and Sulong Z (2016) findings. The government's use of ICT facilitates the spread of innovation throughout public institutions. But in MENA countries, the individual usage variable seems to be not significant and does not influence economic growth in MENA region. Table 8 highlights the influence of environment sub-indexes on economic growth in MENA countries. The political and regulation environment variable is significant at 1% level, an increase of the variable of 1% will lead to an increase of economic growth by 11.06%. The correlation between the two variables is very high. Ensuring an adequate regulation with adequate laws and reforms is very important to guaranty a successful digital

transformation which leads to value creation. Business and innovation environment variable is significant at 10% level.

Table 8. Environment sub-indexes and Economic growth

Variables	Coefficient	Std error	Prob
Constant	2.590793	2.38401	0.277
Δ In Growth $_{t-1}$	0.6037915	0.2487973	0.015**
In FDI	0.1581336	0.0771667	0.040**
In Education	-3.137218	0.8193802	0.000***
In Inflation	-0.0113596	0.1404869	0.936
In political and regulation environment	11.06349	2.661128	0.000***
In Business and innovation environment	-6.470013	3.766203	0.086*
AR (1)			0.037**
AR (2)			0.2203
Sargan test p value			0.2748

** and *** indicate rejection of the respective null hypothesis at the 5% and 1% significance levels, respectively.

The table 9 indicates the impact of readiness pillars on economic growth in MENA region, the results show a positive and a significant correlation between digital infrastructure and economic growth, the level of significance is at 1%. Our results confirm the Katz R and Callorda F (2018) findings, according to their research; a 1% rise in fixed broadband adoption boosts GDP by 0.08 percent, while a 1% increase in mobile broadband adoption boosts GDP by 0.15 percent. As the region's adoption rate rises, this might lead to considerable increases in GDP. Affordability variable is also significant and positively correlated with economic growth at 5% threshold. However, the third pillar of readiness sub-index "skills" is not significant, this result

confirm that MENA countries should invest further in ICT human capital.

Table 9. Readiness sub-indexes and Economic growth

Variables	Coefficient	Std error	Prob
Constant	4.143686	2.033156	0.042**
Δ In Growth $_{t-1}$	0.3150925	0.098235	0.165
In FDI	0.1598128	1.176622	0.104
In Education	-1.482682	0.153537	0.208
In Inflation	-0.0604482	0.153537	0.694
In infrastructure	2.50122	0.8895451	0.005***
In affordability	0.9659562	0.47344	0.041**
In Skills	-5.441832	3.037941	0.073*
AR (1)			0.005***
AR (2)			0.2740
Sargan test p value			0.3133

** and *** indicate the rejection of the respective null hypothesis at the 5% and 1% significance levels, respectively.

A higher degree of education is required because of technical advances; the technological mutations require new qualifications through specialized education. Developing digital skills is necessary to succeed the digital transformation in MENA countries. This result is confirmed in the study of Grigorescu A and al (2021). In their research, they identified the relationship between the population's welfare of 11 Central and Eastern European Countries (CEECs), and the components of the digitalization, including the new human cloud industry, ICT, and the connectivity to the Internet. They used a multiple regression analysis and panel models with fixed effects analysis. The results confirm our findings that developed digital human capital and the digitalization of the economy will inevitably lead to the increase of the population's welfare.

3-3- Robustness check

We ran statistical tests to ensure that all of the estimates resulting from the use of the GMM growth model in this study were accurate. To check the robustness of our models we first check the presence of multi-collinearity problems, we use the variance inflation factor (VIF). We obtained a weak VIF values in all of our estimations, indicating that there is no high multi-collinearity among the explanatory factors (Inferior to 2.15). The second test is related to the p-values of AR (1) test and AR (2) test. The tests indicate the existence of autocorrelation in first differences of error term but no second-order correlation, showing the absence of serial correlation. The Sargan test indicates that the null hypothesis "the over identifying restrictions are valid in our GMM models" is rejected. The instruments are then correctly specific for all our estimations of all our models.

CONCLUSION

This paper aims to identify the impact of economic digitalization on economic growth in MENA region. We used system GMM on 14 MENA countries from the period of 2012 to 2016. We used the Networked Readiness index (NRI) indicators and pillars to measure economic digitalization. Our results confirm the existence of strong relationships between economic digitalization and economic growth in the region.

To implement a digital transformation, the government should emphasize on the environment parameters such as, the political regulations and ensure an environment conducive to innovation. Indeed, our results confirm the existence of positive and a significant correlation between the political and regulation

environment variable and the business and innovation environment variable. MENA countries should integrate digitalization in public institutions and encourage companies and different stakeholders to invest in digital technologies. Our results highlight that the business usage and government usage, tend to affect positively the economic growth. In addition to that, we strongly recommend MENA countries to develop their digital infrastructures. Finally, in the digitalization era, developing the competences, the quality of human capital and education is necessary in order to be in phase with the requirements of technological development. Our research confirms the non-significance of the skills variable, and the negative correlation of the education variable and economic growth.

We confirm the Caselli F and Coleman II (2006) approach. MENA region's skilled labor endowments are weak; this is why the transition to economic digitalization does not seems to be efficient yet. MENA countries should invest more in digital skills and education to improve its quality, and enhance economic growth.

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