The Impact of Internet on Economic Growth in North Africa: New Empirical and Policy Analysis

Sayef BAKARI
Faculty of Economic Sciences and Management of Tunis
University of Tunis El Manar, Tunisia
bakari.sayef@yahoo.fr

Sofien TIBA
Faculty of Economic Sciences and Management of Sfax
University of Sfax, Tunisia
sofienetiba@gmail.com

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Abstract:

The purpose of this paper is to treat the impact of the Internet on growth for a sample in the case 4 economies of the North Africa over the period 1995-2017 using various techniques such as the ARDL bounds testing approach, Panel ARDL Model, OLS Fixed Effect, OLS Random Effect, FMOLS, 2 SLS, RLS, GLM, and GMM. Indeed, for the time series results, the ARDL highlights reported the presence of a negative impact of the Internet on economic growth in Algeria, Egypt, Morocco, and Tunisia. Also, the main results of the Panel data models confirm the fact that the Internet exerts a significant negative impact on growth for North Africa as a whole. These economies are invited to orient the use of the Internet towards productive ways to reap the benefits of the spread of the Internet and proactively enhance the prosperity in this region as a whole.

Keywords: Internet use; economic growth; North Africa.

JEL Classification: O11; O14; O22; O30; O38; O40; O47; O55.

Introduction

The international organization, governments, and the United Nations have recognized the real change in the economic structure due to the potential of the Internet spread. Over the past two decades, due to the phenomenal spread of the Internet as a stylized fact, the emergence of the role of the Internet in the social dimension and also in the economic stream through its positive externalities in terms of enhancing productivity and technological diffusion (Elgin 2013, Sassi and Goaied 2013).

From this perspective, the spread of the use of Internet seen as a natural result of the information communication technologies (ICT) revolution with the beginning of the new millennium, which brings prosperity growth through stimulating demand, production, and reducing transaction costs of the economy (Roller and Waverman 2001, Pohjola 2002, Van Zon and Muysken 2005). Indeed, the modern endogenous growth theories pointed out the fact that the Internet enhances economic growth by accelerating the diffusion of innovation in the production processes (Lucas 1988, Romer 1986 and 1990, Aghion and Howitt 1998, Barro 1998). Besides, Nelson and Phelps (1966) and Benhabib and Spiegel (2005), among others, pointed out that the Internet boots the productivity of the economy via the diffusion and the creation of spillover, the know-how, expertise, and information dissemination which leads to facilitating the adoption of innovative technologies in the production processes, and then, economic growth promotes. In addition, the Internet accelerates the diffusion and decentralization of the data and information across the world.

Furthermore, the Internet facilitates the creation of a new business that strongly linked to the spread and share of information which leads to increasing the adoption of innovative techniques. Also, the Internet contributes to the increase of market transparency and then intensifies the competition. Indeed, the use of the Internet in the production process significantly improves productivity and then the economic growth due to IT-using firms (Stiroh 2002, Jorgensen *et al.* 2008). Recently, the results of the empirical investigations are seemed to be inconclusive, which they have failed to reach any consensus about the presence of positive or negative significant influence of the use of Internet and economic growth (Noh and Yoo 2008, Choi and Yi 2009, Elgin 2013, Najarzadeh *et al.*

2014, Ishida 2015). Hence, Choi and Yi (2009) examined the impact of Internet usage on economic growth for a sample of 207 economies over the period 1991-2000 using various econometrics methods such as pooled OLS, individual random effects, individual fixed effects, time fixed effects, individual random and time fixed model and finally panel GMM and by taking into consideration other macroeconomic aspect. Their insights recorded a significant positive influence of Internet usage in spurring economic growth. Additionally, Salahuddin and Gow (2016) examined the effect of Internet usage on economic growth using the ARDL bound testing for the case of the South African economy over the period 1991-2013. Their results point out a significant positive effect of the Internet on economic growth. Moreover, their results recommended more investing in the Internet infrastructure and expanding its networks and generalizing its usage. However, Ishida (2015) treated this issue for the case of Japan during the period 1980-2010.

The results recorded that ICT did not support the economic growth of Japan. Maurseth (2018) treated the nexus between the Internet and economic growth for a sample of 171 countries over the period 1990-2015 using several econometric techniques the pooled ordinary least squares (OLS), the individual random effects, the individual fixed effects, the time fixed effects, the individual random effects and time fixed effects, and the panel generalized method of moments (GMM). The findings recorded a significant negative impact of Internet usage on economic growth in contradiction with the results of Choi and Yi (2009). Recently, Haftu (2019) examine the relationship between ICT and economic growth using the two-step system GMM for a sample of 40 Sub-Saharan Africa countries from 2006 through 2015. The findings reveal the absence of a significant impact of ICT on economic growth.

To the best of our knowledge, there is no empirical investigation that treated the impact of Internet use on economic growth for the North Africa region. The motivation that hidden behind the current investigation is due to the number of the Internet user in this region which is range from 44.2% in Algeria to 67.7% in Tunisia in 2018, none of the previous studies investigated this controversial issue for this region. For this purpose, we attempt to treat the impact of the Internet on growth for a sample of four North African economies for the individual (*e.g.* Time series analysis) and global scale (*e.g*. Panel data analysis) using different econometric methodologies over the period 1995-2017.

The rest of this paper is structured as follows: Section 2 briefly reviews the literature. Section 3 portrays the data and methodology. Section 4 outlines the discussion of the results. Section 5 concludes the paper.

1. Literature Survey

A lot of works are conducted to investigate the relationship between ICT, Internet, and economic growth over the past two decades. For the case of 36 economies (14 developing and 22 developed ones) and over the period 1985–1993, Dewan and Kraemer (2000) have reached a significant positive influence of the ICT on the economic proxy for the developed economies. However, no significant impact detected in the case of developing ones. For a sample of 42 economies, Pohjola (2002) pointed out the absence of a significant impact of the ICT on economic growth over the period 1985-1999. In the case of the American industrial sector over the period from 184 to 1999, Stiroh (2002) pointed out a negative contribution of ICT to economic growth. Despite these findings and through the use of an updated data set, Stiroh (2005) has revealed a significant positive contribution of ICT to the production. For a sample of 22 developed and 20 developing economies over the period from 1993 to 2001, Papaioannou and Dimelis (2007) have recorded the influence of ICT on labor productivity where it is more clear and strong in developed economies than in developing ones.

Furthermore, Dimelis and Papaioannou (2010) argued that the influence of ICT and the use of the Internet are strongly reported in the emerging and developing economies than the developed ones. Paradoxically, Yousefi (2011) has recorded that ICT has no significant impact on economic growth for developing countries. For the Asian dragons and Latin America, Jorgenson and Vu (2005, 2010, 2011, 2016) have analyzed the impact of ICT on economic performance growth, where they concluded that the impact of ICT on economic growth has the same trend in developing and developed economies. In the micro-level, Commander *et al.* (2011) have reported a significant positive impact of ICT and the productivity of Brazilian and Indian firms. Following an analogous way, Paunov and Rollo (2016) have recorded a positive contribution of the use of the Internet to the firm productivity from 117 developing and emerging economies. In contradiction, Cirera *et al.* (2016) revealed a positive influence of ICT on innovation, but no conclusive findings concerning the relationship between innovation and productivity in six African economies.

In this context, Inklaar *et al.* (2005), Inklaar *et al.* (2008), Van Ark *et al.* (2008), O'Mahony and Timmer (2009), Strauss and Samkharadze (2011), and Timmer *et al.* (2011) proved the importance if the ICT and Internet to boost the labor productivity and then the economic performance in the developed economies. Several conducted studies especially for developed economies using quantitative and qualitative approach such as Indjikian and Siegel (2005), Draca *et al.* (2007), Van Reenen *et al.* (2010), Biagi (2013), and Cardona *et al.* (2013), showed a strong impact of the ICT and the use of Internet on the economic sphere. In the same pathway, Biagi (2013), Cardona *et al.* (2013), Draca *et al*. (2007), and Van Reenen *et al.* (2010), Bertschek *et al.* (2015), among others, pointed out the positive influence of ICT and the use of Internet on the economic sphere. Dedrick *et al*. (2013) have treated this question for the context of 45 developing and developed economies over the period from 1994 to 2007. Their findings revealed a positive influence of ICT on the economic growth for both developing and developed economies.

Salahuddin and Gow (2016) examined the impact of the Internet on economic growth by including financial development for the case of the South African economy during the period 1991-2013 by using the ARDL bounds testing methodology. The findings recorded a positive and significant long-run relationship between the use of Internet usage and economic growth in South Africa. Furthermore, the causality analysis records that the Internet causes economic growth. Niebel (2018) treated the issue of the nexus between ICT and economic performance for a sample of 59 economies over the period from 1995 to 2010. The highlights are in line with the majority of conducted studies in terms of the positive contribution of ICT to economic growth. However, the findings indicated that developing and emerging economies are 'leapfrogging' through ICT.

Recently, Vu (2019) employed the empirical model of Choi and Hoon Yi (2009) and Maurseth (2018) to examine the impact of the Internet on economic growth and to give explanations to the conflicting results. By the problems of the two used approaches through a modified model overcomes the endogeneity question and omitted variable bias. The results prove the presence of significant positive the effect of the Internet on economic growth. In the same way, by using the "Economic Complexity Index" as a proxy to measure economic growth, Lapatinas (2019) attempts to examine the impact of the use of the Internet on the economic sophistication for the case of 100 economies over the period from 2004 to 2015. The findings reveal that the use of the Internet has a significant positive impact on economic sophistication.

2. Methodology

2.1. Data

The data set used in this paper includes 4 countries of North Africa1 for the period 1995 to 2017. The selection of the sample size and the period of study reckon on the faith of data. All data are obtained and calculated from the World Bank database. We take the gross domestic product as a proxy to express economic growth and individuals using the Internet to express the usage of the Internet.

2.2. Model Construction

An empirical analysis of the time series and empirical analysis of the panel series are used to explain the impact of the usage of the Internet on economic growth and innovation. The long-run relationship between the usage of Internet and economic growth could be in view by the following model:

The time series model specification takes the following form:

$$\text{Log}(Y)_t = \delta_{1t} + \beta_1 \text{Log}(I)_t + \beta_2 \text{Log}(PI)_t + \varepsilon_{1t} \quad (1)$$

The Panel series model specification takes the following form:

$$\text{Log}(Y)_{it} = \delta_{1it} + \beta_{1i} \text{Log}(I)_{it} + \beta_{2i} \text{Log}(PI)_{it} + \varepsilon_{1it} \quad (2)$$

where: Log (Y) is the natural logarithm of gross domestic product (2010 constant US $), Log and Log(I) is natural logarithm of Individuals using the Internet (millions of inhabitants), δ is an intercept term, β_1 and β_2 are the long-run elasticity estimates, 'ε' is the term error, 'i' is the individual dimension of the panel (the country) and 't' is the temporal dimension.

2.3. Time Series and Panel Unit Root Tests

2.3.1. Time Series Unit Root

Before any empirical analysis in the time series framework, we should check the order of integration of the variables. For this reason, we employed the ADF and PP unit root tests. The null hypothesis for ADF and PP tests assumes that the series has a unit root. If the series is non-stationary at level, the first difference transformations of the series should be taken to make the series stationary. The basics model of the ADF and PP tests is specified as follows:

[1] Algeria, Egypt, Morocco, and Tunisia

$$\Delta y_{t-1} = \alpha_0 + \lambda y_{t-1} + \alpha_1 t + \sum_{i=2}^{p} \beta_j \Delta y_{t-1+1} + \omega_t \tag{3}$$

where: *y* reflects the dependent variable, *t* is the trend, α is the intercept, ϖ portrays a Gaussian white noise, *p* is the lag level.

2.3.2. Panel unit root

To determine the order of integration, it is fundamental to test the presence of a unit root test. In our current work, we performed the most commonly used unit root tests for panel data such as Levin *et al.* (2002), Im *et al.* (2003). The Levin *et al.* (2002) is structured around the ADF panel test assuming the homogeneity in the dynamics of the autoregressive coefficients for all panel units with cross-sectional independence. They considered the following equation:

$$\Delta X_{it} = \alpha_i + \beta_i X_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta X_{i,t-1} + \upsilon_{it} \tag{4}$$

where: Δ portrays the first difference operator, X_{it} is the dependent variable, υ is a white-noise disturbance with a variance of σ^2, i =1, 2,…, N indicates the country and t = 1, 2,…, T indicates the time span.

Levin *et al.* (2002) assumed:

$$\begin{cases} H_0 : \beta_i = 0 \\ H_1 : \beta_i \prec 0 \end{cases}; \tag{5}$$

where the alternative hypothesis indicates that x_{it} being stationary.

Levin *et al*. (2002) found that the panel approach substantially increases power in finite samples when compared with the single- equation ADF test. They also proposed a panel-based version that restricts $\hat{\beta}_i$ by keeping it identical across cross-countries.

Im *et al.* (2003 IPS) used the mean group approach. They had taken the average of the tβ1 statistics from Eq. (2) to establish the $\bar{Z}$ statistic as follow:

$$\bar{Z} = \frac{\sqrt{N}\left[\bar{t} - E(\bar{t})\right]}{\sqrt{V(\bar{t})}} \tag{6}$$

where: $\bar{t} = (\frac{1}{N})\sum_{i=1}^{N} t_{\beta_i}$, $E(\bar{t})$ and $V(\bar{t})$ are respectively the mean and variance of each tβ1 statistic, and they are generated by simulations. $\bar{Z}$ converges to a standard normal distribution. This test is also based on the averaging individual unit root test, denoted by:

$$\bar{t} = (\frac{1}{N})\sum_{i=1}^{N} t_{\beta_i}.$$

2.3.3. Panel Cointegration Tests

After the unit root tests verification, then it should be looking at the presence of a long-run relationship between the series. Given that, our framework is characterized by the use of the panel data then we employ the Kao panel cointegration test.

Indeed, the Kao's test employed the residual of Phillips and Perron (1988) and Dickey and Fuller (1979). The specification of this test is specified as follow:

$$\hat{\varepsilon}_{i,t} = \rho \hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{p} \varphi_j \Delta \hat{\varepsilon}_{i,t-j} + \mu_{i,t,p} \tag{7}$$

where: ρ is selected when $\mu_{I,t,p}$ is not correlated in the null assumption, supporting the fact that there is no cointegrating relationship.

Consequently, the ADF statistic test expressed as follow:

$$ADF = \frac{t_{ADF} + \frac{\sqrt{6N}\,\hat{\sigma}_{\mu}^{2}}{2\hat{\sigma}_{0\mu}}}{\sqrt{\frac{\hat{\sigma}_{0\mu}^{2}}{2\hat{\sigma}_{\mu}^{2}} + \frac{3\hat{\sigma}_{\mu}^{2}}{10\hat{\sigma}_{0\mu}^{2}}}} \underset{underH0}{\longrightarrow} N(0,1) \tag{8}$$

where: t_{ADF} is the t-statistic of ρ in Eq. above, and $\sigma_{0\mu}$ is resulting from the covariance matrix $\Omega = \begin{bmatrix} \sigma_{0\mu}^2 & \sigma_{0\mu\upsilon} \\ \sigma_{0\mu\upsilon} & \sigma_{0\mu}^2 \end{bmatrix}$ of the bi-varied process $(\mu_{i,t}, \upsilon_{i,t})'$.

2.3.4. ARDL Bounds Testing

Also, our initial model specification can be written in the ARDL Cointegration regression format of ARDL model as follows:

- For the Time series framework, the ARDL model is specified as follows:

$$\Delta \log Y_{(t)} = \mu_1 + \sum_{i=1}^{m} \beta_{1i} \log Y_{(t-i)} + \sum_{i=0}^{n} \beta_{2i} \log I_{(t-i)} + \sum_{i=0}^{k} \beta_{3i} \log PI_{(t-i)} + \delta_{11} \log I_{(t-i)} + \delta_{21} \log PI_{(t-i)} + \varepsilon_{1t}$$

$$\Delta \log I_{(t)} = \mu_2 + \sum_{i=0}^{n} \beta_{2i} \log I_{(t-i)} + \sum_{i=1}^{m} \beta_{1i} \log Y_{(t-i)} + \sum_{i=0}^{k} \beta_{3i} \log PI_{(t-i)} + \delta_{12} \log I_{(t-i)} + \delta_{22} \log PI_{(t-i)} + \varepsilon_{2t}$$

$$\Delta \log PI_{(t)} = \mu_3 + \sum_{i=0}^{k} \beta_{3i} \log PI_{(t-i)} + \sum_{i=1}^{m} \beta_{1i} \log Y_{(t-i)} + \sum_{i=0}^{n} \beta_{2i} \log I_{(t-i)} + \delta_{13} \log I_{(t-i)} + \delta_{23} \log PI_{(t-i)} + \varepsilon_{3t} \tag{9}$$

- For the Panel data framework, the ARDL is specified as follows:

$$\Delta \log Y_{(it)} = \mu_{1i} + \sum_{i=1}^{m} \beta_{1i} \log Y_{(it-i)} + \sum_{i=0}^{n} \beta_{2i} \log I_{(it-i)} + \sum_{i=0}^{k} \beta_{3i} \log PI_{(it-i)} + \delta_{1i} \log I_{(it-i)} + \delta_{2i} \log PI_{(it-i)} + \varepsilon_{1it}$$

$$\Delta \log I_{(it)} = \mu_{2i} + \sum_{i=0}^{n} \beta_{2i} \log I_{(t-i)} + \sum_{i=1}^{m} \beta_{1i} \log Y_{(t-i)} + \sum_{i=0}^{k} \beta_{3i} \log PI_{(t-i)} + \delta_{12} \log I_{(t-i)} + \delta_{22} \log PI_{(t-i)} + \varepsilon_{2it}$$

$$\Delta \log PI_{(it)} = \mu_3 + \sum_{i=0}^{k} \beta_{3i} \log PI_{i(t-i)} + \sum_{i=1}^{m} \beta_{1i} \log Y_{i(t-i)} + \sum_{i=0}^{n} \beta_{2i} \log I_{i(t-i)} + \delta_{13} \log I_{i(t-i)} + \delta_{23} \log PI_{i(t-i)} + \varepsilon_{3it} \tag{10}$$

where: μ reflects the intercept; *m*, *n*, and *k* represent the lags order; Δ is the difference operator; and ε_t portrays the error terms in the equation. The null hypothesis of no cointegration is as follows: H0: δ1 = δ2 = 0 against the alternative hypothesis H1: δ1≠ δ2≠ 0.

3. Empirical Analysis

Cross-country empirical investigation

The first step is to inspect whether the variables under consideration are stationary or not. The univariate analysis is effectuated to verify the stationary of the data.

The stationarity of the series was more inspected with two different unit root tests: Augmented Dickey-Fuller (ADF) test and the Phillips Perron (PP) test.

Table 1. Unit root test

Variables	ADF		PP	
	C	CT	C	CT
Algeria				
Log (Y)	(1.293207)	(0.897510)	(1.205734)	(1.125608)
	[3.845226]***	[3.970681]**	[3.936940]***	[4.021131]**
Log (I)	(3.550556)**	(1.521788)	(4.137904)***	(1.525095)
	[4.773210]***	[2.419783]	[3.814054]***	[5.867265]***
Egypt				
Log (Y)	(1.382575)	(3.066865)	(1.357112)	(1.560341)
	[3.133159]**	[3.452469]*	[2.199880]	[2.322009]
Log (I)	(3.845588)***	(0.858269)	(3.648804)**	(0.874229)
	[1.165353]	[2.134647]	[3.464700]**	[5.006087]***
Morocco				
Log (Y)	(2.260018)	(2.057615)	(1.054414)	(3.434053)*
	[11.48956]***	[1.049615]	[9.939555]***	[9.639378]
Log (I)	(6.542192)***	(2.957262)	(12.15522)***	(2.321767)
	[1.651698]	[0.989361]	[3.051359]**	[7.107040]***
Tunisia				
Log (Y)	(3.729592)**	(0.700369)	(3.696958)**	(0.720769)
	[3.277540]**	[4.377492]**	[3.277540]**	[4.377435]**
Log (I)	(3.958817)***	(1.886501)	(6.206270)***	(2.219423)
	[3.011322]*	[3.892749]**	[3.011322]*	[3.837368]**

Note: ***, ** and * denote significances at 1%, 5% and 10% levels, respectively; ( ) denotes stationarity in level; [ ] denotes stationarity in first difference; 'C' denotes Constant; 'CT' denotes Constant and Trend.

Table 2 portrays the results of these tests for variables at levels and first differences. The empirical exercise furnishes a dissimilar order of integration for the variables I(1) and I(0). This dissimilarity results in a rationale for applying the ARDL bounds testing approach to co-integration developed by Pesaran *et al*. (2001). The value of the F-statistics was collated with the upper or lower boundary reported by Pesaran *et al*. (2001). If the value of F-statistics is greater than the upper bound, we reject the null hypothesis and if it is less than lower bound then we accept the null hypothesis and if the value of F-statistic falls between lower and upper bound then the test will be inconclusive.

Table 2. Cointegration analysis

ARDL Bounds Test		
Algeria		
Test Statistic	Value	K
F-statistic	7.079746	1
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84
Egypt		
Test Statistic	Value	K
F-statistic	5.053132	1
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84
Morocco		
Test Statistic	Value	K
F-statistic	63.34219	1
Critical Value Bounds		

ARDL Bounds Test		
Significance	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84
Tunisia		
Test Statistic	Value	K
F-statistic	10.78717	1
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84

As the calculated value of the F-statistics is higher than the upper bound of this critical value, Table 2 reported that there is a long-run relationship between the variables included in the model in the 4 countries.

Table 3 presents the 4 equations of long-run equilibrium for each country. In the 4 equations, the use of the Internet has a negative effect on long-term economic growth. To verify the credibility of all these results, we must test the significance of these equations. If the coefficient of the error correction term is negative and has a probability of less than 5%. So in this case, we can say that the equation of the long-term equilibrium is significant and validated (means that there is a long term relationship between variables). Indeed, the negative impact of Internet usage in these countries is justified that the Internet in the economic sphere is channelized away from its economic benefits towards non-productive activities (*e.g.* social media, wasting time, online gaming).

Table 3. Estimation of ARDL models

Country	Long-term equilibrium relation in ARDL Models	ECT
Algeria	$\mathrm{LOG(Y)} = -0.0006 * \mathrm{LOG(I)} + 0.0426$	-0.916833***
Egypt	$\mathrm{LOG(Y)} = -0.0021 * \mathrm{LOG(I)} + 0.0768$	-0.712208***
Morocco	$\mathrm{LOG(Y)} = -0.0020 * \mathrm{LOG(I)} + 0.0409$	-1.537811***
Tunisia	$\mathrm{LOG(Y)} = -0.0199 * \mathrm{LOG(I)} + 0.3343$	-1.008544***

Note: *** denote significance at 1% level; ECT denote Error Correction Term

In all countries, Table 3 shows that the error correction term has a negative coefficient and a probability less than 5% in this case, we can say that the equilibrium cointegration equation is significant and that there is has a long-term relationship between the variables. So we can substantiate that in Algeria, Egypt, Morocco, and Tunisia the usage of the Internet has a negative effect on economic growth in the long run.

Finally, diagnostic tests (serial correlation, normality test, and heteroscedasticity test) are all derived under a sensitivity analysis to establish the authenticity of the data used for the variables involved in the four models. Therefore, Table 4 reported that the results of the diagnostic tests further validated the estimated models.

Table 4. Diagnostic tests

	Algeria	Egypt	Morocco	Tunisia
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.1148	0.6222	0.4214	0.9584
Heteroskedasticity Test: Harvey	0.1353	0.4598	0.7716	0.0537
Heteroskedasticity Test: Glejser	0.1202	0.5515	0.6305	0.8232
Heteroskedasticity Test: ARCH	0.5624	0.9193	0.9904	0.9610
Breusch-Godfrey Serial Correlation LM Test:	0.6292	0.5535	0.2989	0.2983
Test of Normality	0.767594	0.808343	0.758210	0.181391

Panel Empirical Analysis

Previous to the introduction of the empirical results, there is some pre-tests of data are considered very important and very essential to lend some prerequisites about the tie of the attacked variables.

Table 5 points out that all variables have a probability of refusal of less than 5%, which tick that they are all respected during the period of the study. Skewness and Kurtosis coefficients go through variables that keep a normal distribution.

Table 5. Panel descriptive statistics

	At level		At log level	
	Y	I	LOG(Y)	LOG(I)
Mean	1.10E+11	7374472.	25.22736	13.96902
Median	1.05E+11	3526006.	25.37246	15.07566
Maximum	2.72E+11	43850341	26.32800	17.59629
Minimum	2.22E+10	511.3037	23.82192	6.236964
Std. Dev.	6.48E+10	9666051.	0.669750	2.972256
Skewness	0.554426	1.663353	-0.355344	-1.065244
Kurtosis	2.414738	5.524051	2.033272	3.202174
Jarque-Bera	6.026329	66.84495	5.518618	17.55609
Probability	0.049136	0.000000	0.063336	0.000154
Sum	1.01E+13	6.78E+08	2320.917	1285.150
Sum Sq. Dev.	3.82E+23	8.50E+15	40.81948	803.9216
Observations	92	92	92	92

The correlation matrix is reported to check for multicollinearity among variables. Table 6 indicated positive and significant correlations exist between the Internet and economic growth.

Table 6. Panel Correlation test

Panel Correlation test at level			Panel Correlation test at log level		
	Y	I		LOG(Y)	LOG(I)
Y	1		LOG(Y)	1	
I	0.7065970417191986	1	LOG(I)	0.4938056884141956	1

It is substantial to define the order of integration prior to the estimation of the panel. We utilize several panel unit root tests including Levin, Lin, and Chu (2002), Im, Pesaran, and Shin (2003) and Fisher type tests using ADF and PP tests.

Table 7. Panel Unit Root Tests

Unit Root Test	Log (Y)		Log (I)	
	C	CT	C	CT
LLC	(4.40275)***	(1.16056)	(8.45672)***	(2.04117)**
	[8.09859]***	[0.63542]	[1.54874]*	[4.92064]
IPS	(1.47683)*	(0.98737)	(6.40278)***	(0.72019)
	[8.40225]***	[2.43244]***	[2.42346]***	[0.62262]
ADF	(14.4196)*	(5.40496)	(49.1323)***	(5.08343)
	[73.0055]***	[21.4723]***	[21.1473]***	[10.5543]
PP	(11.4936)	(6.05102)	(91.0938)***	(3.96407)
	[58.1606]***	[48.5296]***	[29.2883]***	[52.7812]***
Decision	I(1)		I(0)	

Note: ***, ** and * denote significances at 1%, 5% and 10% levels, respectively; ( ) denotes stationarity in level; [ ] denotes stationarity in first difference; 'C' denotes Constant; 'CT' denotes Constant and Trend;

According to the stationary results in Table 7, Log (y) is stationary at first difference and Log (I) is stationary at level. Since all variables are stationary, we can move to the next step, which consists of determinate the cointegration between variables includes in our model. The next step is to test for the existence of a long-run cointegration between economic growth and the usage of the Internet by using a panel cointegration test suggested by Kao (1999).

Table 8. Panel cointegration analysis

Kao Residual Cointegration Test		
	t-Statistic	Prob.
ADF	6.833671***	0.0000
Residual variance	0.000754	
HAC variance	0.000296	

Table 8 reported the results of the Kao (1990) panel cointegration test. The test results suggest a long-term relationship of cointegration between economic growth and the Internet. The results of the application of descriptive statistics, correlation tests and cointegration tests on the variables included in our investigation, allow us to apply empirical estimates on several models to confirm the robustness of our empirical results. Among these empirical models, we will use Panel ARDL Model, OLS Fixed Effect, OLS Random Effect, FMOLS, 2 SLS, RLS, GLM, and GMM.

Table 9. Panel estimation models

Estimated Models	Dependent Variable: Economic Growth			
	Long run Equation ARDL Model	Fixed Effect	Random Effect	FMOLS
Internet	-0.006485***	-0.002034**	-0.001560**	-0.002099**
Constant	0.125639***	0.068354***	0.061593***	
Estimated Models	2 SLS	RLS	GLM	GMM
Internet	-0.001560**	-0.001608**	-0.001560**	-0.001560**
Constant	0.061593***	0.062721***	0.061593***	0.061593***

Note: ***, ** and * denote significances at 1%, 5% and 10% levels, respectively; Autoregressive distributed Lags (ARDL); Panel Fully Modified Least Squares (FMOLS); Panel Two-Stage Least Squares (2SLS); Robust Least Squares (RLS); Panel Generalized Linear Model (GLM); Panel Generalized Method of Moments (GMM).

Table 9 shows eight distinct methods of estimating the impact of the usage of the Internet on economic growth in this paper. The estimates obtained from the panel models show all that the usage of the Internet has a negative effect on economic growth.

Concluding Remarks

Due to the increasing of the role of Internet in the economic sphere, we attempt to shed the lights on the impact of the Internet on economy in the case 4 economies of the North Africa over the period 1995-2017 using various techniques such as the ARDL bounds testing approach, Panel ARDL Model, OLS Fixed Effect, OLS Random Effect, FMOLS, 2 SLS, RLS, GLM, and GMM.

Concerning the individual scale analysis, the ARDL results pointed out that there is has a long-term relationship between the Internet and economic growth. Also, the highlights reported the presence of a negative impact of the Internet on economic growth in Algeria, Egypt, Morocco, and Tunisia. Concerning the global-scale analysis, the main results of the Panel ARDL Model, OLS Fixed Effect, OLS Random Effect, FMOLS, 2 SLS, RLS, GLM, and GMM methodologies, confirm the fact that the Internet exerts a significant negative impact on growth for the North Africa as a whole.

From this perspective, these economies are invited to orient the use of Internet towards productive ways to reap the benefits of the spread of Internet, in terms of the diffusion and the creation of spillover, the know-how, expertise, and information dissemination which leads to facilitating the adoption of innovative technologies in the production processes, and proactively enhance the prosperity in this region as a whole.

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